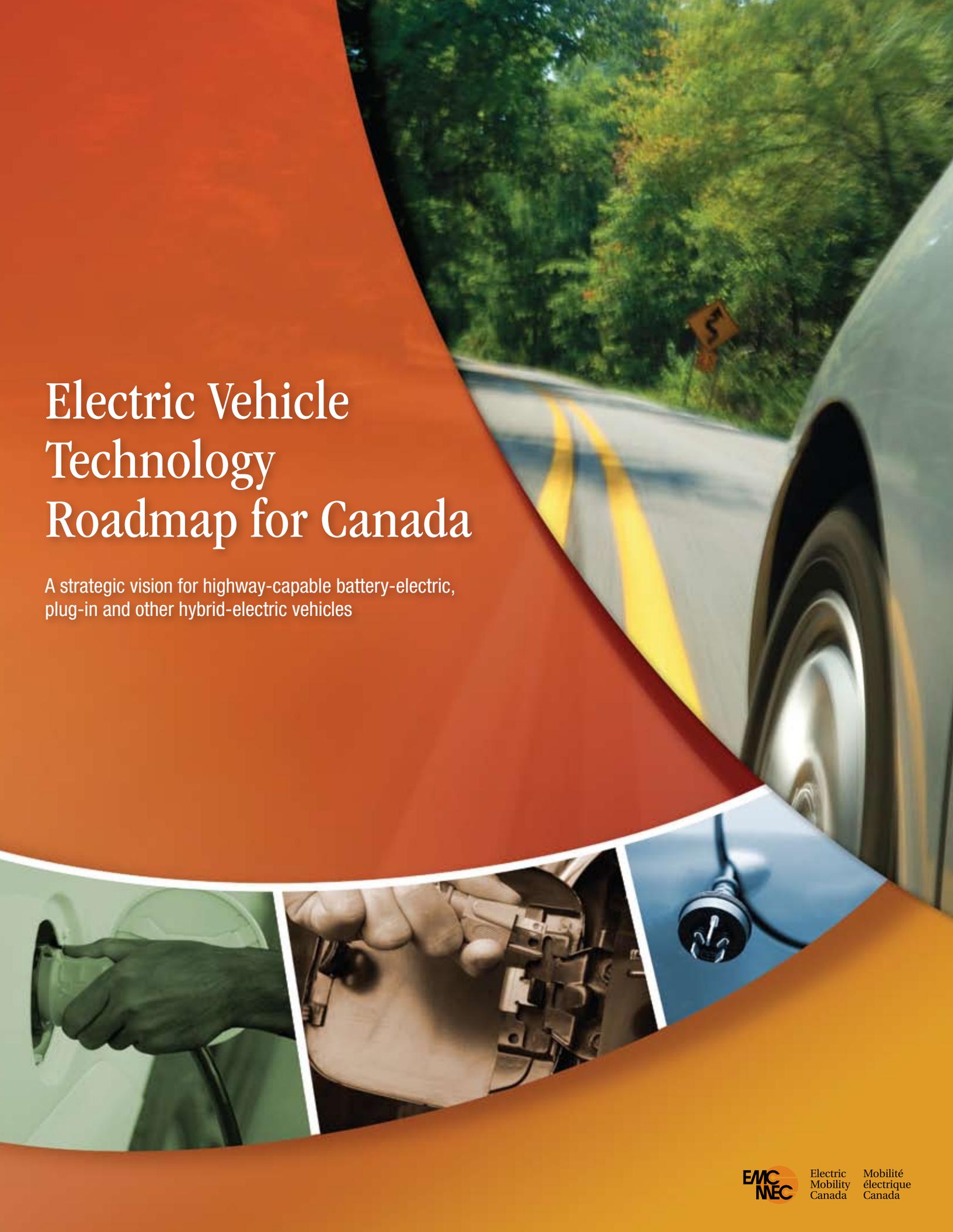


# Electric Vehicle Technology Roadmap for Canada

A strategic vision for highway-capable battery-electric,  
plug-in and other hybrid-electric vehicles



By 2018, there will be at least 500 000 highway-capable plug-in electric-drive vehicles on Canadian roads, as well as what may be a larger number of hybrid-electric vehicles. All these vehicles will have more Canadian content in parts and manufacture than vehicles on the road in Canada in 2008.

## Executive summary

Electricity as an alternative to traditional transportation energy is becoming a near-term reality for many countries, including Canada. Electric vehicles (EVs) will contribute to promoting sustainable energy development while addressing air quality and climate change.

The market for EVs in Canada is growing as Canadians look for cleaner, more efficient vehicles. Research confirms that consumers in North America are willing to pay more for an EV if the environmental benefits are significant. In Canada, it is expected that these benefits can be achieved because the majority of our electricity is generated from renewable and low-emission sources.

With our significant amounts of energy and a growing EV industry, Canada is well positioned to capitalize on this form of clean transportation. Our industry is well placed to be a major supplier of EV components and vehicles, not only in Canada but also internationally. Canada has the opportunity to link our efforts with those of the United States because of the integrated North American automotive industry.

To achieve the timely and effective commercialization of EVs, governments and industry must work together on ensuring that the necessary steps are taken. These steps include many activities, such as the development of advanced batteries, a charging infrastructure, electricity storage devices, codes and standards, and policies, as well as public education and consumer acceptance.

The most important of these activities is energy storage. Progress toward widespread use of the vehicles covered by the *Electric Vehicle Technology Roadmap for Canada* (the Roadmap) depends above all on one factor: increasing the amount of electrical energy that can be stored in a given volume or weight on board a vehicle, thereby extending electric traction's range.

The Roadmap is intended to provide the strategic direction to ensure the development and adoption of EVs in Canada, while building a robust industry.

The Roadmap provides the perspective of numerous stakeholders, mainly industry, as to how EVs for highway use should evolve in Canada over the next nine years and what should be done to secure this evolution. The Roadmap covers a wide range of topics related to the production and deployment of 500 000 or more EVs in Canada by 2018. The topics include energy storage, components for EVs, vehicle integration, business models and opportunities for EVs, government policies, regulatory and human resource issues, and public awareness and education.

Included in the Roadmap are two types of personal and commercial vehicles that rely exclusively or primarily on electric traction:

- battery EVs that have only electric traction and are almost always charged from the electricity grid
- EVs that have an internal combustion engine (ICE) in addition to an electric traction motor. The ICE can charge the vehicle's battery by powering a generator while the vehicle is in motion, and may also provide traction.

Other EVs that are not considered in the Roadmap include fuel-cell-based vehicles, vehicles with two or three wheels, low-speed and off-road vehicles, military vehicles, and vehicles such as trolley buses that are powered from the grid while in motion.

There is a call for a reduction in carbon emissions by focusing on EVs that rely exclusively or heavily on connection to the electricity grid for recharging their batteries. Part of Canada's potential strength as a focus for EV production and use is the sophistication of the electricity grid and the electrical generation that feeds it.



In Canada, a higher share of this electrical generation is from renewable sources than in almost any other country, which means that conversion of the Canadian on-road fleet to EVs would result in large reductions in the fleet's carbon emissions. Moreover, several of the provincially, territorially and locally owned utilities that provide electrical energy in Canada have a strong interest in electric traction.

The Roadmap includes three recommendations for securing the vision for EVs in 2018. It also identifies numerous matters that require action – strategic initiatives that complement the recommendations.

If the recommendations are adopted and the strategic initiatives are implemented, Canada will retain its vibrant and growing EV industry and play a role in the transition toward a more sustainable energy mix.

The recommendations, addressed to governments, industry and other stakeholders, are these:

1. Make timely and substantial investments in Canadian development and manufacture of EVs and in energy storage devices to build on Canada's already strong presence in these industries.
2. Consider supplementing federal, provincial and territorial mechanisms to promote the development, public acceptance and procurement of personal and commercial EVs, and the installation of the charging infrastructure.
3. Reconstitute the Steering Committee as a Roadmap Implementation Committee mandated to ensure that the strategic initiatives identified in the Roadmap are addressed.

### Strategic initiatives

The strategic initiatives identified by stakeholders are summarized below in four categories. All are important, and all should have the timely attention of the Roadmap Implementation Committee. Where feasible, action on each initiative should begin before mid-2010.

### Technology

- Improve energy storage through basic and applied research, including improvements in:
  - manufacturing techniques – with the goals of adding scale, improving efficiency and reducing costs
  - energy density – to reduce costs, increase range and achieve smaller, lighter systems
  - management and control electronics – for more efficient use of available energy storage
  - system packaging – to optimize thermal, electrical, mechanical and safety elements
- Reduce the cost of EV components by a factor of two to three so they can be competitive with equivalent ICE components.
- Reduce the weight of the components.
- Test options for the charging infrastructure in each major region of Canada, including smart charging and vehicle-to-home and vehicle-to-grid arrangements. Recommend changes and improvements, noting impacts of multiple chargers on power quality.
- Demonstrate vehicle use in real-world operation to assess the reliability and durability of energy storage and other components.

### Codes, standards, regulations and infrastructure readiness

- Review national, provincial/territorial and municipal regulations that impact the manufacture and use of EVs in Canada. Ensure that the regulations support EV development without compromising safety and other concerns.
- Harmonize North American standards and practices concerning the integration of EV components, including charger interfaces.
- Develop harmonized standards for the conversion of used vehicles to electric traction.

- Amend building codes and other regulations to require that at least the rough-in for outlets for charging EVs is included in all new buildings. Provide model codes and regulations.
- Develop action plans for infrastructure readiness.

### Studies and assessments

- Assess the merits of, and develop a mandate for, an Electric Transportation Institute as a Canadian focus of applied EV research and development and other activities required to accelerate widespread use of EVs.
- Assess the potential impacts of incentive programs for the purchase of EVs on EV penetration and the impacts of battery warranty and lease programs.
- Estimate how much EVs will increase the demand for national and regional electrical energy and power over several periods and at several levels of market penetration. Take into account the reduced block heater loads and the additional battery conditioning loads. Assess the current and expected future ability to handle these demands, noting additions that would be required to the generation and distribution infrastructure.
- Estimate the lifetime savings that will result from the shift to EVs from ICE-based vehicles, anticipating changes in electricity rates and fossil fuel prices.
- Identify the effects on government revenue from the shift to EVs from ICE-based vehicles.
- Assess if renewable sources of electricity will be able to support use of the proposed 500 000 or more EVs by 2018.
- Assess the prospects for battery leasing models and the viability of battery “repurposing.”
- Compare the social benefits and costs of electric traction with ICE-based traction that uses fossil fuels.
- Identify the feasibility, costs and benefits of creating a Canadian brand of highway-capable EVs.
- Identify new business opportunities for Canadian electrical utilities that could arise from growth in the EV industry.

- Identify and assess the challenges and opportunities for Canada’s EV industry posed by the *American Recovery and Reinvestment Act of 2009* and other such measures.
- Identify potential early adopters of EVs, particularly fleets, and how they may be encouraged to become early adopters.

### Education and outreach

- Assess the resource requirements for training, education and certification in skills related to the emerging EV industry. Provide this information to organizations that can develop:
  - technical courses on EV repair, service and maintenance and on the conversion of ICE-based vehicles to EVs
  - courses to help graduates of universities and colleges secure employment in high-paying jobs in the emerging EV industry in areas such as battery engineering, power systems engineering, power electronics, manufacturing processes and development of new business models
- Develop educational and public relations programs that increase awareness across Canada of the benefits of EVs and associated technologies.

An additional task for the Roadmap Implementation Committee could be to review the limited scope of the current Roadmap and, after appropriate consultation, seek to initiate roadmaps in other areas of electric traction.

We live in extraordinary times, from a transportation and energy perspective as well as many others. Our times are fraught with challenge but also brimming with opportunity.

The basic message of the Roadmap is clear: early action, mainly by governments and industry, will sustain Canada’s strong position in electric transportation and enhance it for the benefit of all Canadians.

*The Roadmap and this Executive Summary provide the perspective of numerous stakeholders and were prepared under the direction of the Industry Steering Committee. The contents, conclusions and recommendations are not necessarily endorsed by participating organizations and their employees nor by the Government of Canada.*

