Supplemental Information

for

Vermont's Low Emission Vehicle and Zero Emission Vehicle Proposed Rules

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1 Background

This document includes technical support and supplemental information for the Agency of Natural Resources' Low Emission Vehicles and Zero Emission Vehicle proposed rules, which incorporate by reference California's Advanced Clean Cars II, Advanced Clean Trucks, the Low NOx Heavy-Duty (HD) Omnibus, and Phase 2 Greenhouse Gas emission standards for trucks and trailers. These rules were incorporated in Vermont's Initial Climate Action Plan as part of the strategy to reduce emissions from Vermont's transportation sector, and pursuant to the Vermont Global Warming Solutions Act, ANR is required to adopt these rules on or before December 1, 2022.

Supplemental information as referenced and required in the Economic Impact Statement, the Environmental Impact Statement, and Scientific Information Statement in the Standardized Rule Forms required by the Vermont Administrative Procedure Act is included herein.

2 Economic Impact Statement Supplemental Information

2.1 Summary of the rules

Emissions from mobile sources are the greatest contributor to emissions of greenhouse gases (GHG) and criteria pollutants[1] and greenhouse gases (GHG) in Vermont, accounting for approximately 40% of statewide GHG emissions and about 51%[2] of non-biogenic ozone precursor emissions (including nitrogen oxides (NOx) and volatile organic compounds). In this rulemaking, the Agency of Natural Resources (ANR) proposes to adopt or amend key regulations that reduce greenhouse gas and criteria pollutant emissions from passenger cars, light-duty trucks, and medium- and heavy-duty vehicles that are delivered for sale or placed in service in Vermont. This suite of rules includes the adoption of California's Advanced Clean Trucks Rule, the Low NOx Heavy-Duty Omnibus Rule, and the Phase 2 Greenhouse Gas Rule, and amendments to California's Advanced Clean Cars program which was originally adopted by Vermont in 2012[3] and incorporates previously adopted rules to control criteria pollutants and GHG emissions. The Advanced Clean Trucks Rule (ACT) requires the sale of at least 30% zero-emission trucks by 2030 (depending on vehicle classification). The Low NOx Heavy-Duty Vehicle Omnibus Rule (HD Omnibus) requires a 90% reduction in NOx emissions for model year (MY) 2027

[1] Criteria pollutants are those classified as such pursuant to the Clean Air Act: Oxides of nitrogen, Sulphur dioxide, Carbon monoxide, lead, ozone, and particulate matter.
[2] EPA - 2017 National Emissions Inventory: https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data#dataq
[3] Prior to 2012, Vermont adopted California vehicle emissions standards that were later combined into California's Advanced Clean Cars program.

engines. The Phase 2 Greenhouse Gas Rule (Phase 2 GHG) sets greenhouse gas emission standards for heavy duty trucks and truck trailers. Advanced Clean Cars II (ACCII) requires that all passenger car and light-duty truck vehicles delivered for sale by 2035 meet the definition of zero-emission vehicle and will further reduce smog-forming and GHG emissions from new internal combustion engine vehicles (ICEVs). For a more detailed summary of each rule and adopting authority, see the Regulation Summary Document.

2.2 Background and analysis

The proposed regulations will result in reduced GHG, NOx and PM2.5 emissions. Each of these pollutants presents a distinct set of challenges and risks to public health and the environment.

GHGs contribute to climate change causing increased risks to public health and safety, food and water resources, infrastructure, and ecosystems. Additional details on GHG emission impacts can be found in Environmental Impact Supplemental Information, below.

NOx are a group of highly reactive compounds that pose direct human health impacts, such as irritation of the respiratory tract, and the worsening or triggering of asthma.[4] These gases are also precursor pollutants that undergo complex chemical reactions in the atmosphere to form other air pollutants of concern, such as PM2.5 and ground-level ozone (also known as smog). Breathing air with elevated concentrations of ozone is especially harmful to children, the elderly, and people of all ages who have asthma and other respiratory impairments. Breathing ozone can trigger a variety of health issues ranging from coughing to chest pain, to reduced lung function or damage.[5] NOx also contributes to the formation of acid rain[6] and visibility impairment (haze)[7] in Vermont.

PM2.5 is emitted directly from vehicle exhaust and formed through secondary reactions with NOx and other pollutants in the atmosphere. PM2.5 can be inhaled deeply into the lungs and transferred into the bloodstream resulting in significant health problems, such as reduced lung function, worsened asthma, non-fatal heart attacks, and premature death in individuals with heart or lung disease.[8]

To complete a thorough and sophisticated analysis of the emissions and economic benefits and impacts of the suite of rules proposed, Vermont is collaborating with several other "Section 177 states" and the Northeast States for Coordinated Air Use Management (NESCAUM). This analysis uses models such as the MOtor Vehicle Emission Simulator (MOVES)[9], the CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA)[10], and other tools to aid in understanding the how implementation of these rules will benefit Vermonters, and what economic impacts may result.

[4] EPA – Basic Information about NO2 webpage: https://www.epa.gov/no2-pollution/basic-information-about-no2
[5] EPA – Health Effects of Ozone Pollution webpage: https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution
[6] EPA – Acid Rain webpage: https://www.epa.gov/acidrain
[7] EPA – Visibility and Regional Haze website: https://www.epa.gov/visibility
[8] EPA – Health and Environmental Effects of Particulate Matter (PM): https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm
[9] https://www.epa.gov/moves
[10] https://www.epa.gov/cobra

This Technical Support Document (TSD) also relies on the comprehensive analysis of costs and other impacts performed by the California Air Resources Board and is extrapolated here to apply to Vermont and the expected impacts from the adoption of this suite of rules locally.

2.3 Affected parties

2.3.1 Costs and benefits to individuals: ACCII

The proposed regulation will benefit Vermonters mainly from the reductions in NOx resulting in reduced ozone exposure and reduced PM exposure from the secondary formation of NOx and PM2.5, improving Vermont air quality and reducing adverse health impacts. The reduction of GHG emissions will also reduce the future social costs of carbon emissions, which is the monetized value of the damages to society caused by each additional increment of CO_2 emissions, as discussed below. Further, ANR is required to adopt these rules pursuant to the Global Warming Solutions Act, as they were incorporated into the Initial Climate Action Plan.

The proposed ACCII regulation will reduce NOx, PM2.5, and GHG emissions. Reductions in NOx and PM2.5 emissions result in health benefits for individual Vermonters, including reduced instances of premature deaths, hospitalizations for cardiovascular and respiratory illnesses, and emergency room visits.

Using U.S. EPA's COBRA screening model, NESCAUM assisted Vermont in calculating the estimated economic value of the health benefits associated with the adoption of the proposed rules. Utilizing the COBRA model is generally consistent with EPA practice for estimating avoided health impacts and monetized benefits. The COBRA model estimates impacts to particulate matter (PM) air pollution concentrations, which are translated into health outcomes. Table 1 shows the estimated total cost savings from avoided premature deaths, avoided hospitalizations for cardiovascular and respiratory illnesses, and avoided emergency room visits due to a reduction in criteria pollutant emissions resulting from the proposed ACCII regulation for the year 2040 in Vermont, relative to the baseline. Note that this analysis does not include costs avoided due to reductions in GHG emissions. See below for a discussion of Social Cost of Carbon benefits resulting from GHG reductions associated with ACCII.

Proposed Regulations	**Valuation**	**Year**	**Total Costs Avoided**
ACC II	$2018	2040	**$373,000-840,000**

Table 1: Annual COBRA-estimated economic values of Vermont adopting ACCII, in US dollars for the year 2040. Total costs avoided are due to criteria pollutant emission reductions.

Notes:

1. COBRA version 4.0.
2. Discount rate of 3%.

The proposed ACCII regulations account for GHG benefits in terms of carbon dioxide (CO2) emissions avoided. The social cost of carbon (SC-CO2) is an estimate of the monetized value of long-term impacts (economic, health and environmental) from climate change as a result of a single metric ton increase in

CO_2 emissions in a given year. [11] For a discussion of the impacts of climate change, please refer to the Environmental Impact Statement starting on page 17. Estimates of the Social Cost of Carbon are calculated in four steps using specialized computer models that: (1) Predict future emissions based on population, economic growth, and other factors, (2) Model future climate responses, such as temperature increase and sea level rise, (3) Assess the economic impact that these climate changes will have on agriculture, health, energy use, and other aspects of the economy, and (4) Convert future damages into their present-day value and add them up to determine total damages.[12]

This analysis utilizes the Vermont Climate Council recommended SC-CO2 values and discount rates, which is a method of placing a present value on costs or benefits that will occur at a future date, identified in the *Initial Vermont Climate Action Plan*.[13] Because the SC-CO2 is highly sensitive to the discount rates applied, the range of discount rates from 1% to 3% is used to illustrate the varying magnitude of possible economic outcomes, however, the Council determined it was reasonable to use the SC-CO2 value developed using the central discount rate of 2% for the Vermont Climate Action Plan. Table 2 shows the estimated avoided social costs based on the GHG emissions reductions benefits from the proposed ACC II regulation from 2026 through 2040.

Table 2: 2026-2040 Statewide Estimated Avoided Social Cost of CO2 from ACCII vehicle rules

Year	3% Average Discount Rate		2% Average Discount Rate		1% Average Discount Rate	
	Value (2020$/metric ton CO_2)	Cost Avoided	Value (2020$/metric ton CO_2)	Cost Avoided	Value (2020$/metric ton CO_2)	Cost Avoided
2025	56	$0	129	$0	418	$0
2026	57	$1,632,352	131	$3,751,545	421	$12,056,492
2027	59	$4,396,029	132	$9,835,183	423	$31,517,290
2028	60	$7,827,762	134	$17,482,002	426	$55,577,111
2029	61	$11,803,968	136	$26,317,043	428	$82,821,283
2030	62	$16,297,046	137	$36,011,215	430	$113,027,900
2031	63	$21,645,039	139	$47,756,514	433	$148,766,695
2032	64	$27,309,283	141	$60,165,764	435	$185,617,782
2033	65	$33,048,083	142	$72,197,350	437	$222,184,803
2034	66	$39,138,873	144	$85,393,905	440	$260,925,820
2035	67	$45,259,739	146	$98,625,699	442	$298,579,172
2036	69	$51,967,387	147	$110,713,130	444	$334,398,841

[11] The National Academy of Sciences defines the Social Cost of Carbon as "an estimate, in dollars, of the present discounted value of the future damage caused by a metric ton increase in carbon dioxide (CO2) emissions into the atmosphere in that year or, equivalently, the benefits of reducing CO2 emissions by the same amount in that year."
[12] Resources for the Future, Social Cost of Carbon 101. https://www.rff.org/documents/2153/SCC_Explainer.pdf
[13] Vermont Climate Council, *Initial Vermont Climate Action Plan*, December 2021. https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/2021-12/Initial%20Climate%20Action%20Plan%20-%20Final%20-%2012-1-21.pdf

2037	70	$57,183,745	149	$121,719,685	446	$364,342,144
2038	71	$61,730,493	151	$131,285,979	449	$390,380,163
2039	72	$65,632,506	152	$138,557,513	451	$411,114,726
2040	73	$68,937,818	154	$145,430,465	453	$427,792,213
TOTAL		**$513,810,122**		**$1,105,242,991**		**$3,339,102,434**

The proposed regulation imposes requirements on vehicle manufacturers to produce and deliver ZEVs for sale. Individuals are not required to purchase ZEVs under the proposed regulation. If an individual chooses to purchase electric vehicle an impact on the individual vehicle owners will be expected in the form of operation and ownership costs. These costs include the costs impacts of installing an electrical receptable for electric vehicles supply equipment (EVSE) for purchasers of ZEVs, fuel costs, difference in maintenance costs, registration costs, and insurance costs over a ten-year period. These costs are combined with the incremental vehicles prices to estimate the total cost of ownership (TCO) during the period of proposed regulation. Two analyses of the TCO for individual vehicle owners conducted by ANR in consultation with Atlas Public Policy concludes that operational savings will offset any incremental costs of the initial electric vehicle purchase. The first analysis in Table 3 compares the TCO to a Vermont single-family home over 10 years of a gasoline powered half-ton 4 -wheel drive light-duty truck to an electric half-ton 4-wheel-drive light-duty truck. The analysis shows a total incremental cost-savings of nearing $2,000 over the 10-year period.

Table 3: Total cost of ownership over 10 years for individual Ford F-150 Pick-up Lighting 4WD to a Ford F-150 Pick-up 4WD in a single-family home.

	Incremental Cost (2022$) for 2030 MY BEV (300-mile range) w/ home charger
Incremental Net present value (NPV) of vehicle price (loan principal)	$3,357
Incremental NPV of vehicle price financing (loan interest)	$556
Incremental cost of home level 2 charging circuit	$680
Incremental NPV of depreciated value after 10 years	$1,605
Incremental NPV of fuel costs	($6,343)
Incremental NPV of maintenance costs	($3,509)
Incremental NPV of insurance	$1,480
Incremental NPV of taxes & Fees	$255
Incremental TCO (10 years)	**($1,918)**

The second analysis in Table 4 compares the TCO to a Vermont single-family home over 10 years of a gasoline powered all-wheel drive SUV "crossover" to an electric all-wheel drive SUV crossover. The analysis shows a total incremental cost-savings of nearly $3,400 over the 10-year period.

Table 4: Total cost of ownership over 10 years for individual Kia EV6 AWD (long-range) electric passenger car to a Subaru Crosstrek AWD gasoline car in a single-family home.

	Incremental Cost (2022$) for 2030 MY BEV (300-mile range) w/ home charger
Incremental NPV of vehicle price (loan principal)	$2,096
Incremental NPV of vehicle price financing (loan interest)	$347
Incremental cost of home level 2 charging circuit + charging cable	$880
Incremental NPV of depreciated value after 10 years	($164)
Incremental NPV of fuel costs	($4,077)
Incremental NPV of maintenance costs	($3,509)
Incremental NPV of insurance	$925
Incremental NPV of taxes & Fees	$154
Incremental TCO (10 years)	**($3,347)**

The costs of maintenance and scheduled repairs for ZEVs and PHEVs are expected to be lower than that of an equivalent ICEV. The Argonne National Laboratory (ANL) has provided estimates of incremental maintenance costs that are below that of an ICEV based on vehicle technology type and miles driven.[14] For BEVs, the average cost of maintenance and planned repairs is approximately 40% lower than a conventional passenger car (PC), for example, due to fewer oil changes, oil filters, timing belts and other replacement parts (spark plugs and oxygen sensors, for example). The per-mile maintenance savings for this analysis was extracted from the ANL study for passenger vehicles of each drivetrain type and then adjusted using incremental vehicle costs to estimate the per mile savings for the other vehicle types.

Estimated incremental maintenance costs for each vehicle classification and powertrain type, in dollars per mile (values in parentheses are negative values, indicating savings relative to a comparable internal combustion engine vehicle) is shown in Table 5, below:

Table 5: Average dollars per-mile savings of maintenance costs across vehicle types over a ten-year period.

Vehicle Types	Average dollars per mile savings 2026 - 2035

[14] ANL 2021 Report: *https://publications.anl.gov/anlpubs/2021/05/167399.pdf*

BEV – Passenger Car	(0.040)
BEV – Light Duty Truck 1	(0.039)
BEV – Light Duty Truck 2	(0.053)
BEV – Medium duty vehicle	(0.091)
PHEV – Passenger Car	(0.007)
PHEV – Light Duty Truck 1	(0.009)
PHEV – Light Duty Truck 2	(0.007)
PHEV – Medium Duty Vehicle	(0.007)

While the cost of battery replacement may be incurred, it is important to note that the durability and warranty requirements of the proposed rule ensure that consumers will not have to bear the cost of a battery replacement in advance of the battery's useful life within the warranty period.

Increasing access to ZEVs and clean mobility in low-income and frontline communities is of utmost importance. The proposed ACC II regulations will reduce exposure to vehicle pollution in communities that are often disproportionately impacted by motor vehicle pollution, such as near-roadway communities, by reducing emissions from ICEVs and accelerating the transition to ZEVs. Further, the proposed ZEV assurance measures will ensure these emissions benefits are long lasting and support the development of a robust used ZEV market. In addition, the ZEV regulation incentivizes automakers to invest in community carshare programs, produce more affordable ZEVs, and ensure that more used ZEVs are available. While the proposed ACC II regulations will advance equity, a whole-of-government approach is needed to maximize access, ensure affordability, and direct benefits to low-income and frontline communities. Thus, other policies and programs beyond ACC II will be needed to ensure these communities benefit from and have direct access to ZEVs.

2.3.1.1 Funding Opportunities to Support the Transition

The above TCO scenarios will likely be further influenced, and additional cost savings realized, by the multiple programs that Vermont has supported, and continues to support, to encourage the transition cleaner transportation options. The Vermont legislature authorized statewide incentive programs for income-qualified Vermonters including 1) an incentive program for the purchase or lease of new plug-in electric vehicles, 2) a high-fuel-efficiency used-vehicle incentive program called MileageSmart, 3) Replace Your Ride, to encourage cleaner alternatives to high-polluting vehicles, and 4) an incentive program for the purchase of an electric bike. Since 2019, more than $16.7 million has been provided for the Vermont incentive program for new plug-in electric vehicle purchases or leases. Currently, new purchase incentives range from $1,500 to $4,000 depending on income level and whether the vehicle is an all-electric or plug-in hybrid model. Additionally, Vermonters purchasing plug-in electric vehicles may be eligible for a federal tax credit of up to $7,500 and/or offers from electric utilities.

Since 2019, more than $4 million has been provided for the MileageSmart program administered by Vermont's Community Action Agencies. MileageSmart provides point-of-sale financial assistance to income-eligible Vermonters to purchase used electric or fuel-efficient vehicles, including all-electric or plug-in hybrid models.

Replace Your Ride launched in September 2022 and offers up to $3,000 for income-eligible Vermonters who retire a high-polluting gas vehicle in favor of cleaner transportation options, such as an EV, bike, electric bike, electric motorcycle, shared mobility services like carsharing or vanpooling, or some combination of these. Vouchers can be used in combination with the other incentive programs.

The Electric Bike Incentive Program launched July 21, 2022, but closed shortly afterwards on September 16, 2022, when the $105,000 authorized in program funding was exhausted. Vermont residents aged 16 or older were eligible on a first-come, first-served basis for up to $400 towards the purchase of an electric bicycle, with higher incentives for households and individuals with lower incomes.

Since 2014, the State of Vermont has invested over $3.5 million in public EV charging stations in all 14 counties across the state including 41 direct current fast charging (DCFC) stations and 89 Level 2 charging stations. More recently, Governor Scott and the Legislature have allocated $10 million in funding to help reduce the cost of installing charging stations in multiunit residential properties, workplaces, and public attractions. This program is building on a $1 million pilot program to provide residents of multiunit residential properties access to home EV charging. The pilot program funds have been fully obligated and are expected to result in 84 new Level 2 charging ports at 37 different affordable multiunit residential properties across the state, providing access to home charging for over 6,000 Vermont households.

To support the buildout of fast charging that meets EV drivers need to re-charge more quickly when traveling longer distances, the State has set a goal to have a DCFC within 1 mile of every interstate exit, and within 25 miles of the next DCFC on the State highway network. In support of achieving this goal, Governor Scott and the Legislature have allocated $2 million in FY23; the State will also receive $21.2 million over the next 5 years from the Federal Highway Administration to build fast charging stations. This network of public DCFC chargers can provide 30-90 miles of range per 10 minutes of charging.

2.3.2 Costs and Benefits to Individuals: ACT/Low NOx HD Omnibus/Phase 2

The proposed ACT regulation will reduce GHG, NOx, and PM2.5 emissions, while the proposed HD Omnibus regulation will reduce NOx and secondary PM2.5 formation since NOx is a precursor to secondary PM2.5 formation. The proposed Phase 2 GHG regulations will require heavy duty trucks and trailers to reduce GHG emissions. Reductions in NOx and PM2.5 emissions result in health benefits for Vermonters, including reduced instances of premature deaths, hospitalizations for cardiovascular and respiratory illnesses, and emergency room visits.

Using U.S. EPA's COBRA screening model, NESCAUM assisted Vermont in calculating the estimated economic value of the health benefits associated with the adoption of the proposed rules. Utilizing the COBRA model is generally consistent with EPA practice for estimating avoided health impacts and monetized benefits. The COBRA model estimates impacts to PM air pollution concentrations, which are translated into health outcomes. Table 6 shows the estimated total cost savings from avoided premature deaths, avoided hospitalizations for cardiovascular and respiratory illnesses, and avoided emergency room visits due to the reductions in criteria pollutant emissions associated with the proposed ACT, HD Omnibus, and Phase 2 GHG regulations for the year 2040 in Vermont, relative to the baseline. Table 7 shows the estimated total avoided costs from avoided premature deaths, hospitalizations for cardiovascular and respiratory illnesses, and emergency room visits due to the reductions in criteria pollutant emissions associated with the proposed ACT, HD Omnibus, and Phase 2 GHG regulations for 2025 through 2050 in Vermont, relative to the baseline.

Table 6: Annual COBRA-estimated economic values of Vermont adopting ACT/HD Omnibus/Phase 2 Rules, in US dollars for the year 2040. Total costs avoided are due to criteria pollutant emission reductions.

Proposed Regulations	**Valuation**	**Year**	**Total Costs Avoided**
ACT/HD Omnibus/ Phase 2 Rules	$2018	2040	**$304,000-685,000**

Table 7: 2025-2050 Statewide estimated Cumulative Health Impacts from ACT, HD Omnibus, and Phase 2 GHG Rules, in US dollars. Total costs avoided are due to criteria pollutant emission reductions.

Proposed Regulations	**Valuation**	**Years**	**Total Cumulative Costs Avoided**
ACT/HD Omnibus/ Phase 2 Rules	$2018 (millions)	2025-2050	**$11-24M**

Notes on COBRA modeling:

1. COBRA version 4.0.
2. Emissions baseline year, Phase II Source-Receptor (S-R) Matrix and adjustment factors, and incidence and health effect functions for 2023.
3. Vermont population projection for 2025-2050 utilized the 2017 U.S. Census Bureau National Population Projections as a baseline, which was adjusted at the state and county levels using the COBRA population inventory database.
4. Valuation functions were projected for 2025-2050 using a linear model based on the COBRA valuation inventory database.
5. Discount rate of 3%.

The proposed ACT and Phase 2 GHG regulations account for GHG benefits in terms of carbon dioxide (CO2) emissions avoided. The social cost of carbon (SC-CO2) is an estimate of the monetized value of long-term impacts (economic, health and environmental) from climate change as a result of a single metric ton increase in CO2 emissions in a given year. [15] For a discussion of the impacts of climate change, see the Environmental Impact Analysis on page 17. Estimates of the Social Cost of Carbon are calculated in four steps using specialized computer models that: (1) Predict future emissions based on population, economic growth, and other factors, (2) Model future climate responses, such as temperature increase and sea level rise, (3) Assess the economic impact that these climate changes will have on agriculture, health, energy use, and other aspects of the economy, and (4) Convert future damages into their present-day value and add them up to determine total damages.[16]

[15] The National Academy of Sciences defines the Social Cost of Carbon as "an estimate, in dollars, of the present discounted value of the future damage caused by a metric ton increase in carbon dioxide (CO2) emissions into the atmosphere in that year or, equivalently, the benefits of reducing CO2 emissions by the same amount in that year."

[16] Resources for the Future, Social Cost of Carbon 101. https://www.rff.org/documents/2153/SCC_Explainer.pdf

This analysis utilizes the Vermont Climate Council recommended SC-CO2 values and discount rates, which is a method of placing a present value on costs or benefits that will occur at a future date, identified in the *Initial Vermont Climate Action Plan.*[17] Because the SC-CO2 is highly sensitive to the discount rates applied, the range of discount rates from 1% to 3% is used to illustrate the varying magnitude of possible economic outcomes, however, the Council determined it was reasonable to use the SC-CO2 value developed using the central discount rate of 2% for the Vermont Climate Action Plan. Table 8 shows the estimated avoided social costs based on the GHG emissions reductions benefits from the proposed ACT and Phase 2 GHG standard regulations from 2025 through 2050.

Table 8: 2025-2050 Statewide Estimated Avoided Social Cost of CO_2 from Medium- and Heavy-duty vehicle rules

Year	3% Average Discount Rate		2% Average Discount Rate		1% Average Discount Rate	
	Value (2020$/metric ton CO_2)	Cost Avoided	Value (2020$/metric ton CO_2)	Cost Avoided	Value (2020$/metric ton CO_2)	Cost Avoided
2025	56	$491,268	129	$1,131,670	418	$3,666,962
2026	57	$903,723	131	$2,076,977	421	$6,674,865
2027	59	$1,353,279	132	$3,027,676	423	$9,702,324
2028	60	$1,801,145	134	$4,022,558	426	$12,788,131
2029	61	$2,263,175	136	$5,045,768	428	$15,879,329
2030	62	$2,739,370	137	$6,053,124	430	$18,998,856
2031	63	$3,629,188	139	$8,007,256	433	$24,943,465
2032	64	$4,545,851	141	$10,015,078	435	$30,897,582
2033	65	$5,489,360	142	$11,992,141	437	$36,905,390
2034	66	$6,459,715	144	$14,093,923	440	$43,064,764
2035	67	$7,456,915	146	$16,249,396	442	$49,193,377
2036	69	$8,800,151	147	$18,748,147	444	$56,627,056
2037	70	$10,064,572	149	$21,423,160	446	$64,125,699
2038	71	$11,361,475	151	$24,163,137	449	$71,849,329
2039	72	$12,690,861	152	$26,791,818	451	$79,494,143
2040	73	$14,052,729	154	$29,645,483	453	$87,203,922
2041	74	$15,262,572	156	$32,175,151	456	$94,050,443
2042	75	$16,499,910	158	$34,759,811	459	$100,979,450
2043	77	$17,998,491	160	$37,399,461	461	$107,757,198
2044	78	$19,304,568	162	$40,094,103	464	$114,837,432
2045	79	$20,638,141	164	$42,843,737	467	$122,000,152
2046	80	$21,761,337	166	$45,154,773	469	$127,575,836

[17] Vermont Climate Council, *Initial Vermont Climate Action Plan*, December 2021. https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/2021-12/Initial%20Climate%20Action%20Plan%20-%20Final%20-%2012-1-21.pdf

2047	81	$22,906,081	167	$47,226,117	471	$133,194,617
2048	82	$24,072,374	169	$49,612,575	472	$138,562,931
2049	84	$25,564,555	170	$51,737,790	474	$144,257,133
2050	85	$26,784,720	172	$54,199,669	476	$149,994,433
TOTAL		**$304,895,525**		**$637,690,498**		**$1,845,224,820**

The ACT regulation imposes requirements on vehicle manufacturers to produce and sell ZEVs. However, individuals are not required to purchase zero emission trucks under the proposed ACT regulation. If an individual chooses to purchase electric trucks, they will incur costs associated with electric vehicle infrastructure in addition to the vehicle purchase cost. The proposed ACT regulation would reduce overall costs as lower operational and maintenance costs outweigh the higher upfront purchase price and infrastructure costs. The HD Omnibus regulation imposes requirements on vehicle manufacturers to produce and sell vehicles that may have higher upfront costs. These costs are expected to be passed on to Vermont vehicle fleets and individuals who purchase these vehicles, resulting in indirect impacts to those entities and individuals. The Phase 2 GHG regulation imposes requirements on medium- and heavy-duty engines, vehicles, and trailer manufacturers, which results in increased compliance costs that are also expected to be passed on to Vermont vehicle fleets and individuals who purchase these vehicles and trailers. While there are no direct costs to individuals as a result of these regulations, the positive and negative indirect impacts to small businesses, which may impact individuals that own fleets or a single medium or heavy-duty vehicle, are discussed below.

For the ACT rule, individuals may see health benefits due to ZEVs displacing ICE vehicles and providing statewide, regional, and local emission benefits. Individuals are also likely to benefit from cost savings as a result of reduced fuel consumption and fuel costs. Cost savings are also likely due to the enhanced warranty requirements of ACT and the HD Omnibus Rules. These warranty provisions should result in longer useful life of the subject vehicles, and broader coverage of warranty-repairs within the subject vehicle’s warranty period.

2.3.3 Costs and benefits to businesses, including small businesses: ACCII

Businesses that will be directly affected by the proposed regulation include light- and medium-duty vehicle manufacturers because they are entities directly regulated and required to comply. Auto manufacturing is currently not occurring in Vermont. ZEV-only manufacturers are likely to directly benefit from the regulation because they do not manufacture ICEV and will be able to over comply and sell surplus credits to other manufacturers.

Businesses that may be indirectly affected, and likely exist in Vermont, are suppliers of Tier 1 components supplied directly to auto manufacturers, electric vehicle service providers, electric utilities, electric charging and hydrogen infrastructure providers.

Suppliers of Tier 1 components would benefit from increased opportunities created by the need to develop, sell, and support technology to decrease emissions from ICEVs. Many of these companies are also changing their business models to include components for vehicle electrification, as demand for conventional vehicle components declines.

Fleet owners are not required to purchase ZEVs under the proposed rule; however, if a fleet owner chooses to add electric vehicles to their fleet, costs relating to EVSE, infrastructure, and other transitional costs will be incurred.

As mentioned above, Governor Scott and the Legislature have allocated $10 million in funding to help reduce the cost of installing charging stations at workplaces, public attractions, and multiunit residential properties. Additionally, to support the buildout of fast charging that meets EV drivers need to re-charge more quickly when traveling longer distances, the State has set a goal to have a DCFC within 1 mile of every interstate exit, and within 25 miles of the next DCFC on the State highway network. In support of achieving this goal, Governor Scott and the Legislature have allocated $2 million in FY23; the State will also receive $21.2 million over the next 5 years from the Federal Highway Administration to build fast charging stations. This network of public DCFC chargers can provide 30-90 miles of range per 10 minutes of charging.

The proposed regulation will increase the total amount of electric vehicle miles traveled in the state, and the charging of those electric vehicles will increase Vermont's overall electric load and Vermont's electric utilities[18] will likely be impacted by this shift. Electric infrastructure needed to charge BEVs and PHEVs represents a significant area of expected increased load for electric utility companies, as traditional areas of growth have slowed due to energy conservation and energy efficiency efforts. Understanding the grid impacts of the additional load expected from electrification of the transportation system is an important consideration. ISO New England, the independent regional grid operator, prepares an annual long-term forecast for electricity demand in each state, including demand for EV charging. The 10-year projections are published in its annual Capacity, Energy, Loads, and Transmission (CELT) Report, and are used in power system planning and reliability studies[19]. ISO New England's Regional System Plan, last updated in 2021, summarizes system needs for generation resources and transmission facilities[20]. Sufficient resources are expected through 2030 (the time horizon of the plan). The plan anticipates new resource development (namely on- and off-shore wind, solar, and battery resources) and identifies transmission system investments needed to improve reliability and reduce congestion. The report accounts for state policy initiatives and increasing electrification of heating and transportation loads.

VELCO, Vermont's transmission system operator, works with the Vermont System Planning Committee to forecast changes in electric load and model the ability of Vermont's grid to accommodate electric demand under various scenarios. The results are published in the Long-Range Transmission Plan (LRTP) updated every three years; the most recent LRTP was published on July 1, 2021 and looks out 20 years[21]. The plan concluded that Vermont's transmission system has sufficient capacity for expected demand through 2030, and that—by managing 75% of EV load to reduce charging during peak periods—significant transmission upgrades would not be needed. This is also true through 2040, even when considering a higher-than-expected rate of electrification of the transportation and heating sectors. Three distribution utilities already offer EV load management programs, and all utilities will be required

[18] Vermont's distribution utilities are fully regulated by the Vermont Public Utilities Commission, and infrastructure costs of electric distribution are fully recoverable in electric rates.
[19] https://www.iso-ne.com/system-planning/system-plans-studies/celt/
[20] https://www.iso-ne.com/system-planning/system-plans-studies/rsp
[21] https://www.velco.com/our-work/planning/long-range-plan

to offer rates for EV management by June 30, 2024 (per Act 55 of 2021). The Department of Public Service estimates that 31% of residential EV charging is currently managed and this percentage is consistently growing.

In addition, each electric distribution utility completes an Integrated Resource Plan to meet the need for electricity in a safe, reliable manner with the lowest possible economic and environmental costs. These plans are also updated every three years and account for recent and projected trends in electric loads and economic activity. Distribution utilities monitor equipment capabilities as load grows and anticipate which substations and circuits will require upgrades. Infrastructure investments do incur costs, but load growth moderates rate impacts by spreading expenses across additional electricity sales. Home EV charging is typically a flexible load that can be scheduled when the grid is less stressed and wholesale electricity costs are below average. Although early in development, some Vermont distribution utilities have begun testing vehicle-to-grid energy storage services that may further reduce ratepayer costs and improve system reliability.

The LRTP also found that many distribution substation transformers may not require upgrades to accommodate electrification load growth. Comprehensive analysis by the distribution utilities of all circuits to determine their load hosting capacity has not yet been conducted, but it is believed that many existing roadside power lines will be sufficient. The capacity and availability pole-top service transformers is a key consideration. Upgrades of these transformers may be necessary for some households that wish to connect electric vehicles, and global supply chain issues currently cause delays in obtaining them. However, protocols are in place and in development to address this issue.

In addition to the electric utilities that will supply additional electricity to power BEVs and PHEVs under the proposed regulation, ZEV infrastructure businesses will benefit as well. This includes companies that manufacturer, install, operate, and maintain EV charging stations and hydrogen dispensing equipment. Electric Vehicle Supply Equipment (EVSE) providers, and hydrogen station operators will all benefit from increased demand for their equipment with home and public fueling stations. The proposed regulation will increase the total amount of electric vehicle miles travelled in the state, which in turn will likely increase utilization of charging and hydrogen stations across the state and lead to increased revenue for these businesses, making the business model for their investment more stable and predictable. This allows investor capital and venture capital funds to be accessed for increased deployment rates of ZEV infrastructure. Increased use of public charging stations may also have benefits to retail businesses operating or close to charging stations. Many charging stations are located in areas with available shopping, food, or other services. Additionally, Vermont businesses that are contracted to install stations will benefit from the rapidly growing network.

The decreasing trend in demand for gasoline has the potential to result in the fewer gasoline stations, if sustained over time, unless they adapt and provide charging and repair services for ZEVs that enable them to continue offering other services to drivers, such as convenience foods, that tend to be their profit centers. Increased employment opportunities in fields related to electric vehicle charging infrastructure and training technicians to service ZEVs is expected.

Typical passenger car rental businesses could see increasing incremental purchase costs for vehicles over the course of the regulation as stringency increases. At the same time, rental firms would benefit from operational savings due to the reduction in repair and maintenance costs. There may also be an increased cost for electricity depending on whether the rental business or the driver ends up bearing the costs of vehicle charging, though reduced gasoline usage leads to net fuel savings in nearly all cases.

ZEVs inherently have far fewer propulsion-related parts especially mechanical moving parts as electric motors and power electronics dominate the electric drive propulsion system instead of mechanical internal combustion engines and automatic transmissions comprised of mechanical components like valves, springs, and gears. As a result, it is expected that individual ZEVs will likely need fewer propulsion-related repairs than ICEVs. While this will be a benefit to individual vehicle owners, the vehicle repair and maintenance service industry is estimated to see negative impacts, including dealerships that have service departments, as ZEVs become a greater portion of the fleet. This trend would suggest that the number of businesses providing the services may decrease along with the reduced demand. However, the service information provisions of the regulation are expected to increase participation of small independent repair shops in the transition to ZEV technologies because these repair shops will now be guaranteed access to repair information for ZEVs.

Vehicle dealerships wishing to be certified for sales and service of ZEVs may face costs imposed by their manufacturers for training and equipment but there is no requirement that every dealer be qualified to sell such vehicles, and this will end up being a business decision between dealers and manufacturers. As with any other transitional costs, these impacts may be particularly challenging for smaller or more rural dealerships. Dealers may also incur costs associated with installing electric vehicle charging infrastructure.

Although the proposed regulation could increase initial vehicle prices and incremental costs on small fleet owners in the early years of the regulation, the proposed regulation would provide operational savings to small businesses and small fleet owners. The proposed ZEV assurance measures would help owners of small fleets that choose to purchase ZEVs by eliminating or greatly limiting subsequent out-of-pocket costs for vehicle repairs during the time the vehicle is under warranty. In addition, the enhanced useful life and warranty reporting and battery warranty provisions would encourage manufacturers to produce more durable components, resulting in fewer failures and less downtime for the small fleet owner. Small businesses would also benefit from the operational and fuel savings discussed above in 2.3.1. In an example analysis conducted by ANR in consultation with Atlas Public Policy, a cost example (Table 9) for a small Vermont business that purchases a typical full-size light truck for business use is considered and the total cost of ownership analyzed over time. This result shows a TCO savings over 10 years of nearly $1,500.

Table 9: Total cost of ownership over 10 years for a small business comparing a Ford F-150 Pickup 4WD to a Ford F-150 Lighting 4WD.

	Incremental Cost (2022$) for 2030 MY BEV (300-mile range) w/ Level 2 charger
Incremental NPV of vehicle price (loan principal)	$10,319
Incremental NPV of vehicle price financing (loan interest)	$1,709

Incremental cost of level 2 charging circuit	$680
Incremental NPV of depreciated value after 10 years	$5,511
Incremental NPV of fuel costs	($16,126)
Incremental NPV of maintenance costs	($8,920)
Incremental NPV of insurance	$4,551
Incremental NPV of taxes & Fees	$811
Incremental TCO (10 years)	**($1,464)**

2.3.4 Costs and benefits to businesses, including small businesses: ACT/Low NOx HD Omnibus/Phase 2 GHG

2.3.4.1 Advanced Clean Trucks

Manufacturers sell trucks to trucking fleets who operate the vehicles and incur costs following the point of sale including taxes, fueling, maintenance, midlife costs, and registration fees. Fleet owners are not required to purchase zero emission trucks under the ACT regulation; however, if a fleet owner chooses to add electric trucks to their fleet, costs relating to EVSE, infrastructure, maintenance bay upgrades, workforce training, and other transitional costs will be incurred.

The proposed ACT Regulation is likely to increase the supply of ZEVs and will provide additional vehicle options for fleets to consider in meeting their needs. Individual businesses that have operations that are well suited for using ZEVs will likely be able to lower their total cost of ownership by taking advantage of the operational cost savings of battery-electric vehicles. In some situations, reduced costs to the overall state's trucking fleet are forecast as the operational cost savings of the ZEVs likely outweigh the potential infrastructure and vehicle prices, which will especially be the case with available purchase incentives. Amortizing the vehicle and infrastructure investments will help with these companies' cash-flow to realize a cost savings over the life of vehicle ownership.

ANR, in consultation with Atlas Public Policy, conducted analyses of two fleet examples using data collected from one municipal fleet and one commercial fleet. The municipal fleet serves an average sized town in central Vermont, and the commercial fleet is a medium-sized landscaping business in northwest Vermont. These analyses utilize data, information, and assumptions provided by the fleet operators and are local to Vermont, where possible. Table 10, below, shows the total incremental cost of ownership over 10 years for the municipal fleet, which consists of six Class-8 plow/dump trucks and one class-3 pick-up truck, comparing MY2030 EVs to ICEVs. Table 11 shows the total incremental cost of ownership over 10 years for a small business fleet consisting of eight Class-7 trucks, five Class-2b pick-up trucks, and two Class-2a pickup trucks, comparing MY2030 EVs to ICEVs. As demonstrated in both analyses, the upfront capital expenses are significantly higher for the BEV fleet. Access to capital or financing will be critical for fleets to take advantage of the overall savings of BEVs. Tables 10 and 11 also show the impact that state and federal incentive programs for medium- and heavy-duty vehicles will have on EV fleet purchases, especially in situations where an entity owns and operates a majority of heavier vehicles. The incentives incorporated into the cost analyses in Tables 10 and 11take into account the tax-credit available to cover incremental vehicle costs up to $40,000 and other likely purchase and EVSE incentives that will be available via the federal Inflation Reduction Act to offset incremental costs. For the 10-year ownership period, the municipal fleet will realize a cost savings of over $7,000 and the small-business fleet will realize a cost savings of over $75,000, with purchase incentives.

Table 10: Incremental cost of Vermont municipal fleet example, comparing EVs to ICEVs with purchase and EVSE incentive funding opportunities from the IRA

	Incremental Cost (2022$) for 2030 fleet w/ 3 DCFC depot chargers			
	Six Class-8 Truck	One Class-3 Pickup	**Fleet total**	**Fleet total w/ purchase incentives**
Incremental NPV of vehicle price (loan principal)	$74,486	$8,924	$83,410	$8,924
Incremental NPV of vehicle price financing (loan interest)	$12,338	$1,478	$13,816	$1,478
Incremental cost of depot DCFC or L2 charging infrastructure	$71,400	$880	$72,280	$36,140
Incremental NPV of depreciated value after 10 years	($6,818)	($817)	($7,635)	($7,635)
Incremental NPV of fuel costs	($36,394)	($1,555)	($37,948)	($37,948)
Incremental NPV of maintenance costs	($2,997)	($5,702)	($8,699)	($8,699)
Incremental NPV of insurance	$0	$0	$0	$0
Incremental NPV of taxes & Fees	$0	$713	$713	$713
Incremental TCO (10 years)	**$112,015**	**$3,922**	**$115,937**	**($7,027)**

Table 11: Incremental cost of Vermont small business fleet, comparing EVs to ICEVs with purchase and EVSE incentive funding opportunities from the IRA.

	Incremental Cost (2022$) for 2030 fleet w/ 4 DCFC and 4 L2 depot chargers

	Eight Class-7 Truck	Five Class 2b Pickup	Two Class 2a Pickup	**Fleet total**	**Fleet total w/ incentives**
Incremental NPV of vehicle price (loan principal)	$96,196	$34,707	$20,639	$151,541	$55,345
Incremental NPV of vehicle price financing (loan interest)	$15,934	$5,749	$3,419	$25,102	$9,186
Incremental cost of depot DCFC or L2 charging infrastructure	$95,200	$2,640	$680	$98,520	$49,260
Incremental NPV of depreciated value after 10 years	($8,806)	($3,177)	$10,376	($1,606)	($1,606)
Incremental NPV of fuel costs	($169,403)	($75,661)	($30,260)	($275,324)	($275,324)
Incremental NPV of maintenance costs	($42,496)	($61,402)	($16,652)	($120,550)	($120,550)
Incremental NPV of insurance	$0	$0	$9,102	$9,102	$9,102
Incremental NPV of taxes & Fees	$30,192	$6,137	$1,622	$37,951	$37,951
Incremental TCO (10 years)	**$16,817**	**($91,008)**	**($1,074)**	**($75,265)**	**($236,654)**

The proposed ACT Regulation will increase the number of ZEVs deployed, which will in turn increase electricity usage. Electricity usage by ZEVs provides an opportunity for a number of benefits to the utilities, their customers, and the overall grid itself. Electric vehicles are capable of shifting load to off-peak periods, stabilizing voltage frequency, and potentially reducing the use of temporary frequency regulation through emergency generators, while also increasing overall demand, creating a more efficient, highly utilized grid with storage potential. Studies have found that light-duty ZEVs provide a benefit to all utility customers as their electricity utilization drives down rates for all other ratepayers; this is likely to occur in the case of heavy-duty charging as well[22].

There is no expected direct cost on small businesses, defined as businesses having 3 or fewer medium- and heavy-duty vehicles, under the ACT Regulation. No manufacturers or fleets who are regulated under this rule are considered to be small businesses. Small businesses who operate trucks will not be required to purchase zero-emission trucks but may independently decide to do so. This may enable cost savings for small businesses due to electric trucks' lower cost of operation.

[22] M.J. Bradley and Associates, MJB&A Analyzes State-Wide Costs and Benefits of Plug-in Vehicles in Five Northeast and Mid-Atlantic States, 2017. (https://www.mjbradley.com/reports/mjba-analyzes-state-wide-costs-and-benefits-plug-vehicles-five-northeast-and-mid-atlantic).

Vehicle dealerships wishing to be certified for sales and service of zero emission vehicles may face costs imposed by their manufacturers for training and equipment but there is no requirement that every dealer be qualified to sell such vehicles, and this will end up being a business decision between dealers and manufacturers. As opposed to the ACCII, the point of compliance for automakers in ACT occurs once the vehicle is “placed in service” meaning that it has been sold and registered in Vermont and operating on Vermont roadways. This difference is significant for dealers, as it will likely result in the automakers offering critical resources, infrastructure and support to dealers of medium- and heavy-duty vehicles to ensure that EVs delivered are sold and place in service.

2.3.4.1.1 Funding Opportunities to Support the Transition

Vermont has supported, and continues to support, programs that reduce public exposure to harmful diesel emissions, which in turn encourages the transition cleaner transportation options. Under ANR’s Diesel Emissions Reduction Program, technical assistance in addition to funding from the Volkswagen Environmental Mitigation Trust (VW Trust) and the U.S. EPA Diesel Emissions Reduction Act (DERA) program are provided to fleet owners for projects that reduce diesel emissions including fleet electrification. ANR has allocated approximately $15 million of Vermont’s VW Trust funds for the replacement or repowering of diesel trucks and buses with all electric models. Currently, VW Trust funds have been awarded to fleets for the electric replacement of a rack truck, school buses, refuse haulers, and bucket trucks. ANR will continue to solicit future project applications periodically for projects that achieve significant emissions reductions until all remaining funds have been obligated.

The U.S. EPA’s Clean School Bus Program was announced earlier this year. Funded by the Bipartisan Infrastructure Law, the Clean School Bus Program will provide $5 billion over the next five years to replace existing school buses with zero-emission and low-emission models. The first funding opportunity closed this summer, and a second opportunity is expected to be announced by the end of 2022.

Although these vehicle replacement funding opportunities may be used by some businesses and municipalities to help purchase heavy-duty EVs, these specific diesel emission reduction funding opportunities are not solely medium- and heavy-duty EV purchase incentives. ANR recognizes additional resources are needed for future medium- and heavy-duty EV purchase incentives.

The Inflation Reduction Act (IRA) includes a number of provisions that are meant to accelerate the adoption of technologies to transition away from the use of fossil fuels and mitigate and build resiliency to climate change[23]. The IRA updates, reauthorizes and creates a number of vehicle tax credits, including those that apply to medium- and heavy-duty vehicles. The IRA also creates a number of funds to be administered by federal agencies that allocate resources directly to state agencies to plan for and implement programs to reduce GHG emissions. The vehicle tax credit provisions of the law, coupled with the funding available to meet states’ unique needs relevant to climate change mitigation, will accelerate the transition to EV technology and make EVs more accessible and affordable for individuals, businesses, and government fleets.

2.3.4.2 HD Omnibus/Phase 2 GHG

Medium- and heavy-duty engine/vehicle manufacturers are the regulated entities under the HD Omnibus Rule. Because these manufacturers are located outside of Vermont, ANR assumes those

[23] https://www.democrats.senate.gov/imo/media/doc/inflation_reduction_act_of_2022.pdf

manufacturers would pass the direct compliance costs onto the Vermont vehicle fleets that purchase the California-certified vehicles and engines that are subject to the HD Omnibus Rule. Typical businesses are defined here to be Vermont fleets with four or more medium- and heavy-duty vehicles (GVWR >10,000 pounds). The actual cost impact on fleets would depend on the number of new California-certified heavy-duty vehicles that fleets would purchase during the lifetime of this cost analysis. A lifetime analysis including initial purchase price increase, lifetime Diesel Exhaust Fluid (DEF) consumption for NOx control, lifetime savings from warranty, net lifetime cost impact, and percent increase in lifetime cost from the assumed purchase price is presented in Figure 1[24].

Engine MY	Lifetime Net Cost Per Vehicle	Lifetime Net Cost of 20 Vehicles
2024	$2,839	$56,780
2027	$5,317	$106,340
2031	$5,814	$116,280

Figure 1: Lifetime Cost Analysis of 20 Medium Heavy-Duty Diesel Trucks

Similar to typical fleets, the actual cost impact on smaller businesses and their fleets would depend on the number of new California-certified heavy-duty vehicles that fleets would purchase during the lifetime of this cost analysis. As shown in Figure 1 above, for a small fleet that would buy one new medium heavy-duty diesel (MHDD) vehicle with a 2024, 2027, or 2031 MY engine, the net lifetime vehicle cost due to the HD Omnibus is estimated to be $2,839, $5,317, or $5,814, respectively.

The HD Omnibus Rule impacts new vehicle dealerships by requiring that new on road heavy-duty engines and vehicles for sale in Vermont meet California emissions standards. By aligning Vermont's requirements with other states in the region (Massachusetts and New York), dealerships will benefit from the ability to continue to trade vehicles with dealers in those states.

2.3.5 Costs and benefits to schools and school districts: ACCII

ACCII does not provide for the direct regulation of schools or school districts. The ACCII regulation imposes requirements on vehicle manufacturers to produce and deliver ZEVs. Schools and school districts are not required to purchase ZEVs under the proposed regulation. To the extent schools or school districts have passenger cars and light duty trucks as part of their school transportation fleet and they choose to purchase ZEVs, these entities should experience the same net benefit as described above when considering the total cost of ownership of a BEV when replacing an ICEV.

2.3.6 Costs and benefits to schools and school districts: ACT/Low NOx HD Omnibus/Phase 2

The ACT regulation imposes requirements on vehicle manufacturers to produce and sell ZEVs. Schools and school districts are not required to purchase ZEVs under the proposed ACT regulation. ACT, the HD Omnibus, and the Phase 2 rules do not provide for the direct regulation of schools and school districts.

[24] California Air Resources Board – HD Omnibus Initial Statement of Reasons, at Pg. IX-52.

As most school districts have heavy-duty buses in their fleet, these entities are likely to experience the same cost savings and net lifetime vehicle cost as explained above in the discussion on the impact of these rules on medium- and heavy-duty fleets. Early adoption of school bus electrification has been identified as critical in reduction of children's exposure to criteria pollutants emitted by traditional fossil-fueled school buses. Several state and federal incentive programs for school bus replacement are currently available and are likely to be expanded in the future. Vermont has been a leader in investigating the feasibility of electric school buses in operation in a cold climate and rural setting via our on-going Electric School and Transit Bus Pilot project.

For a discussion of current funding opportunities that may be available to schools to help to offset the upfront costs of transitioning to EVs, see Section 2.3.4.1.1 above.

2.3.7 Costs and benefits to Local and State Agencies

The ACCII regulation imposes requirements on vehicle manufacturers to produce and deliver for sale zero emission passenger cars, light duty trucks and medium-duty passenger cars in Vermont, while the ACT regulation imposes requirements on vehicle manufacturers to produce and sell medium- and heavy-duty ZEVs in Vermont. State agencies are not required to purchase electric vehicles under the proposed regulations. As with individuals and businesses, state agencies choosing to purchase ZEVs will have to plan to pay higher vehicle prices as the proposed standards are phased in. However, as discussed above, the operating costs of vehicles subject to these standards should outweigh the higher vehicle prices, resulting in a net benefit.

The new complying vehicles are also expected to impact revenues from sales, gas, and diesel taxes. Revenues from vehicle sales taxes would be expected to rise as vehicle prices increase. However, assuming fuel tax rates and vehicle miles traveled remain the same, fuel tax revenues would be expected to decline as the proposed ZEV standards are implemented due to increased electric vehicles on the road. With ICE vehicles becoming more fuel efficient over the years, gas tax revenue has already begun to decline without the proposed rules in place. Recognizing the problem with reduced fuel tax revenue, the Vermont Agency of Transportation (VTrans) has already begun researching methods to replace fuel tax revenue. VTrans convened a group of stakeholders, the Road Usage Charge Advisory Committee to help with this effort and their assessment focused on different revenue mechanisms for electric vehicle owners who pay little to no fuel taxes. Their final report, *Vermont Road Usage Charge Study*, dated March 14, 2022, notes that in 2021 the lost fuel tax revenue ($300,000) was minimal when compared to the total state transportation fund revenues ($283 million), but will continue to grow, and concludes that a mileage-based road user fee assessed to electric vehicles is feasible to collect displaced fuel tax revenue and VTrans continues to explore this option.

2.3.8 Total economic impact of ACCII and ACT

To determine the total economic impact of the ACCII and ACT regulations in Vermont, ANR compared the above analyses of public health benefits and costs avoided due to reduced emissions of greenhouse gases to the total costs of implementing these regulations in Vermont. A similar analysis was conducted in California for ACT[25] and ACCII[26]. To appropriately scale the cost impact conclusions reached in California to those likely to occur in Vermont, ANR applied a scaling factor that uses vehicle-miles

[25] https://ww3.arb.ca.gov/regact/2019/act2019/30dayattc.pdf
[26] https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/fsorappf.pdf

traveled (VMT) data and compares the VMT of different vehicle weight classes in California to those in Vermont. In some cases, the use of the scaling factor was not appropriate or applicable, and a more detailed scaling exercise was used depending on the metric being analyzed. For example, California's motor vehicle registration fees were not comparable to Vermont's and therefore Vermont's specific fee schedule, along with modeled vehicle population data, was used to determine the vehicle registration costs associated with the proposal in Vermont. In some instances, additional scaling factors were used to further account for the difference in fuel prices or electricity rates in Vermont.

The costs and benefits of adopting ACCII and ACT[27] in Vermont are shown below in Table 12. Total costs, or negative impacts, include the incremental cost of electric vehicles, maintenance bay upgrades, electric vehicle supply equipment, registration fees, workforce transition, midlife vehicle costs, and sales tax. The cost savings include avoided fuel and maintenance costs, savings related to other regulatory compliance, as well as vehicle to grid (V2G) related savings. Benefits include avoided costs of public health impacts from air pollution and the avoided social cost of carbon. When fully accounting for all analyzed costs, savings, and benefits, the adoption of ACCII will provide a net benefit of nearly $4 billion and the adoption of ACT will provide a net benefit of over $494 million in Vermont, the aggregate benefits of both regulations will be nearly $4.5 billion.

Table 12: Total costs and benefits of ACCII and ACT in Vermont

Scenario (2018$ billion)	Total Costs (negative)	Health benefits	Total cost-savings	Total benefit	Net benefit	Social Cost of Carbon Avoided	**Net benefit (including Social Cost of Carbon, 2018$ billion)**
ACCII Vermont costs and benefits 2025-2040	3.574	.004	6.441	6.445	2.871	1.105	**$3.976**
ACT Vermont costs and benefits 2025-2040	$.467	$.006	$.317	$.323	-$.143	$.637	**$.494**
Total ACCII and ACT Benefits	$4.04	$.009	$6.76	$6.77	$2.73	$1.74	**$4.47**

2.3.9 Alternatives to rule as proposed

As discussed above, the only alternative that ANR considered is to not amend Advanced Clean Cars or adopt Advanced Clean Trucks, the Low NOx HD Omnibus, or the Phase 2 Greenhouse Gas rules. Pursuant to Section 177 of the Clean Air Act, Vermont's adoption of California's motor vehicle emission standards must be identical to California's rules. Therefore, if Vermont does not adopt or amend these

[27] A total cost analysis of the Low NOx HD Omnibus and Phase 2 GHG components of the proposed rule was unable to be completed with the time and resources available to ANR for this work, and a discussion of the economic impacts to individuals, small businesses, and other entities required to be analyzed pursuant to the APA is included in the Supplemental Information.

rules, this will result in a reversion to the federal motor vehicle emission standards for passenger cars and light-duty trucks, which are less stringent and would represent significant regulatory backsliding. It would also stall or stifle the progress Vermont has made in reducing criteria pollutant emissions and greenhouse gas emissions as a result of implementation of these rules. All of the benefits articulated in this document, including public health benefits shown via the COBRA model results (see Pages 4 and 8), the emission reduction benefits shown in the Environmental Impact Analysis (see Pages 26-27), and the avoided costs associated with climate change shown via the Social Cost of Carbon analysis (see Pages 5 and 11) would potentially be lost if Vermont chose not to adopt the rule amendments proposed. Also, states that do not participate in Advanced Clean Cars are less likely to receive cleaner and electric vehicles from auto manufacturers, so Vermonters would also have reduced access to these types of vehicles.

3 Environmental Impact Statement Supplemental Information

3.1 Impact on Air Quality and Climate Change

3.1.1 Impacts on Air Quality

Vermont's air quality is often considered to be among the best in the nation. However, the air we breathe is not pollutant-free. Motor vehicles, building heating systems and manufacturing all generate air pollution. Our air quality is also affected by emissions that occur outside of the state, from sources such as electricity generating facilities and wildfires. The weather also plays an important role. Brisk winds and fast-moving weather fronts move pollutants out of our area, while stagnant weather systems can cause pollutants to linger and accumulate, particularly in mountain valley areas.

As the seasons change, so do the sources and causes of decreased air quality. Hazy hot summer days combined with increased motor vehicle emissions during "driving season" can result in increased concentrations of ground level ozone and volatile organic compounds contained in fossil fuel. As winter and "heating season" arrives, emissions from furnaces and boilers, in particular those using wood for fuel, increase and can be trapped in valley areas during temperature inversion events. Throughout the year, fuel burning, agriculture and industry release heat-trapping greenhouse gases such as carbon dioxide, methane, nitrous oxide and sulfur hexaflouride into the atmosphere.

Emissions from mobile sources include GHGs; volatile organic compounds (VOCs) and NOx, which combine to form ground level ozone that triggers asthma attacks, damages lung tissue, and damages forests and crops; fine PM, which causes respiratory and cardiovascular damage, and leads to haze that limits visibility; toxic and carcinogenic compounds such as benzene, aldehydes and butadiene; and carbon monoxide (CO), which interferes with the delivery of oxygen to the body's organs and tissues.

Toxic and carcinogenic air pollutants are of concern because they are known or suspected of causing cancer in humans, and pose a threat even at very low levels. Diseases aggravated by air pollution include chronic sinusitis, bronchitis, asthma, and allergies. Studies show that air pollution poses significant risk of pulmonary problems in developing fetuses, young children, and older individuals, and damages the immune system in healthy adults.

Reductions in greenhouse gas emissions and other criteria and toxic air contaminants listed above are expected to occur from the adoption of the proposed rule and will therefore have a positive impact of air quality and public health in Vermont.

3.1.2 Impacts on Climate Change

The *Initial Vermont Climate Action Plan* released in December 2021 includes a section devoted to understanding climate and climate change in Vermont. Climate change is currently impacting Vermont. In working to implement the GWSA, ANR is modeling the types of changes that are needed globally to mitigate the impacts of climate change. The key messages from the Climate Action Plan include the following:

- Across Vermont, the 11-year period of 2010-2020 was the warmest since records began in 1895, with the warmest winter and summer seasons occurring in the 2000-2020 period.

- Vermont's average annual temperature has increased over 2.5°F from the 1970s [1960s] to 2010s and over 3°F from the end of the last century.
- The rate of warming has increased through the last 120 years and is currently around +0.5°F a decade.
- Warming is having a number of notable effects, such as the lengthening of the growing season, less reliable winter snow cover, and shifting peak energy usage to the summertime.
- Seasonal temperature trends show the winter season warming nearly twice as fast [over 1.5 times faster] as the annual average, increasing over 4°F from the 1960s to the 2010s.
- Other observed seasonal shifts include an expanding warm season causing longer falls and winter to have more false starts, and more temperature fluctuation within seasons.
- Backward or false springs (during which snow and freezing rain can occur in April-June after the normal progression of warming temperatures) continue to be observed, even with the observation that freeze-free seasons are longer.
- As Vermont's climate warms there has been an observable shift in temperature extremes. Heat waves are becoming more likely while cold waves are decreasing. Evidence for this from Burlington shows a steady decline in cold waves peaking around nearly 6 per year in the 1970s to less than 2 per year in the 2010s. Heat waves have generally increased from around 3 to 4 per year in the 1960s/1970s to over 7 per year in the 2010s.
- Since the mid-2000s, a below average number of very cold nights (defined as nighttime temperatures of 0°F or less) have also been observed in winter, with a near to above average annual number of warm nights in the 2000-2020 period.
- As Vermont's climate warms, the overall amount of precipitation is also increasing. Warmer temperatures produce increased evaporation of water vapor from nearby bodies of water, resulting in a greater potential for weather systems to produce higher amounts of precipitation. In general, increases in annual precipitation changes are relatively small, on the order of +0.5" to +1.0" a decade, with the greatest increases in precipitation occurring during the winter season.
- Extreme precipitation (defined as greater than 2" over 24 hours) has also trended above the long-term average since 1995. These trends are reflected in the increases in stormflow between 1950-2006 as well as the increasing magnitudes of the 1% (100-year return interval) storms across timescales from 1 hour to 1 day.
- The Vermont Department of Health has documented the combined influence of warmer winters and longer warm seasons as contributing to both a more hospitable environment for blacklegged ticks, as well as their hosts, white-footed mice. There has been an exponential increase in probable Lyme disease cases between 1990 and 2016, with Vermont and Maine being the states with the highest increases in actual reported case rates since 1991

3.1.3 Cause

The Intergovernmental Panel on Climate Change (IPCC) released "AR6 Climate Change 2021: The Physical Basis"[28] as part of the Sixth Assessment Report (AR6) process. This report states that human

[28] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth

influence on the climate system is now an established fact. "It is unequivocal that the increase of CO_2, methane (CH_4) and nitrous oxide (N_2O) in the atmosphere over the industrial era is the result of human activities and that human influence is the principal driver of many changes observed across the atmosphere, ocean, cryosphere and biosphere."

3.1.4 Greenhouse gas emissions from motor vehicles in Vermont

Motor vehicles and other mobile sources in Vermont are the largest source of a number of air pollutants in the state. These pollutants include, but are not limited to, nitrogen oxides (NOx) and volatile organic compounds (VOCs), which are precursors to ground level ozone formation (smog), carbon monoxide (CO), particulate matter (specifically $PM_{2.5}$), and greenhouse gases (GHGs). For information on the impacts of criteria pollutant emissions in Vermont, please refer to the discussion above in the Economic Impact Statement Supplemental Information. Impacts of greenhouse gas emissions are also explained above. Greenhouse gas emissions from mobile sources make up approximately 40% of Vermont's total GHG emissions profile, or 3.43 million metric tons of CO_2 equivalent (CO_2e) in 2018, with light-duty vehicles accounting for over 70% of that total and the heavy-duty fleet contributing approximately 12%[29].

Although Vermont is a relatively small state it has one of the highest rates of GHG emissions per capita in the Northeast driven by high per capita vehicle miles traveled[30]. In order to meet the mandatory GHG reductions set forth in the Vermont Global Warming Solutions Act of 2020 dramatic emissions reductions from the transportation sector, and especially from light and medium duty on-road vehicles, will be required. Reductions from the sector can be achieved through multiple strategies but electrification of the vehicle fleet plays a critical role in reducing GHG emissions due to the general rural nature and non-centralized development patterns in the state.

3.1.5 GHG and Criteria pollutant emission reductions

3.1.5.1 ACCII

To understand the impact these regulations could have on passenger car and light-duty truck emissions in Vermont, Vermont partnered with NESCAUM and the International Council on Clean Transportation (ICCT) who commissioned Sonoma Technology, Inc. (STI) to estimate the cumulative avoided nitrogen oxides (NOx), fine particulate matter (PM2.5) and carbon dioxide equivalent (CO2e) emission reductions beginning in 2025 from the Advanced Clean Cars II Rule.

Table 13, below, estimates the cumulative emission reduction benefits of the zero-emission vehicles first sold in Vermont over various time periods. Since the current ACCII proposal requires 100% ZEV sales by 2035, emissions benefits are only modeled until 2040. Additional modeling to project emissions benefits further to 2050 could be conducted in the future.

Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[29] Vermont DEC, 2021: Vermont Greenhouse Gas Emissions Inventory and Forecast 1990 – 2017: https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[30] Energy Action Network (EAN), 2020: 2019 Annual Progress Report for Vermont: https://www.eanvt.org/wp-content/uploads/2020/03/EAN-report-2020-final.pdf

Table 1313: Cumulative Avoided Emissions of GHG, NOx and PM from ACCII Rule

Avoided Passenger car and light-duty truck emissions, 2025-2030			
	NOx (short tons)	PM2.5 (short tons)	CO2e (million metric tonnes)
ACCII	(74)	(7)	(0.69)
Avoided Passenger car and light-duty truck emissions, 2025-2035			
	NOx (short tons)	PM2.5 (short tons)	CO2e (million metric tonnes)
ACCII	(323)	(32)	(3.25)
Avoided Passenger car and light-duty truck emissions, 2025-2040			
	NOx (short tons)	PM2.5 (short tons)	CO2e (million metric tonnes)
ACCII	**(811)**	**(72)**	**(7.57)**

3.1.5.2 ACT/ Low NOx HD Omnibus / Phase 2 GHG

To understand the impact these regulations could have on medium- and heavy-duty vehicle emissions in Vermont, Vermont partnered with NESCAUM and the International Council on Clean Transportation (ICCT) who commissioned Sonoma Technology, Inc. (STI) to estimate the cumulative avoided nitrogen oxides (NOx), fine particulate matter (PM2.5) and carbon dioxide equivalent (CO2e) emission reductions beginning in 2025 from Advanced Clean Trucks, the HD Omnibus Rule, and the Phase 2 GHG Rule.

Table 14[31], below, estimates the emission reduction benefits of the zero-emission vehicles first sold in Vermont, whether or not the vehicle remains registered in Vermont through the end of its life. All sales that comply with ACT requirements are credited to the ACT, regardless of whether those zero-emission vehicles would have been sold without such regulation.

Table 1414: Avoided Emissions of GHG, NOx and PM from ACT, HD Omnibus, and Phase 2 GHG Rules

Avoided Medium- and Heavy-Duty Emissions, 2020-2040			
	NOx (short tons)	PM2.5 (short tons)	CO2e (million metric tonnes)
ACT	(1,820)	(16)	(1.22)
HD Omnibus[32]	(1,710)	-	-
Phase 2 GHG Stds	-	-	(0.22)
Full Harmonization	(3,010)	(16)	(1.41)
Avoided Medium- and Heavy-Duty Emissions, 2020-2050			
	NOx (short tons)	PM2.5 (short tons)	CO2e (million metric tonnes)
ACT	(5,590)	(44)	(3.77)
HD Omnibus	(4,330)	-	-

[31] The ICCT and STI - Benefits of adopting California medium- and heavy-duty vehicle regulations under Clean Air Act Section 177 (https://theicct.org/publication/state-level-hdv-emissions-reg-fs-dec21/)

[32] Only NOx emissions benefits were quantified for the Low NOx Omnibus Rule. This is because technologies that reduce NOx (e.g., an improved selective catalytic reduction [SCR] catalyst) are expected to have minimal impact on particulate matter (PM) and greenhouse gas (GHG) emissions. Despite this outcome, the Low NOx Omnibus rule remains a necessary component of the suite of rules because it is legally and substantively complimentary to the compliance and goals of the other rules proposed.

Phase 2 GHG Stds	-	-	(0.41)
Full Harmonization	**(8,190)**	**(44)**	**(4.07)**

3.1.6 Emissions reductions in the context of the requirements of 10 V.S.A. §578

The GWSA requires that Vermont reduce greenhouse gas emissions by 26% by 2025, compared to the 2005 baseline emissions, 40% by 2030, compared to the 1990 baseline, and 80% by 2050, compared to the 1990 baseline. The suite of proposed rules does not take effect until 2026, so emissions reductions from these rules have been evaluated in the context of the 2030 emissions reduction requirement. While the GWSA does not mandate a specific level of emission reductions for the transportation sector alone, it does require that the Climate Council consider each sector's proportional contributions to GHG emissions in Vermont when making decisions about actions and strategies to adopt in the Climate Action Plan and its amendments. Based on the sector proportionality analysis conducted by the Vermont Climate Council in the *Initial Climate Action Plan*, Vermont would need to reduce its transportation GHG emissions to 2.06 MMTCO2e by 2030. Assuming that transportation emissions from 2021, preliminarily estimated to be 2.93 MMTCO2e, will represent Vermont's baseline transportation emissions in 2030, Vermont would need to reduce transportation GHG emissions by 0.87 MMTCO2e by 2030 to meet the sector's proportional reduction target. ANR maintains 2021 emissions data as the 2030 baseline emissions due to a high level of uncertainty in emissions trends following the COVID-19 pandemic and a variety of factors including but not limited to increased auto-manufacturer EV commitments, record fuel prices, manufacturer supply chain issues, and expected increases in VMT. As depicted in Figure 2 below, emissions reductions from the proposed suite of rules are estimated to be 0.30 MMTCO2e in 2030, leaving a "gap" of 0.57 MMTCO2e in the transportation sector for 2030 emissions reductions. Beyond 2030, it is likely that the emissions "gap" will begin to close more quickly as internal combustion technology phase-out accelerates and electric vehicles have a broader application. It is important to note that the anticipated reductions shown here assume that the vehicles that manufacturers are required to deliver to Vermont are all registered and operated (placed in service) in Vermont. Complimentary policies, such as vehicle purchase incentives and EV charging infrastructure deployment, will help ensure that vehicles required to be delivered in Vermont are placed in service in Vermont. Otherwise, the emissions reductions discussed here will not be realized solely via the regulatory requirements of this suite of rules.

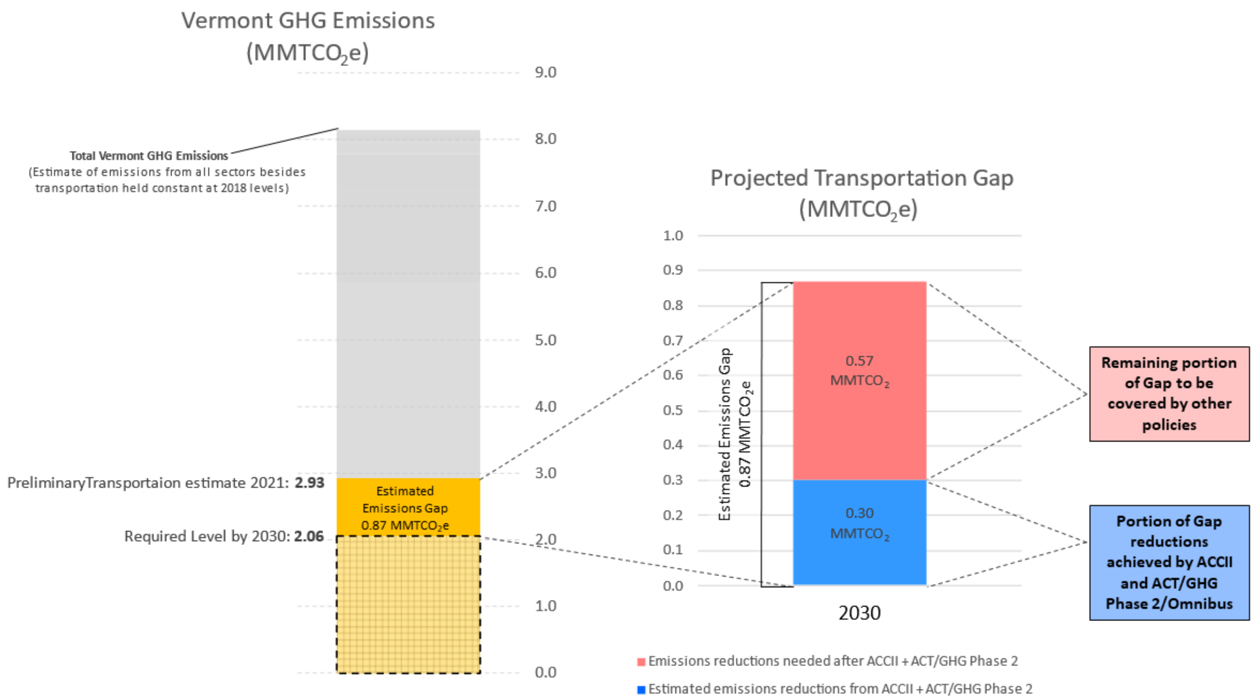

Figure 2: Estimation of ACCII, ACT, and Phase 2 Rules' Impact on Emissions in the Transportation Sector in 2030

3.2 Impacts on water quality

The effects of climate change in Vermont – including increased temperatures and more intense precipitation – can adversely impact water quality.[33] To the extent that reductions of emissions from motor vehicles will help to mitigate the impacts of climate change, water quality in Vermont will generally benefit from actions that help to mitigate climate change. As noted above, in working to implement the GWSA, ANR is modeling the types of changes needed worldwide to mitigate the impacts of climate change.

3.3 Impacts on forest and agricultural land use and recreation

Climate change has impacted the duration and frequency of several natural hazards that impact land use and recreation in Vermont. These include severe storms, winter storms, drought, flooding, wildfires, air pollution, ground-level ozone, temperature extremes, localized winds, and biotic elements (insects and disease)[34]. While mitigation of air contaminants from motor vehicles, including greenhouse gases will help to mitigate the impacts of climate change, absent multi-national action climate change will continue to impact land use and recreation in Vermont. Given this, and although outside the scope of this rulemaking, implementation of adaptation and resilience strategies is a critical component of responding to climate change in Vermont.

[33] Initial Vermont Climate Action Plan, 2021, Page 29.

[34] Initial Vermont Climate Action Plan, 2021, Page 18.

3.4 Other Impacts

3.4.1 Life-cycle emissions

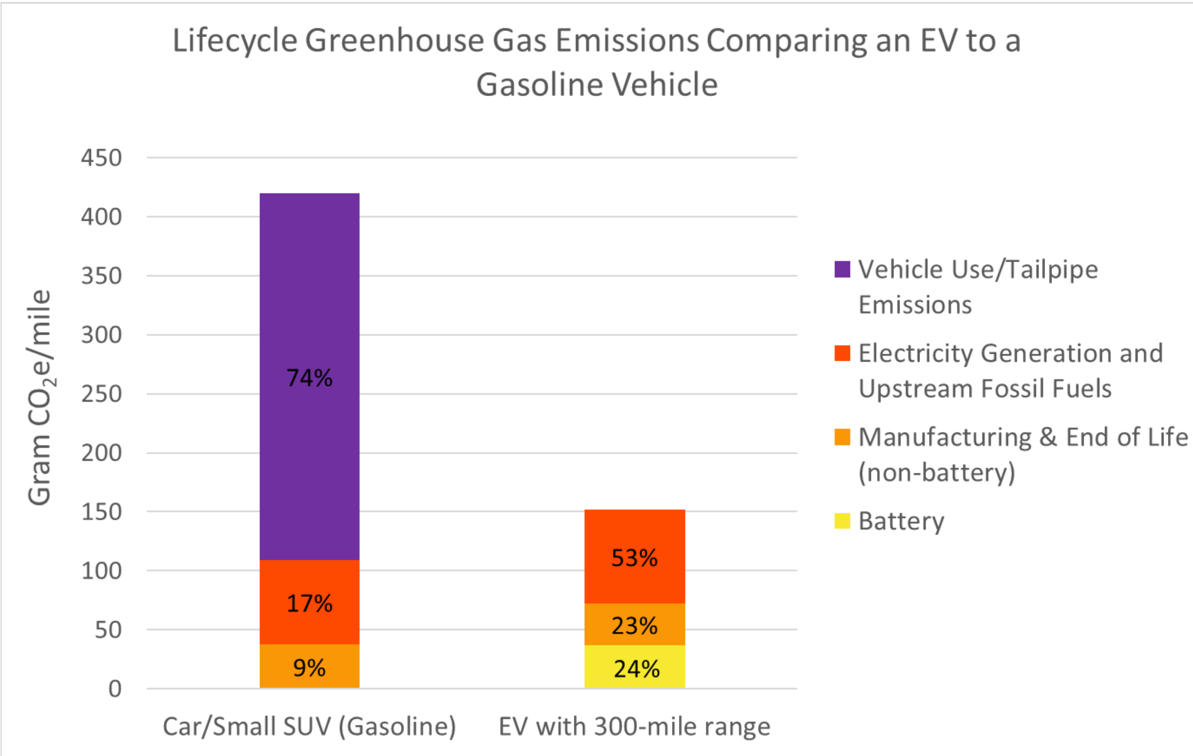

Figure 3: Life-cycle emissions of an EV compared to a small gasoline SUV

When comparing the emissions benefits of vehicle electrification, considering emissions from the entire lifecycle of the vehicle, which include upstream and end-of-life emissions, is important to make a fair assessment of the transition. The comparison shown above includes greenhouse gas emissions associated with the production of the battery, manufacturing of the vehicle, upstream emissions from the generation of electricity to charge the EV and from the extraction and processing of the gasoline, emissions from driving the vehicle, and vehicle end-of-life emissions. Greenhouse gas emissions from the production of the EV battery are important, and the emissions from the generation of the electricity to power the EV are certainly not zero, but they are relatively small when compared to the emissions associated with the gasoline vehicle tailpipe emissions. It should be noted that this comparison is an example using a specific set of vehicles, and that a different EV and a different gasoline vehicle could produce slightly different results, however, this comparison is a fairly representative, and the lifetime greenhouse gas emissions of the EV are generally found to be less than half of those from the gasoline vehicle. It is also true that with expected increases in renewable and low-carbon electricity usage in Vermont, and with the incredibly large investments currently happening in battery technologies, that lifetime emissions from EVs are likely to continue to decline.

3.4.2 Semi-Precious Metal Availability, Mining Impacts, and Battery Recycling

Electrification of the on-road vehicle fleet will likely result in increased demand for lithium, among other semiprecious metals, such that global supply may not be capable of meeting this demand. There are also likely potential adverse environmental effects from increased mining activity of lithium and other semi-precious metals. Vermont cannot, without speculating, predict the location of these impacts or account for the regulatory environment that may be capable of reducing impacts from these activities. For instance, mining activities that occur overseas in countries that may have fewer regulations in place to mitigate environmental impacts are beyond Vermont's authority to mitigate or regulate. Nevertheless, these potential impacts are identified and discussed here.

The Agency recognizes that its rules and regulations related to the use of zero-emission technology may induce additional new demand for various metals including lithium, graphite, cobalt, nickel, copper, manganese, chromium, zinc, and aluminum. Other federal and international activities[35] and commitments are already, and will in the future, impact this demand. It is also important to note that ICEVs require aluminum alloys, magnesium, iron, and steel, which are all metals that already require extensive mining with similar physical impacts to the environment, including loss of habitat, agricultural resources, and forests; water, air, and noise pollution; and erosion.

In response to the industry's electrification commitments and potential obligations, the recycling of lithium-ion batteries is increasing to ensure that minerals are recovered and reused instead of discarded. Policy recommendations aimed at ensuring that as close to 100 percent as possible of lithium-ion vehicle batteries are reused or recycled at end-of-life in a safe and cost-effective manner have also been submitted to the California Legislature by the Lithium-Ion Car Battery Recycling Advisory Group. Additionally, new sources of lithium, among other minerals, have been identified internationally and domestically. Industry is also rapidly moving to batteries with different chemistries or formats to address concerns with mineral supply chain issues or human rights concerns. Moreover, as a component of the proposed rule, automakers will be required to produce ZEV batteries that provide a label to enable second use and recycling processes to conserve semi-precious metals used in the manufacturing process of ZEV batteries. The proposed Advanced Clean Cars II regulation includes durability requirements for batteries that lead to reduced battery degradation and therefore less battery replacements. This has a benefit of reducing battery manufacturing impacts of facility emissions and sourcing of raw minerals, as well as slowing down the need for battery recycling and reuse activities.

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[35] The federal government recently enacted legislation providing significant support for ZEVs. The Inflation Reduction Act of 2022 provides significant tax credits for new and used ZEVs and electric vehicle charging infrastructure. It provides an advanced manufacturing tax credit for production of critical minerals used in ZEV batteries, appropriates $500 million for "enhanced use" under the Defense Production Act to incentivize critical mineral production. It authorizes the Department of Energy to commit up to an additional $40 billion in loan guarantees (on top of an existing program of $24 billion) for innovative technologies - which includes projects that avoid GHGs and other air pollutants or that employ new or improved technologies. Various international efforts are also underway to electrify the mobile-source sector pursuant to commitments made in the European Union, 30 United Nations (UN) Paris Accord, Kyoto Protocol, and by members of the Under2 Coalition, among others.

4 Scientific Information Statement Supplemental Information

4.1 List of material incorporated by reference (IBR)

Proposed Rule Record, available at: https://ww2.arb.ca.gov/rulemaking/2022/advanced-clean-cars-ii

Title 13 California Code of Regulations available at:
https://govt.westlaw.com/calregs/Index?transitionType=Default&contextData=%28sc.Default%29

Title 17 California Code of Regulations available at:
https://govt.westlaw.com/calregs/Index?transitionType=Default&contextData=%28sc.Default%29

4.2 Summary of record and documentation developed by CARB

4.2.1 Final Statements of Reason and Standardized Regulatory Impact Assessments

Advanced Clean Cars II, available at:
https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/fsor.pdf

Advanced Clean Trucks, available at: https://ww3.arb.ca.gov/regact/2019/act2019/fsor.pdf

Low NOx HD Omnibus, available at:
https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2020/hdomnibuslownox/fsoraddendum.pdf

Phase 2 GHG Rules, available at: https://www.arb.ca.gov/regact/2018/phase2/fsorp2addendum.pdf

4.3 Other materials cited in Supporting Documents

The ICCT and STI - Benefits of adopting California medium- and heavy-duty vehicle regulations under Clean Air Act Section 177, December 2021, available at https://theicct.org/publication/state-level-hdv-emissions-reg-fs-dec21/

The ICCT and STI – Benefits of adopting California Advanced Clean Cars II regulations in Vermont, October 2022, available upon request from the Agency of Natural Resources

Atlas Public Policy – Analysis and Assumptions for ACCII and ACT Total Cost of Ownership in Vermont, October 2022, available upon request from the Agency of Natural Resources