

Vermont Agency of Transportation
Transportation, Climate Change, and Energy
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I. Overview

Climate Change presents a significant risk to the State of Vermont's transportation infrastructure. The Vermont Agency of Transportation (VTTrans) is responsible for working with other state agencies to mitigate the magnitude of climate change by reducing greenhouse gas emissions from the transportation sector, which is the largest source of greenhouse gas emissions in the State. In addition, VTTrans is responsible for adapting the State's transportation network to changes in the climate that cannot be avoided.

Climate change presents Vermont and other jurisdictions—in the U.S. and abroad—with both challenges and opportunities. A robust response to climate change promises to advance energy security, stabilize energy prices, redirect energy investments into local economies, and protect the natural and built environments. This paper provides a brief overview of VTTrans' role in mitigating the effects of climate change and adapting to its effects on transportation.

II. Mitigation

Mitigating greenhouse gas emissions from the transportation sector demands a multi-pronged effort. For VTTrans, this effort includes working in cooperation with regional planning commissions and municipalities to continue to reduce vehicle miles traveled in the State. The means of reducing vehicle miles traveled include advancing Vermont's core planning objective of mixed use compact development surrounded by working rural landscapes, increasing freight and passenger rail, incorporating bicycle and pedestrian facilities into the transportation network, and making public transportation more convenient. VTTrans is active along all these fronts.

Mitigation in the transportation sector also requires adopting and implementing public policies to reduce motor vehicle emissions as rapidly as possible. Electric vehicle technology is advancing at an explosive rate. The rate of change includes lower prices, longer ranges, better performance, broader vehicle model selections, wider charging station availability, and faster charging times. Although electric vehicles currently represent only a small fraction of motor vehicle sales, the market share of electric passenger vehicles has been climbing rapidly in recent years, and all forecasts predict the rate of change to accelerate. Battery electric passenger vehicle technology has become competitive with internal combustion vehicles, and battery electric public-transit and school buses are emerging.

Major auto makers are also working to bring hydrogen fuel cell technology to market. Hydrogen electric motors may eventually compete with internal combustion engines in long-haul freight, construction, and other heavy-duty trucks (like plow trucks), where battery technology may not be suitable. Until battery or hydrogen technology can power heavy-duty electric trucks, biofuels

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and other gasoline and diesel alternatives (like compressed natural gas) may serve as important transitional technologies.

In spite of the rapid advances in electric vehicle technology and deployment, the free market is not expected to move quickly enough by itself to enable Vermont (or other jurisdictions in the U.S. and abroad) to meet the renewable energy targets they have established in order to mitigate the worst effects of climate change. One of the most important measures Vermont can take to mitigate greenhouse gas emissions, and perhaps the most important measure Vermont can take in the transportation sector, is to adopt and implement public policies that will accelerate the market share of electric vehicles. Research has shown that the biggest barriers to consumer adoption of electric vehicle technology are range, charging-infrastructure availability, price, charging time, and model availability.

Vermont and other jurisdictions can pressure automakers to improve and market electric vehicles by continuing to support technology-forcing corporate average fuel economy (CAFÉ) standards and continuing to adopt California's exhaust emission standards through the Multi-State Zero Emission Vehicle Action Plan. In addition, Vermont must continue its efforts to increase the availability of fast-charging infrastructure in the State and adopt measures to make electric vehicles more affordable for more Vermonters. Significant rebates have proven very effective at moving electric vehicle sales in Vermont, other states, and other countries.

To help transition the motor-vehicle market to renewable technologies, California has incorporated transportation fossil fuels into its cap and trade system. Vermont and other Northeastern states could consider following California's example by incorporating gasoline and diesel into their Regional Greenhouse Gas Initiative (RGGI) or establishing another regional market-based system to accelerate the transition from fossil fuels to renewable energy in the transportation sector. The revenues generated could go directly to consumers in the form of rebates for electric vehicles and support for a network of affordable electric vehicle charging infrastructure.

Additional information on steps VTrans is taking to mitigate climate change in the transportation sector follows.

A. Policy Context for VTrans' Work on Mitigating Climate and Energy Issues

Much of VTrans' work on climate and energy derives from the State's Comprehensive Energy Plan (CEP):

1. The CEP, which is prepared by the Department of Public Service, is required by statute. (30 V.S.A. § 202b.)
2. The CEP in turn leads to a number of other documents:
 - a. State Agency Energy Plan (SAEP), which is prepared by the Department of Buildings and General Services. (3 V.S.A. § 2291.)
 - b. VTrans' State Agency Energy Implementation Plan (SAEIP). (3 V.S.A. § 2291b.)

- c. The Vermont Transportation Energy Profile, which the University of Vermont's Transportation Research Center prepares under contract with VTrans every two years.
3. VTrans' responsibilities under the CEP fall into two categories:
 - a. First, VTrans needs to reduce the climate and energy footprint of its own operations. This alone involves considerable work because VTrans owns and operates numerous buildings and a large fleet of vehicles, including both cars and heavy trucks. In addition, VTrans has an enormous electricity bill from street lights, traffic signals, and other devices. VTrans' SAEIP, which helps carry out the SAEIP, details VTrans' work in this area.
 - b. VTrans' second area of responsibility under the CEP goes beyond its own energy footprint and extends to moving the transportation sector as a whole toward a more renewable system. The big lift here involves helping to bring plug-in electric vehicles in Vermont out of their early market phase and into the mainstream. VTrans' Transportation Energy Profile tracks metrics in this area but does not address the activities VTrans is undertaking to move these metrics.

The following sections address VTrans' work on reducing its own energy footprint and then provide additional information about some of VTrans' work to increase the market share of electric vehicles in Vermont, along with other efforts to advance renewable energy in the transportation sector.

B. VTrans' Work on Reducing its Own Energy Footprint

VTrans' internal energy-efficiency and renewable-energy programs have so far resulted in cost savings for the agency. To provide some examples:

1. VTrans has installed and owns solar photovoltaic systems with capacity ratings from ten to twenty kilowatts at about ten of its garages. At the Rutland Airport, VTrans installed and owns a 60,000 kilowatt solar photovoltaic system.
2. In addition, VTrans entered into third-party agreements with All Earth Renewables, which installed solar photovoltaic systems at the Fair Haven Welcome Center and three VTrans garages.
3. VTrans commissioned a Solar Plan, which was released in December 2016, to help with the complex decision making involved in siting and operating solar projects on VTrans properties, including rights of way. VTrans is working with other agencies on how to move forward with the Solar Plan in view of recent changes to Vermont's net metering rule that may make future solar projects on transportation property less cost effective.
4. VTrans is converting the lighting at all of its park & ride facilities and all of its street lights to LED. VTrans has also converted its traffic signals and flashing beacons to LED, and some use solar power.

5. VTrans is working on moving away from heating oil to natural gas, propane, and wood to heat its buildings. About half of VTrans' garages burn wood as a primary heat source. VTrans is committed to installing at least three new outdoor high efficiency wood boilers per year at its garages. Wood is considered a renewable source of energy.

C. VTrans' Work to Advance Renewable Energy in the Transportation Sector

VTrans is performing extensive work beyond addressing its own energy footprint by helping to move the State's transportation network to renewable energy. Some examples:

1. VTrans is installing Level 1 electric vehicle charging at all new park & ride facilities and also in retrofit projects that involve new lighting. VTrans installs Level 1 charging on every light pole that has parking spaces nearby. This policy avoids having to designate certain spaces as electric vehicle parking only.
2. VTrans plans to install Level 2 charging at the Dill Building near the Knapp Airport in Berlin, and VTrans is looking into installing direct current fast charging (DCFC) infrastructure at its maintenance facility in White River Junction, with plans to make the charging ports available to all state vehicles. VTrans is in the process of procuring a Nissan Leaf and a Chevy Bolt for its fleet.
3. VTrans commissioned a study of the feasibility of installing fast charging for electric vehicles at rest areas and welcome centers along interstate corridors in Vermont. Initial results revealed that doing so would not be cost effective because of lack of proximate phase 3 power. VTrans worked with Drive Electric Vermont, other agencies, and VTrans' consultant (Dubois & King) to modify the work plan to investigate alternative sites on private properties (filling stations, convenience stores, etc.) near interstate exchanges and other major highways.

The modified study, which is still underway, has identified six potential sites that, together with existing publicly available fast chargers, would bring fast charging within thirty miles of almost every location in Vermont. Implementing this study will achieve VTrans' third most important goal to meet the Governor's top strategic priorities: "By 2023, 90% of Vermont households will be 30 miles or less from an electric vehicle fast charge station."

VTrans will continue to work with its partner agencies on the complex contracting and financing mechanisms that may be necessary to implement the study's findings. However, VTrans hastens to add that state government must continue to help build out electric vehicle charging infrastructure beyond the sites identified by the Dubois & King study to help increase the market share of electric vehicles and that significant rebates to consumers who purchase electric vehicles are also necessary.

4. VTrans, in consultation with other agencies and with technical support from the Vermont Energy Investment Corporation (VEIC), and in response to a legislative mandate, produced a report in December 2016 on whether it would be appropriate to

assess additional registration fees on plug-in electric vehicles. Based on that report, VTrans provided testimony to the Senate Transportation Committee during the 2017 legislative session that additional fees for electric vehicles would not raise significant revenues and would dis-incentivize electric-vehicle purchases until electric vehicles constitute at least fifteen percent of new passenger car sales.

5. VTrans has been a regular participant in the Transportation & Climate Initiative (TCI), facilitated by the Georgetown Climate Center. This group of Northeast and Mid-Atlantic states works collaboratively to support the deployment of electric vehicles and to maximize the economic opportunities these vehicles can bring to the region. TCI's work extends well beyond electric vehicles to the gamut of climate-change and renewable-energy challenges and opportunities. TCI conferences include representatives of not only state governments, but also private companies and major non-profit organizations. Vermont and other TCI states have found it effective to work in partnership due to the relatively small nature of our geography and the high frequency of interstate travel in our region.
6. The Fixing America's Surface Transportation (FAST) Act requires the Secretary of Transportation to designate national electric-vehicle charging, hydrogen, propane, and natural gas fueling corridors. In 2016, Vermont submitted a regional nomination for Alternative Fuel Corridor Designation on behalf of the TCI states. Vermont was successful in receiving designation of the majority of its interstates as alternative fuel charging corridors. These corridors include the whole of I-89, from the New Hampshire border to the Canadian border. The Federal Highway Administration awarded designations based on minimum thresholds of existing electric vehicle charging infrastructure. While the designation currently does not provide for funding, it enables the states to implement a unified signing program intended to encourage and promote the further development of electric vehicle travel and infrastructure. VTrans plans to install signs for the DCFCs along the designated corridors.
7. VTrans is a stakeholder in Drive Electric Vermont (DEV), which is facilitated by VEIC. DEV works to increase awareness of electric vehicles, encourage investment in charging infrastructure, and coordinate with other New England and Mid-Atlantic states to plan for greater regional infrastructure buildout. DEV offers incentives for purchasing zero emission vehicles (ZEVs), raises consumer awareness, keeps data, and works on legislation and policy relating to ZEVs.
8. VTrans has been an active participant in the New England Governors & Eastern Canadian Premiers Tactical Air Quality Committee and worked with Governor Scott's Office on the revised regional Climate Change Action Plan that the Governors and Premiers accepted last summer.
9. VTrans includes the State's renewable energy goals into its planning work. VTrans produces and updates numerous plans, including for example, plans for passenger rail, freight rail, aviation, bike/ped, public transit, and highways. Many renewable energy

planning strategies complement one another. For example, compact mixed use development works well for walking and biking. VTrans also works in close cooperation with regional planning commissions, which are responsible for including energy planning standards into their regional plans. VTrans analyzes greenhouse gas emissions from proposed projects requiring an environmental assessment or an environmental impact statement under the National Environmental Policy Act.

10. VTrans has developed and operates around thirty state-owned park & ride facilities and has assisted in developing over sixty-two municipal park & ride facilities. VTrans also runs a commuter ride share program known as Go Vermont.
11. VTrans and other agencies are looking at the use of some of the Volkswagen settlement funds to help build out charging infrastructure. Vermont is expected to receive \$18.7M under Appendix D of the settlement. Up to fifteen percent (\$2.8M) of these funds may be used for this purpose. Appendix D funding may also be used to support additional electric vehicle infrastructure as necessary to support electric buses purchased with Appendix D funds. In addition, VTrans is working with other agencies on encouraging Volkswagen to direct Appendix C settlement funding toward Vermont through Volkswagen's Electrify America program, which will invest \$2B over the next ten years in zero emission vehicle infrastructure and awareness. The VW funds will help stimulate market transformation and the electrification of the transportation sector.
12. The Federal Transit Administration (FTA) recently awarded VTrans \$480,000 through its Low or No Emission Vehicle Deployment competitive grant program (Low-No) to offset the costs of purchasing electric transit buses. VTrans is working with the Green Mountain Transit Authority (GMT) and the Burlington Electric Department (BED) on leveraging these funds to secure a VLITE grant of \$242,000. BED will contribute \$66,500 to help fulfill its obligations under Tier 3 of Vermont's renewable energy standard. Depending on the outcome of the VLITE grant application, VTrans expects that GMT will have two to four electric transit buses in service by next fall. BED will serve as the host utility, and the buses will charge at GMT's Burlington facility during off-peak hours. GMT will serve as the technical lead for project implementation, responsible for procuring vehicles and equipment and managing deployment of the infrastructure at their operations and maintenance facility in Burlington.

III. Adaptation

Our transportation infrastructure is vulnerable to climate change. The unprecedented flooding of 2011 made this fact overwhelmingly clear. Tropical Storm Irene damaged 500 miles of roads and 200 bridges on the state highway system alone. Road damage isolated thirteen Vermont communities entirely, and total infrastructure damage was on the order of \$250 to 300 million. Although we cannot say with certainty that Tropical Storm Irene or any other meteorological

event was the result of climate change, we do know that one effect of climate change in Vermont will be an increase in the frequency of extreme precipitation events.

A. Measures Taken

VTrans has taken a number of steps to assess the risks that climate change poses to transportation infrastructure, to prioritize those locations most at risk, and to develop plans to adapt to the risks. Among the projects to reduce climate vulnerabilities in the state's transportation system are the following:

1. VTrans is using LiDAR (Light Detection and Ranging) to map primary transportation and river corridors to improve the precision of flood models. This project is an expansion of previous collaborations between VTrans and the Agency of Natural Resources to identify infrastructure in high-risk flood or erosion zones.
2. VTrans conducts flood resiliency training programs to educate key audiences on river dynamics, impacts of floods on infrastructure, and related best management practices.
3. VTrans is developing Transportation Resiliency Plans on a watershed basis to identify infrastructure most at risk of flood damage and to evaluate strategies to mitigate that risk. This will allow the state to efficiently prioritize spending on infrastructure adaptation.
4. VTrans is collecting condition and performance data on state-owned transportation infrastructure to improve the state asset inventory and to inform project prioritization decisions.
5. VTrans and the Institute for Sustainable Communities have introduced the Resilient Vermont Project to increase Vermont's resilience to extreme weather events. The project seeks to compile an inventory of resilience building activities across the state and prioritize investments and actions that will improve resilience.
6. VTrans has developed a computerized tool that can rapidly assess culvert vulnerability. This will allow the state to expedite support during emergencies and efficiently reassess culvert vulnerabilities.
7. Emergency management training remains a focus for the Agency with all staff required to complete incident command training annually to ensure everyone speaks the same language should disaster strike. Managers and other critical staff train at even higher levels and stand ready to support other agencies through Vermont Emergency Management. VTrans and the Agency of Natural Resources have developed guidance to coordinate expedited permitting in emergencies, and the agencies continue to meet to coordinate emergency preparedness.

8. In the aftermath of Tropical Storm Irene, which flooded much of Vermont in 2011, VTrans worked in close cooperation with the Agency of Natural Resources to convince the Federal Emergency Management Agency (FEMA) to accept Vermont's modern bridge and culvert standards as eligible for replacement-project funding. FEMA finally agreed after years of litigation and negotiation. These modern standards protect the environment by allowing for the passage of aquatic organisms and also by preserving stream equilibrium. They also result in bridges and culverts that typically survive high water events that would destroy other stream crossing structures. VTrans staff participates in the Department of Environmental Conservation's Rivers and Roads Training program to stay current on the interaction of waterways and stream crossings. VTrans also worked closely with the Agency of Natural Resources on complying with its Flood Hazard Area and River Corridor Protection Rule.
9. VTrans is working in close cooperation with Vermont Department of Fish and Wildlife on a variety of initiatives involving the intersection of transportation systems and wildlife habitat. Creating a transportation network that is more permeable to wildlife has become more important than ever with the pressures that climate change is placing on wildlife populations. To provide a smooth, vegetated surface that wildlife can walk on, VTrans now incorporates side-slope riprap grubbing into its new bridge projects where doing so is reasonably practicable. At a critical pinch point for wildlife between two large habitat blocks (near the Little River in Waterbury), VTrans worked with the Department of Fish and Wildlife to install a landscaped wildlife shelf to facilitate wildlife passage beneath an interstate bridge and another nearby bridge that carries a busy state highway. VTrans will work with the Department of Fish and Wildlife to maintain the wildlife shelf for long-term functionality.
10. VTrans keeps abreast of climate adaption policy and research through participation in a number of organizations. These include, for example, the Vermont EPSCoR research project known as Basin Resilience to Extreme Events, organized by the University of Vermont; the workgroup on Methods and Tools for Transportation Resilience Planning, organized by the American Association of State Highway and Transportation Officials (AASHTO); and the State Smart Transportation Institute (SSTI), organized by the University of Wisconsin.

B. Future Measures

While the aforementioned projects are a step in the right direction, opportunities remain for VTrans to improve the adaptive capacity of Vermont's transportation system. Expansion of data gathering and monitoring programs would improve the agency's ability to recognize and respond to climate threats. Updating project prioritization guidelines and best practices would similarly aid in mitigating climate change risks. Improvements in these areas are of particular value because they are likely to provide benefits under any climate scenario. Some specific actions might include:

1. Establish an electronic database of Project Worksheets (PWs) and Detailed Damage Inspection Reports (DDIRs) to improve identification of vulnerable infrastructure and speed the federal funding process in the event of a disaster. PWs and DDIRs are forms used by FEMA and FWHA respectively that define work and cost estimates of projects seeking reimbursement.
2. Conduct research to identify climate related thresholds at which specific types of infrastructure are subject to significant deterioration. This will improve decision making on matters such as when to institute higher construction standards for new projects or when to reassess infrastructure for vulnerabilities.
3. Further expand the quality and quantity of the data in the state's asset inventory. Look to standardize data held by different agencies and stakeholders. An improved ability to track state infrastructure will allow changes to be made to vulnerable assets before they fail. This effort should be supplemented by increased support of local asset inventory creation and maintenance.
4. Develop analytical vulnerability and risk assessment tools. Examples include a real-time flood monitoring system, or tools to assess the costs associated with differing infrastructure under various potential climate scenarios.
5. Update project prioritization guidelines to take into account vulnerability to flooding and fluvial erosion. Update the hydraulics manual to include refined best practices given the threats posed by climate change.

Many of these changes are not easy to implement. Limited budgetary resources are a perpetual challenge to long-term resilience investments. Scientific uncertainties regarding regional climate forecasts, political and economic barriers, and regulatory hurdles all further the difficulty of adaptation planning. To minimize the creation of additional financial burdens, VTrans works to incorporate adaptation efforts and best practices into regular system reinvestments. These frameworks, combined with the specific actions outlined above, will enhance the adaptive capacity of Vermont's transportation system and bolster the ability of VTrans to respond to climate threats in all present and future scenarios.

IV. Conclusions

VTrans is an essential part of a multi-agency effort to meet the State's renewable energy goals and adapt to climate effects that can no longer be avoided. VTrans' facilities have a significant environmental impact, and the transportation sector is the largest source of greenhouse emissions and energy consumption in the State. VTrans will continue to work to reduce its own carbon footprint and to move transportation in Vermont toward renewable energy as rapidly as possible, while also working to protect the State from the changes to the climate that cannot be prevented.