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Advanced Clean Cars II in VT: Implications for EVs and GHG Emissions

The Advanced Clean Cars II ("ACC II") regulations are in development by the California Air Resources Board. ACC II is a continuation of California's long-running program to reduce criteria pollutants and greenhouse gas emissions ("GHG") from new light- and medium-duty vehicles, while increasing the number of zero-emission vehicles ("ZEV"). ZEVs are primarily all-electric vehicles ("AEV") and plug-in hybrid vehicles ("PHEV").[1] This research brief explores the implications of adopting ACC II in Vermont, with a specific focus on:

- The number of new plug-in electric vehicles ("EVs") that will be available for sale as a result of ACC II.
- The accompanying GHG emissions reductions from these vehicles.
- What this means for meeting Vermont's overall emissions reduction requirements.

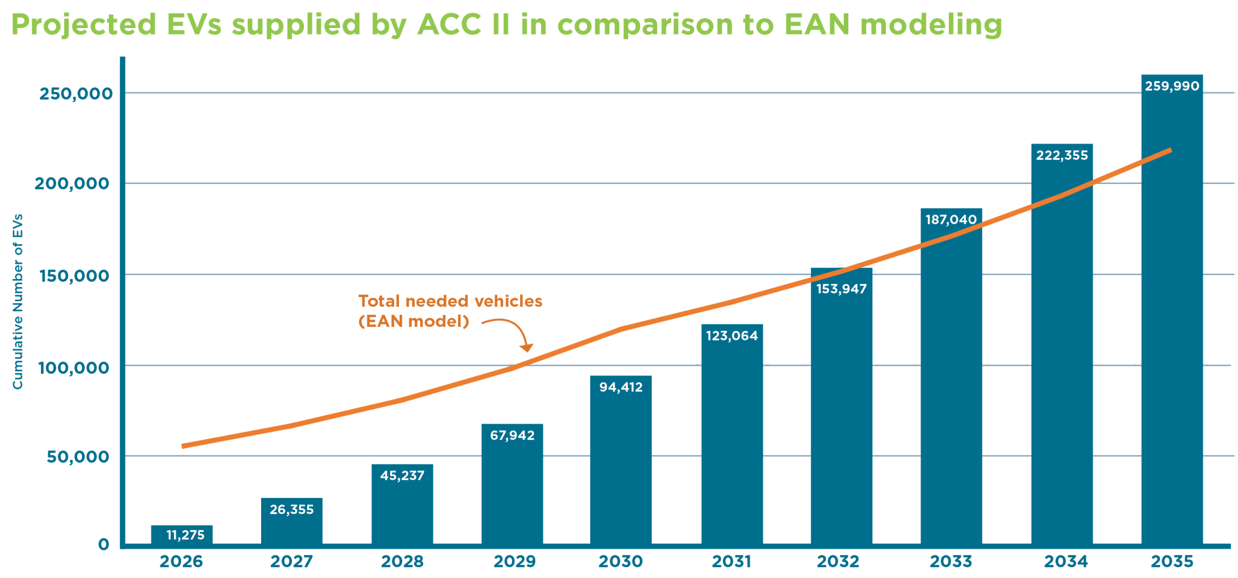
Joining California in adopting ACC II is a recommended action in Vermont's Climate Action Plan ("CAP"), approved on December 1, 2021.[2,3] Besides Vermont, several other Section 177 states have signaled their intent to move forward with adoption of ACC II in 2022.[4] Specific to Vermont, the CAP recommends that Vermont adopt California's ACC II regulations, including "amending Vermont's existing Low and Zero Emission Vehicle Regulations beginning no later than Model Year 2026." The recommendation further notes that ACC II includes a 100% ZEV sales requirement by 2035, more stringent criteria pollutant emissions standards, a robust

[1] CARB regulations technically also include hydrogen fuel cell vehicles in the light-duty ZEV category. However, given technology, cost, and logistical barriers, hydrogen fuel cell vehicles are not a scalable strategy in the near term for Vermont ,so this analysis does not study them.
[2] The rules have not yet been finalized or adopted, so there is the potential that requirements and timing may change.
[3] See pages 71-72, https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Initial%20Climate%20Action%20Plan%20-%20Final%20-%2012-1-21.pdf
[4] Section 177 states refer to states that have adopted California's vehicle emissions standards under Section 177 of the federal Clean Air Act. There are currently 12 states involved.

vehicle durability standard, warranty provisions, battery state of health standardization, battery labeling, and availability of repair information to independent repair shops.

This memo explores two analysis scenarios: an internal combustion engine (“ICE”) replacement scenario and a business-as-usual scenario. Each of these scenarios result in different emissions reduction impacts. The ICE replacement scenario explores the emissions impacts of ACC II by using the counterfactual of ICE vehicles being driven rather than EVs. The business-as-usual scenario explores the emissions impacts of ACC II by using the counterfactual of EVs being adopted at a business-as-usual rate, which is what it would be absent the ACC II. Under the definitions of the CAP, the ICE replacement scenario falls under the category of being a “high impact plan,” accounting for approximately 10% of overall emissions reductions in 2030. The business-as-usual scenario is a “medium impact plan,” accounting for approximately 8% of overall reductions in 2030. The following discussion will explore this analysis more in depth. While these are the modeled reductions from the vehicles made available by ACC II, actual reductions will also depend on other concurrent factors, such as purchase incentives, charging network infrastructure development, among other things.

ACC II is particularly important as it directly addresses one of the challenges to increasing EV adoption: having enough vehicles on the market for consumers to choose from. ACC II sets requirements for a minimum number of EVs that are delivered for sale to Vermont. The annual requirements increase over time to reflect changing market conditions. The graphic on the following page sets the context of the potential cumulative ZEV market supply from ACC II as compared to how many estimated EVs are needed to replace fossil fueled vehicles for Vermont to meet its



Source: ANR; EAN Emissions Reductions Pathways, 2021.

transportation emissions reduction goals. This view is in comparison to the estimated vehicle count forecasts as outlined in the EAN Emissions Reductions Pathways Model ("EAN model") of 120,000 EVs by 2030.[5,6] Also seen in the graphic, the EAN model shows EV adoption in 2030 beyond what ACC II alone can guarantee, since ACC II will not go into effect until model year 2025, while the EAN model begins four years before that.

The main takeaway from the above figure is that the number of EVs required by the proposed ACC II regulations will not be enough to account for all of the needed EVs to meet the 2030 emissions reductions.[7] Compared to the EAN model, there is a deficit of around 26,000 EVs needed to reach the 2030 reduction goal.[8] However, this deficit could be met in a variety of ways. First, there will continue to be EVs supplied in Vermont, especially between 2022-2025, that are not supplied by ACC II. As of the end of 2021, there are approximately 6,000 EVs

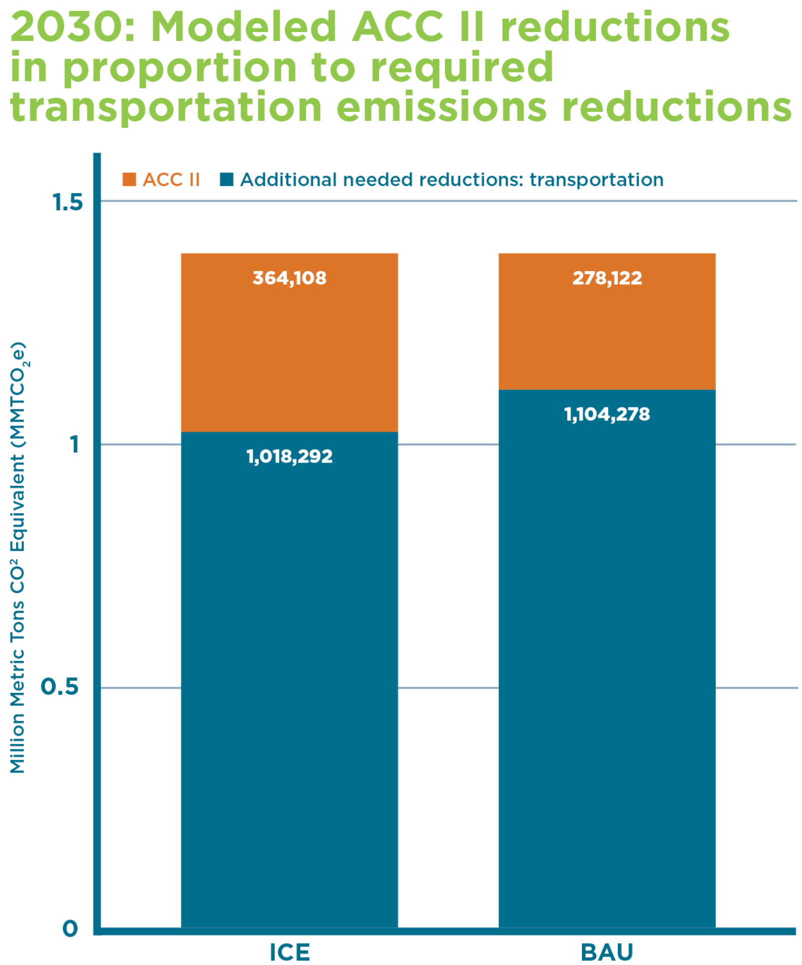
[5] EAN Emissions Reductions Pathways Model, EAN, 2021.
[6] The vehicle projections estimated by the Vermont Climate Council's LEAP modeling has ranged from 96,000 EVs to 159,000 EVs. As of the release date of this research brief (January 20, 2022), the final projections had not yet been published.
[7] ACC II does not begin until 2025 so will not contribute towards meeting the 2025 transportation emissions reductions goals.
[8] This number is in comparison to the EAN Emissions Reductions Pathways Model.

registered in Vermont. If market trends from recent years continue,[9] it is possible for another 20,000 or more EVs to be registered between 2022-2025,[10] making up the needed difference before ACC II goes into effect.[11] Second, there is an expanding used market for EVs that also has the potential to contribute to EV ownership in the state. The EAN model includes used EVs, showing that used EVs are considered to be a large potential source for EVs over time. For these reasons, the EV estimation difference between ACC II and the EAN model may not be as significant as it appears.

While ACC II would not fulfill all needed EVs for 2030, starting in 2032 ACC II may actually start supplying *greater than* the minimum number of EVs needed to meet reduction goals, which is also shown in the figure on the previous page. This suggests that the adoption of these rules could lead to a greater amount of emissions reductions from EV adoption starting in 2032 than previously modeled by EAN. It should also be noted that the analysis differentiates between AEVs and PHEVs, which each have differing emissions implications. According to the ACC II EV projections, throughout the 2026-2035 time period AEVs represent 80% of the newly-added electric vehicle fleet, and PHEVs 20%.[12]

The second component of ACC II that this analysis addresses is that of the resulting emissions reductions from the EVs that ACC II makes available. Two analysis scenarios were run for

[9] EV availability in 2021-2022 has severely been impacted by supply chain issues that have led to lower EV adoption rates than initially expected. Industry experts suggest that a full recovery may take more than a year.
[10] Since ACC II is based on model year, the regulations should take effect at some point in mid-to-late 2025.
[11] The October 2021 Auto Outlook issued by the Vermont Vehicle and Automotive Distributors Association (VADA) reported that EV registrations as a share of overall new vehicle registrations in Vermont, increased from 2.7% in 2020 to 5.4% in 2021 (year-to-date), which represents a doubling in just one year. In 2020 1,000 EVs were registered, while there were 2,000 in 2021.
[12] VT Department of Environmental Conservation, 2021.



Source: ANR; EAN Emissions Reductions Pathways, 2021.

comparison: an internal combustion engine ("ICE") replacement scenario, and an EV business-as-usual ("BAU") scenario. Each of these scenarios result in different emissions reduction impacts, which is shown in the accompanying figure. The type of EV being added to the fleet also has differential reduction impacts. AEVs result in greater emission reductions, as they fully run on battery power, while PHEVs still consume some amount of gasoline.

General assumptions for both scenarios include annual vehicle miles traveled (VMT) reducing over time for all vehicle types, reflecting recent trends related to an increase in telecommuting, among other factors. Each vehicle type is also expected to increase in efficiency over the time period. This is true for both the EVs as well as the ICEs. Finally, the emissions intensity of electricity is expected to decrease greatly over the time period, even simply assuming continued compliance with Vermont's existing Renewable Energy Standard, which will continue to increase the emissions reduction benefit of EVs over time.

It is also important to note that electric vehicle adoption is just one of many transportation pathways to meet emission reductions targets. These other pathways range from other electrification options, to efficiency and low-carbon fuel options, to transportation mode changes. Although the other pathways are not discussed in this analysis, they are all necessary for Vermont to reach its emissions reduction goals.

ICE Replacement Scenario:

This scenario explores the emissions impacts of ACC II by using the counterfactual of ICE vehicles being driven rather than EVs. The result of this scenario is an estimated cumulative reduction of 364,108 MT CO_2e by 2030.[13] This makes up around 26% of overall needed reductions to meet the 2030 transportation sector emissions reduction goals,[14] or around 11% of the overall needed statewide GHG reductions by 2030. According to the CAP, any measures that account for more than 10% of overall reductions are categorized as "high impact plans," [15] so in this scenario, ACC II is a high impact plan. However, an additional 1,018,292 MT CO_2e of transportation sector reductions will still be needed from other sources.

Electric Vehicle Business-as-Usual Scenario:

This scenario explores the emissions impacts of ACC II by using the counterfactual of EVs being adopted at a business-as-usual ("BAU") rate, which is what it would be absent the ACC II. It is difficult to estimate what the BAU would be, as many variables, especially policies and incentive programs, interact with each other. However, for purposes of this analysis, the "low" EV adoption rate as modeled by VEIC was used as the BAU.[16] The BAU also has a changing proportional breakdown of AEVs to PHEVs, with AEVs representing 63% of new electric vehicles in 2026, increasing to 83% in 2035.

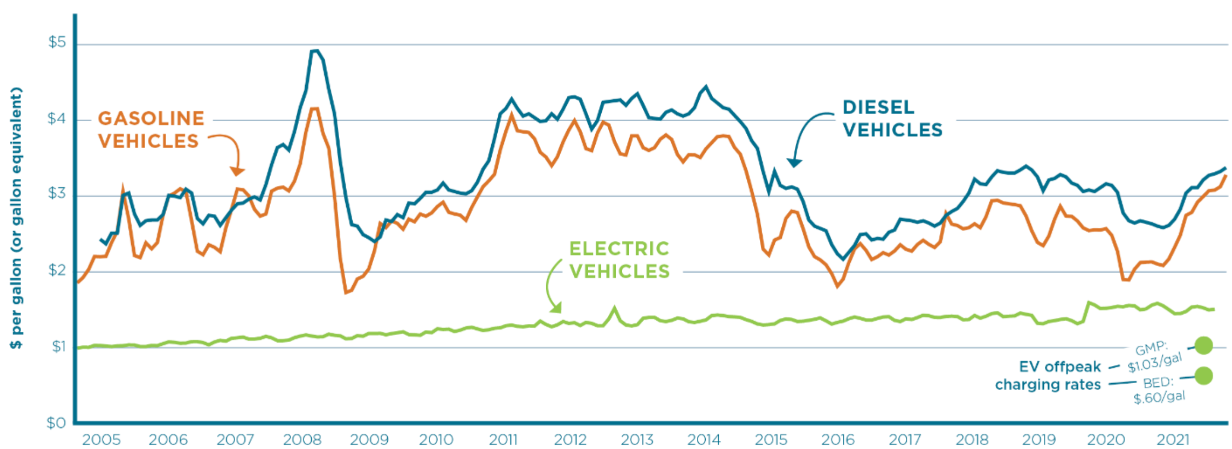
The result of this scenario is an estimated cumulative emissions reduction of 278,122 MT CO_2e by 2030. This makes up around 20% of the needed reductions to meet the 2030 transportation

[13] This accounts for emissions reductions over the period 2026-2030.
[14] The remaining 74% of transportation emissions reductions will be met through other pathways not discussed in this research brief
[15] P41: https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/202112/Initial%20Climate%20Action%20Plan%20-%20Final%20-%2012-1-21.pdf
[16] Vermont's current rates lie in between VEIC's low and medium scenarios

sector emissions reduction goals, or 8% of the overall needed statewide GHG reductions by 2030. An additional 1,104,278 MT CO_2e will be needed from other sources to meet the 2030 transportation sector goals. While this scenario falls below the standards for the CAP's high impact plans, the Electric Vehicle BAU Scenario would categorize ACC II as a "medium impact plan," which the CAP defines as falling between 2.5% and 10% of overall needed reductions.

Beyond emissions benefits, there are also clear economic benefits for consumers from ACC II. This is largely in relation to making EVs available that provide decreased operational and maintenance costs, as compared to fossil fueled vehicles. For instance, the Union of Concerned Scientists estimates that EV drivers in rural Vermont can save up to $1,500 per year compared to driving an ICE vehicle, primarily due to decreased fuel and maintenance costs.[17] The chart below shows how drivers of vehicles that use gasoline and diesel face higher and more volatile costs than EV drivers. EV charging costs have proven to be lower on a gallon equivalent basis, and much more stable over time.

Comparison of Vermont transportation fuel costs, 2005–2021



Sources: Gas and Electric — Drive Electric VT (via EIA); Diesel — Vermont Agency of Transportation (VTrans).

This analysis of ACC II is meant to aid policy deliberations regarding how Vermont should proceed with electric vehicle strategies. However, simply ensuring greater EV availability within the state via ACC II does not necessarily mean that those vehicles will be purchased or that

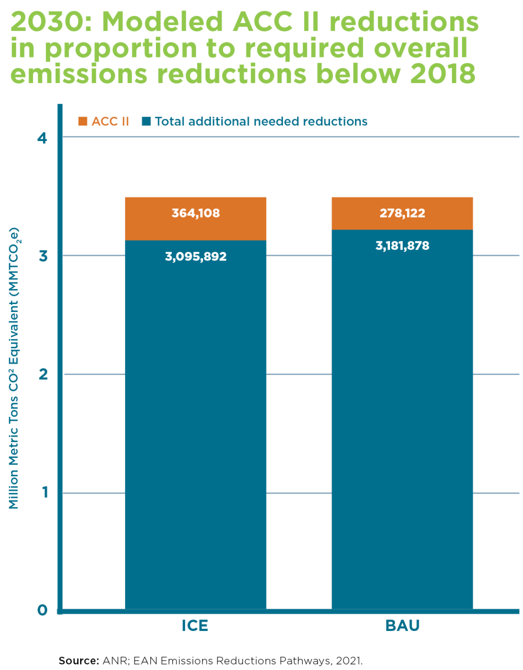
[17] https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles

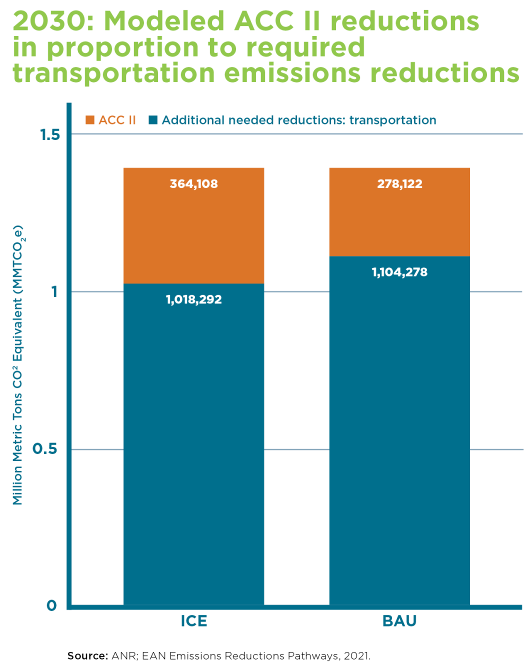
transportation emissions targets will be met. Although ACC II will increase the number of EVs available for sale, complementary policies and programs will be needed to ensure that those vehicles are affordable, with the necessary supporting infrastructure at scale.

Note: Thank you to the Vermont Department of Environmental Conservation for providing the underlying data used to conduct this analysis, as well as for collaborating and providing feedback on results. This work would not have been possible without the help of Deirdra Ritzer, Collin Smythe, and Megan O'Toole. Also, thanks to David Roberts at Drive Electric VT for being a thought partner on the assumptions related to EV adoption.

APPENDICES

APPENDIX A: ACC II Impact Compared to Emissions Requirements





APPENDIX B: ACC II Modeling Results

ACC II analysis summary chart

	UNIT	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Annual New ZEVs	*vehicles*	**11,275**	**15,080**	**18,883**	**22,705**	**26,470**	**28,652**	**30,882**	**33,093**	**35,315**	**37,635**
Cumulative ZEVs	*vehicles*	**11,275**	**26,355**	**45,237**	**67,942**	**94,412**	**123,064**	**153,947**	**187,040**	**222,355**	**259,990**
ICE Scenario											
Annual Emissions Reductions	*MT CO2e*	**47,310**	**61,064**	**73,790**	**85,619**	**96,325**	**103,219**	**110,146**	**116,862**	**123,485**	**130,319**
AEV	*MT CO2e*	39,309	50,701	61,221	70,981	79,793	85,435	91,093	96,565	101,949	107,496
PHEV	*MT CO2e*	8,001	10,363	12,569	14,638	16,532	17,784	19,053	20,297	21,536	22,823
Cumulative Emission Reductions	*MT CO2e*	**47,310**	**108,374**	**182,164**	**267,783**	**364,108**	**467,327**	**577,473**	**694,335**	**817,820**	**948,139**
BAU Scenario											
Annual Emissions Reductions	*MT CO2e*	**34,741**	**46,354**	**56,739**	**66,074**	**74,214**	**77,998**	**81,883**	**85,847**	**90,235**	**95,610**
AEV	*MT CO2e*	30,788	40,314	48,727	56,168	62,518	65,321	68,121	70,914	74,007	77,898
PHEV	*MT CO2e*	3,953	6,040	8,012	9,906	11,696	12,678	13,761	14,933	16,228	17,712
Cumulative Emission Reductions	*MT CO2e*	**34,741**	**81,095**	**137,834**	**203,907.69**	**278,122**	**356,120**	**438,003**	**523,849**	**614,084**	**709,694**

Source: ANR; EAN Emissions Reductions Pathways, 2021.