MassCEC Vehicle-To-Everything (V2X)
Demonstration Program

VEHICLE-TO-EVERYTHING
RESEARCH REPORT

PREPARED BY

CONVERGE STRATEGIES

VGIC
VEHICLE-GRID INTEGRATION COUNCIL

PREPARED FOR

MASSACHUSETTS CLEAN ENERGY CENTER®

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ABOUT CONVERGE STRATEGIES, LLC

Converge Strategies, LLC (CSL) provides consulting services focused on the intersection of clean energy, resilience, and national security. CSL's mission is to integrate resilience and security as first principles in the clean energy transformation. CSL provides project facilitation services, policy design and research, and market strategy development. CSL frequently works with the Department of Defense (DoD), the U.S. Department of Energy (DOE), national laboratories, city and state governments, and a variety of private sector organizations.

ABOUT THE VEHICLE GRID INTEGRATION COUNCIL

The Vehicle Grid Integration Council (VGIC) is a national 501(c)(6) membership-based advocacy group committed to advancing the role of flexible EV charging and discharging through policy development, education, and research. The mission of VGIC is to support the transition to decarbonized transportation and electric sectors, ensuring the value of flexible EV charging and discharging is recognized and compensated in support of a more reliable, affordable, and efficient electric grid.

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ACRONYMS

BEV: Battery-operated electric vehicle
BGE: Baltimore Gas & Electric
CECP: Clean Energy and Climate Plan
CPECs: Clean Peak Energy Certificates
CPUC: California Public Utilities Commission
CPS: Clean Peak Energy Standard
DC: Direct-current charging
DERMS: Distributed energy resource management system
DOER: Department of Energy Resources
CEC: California Energy Commission
ELRP: Emergency Load Reduction Program
ESB: Electric school buses
ESS: Energy storage systems
EV: Electric vehicle
FUSD: Fremont Unified School District
HIS: Home Integration System
kWh: Kilowatt hours
MassCEC: Massachusetts Clean Energy Center
MassEVIP: Massachusetts Electric Vehicle Incentive Program
MOR-EV: Massachusetts Offers Rebates for Electric Vehicles
PG&E: Pacific Gas & Electric
RVXDS: Replicable V2X Deployment For Schools
SCE: Southern California Edison Company
SDES: Standalone short-duration energy storage
SDG&E: San Diego Gas & Electric
V2G: Vehicle-to-Grid
V2H/V2B/V2L: Vehicle-to-Home, Building, Load
V2X: Vehicle-to-Everything

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1. REPORT SUMMARY

The purpose of this research report is to provide V2X installers, utilities, customers, and others with lessons learned and key insights from national and international V2G and V2X pilot programs. Drawing on publicly available resources and programs as well as external information, the authors aim to identify key industry pain points and opportunities across geographies for Massachusetts to consider in the next stages of the MassCEC V2X Demonstration Program. This report is intended as a practical resource, not a comprehensive survey of the field.

Key themes include policy, regulatory, funding, and stakeholder coordination considerations for V2X deployment, with particular emphasis on the role of consistent funding, robust state policy, and cross-sector collaboration.

When properly coordinated, V2X pilots can serve as distributed assets that support grid stability, reduce peak demand stress, and build resilience against energy supply disruptions during extreme weather. With the right infrastructure, EVs can be selectively charged and discharged to meet grid needs and provide backup power during outages — all while remaining operational as personal or fleet transportation and maintaining long-term battery health.[1]

The findings of this report will guide a set of regional workshops across Massachusetts and a guidebook outlining key findings from the MassCEC program.

2. REPORT INTRODUCTION

The Massachusetts Clean Energy Center (MassCEC) Vehicle-to-Everything (V2X) Demonstration Program seeks to identify and implement a set of electric vehicle (EV) charging demonstration projects across the state of Massachusetts that will enable vehicle-to-home (V2H) and/or vehicle-to-grid (V2G) capabilities, and to develop guidance for vehicle-to-everything (V2X) deployment for different use cases. Through the V2X demonstration program, MassCEC is helping residential and commercial customers, as well as school districts that own or are in the process of purchasing an EV capable of bidirectional charging, to create a more resilient grid by using EVs as energy storage.

With this information in mind, the research report is designed with the express purpose of providing the V2X audience with lessons learned and key findings that could provide a useful foundation for the MassCEC Demonstration Program. The report structure is built to meet the needs of this purpose. This report is structured as follows:

[1] "Table of State Energy Storage Targets and Progress," Clean Energy State Alliance, accessed March 2026

- **Section 1: Report Summary.** Provides an overview of the reports contents and highlights key findings.
- **Section 2: Report Introduction.** Outlines baseline information about the V2X program and informs the reader on what they can expect from each section.
- **Section 3: Introduction to Vehicle-to-Everything (V2X) Technologies.** Provides the reader with an understanding of the V2X ecosystem and the benefits associated with V2X.
- **Section 4: EV Market Demand.** Conveys critical information about the state of the EV market in relation to the U.S. and the Commonwealth of Massachusetts.
- **Section 5: Massachusetts Policy Landscape.** Outlines the current policy and research landscape of Massachusetts, highlighting opportunities and potential ambiguity.
- **Section 6: Introduction to V2X Case Studies.** Provides a comprehensive framework for readers to view the case studies with.
- **Section 7: V2X Case Studies.** Reviews five case studies, providing diverse perspectives across V2X scenarios.
- **Section 8: Case Study Findings.** Outlines critical lessons learned pulled from the reviewed case studies, notes gaps of information still to be explored, and opportunities for MassCEC to lead in the V2X space.

3. INTRODUCTION TO VEHICLE-TO-EVERYTHING (V2X) TECHNOLOGIES

3.1. ABOUT VEHICLE-TO-EVERYTHING (V2X)

Vehicle-to-everything (V2X) technology enables electricity stored in electric vehicles' (EVs) batteries to be discharged to external systems. V2X can also refer to wireless communication between a vehicle and any other entity, allowing vehicles to interact with and share data with their surroundings. This report does not focus on V2X communication, such as vehicle-to-vehicle or vehicle-to-pedestrian.

This report primarily focuses on three categories of V2X applications:

- **Vehicle-to-load (V2L)**: EV battery powers a load, such as an appliance.
- **Vehicle-to-building (V2B) and Vehicle-to-home (V2H)**: Bidirectional flow between an EV battery and a building or homes, buildings, or appliances. This can include discharging when the home, building, or load is grid-parallel or grid-disconnected.
- **Vehicle-to-grid (V2G)**: Bidirectional flow between an EV battery and the larger utility grid.

V2G creates a two-way flow of energy, leveraging EVs' mobile batteries to power homes and buildings or send power back to the electrical grid. Fundamentally, V2G involves pairing EV batteries with bidirectional charging equipment so they can serve as power sources without compromising the primary mobility use case. In comparison, V1G is unidirectional smart charging with enhanced controls that lower costs. V2G enables revenue generation by selling energy back to the grid and provides grid stability during periods of high demand.

The focus on these three V2X categories in this report stems from the resilience benefits they provide. With an average capacity of 40-60 kWh on a full charge, bidirectional-enabled battery-operated electric vehicles (BEVs) could provide backup power to an American home for 1-2 days. Larger EVs can store up to 200 kWh, and long-range buses can store up to 650 kWh, raising backup capacity to 6-21 days per facility.[2] Backup power, such as that provided by bidirectional charging, can serve as a lifeline during outages, protecting critical facilities and homes.

Peak load on the electrical grid occurs at the time of highest electricity use. For example, this can occur during very high or very low temperatures when HVAC system loads require utilities to use more costly "peaker" generation sources to meet the surge in demand. This increases electricity costs and strains the electrical grid. There is growing evidence that V2X can also address distribution system constraints, creating value by deferring or eliminating the need for expensive infrastructure investments.

V2X solutions also allow customers to discharge energy during normal "blue sky"[3] grid conditions. In this grid-parallel mode, V2X customers can use energy from the vehicle to manage energy use in buildings and export energy to the grid, providing grid services. Today, this practice is primarily used to participate

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[2] EnergySage Editorial Team, "Bidirectional EV Chargevehicle energy to manage building energy use rs," *EnergySage*, October 1, 2025.

[3] The term "blue sky" refers to normal, routine operating days for utilities. These days are categorized by routine loads and the absence of emergencies such as severe weather or cyber indcidents.

in demand response programs as offered by utilities to reduce peak energy use when the grid is most stressed during periods of high costs. Though not yet widely used, another use case for this technology that would generate utility bill savings is a form of "energy arbitrage" in which energy stored in the vehicle's battery during "off-peak hours," when energy rates are lower, is then discharged during peak hours, when electricity is 2-3 times more expensive on average across the United States.[4] Increasing the integration of distributed energy resources, such as solar arrays and EV batteries, can also provide ancillary services, helping to maintain the grid balance between energy production and consumption.[5]

3.2 V2X FINANCIAL BENEFITS

There are both passive and active ways V2X adopters can generate financial earnings: by saving money on their electricity bills through peak-load shaving or by actively generating revenue participating in utility demand response programs or selling electricity back to the grid. Heavy-duty trucks, medium-duty trucks, and school buses can leverage their large vehicle batteries and direct-current (DC[6]) fast-charging infrastructure to maximize V2X revenue and savings. According to an analysis by McKinsey & Company, these vehicle types have the potential to earn ~$7-$12k per vehicle annually in Southern California's Edison territory.[3]

V2X allows EV owners and fleet operators to charge their vehicle(s) when energy is inexpensive and discharge when demand peaks. This provides customers with an opportunity to support the grid's resilience and reliability, while potentially earning revenue from energy sold back to the grid. However, few existing rate structures compensate customers for exporting to the grid. A number of national and international pilot programs have highlighted the opportunities and gaps for V2X deployment worldwide.

4. EV MARKET DEMAND

In 2024, EVs made up 20% of the market share of total vehicles purchased, with 17 million EVs sold globally.[7] Despite current political and demand uncertainty, it is anticipated that EVs will account for between 12 and 50% of all car sales in the U.S. by 2030.[8] As EVs continue to gain global market share across the transportation sector, with almost half of car sales in China being electric in 2024, representing almost two-thirds of electric cars sold globally, their availability as a flexible grid-edge asset also increases. Despite the loss of federal EV incentives in the U.S., approximately 1.5 million were sold in 2025, representing 7.8%–10% market share.[9]

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[4] Julia Zaraeva, "Peak and off-peak electricity: Cheapest time to use energy," *A1 SolarStore*, May 04, 2025.

[5] McKinsey & Company, "What promise does V2X hold for fleets?," August 29, 2023.

[6] High-power, unidirectional charging converted from household alternating current at the EVSE and delivered directly to the EV's battery

[7] "Trends in electric car markets," *U.S. Energy Information Administration (EIA)*, 2025.

[8] Walton, Robert, "US electric vehicle sales are slowing amid policy shifts: BNEF," *Utility Dive*, June 18, 2025.

[9] Argonne National Laboratory, "Light Duty Electric Drive Vehicles Monthly Sales Updates," *Argonne National Laboratory,* updated monthly.

There are currently approximately 166,296 EVs on the road in Massachusetts as of the end of 2025.[9] The following figures illustrate the numbers of light-, medium-, and heavy-duty EVs on the road in Massachusetts, as well as the miles they travel.

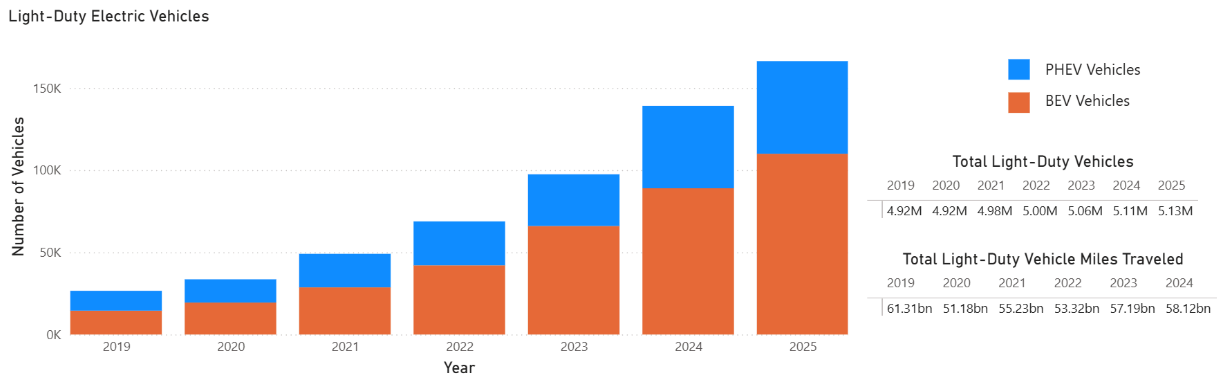

Figure 1: The above figure shows data on light-duty electric vehicles, both PHEV and BEV, as well as vehicle miles traveled in Massachusetts. Figure sourced from the Commonwealth of Massachusetts.

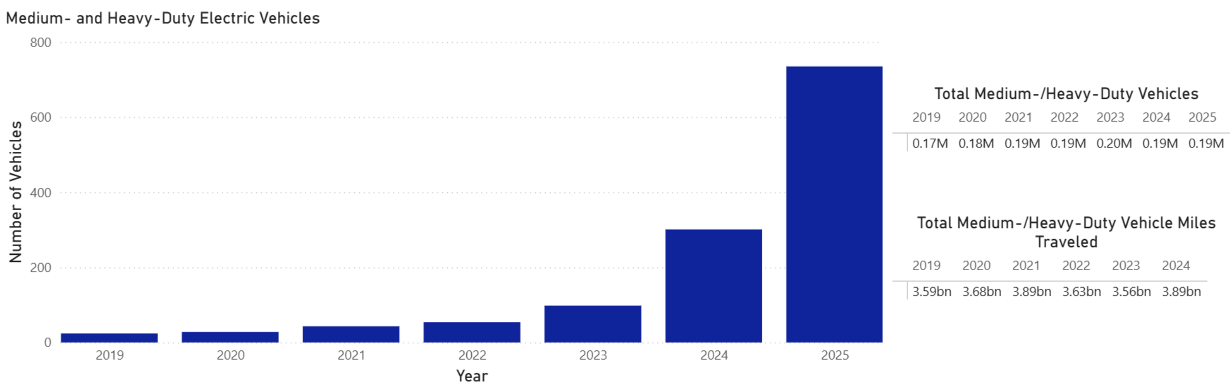

Figure 2: The above figure shows data on medium and heavy-duty electric vehicles and vehicle miles traveled in Massachusetts. Figure sourced from the Commonwealth of Massachusetts.

Per its Clean Energy and Climate Plan (CECP), Massachusetts has set a goal of 900,000 EVs on the road by 2030, with benchmark targets of 5 million light-duty EVs and more than 350,000 medium- and heavy-duty EVs by 2050. See section 5 Massachusetts Policy Landscape for additional information on these goals.

The exact number of vehicles currently being used in V2X applications in Massachusetts is uncertain due to a lack of collected data. For the state to make informed decisions about V2X policy, regulation, and strategy, more robust data on current V2X deployments and use cases is necessary. A full V2X market characterization for Massachusetts is beyond the scope of this research report. Several considerations could be taken into account in future research efforts:

[9] Commonwealth of Massachusetts, "Massachusetts Clean Energy and Climate Metrics," *Mass.gov*, accessed March 26, 2026.

- **Vehicle registrations.** Document new vehicle registrations by make and model, and identify the number of vehicles that have V2X capability.
- **Vehicle capability.** V2X capabilities can vary by vehicle. Some vehicles have V2X capability as a built-in feature (e.g, the Ford F-150 Lightning, the Kia EV6, and the Hyundai Ioniq 5). Other vehicles can add V2X capability by using additional equipment, such as third-party adapters or home bidirectional chargers.
- **V2X applications.** Some vehicles are only capable of V2L operation (e.g., Rivian R1T and Lucid Gravity), whereas other vehicles can feed power back into a building via a bidirectional charger (e.g., Tesla Cybertruck and Nissan Leaf).
- **V2X usage.** The use of V2X capabilities is an area for further research. It is unclear, for example, whether EV owners are using their V2X capabilities, and for what purpose.

5. MASSACHUSETTS POLICY LANDSCAPE

V2X-capable vehicles occupy a unique place in state policy and planning because they can contribute to a wide range of policy objectives across different infrastructure domains (e.g., transportation, electricity, and buildings) and agency responsibilities. This flexibility also creates complexity - it is not clear who "owns" the V2X opportunity or what strategies would be most effective for unlocking it. The project team surveyed recent policies that are relevant to the V2X market. This section briefly profiles policies, strategy documents, and plans in three categories:

- Statewide climate, energy, and resilience policy and planning
- Energy storage strategies
- Incentive programs

5.1 STATEWIDE CLIMATE, ENERGY, AND RESILIENCE POLICIES AND PLANNING

The state's decarbonization and clean energy policies set overall greenhouse gas reduction targets that would require the electrification of vehicle fleets and also set specific targets for electric vehicles.

Massachusetts expanded upon its climate legislation in 2022 when the state signed An Act Driving Clean Energy and Offshore Wind into law.[10] The legislation identified a need for Massachusetts to develop a comprehensive plan to reduce transportation emissions. It also established the Electric Vehicle Infrastructure Coordinating Council (EVICC) as the leading entity of the effort, and defined their mission to create "an equitable, interconnected, accessible and reliable electric vehicle (EV) charging network in Massachusetts."[11]

- **Global Warming Solutions Act of 2008 and the 2021 Climate Act.** Establishes a legally binding framework for reducing statewide greenhouse gas emissions and sets a long-term goal of achieving

[10] Commonwealth of Massachusetts, "AN ACT DRIVING CLEAN ENERGY AND OFFSHORE WIND," accessed May 6, 2026.

[11] Commonwelath of Massachusetts, "Electric Vehicle Infrastructure Coordinating Council (EVICC)," accessed May 2026.

net-zero emissions by 2050.[12] The transportation and electricity sectors account for 37% and 18% of Massachusetts' total GHG emissions, respectively.[13] By setting the greenhouse gas standard, the laws effectively require a transformation of the electricity system and the electrification of the vehicle fleet.

- **Clean Energy and Climate Plan (CECP) for 2025 and 2030.** Establishes interim reduction targets of 50% below 1990 levels by 2030, 75% by 2040, closing out with net zero by 2050.[14] Sets an interim 2030 target of 900,000 EVs on the road, and 50% of new vehicle sales being EVs. Targets ~5 million light-duty EVs and ~353,000 medium and heavy-duty EVs by 2050. The CECP specifically notes the potential of bidirectional charging to enable vehicles to provide backup power.

Several additional planning and strategy documents discuss, including the 2050 Decarbonization Roadmap (2021), the Transportation Sector Technical Report (2021), the Recommendations of the Climate Chief (2023), and the MassDOT Beyond Mobility Plan (2024) plan, which provide additional analysis, next steps, and recommendations related to vehicle electrification but do not specifically mention V2X strategies. The ResilientMass Plan focuses on transportation electrification and the need for emergency generators, but does identify V2X as a backup power strategy.

5.2 ENERGY STORAGE STRATEGIES

To inform implementation planning and identify the most effective pathways for grid modernization, Massachusetts commissioned three studies that assessed the state's energy storage landscape and needs. The findings from these studies directly informed the policies, programs, and incentive structures that followed.

2015 - State of Charge: A Comprehensive Study of Energy Storage in Massachusetts evaluated the economic benefits and market opportunities for energy storage.[15]

Findings: Energy storage has the potential to address multiple grid challenges, including growing peak load, generator retirement, and weather resilience. While this presents a substantial opportunity, the public policy intervention and targeted investment necessary to make large-scale storage economically viable were lacking.

2020 - The Mobile Energy Storage Study examined the feasibility of using mobile battery storage systems to respond to extreme weather events.[16]

Findings: Mobile energy storage systems (ESS) can deliver significant value across multiple use cases, with a primary focus on providing emergency relief services during emergency conditions. The study

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[12] "Global Warming Solutions Act Background," Commonwealth of Massachusetts, 2008
[13] "Tracking GHG Emission," Commonwealth of Massachusetts, accessed March 2026
[14] "Massachusetts Clean Energy and Climate Plan for 2025 and 2030," Commonwealth of Massachusetts, 2022
[15] "State of Charge: A Comprehensive Study of Energy Storage in Massachusetts," Commonwealth of Massachusetts, 2015
[16] "Mobile Energy Storage Study," Commonwealth of Massachusetts, 2020

suggests that this optionality value can stack with the value from everyday energy services, including enabling renewable energy penetration and other grid services.

2023 - Charging Forward: Energy Storage in a Net Zero Commonwealth assessed the current storage landscape and examined the role of mid and long duration storage in supporting state grid reliability.[17]

Findings: The study concluded that storage is essential to achieving a net-zero grid in Massachusetts, capable of delivering ancillary services, providing capacity value, and reducing emissions. It also found that existing state and utility programs are insufficient to achieve deployment at the required scale, and that expanding both distribution-circuit and behind-the-meter storage is necessary to deliver meaningful reliability benefits.

Each of these studies forms a clear progression, building off one another to provide a foundation of knowledge and recommendations for the framework needed to support a program like V2X. *The State of Charge* report establishes the foundational framework and targets for stationary storage. *The Mobile Energy Storage Study* extends the opening to mobile platforms, including EVs, and planted the seeds for V2X thinking within an energy storage and emergency response frame. *Charging Forward* then acknowledged V2X as a legitimate storage resource that can compete and or complement standalone storage – though the study chooses not to analyze V2X, creating an explicit placeholder for a future study. The authors write, "We do not consider flexible load or V2X explicitly in this study, but we note that they will provide some of the same value as standalone short duration energy storage (SDES) in the future."

This demonstration has the potential to fill the knowledge gap left by the studies while actively catalyzing the deployment of EVs and battery storage.

2025 - Evaluating Load Management Strategies for a Net Zero Grid in Massachusetts, prepared by Energy and Environmental Economics (E3) for the Massachusetts Department of Energy Resources (DOER), assessed the technical and economic potential of load management strategies to support the Commonwealth's path to net zero emissions under the Global Warming Solutions Act.[18]

Findings: The study models V2G-only in the CECP 2050 Growth scenario, with zero uptake assumed in the Incremental Growth scenario. In this model, V2G participation reaches 50% of light-duty EVs and 90% of medium- and heavy-duty EVs by 2050. V2G then becomes the single largest contributor to peak reduction, accounting for a dominant share of the 4.3 GW of active demand reduction in that scenario — roughly 2.5–3 times the potential of V1G managed charging alone.

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[17] "Charging Forward: Energy Storage in a Net Zero Commonwealth," MassCEC & DOER, 2023

[18] Energy and Environmental Economics, Inc., "Evaluating Load Management Strategies for a Net Zero Grid in Massachusetts,"December 2025.

5.3 POLICIES AND INCENTIVES

Building on the recommendations of prior studies, Massachusetts has established a number of policies and incentive programs targeting both electric vehicle adoption and energy storage. Many of which provide a foundation for advancing V2X deployment, though not all explicitly recognize EVs in that capacity.

On the EV adoption side, two flagship state programs directly support vehicle electrification:

- **The Massachusetts Offers Rebates for Electric Vehicles (MOR-EV)** program offers residents, businesses, and nonprofits partial rebates on the purchase or lease of qualifying electric vehicles, with benefit levels varying by vehicle type, use, and household income.[19]
- **The Massachusetts Electric Vehicle Incentive Program (MassEVIP)** complements MORE-EV by extending support to public entities through vehicle purchase and lease grants, while also funding the buildout of EV charging infrastructure across the state.[20]

Beyond these state-level programs, a number of municipal utilities and local governments operate their own EV incentive programs. Together, these potentially layered incentives can support the adoption of the V2X program and the state's established target of 900,00 electric vehicles on the road by 2030.[21]

Energy storage policy in Massachusetts has advanced on a parallel but largely separate track.

The 2024 Clean Energy Act established a statewide energy storage mandate of 5,000 MW by 2030 and directed utilities to enter into long-term contracts for storage through competitive solicitation processes.[22] The Act introduced permitting reforms intended to reduce regulatory barriers to storage deployment. To further incentivize private investment, the state launched the **Clean Peak Energy Standard (CPS)** in August 2020, which rewards storage systems that discharge during peak-demand periods by issuing tradeable **Clean Peak Energy Certificates (CPECs)**.[23]

In relation to the V2X work, the CPS does reference "demand response resources," a category that EVs could theoretically fall into; however, 'electric vehicles' are not explicitly named, leaving their eligibility open to interpretation. While these policies represent meaningful progress toward the Commonwealth's storage goals, the absence of explicit EV recognition in either framework leaves potential participants unclear about whether EVs participating in V2X programs can access the benefits and incentive structures these policies provide.

The Commonwealth has a meaningful opportunity to accelerate V2X adoption by clarifying how V2X capabilities fit into the broader policy landscape and the state's sustainability goals. Explicitly connecting

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19 MOR-EV, Center for Sustainable Energy, accessed February 2026
20 "State and Federal Electric Vehicle Funding Programs", Commonwealth of Massachusetts, 2025
21 "2025-EVICC Assessment," Commonwealth of Massachusetts, 2025
22 "Table of State Energy Storage Targets and Progress," Clean Energy State Alliance, accessed March 2026
23 "225 CMR 21.00: Clean peak energy portfolio standard (CPS)", Massachusetts Department of Energy Resources, 2025

V2X efforts to existing and emerging policy mechanisms could help stakeholders more readily identify the financial opportunities available to support deployment.

5.4 MASSACHUSETTS CLEAN ENERGY CENTER (MASSCEC) V2X DEMONSTRATION PROGRAM

The Massachusetts Clean Energy Center (MassCEC) launched its V2X Demonstration Program in February 2025. The program is designed to increase adoption of V2X technologies among individuals and institutions by gathering data from the technology and studying its impact on the electric grid. This program provides free implementation of bidirectional EV chargers, including associated equipment and installation costs, to selected participants. The program aims to help residential customers, commercial customers, and school districts that own or are in the process of purchasing an EV capable of bidirectional charging contribute to a more reliable, affordable, and efficient grid. During the program period, data is being collected on each step in the process, including charging data from the installed equipment. This information will be analyzed to develop guidance for further V2X deployment across a wide range of use cases.[24]

As part of the MassCEC V2X Demonstration Program, the project team has deployed V2X charging across 30 residential sites, 4 municipal sites, and 5 school sites. The distribution of awardees by town is shown in the figure below:

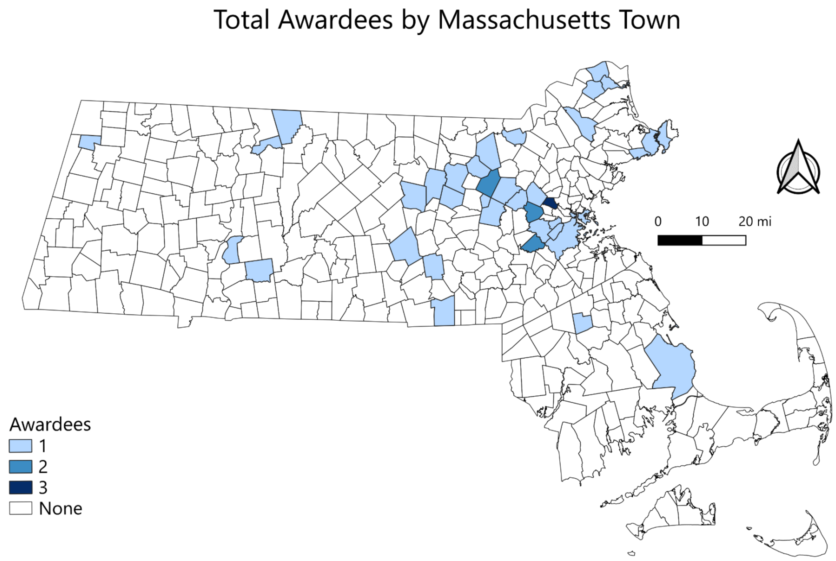

Figure 3: MassCEC V2X Demonstration Program awardee distribution by town in Massachusetts. Image created by Resource Innovations.

As of March 2026, the Project Team is completing the installation of bidirectional chargers at applicant sites. Additional data on program benefits for customers and the electrical grid will be gathered in the summer of 2026. Key takeaways, lessons learned, and recommended next steps will be included in the program guidebook, which will be released at the end of 2026.

[24] "Vehicle-to-Everything Demonstration Projects." Massachusetts Clean Energy Center (MassCEC), accessed March 2026

6. INTRODUCTION TO V2X CASE STUDIES

This report will profile five pilot programs to demonstrate the current status of V2X projects globally. The five pilot projects were selected to be representative of the V2X market because they vary across geography, size, use case, and structure. They were also selected for their relevance to the MassCEC V2X Demonstration Program and to future V2X applications in Massachusetts.

The case studies are profiled based on their coverage across the following domains: Program Funding, Compensation and Economics, Standards and Policy, Data Management, and Stakeholder Coordination. The domains were identified as growth areas across the industry that support success for V2X implementation when executed correctly. While V2X technology and its implementation have been demonstrated in dozens of pilot projects, the technology has quickly evolved and is poised to scale across a broader market. Pilot projects help V2X stakeholders, including equipment vendors, installers, EPCs, permitting agencies, and utilities, gain practical lessons learned from V2X project implementation, streamlining processes and making V2X more feasible and advantageous. The table indicates whether the profiled case study or pilot project considers these domains and whether it provides implementation insights or recommendations for future projects.

See below for more details on what each of the case studies was evaluated for across these domains:

- **Program Funding**. What funding mechanisms enable this pilot, and is there guidance for future funding?
- **Compensation & Economics**. How did project benefits such as revenue, savings, and incentives flow for this pilot, and is there a sustainable structure for ongoing participation?
- **Standards & Policy**. How did standards and policy interact with this pilot, and how did this interaction enable or constrain this pilot and future V2X deployment?
- **Data Management**. What data management ownership and structures operate for this pilot, and how might this inform future pilots?
- **Stakeholder Coordination.** Who were the key stakeholders involved in this pilot, and how did this coordination structure affect the success or failure of this pilot?

7. V2X CASE STUDIES

	Baltimore, Maryland	Beverly, Massachusetts	Fremont, California	Utrecht, Netherlands	Exmouth, Australia
Vehicle Type	Ford F-150 Lightning	Thomas Built Buses, Saf-T-Liner C2 Jouley ESBs	Thomas Built, Microbird, and BYD ESBs	Hyundai: IONIQ 5, Renault 5	Nissan Leaf
Number of Vehicles	Three	Three (As of 2024)	14	Hyundai: 25 Renault: 50	Five
Year	2024: grid-parallel, non-export. 2025: grid-parallel, export	2021-Present	2025-Present	Hyundai: 2022 Renault: 2024	2024-2025
Program Funding	U.S. Department of Energy (DOE) grant funding	Private partnership with Highland	California Energy Commission (CEC) Replicable V2X Deployment for Schools (RVXDS) grant	No public information on funding source	Western Australian Government
Compensation & Economics	Baltimore Gas and Electric Company rebates	National Grid Connected Solutions	CAISO's Emergency Load Reduction Program (ELRP)	No public information on compensation structure	No public information on compensation structure
Standards & Policy	Maryland Public Service Commission (PSC) DRIVE Act, Code of Maryland Regulations (COMAR) 20.50 V2G interconnection rules	DOER V2G School bus Pilot, MOR-EV program, MASS-EVIP program	California Public Utilities Commission's (CPUC) interconnection pathways, Open Charge Point Protocol (OCPP) version 2.1, and ISO 15118	Energy Taxation Directive disincentivizing V2X. New EU AFIR standard for interoperability issues	No public information on standards and policy
Data Management	Sunrun's Home Integration System (HIS), as part of the Ford Intelligent Backup Power suite	Synop energy management software	The Mobility House ChargePilot and Cascade software platforms	No public information on data management	Horizon Power's Distributed Energy Resource Management System (DERMS)

	Baltimore, Maryland	Beverly, Massachusetts	Fremont, California	Utrecht, Netherlands	Exmouth, Australia
Stakeholder Coordination	BGE, Sunrun, and Ford organized and executed the pilot	Massachusetts DOER + Synop enabled coordination between Highland and National Grid	The CEC provided grant funding; The Mobility House led the project, which was hosted by the Fremont Unified School District and supported by PG&E. Several other organizations served as project partners	MyWheels and We Drive Solar executed the pilot, with the City of Utrecht's support	Horizon Power executed the pilot, engaging four community organizations. Jet Charge provided the chargers, and the Western Australian Government supported with key regulatory information

CASE STUDY
5.1 BALTIMORE, MARYLAND

5.1.1 ABOUT

In the summer of 2025, **Sunrun** and Maryland's largest utility, **Baltimore Gas and Electric (BGE)**, launched a V2G pilot program in Maryland, aiming to demonstrate the capabilities of Ford F-150 Lightning batteries to provide peak-shaving during peak demand hours. This partnership began with the launch of grid-parallel, non-exporting vehicle-to-home capability in 2024. In 2025, this initiative expanded to pioneer grid-parallel, exporting vehicle-to-grid dispatch by sending energy from F-150 Lightning Truck batteries to the grid between 5 p.m. and 9 p.m., earning payments for participating customers under a compensation structure.[43]

The Ford F-150 Lightning can be enabled to be a home backup generator and mitigate the effects of scheduled outages and rolling blackouts.[25] If the Lightning is plugged in when an outage occurs, it can automatically discharge and power the home. When power is restored, it will automatically revert to its planned charging schedule. This requires a Ford Charge Station Pro and Home Integration System, which can be purchased and installed through Sunrun. A fully charged F-150 Lightning can provide full-time power for up to three days and up to ten days if power is rationed.[33] For this pilot, the Sunrun and Ford partnership, in close coordination with and expressed approvals from BGE, expanded beyond its backup power use case to enable grid-parallel bidirectional activity.

This pilot marked the launch of America's first residential grid-exporting V2G deployments.[26] The program enrolled three customers who used a Home Integration System to discharge electricity from their vehicle batteries to the grid. This initiative successfully demonstrated EVs' ability to support the grid, reduce costs, and create new income streams for real EV owners.

5.1.2 PROGRAM FUNDING

BGE was awarded grant funding from the **U.S. Department of Energy (DOE)** to create an EV virtual power plant and partnered with Sunrun to develop and administer the program.[27] By discharging F-150 Lightnings' onboard batteries directly into participants' homes, the program demonstrates how EVs can serve as stationary batteries to reduce grid demand and build a more resilient, reliable energy system for all BGE customers in Maryland. Further details on the grant are not publicly available.

Image by Solar Builder Magazine

STAKEHOLDERS

bge AN EXELON COMPANY
sunrun
MARYLAND Public Service Commission
Ford
Department of Energy, United States of America

CASE STUDY
5.1 BALTIMORE, MARYLAND

5.1.3 COMPENSATION & ECONOMICS

Program participants earned payments based on the amount of electricity discharged back to the grid between 5:00 PM and 9:00 PM on weekdays, up to a maximum of $1,000 annually.[28]

5.1.4 STANDARDS & POLICY

Maryland's V2G pilot aligns well with the passage of first-of-its-kind legislation. In 2024, the legislature adopted the DRIVE Act, which directs the Maryland Public Service Commission (PSC) to take several key actions to advance V2G. In 2025, the PSC unanimously voted to adopt the nation's first comprehensive set of V2G interconnection rules for both V2G DC and AC systems.[29] Updated in the Code of Maryland Regulations (COMAR) 20.50, the guidelines include key provisions concerning V2G system definitions and utility interconnection pathways.

5.1.5 DATA MANAGEMENT

Sunrun utilizes its Home Integration System (HIS), co-developed with Ford Motor Company as part of the Ford Intelligent Backup Power suite. It is the first commercially available bidirectional charging system in the U.S, and was the first enabled in grid-parallel mode on customer premises as part of this pilot program. It allows the Ford F-150 Lightning and a home's electrical system to work together, sending power where and when it's needed. The summer following the initial pilot, the program advanced to full grid-parallel export, with the HIS enabling customers to send energy past the meter and to the grid.[30]

5.1.6 STAKEHOLDER COORDINATION

Multiple stakeholder groups coordinated over the course of this program. **Sunrun** and **BGE** collaborated to launch the pilot, using **Ford** vehicles to demonstrate the program's effectiveness. The **Maryland Public Service Commission (PSC)** utilized the program's findings to pass regulation to advance V2G deployment and adoption in the state.

SOURCES

[25] Ford Motor Company, "What is Ford Home Backup Power?," accessed March 26 2026.
[26] Chris Crowell, "Sunrun, BGE, and Ford Active Residential Vehicle-to-Grid Power Plant with Three Customers," Solar Builder, (September 24, 2025).
[27] Walton, Robert, "Sunrun, BGE Launch First US Electric Vehicle-to-Home Virtual Power Plant," Utility Dive, July 25, 2024.
[28] Baltimore Gas and Electric Company, "BGE and Sunrun Operate Nation's First Residential Vehicle-to-Grid Distributed Power Plant Using Ford F-150 Lightning Trucks," BGE, September 24, 2025.
[29] Woogen, Zach, "Maryland Becomes First to Adopt Comprehensive Vehicle-to-Grid (V2G) Interconnection Rules," Vehicle-Grid Integration Council, June 12, 2025.
[30] Sunrun, Inc., "Sunrun Launches Nation's First Vehicle-To-Home Grid Support in Maryland Using Ford F-150 Lightning Trucks," Sunrun Investor Relations, July 24, 2024.

CASE STUDY
5.2 BEVERLY, MASSACHUSETTS

5.2.1 ABOUT

Beverly Public Schools was one of the first in the country to use its electric school buses' bidirectional capabilities in a V2G pilot in 2021. **Highland Electric Fleet** leases the electric school buses to Beverly, oversees the construction of the charging infrastructure, and manages the charging and discharging of the vehicles, all at "about the cost of a regular school bus."[31] **National Grid** is a key partner with Highland, and will alert Highland before they anticipate needing power to ensure that the ESBs are charged and plugged in, ready to discharge power.

5.2.2 PROGRAM FUNDING

No public information related to program funding beyond Highland Electric leasing electric school buses to Beverly at a discounted rate was available for this case study. Public-private partnership allowed Beverly to benefit from the V2G program without bearing the full cost.[32] In 2024, Highland received nearly $11 million in cost-share funding from the DOE Grid Deployment Office to launch 14 V2G school bus pilots across the country.[33]

5.2.3 COMPENSATION & ECONOMICS

A goal of this pilot was to make it profitable for the school district and to lower energy costs. Partnering with Highland Electric Vehicles made acquiring the ESB and infrastructure affordable for the Beverly school district, a key barrier to entry for small school districts. Coverage of this pilot project focuses on the compensation mechanism for selling power back to the grid, and the revenue potential of converting more of the bus fleet to bidirectional ESBs.[34] National Grid's ConnectedSolutions Program compensates the bus operator for power provided during demand response events in the summer months, which can generate $200 per kW discharged if the bus participates in every peak demand event.[35] For a 60 kW charger, like the ones offered by project partner BorgWarner, this could yield up to $12,000 annually per school bus. Across the summers of 2021 and 2022, a single bus discharged 10.78 MWh to the Massachusetts grid, generating $23,500 in revenue.[36]

Image by Robin Lubbock, WBUR

STAKEHOLDERS

nationalgrid

Highland

Beverly Public Schools

Massachusetts Department of Energy Resources

Synop

CASE STUDY
5.2 BEVERLY, MASSACHUSETTS

5.2.4 STANDARDS & POLICY

Based on state-wide goals to lower emissions, Massachusetts has increased investment in ESBs, including the **Massachusetts DOER**'s Vehicle-to-Grid School Bus Pilot Program,[37] Massachusetts offers Rebates for Electric Vehicles (MOR-EV) Program,[38] and the Massachusetts Electric Vehicle Incentive Program (MassEVIP).[39]

5.2.5 DATA MANAGEMENT

Synop, an enterprise-grade software platform, was a partner on this project and offered its commercial charging and energy management software, which integrates with vehicles, chargers, and utilities. This software enabled a prompt exchange between the utility and the fleet, coordinating with the fleet's charging schedule to confirm excess capacity. Once this was validated, the platform used the Open Charge Point Protocol to deploy the charging schedule so that excess energy can be discharged from the battery back to the grid.[38]

5.2.6 STAKEHOLDER COORDINATION

This project was only possible with detailed coordination between **Highland Electric Fleet** and **National Grid**, with this communication allowing utilities to maintain a stable and reliable grid. Highland Electric Fleet partnered with a few key partners to source the technology for this project, including **BorgWarner** and **Rhombus** for the DC fast-charging system, **Proterra** for the battery and drivetrain technologies, **Thomas Built Buses**, the OEM for the ESBs, and **Synop** for the energy management software.[28] Additionally, the partnership between **Beverly Public School** and Highland made the ESBs a feasible cost for the school district, without which this project would not have succeeded. Additionally, the **Massachusetts Department of Energy Resources** is an important stakeholder here, as the success of this pilot project encouraged the state to establish programs that invest in ESBs.

SOURCES

[31] Moura, Paula, "Electric School Buses Serve as Mini Power Plants During the Summer," WBUR, April 18, 2023.

[32] Highland Electric Fleets, "Highland Electric Fleets Coordinates Electric School Buses' Summer Job—Supporting Local Grid with Vehicle-to-Grid Technology," PR Newswire, August 25, 2022.

[33] Highland Electric Fleets, "U.S. Department of Energy Awards Highland Electric Fleets' Project Approximately $10.9 Million in Cost-Share Funding to Accelerate Vehicle-to-Grid Services," PR Newswire, October 18, 2024.

[34] Moura, Paula, "More Massachusetts Districts Are Switching to Electric School Buses," WBUR, January 23, 2023.

[35] World Resources Institute, "Latest Lessons from Electric School Bus Vehicle-to-Grid Programs," World Resources Institute, accessed March 2026.

[36] Synop, "Success Story: Synop Software Facilitates First U.S. Commercial Vehicle-to-Grid (V2G) Program for Electric School Buses," Synop, accessed March 2026.

[37] Massachusetts Department of Energy Resources, "EV Programs & Incentives," Mass.gov, accessed March 2026.

[38] Highland Electric Fleets, "Electric School Bus Incentives in Massachusetts," *Highland Electric Fleets*, accessed March 2026.

[39] Massachusetts Executive Office of Energy and Environmental Affairs, "Massachusetts Energy Rebates & Incentives," Mass.gov, accessed March 2026.

CASE STUDY
5.3 FREMONT, CALIFORNIA

5.3.1 ABOUT

The **California Energy Commission (CEC)** launched the Replicable V2X Deployment for Schools (RVXDS) funding opportunity as part of its Clean Transportation Program. This $2.9 million program seeks to install bidirectional chargers at four California school locations that can send stored power back to the grid during peak demand, using replicable, open standards across vehicles, hardware, and software. The Mobility House was among the awarded stakeholders and is actively participating with two school district sites that operate T**homas Built**, **BYD**, and **Microbird** electric school buses. One of these sites, **Fremont Unified School District** (FUSD), has installed six 60kW chargers operated by **The Mobility House**'s ChargePilot charge management system. ChargePilot provides fleet operators with charger data monitoring, error troubleshooting, and charge management tools. As part of an additional layer of aggregation, TMH's Cascade EV aggregation platform allows the buses to be enrolled in **CAISO**'s Emergency Load Reduction Program (ELRP), enabling schools to be compensated up to $2/kWh for reducing energy consumption or exporting stored energy during critical grid emergencies. This initiative follows the deployment of an electric bus fleet in nearby Oakland in 2024.[40]

5.3.2 PROGRAM FUNDING

This project with FUSD was funded by the $2.9 million RVXDS grant received by the CEC as part of its Clean Transportation Program. This program seeks to support transportation innovation and accelerate the implementation of clean transportation and fuel technologies. This program also supports California's climate goals, including reducing petroleum use, improving air quality, and adopting zero-emission vehicles.[41]

5.3.3 COMPENSATION & ECONOMICS

The Emergency Load Reduction Program (ELRP) offers aggregators, such as The Mobility House, up to $2/kWh to reduce EV charging load and/or export power to the grid for EV owners in the service territories of PG&E, Southern California Edison Company (SCE), and San Diego Gas & Electric (SDG&E). Of the many ELRP groups, the ELRP option designed for VGI aggregation guarantees that sites will be dispatched for a minimum of 30 hours per year, providing a predictable revenue stream that can support overall project economics.[42]

Image by Rich McKie, The Mobility House

STAKEHOLDERS

PG&E
Polara
California Energy Commission
cte
THE MOBILITY HOUSE
WORLD RESOURCES INSTITUTE
Fremont Unified School District

CASE STUDY
5.3 FREMONT, CALIFORNIA

5.3.4 STANDARDS & POLICY

A suite of relevant policies and standards contributed to this successful deployment. First, the California Public Utilities Commission's (CPUC) adoption of a clear interconnection pathway for DC-based bidirectional charging systems – where the inverter is off-board the vehicle and integrated into the charging station – provided site developers with some certainty that the utility would approve the selected equipment. Second, the establishment of the ELRP program as an emergency reliability offering following California's 2020 rolling blackouts provided an additional source of export revenue. ELRP offers a higher incentive rate for EV aggregations relative to other customer groups ($2/kWh vs $1/kWh) and higher minimum guaranteed dispatch terms for these customers (30 hours vs 10 hours for stationary batteries, with no minimum dispatch guarantee for other customers). After the launch of ELRP, the 4-hour event dispatch window was reduced to accommodate the energy-limited nature of some EV batteries, which need to preserve capacity to support mobility use cases and maintain long-term battery health. These special conditions were introduced and maintained by the CPUC in explicit recognition of the nascent state of the V2X market and the commensurate need for added market transition support relative to other customer groups. Perhaps most important for the regulatory landscape, all CEC-funded charging equipment must adhere to, or be "hardware-ready" to adhere to, the following technical standards to ensure interoperability: Open Charge Point Protocol (OCPP) version 2.1 and ISO 15118.

5.3.5 DATA MANAGEMENT

The Mobility House used its ChargePilot and Cascade software platforms for this pilot, offering real-time fleet monitoring and fleet energy management. A ChargePilot local controller installed on site enables continuous data collection and load management that is remotely monitored, even if the internet connection to the site is temporarily lost.[40] In this pilot, the Cascade platform receives notifications from PG&E about upcoming demand response events, creates optimized charging schedules to support grid resilience, and deploys these charging schedules through ChargePilot.[41]

5.3.6 STAKEHOLDER COORDINATION

This program brought together a diverse coalition of public and private partners. The **California Energy Commission** provided grant funding through its Clean Transportation Program, while **The Mobility House** led the project, supplying its ChargePilot intelligent charge management platform to optimize the fleet's charging and discharging. **PG&E** supported grid interconnection by expediting a service upgrade to accommodate the full allocation of bidirectional V2G DC fast chargers and integrating the system into its Emergency Load Reduction Program. **Polara Energy USA**, **World Resources Institute**, and the **Center for Transportation and the Environment** served as project partners, contributing technical and research expertise to support the deployment. **Fremont Unified School District** hosted the project and operated the electric bus fleet at the center of the pilot.

SOURCES

[40] The Mobility House, "California Energy Commission Awards $2.9 Million Grant for Electric School Bus Bidirectional Charging Infrastructure," The Mobility House, December 26, 2023.
[41] California Energy Commission, "Clean Transportation Program," California Energy Commission, accessed March 2026.
[42] The Mobility House, "The ChargePilot® System Architecture," The Mobility House, accessed March 2026.
[43] The Mobility House, "The Mobility House Energizes V2G Charging System for Fremont Unified School District's Electric School Bus Fleet," Business Wire, August 11, 2025.

CASE STUDY
5.4 UTRECHT, NETHERLANDS

5.4.1 ABOUT

The City of Utrecht has launched the first fully operational large-scale V2G car-sharing network. The initiative uses shared electric vehicles and integrates them into the local electricity grid.[44] 35% of rooftops in Utrecht have solar panels, so grid balancing during renewable energy generation from the EV resources is advantageous. Additionally, Utrecht's local distribution grid is significantly constrained, creating challenges for new homes and businesses to connect to electrical service. The program leverages a city with pedestrian- and bike-friendly infrastructure to create a pilot program less focused on private vehicle ownership and more on flexible asset utilization in a densely populated area. Two pilots with these same goals were launched: 25 Hyundai IONIQ 5s in partnership with We Drive Solar, and 50 Renault 5s in partnership with MyWheels and We Drive Solar. This initial fleet for 50 Renault vehicles was estimated to have already delivered 65,000 kWh back to the grid, reducing evening congestion by up to 300 kW.[45] Based on this success, the Renault project is expanding to include 500 vehicles, making Utrecht one of the first European cities to deploy V2G at this scale in an urban environment.34 Similarly, the success of this pilot project is encouraging other cities to roll out similar programs, such as in Eindhoven, Netherlands and Ghent, Belgium.[46]

5.4.2 PROGRAM FUNDING

No publicly available information on program funding was available for this case study.

5.4.3 COMPENSATION & ECONOMICS

No publicly available information on program compensation or economics was available for this case study.

Image by We Drive Solar

STAKEHOLDERS

WE DRIVE SOLAR
mywheels
City of Utrecht
HYUNDAI
RENAULT

CASE STUDY
5.4 UTRECHT, NETHERLANDS

5.3.4 STANDARDS & POLICY

In its press release, Renault Group cites the need for a supportive regulatory framework to address barriers to adoption, such as unfavorable tax policies, grid fee structures, and complex certification processes.[43] These unfavorable tax policies include “double taxation” in the current version and proposed revision of the Energy Taxation Directive in the EU.[44] This “double taxation” occurs when the energy stored in an EV is taxed both on the consumption side when charging and again when discharging back to the grid, because it is treated as a new sale and a new stage of consumption. Renault Group is calling for revisions to this directive that better incentivize bidirectional charging, as well as for clearer, more consistent regulations, including fiscal incentives, grid fee revisions, streamlined certification processes, and support for smart meter deployment. Meanwhile, the European Union has established Alternative Fuels Infrastructure Regulation (AFIR) standards, requiring technology providers to meet the ISO 15118-20 communications standard to support widespread EV and EVSE interoperability starting in 2027.[45] ISO 15118-20’s Amendment 1 is being finalized to support the bidirectional power transfer functionality. Although additional gaps remain, the AFIR directive may nudge the market toward wider interoperability, including for bidirectional charging. This, in turn, may support a scale-up of V2G deployment in Utrecht, the Netherlands, and the EU as a whole.

5.4.5 DATA MANAGEMENT

Mobilize, Renault Group’s mobility brand, provides the in-vehicle technology, and can communicate with We Drive Solar’s AC bidirectional chargers using iSO 15118-20.[46] No other public information related to data management was available for this case study.

5.4.6 STAKEHOLDER COORDINATION

Considerable collaboration among many stakeholders, including **Renault**, **Hyundai**, **MyWheels**, **We Drive Solar**, and the **City of Utrecht**, was needed to launch the first large-scale V2G car-sharing service in Europe.

SOURCES

[43] Renault Group, "Utrecht Becomes Europe's First City with a Vehicle-to-Grid (V2G) Car-Sharing Service," Renault Group Newsroom, June 5, 2025.

[44] Fleet Europe, "How V2G is Reshaping Fleet Electrification: First Results from Utrecht's Pilot with Renault," Fleet Europe, 2025.

[45] Platform for Electromobility, "Bidirectional Charging: Let's Avoid Double Taxation for EV Owners," Platform for Electromobility, September 16, 2022.

[46] European Commission, "Alternative Fuels Infrastructure," European Commission – Mobility and Transport, accessed March 2026.

[47] We Drive Solar, "Utrecht Becomes Europe's First City with a Vehicle-to-Grid (V2G) Car-Sharing Service," We Drive Solar, June 5, 2025.

CASE STUDY

5.5 EXMOUTH, AUSTRALIA

5.5.1 ABOUT

Western Australian government-owned energy provider, Horizon Power, launched its Exmouth Vehicle-to-Grid Orchestration Trial (EVOT) program in April 2024 to demonstrate how grid-connected EVs can be integrated into regional microgrids. The program provided Nissan Leafs and Wallbox Quasar smart chargers, supplied by Melbourne-based EV charger company, Jet Charge, to four local organizations in the town of Exmouth. Horizon utilized its Distributed Energy Resource Management System (DERMS) to automatically manage EV charging and discharging to stabilize the grid, support customer flexibility, and bring value to regional communities.

Horizon Power has noted that with further development, the trial and its technology could be rolled out at scale. Importantly, the trial also revealed that real-world experience – allowing people to see and use EVs – was the single biggest driver of positive sentiment. The Exmouth EV orchestration trial demonstrated that bidirectional charging technology can be effectively integrated into remote microgrids, providing support during peak demand periods. It also proved promising for enabling more people in rural areas to adopt EVs, creating opportunities for customers to play an active role in the energy transition.

5.5.2 PROGRAM FUNDING

Horizon Power provided funding for this pilot program, aiming to increase its understanding of the potential of utilizing EVs as mobile grid resilience assets.[47]

5.5.3 COMPENSATION & ECONOMICS

No public information on program compensation or economics was available for this case study.

Image by Fleet EV News Team

STAKEHOLDERS

HORIZON POWER
The Government of Western Australia
Shire of Exmouth
JETCHARGE
wallbox

CASE STUDY
5.5 EXMOUTH, AUSTRALIA

5.3.4 STANDARDS & POLICY

No publicly available information on standards or policy was available for this case study.

5.4.5 DATA MANAGEMENT

For this pilot, Horizon Power utilized its Distributed Energy Resource Management System (DERMS). This system connects solar, home batteries, EVs, and weather forecasts to predict the availability of solar energy and to balance the overall availability of energy in the system with customer needs.[48] The technology was originally designed to help Horizon Power manage rising levels of distributed solar and storage, so this V2X pilot program was built directly on that existing data management foundation.[49]

5.4.6 STAKEHOLDER COORDINATION

Horizon Power served as the primary organizer of this program. Horizon designed and initiated the program, rolling it out to four community organizations across Exmouth. **Jet Charge**, a Melbourne-based EV charger supplier, provided the bidirectional chargers that made the pilot possible. **The Western Australian Government** provided the policy and funding framework that enabled the pilot, conducting the program as part of the government's Electric Vehicle Action Plan.[50] **The Town of Exmouth** was selected due to its tourism-reliant economy, which causes energy consumption to fluctuate significantly due to daily and seasonal demand.[51]

Image by Horizon Power

Image by Horizon Power

SOURCES

[47] Hill, Joshua S., "Vehicle to Grid Trial to Test EVs as 'Batteries on Wheels' in Remote Off-Grid Towns," The Driven, April 25, 2024. .
[48] Energy Magazine, "WA Two-Way Electric Vehicle Charging Trial Kicks Goals," Energy Magazine, September 27, 2025.
[49] Hill, Joshua S., "Network Completes V2G Trial to Show Technology Works in Remote Micro-Grids," The Driven, September 22, 2025.
[50] Heynes, George, "V2G Trial in Western Australia Demonstrates Microgrid Integration Potential of Bidirectional EV Charging," EV Infrastructure & Energy News, September 23, 2025.
[51] Energy Magazine, "Horizon Power to Trial EV-to-Grid Capability," Energy Magazine, April 24, 2024.

8. CASE STUDY FINDINGS

8.1 LESSONS LEARNED

The demonstration programs highlighted above illustrate the wide range of V2X applications and the key components for success. Each pilot reflects a unique combination of stakeholders, funding mechanisms, vehicle types, and utility partnerships, yet a common set of lessons learned emerged. These programs offer a valuable cross-section of what it takes to successfully roll out a regional V2X program.

Alignment among stakeholders and positive customer sentiment signal strong potential for V2X opportunities in regional communities. Stakeholders involved in these pilots possessed varying goals, with utilities generally valuing increasing grid reliability, commercial sites valuing operational costs, residential customers valuing rebates and revenue, etc. The pilot program in Fremont, California illustrates successful stakeholder coordination, as each stakeholder group aligned with the common goal of demonstrating that school bus fleets can serve as assets to the grid. This coordination is especially important when pilot program operators work with utilities and regulators. Utility interconnection and regulatory compliance can be time-consuming and require clear, effective communication among stakeholders. A utility's willingness to expedite grid interconnection and create demand response pathways is essential to efficient program launch. The Maryland PSC's adoption of V2G interconnection rules signals the importance of foundational regulatory alignment for scaling pilot programs.

Consistent program funding poses a critical risk to scalable V2X pilots, as both upfront investments and ongoing program maintenance require significant funding. Ongoing maintenance costs can include ongoing hardware and software management and maintenance, utility infrastructure upgrades and upkeep, vehicle fleet management, and more. Without funding continuity and therefore support to program equipment and administrators, program stakeholders and assets can become stranded. Refer to section 8.2.2 Program Funding for further information.

It is worth noting that significant regional differences in policy and cultural norms impact the scalability of V2X technology. With 1.9 million electric vehicles expected on the Dutch grid by 2030, the Dutch National Charging Infrastructure Agenda is working to strategically expand its charging infrastructure. However, in the United States, the current charging infrastructure is lagging, with only one public charging port added for every 42 new registered EVs.[49] While policy and regulation lessons learned from pilots in the Netherlands and Australia may not be directly transferable to those in the United States, they underscore the importance of stakeholder alignment and locally tailored policy frameworks to successful regional V2X deployment.

Additional gaps and open questions from the case studies are outlined in the subsections below.

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[49] Alliance for Automotive Innovation, "Alliance for Automotive Innovation Reports New U.S. Electric Vehicle Data," June 24, 2025.

8.2 CHALLENGES & GAPS

8.2.1 LIMITATIONS

Information Sourcing

The majority of the information used for the above case studies was drawn from public coverage of the projects. These publications were intended to provide an overview of each endeavor to a broad audience; as a result, most sources offered an accessible, generalist overview of the projects and did not provide in-depth information on the more technical and sensitive aspects of the work. Due to a lack of public information, the authors of this report had limited visibility into some of the more technical aspects of these cases, leading to knowledge gaps. This is most prominent in relation to the following domains: *Program Funding and Compensation & Economics.*

Information Sensitivity

Many of these programs are first-time endeavors taken on in partnership between public and private entities. These programs often use cutting-edge, privately owned and managed technology to monitor and track program execution. As a result, information on statistical case study insights was likely considered sensitive information or intellectual property that was not shared with the public. This proved to be a limitation in understanding domains like *Data Management.*

8.2.2 PROGRAM FUNDING

Initial project funding: Across the case studies, sources of pilot program funding were varied. While some case studies publicly noted their use of state or federal funding, others provided little to no background on the source of their programs' funding. This leaves a knowledge gap regarding which strategies, beyond state and federal funding, communities could use to establish and support similar V2X programs.

Ongoing program funding: Across all five case studies, only one mentioned funding for program continuation. The pilot program in Fremont, California is entering its second phase of deployment with more chargers being installed. This second phase will use funds previously allocated, rather than receiving new funding for program expansion. Recent publications indicate that programs like the one in Utrecht, Netherlands, are also set to expand due to their success.

8.2.3 COMPENSATION & ECONOMICS

Outside of the Baltimore, Maryland, and Fremont, California case studies, there was limited information on compensation for program participants and the program's financial impact on those involved. Because these programs provide critical electricity back into the grid, there is a high likelihood that participants received an economic benefit from their efforts, but due to the lack of public information, it is unclear how they were compensated.

8.2.4 DATA MANAGEMENT

Information on data management for these case studies was in short supply, largely due to the sensitivity of the information noted above. The information provided indicated a strong benefit of having data controlled by a single entity, enabling more efficient data management and future integration. Beyond the information mentioned, it is clear that there is a gap in publicly available information on data management in the V2X case study space.

8.2.5 USAGE PATTERNS

A key consideration across case studies is the vehicles' usage patterns and how they may affect the resilience benefits. The pilot program in Beverly, MA demonstrated a unique opportunity for ESBs to support bidirectional capabilities due to their usage patterns.[19] Compared to other vehicles, a fleet of school buses is an ideal source of distributed power due to their predictable usage patterns and their idle time during the middle of the day and summer months when energy demand is at its highest.[50] However, it is important to keep in mind that the vehicles must primarily be used for student transportation, and are not an equivalent to stationary storage.

One of the main user-related barriers to V2G adoption is the loss of flexibility, where customers are concerned that the vehicle's state of charge, mandatory minimum plug-in times, and third-party control over charging functions may restrict their freedom and convenience to use their EV whenever they need to.[51] Initial insights into user characteristics indicate that high daily mileage discourages participation in V2G programs due to concerns about vehicle availability.[49] However, the same analysis found that frequent routine drivers (greater than or equal to five days a week) are more likely to participate than those who are less frequent drivers (less than three days a month).[49] Additionally, users involved in car sharing are more likely to participate in V2G. All together, this indicates that an ideal usage pattern for a V2G pilot project is one in which users are confident they can maintain adequate charge in their vehicles.

8.3 OPEN QUESTIONS & FUTURE THINKING

8.3.1 OPEN QUESTIONS

The background information presented in this report has provided the MassCEC V2X Demonstration Program with an overview of lessons learned that can be used to bolster the Program's impact. However, while these lessons are invaluable, a number of open questions remain regarding the implementation of V2X initiatives, questions that require further exploration through primary-source conversations. These open questions largely align with the information gaps identified throughout the research reports gap section, and as this project progresses, the team will make a concerted effort to address them, later integrating the findings into the comprehensive guidebook to support ongoing and future V2X work.

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[50] Robert Stafford, "Latest Lessons from Electric School Bus Vehicle-to-Grid Programs," *World Resources Institute (WRI)*, May 13, 2025.

[51] Bakhuis, Jerico, Natalia Barbour, and Émile J.L. Chappin, "Exploring User Willingness to Adopt Vehicle-to-Grid (V2G): A Statistical Analysis of Stated Intentions," *Energy Policy*, vol. 203, 2025.

Many of these gaps became apparent through the case studies examined in this report, which, while offering valuable insight into program implementation, also surfaced several areas lacking sufficient detail. Notably, a clear financial structure or consistent funding streams, for both initial and ongoing programming, were not evident across the cases. Similarly, little information was provided regarding participant compensation, leaving open questions around compensation structures, rates, and engagement models. On the topic of data management, while the cases reinforced the value of centralizing data under a single entity to streamline information flow, they offered limited detail on collection, reporting, or analysis practices, leaving the strategies actually being utilized unclear. Finally, although most case studies described efforts to engage multiple local entities, the specific strategies employed and which proved most effective remained unclear, as did broader questions around long-term program management and external engagement planning.

8.3.2 NEXT STEPS

The pilot projects profiled in this report demonstrate the feasibility of V2X projects and highlight opportunities to expand V2X adoption. Insight gathered from these pilot projects can help steer the continued development of V2X across the country. The MassCEC V2X Demonstration Program provides an opportunity to gain insight into ongoing questions about how funding structures, project benefits, data management, and standards operate in implementing V2X projects on a larger, longer-term scale.

The MassCEC V2X Demonstration Program has implemented a set of EV charging demonstration projects across the state and will soon be collecting data from participants' operations. The Program Team will soon be organizing a series of regional workshops for participants and project stakeholders to share their lessons learned. The program will culminate with the release of a guidebook that uses these lessons learned to create guidance on implementing V2X programs and the framework necessary to do so. This guidebook will build on the ongoing questions identified through this research and provide a recommended approach for stakeholders in Massachusetts and across the country to lead in V2X.