



GREENING GOVERNMENT FLEETS

A helpful guide to understanding
best practices

May 2018

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Glossary of Terms

AC: Alternating Current

AFV: Alternative Fuels Vehicle

BEV: Battery Electric Vehicle

CCS: Combined Charging System

CNG: Compressed Natural Gas

DC: Direct Current

DCFC: Direct Current Fast Charging

DSO: Distribution System Operator

EV: Electric Vehicles

EVI: Electric Vehicle Initiative

EVSE: Electric Vehicle Supply Equipment

GHG: Greenhouse Gas

HDV: Heavy-duty Vehicle

HEV: Hybrid Electric Vehicle

kW: Kilowatt

LNG: Liquefied Natural Gas

LSEV: Low-speed Electric Vehicle

MURB: Multi-unit Residential Building

MVI: Manufacturers' Vehicle Inventory

NMHC: Non-methane Hydrocarbons

NOx: Nitrogen Oxide

OEM: Original Equipment Manufacturer

PCF: Pan-Canadian Framework on Clean Growth and Climate Change

PHEV: Plug-in Hybrid Electric Vehicle

PM: Particulate Matter

PSPC: Public Services and Procurement Canada

RFI: Request for Information

TCO: Total Cost of Ownership

ULEV: Ultra-low Emission Vehicle

VAC: Volts Alternating Current

ZEV: Zero Emission Vehicle

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01 EXECUTIVE SUMMARY

In December 2016, First Ministers endorsed the Pan-Canadian Framework on Clean Growth and Climate Change (PCF) – a plan to enable clean economic growth, reduce greenhouse gas (GHG) emissions, and build resilience to a changing climate. The PCF sets Canada on a path to meet its target under the Paris Agreement of reducing emissions by 30% from 2005 levels by 2030. The framework includes a comprehensive strategy to reduce emissions from the transportation sector, through improved efficiency, greater electrification, fuel switching, and the development of a clean fuel standard among other actions.

The framework also acknowledges that, though governments are directly responsible for a relatively small share of Canada's emissions (about 0.6%), they have an opportunity to lead by example.

Commitments for government leadership include:

1. Setting ambitious targets
2. Cutting emissions from government buildings and fleets
3. Scaling up clean procurement

Canada's Greening Government Strategy, released in December 2017, includes clear commitments to reduce emissions from government fleets, with clear targets for greater electrification.

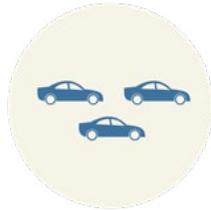
Canada has echoed these domestic commitments, by also showing leadership internationally. During the North American Leaders Summit, in June 2016, Canada, the U.S. and Mexico agreed to collaborate on a variety of actions to lower emissions across the economy. Specific commitments for transportation included working together to deploy greater amounts of electric vehicles in government fleets. Similarly, in November 2016, Canada joined seven other nations (China, France, Japan, Norway, Sweden, the United Kingdom and the United States of America), by signing on to the Government Fleet Declaration under the auspices of the Clean Energy Ministerial – Electric Vehicle Initiative, committing to deploy greater numbers of electric vehicles in government fleets.

With these commitments in mind, this guide is meant to provide information to help fleet managers at all levels of government implement a simple, cost-effective, step-by-step process for reducing their environmental impacts and operating costs by deploying new low carbon vehicle technologies and fuels.

The existing fleet model is provided as a baseline, followed by examples of the most successful programs and policies for sustainable, energy efficient, lower carbon practices which can be integrated into public fleets across all levels of government (i.e. provincial, territorial, and municipal). Understanding that fleet managers need assurances that any new technology will not impact the day-to-day operations of their fleet, the guide also provides an overview of the types of low carbon vehicles and refuelling infrastructure which is currently available. An overview of global efforts for electric vehicle deployment is also included, to put government efforts into perspective.

The Government of Canada is not alone in setting ambitious targets and implementing actions to lower emissions from its fleet. Many provinces and territories have also adopted greening policies and procedures for their fleets, and in some cases they are sharing this experience to assist municipal governments to implement their own suite of measures. Similarly, international governments have also established targets and supporting policies, many of which focus on greater electric vehicle deployment, and charging infrastructure to support these vehicles.

Taking all of these policies, targets, and actions into account, the guide provides a systematic, step-by-step process which can be implemented by governments and fleet managers at all levels, to transition the fleet of today, into a lower carbon fleet of tomorrow.



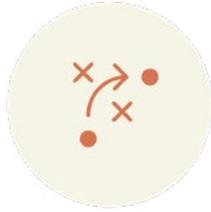
Assess Your Fleet

As a first step, it is essential that fleet managers know their fleets. The most immediate way to lower emissions from a vehicle fleet is through reducing reliance on on-road vehicle transportation and vehicle purchases altogether. Implementing a long-term approach that leads to a smaller, more efficient fleet begins with critically evaluating alternative options to continually replacing existing fleet vehicles. A key component to this is establishing a baseline of fleet vehicle usage, and fuel consumption. This is best done through the installation fleet telematics devices, which can track a vehicles usage pattern, in real-time.



Get Aligned

Following this, it is important to establish internal support for the transition. Changes to a fleet can be met with resistance from employees that depend on vehicles to do their job. This is why it is crucial to engage employees and senior management early in the decision-making process in order to gain support. It is important to communicate that operational suitability will not be lost during the transition to a lower-carbon fleet. Also the initial higher purchase cost of low carbon vehicles and the required charging/refuelling infrastructure may pose a barrier with senior management. This engagement will also provide an opportunity to establish ambitious deployment and emissions reductions targets, supported by users and management.



Understand Needs & Strategize

The next step is undertaking in-depth analysis, on fleet needs. This enables fleet managers to optimize the fleet to ensure that it is operating with the most efficient assets and the right amount of assets. It also assists fleet managers to identify and select the lowest carbon options which will continue to meet their operation needs.

Once the fleet needs are well understood, developing a strategic plan which identifies a clear path toward the transition to a lower carbon fleet which is sustainable over the long-term is essential to achieving greening government fleet goals. This strategy should include a concise vehicle replacement schedule as well as plans for the installation of charging and refuelling infrastructure to ensure vehicles can refuel where and when required.

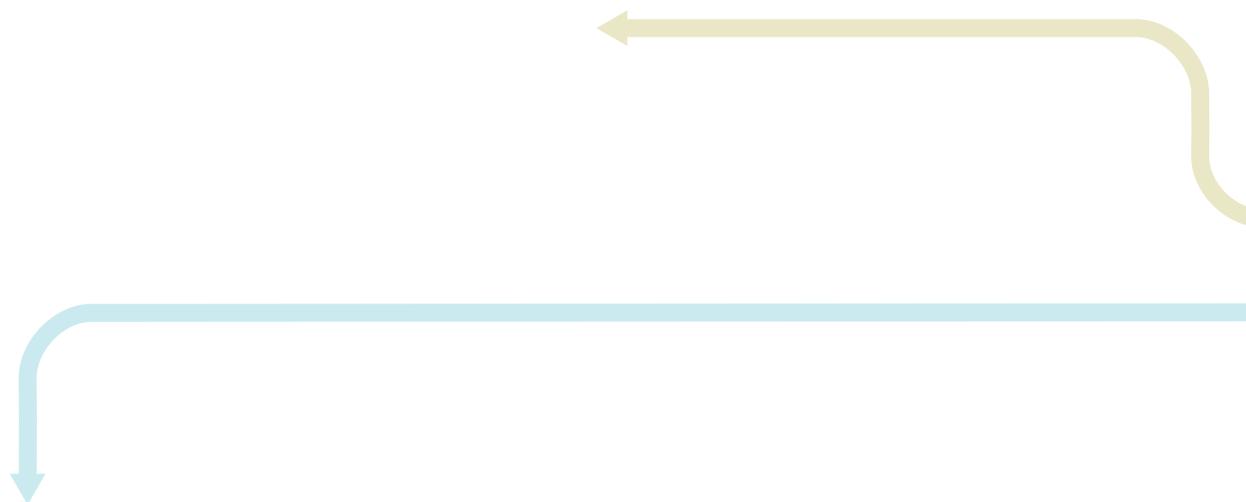
Leveraging a suite of online resources also assists in the transition. Online tools such as portals with fuel consumption, emission and driving behaviour information can help to increase the efficiency of a fleet. A fleet manager can have access to real-time data to identify areas where improvements can be made. Even in cases where no lower carbon vehicle options are possible (e.g. due to operation needs) drivers can lower their fuel consumption by using fuel efficient driving techniques.

The final step is to implement the strategy, and track results.

This document outlines a roadmap for what success for greening government fleets will look like. The fleet of the future will be different than today's. It will be optimized and composed of a variety of low carbon vehicle technologies. Its vehicles will be operated efficiently. It will be cost-effective and fiscally responsible. It will have reduced emissions and energy use significantly when compared to the existing fleet. It will also be flexible and well positioned to adopt additional innovative new clean technologies as they enter the market. If followed, the advice and steps outlined in this guide will help to lay the foundation to support this transition over the next decade or more.

INTRODUCTION

For over three decades, Natural Resources Canada (NRCan) has been helping Canadians improve energy efficiency in transportation; by influencing choice through programs such as the EnerGuide vehicle label, educating with the Fuel Consumption Guide and promoting fuel-efficient driver habits with ecoDriving training. Through the Transportation Working Group on Energy Efficiency, NRCan works with Provincial and Territorial governments to share the experience and knowledge on these programs and policies to promote energy efficient practices across the Canadian transportation sector.



Canada is playing a significant role in the transition to a low carbon future through provincial, territorial and federal collaboration across the energy sector. In December 2016, First Ministers endorsed the Pan-Canadian Framework on Clean Growth and Climate Change (PCF) – a plan to enable clean economic growth, reduce GHG emissions, and build resilience to a changing climate. The PCF sets Canada on a path to meet its target under the Paris Agreement of reducing emissions by 30% from 2005 levels by 2030.

The Framework acknowledges that, though Governments are directly responsible for a relatively small share of Canada's emissions (about 0.6%), they have an opportunity to lead by example.

Commitments for government leadership include:

1. Setting ambitious targets
2. Cutting emissions from government buildings and fleets
3. Scaling up clean procurement

Even before formalizing the PCF, the Government of Canada had already begun to show leadership internationally. In November 2016, Canada joined seven other nations (China, France, Japan, Norway, Sweden, the United Kingdom and the United States of America), by signing on to the Government Fleet Declaration under the auspices of the Clean Energy Ministerial – Electric Vehicle Initiative, committing to deploy greater numbers of electric vehicles in government fleets.

Canada's domestic Greening Government Strategy was released in December 2017. Led by the Centre for Greening Government at the Treasury Board of Canada Secretariat, the Government of Canada is working to ensure that Canada is a global leader in low-carbon, resilient and green government operations. The strategy sets an ambitious target to reduce GHG emissions from federal operations by 80% by 2050.

There is a fleet component to these commitments. Specific targets to modernize the Government of Canada's fleet are as follows:

- Starting in the 2019-2020 fiscal year, 75% of new light-duty administrative fleet vehicle purchases will be zero-emission vehicles (ZEVs) or hybrid, with the objective that the government's administrative fleet comprises at least 80% ZEVs by 2030. Priority is to be given to purchasing ZEVs
- Starting in the 2018-2019 fiscal year, all new executive vehicle purchases will be ZEVs or hybrids

- Fleet management will be optimized including by applying telematics to collect and analyze vehicle usage data on vehicles scheduled to be replaced
- Alternative energy options and their potential use in fleet operations related to national safety and security will be examined

Similarly, some provinces and territories have established their own greening government strategies, which include fleet targets, and actions. For example, Québec has a target to 1,000 electric or hybrid vehicles into their fleet by 2020.

The goal of this guide is to continue this federal/provincial/territorial collaboration to identify, evaluate, analyze and recommend the best practices which public fleets have implemented across multiple jurisdictions in an effort to lower emissions from fleet operations. The existing fleet model is provided as a baseline, followed by examples of the most successful programs and policies for sustainable energy efficient, lower carbon practices which can be integrated into public fleets across all levels of government (e.g. provincial, territorial, and municipal).

This guide provides information to help fleet managers implement a simple, cost-effective, step-by-step process for reducing their environmental impacts and operating costs when deploying new technologies and fuels. Since there is no single fuel or technology solution that exists today to cover every vehicle, fleet or location – all fleets need to establish a portfolio of technology and fuel options and practices that will save money and reduce their carbon footprint.

Implementing these actions does have its barriers. One of the biggest concerns fleet managers have with new technologies and alternative fuels is ensuring that they get a favourable return on investment once they put those vehicles into service. Another basic challenge is knowing where to start on developing a “sustainable fleet plan” for greening their fleet. A “sustainable fleet” is a fleet that manages and reduces net environmental impacts from operations at, or ahead of, the pace required to meet the targets and commitments.

The high up-front purchase cost has long been considered a major barrier to adoption of lower-carbon vehicles. Several studies suggest that financial incentives (e.g. rebates, tax credits) are an effective means of increasing deployment of low carbon vehicles (e.g. electric vehicles, hydrogen fuel cell vehicles, natural gas trucks) in the private sector. Direct incentives may not be available to address up-front costs in government fleets, however bulk vehicle purchase provides another option which government fleets at all levels could utilize to lower the purchase price.

Access to refuelling/charging infrastructure where and when needed is also a challenge which fleet managers must consider when looking for lower carbon options. As a captured fleet, overnight charging at home base is always an option, but given public fleets also operate across jurisdictions, access to public refueling infrastructure is an important consideration.

This guide discusses the findings around these major obstacles to lower-carbon vehicle adoption and offers a framework to address them, while also identifying enabling actions that can be taken. It gives both a high-level overview of the state of electric vehicles worldwide to guide policy decisions as well as a lower-level view of how to green your fleet to support individual fleet managers.

03 POLICIES & TARGETS

A supportive policy environment enables market growth by making vehicles appealing for fleets, reducing risks for investors and encouraging manufacturers to develop business streams on a large. In particular, these factors enable a wider variety of vehicle models offered which is key to spurring sales growth.

At this stage of low carbon vehicle deployment, policy support is still indispensable to support adoption. Policy support mechanisms can be grouped into four major categories: support for the research and development of innovative technologies; targets, mandates and regulations; financial support; and other instruments (primarily enforced in cities) for allowing increases in the value proposition of electric vehicles (EVs). Public procurement is also well suited to facilitating EV uptake.

The following section outlines various policies and targets which governments have established as they move toward greener government fleets.

Current Government Policies & Targets

CANADA

As mentioned earlier, Canada has committed to lowering emissions from all government operations, including facilities and fleets. The Pan-Canadian Framework on Clean Growth and Climate Change included commitments for Governments at all levels to lead by example, and reduce emissions from operations. The federal government will use cleaner energy and become more energy efficient across many areas – from buildings, to transportation, to buying more sustainable products. A portion of these reductions will be achieved through strategic investments in the use of electric vehicles in government fleets, as well as building the required charging infrastructure. Canada will also work with the Provincial and Territorial partners to encourage all levels of government to deploy lower emitting vehicles in their operations, through the establishment of best-practices and sharing of the experiences learned from early adopters.

In December 2017, the Federal Government released its Greening Government Strategy, which sets an ambitious target to reduce GHG emissions from federal operations by 80% by 2050.

There is a fleet component to these commitments. Specific targets to modernize its fleet as follows:

- Starting in the 2019 to 2020 fiscal year, 75% of new light-duty administrative fleet vehicle purchases will be ZEVs or hybrid, with the objective that the government's administrative fleet comprises at least 80% ZEVs by 2030. Priority is to be given to purchasing ZEVs
- Starting in the 2018 to 2019 fiscal year, all new executive vehicle purchases will be ZEVs or hybrids
- Fleet management will be optimized including by applying telematics to collect and analyze vehicle usage data on vehicles scheduled to be replaced
- Alternative energy options and their potential use in fleet operations related to national safety and security will be examined

These domestic commitments echo earlier commitments, made internationally. During the North American Leaders Summit, in June 2016, Canada, the U.S. and Mexico agreed to collaborate on a variety of actions to lower emissions across the economy. Specific commitments for transportation included working together to deploy greater amounts of electric vehicles in government fleets. Similarly, and shortly there after, at the 22nd Conference of the Parties (COP 22) in Marakesh, Canada joined seven other nations (China, France, Japan, Norway, Sweden, the United Kingdom and the United States of America), by signing on to the Government Fleet Declaration under the auspices of the Clean Energy Ministerial – Electric Vehicle Initiative, committing to deploy greater numbers of electric vehicles in government fleets.

Federal actions are complemented by actions and commitments at the provincial level.

BRITISH COLUMBIA

The BC Government, BC Utilities, and non-profit organizations offer a wide range of programs that can help BC local governments advance climate protection.

The Green Fleet Action Plan¹ provides a toolkit which is the foundation and overall direction for fuel-efficient fleet management. They reflect business needs, costs, and technical opportunities and restraints.

MANITOBA

The Government of Manitoba has made commitments to adopt lower emitting technologies in their fleets. These commitments start with an executive fleet policy requiring the use of hybrid vehicles. Departments and agencies are required to reduce the amount of gasoline and diesel used in fleet vehicles by increasing vehicle fuel efficiency, operating efficiency and reducing the number of kilometres driven by employees. Departments are required to limit the purchase or lease of four-wheel drive sport utility vehicles and similar vehicles to situations where there is a clear business need. Priority should be

¹ <https://www.toolkit.bc.ca/tool/green-fleet-action-plan>

placed on hybrid gas/electric and other fuel-efficient/low-emission vehicles. The Fleet Vehicles Agency will identify vehicles that meet the requirements of Manitoba's green fleet objectives.

QUÉBEC

The Québec government intends to lead by example in matters of energy efficiency in transportation. In Québec's 2030 Energy Policy – Energy in Québec a Source of Growth² the government sets targets to electrify the fleet and reduce its dependence on fossil fuels when it comes to transportation.

These targets include:

- Integrate by 2020 1,000 electric or hybrid vehicles into its fleet
- Ask Hydro-Québec to promote the replacement of its current vehicles at the end of their useful life with wholly or partially electric vehicles of equivalent capacity

NEWFOUNDLAND & LABRADOR

The Newfoundland government maintains a diverse fleet that includes passenger vehicles, trucks, ferries, heavy equipment, air ambulances and water bombers. These assets form a crucial part of service delivery in the province on a daily basis. Additionally, government employees often travel within and outside of the province on business. In 2015, the government began to integrate green considerations into fleet management and travel practices given the environmental benefits, such as reduced greenhouse gas emissions, and economic benefits as consuming less fuel will lower operating costs.

Specific actions undertaken include:

- Preparing and circulating tips for employees to reduce fuel consumption and maximize travel efficiencies

² <https://politiqueenergetique.gouv.qc.ca/wp-content/uploads/Energy-Policy-2030.pdf>

- Developing guidance and providing advice on selecting fuel-efficient vehicles for operations, including guidance on right-sizing to ensure the type of vehicle being used matches its function
- Maintaining government's target of ensuring at least 35% of new passenger vehicle purchases are fuel-efficient
- Examining the scope for a demonstration project for electric vehicles
- Taking steps to reduce the environmental impact of government's ferry fleet
- Monitoring progress towards integrating green considerations into fleet management and travel practices

NEW BRUNSWICK

In 2014, as part of implementing the NB Climate Change Action Plan 2014-2020, the Department of Environment and Local Government partnered with NB Power to engage a group of experts and stakeholders to examine options and opportunities for advancing electric vehicles in New Brunswick. Under the guidance of this group, known as the Electric Vehicle Advisory Group, salient issues were examined and favourable options were explored which include increasing the fleet adoption of electric vehicles and outlined in the province's Electric Vehicle Roadmap³.

SASKATCHEWAN

The government of Saskatchewan announced sizeable reductions to their fleet operating budget. The reduction was achieved by moving under-utilized vehicles to areas of government where there was more need, and selling older ones. Additionally, a yearlong pilot project was conducted using private sector, short-term vehicle rentals for government business.

³ <https://nb.lung.ca/sites/default/files/media/An%20Electric%20Vehicle%20Roadmap%20for%20New%20Brunswick.pdf>

SWEDEN

The Swedish government has announced that Sweden will be one of the world's first fossil-free welfare nations, and that in the long-term their energy system will be based on 100% renewable energy.

Sweden had indicated their belief that the transport sector will be a particular challenge in accomplishing their goals. Electric vehicles are expected to play a key role and government fleets can act as precursors. Apart from general incentives, promoting environmentally-friendly and electric vehicles, the Swedish government has launched particular incentives directed towards governmental fleets. One example is that governmental agencies are forced to consider the environmental aspect in the procurement of vehicles, by purchasing electric vehicles or by using biofuels. Another example is a recently launched subsidy for electric buses used in public transport: Public transport agencies will receive up to 700,000 SEK for each electric bus and up to 350,000 SEK for each plug-in hybrid bus.

CHINA

The Chinese government promulgated in 2014 the Implementation Plan for the Purchase of New Energy Vehicles by Government Organizations and Public Institutions.

From 2014 to 2016, new energy vehicles accounted for a minimum of 30% of annual new vehicles purchased by government departments, government organs and public institutions at the level of central government. The minimum percentage of new energy vehicles in annual purchases by the categories of institutions listed above will gradually increase in subsequent years.

The Implementation Plan further mandates minimum procurement shares by municipal and regional government organs and public institutions. In 2014, at least 10% of new vehicle purchases by regional and local organs and institutions were required to be new energy vehicles. The 2014 minimum procurement share is 15% in municipal and regional government organs and public institutions located in key developed regions and regions where particulate matter (PM) concentrations are particularly high. The minimum

percentage increased for municipal and regional organs to 20% in 2015 and to 30% in 2016 and will subsequently gradually increase annually thereafter.

FRANCE

The French State and its public bodies are committed to introduce a minimum share of 50% of vehicles with low emissions of CO₂ and air pollutants, including primarily battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEVs), when renewing their fleets.

Local authorities are subject to the same requirement, with a minimum threshold set at 20% of the vehicles they will purchase to renew their fleets.

This is expected to result in 5,000 low emission vehicles per year for the central government and its public bodies and 4,000 low emission vehicles per year for local authorities as of January 2017.

All new buses and coaches that shall be acquired for public transport services from 2025 onwards must also be low-emission vehicles.

JAPAN

The Japanese Plan for Global Warming Countermeasures Related to Government Affairs illustrates that the Japanese government is making every effort to ensure that, by 2030, all government vehicles will be next-generation vehicles, except in cases where no alternative next-generation vehicles exist.

As an intermediate goal, the Japanese government is making every effort aiming to ensure that, by 2020, approximately 40% of the governmental fleet vehicles (close to 9,000 vehicles out of 22,600 in the governmental fleet) will be composed by next-generation vehicles. This means that most of the governmental vehicles scheduled for renewal will need to be next-generation vehicles by 2020.

Governmental action on the renewal of its vehicle fleet is expected to contribute significantly to the aim of the Japanese Road Map for the Dissemination of Electric and Plug-in Hybrid Vehicles to increase to one million the total stock of electric and plug-in hybrid vehicles.

UK

The Government of the United Kingdom (UK) has a commitment that nearly all cars and vans in the UK will be zero emission by 2050 and has committed over £600 million in the period 2015-2020 to support this. Government and wider public-sector fleets must show leadership in supporting the inevitable switch to ultra-low emission vehicles (ULEVs). A number of programs, led by the Office for Low Emission Vehicles, are aimed at supporting the UK public sector in the uptake of ULEVs.

The UK government has reviewed the largest UK public sector fleets to assess the opportunity for vehicles in these fleets to be switched to ULEVs. As a first positive step in this transition, a £5 million public sector ULEV readiness program is bringing 300 vehicles into the public-sector fleet and supporting the installation of appropriate charging infrastructure.

The UK government worked with 12 local authorities on specific measures to increase the uptake of ULEVs and has supported action in 8 key areas under the UK's £40 million Go Ultra Low City scheme. Three exemplar cities – Bristol, Nottingham and Milton Keynes – have committed to increase the number of ULEVs in their fleets by around 200 vehicles.

Infrastructure is a key enabler for local authorities and Government has already helped them install nearly 1,000 charge points. This number will be increased significantly through the UK's £7.5 million workplace charging scheme, announced in October 2016.

Around 30 fuel cell electric vehicles are being trialled by public sector bodies under the £11 million HyTAP (Hydrogen for Transport Advancement Program) initiative.

The UK Government is undertaking a review of its Buying Standards for vehicles and plans to amend these standards to encourage future Government and public-sector vehicle purchases to be ultra-low emission.

USA

In 2015, the U.S. federal government set aggressive targets to reduce its own greenhouse gas emissions 30% by 2025 and acquire 20% of all new passenger vehicles as ZEV or plug-in hybrid by 2020 and 50% by 2025.

The U.S. federal government has entered into a new partnership with state and local governments (Supporting state and local partnerships to increase the electric vehicles on the road) to make public commitments to fleet electrification. By working together, federal, state and local leadership can aggregate demand to lower purchase costs, promote electric vehicle innovation and adoption and expand the national electric vehicle infrastructure.

Twenty-four state and local governments have joined the U.S. federal government to electrify its fleets. These new commitments accounted for over 2,500 new electric vehicles in 2017 alone and help pave a path for a sustained level of purchases into the future.

This builds upon prior commitment and action by forward leaning states and cities that have and continue to pursue fleet electrification.

Executive Order 13693 – Planning for Sustainability in the Next Decade (enacted March 19, 2015)

The goal of EO 13693 is to maintain Federal leadership in sustainability and greenhouse gas emission reductions. Federal Agencies shall promote building energy conservation, efficiency, and management by reducing agency building energy intensity by 2.5% annually through the end of the fiscal year of 2025. This reduction is relative to the baseline of the agency's building energy use in fiscal year 2015 and takes into account agency progress to date. This is to be done where it is lifecycle cost-effective starting in the fiscal year of 2016, unless otherwise specified.

Key Executive Order Points

- Sets out to cut the federal government's emissions by 40% over the next decade
- Mandates that beginning in fiscal year 2016, federal fleets reduce per-mile GHG emissions 30% by 2025 from a 2014 baseline and sets specific reduction targets for intermediary years
- Revokes EO 13423 (2007), EO 13514 (2009) and the 2011 Presidential Memorandum on Federal Fleet Performance which mandated all new light-duty vehicle acquisitions leased or purchased by federal agencies to be alternative fuel vehicles (AFVs) by December 15, 2015
- Mandates federal agencies to increase the percentage of zero emission and plug-in hybrid vehicle acquisitions in their fleets to comprise 20% of all new vehicle acquisitions by 2020 and 50% of all new acquisitions by 2025
- Charges the Agency head to determine the optimum fleet inventory with emphasis placed on eliminating unnecessary or non-essential vehicles
- Directs agencies to deploy vehicle telematics that allow for vehicle level data capture and reporting

The executive order also mandates agencies to plan for appropriate charging or refuelling infrastructure for zero-emission vehicles or plug-in hybrid vehicles and look towards opportunities for ancillary services to support vehicle-to-grid technology⁴.

EUROPEAN UNION

Clean Vehicles Directive

The Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles (2009/33/EC – known as the Clean Vehicles Directive) is aimed at a broad market introduction of more efficient, lower emission vehicles.

⁴ https://www.whitehouse.gov/sites/default/files/docs/eo_13693_implementing_instructions_june_10_2015.pdf

It requires public purchasers and private companies running public transport services to consider energy and environmental impacts when purchasing road vehicles.

Purchasers must take the following aspects into account as part of their purchasing decision:

- Energy consumption
- CO₂ emissions
- NO_x (nitrogen oxide)
- NMHC (non-methane hydrocarbons)
- Particulates

Procurement Methodologies

Purchasers may use one of three methodologies to take the above aspects into account when procuring road vehicles:

1. **Technical specifications:** Defining minimum performance for the listed aspects. As Euro Standards already include emissions thresholds for NO_x, NMHC, and particulates, specifying a vehicle of a particular Euro Standard will ensure that these pollutants are being taken into account. The Euro Standard specified will determine to what extent they are addressed. Procurers should aim for the highest available Euro Standard.
2. **Award criteria:** Including the listed aspects as award criteria.
3. **Operational lifetime cost method:** Assigning a monetized value to each aspect to be used in an operational lifetime cost comparison of different bids. Where this approach is used a methodology defined in the Directive must be followed.

Some EU countries have restricted which of the above methodologies may be used – Sweden allows only methodologies 1 and 3, the Czech Republic allows only methodologies 1 and 2, Slovenia only allows methodology 2.

Exclusions

Certain road vehicles are excluded from the Directive – specifically those in the following categories which are not subject to type approval or individual approval in the country where the procurement occurs:

- Vehicles designed and constructed for use principally on construction sites or in quarries, port or airport facilities
- Vehicles designed and constructed for use by the armed services, civil defence, fire services, and forces responsible for maintaining public order
- Mobile machinery

CHALLENGES & POSSIBILITIES

There are many challenges to adopting lower-carbon vehicles (e.g. battery electric, fuel cell, plug-in hybrid electric, hybrid or other types of fuels such as natural gas). This guide outlines the variety of successful policies and initiatives that can be modified to suit your specific requirements to address these challenges and greening your fleet.

Typically, government fleets procure their vehicles from a competitive request for standing offer that is renewed annually, in which manufacturers are requested to provide prices for new model year vehicles in accordance with specifications and popular option combinations. Government departments then order vehicles from the manufacturers' vehicle inventory (MVI).

Urgent vehicle requirements often arise as a result of accidents, theft, fire, program changes, etc. At one time, these vehicles could be supplied only through dealer stock purchases. However, the vehicles on the dealers' inventories are mostly outfitted with options tailored for the consumer retail market, making them more expensive than the fleet vehicles normally required to meet the operational needs of the fleet. In addition, discount levels from dealerships were not and are still not as significant as those provided to fleets. The MVI method is designed primarily to assist with urgent requirements and purchase cost reductions.

Governments have made commitments to reduce fleet related emissions. To ensure these commitments are met, governments must consider the acquisition of environmentally favourable vehicles. They may emphasize leadership in vehicle by balancing the environmental benefit of adopting lower carbon vehicles, while also ensuring fiscal responsibility, in relation to the cost of the vehicle.

Procurement Methods & Decision Factors

The procurement methods utilized by governments at all levels to acquire fleet vehicles usually follow similar steps to the following:

STANDING OFFERS

The standing offer method offers a choice of vehicles with a variety of options at pre-agreed prices for a specific period of time. As an example, for the 2017 model year, the Federal – Departmental Individual Standing Offer was expanded to include more lower emitting vehicles by obtaining prices from manufacturers for each option package as well as each individual vehicle available to them.

Whenever a requisition for a vehicle is received by procurement officers, the specifications are reviewed and the requirement is evaluated promptly using the pre-agreed vehicle and option prices. A contract is awarded to the manufacturer offering the lowest responsive price for the vehicle and options that are required by a fleet.

The responsible department evaluates vehicles in categories that are equipped with gasoline engines or alternative fuel engines using a four-step approach detailed below.

Battery plug-in technology and all alternative fuel vehicles are evaluated on base price only.

Step 1: The offer with the lowest price and those within 10% will be selected for the second step.

Step 2: Out of the vehicles identified in Step 1, the offer presenting the lowest fuel consumption and those within 10% will be evaluated for an estimated 6 year of fuel consumption for a prescribed distance, mix of highway and city driving and fuel cost per litre. Those vehicles will also be selected for Step 3.

Step 3: For those vehicles selected in Step 2, a value to the GHG emissions is calculated.

Step 4: The item evaluated price is established by the addition of the price offered plus the costs of its fuel consumption and its GHG emissions.

Tracking Vehicle Usage

Conventionally, government fleets have a variety of means by which they can monitor vehicle and fuel usage. The most common method is by using log-books. This requires vehicle operators to manually track their vehicle usage, including identifying data such as kilometres travelled, and fuel usage over that distance. Trip start and end points are usually included. This type of system provides basic facts on vehicle usage, but is 100% reliant on operators keeping log-books up to date and as accurate as possible.

More recently, fleets have begun to use vehicle telematics. Usually provided through third party arrangement, telematics can track a variety of data inputs, directly from the vehicles on-board diagnostics systems. There are a variety of telematics providers, and the suite of data that is tracked is dependant on the technology used, as well as how many resources fleet managers are able to provide. The advantage of these systems is that they can track vehicle and fuel usage in real-time providing up to date information for fleet managers, removing the human error factor provided by log-books.

A shift in vehicle technology will often have a number of important consequences which need to be taken into account in planning – not least, refuelling options and infrastructure, and vehicle usage profiles.

Determining Best Options Given Fleet Size & Budget

When planning for the procurement of new vehicles, fleet managers must first decide whether to:

a) Determine in advance the type of vehicle technology/fuel to be purchased (e.g. electric, hybrid, diesel etc., or a combination)

– OR –

b) Make the tender technology neutral – where different vehicle types compete against a common set of specifications and incentive criteria

Factors Affecting Procurement Decisions

Many governmental procurement authorities will establish large framework contracts with several vehicle suppliers, covering a range of different vehicle types, and also potentially vehicle technologies. In these cases, the final decision of which vehicle is purchased will often be made by the end user department, based on their individual requirements and preferences, rather than through a procurement activity. Where a technology/fuel new to the procuring authority is under consideration, many authorities opt to carry out testing and pilot actions to assess their performance under on-road conditions, and then base their decision on the results achieved. Trials and demonstrations can help to not only identify any unforeseen issues related to the new technology but can also help to increase acceptance of new technologies if end users are involved in testing actions.

There are a variety of factors which a procurement manager or transport operator will take into account when determining their vehicle procurement approach, as well as which fuel/technology option(s) to select:

FINANCIAL SUPPORT

The availability of financial support for the introduction of alternative fuels and technologies varies substantially from jurisdiction to jurisdiction. This is often the most important factor in determining whether such technologies are cost-effective, and which fuel/technology to choose.

TOTAL COST OF OWNERSHIP (TCO)

Many alternative fuel/technology options have higher upfront investment costs, both in terms of the vehicles, the infrastructure required, and potentially driver and maintenance training, but can demonstrate cost savings over the lifecycle of the vehicle due to lower fuel consumption/prices, and potentially longer lifespans and lower maintenance costs. TCO comparisons can be complex, and are heavily dependent on usage patterns, as well as available subsidies and incentives. For some authorities the split in budgetary responsibility between Capex (capital expenditure) and Opex (operational expenditure) can also make it problematic to base decisions on a TCO approach.

PRIORITIZATION OF AIR POLLUTION OR CO₂ EMISSIONS

A major determining factor in fuel/technology selection is your priority in terms of environmental performance. If local air pollution has higher political priority than CO₂ reductions, this may lead to a different choice of technology/fuel.

LOW-EMISSION ZONES

An increasing number of cities are introducing low-emission zones or emissions-based congestion charging schemes. The type of emissions which are restricted, and the limits set will have a significant impact on the choice of vehicle.

AVAILABILITY OF SPARE PARTS & OTHER MAINTENANCE ISSUES

When considering the introduction of new fuels and technologies, ensuring the availability of spare parts and readily accessible experienced maintenance technicians is an important factor in the procurement process.

USAGE PATTERNS, TOPOGRAPHY & CLIMATE

Where and how the vehicles will be operating can also have a major impact on the right choice of fuel/technology, and possibilities for new infrastructure developments – for example how hilly an area is, the length of trips, the distance between stops, load volumes, the density of passenger occupation, conditions of extreme heat and extreme cold, narrow access or historical districts, rough road surfaces and many other factors.

SCOPE OF REPLACEMENT ACTIVITIES

The extent to which a new technology may be introduced will also be influenced by the approach to replacement within the fleet. The introduction of a new refuelling infrastructure will likely only be cost effective where a major fleet overhaul is occurring. Where individual vehicles are being replaced, different fuel/technology choices may be most appropriate.

TIME & EXPERTISE AVAILABLE FOR PROCUREMENT

Shifting to new vehicle/fuel technologies can require both a longer procurement process and additional technical expertise within the procurement team. Support and advice from similar organizations who can share experiences, through established relationships or relevant networks as well as through this guide may be beneficial.

TRAINING REQUIREMENTS

The introduction of new fuels and technologies may have implications on training for operators on low carbon vehicle driving techniques, as well as technology specific training for in-house vehicle maintenance staff.

INFLUENCE ON THE MARKET

How important a customer are you to the market? For passenger cars, governments likely represent only a very small market share, and consequently have little power to influence the market, so procurement should be based on existing options should. For other vehicle categories, such as buses or waste collection trucks,

governments may be the most significant, or even only customer on the market. In these cases, there may be considerably more scope to work with suppliers to develop cleaner alternatives. Joint procurement, where authorities combine their procurement activities is another way to increase attractiveness to the market.

Availability of Charging/ Refuelling Infrastructure

A significant amount of planning is required to correctly size the EV parking and charging area for fleet applications. Consideration should be given to the current requirements as well as anticipated future requirements. Depending on the number and type of fleet vehicles charging at a single facility, electrical service requirements can be higher than residential or multi-unit residential building (MURB) installations, can have a significant impact on electrical usage and the local utility. For that reason, electrical utility planners need to be involved early on in the fleet planning process.

Installation of electric vehicle supply equipment (EVSE) at a facility typically consists of installing new dedicated branch circuits from the central meter distribution panel to a Level 2 AC EVSE. In a fleet, there are typically many such EVSE units in adjacent parking stalls. Proximity to the electrical service is an important factor in locating the parking area as the length and the quantity of the circuit run will have a significant impact on the cost. Fleet managers must also be aware of other equipment to be stored in the vicinity of the EVSE.

STANDARDS & TYPES OF CHARGERS

Charging electric vehicles requires the use of cables, connectors, and communication protocols. These communication protocols need to be between the vehicles, the EVSE, and the EVSE-grid communication (i.e. the communication between the EVSE and the DSO).

The EVSE suitable for electric cars has three main characteristics:

1. Level: the power output of an EVSE outlet
2. Type: the socket and connector being used for charging
3. Mode: the communication protocol between the vehicle and the charger

LOCATE EXISTING CHARGING/REFUELLING INFRASTRUCTURE

Similar to gasoline vehicles, drivers can expect that it will sometimes be more convenient to charge and/or refuel lower emitting vehicles off-site, rather than returning to a home facility. Public charging/refuelling stations are available in many municipalities in Canada, and departments are encouraged to supply their drivers with information on how to recharge or refuel their vehicles at public stations, as well as how to process and record fuel (electricity, hydrogen, natural gas) purchases in the vehicle usage database.

There are a number of resources available to help fleets to locate these charging stations:

- [NRCan's Electric Charging & Alternative Fuelling Stations Locator](#) ↗
- CAA
- ChargeHub

CONSIDER AN ACCESS & PRICING APPROACH FOR EMPLOYEES

Government departments are expected to purchase and install appropriate charging infrastructure to meet the operational needs of their executive and administrative fleets. There may be some instances where charging infrastructure meant to support fleet electrification could also be used by employees. In such cases, the following should be considered:

- Use of charging stations installed for fleet vehicles should be prioritized for charging fleet vehicles
- Restrictions for employee personal vehicles and public use of fleet charging stations should be at the discretion of the department
- Any charging stations installed at personal residences for executive vehicles will be at personal expense

For employee's personal vehicles, departments may choose to install charging infrastructure for employee or public use. If a department does so, it is recommended that:

- Employees are encouraged to charge their zero-emission vehicles during off-peak hours – making their home or public charging stations their primary charging location
- Departments should strongly consider charging a fee based on usage for Level 2 and DC fast chargers (without charging below cost)

DC FAST CHARGING (DCFC)

DCFC has an advantage in being able to charge vehicles in much shorter times as compared to Level 2 AC charging. A trade-off for this convenience comes through power requirements that are much higher than Level 1 and Level 2 AC, which complicates installation and increases costs. Deployment of DCFC is best suited

along highways and intercity corridors. BEVs rely entirely on their battery's electrical storage for the vehicle range. Traveling between metropolitan areas or from locations remote from metropolitan areas will require charge facilities along the way. DCFC infrastructure is ideal for these transportation corridors. Drivers prefer a short time to charge while on route to their destination and DCFC infrastructure delivers that capability.

Available Vehicle Technologies

Recently there have been significant advances in alternative vehicle technologies and increasing penetration in commercial vehicle markets. The picture is complex, however, with a wide range of low carbon fuels and technologies, all with different advantages and challenges, appropriate for different usage patterns, and at different stages of development. This section will cover hybrids, electric and hydrogen-based vehicles and how they impact the day-to-day energy uses.

HYBRIDS & ELECTRIC VEHICLES

Many consider the full electrification of vehicle fleets to represent the most likely development path in vehicle propulsion due to the absence of exhaust emissions and because the technology for implementation is relatively available. However, questions remain around the additional electricity demand and ability of batteries to replicate the simplicity of liquid fuels, especially in large, heavy vehicles.

Hybrid electric vehicles (HEVs), which combine a conventional internal combustion engine with an electric motor, are already well-established on the passenger car market. PHEVs can be charged by being plugged in to the electricity grid, and can travel further in electric only mode, giving significantly higher reductions in CO₂ and harmful emissions in comparison to standard hybrids. Though greater reductions in CO₂ from PHEV and HEVs occur when operating them in urban and semi urban, stop/start conditions they still offer many benefits in longer commutes.

Some vehicle manufacturers (commonly referred to as Original Equipment Manufacturers or OEMs) offer BEVs as part of their government standard offering. These are available in the A to D car segments⁵. OEMs are also starting to offer low and zero-emission vehicles in larger vehicle segments (e.g. van and heavy-duty vehicle market) which emit zero tailpipe emissions when in EV mode. It should be noted that vehicle range can be substantially reduced based on when, where and how the vehicle is operated. The principle challenge is to identify the most suitable vehicle technology to meet operational requirements.

NATURAL GAS

Natural gas offers a cleaner more affordable transportation fuel than conventional fuels like gasoline or diesel. Natural gas engine technology has been evolving over the last 10 or more years. Factory built engines and vehicles designed from the ground-up to operate using natural gas are now available in a variety of horse-power ranges, applicable for use in both public and private fleets.

Medium and Heavy-duty Trucks

Significant numbers of medium and heavy-duty natural gas powered vehicles are currently operating throughout North America, delivering lower GHG emissions and fuel savings to the fleets and the communities they serve.

Refuse Trucks

Refuse trucks operating on natural gas are now readily available in the market. These trucks offer an opportunity to reduce the operating costs of refuse collection vehicles which is an important consideration for municipalities. Natural gas powered refuse trucks also offer concurrent environmental benefits contributing to better air quality and meeting local GHG emissions reductions targets.

⁵ www.clean-fleets.eu/fileadmin/files/documents/Publications/Clean_Fleets_Guide_screen_version.pdf

Bus Fleets

Natural gas engines are now available as an option for both public transit bus fleets and school buses. These busses deliver cost effective emissions reductions to Canadian communities. Compressed natural gas (CNG) busses deliver cost effective emissions reductions to Canadian communities.

Refuelling Infrastructure

When used as a transportation fuel, natural gas is either compressed or liquefied to increase its energy density and allow for sufficient on-board storage to give the means of transportation an acceptable range of operation.

Compressed Natural Gas (CNG) is compressed at a high pressure to reduce its volume by up to 300 times compared with natural gas at a normal pressure. It is ideal for passenger cars, pick-up trucks, cube vans, buses, shuttles, short-haul tractor trailers, dump trucks, medium and long-haul trucks, and refuse trucks.

Fleets that choose natural gas have a range of refueling station options and a choice of service providers for vehicle refueling. Stations dispensing CNG can be designed as fast fill stations capable of matching the filling times of liquid fuels or time fill stations that refuel all vehicles simultaneously with refueling typically taking place overnight in the fleet yard. Refueling at an existing public CNG station may be an option at the early stages when switching to natural gas. If a public station is to be used, fill time and site access are important considerations.

Private onsite refueling stations may be suitable if the fleet's total natural gas fuel volume is sufficient. A simple rule of thumb is that typically 20 medium or heavy vehicles are needed in order to consider a private onsite station.

Liquefied Natural Gas (LNG) is natural gas, cooled to a liquid state at -16° Celsius to reduce its volume by 620 times compared with natural gas at normal pressure. LNG is ideal for ferries, ships, rail, long-haul trucks, mining applications and industrial uses.

LNG stations refuel vehicles in times similar to diesel station refueling. An LNG refueling station must have a local supply of fuel. Given that LNG is delivered by tanker truck, delivery cost and proximity of the LNG production facility are important considerations.

HYDROGEN & FUEL CELLS

Using hydrogen as an alternative fuel to conventional fossil fuels can offer significant environmental benefits, including reductions in GHGs by more than 80%, with similar reductions in criteria air contaminants. A fuel cell produces electricity through a chemical reaction, but without combustion. It converts hydrogen and oxygen into water, and in the process also creates electricity. Fuel cells operate much like a battery, except they don't require electrical recharging.

Vehicles

This means that hydrogen fuel cell vehicles can be considered as another type of electric vehicle. Unlike pure battery electric vehicles, hydrogen vehicles can be refueled with compressed hydrogen in about the same time as it would take to fill a conventional gas or diesel vehicle. Fuel cell technologies are currently available in a small number of passenger vehicles, in select markets. Fuel cell buses have also been successfully deployed as large-scale demonstrations in some municipal fleets around the world.

Refuelling Infrastructure

Hydrogen fuel is dispensed from specially designed refuelling infrastructure, at high pressure (350 or 700bar). A full tank of fuel for a passenger vehicle can be delivered in under 5 minutes. There are specific guidelines and regulations which must be followed when installing hydrogen stations, and it is worth noting that these regulations are specific to the jurisdiction where the station is being installed.

Challenges Fleet Managers Encounter

LONG DELIVERY TIMES

The electric vehicle stock varies from province to province. If you are buying vehicles from the dealer stock fleet managers can expect to wait as much as 6 months or even longer before taking delivery of an EV.

CARS

Hybrid cars are already well established on the mass market, and there has been a significant increase in the offer of PHEVs and full electric vehicles from the major car manufacturers. Both present a viable alternative to standard gasoline/diesel vehicles for public authority fleets, depending on the usage patterns of the vehicles concerned and on local climatic, topographical and congestion conditions. A cost comparison between electric, hybrid and traditional vehicles can heavily depend on available financial support.

VANS

There are some, smaller, full electric vans on the market. Some larger 3.5 tonne vans are becoming available although the weight of the battery can cause issues related to load capacity, aftermarket retrofit hybrid systems are available for 3.5 tonne vans. In some parts of Canada vans and associated refuelling infrastructure for biofuels and CNG are available.

MINIBUSES

Full electric minibuses are available from conversion companies, but not from original equipment manufacturers. In some parts of Canada pilot EV minibuses and associated refuelling infrastructure for biofuels and CNG are available.

BUSES

As with all heavy-duty vehicles (HDVs), buses have traditionally run on diesel, however a wide variety of alternatives exist at different levels of market maturity today. A significant number of hybrid

and CNG buses can be found today in cities, due to the lower local emissions of PM and NO_x. Hybrid buses are also increasingly well-established on the market, and many cities are piloting the use of full electric buses as well as hydrogen fuel cell buses.

OTHER HDVS

Due to vehicle size, weight and recharging speeds, electric propulsion is not a significant option for other HDVs currently. CNG is already well established on the market for HDVs in certain countries, and biogas offers an attractive alternative where refuelling infrastructure is in place. Hydrogen may offer a longer-term solution but remains too expensive currently for commercial operation. Electric and hybrid vehicles are being introduced for some specialist/vocational vehicle types with an appropriate usage pattern (regular stop-start and recharging time) such as street cleaning and waste collection trucks. For instance, California has taken delivery of its first all-electric garbage truck in June 2017⁶.

AVAILABILITY OF FUEL & REFUELLING INFRASTRUCTURE

The highly differentiated availability of a refuelling infrastructure for alternative fuel types has a major impact on the practicality of selecting certain vehicle types. Often a decision to invest in a new form of vehicle fuel/technology will need to go hand in hand with investment in refuelling or charging stations. This in turn will depend on the overarching national or regional commitment to renewable energy.

A significant amount of planning is required to correctly size the EV parking and charging area. Consideration is given to the current requirements as well as anticipated future requirements. Electrical service requirements will be much higher than residential or multi-family installations and can have a significant impact on electrical usage and on the utility. Electrical utility planners need to be involved early on in the fleet planning process. The individual home owner will be interested in charging his/her vehicle off-peak. That interest will be greater for the fleet manager.

⁶ <https://electrek.co/2017/06/14/all-electric-garbage-truck-california/>

Flood prone area restrictions must be considered as well as issues of standing water. Often large parking lots will have low spots where water accumulates. Although the Level 2 EVSE contains the proper protection device, employees will not be comfortable operating the EVSE in standing water.

Installation of the EVSE at a fleet facility typically consists of installing new dedicated branch circuits from the central meter distribution panel to a Level 2 EVSE. In a commercial fleet, there are typically many such EVSE units in adjacent parking stalls. Proximity to the electrical service is an important factor in locating this parking area. The length of the circuit run and the quantity will have a significant impact on the cost.

Because these EVSE units are in a designated area, the potential for pedestrian traffic is less therefore consideration can be given for the most economical installation methods. In addition, the commercial nature of the site allows greater overall security, such as fences and gates, so that the threat of vandalism is minimized.

Fleet manager interest and priorities can also stimulate the development of Level 3 charging. The higher charge rate means a shorter turn-around for each vehicle and maximizes on-road time. The 480/600 VAC is generally available in commercial facilities.

The amount of time needed to completely charge an EV battery when fully depleted is a function of several factors:

- Battery size/depletion
- Charging option selected: Level 1 AC, Level 2 AC or DCFC
- The vehicle's battery management system
- The on-board charger specifications
- The voltage and amperage of the charging station

CURRENT STATE OF GLOBAL LOW-CARBON VEHICLE DEPLOYMENT

The governments mentioned in this guide have committed to lower emissions from their fleet operations, and are deploying EVs as part of the solution. These efforts are also occurring in the private sector, with private fleets and consumers also opting to drive an electric vehicle. For context, this section outlines the current state of global EV deployment.

The global electric car stock surpassed 2 million units in 2016 after crossing the 1 million vehicle threshold in 2015 (Figure 1).

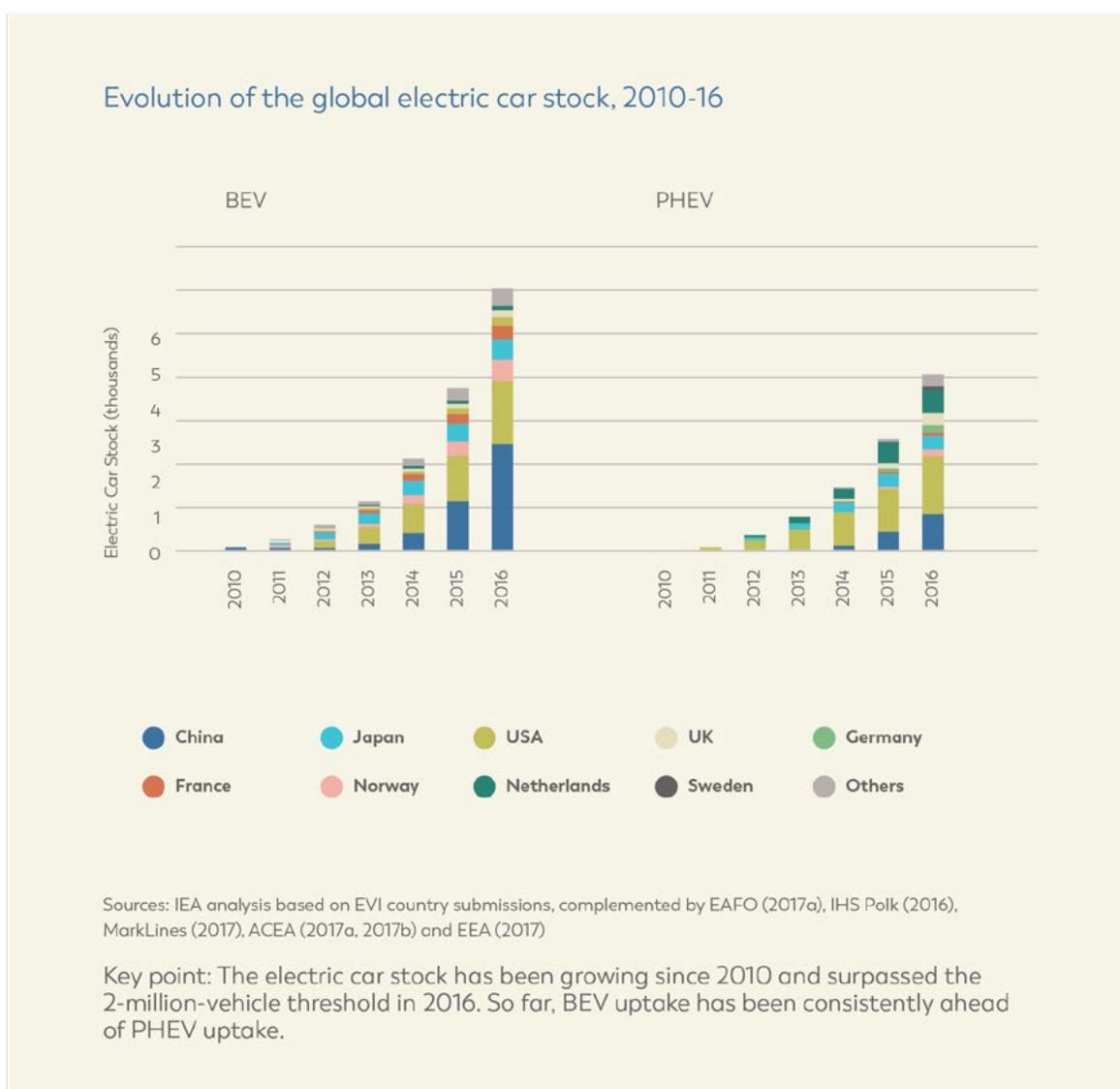


FIGURE 1

Despite a continuous increase in the electric car stock, annual growth rates have been consistently decreasing since 2011. In 2016, stock growth was 59%, down from 76% in 2015 and 84% in 2014. BEVs still account for the majority of the electric car stock at 60%. Their share did not change significantly since 2012 and kept fluctuating around this value.

When compared with the global car stock, the global electric car stock tracked in this report still accounts for a small fraction, 0.2%, of the total passenger light-duty vehicles in circulation worldwide.

China surpassed the United States in 2016 in total electric car stock, becoming the country with the most EVs on its road network. This evolution is primarily due to China's rapidly growing BEV market, where BEVs have continued to dominate over PHEVs. Since 2014, BEVs stabilized at about 75% of the Chinese electric car stock share. China and the United States make up 60% of the global electric car stock. European countries, combined, account for most of the rest, representing 28% of the global total. Like electric car sales, the global stock is still concentrated in a few markets. The top five countries account for 80% of the total, while the top ten countries account for 96%.

The global BEV stock has experienced a higher annual growth rate than that of PHEVs since 2013. In 2016, BEVs grew by 62%, while PHEVs grew by 59%. The narrative changes if China is not considered. When excluding China, the growth rate of the global PHEV stock has been higher than for BEVs since 2009, with only the exception of 2014.

As in the case of sales, different countries have different characteristics. The electric car stock in China, France, and Norway is primarily composed of BEVs. The Netherlands is clearly the country with the largest share of PHEVs in its stock, at 88% of the total. A third group of countries, including Canada and the United States, have a fairly even distribution of PHEV and BEVs in their stock.

Overall, accounting for the global OEM announcements and targets listed in Figure 2, the electric car stock stemming from the OEM targets could range between 9 million and 20 million by 2020.

OEM	Announcement	Source
BMW	0.1 million electric car sales in 2017 and 15-25% of the BMW group's sales by 2025	Lambert (2017b)
Chevrolet (GM)	30 thousand annual electric car sales by 2017	Loveday (2016)
Chinese OEMs	4.52 million annual electric car sales by 2020	CNEV (2017)
Daimler	0.1 million annual electric car sales by 2020	Daimler (2016a)
Ford	13 new EV models by 2020	Ford (2017)
Honda	Two-thirds of the 2030 sales to be electrified vehicles (including hybrids, PHEVs, BEVs and FCEVs)	Honda (2016)
Renault-Nissan	1.5 million cumulative sales of electric cars by 2020	Cobb (2015b)
Tesla	0.5 million annual electric car sales by 2018 1 million annual electric car sales by 2020	Goliya and Sage (2016), Tesla (2017a)
Volkswagen	2-3 million annual electric car sales by 2025	Volkswagon (2016)
Volvo	1 million cumulative electric car sales by 2025	Volvo (2016)

FIGURE 2: List of OEMs announcements on electric car ambitions, as of April 2017

Note: Chinese OEMs include BYD, BJEV-BAIC Changzhou factory, BJEV-BAIC Qindao factory, JAC Motors, SAIC Motor, Great Wall Motor, GEELY Auto Yiwu factory, GEELY Auto Hangzhou factory, GEELY Auto Nanchong factory, Chery New Energy, Changan Automobile, GAC Group, Jiangling Motors, Lifan Auto, MIN AN Auto, Wanxiang Group, YUDO Auto, Chongqing Sokon Industrial Group, ZTE, National Electric Vehicle, LeSEE, NextEV, Chehejia, SINGULATIO Motors, Ai Chi Yi Wei and WM Motor.

Key Point: By April 2017, nine global OEMs had publicly announced their willingness to create or significantly widen their electric model offer over the next five to ten years. Several Chinese OEMs also announced very significant electric car production capacity scale-up plans.

Considering announcements to 2025 and applying growth rates based on the targets announced to 2020, the OEM announcements listed in Figure 2 could lead to 40-70 million electric cars on the road by 2025.

The level of ambition resulting from the OEM announcements shows a fairly good alignment with country targets to 2020. To 2025, the range estimated suggests that OEMs' ambitions lie within the range corresponding to the RTS (Reference Technology Scenario) and 2DS (2°C Scenario) projections from the International Energy Agency, broadly matching the Paris Declaration. In order to see

these ambitions materialize, EV (and battery) production capacity needs to increase. The scale of this challenge can be illustrated by comparing the battery capacity additions needed against recent developments. Attaining the mid-point of the estimated ranges for OEM announcements in 2025 would require the construction of roughly ten battery manufacturing facilities with the production capacity of the Tesla Gigafactory.

LOW-SPEED ELECTRIC VEHICLES

Low-speed electric vehicles (LSEVs) are gaining relevance primarily in China, where they have emerged as a competitor to both electric vehicles and two-wheelers. LSEVs generally have a maximum speed of between 40 km/h and 70 km/h, have short ranges, and, in some cases, use lead-acid batteries and basic motor technology. Estimates for LSEV sales in 2016 were between 1.2 million and 1.5 million, and the year-on-year growth rate since 2014 was close to 50% for the third consecutive year⁷. Since LSEVs started to develop after 2011⁸, their current stock is likely to be close to 3-4 million units.

The main attractions of LSEVs are their low cost, small size, and the lack of regulations (for instance, they do not require a drivers licence or insurance to operate). This is especially advantageous for those in cities where the number of new licence plates is restricted. In China's Shandong province, the growing LSEV industry has also contributed significantly to job creation.

The growing use of LSEVs has not materialized without concerns. The use of lead-acid batteries has had negative environmental effects, and the lack of regulations for LSEV manufacturers has led to poor safety performance. Traffic safety is also at stake. LSEVs struggle in large cities due to their poor acceleration and low top speeds. They are often used in bike lanes, and, since both the drivers and the LSEVs themselves do not require specific documentation to operate, are difficult to control. Lastly, LSEVs could jeopardize the market for electric cars, one of China's priorities for industrial policy development.

⁷ Auto Sohu, 2016, 2017a, 2017b; CIIN, 2016; Daily Economic News, 2016 and Jiren, 2017

⁸ EVI, 2016a

Legislation to regulate and standardize LSEVs is currently being discussed by the Chinese government⁹. According to the China Electrical Car Network, some of the issues that will be addressed by regulations include battery types (lead-acid versus lithium-ion batteries), mandatory safety tests and vehicle dimensions¹⁰. The high-level objective is to upgrade the LSEV fleet in circulation, regulate and standardize the vehicles and eliminate the LSEVs that do not comply with these standards.

TWO-WHEELERS & THREE-WHEELERS

China continued to dominate both new registrations and the global stock of electric two-wheelers in 2016, with estimates of roughly 26 million sales. Given the development of two-wheeler sales over time and scrappage ages that should be reasonably close to eight to ten years, the vehicle stock should also be in the same magnitude of the values estimated for 2015, in the 200-230 million range. While data quality and collection remain an issue, it is evident that China is by far the global leader. The high growth rate in electric two-wheelers is partially due to the country's policies to limit air pollution hazards, such as its ban on gasoline-powered motorcycles, limits on the issuing of licences, and the division of lanes¹¹.

Further data collection is necessary to validate and compare more countries and rationalize information for international comparison. The few data points available suggest that the United Kingdom experienced a positive growth in the number of two-wheelers from 2015 to 2016. Sweden also witnessed an increase in 2015 from 2014, but data were unavailable for 2016.

Three-wheelers, widespread in Asian countries and mainly known as tuk-tuks, are also attracting the attention of policy-makers and are bound to become increasingly electrified. For example, the Thai government is planning to start electrifying its vehicle fleet by tackling tuk-tuks through a subsidy program aimed at supporting the introduction of 100 of them by 2018. The policy goal is to fully replace the 22,000 tuk-tuks currently on the roads by 2021.

⁹ MIIT, 2016

¹⁰ Yang, 2016

¹¹ Yang et al., 2014

ELECTRIC BUSES

The global battery-powered electric bus stock grew to about 345,000 vehicles in 2016, double the number in 2015. Despite potentially significant data classification issues, China emerges as the global leader in the electrification of buses. According to available statistics, the stock of electric buses in China reached 343,500 units in 2016 and included about 300,000 BEVs. Within China, Shenzhen is one of the most ambitious cities regarding the electrification and modernization of its bus systems. In 2016, hundreds of electric buses were already in operation. Shenzhen has also set the goal of having a 100% electric bus fleet in 2017¹².

Europe accounted for 1,273 vehicles in the global electric bus stock in 2016, while the United States accounted for 200. The European electric bus stock more than doubled from 2015, suggesting that the market is moving beyond the demonstration phase into commercial development. An example of this can be found in the city of Paris where the public transport operator opened its first electric bus line in 2016. This operator is getting ready for widespread electrification and plans to replace 80% of its existing bus fleet with electric buses by 2025 – this translates to roughly 4,000 electric buses being deployed in the next eight years¹³. In the United States, the electric bus manufacturer Proterra doubled its sales in 2016 compared to 2015 but has only sold 380 vehicles since the company's founding in 2004¹⁴.

NATURAL GAS

In Canada, the total number of natural gas vehicles has remained relatively constant at approximately 12,500 in 2016 compared to 12,000 reported in 2010. Medium-duty and heavy-duty vehicle sales have made up the majority of the market since 2010. By the end of 2016 more than 1,600 natural gas-fuelled trucks and buses on the road in Canada. Sales remain at approximately 300 vehicles per year, representing a market penetration of less than 1% of all Class 7/8 trucks and buses sold in Canada.

¹² Hall et al., 2017

¹³ RATP, 2017

¹⁴ Proterra, 2017

Refuse and transit segments accounted for almost all of the growth in natural gas vehicle sales in Ontario, Alberta, Manitoba, and Nova Scotia. Overall sales numbers for North America indicate that up to half of the new refuse vehicles sold during the last five years were equipped with natural gas engines.

CNG fuelling infrastructure installed to support these new fleets are operated through a combination of one of three models: Do-it-yourself, wherein the fleet owns and operates the refuelling infrastructure in-house, at the fleet garage; Utility Package, wherein the local utility operates and maintains the refuelling stations; and Third-Party Service Provider, where one fleet provides other fleets access to their refuelling stations, for an agreed upon fee. Most existing models see the refuelling stations operating on a private basis (i.e. only accessible to specific fleets, and not open to general public). More recently, two refuse fleets have opened their fueling stations to third parties, with one partnering in the development of a new public refueling station.

HYDROGEN

The current state of hydrogen and fuel cell vehicle deployment is in its infancy. There are currently three light-duty vehicle models available for lease in Canada. However, Toyota recently announced that it would be deploying 50 of its Mirai fuel cell vehicles in Québec City. Similarly, there are only 5 hydrogen refuelling stations in Canada, but as the number of vehicles grows, so will the number of refuelling stations.

CHARGING EQUIPMENT STOCK

Charging infrastructure, whether at home, at work, or at public locations, is indispensable for operating EVs. Early EV market developments showed that the availability of chargers was one of the key factors that contributed to the market penetration of EVs. Ensuring the availability of chargers is also essential for enabling the diversification of the transport fuel mix and catalyzing its transition towards clean energy.

In terms of the number of vehicles, electric car growth is expected to significantly exceed buses, other public transport vehicles, and trucks. This is due to the fact that these modes constitute a fairly small fraction of the total vehicle stock.

	Level	Current	Power	Type			
				China	Europe	Japan	North America
	Level 1	AC	≤ 3.7 kW	Devices installed in private households, the primary purpose of which is not recharging electric vehicles			SAE J1772 Type 1
Slow Chargers	Level 2	AC	> 3.7 kW & ≤ 22 kW	GB/T 20234 AC	IEC 62196 Type 2	SAE J1772 Type 1	SAE JJ1772 Type 1
	Level 2	AC	≤ 22 kW	Tesla connector			
Fast Chargers	Level 3	AC, triphase	< 22 kW & ≤ 43.5 kW		IEC 62196 Type 2		SAE J3068 (under development)
	Level 3	DC	Currently < 200 kW	GB/T 20234 DC	CCS Combo 2 Connector (IEC 62196 Type 2 & DC)	CHAdEMO	CCS Combo 1 Connector (SAE JJ1772 Type 1 & DC)
	Level 3	DC	Currently < 150 kW	Tesla and CHAdEMO connectors			

FIGURE 3

The power requirements needed for the energy supply of electric cars clearly exceed those needed to charge smaller vehicles. Electric cars are more likely to require the deployment of novel components of the electricity production, transmission, and distribution infrastructure.

HISTORICAL DEVELOPMENTS

Similar to the global electric car stock, global EVSE outlets surpassed 2 million in 2016. Electric cars still outnumber public charging stations by more than six to one, indicating that most drivers rely primarily on private charging stations (Figure 4).

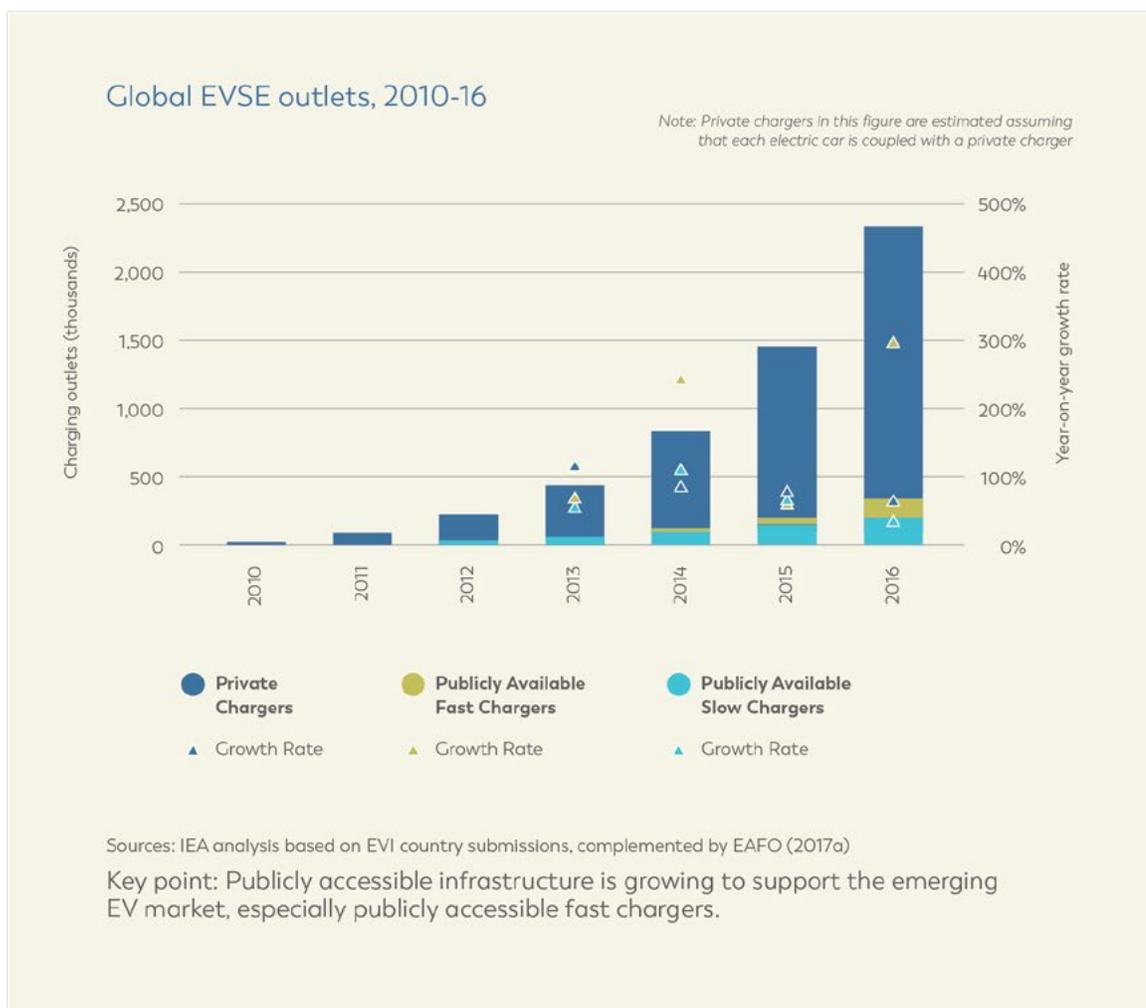


FIGURE 4

The growth of publicly accessible chargers accompanies the increase in the number of electric cars on the road: the growth rate in the number of publicly accessible chargers in 2016 (72%) was higher, but of similar magnitude, to that of the electric car stock growth in the same year (60%). The higher rate of growth for chargers than electric cars fits the pattern of chargers being required before electric vehicles will be adopted.

Publicly accessible EVSE growth was primarily driven by the rapid increase in the number of fast-chargers, largely attributable to China, where fast chargers grew sevenfold to nearly 90,000 units. Even when China is not considered, the growth rate for publicly accessible fast chargers in 2016 was still greater than publicly available slow chargers.

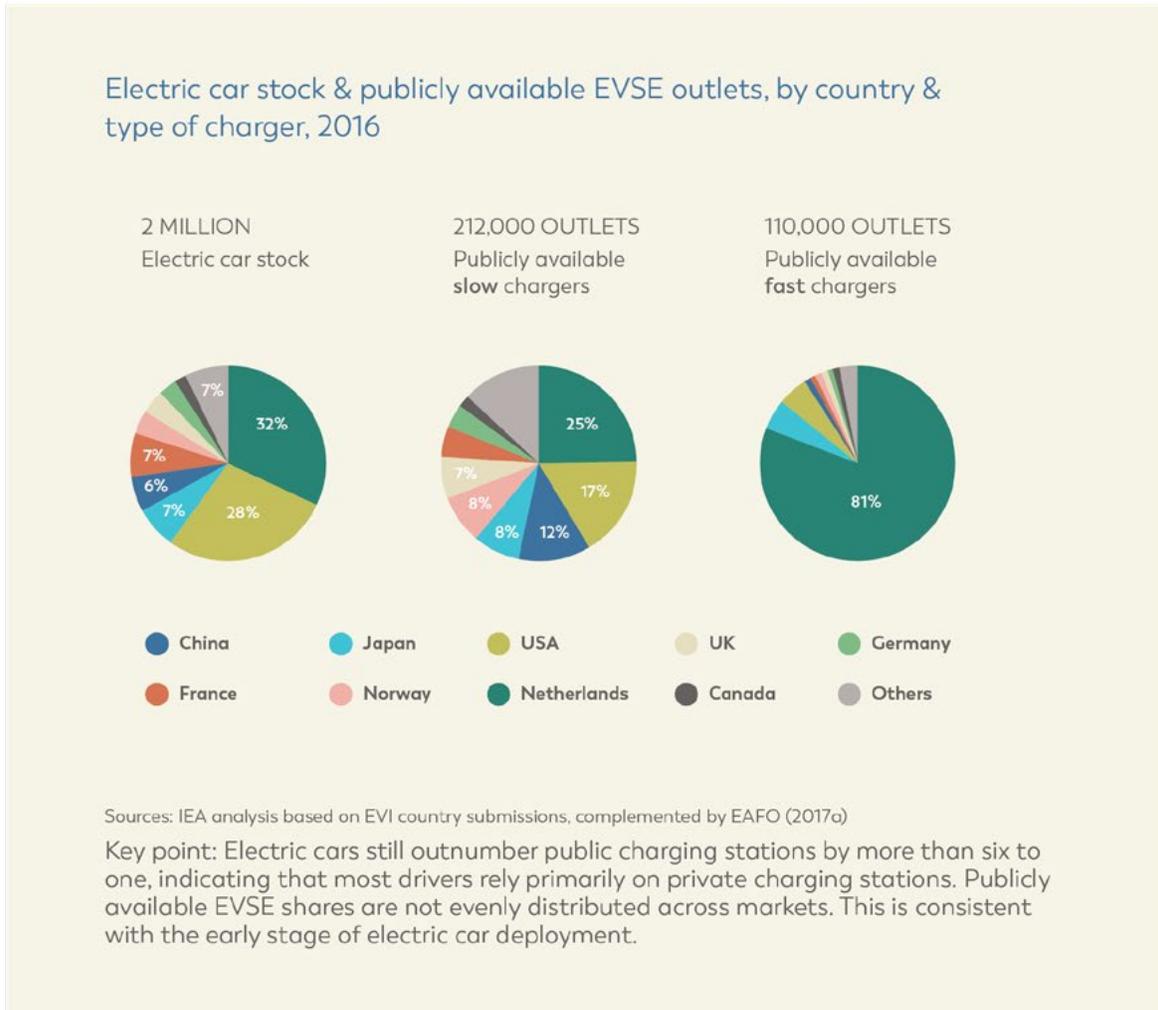


FIGURE 5

Figure 5 shows the regional distribution of electric cars (left-hand chart), publicly accessible slow chargers (centre chart) and fast chargers (right-hand chart). Figure 5 indicates that the shares of publicly available EVSE are not evenly distributed across markets, reflecting large variations in EV/EVSE ratios across countries. This is consistent with the early stage of EV deployment in most markets.

In the case of fast chargers, the large global share for China could be the result of the rapid growth of electric buses (significantly larger than in any global region so far) and significant uncertainty about the share of fast chargers actually dedicated to bus services. Japan, where 50 kW fast chargers were deployed early in order to address range anxiety (i.e. the fear that a vehicle has insufficient energy stored on board to reach the next available charging point or its destination), but where EV sales have not experienced recent, significant year-on-year growth, also has high shares of fast chargers per EV compared with other countries.

BEST PRACTICES

This section outlines a suggested six-step approach for developing a strategy for reaching the on-road vehicle targets (both administrative and executive).

SUGGESTED IMPLEMENTATION APPROACH

As part of their individual fleet management strategy, governments should plan to meet and/or exceed the targets for low carbon vehicle deployment as they come into effect. They also must ensure that adequate charging or refuelling infrastructure is available to service the fleet vehicles when and where needed.

Step 1 – Know Your Fleet

CRITICALLY EVALUATE TRANSPORTATION CHOICES

The most immediate way to lower emissions from a vehicle fleet is through reducing reliance on on-road vehicle transportation and vehicle purchases altogether. Implementing a long-term approach that leads to a smaller, more efficient fleet begins with critically evaluating alternative options to continually replacing existing fleet vehicles.

Suggestions for initial steps include:

- Exploring contracting out with a vehicle service for surge capacity
- Exploring options to reduce the need for or frequency of longer-distance operations
- Sharing or pooling vehicles between client departments
- Initiating consultations with end-use clients on the feasibility of implementing alternate models

FORECAST HOW DEPARTMENTAL NEEDS MAY CHANGE OVER TIME

ZEVs and the charging infrastructure necessary for operation represent important medium- and long-term investments, which should be taken into account alongside forecasted transportation needs. For example, a trend of growing operations in one region may indicate a need to prioritize investment in charging infrastructure in that location. Even understanding general trends, such as whether an entire fleet has been expanding or contracting, can be valuable information.

Where possible, efforts should be made to predict potential upcoming right-sizing opportunities (e.g. sunsetting programs, facility closures, etc.) that are in line with departmental priorities. Identifying where these nearest opportunities, challenges and uncertainties are can help decision makers to more effectively focus their resources and plan ahead as they weigh options for replacement.

CONSIDER INITIATING A STUDY

Departments, particularly those with large fleet portfolios, may consider commissioning a third party organization to develop a macro-level long-term path to decarbonization of their fleet assets. For example, under the federal Greening Government Strategy, departments emitting the most greenhouse gas emissions must maintain a Carbon Neutral Portfolio Strategy that provides a roadmap to 2050 to achieve a carbon neutral portfolio. Several of these departments have already initiated studies to better

understand their departmental emissions. For its large real property portfolio, Public Services and Procurement Canada (PSPC) retained a consultant, WSP, to develop a departmental path to achieving carbon neutrality before 2050. For its procurement portfolio, PSPC's Région du Québec retained CIRAIG to identify the greatest sources of emissions from procurement and to propose recommendations.

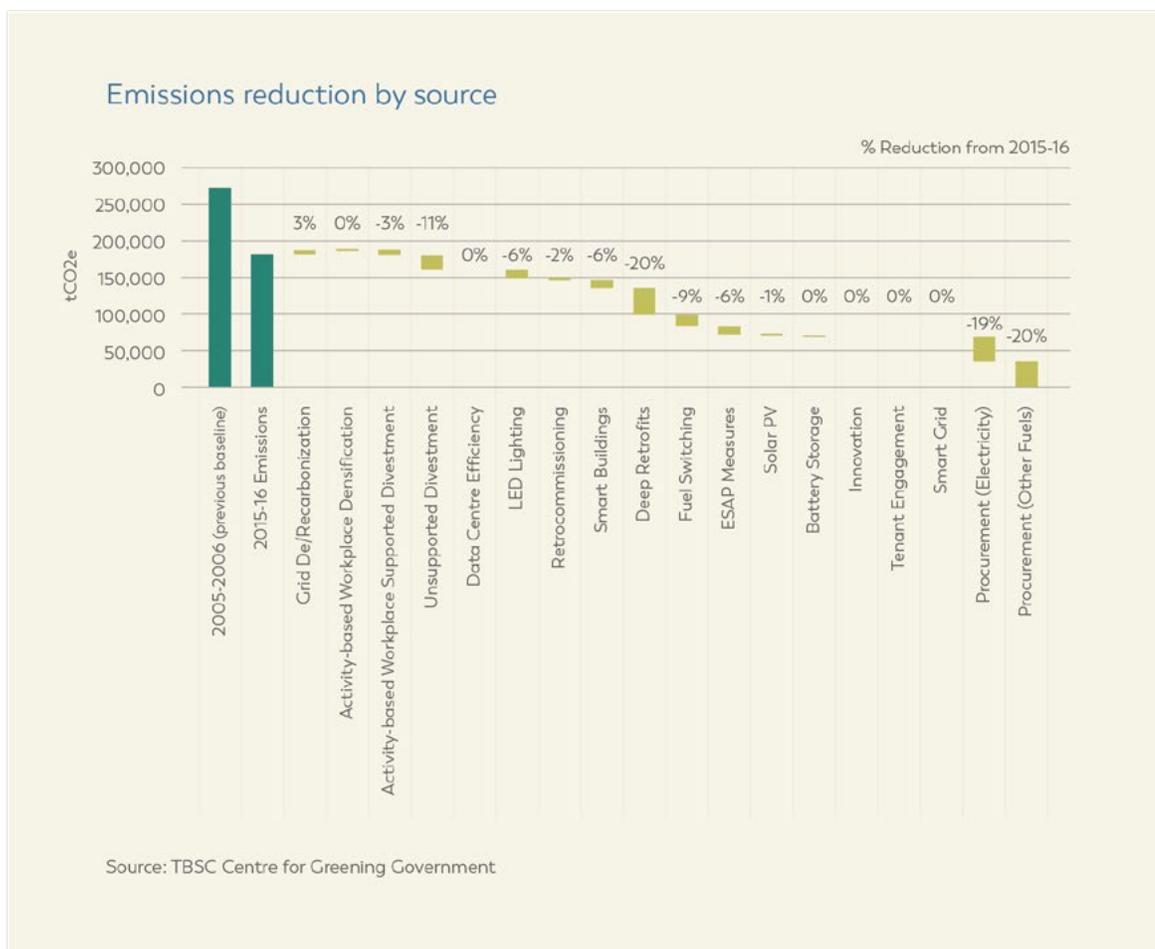


FIGURE 6

For large fleet-owning departments, a similar independent analysis could offer a concrete long-term path for efficient vehicle procurement based on future projections about price of vehicles and market availability in Canada. Depending on the size of the investment involved in transitioning an entire department's fleet to meet the existing fleet target (and the availability of internal resources), the cost associated with commissioning a study could be outweighed by the long-term savings in implementing an efficient plan.

INSTALL DATA LOGGERS

On a micro-level, there are resources available within the Government of Canada to assist departments in measuring the real-world use of their individual vehicles with data loggers. Information gathered using these devices can support departments in making the greenest and most operationally-appropriate replacement purchases.

Natural Resources Canada (NRCan) received resources in Budget 2017 to support the installation of data loggers in administrative and executive vehicles, and is offering this service to all departments at no additional cost. Data loggers (i.e., telematics) are small electronic devices that can be placed in any vehicle to record how and when that vehicle is being operated. The data is collected in real-time and can be accessed by fleet managers, who will receive accurate fuel usage reports and evidence-based replacement recommendations. These devices are typically installed in all vehicles in a fleet, which allows managers to accurately identify right-sizing opportunities and to plan their replacements accordingly.

To find out more or to join the program, please contact Yves Madore at NRCan's Greening Government Office: yves.madore@canada.ca

Step 2 – Build Internal Support

The most immediate way to lower emissions from a vehicle fleet is through reducing reliance on on-road vehicle transportation and vehicle purchases altogether. Implementing a long-term approach that leads to a smaller, more efficient fleet begins with critically evaluating alternative options to continually replacing existing fleet vehicles.

Changes to a fleet will be met with resistance from fleet manager and operators. This is why it is crucial to engage important stakeholders early in the decision making process in order to gain support. Also, deputy heads might perceive other barriers such as the initial higher purchase cost of zero-emission vehicles and the need to install the supporting infrastructure as barriers.

Suggestions for initial steps include:

CONSIDER SUPPORTING POLICY REQUIREMENTS

This guide outlines federal and provincial policies that may support the transition to lower-carbon vehicles and fleet GHG reductions. Choose the right one for your jurisdiction or use them as a basis to establish your own. Building a strong directive supported by national and international policy will help to contextualize the necessary changes to your fleet and help gain internal support.

SET INTERNAL GHG REDUCTION TARGETS

Setting internal targets in the short, medium and long-term will allow you to keep track and measure progress. You may choose to set targets based on percentage of annual ZEV purchases or focus on specific vehicle classes where ZEVs are most suitable.

SELECT THE OPTIMAL LOWEST CARBON VEHICLE TECHNOLOGY

It is important to communicate that operational suitability will not be lost during the transition to a lower-carbon fleet. As mentioned before, with the proper analysis you can make sure that the right vehicle is selected without impacting daily operations and demonstrate suitability and lifecycle GHG and cost reductions.

GREEN PROCUREMENT

Vehicles are purchased or used by many public authorities and will play a role in the delivery of other contracts such as for construction, landscaping, waste management, social care, facilities management, and highways maintenance. Specialized vehicles such as buses and waste collection trucks are examples of market sectors where

public demand may be particularly influential in moving towards lower emissions and greater fuel efficiency. Under the Clean Vehicles Directive, contracting authorities are obliged to take energy efficiency and tailpipe emissions of CO₂, NO_x, PM and NMHC into account at a minimum. A comprehensive sustainable procurement approach will also take account of other factors, including full 'well-to-wheel' analysis of fuel-related emissions including production, distribution and consumption, as well as the raw materials used to construct vehicles, their life-time mileage, maintenance needs and end-of-life disposal characteristics.

The gains associated with sustainable procurement in this sector are financial as well as environmental. Savings on fuel and, in many cases, vehicle tax, can be substantial when cleaner and more efficient vehicles are chosen. Further savings can be realized by rationalizing fleet requirements and making the most of eco-driving and innovative technologies such as telematics and satellite navigation to reduce wear and tear and unnecessary mileage. On the innovative end of the market, electric, hybrid, biogas, hydrogen and other alternative fuel technologies are making inroads within public fleets. The human and economic benefits in terms of better air quality and, where existing patterns of vehicle use are challenged, reduced traffic congestion, are considerable. In addition to the public authority's own fleet, procurers can exercise further influences on sustainable urban transportation patterns by also setting demands relating to the use of low emission vehicles in the delivery of goods and services procured by the authority. An increasing number of public authorities have, for example, established urban freight consolidation centres to reduce traffic related to goods deliveries. To optimize impact, vehicle procurement should be undertaken as part of a broader integrated mobility strategy where possible.

Fleet procurement is another major policy adopted by both countries. The four largest cities on the west coast, Los Angeles, Seattle, San Francisco, and Portland, plan to purchase 24,000 EVs for their municipal fleets, according to their joint Request for Information (RFI). The city of New Bedford, Massachusetts, has procured 23 EVs from Nissan using \$7,500 USD in state incentives and a federal tax credit

of \$7,500 USD. The U.S. Department of the Navy also proposed a purchase of 400-600 EVs from Ford Motor Company using a federal tax credit.

Government procurement of EVs is playing an even greater role in China. In 2014, China required that the central government, as well as some cities and public organizations, should have at least 30% of their vehicle fleet consist of EVs by 2016. In 2016, this goal was increased to at least 50% EVs.

LEARN ABOUT LOW & ZERO-EMISSION TECHNOLOGIES

Fleet managers know their fleet best. They should be encouraged to keep up to date with emerging technologies and pilot vehicles that they think will help to meet the GHG reductions set by departments.

Step 3 – Match Options to Fleet Needs

A truly optimized fleet is consistently analysed to ensure that it is operating with the most efficient assets and the right amount of assets.

COMPLETE SUITABILITY ASSESSMENTS

Suitability assessments take the guessing game out of it. You need to ensure that you have access to accurate vehicle utilization data to make the right vehicle choice when it comes time to replace it.

SELECT OPTIMAL LOWEST CARBON VEHICLE TECHNOLOGIES

As you are completing your suitability assessment it's important to approach this step with a mentality of being technology agnostic. Remove any bias that you may personally have with regard to a technology. It's about finding the lowest carbon vehicle technology that meets operational requirements.

RIGHT-SIZE YOUR FLEET BASED ON OPERATIONAL REQUIREMENTS

Again, the more accurate data you have on vehicle usage and duty-cycles the better you will be at understanding your fleets' needs. This allows you to identify underutilized assets and either move them to where they will be better utilized or decommission them.

Step 4 – Strategy Planning to Meet Targets

Strategic planning is essential to ensure the sustainability and measurable approach to achieving your fleet greening goals.

ESTABLISH VEHICLE REPLACEMENT SCHEDULE

You can target specific groups or categories of vehicles or tackle the issue based on region. Consider what vehicle technologies are available to meet your short-term goals and where the supporting infrastructure currently is or will be in the near future.

INSTALL CHARGING & RE-FUELING INFRASTRUCTURE

Look for opportunities to leverage federal or provincial incentives and approach this issue systematically and holistically with your greening facilities objectives.

Once a department has an accurate understanding of the type and quantity of zero-emission vehicles that it intends to purchase over the long term, telematics can assist in modelling the infrastructure necessary to support the operation of these vehicles. For EVs, the number and type of chargers required will vary depending on the needs of the department, and numerous options and configurations for charging equipment are available. For instance, some vehicles which are used infrequently may only require access to a Level 1 charger, whereas other vehicles that need to be refuelled more than once a day would require access to a Level 2 or 3 charger.

INITIATE THE INSTALLATION PROCESS

The process for installing charging infrastructure will differ based on the custodian of the parking infrastructure. If a department is the custodian of the property where electric vehicle charging infrastructure is to be installed, that department may procure equipment from the suppliers under the a standing offer in place for charging infrastructure. Alternatively, a department may choose to launch a competition for charging infrastructure supply equipment.

If a department is not the custodian of the property where electric vehicle charging infrastructure is to be installed, the department must contact the service provider to discuss their options for installation, understand the landlord's requirements and communicate the long-term requirement for the department to comply with the Greening Government Strategy if one is in place.

HOW TO INSTALL & IMPLEMENT WORKPLACE CHARGING

Companies choose to provide workplace charging for a number of reasons, believing it can provide benefits to the company and its employees. The following sections describe the steps that a company should follow in order to install a workplace charging solution that will fit its needs, regardless of whether it is a large or small business.

Gain Internal Support

The interest in workplace charging may initiate from the company management (such as the sustainability manager, facility managers, or the CEO) or from enthusiastic employees. In the case where it's the employee who wants to begin a workplace charging program, he or she needs to get buy-in from senior management. Generally, as with any work-related issue, finding a colleague who is an ally is crucial, especially with larger firms. If the employee can develop a base of internal support, then convincing higher-level management may become easier. In this way, employees essentially create local 'EV showrooms' for information sharing on the vehicles. If the initiative is from the management side, getting input and engagement from employees is equally important to ensure that a successful and useful program is developed.

No matter who initiates the program, it will be important to illustrate the benefit to the company overall, estimate the options and costs, and provide examples of companies, preferably in the same industry, that have adopted workplace charging.

Take an Employee Interest Survey

As a first step, determine the current and future interest level of your employees in charging EV's at work by taking an Employee Interest Survey. Knowing the number and types of vehicles (BEVs or PHEVs) that may be charged will be the foundation for developing your charging station installation plans.

When choosing among infrastructure options, the first question employers must tackle is what charging rate or charging level is best suited for their company. Most often this comes down to whether to offer Level 1 or Level 2 infrastructure. The answer will largely depend on a couple of factors: (1) the commute distance of the employees who drive EV's – which can be determined through an Employee Interest Survey, and (2) the cost of the system.

Potential survey questions could include:

- Do you own a EV?
- If so, how often do you drive it to work?
- If so, what is the typical time required to charge your EV to 90%?
- If you drive to work, approximately how far is your trip (one-way)?
- Are you considering a purchase or lease of a EV in the future?
- Would you consider purchasing a EV if workplace charging were available?
- How soon do you plan on buying or leasing your next vehicle (any type)?
- Would the option to charge your car at work be desirable?
- If workplace charging were an option, would you be willing to pay for the service?

If the interested employees work full-time and commute approximately 25 kms or less one-way, then Level 1 charging may be adequate. If there are employees who work part-time, or often travel in and out of the office, then Level 2 charging may be required for their needs.

As a parallel effort to the survey, you should collect information from your facilities manager about the type of wiring at your location and the size of the circuit breakers in order to assess the level of readiness for the site.

After assessing employee commuting patterns from the survey, and understanding the type of wiring you currently have, you can move to making decisions on the type of charging infrastructure.

CHOOSE THE APPROPRIATE SYSTEM

Charging Equipment, Options and Costs

Installing Level 1 charging is a good entry point for companies new to workplace charging. It is relatively easy and inexpensive and is likely the most practical approach to meet the needs of employees who are parked for long durations. Level 1 EVSE can be as simple as a cord combined with a standard household electric outlet that provides basic grid connectivity. However, there may be a small risk of overloading a circuit breaker on a limited-ampereage circuit, so some Level 1 systems include an electrical outlet and enclosure designed specifically for electric vehicle charging using a dedicated circuit. A few Level 1 EVSE come with a wall-mountable cord-set, while others allow you to attach the cord that comes with the vehicle. On the other hand, installing Level 2 EVSE at the workplace allows one charging station to serve many different vehicles throughout the day as long as the vehicles are swapped out when they finished charging.

Level 2 is also ideal for employees and visitors who need a faster charge than what Level 1 provides. In general, Level 1 charging solutions range from little cost to no cost at all, for example when a cord-set is used to plug into a regular outlet. Commercial Level 1 EVSEs are not available in a wider range yet, but according to a study titled Ready, Set, Charge, California, Level 1 hardware generally ranges in cost from \$300 to \$500 USD.

Comparison of common charging levels

	LEVEL 1 Wall Socket	LEVEL 2 Standard	LEVEL 3 DC Quick Chargers
			
AC	120 VAC ≤ 12 amps, 16 amps ≤ 1.44 kW, 1.92 kW	208 - 240 VAC, 1Φ ≤ 80 amps ≤ 1.92 kW	TBD* ≤ 19.2 kW (assumed) 1Φ or 3Φ
DC	200-450 VDC* ≤ 80 amps ≤ 1.92 kW	200-450 VDC* ≤ 200 amps ≤ 90 kW	200-600 VDC* ≤ 400 amps? ≤ 240 kW?

*Specifications not finalized

Source: http://www.calstart.org/Libraries/Publications/Best_Practices_for_Workplace_Charging.sflb.ashx

FIGURE 7

According to the same study, Level 2 hardware has a wider range of costs, from \$500 to \$6,000 USD, while fast-charging hardware is likely to be cost-prohibitive for the majority of workplaces since costs can be as much as \$55,000 USD per unit.

Several companies have considered a hybrid approach with Level 1 serving the needs of most employees, and one or two pay-per-use Level 2 charging stations available for visitors and those that need a quicker charge. EVSEs can now be ordered online or at retail locations from a variety of suppliers.

Comparison of different charging levels is shown in Figure 7 including AC and DC charging.

The actual charging time will depend on the on-board type of charger, type and level of EVSE, and the state of charge of the vehicle battery. For an approximation of charging times please review the vehicle manual. A guide table is also available at the Plug-in Electric Vehicle Resource Center¹⁵.

Electric vehicles are equipped with on-board chargers that convert AC power from the grid to DC power needed by the battery. DC fast chargers bypass a vehicle's on-board charger and deliver electricity directly to the battery at a higher rate than the on-board chargers would allow.

The list of EVSE manufacturers is extensive. A good source for a listing of EVSE companies can be found on the Plug In America website as well as a few others listed at the end of this section. For a reference on costs of some of the systems, visit the AQMD website¹⁶ that has a list of quotes provide as part of the So Cal EV program.

INSTALLATION COSTS

Power Requirements

In some instances, a new or second electrical panel and circuit breakers might be necessary to support the new EVSE load. A sub-panel upgrade (200A, 120/240 VAC single phase) can amount to approximately \$2,000 USD. In the unlikelyhood that there is inadequate capacity to support the desired number of EVSEs, a utility transformer upgrade may be necessary. Your local utility will determine whether or not the transformers serving the site need to be upgraded. If a service upgrade is required, the utility will work with the property owners to determine allowances and cost.

Siting Considerations

Avoid costs for trenching and conduits by locating the EVSE close to the existing electrical supply. Adding new circuitry can increase capital costs significantly, since the costs rise per linear foot.

¹⁵ <https://www.driveclean.ca.gov/pev/Charging.php>

¹⁶ http://www.aqmd.gov/docs/default-source/technology-research/socal-ev/av_evse_price_list.pdf

PROVIDE EXTRA TRAINING FOR EMPLOYEES & DRIVERS

Demonstrate to your employees that you are also investing in them. Promoting fuel-efficient driving behaviour will increase your GHG reductions.

Step 5 – Maximize Online Tools

Online tools such as portals with fuel consumption, emission and driving behaviour information can help to increase the efficiency of a fleet. A fleet manager can have access to real-time data to identify areas where improvements can be made.

ENCOURAGE BETTER DRIVING HABITS

Through training and communication, fleet managers can encourage fuel-efficient driving behaviour. It will reduce GHG's and operating costs and increase safety. It's about identifying the most useful touch points and nudges for operators. Consider challenging groups of fleet operators or individuals and acknowledging or rewarding the most fuel-efficient drivers.

INCREASE ON-ROAD FUEL EFFICIENCY DURING DAILY OPERATIONS

For PHEVs for example, it's important to dispatch these vehicles with the thought of maximizing their EV range and charging opportunities. Same with BEVs fleet managers who need to match the right vehicle for the right trip.

Step 6 – Procure & Implement

Consider bulk purchases to decrease costs and continuously monitor to maintain a sustainable pace to achieving your goals.

MAKE A BUSINESS CASE FOR USING LOW-CARBON TECHNOLOGY

A business case will allow all pertinent stakeholders to see the long-term benefits of a shift to lower-carbon technologies. It also displays that sound judgement and analysis was the basis for the shift.

SECURE FUNDING TO GREEN THE FLEET

Using your business case will also demonstrate to decision makers to secure funding and the authorities to proceed with your plan.

IMPLEMENT CHOSEN STRATEGY

Implementing the strategy and monitoring results to ensure optimization is crucial to the success of a sustainable strategy. The more data you have along with open lines of communication with your fleet managers the better you'll be able to make adjustments and react to demands more efficiently.

07 CONCLUSION – WHAT SUCCESS LOOKS LIKE

The fleet of the future will be different than today's. This guide will help to lay the foundation to support your transition over the next decade.

Taking action will have additional environmental and economic benefits beyond reducing GHG emissions. Efficiency improvements can help save money by spending less on fuel and reducing the costs of operations. Through proper analysis and by following data driven evidence based advice, fleets can be very efficient while still meeting the operational requirements. A modern fleet is:

- **Right-sized** – right-sizing your fleet will lower costs by decommissioning underutilized assets and also create the need to optimize dispatching.
- **Efficient** – an efficient fleet is one that increases the utilization of low-carbon vehicles and trains, monitors and rewards operators for fuel-efficient driving.
- **Open to new technologies and future proof** – low-carbon vehicle technology is improving at a rapid pace. Fleet managers need to stay aware of emerging technologies and how they could decrease help decrease emissions. Managers also need to predict future requirements to ensure that efficiencies are sustainable.
- **Fiscally responsible** – Improvements in fleets may seem costly at first however, moving to a total cost of ownership model and highlighting the importance of energy efficiency and lowering emissions has to be the priority.
- **Holistic** – the approach to lowering fleet emissions needs to be holistic with the approach to reducing the carbon intensity of facilities.

Use of Telematics

Some governments are using telematics devices, which the data is collected in real-time from the vehicles, which can be accessed by fleet managers and later analyzed.

The data collected can determine how a more fuel-efficient, lower emission vehicle could perform as a replacement.

BASE VEHICLE PROCUREMENT DECISIONS ON IRREFUTABLE DATA

By gaining a complete understanding of your fleet's performance, you'll be able to create multi-year procurement plans with absolute confidence. This makes it easier to gain support for your decisions. Simply, the data doesn't lie.

- Forecast fleet-wide operational costs/savings
- Evaluate multi-year procurement plans
- Clear cost comparisons, an independent audit

MONITOR YOUR VEHICLES FOR INSIGHTS THAT LEAD TO BETTER DECISIONS

Advanced vehicle monitoring finds opportunities to improve fleet performance after the assessment. Real-time monitoring and reporting can prove compliance as government regulations require fleets cut emissions.

- Pinpoint the most efficient vehicle deployment
- Stop improper use of vehicles early
- Ongoing monitor tracks green fleet progress

EXPLORE OPPORTUNITIES TO IMPROVE ROI WITH DETAILED VEHICLE DATA

Explore the results of fleet decisions before committing to them. Evaluate procurement decisions for duty-cycle fit and lifetime cost. Calculate fleet-wide statistics such as greenhouse gas emissions, fuel and energy use.

- Fleet right-sizing through efficient use of assets
- Vehicle fit, simulate duty-cycle performance
- Forecast GHG reduction by fleet compositions

REVIEW THE FINDINGS AND ACHIEVE YOUR GOALS

Finally, it is important to understand exactly what you need, and make sure the data is accurate and draft recommendations based on your needs.

- To ensure the assessment is a success
- Presentation of findings and recommendations
- Your fleet requirements guide our suggestions

The end result is a Vehicle Suitability Assessment report, which provides an accurate analysis of total cost of ownership savings as compared to the original vehicle, along with an estimate of ZEV supply equipment needed for the ZEV fleet implementation.

FUEL SWITCHING

Fuel switching replaces inefficient fuels with cleaner and economical alternatives, such as substituting coal or kerosene for natural gas. Complimented by modern equipment upgrades, fuel switching is a simple approach to reducing energy consumption and costs for end-users, while also curbing carbon emissions.

What are the benefits of financing fuel switching?

- **Growing market:** Rising energy prices and the drive for low carbon fuels are likely to make fuel switching increasingly desirable to end-users
- **Long term energy cost-savings:** Projects often finance themselves over time
- **Performance improvements:** Fuel switching can result in lower operational and maintenance costs for end-users
- **Simple paybacks:** Typical loan paybacks are in the 2.5 to 4-year range, on average
- **Preferential treatment:** National regulations, tariffs, or subsidies may support the switch to a cleaner fuel, thus improving the economics of fuel switching projects
- **Energy security:** Under certain market conditions, fuel switching can enhance reliability of the energy supply
- **Environmental impact:** Financing environmentally-friendly fuel switching can earn reputational capital with policy makers, and investors due to the positive impact projects have on reducing carbon emissions

Successful advancement of greening government operations in Canada over the long-term will require that decision makers and fleet managers undertake significant efforts to transition their vehicles and infrastructure.

