HOUSE OF COMMONS
CHAMBRE DES COMMUNES
CANADA

INNOVATIVE TRANSPORTATION TECHNOLOGIES

Report of the Standing Committee on Transport, Infrastructure and Communities

Larry Miller, MP
Chair

FEBRUARY 2013

41st PARLIAMENT, 1st SESSION

INNOVATIVE TRANSPORTATION TECHNOLOGIES

Report of the Standing Committee on Transport, Infrastructure and Communities

Larry Miller, MP
Chair

FEBRUARY 2013

41st PARLIAMENT, 1st SESSION

STANDING COMMITTEE ON TRANSPORT, INFRASTRUCTURE AND COMMUNITIES

CHAIR

Larry Miller

VICE-CHAIRS

Olivia Chow

Hon. Denis Coderre

MEMBERS

Mark Adler
Robert Aubin
Joe Daniel
Ed Holder
Isabelle Morin
Pierre Poilievre
Mike Sullivan
Lawrence Toet
Jeff Watson

OTHER MEMBERS OF PARLIAMENT WHO PARTICIPATED

Blake Richards
Merv Tweed

CLERK OF THE COMMITTEE

Alexandre Roger

LIBRARY OF PARLIAMENT

Parliamentary Information and Research Service

Allison Padova, Analyst

THE STANDING COMMITTEE ON TRANSPORT, INFRASTRUCTURE AND COMMUNITIES

has the honour to present its

SIXTH REPORT

Pursuant to its mandate under Standing Order 108(2), the Committee has studied Innovative Transportation Technologies and has agreed to report the following:

TABLE OF CONTENTS

INNOVATIVE TRANSPORTATION TECHNOLOGIES

INTRODUCTION

In February 2012, the House of Commons Standing Committee on Transport, Infrastructure and Communities (the Committee) commenced a study on innovation in the transportation sector.[1] Committee members wanted to learn about new transportation technologies that are commercially viable and that could address challenges in the Canadian transportation system, such as: emissions reduction, transportation efficiency and safety, congestion in urban areas, and all-season northern supply. The scope of the study included "game changer" technologies (e.g., electric vehicles and airships), as well as technologies that increase the efficiency of existing transportation networks (e.g., intelligent transportation systems, lower carbon fuels, aerodynamic and lightweight vehicle components, etc.). The Committee agreed to focus their study of innovation in transportation on three central questions:

- What are these new technologies?
- What are the obstacles to their commercialization and/or adoption in Canada?
- What can the Government of Canada do to enable advances in research in these areas and/or encourage the deployment and adoption of market-ready technologies?

While the Committee had wide-ranging discussions with witnesses that covered many other aspects of new transportation technologies, this report is limited to an overview of stakeholders' and members' perspectives regarding the three questions members had identified as the study's focus.

This report reflects what the Committee heard concerning innovation and the adoption of innovation within various industries of the transportation sector, including on-road vehicles, rail, aerospace, and alternative fuels. The Committee convened 21 meetings with, and received several written submissions from, over 40 industry and government representatives. The report begins with a summary of what industry stakeholders and departmental officials said about the role of the federal government in transportation innovation, followed by what the Committee learned about innovation from stakeholders in various transportation industries. The report closes with the Committee's analysis of certain stakeholder suggestions and the Committee's own recommendations

1 The Conference Board of Canada defines innovation in the following way: "a process through which economic or social value is extracted from knowledge — through the creation, diffusion, and transformation of ideas — to produce new or improved products, services, or processes." Conference Board of Canada, Innovation Defined, Centre for Business Innovation.

for the Government of Canada to promote innovation and the adoption of innovation in the transportation sector.

While military and space programs have contributed to transportation technology in the past, history has shown that free enterprise is the major engine behind invention and discovery in this field. With this history in mind, the Committee does not propose new government funding for "the next big technology;" nor does it seek to turn politicians into engineers, inventors or venture capitalists through government programs that pick winners and losers. Rather, it recommends cost-neutral proposals to streamline regulation and expand competition, so that private-sector innovations can better move people and products.

Recommendation:

1. **That the Government of Canada stay small and streamlined in order to minimize impediments to innovation, so that transportation entrepreneurs can take risks, deliver breakthroughs and reap the rewards of their advances.**

This report starts with the premise that meritorious innovations normally pay for themselves.

Recommendation:

2. **Federal departments and agencies that administer public funds for innovation should henceforth ask the following two questions to applicants:**

    - **If your technology is viable, why would the government need to fund it?**

    - **If it is not, why would the government want to fund it?**

FEDERAL GOVERNMENT ROLE IN TRANSPORTATION INNOVATION IN CANADA

In the 19th and early 20th centuries, many European and North American advances in transportation technology appear to have progressed from the drawing board to commercial application backed only by private capital (see Annex A: *A Timeline of Selected Transportation Innovations since 1800*). In contrast, the contemporary story told by witnesses who participated in the Committee's study is one where the public sector is an important partner in the private sector development of new or improved products, processes and business practices (hereafter referred to simply as "innovation") in transportation. Mitch Davies, Assistant Associate Deputy Minister from Industry Canada, told the Committee that, theoretically, "if you don't provide some incentive to the highly risky speculative activity that is the early stage of R and D [research and development] effort, you would get less of it than is socially desirable; therefore, there is support and

incentive in different forms on the part of the public."[2] In Canada, some examples of federal innovation support initiatives for the private sector are:

- The Department of Finance's Scientific Research and Experimental Development Tax Credit, which reduces the cost of research and development (R&D) in all industries in Canada.

- Transport Canada and Natural Resources Canada's grant and contribution funds for:

    - academic and private sector innovators, which reduce the cost of developing and testing new technology; and

    - consumers, to reduce the cost of adopting a new technology.

- Federal departments, agencies and appointed representatives conduct and publish research on transportation technologies to support the development of public policy, the results of which raise producer and consumer awareness of market environment surrounding a particular technology. Transport Canada has ongoing transportation research activity through the Transportation Development Centre and Natural Resources Canada published the *Natural Gas Use in Transportation Deployment Roadmap* and the *Electric Vehicle Technology Roadmap*. A federally appointed panel recently completed the *Aerospace Review*.

- The federal government provides testing facilities for the transportation industry primarily through the National Research Council of Canada, Transport Canada and Natural Resources Canada.

- The federal government purchases many goods and services from the private sector. A policy decision to directly or indirectly support innovation or adoption of innovation can be among the criteria in procurement decisions.

Departmental officials from Transport Canada, Natural Resources Canada, Industry Canada and the National Research Council of Canada (NRCC) who appeared before the Committee discussed their departments' involvement in transportation innovation in Canada, including some of the departments' financial commitments. According to Statistics Canada's most recent issue of *Federal Scientific Activities*, federal spending on transportation-related science and technology, R&D and related scientific activity amounted to $472 million in 2010–2011, including internal and external expenditures.[3]

---

2 Mitch Davies, Associate Assistant Deputy Minister, Science and Innovation Sector, Industry Canada, *Evidence*, Meeting No. 24, 1st Session, 41st Parliament, March 1, 2012, 1000.

3 Statistics Canada, *Federal Scientific Activities 2012–2013*, Catalogue No. 88-204-X, released September 18, 2012, Tables 6-4, 6-2 and 6-3.

The following sections contain an overview of departmental officials' reflections on the role of their department in transportation innovation.

A. Transport Canada

Kristine Burr, Assistant Deputy Minister of Transport Canada's Policy Group, told the Committee that important federal government innovations in the transportation sector that emerged in the last 20 years have included: privatizing and commercializing federal infrastructure and services; using public-private partnerships to finance major transportation projects; focussing on management or performance-based regulations to increase safety and security in transportation; and creating new partnerships within Canada's major supply chains to help improve performance in the transportation of goods. Transport Canada has also been promoting intelligent transportation systems (ITS) innovations in road, rail, marine and air transportation for a number of years to improve the operational efficiency, safety and security of the existing stock of transportation infrastructure as well as reduce the associated environmental impacts.[4] ITS technologies transfer real-time information between the transportation infrastructure and the infrastructure users (including vehicle operators and passengers), allowing the infrastructure users to make choices given the state (e.g., weather, congestion) of the infrastructure. ITS technologies improve traffic flows, which has benefits economy-wide through increased business productivity and travel time savings for individuals. According to Ms. Burr, "Through federal as well as provincial and municipal programs, the basic foundations of ITS have been implemented across Canada. Most major cities today have traffic management systems and traveller information systems."[5]

Ms. Burr noted that productivity in the transportation sector has levelled off or been in decline in recent years. This realization led Transport Canada to consult with academia, industry and other levels of government to identify barriers to innovation in transportation and to determine how the department can foster innovation. Ms. Burr told the Committee that the recurring themes that arose during these discussions were that:[6]

- There are few formal opportunities for industry and academia to engage;
- The sector frequently faces difficulty in qualifying for and accessing broader research and technology programs, such as economic development programs at the federal and provincial levels;
- The sector's focus is often on short-term return on investments, and this focus can be a barrier to R&D and technology deployment; and

4 Kristine Burr, Assistant Deputy Minister, Policy Group, Transport Canada, *Evidence*, Meeting No. 24, 1st Session, 41st Parliament, March 1, 2012, 0925.

5 Ibid.

6 Ibid., 0930.

- Regulatory uncertainty and the fact that regulations can lag behind business practices and not always keep pace with new technologies can negatively influence private sector innovation.

Through the consultations, Transport Canada determined its role to be "one of knowledge broker and facilitator in terms of both helping to address barriers and to identify opportunities." In this role going forward, Transport Canada aims to:[7]

- Encourage the adoption of advanced technologies that enhance the efficiency and security of international supply chains, including land and marine ports of entry, and develop a policy for the next generation of wireless ITS technologies;

- Make modest research and knowledge investments in strategic areas such as cold climate transportation, climate change impacts, and safety and security objectives;

- Use quantitative means to monitor transportation innovation performance; and

- Ensure that Transport Canada's policies and regulations do not create barriers to innovation.

B. Natural Resources Canada

Natural Resources Canada's involvement in the transportation sector is through the department's environmental mandate. The main environmental issue related to the transportation sector is its energy use and air emissions. Geoff Munro, Chief Scientist and Assistant Deputy Minister for the Innovation and Energy Technology Sector at Natural Resources Canada, told the Committee that: "The transportation sector is the second-largest consumer, after industry, and represents close to 30% of total energy demand. I will also point out that transportation is, at the tailpipe, the largest contributor to our greenhouse gas emissions, representing about 37% of Canada's contribution to emissions."[8] The department is working towards achieving a reduction in the energy consumed by the transportation industry, which would reduce the greenhouse gas and other emissions from transportation. The Committee learned that Natural Resources Canada's programs to support R&D in, and the demonstration of, transportation technologies has averaged just over $70 million per year over the past five years.[9] In order to explore opportunities presented by alternative fuel vehicles, Natural Resources Canada coordinated consultative processes that resulted in the *Natural Gas Use in the Canadian*

7 Ibid.

8 Geoff Munro, Chief Scientist and Assistant Deputy Minister, Innovation and Energy Technology Sector, Natural Resources Canada, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0850.

9 Ibid.

Transportation Sector Deployment Roadmap and *Canada's Electric Vehicle Technology Roadmap*. According to Mr. Munro, "Road maps, both the deployment style and the technology approach, have been very useful policy instruments for us in making sure that the full community is aware and involved and owns the results."[10] He also observed that collaboration and having an industry partner in public sector innovation seems to produce better innovation outcomes.

C. Industry Canada

Mr. Davies (Industry Canada) told the Committee that the department's direct R&D support to the transportation sector amounted to close to one billion dollars over the last five years.[11] The Strategic Aerospace and Defence Initiative (SADI) has provided over $750 million in repayable contributions to the private sector for industrial research in aerospace, defence, and space industries to date. In support of Canada's automotive manufacturing industry, the five-year, $145 million Automotive Partnership Canada program has improved the process of reviewing automotive industry projects seeking federal assistance. Another support program for the automotive industry is the five-year, $250 million Automotive Innovation Fund, which focuses on the development and implementation of fuel-efficient technologies and processes. Mr. Davies also mentioned Industry Canada's partnership in two federally funded Networks of Centres of Excellence (NCEs) in Canada for transportation, AUTO21 and the Green Aviation Research and Development Network (GARDN), which support large-scale research in transportation innovation conducted by public sector, industry and academic partners. The grants provided to academics by the Natural Sciences and Engineering Research Council (NSERC) under Industry Canada is another example of how the department provides direct support to researchers in the field of transportation, as well as other sectors.

Mr. Davies told Committee members that their questions about procurement policy as a means to support Canadian transportation innovations should be directed to the Minister of Public Works and Government Services Canada (PWGSC) and the President of the Treasury Board Secretariat. Nonetheless, he did provide some cautionary advice against using innovation outcomes to guide procurement decisions: "You don't want to give licence, obviously, to government managers to take huge bets and risks with taxpayers' money on things that are not well vetted, or when it's not understood what those risks might be, when essentially most procurement is driven by just buying a good or service that's required as an input to some process in a department."[12]

Another aspect of Industry Canada's support for innovation in Canadian transportation is through the intellectual property (IP) regime. Gerard Peets, Director General of Intellectual Property at Industry Canada, told the Committee that the department provides policy advice to the Minister of Industry on the legislative framework around IP and staff the Canadian Intellectual Property Office, which is responsible for the

10 Ibid.

11 Mitch Davies, *Evidence*, Meeting No. 24, 1st Session, 41st Parliament, March 1, 2012, 0920.

12 Ibid., 0940.

administration and processing of IP in Canada. The *Patent Act* is one of the acts in the legislative framework for IP, and is intended to promote innovation by "conferring an exclusive right to prevent others from making, using, selling, or importing an invention. This protection is available for any invention that is new, useful, and non-obvious."[13] Mr. Peets informed the Committee that Canada is fourth in the world in terms of patent filings for fuel cells behind Japan, the United States and Germany.

Stakeholders who commented on Canada's IP regime had different opinions about how effective it is. According to Mr. Peets, "Canada's regime is competitive internationally and is being used by companies that are engaging in emerging technology development in the transportation sector."[14] Mr. Peets explained that Canada's international agreements with its trading partners have led to a degree of standardization across the IP regimes. Mr. Davies added that usually the IP is vested with whoever is going to bring a technology to market, but sometimes university policy applies, which provides that the IP is held by the university or the researchers. Dr. Peter Frise, Chief Executive Officer and Scientific Director of the AUTO21 NCE, told the Committee that he does not think Canada's IP policies in public-sector science are competitive and recommended that policies be standardized across the country. According to Dr. Frise, IP belongs in the hands of industry because "universities don't make cars, so I don't see the great benefit in people trying to own a lot of IP. In AUTO21 we put the IP as much as possible into the hands of the knowledge receptor as quickly as possible."[15]

Mr. Peets acknowledged that small- and medium-sized enterprises (SMEs) have some trouble in using the IP system. This was also observed by a Canadian innovator in natural gas engines who said "I think small and medium-sized enterprises in Canada may be reluctant to go to China for the wrong reasons. The government could play a role in better informing companies about how to establish good business practices for dealing with other countries … ."[16] Mr. Peets indicated that part of the Canadian Intellectual Property Office's role is to educate its clients and Mr. Davies added that "the Canadian Intellectual Property Office is undertaking to increase its level of outreach overall, particularly for SMEs, to make them more aware of intellectual property rights and their importance and to make it easier for them, so that they can claim properly and have legal standing for the rights they should have to what they've developed."[17]

---

13 Gerard Peets, Acting Director General, Marketplace Framework Policy Branch, Strategic Policy Sector, Industry Canada, *Evidence*, Meeting No. 24, 1st Session, 41st Parliament, March 1, 2012, 0940.

14 Ibid., 0920.

15 Peter Frise, Chief Executive Officer and Scientific Director, AUTO21 Network of Centres of Excellence, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0930.

16 Jonathan Burke, Vice-President, Global Market Development, Westport Innovations Inc., *Evidence*, Meeting No. 37, 1st Session, 41st Parliament, May 15, 2012, 0925.

17 Mitch Davies, *Evidence*, Meeting No. 24, 1st Session, 41st Parliament, March 1, 2012, 1005.

D. National Research Council of Canada

Dr. Ian Potter, Vice President of Engineering at the National Research Council of Canada told the Committee about the NRCC's mandate to undertake, assist, and promote scientific and industrial-based research.[18] The NRCC fulfils its mandate by offering programs and research infrastructure that are available to the transportation sector, such as:

- The Industrial Research Assistance Program (IRAP), which provides technological and business advisory services, as well as financial contributions to small- and medium-sized businesses;
- The Centre for Surface Transportation Technology, which develops and tests rail and road transportation products and services for industry and government clients;
- Air transportation research in partnership with industry to find ways to increase the safety and the environmental performance of aircraft; and
- World-class testing and validation facilities.

The NRCC also provides regulatory bodies, such as Transport Canada, with "objective scientific, technological, and engineering expertise in support of their policy decision-making."[19]

INNOVATIONS IN ON-ROAD VEHICLES

The Committee learned that a great deal of innovation is taking place and being adopted in North America in order to meet increasingly strict fuel economy and emission standards coming into effect for on-road vehicles. According to Dr. Frise (AUTO21), "the auto industry faces a new challenge following on the heels of the recession in 2008 and 2009. This new challenge is the rapidly changing fuel economy regulations, known as the corporate average fuel economy, or CAFE standard, in the United States, which is mirrored here in Canada by our drive to reduce greenhouse gas emissions, or GHGs."[20] A representative of the Canadian Trucking Alliance told the Committee that "the U.S. announced last May that it was going to introduce regulations for fuel economy standards/GHG emission reductions for new heavy trucks. Canada, at the same time, said that it was going to mirror those regulations."[21]

---

18 Ian Potter, Vice-President, Engineering, National Research Council of Canada, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0855.

19 Ibid.

20 Peter Frise, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0855.

21 David Bradley, President and Chief Executive Officer, Canadian Trucking Alliance, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0915.

The resounding message the Committee received from stakeholders is that, at this time, there is no single vehicle technology that achieves the fuel economy that will be required in the future and can penetrate the Canadian market on a large scale. Vehicles powered by electric batteries may be the lowest carbon alternatives but, as will be discussed in the following sections, these technologies have not advanced enough to be a viable option for the vast majority of vehicle buyers. In the meantime, consumers must choose among the lower carbon vehicle technologies that are market-ready, which include more fuel-efficient vehicles as well as alternative fuel and hybrid vehicles. The different technologies come at a range of costs and the payback period varies by type of consumer and even by region. In the words of Jim Facette, President and Chief Executive Officer of the Canadian Propane Association (CPA), "There's not one solution that will fit everybody in Canada."[22] A representative from Chrysler Canada illustrated how the economics of vehicle operations vary widely across consumers with the following comment about the company's production decisions: "Chrysler has been in the market in Canada with propane vehicles, natural gas vehicles, flexible fuel vehicles, ethanol and methanol, hybrid vehicles, and we're looking at electric. In fact, on Tuesday we announced the reintroduction of a natural gas pickup truck for the market."[23]

Many witnesses who met with the Committee observed that natural gas engine technology is available for the full range of on-road vehicles and could help Canada achieve its greenhouse gas emission goals. Natural gas, which is used in road vehicles in a compressed (CNG) or liquefied (LNG) format, has the advantages of being a lower carbon fuel (with a 20-30% advantage over gasoline or diesel) and relatively inexpensive compared to crude oil-based products.[24] The Committee learned that the supply of natural gas in North America is enormous and growing due to unconventional extraction techniques and that the price is expected to remain competitive relative to gas and diesel into the future. Mr. Munro (Natural Resources Canada) commented on the positive outlook for natural gas use in transportation until even lower carbon technology is commercially available: "Looking ahead at innovation in the transportation sector, we saw natural gas being an appropriate and significant interim step until we get to the point where we can use other forms of drive."[25]

Within the context of the North American imperative to reduce the role of gasoline in the overall energy mix used for transportation, the key innovations in various types of on-road vehicles, as well as the obstacles facing road vehicle innovators and the adopters

---

22 Jim Facette, President and Chief Executive Officer, Canadian Propane Association, *Evidence*, Meeting No. 25, 1st Session, 41st Parliament, March 6, 2012, 0915.

23 Larry A. Robertson, Manager, Vehicle Environmental and Energy Programs, Engineering and Regulatory Affairs, Chrysler Canada Inc., *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0915.

24 Timothy Egan, President and Chief Executive Officer, Canadian Gas Association, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0855; Alicia Milner, President, Canadian Natural Gas Vehicle Alliance, 1005.

25 Geoff Munro, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0850.

of the new technologies, are presented in the following sections along with witnesses' policy recommendations.

A. Innovation in the Automotive Industry

Witnesses told the Committee that the automotive industry's efforts to reduce fuel consumption have resulted in technological advances in gas-fuelled vehicles, as well as in alternative fuel and hybrid vehicles. Witnesses also mentioned ongoing R&D in the automotive industry to improve automobile safety and to make automobile production more efficient. Mr. Munro summarized the range of innovations that improve the fuel efficiency of, and hence reduce the carbon emissions from, gas-fuelled automobiles: "For the fleet that is already on the road, innovation around tires and tire tread, tire design, tire pressure, the aerodynamics of vehicles, driver training, and intelligent traffic systems can all help. For new vehicles that are already in the pipe, direct gas injection and lightweighting are important innovations."[26]

The Committee learned that many such innovations and others are being developed in Canada jointly by academia, the federal public sector and the automotive industry. Dr. Frise told the Committee that AUTO21's large-scale public-private R&D projects have yielded many innovations being used by the industry today. According to a written brief submitted to the Committee, AUTO21 research projects involving industry partners since 2000 have resulted in a great number of new and improved products and processes being used in the Canadian automotive industry today. These include new manufacturing materials and new sensor technologies; improved exterior parts and an improved biodiesel engine; and, methods for manufacturing lighter weight and stronger metal and plastic parts.[27] Dr. Frise told the Committee that the federal investment of $52.3 million in AUTO21 projects since 2001 has generated an enormous economic benefit for Canada amounting to a "22:1 return on the investment" when the research is fully implemented.[28] Larry A. Robertson, from Engineering and Regulatory Affairs at Chrysler Canada Inc., provided the Committee with examples of advances being made in other aspects of automobile production aside from fuel efficiency, such as autonomous vehicle technologies, which improve crash avoidance.[29] Earl Hughson, President and Chief Executive Officer of automotive electronics manufacturer Invotronics Inc., further highlighted the importance of new autonomous vehicle technologies as well as advances in intelligent transportation systems for personal vehicles. Mr. Hughson told the Committee that Canada is well placed to participate in these areas of automotive innovation because

---

26 Ibid., 1025.

27 Peter Frise, written brief to the Committee dated March 29, 2012.

28 Peter Frise, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0940. Dr. Frise made reference to the May 2010 findings of the study, "AUTO21 Networks of Centres of Excellence, Impact Assessment of the Research & HQP Programs For Selected Projects in the Period 2001-2009," conducted by the Centre for Automotive Research based in Ann Arbor, MI.

29 Larry A. Robertson, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 1005.

they borrow technology from wireless telecommunications and sensor technology used in aerospace applications, two industries in which Canada has well-established expertise.[30]

Another approach to reducing carbon emissions from automobiles, as required by regulation, is to replace some or all of the vehicle's fuel with lower carbon fuels, such as natural gas. The Committee learned that a Canadian company called Westport Innovations Inc. has developed a new natural gas engine technology for light- and heavy-duty vehicles. The Westport engine is an important innovation because it is available in factory-built vehicles purchased from original equipment manufacturers (OEMs) and the buyer is protected by the OEM's warrantee on the vehicle. Westport's light-duty natural gas engine product is not available in vehicles sold in Canada, however. This may change in the future as Westport is now working on a bi-fuel engine, with one tank for gasoline and one for natural gas, with Ford Motor Company. Jonathan Burke, Vice President of Global Market Development at Westport, explained that "they will predominantly run on natural gas. But when they need to — for example, when they run out of natural gas or want to get that extended range — they can just continue to run on gasoline. That provides the maximum amount of flexibility to the consumer."[31] Bi-fuel vehicles are increasingly the focus of automobile makers developing natural gas products. According to David Pascoe, Vice President of Corporate Engineering for the Americas at Magna International Inc., "the automotive manufacturers, are looking at natural gas and how we get this out there. They're all working on bi-fuel vehicles, which are gasoline and natural gas."[32]

Since there are no OEM natural gas automobiles available from dealers in Canada, the vast majority of vehicles currently on the road in Canada are after-market conversions. As there are fewer than 80 public natural gas refuelling stations across Canada, a home refuelling appliance has been devised for use by natural gas vehicle owners who have natural gas service to their residence.[33] A home refuelling appliance that is popular in Europe and other jurisdictions where natural gas is more commonly used in transportation is expected to become available in the Canadian market shortly. Various efforts are underway to bring a higher quality, lower cost home refuelling device to market in the near term. Representatives from Encana Gas and Magna International told the Committee that their companies were involved in initiatives to improve home refuelling technology and Alicia Milner, President of the Canadian Natural Gas Vehicle Alliance, reported that there is a collaborative effort by General Electric and a natural gas company in the United States to bring a next-generation home refuelling appliance to the market for personal natural gas vehicles by mid-2013.

Propane, also known as LPG (liquid petroleum gas) or autogas, is also a lower carbon fuel that can be used in automobiles. According to one witness, propane is "by far

---

30 Earl Hughson, President and Chief Executive Officer, Invotronics Inc., *Evidence*, Meeting No. 45, 1st Session, 41st Parliament, October 4, 2012, 1115.

31 Jonathan Burke, *Evidence*, Meeting No. 37, 1st Session, 41st Parliament, May 15, 2012, 1030.

32 David Pascoe, Vice-President of Corporate Engineering, The Americas, Global Headquarters, Magna International Inc., *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 1025.

33 Geoff Munro, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0850.

the most widely used and accepted alternative fuel in use in the world today. Global consumption of autogas has been rising rapidly in recent years, reaching 22.9 million tonnes in 2010, an increase of about 60% over the year 2000 levels. There are now more than 17 million autogas vehicles in use around the world today."[34] Industry stakeholders outlined the environmental and economic advantages of propane for the Committee. Mr. Facette told the Committee that: "In comparison with conventional energy sources, propane produces less greenhouse gases and air pollutants for nearly all of the applications where it is used. Propane-fueled vehicle fleets produce up to 26% less greenhouse gases than gas-fueled vehicles, representing a kilo of greenhouse gas for each 36 kilometres travelled, and approximately 50% fewer pollutants and other emissions found in smog created by gas engines."[35] Because it requires some processing, propane is marginally more expensive than natural gas but it still has a price advantage over petroleum products. He also told the Committee that "over the last decade, on average, propane has been sold at 36% less than gasoline."[36] Another advantage of using propane vehicles is that they have "the lowest cost of infrastructure of any fuel, gasoline and diesel included" and also have a much larger network of public stations to serve them, comprising some 2,000 locations.[37] Steven Clark from Canada Post told the Committee that "the refuelling infrastructure for fast-filling of 200 Canada Post [natural gas] trucks would cost about three-quarters of a million dollars. Doing the same for propane would cost about $50,000 to $70,000."[38]

Almost all propane vehicles in Canada are after-market conversions for which the technology has advanced in recent years. Cameron Stewart, President of Maxquip, a supplier of propane conversion kits in Canada, told the Committee that "acceleration and top speed using the latest generation of autogas fuel systems are comparable to those for gasoline or diesel."[39] A range of options exists today for consumers who wish to convert their vehicle, including dual-fuel systems, which will allow a gasoline engine to also run on propane, pure propane systems and blended diesel-propane fuel systems.[40] According to Mr. Stewart, "the cost is typically going to be in the range of $3,000 to $5,000. The main variable there is the size of the propane storage tank that you're adding to the vehicle."[41] A number of fleet owners in Canada chose to convert propane vehicles for their operations based on the economics, including Airways Transit, ThyssenKrupp Elevator, Canada Post, UPS and the London Police Department.

---

34 Cameron Stewart, President, Maxquip, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0905.

35 Jim Facette, *Evidence*, Meeting No. 25, 1st Session, 41st Parliament, March 6, 2012, 0900.

36 Ibid., 0905.

37 Todd Mouw, Vice President, Alternative Fuels, Roush Cleantech, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0855.

38 Steve Clark, Director, Fleet Management, Canada Post Corporation, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0930.

39 Cameron Stewart, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0905.

40 Ibid.

41 Ibid., 0935.

OEM propane vehicles have become available for commercial fleet operators in the United States in recent years. For example, Ford and Roush Cleantech, Ford's powertrain supplier, collaborated to develop propane versions of "everything from a commercial perspective related to Ford: trucks, vans, school buses, and cutaways."[42] Todd Mouw, Vice President of Alternative Fuels at Roush Cleantech, told the Committee that his company spent $30 million dollars on developing the technology which is covered by the OEM warranty, delivers the horsepower and torque equivalent to the gasoline vehicle, and has no "cold start" issues.[43] He added that "probably in the next 24 to 30 months you would see a propane-type car from Ford with our technology in it."[44] Mr. Facette told the Committee that innovations such as the Roush technology will allow for greater usage of propane in vehicles.[45]

Some witnesses mentioned other propane vehicle innovations that have allowed for safer fuel handling. For example propane tanks have "built-in valves and mechanisms that shut off the propane when it's full, which for any propane container is no more than 80%."[46] Also, there are "newer-technology dispensing nozzles that prohibit the release of product if the nozzle is not properly attached to the vehicle's filler valve."[47] In Europe, where propane vehicles have much greater market penetration, vehicle operators are permitted to fill their own fuel tanks because the newer refuelling technology allows it to be done safely.

Electric vehicles are the lowest-emission alternative available to some automobile users. According to Dr. Frise (AUTO21), vehicle battery technology has improved dramatically over the past 20 years and some of the research is being done in Canada. He told the Committee that "in the 1990s and since then, lithium battery chemistry has evolved to the point where it really is quite remarkable. The progress has been quantum since then."[48] Mr. Pascoe (Magna International) informed the Committee that "Hydro-Québec has brought some really excellent battery chemistry to bear, and that's being licensed out, I believe. It's the lithium iron phosphate chemistry. That, for hybrid applications, is really very good."[49] He also told the Committee that Magna has a joint venture with the Stronach Group called Magna E-Car Systems, which is working on electric vehicles and plug-in hybrids. Magna E-Car Systems "set up a pilot facility to develop a new next-generation chemistry to ensure that we have something that's going to be economical and competitive performance-wise, or better than what's out there today."[50]

---

42 Todd Mouw, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0855.

43 Ibid.

44 Ibid., 0920.

45 Jim Facette, *Evidence*, Meeting No. 25, 1st Session, 41st Parliament, March 6, 2012, 0920.

46 Ibid., 0940.

47 Cameron Stewart, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0910.

48 Peter Frise, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0920.

49 David Pascoe, *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 1030.

50 Ibid., 0925.

Mr. Pascoe was optimistic that the battery technology available today would soon lead to an alternate industry producing enclosed three-wheeled vehicles, which could operate in three seasons, within the next few years.[51] He told the Committee that the advantages of these vehicles are that they are low cost, have zero emissions and can reduce traffic congestion. The Committee learned that the City of Vancouver has taken an innovative approach to supporting adopters of electric vehicle technology by establishing public charging infrastructure to make it easier for owners to use their cars.[52] The Committee also learned that an international company, Better Place, has brought together private capital, battery companies, a car company, electric infrastructure providers and utilities in order to build infrastructure systems over large geographic areas to promote and support mass adoption of full-sized electric vehicles. Jason Wolf, Vice President of North American Operations at Better Place, told the Committee that his company has built national electric vehicle networks in Denmark and Israel and is testing their business model in the Netherlands, China, Australia, California, and Hawaii.[53] Mr. Wolf summed up the opportunity for Canada in the following words: "Where you have the cars, the batteries, the fuel, which is the electricity, and in Canada it's generated mostly from renewable sources, you can then make a huge leap towards a more affordable, but also an unlimited, a no-compromise transportation system in the light-duty vehicle sector."[54] He suggested that the roll-out of the Better Place business model in California would be a better example for Canada than the company's experience in Israel. Mr. Wolf told the Committee that, "on the exceptional trip—let's say you want to drive from Toronto to Ottawa—you would then switch your battery once or twice, depending on the length of your trip, and you'd be able to make any type of trip."[55]

1. Obstacles to Innovation in the Automotive Industry

Industry and government stakeholders in the Canadian automotive industry provided the Committee with some examples of what they thought held back automotive innovation in Canada. Dr. Frise (AUTO21) observed that "business investment in R and D in Canada is low; as well, our innovation support programs are also comparatively smaller than those of competitor countries."[56] He also suggested that IP held outside of the manufacturing industry does not lead to innovation.[57] Dr. Potter (NRCC) suggested that there is not enough coordination between academic and industry research and development efforts in the automotive industry. He stressed that it is important to bridge the gap between academic research and innovation by companies and to bring companies

51 Ibid., 1030.

52 Geoff Munro, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0850.

53 Jason Wolf, Vice President, North American Operations, Better Place, *Evidence*, Meeting No. 46, 1st Session, 41st Parliament, October 16, 2012, 1215.

54 Ibid., 1110.

55 Ibid., 1240.

56 Peter Frise, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0855.

57 Ibid., 0930.

in earlier to connect with ideas at universities.[58] Mr. Robertson (Chrysler Canada) observed that "technology comes to market faster than regulation can accept it."[59] Mr. Hughson (Invotronics) told the Committee that the Canadian players in the advanced automotive electronics industry, which is a "highly competitive, rapidly growing international business with global competition", are having difficulty demonstrating their technology which is necessary to sell it.[60] In Mr. Hughson's words, "The most advanced graphs and PowerPoint presentations won't get you in the next meeting. Equipment installed in a car and demonstrated to them will get you a purchase order."[61]

In regards to natural gas automobile innovation in Canada, the differences between the laws and codes and standards in the United States and Canada can be a challenge to manufacturers producing vehicles for both markets. Mr. Robertson observed that differing codes and standards were an issue with one of Chrysler's natural gas products initially: "for first two years of production we could not sell them in Canada because the pressure vessel codes were not harmonized with the U.S. We could only sell that product in the U.S."[62] Tim Egan of the Canadian Gas Association (CGA) noted that "the work with the NRCan round table has been a significant first step in an effort to make sure that the conditions are in place for the market to evolve."[63]

The Committee heard that the main obstacle to natural gas automobile adoption in Canada is a "chicken and egg" problem involving vehicles and public refuelling infrastructure. Witnesses told the Committee that there is a restricted supply of OEM natural gas vehicles in Canada comprising a few commercial light-duty options but no vehicles for personal use.[64] Imported natural gas vehicles from outside of North America are not a solution for Canadian consumers because there are restrictions on the importation of foreign-produced natural gas vehicles. According to Dr. Sam Shaw from Encana Corporation, Canada's largest natural gas producer, "You can get a certificate for three years and bring over a Mercedes E350, but at the end of three years, you have to give it up."[65] Even the natural gas Honda Civic produced in North America cannot be brought into Canada without voiding the warranty.[66] This being the case, in order to operate a natural gas vehicle, consumers must pay a considerable amount to convert their vehicle to run on natural gas and must assume some risk too as a converted vehicle does not come with support infrastructure backed by large corporations.[67] Alicia Milner from the

---

58 Ian Potter, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0940.

59 Larry A. Robertson, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0920.

60 Earl Hughson, *Evidence*, Meeting No. 45, 1st Session, 41st Parliament, October 4, 2012, 1110.

61 Ibid., 1120.

62 Ibid.

63 Timothy Egan, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0900.

64 Alicia Milner, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0905.

65 Sam Shaw, Vice-President, Natural Gas Policy Development, Encana Corporation, *Evidence*, Meeting No. 25, 1st Session, 41st Parliament, March 6, 2012, 0950.

66 Alicia Milner, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0935.

67 Jonathan Burke, *Evidence*, Meeting No. 37, 1st Session, 41st Parliament, May 15, 2012, 0930.

Canadian Natural Gas Vehicle Alliance described the long payback period on the cost of conversion (between $7,500 and $12,000) as the "economic" barrier to converting a vehicle to natural gas for all but high-mileage consumers. Tim Sanford from Compression Technology Corporation, a company that markets small natural gas refuelling appliances, confirmed that a consumer would have to drive a converted natural gas vehicle some 35,000 km per year to recover the cost of conversion within a few years through fuel cost savings.[68]

It is the position of some stakeholders, including the Canadian Natural Gas Vehicle Alliance and Magna International, that a more comprehensive network of public natural gas refuelling stations in Canada — currently there are fewer than 80 stations across the country — might lead to a greater volume of vehicles on the road if the new infrastructure encouraged the OEMs offering warranty-protected, factory-built natural gas vehicles in the Canadian market. Until public refuelling stations are more widely established, the premium on a natural gas personal vehicle (in addition to the cost of conversion) would include the cost to purchase and install a home refuelling device in order to have a reliable supply of fuel. Mr. Sanford told the Committee that the cost is in the $5,000 range for a home refuelling product coming to the Canadian market in 2012. Other witnesses told the Committee that home refuelling technology requires improvements and needs to be available at a lower cost in order to induce consumers to switch to a natural gas personal automobile.

Since there are a few OEM light-duty truck products on the market in Canada for commercial users, for owners of small, high-mileage commercial vehicles, the main obstacle to choosing a natural gas vehicle is establishing a reliable supply of fuel. Given the lack of public refuelling infrastructure, commercial vehicle owners would have to decide the most economical way to refuel their vehicle: a commercial vehicle refuelling appliance or a central refuelling station, which comes at a relatively high price because of the compression and storage technology required.

Propane industry stakeholders noted many barriers to the greater penetration of propane vehicles in Canada. Mr. Stewart (Maxquip) considers the limited number of qualified installation centres as a barrier to increasing the volume of propane conversions in Canada. Mr. Stewart also noted that refuelling is inconvenient because of limited infrastructure and the requirement that a vehicle be refuelled by a trained attendant. OEM vehicles using Roush technology are not available in Canada because, as Mr. Mouw told the Committee, "we have some struggles with the rules and regulations and testing standards to make this work here. We're not afraid of spending money to bring the technology to Canada, but we'd just like to have a clear goal line and a clear path of success."[69] Messrs. Stewart, Mouw and Facette all told the Committee that municipal or insurance company restrictions on propane vehicles parking underground prevent some consumers from adopting the technology. Mr. Facette observed that the parking and

68 Tim Sanford, Director of Sales, Compression Technology Corporation, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0930.

69 Todd Mouw, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0900.

refuelling obstacles have arisen because of the perception that propane is not a safe fuel, which Mr. Mouw called a misperception and an "education issue." He told the Committee that "propane is safer than gasoline or diesel," that natural gas was more dangerous than propane in a parking garage, and that newer valve and nozzle technology means there is no need for gloves and goggles when refilling with propane.[70]

With respect to the adoption of electric light-duty vehicles, either for personal or commercial use, the battery technology has not advanced enough yet for the price of electric vehicles to be affordable for most consumers. Mr. Pascoe (Magna International) stated that "in an electric car the battery costs more than the rest of the car. If you have a 12- or 15-year payback, the car is used up before you get your money back on your investment on the battery."[71] Dr. Frise commented that "none of the electric vehicles on the market can replace a full-up family vehicle … There are significant issues around range as well as cost."[72] When asked about the number of dollars and years of R&D it would take to develop an electric vehicle that could replace a gas-powered car, Dr. Frise replied: "I couldn't estimate that number [...] but it would be significant, and in terms of years, it could be significant."[73] The Committee heard a more optimistic outlook for light-duty electric vehicles in Canada from Mr. Wolf (Better Place). Mr. Wolf told the Committee that Better Place, and its automotive partner Renault-Nissan, are able to offer its customers electric vehicles that are competitive with gasoline vehicles in terms of price and performance. He said that "the secret to solving both the upfront cost and the range of an electric vehicle is the separation of the battery from the vehicle."[74] According to Mr. Wolf, Better Place customers are able to purchase an electric vehicle (without a battery) for the same price as a gasoline vehicle and then purchase "kilometres" from Better Place at a lower price than gasoline "kilometres." Mr. Wolf said that this model could enable mass adoption of electric vehicles even in a country where gasoline is only $1.40 per litre, but that the private capital flows first into jurisdictions where gasoline is the most expensive because they offer the best return on the investment.[75]

Mr. Clark (Canada Post) provided a commercial fleet owner's perspective on electric vehicles. He said that "electric vehicles, both hybrid and pure, are far too costly when compared to conventional gas-powered vehicles and remain ill-suited for most fleet applications."[76] He told the Committee that an electric vehicle can cost up to three times the price of a typical conventional gas vehicle for the Canada Post fleet, and that "from the total cost of operation documents that we have prepared at Canada Post, at the current time there is no return on investment."[77] Mr. Pascoe (Magna International) is of the opinion

70 Ibid., 0920.

71 David Pascoe, *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 0855.

72 Peter Frise, *Evidence*, Meeting No. 26, 1st Session, 41st Parliament, March 8, 2012, 0925.

73 Ibid.

74 Jason Wolf, *Evidence*, Meeting No. 46, 1st Session, 41st Parliament, October 16, 2012, 1110.

75 Ibid.

76 Steve Clark, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0855.

77 Ibid., 0935.

that the current battery technology "can be applied, but only on a smaller basis until we get the battery technology ahead. The outlook for that, in my opinion, is uncertain. There's an awful lot of research going on. It could be soon. It could be a long way off. The answer is, I don't know, and I've spoken to a lot of people. I don't know."[78]

2. Innovation in the Automotive Industry: Witness Recommendations

Dr. Potter (NRCC) made two general recommendations relevant to automotive innovation for the Committee's consideration:

- Focus public research and development on the industrial sectors that are critical to Canada; and
- Help bridge the gap between academic research and innovation by companies.[79]

Mr. Hughson (Invotronics) also made recommendations concerning the automotive innovation model in Canada. Like Dr. Potter, he recommended, "aligning, at least, spending money in areas where there are companies that can even potentially pick up the technology and commercialize it within their venue […] rather than developing technologies that are really being commercialized by companies in other places."[80] Mr. Hughson suggested that providing public funding for technology demonstrations in automotive applications would be the best catalyst for Canadian automotive innovation.[81]

Natural gas vehicle stakeholders asked the Committee to consider recommendations with a view to increasing the refuelling infrastructure as well as the availability of natural gas vehicles in Canada. Mr. Pascoe suggested that the federal government:

- Encourage fuel retailers to offer natural gas at a small percentage of its public fuelling stations; and
- Provide consumers with incentives to use home refuelling appliances.[82]

Mr. Sanford (Compression Technology) recommended that Transport Canada be asked to:

- Accept foreign vehicle testing results (for emissions, safety and performance) to help promote the importation of OEM natural gas vehicles into Canada; and

78 David Pascoe, *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 0950.

79 Ian Potter, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0950.

80 Earl Hughson, *Evidence*, Meeting No. 45, 1st Session, 41st Parliament, October 4, 2012, 1155.

81 Ibid., 1120.

82 David Pascoe, *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 0855.

- Encourage the interprovincial harmonization of vehicle conversion and refuelling station infrastructure standards.

Dr. Shaw made similar recommendations concerning foreign vehicles and provincial standards. He further recommended that Canada's regulations and standards for natural gas vehicles, fuelling parts and infrastructure should be aligned with the United States to increase the supply to the Canadian market.

Ms. Milner (Canadian Natural Gas Vehicle Alliance) did not share the views of other witnesses respecting refuelling infrastructure and foreign vehicles. She told the Committee that the federal government did not need to create incentives to build refuelling infrastructure because there is considerable private capital poised to invest in infrastructure for heavy-duty fleets. She suggested that private vehicle operators could utilize this infrastructure as it is built out. In order to increase the availability of natural gas vehicles on the road in Canada, she recommended that the federal government engage automakers, perhaps through the Canadian Automotive Partnerships Council, to determine the market conditions that would lead them to offer a factory-built natural gas product on the Canadian market.[83]

Propane vehicle stakeholders had many recommendations for the Committee to lower or remove the obstacles preventing the proliferation of propane vehicles in Canada. In a joint letter to the Committee following their appearances, Mr. Facette (CPA), Mr. Stewart (Maxquip) and Mr. Mouw (Roush Cleantech) consolidated their recommendations for the federal government:

1. That propane be included as part of the Canadian Natural Gas Deployment Roadmap and that the Roadmap be renamed to reflect the change.

2. That the federal government lead by example by converting more of their fleet vehicles to propane.

3. Recognize that Liquefied Petroleum Gas (LPG) is a viable fuel that can reduce operating costs and reduce emissions today, and promote its use across Canada.

4. Allow alternative-fuelled vehicles with lower greenhouse gas emissions to operate in High Occupancy Vehicle (HOV) lanes with a single passenger, as an incentive to those who invest in such technology and a similar program for toll highways and bridges, whereby toll fees could be reduced or reimbursed for these vehicles.

5. To make funding available for the training of conversion centres and installation personnel.

---

83 Alicia Milner, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 1000.

6. Seek the support of other governments to streamline the certification process.

7. Develop a strategic awareness plan to help the public and private fleets convert from gasoline and diesel to propane.

8. Provide GST/HST reductions for new vehicles that are converted to propane.

9. Create incentives for oil companies to retail auto propane at major stations across Canada.

During his appearance at the Committee, Mr. Facette also recommended that Canada's propane handling standards/regulations be amended to allow for self-refuelling of propane vehicles, which Mr. Mouw and Mr. Stewart later endorsed, and that the federal government encourage the harmonization of propane standards across the provinces. Mr. Mouw recommended the harmonization of rules, regulations and testing standards for propane technology between Canada and the United States to make it easier to bring his company's product to Canada in OEM vehicles.

There were few recommendations from witnesses concerning the obstacles to the adoption of electric vehicles. Mr. Munro (Natural Resources Canada) recommended the harmonization of codes and standards across North America to remove interprovincial or international barriers to electric vehicle fleet users. He also referred the Committee to the recommendations respecting technology, codes and standards, studies and assessments, and education and outreach contained in the *Electric Vehicle Technology Roadmap*. Mr. Pascoe (Magna International) recommended that some legislation around electric assisted bicycles and three-wheel electric vehicles be defined because these products would soon be available to consumers. He also recommended that the federal government continue to support research in battery technologies because "if we're going to get there one day we have to make some investment. It's really a bit of a calculated risk, because we don't know when we're going to get to having broad-based, high-volume, across-the-board electric vehicles. But if we don't start, we won't get there. A certain amount of investment makes sense."[84] Mr. Wolf (Better Place) suggested that if the federal government offsets some of the initial investments in the electric infrastructure required to support a Better Place network in Canada, Canada might move up in the queue for the private capital that is ready to be deployed anywhere the model is profitable.[85]

As an owner of a fleet comprising a full range of vehicles from conventional gasoline to electric, Mr. Clark (Canada Post) offered several recommendations to the Committee, which "would all aid in overcoming the barriers identified and pave the way for the continued and expanded use of these technologies."[86] These included:

---

84 David Pascoe, *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 0945.

85 Jason Wolf, *Evidence*, Meeting No. 46, 1st Session, 41st Parliament, October 16, 2012, 1110.

86 Steve Clark, *Evidence*, Meeting No. 42, 1st Session, 41st Parliament, June 7, 2012, 0855.

- Offer financial incentives or tax rebates to vehicle owners that would help offset the incremental cost of purchasing or converting vehicles to operate on alternative fuel or electric vehicle technology;

- Standardized regulations across all provinces as they pertain to the use, marking, and inspection of alternative fuelled vehicles; and

- Provide incentives to fuel companies to improve the availability of refuelling infrastructure for gaseous fuels.

B. Innovation in the Trucking Industry

Most of the trucking innovations developed by and/or available to the Canadian trucking industry in recent years that witnesses mentioned during Committee meetings focus on environmental and fuel efficiency advances for the industry. David Bradley, President and Chief Executive Officer of the Canadian Trucking Alliance (CTA), told the Committee that "as of 2007, all new tractors and engines produced in North America have basically zero smog emissions. They've eliminated NO_x and particulate matter emissions."[87] Don Moore, Executive Director of the Canadian Transportation Equipment Association (CTEA), mentioned that electric and hydraulic hybrids are being deployed in cities to power the work some trucks do while idling, such cement mixers and garbage trucks, to reduce the amount of greenhouse gas and improve fuel economy.[88] The Committee learned that Westport Innovation Inc.'s heavy-duty engine technology has been incorporated into OEM trucks in use by Canadian companies such as Robert Trucking in Quebec and Vedder Transport in British Columbia. The advantages of natural gas engines in trucking were described by Mr. Egan (CGA): "the life-cycle carbon emission reduction opportunity by use of natural gas in heavy-duty vehicles is 20% to 25%. Increasingly important is the cost-saving opportunity that the fuel option represents. In the right-sized fleet it can reduce fuel costs by 15% to 30%."[89] The Committee learned that companies in Canada are also developing refuelling technologies to serve the heavy-duty natural gas fleets. Mr. Burke (Westport Innovations) told the Committee that "a very well-known Canadian company, now owned by a U.S. company but headquartered in Chilliwack, British Columbia, called IMW Industries, is one of the world leaders in natural gas refuelling stations. They provide anything from a small-scale refuelling station that has one receptacle all the way up to these large-scale, multi-point refuelling stations for big waste fleets or transit fleets."[90] Dr. Shaw told the Committee that "Encana has pioneered mobile refuellers, so we can go to a yard of heavy-duty trucks and fill them on location."[91] Some witnesses assured the Committee that the private sector is ready and willing to deploy the advanced natural gas refuelling technology for heavy-duty natural gas truck

---

87 David Bradley, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0850.

88 Don Moore, Executive Director, Canadian Transportation Equipment Association, *Evidence*, Meeting No. 28, 1st Session, 41st Parliament, March 15, 2012, 0850.

89 Timothy Egan, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0855.

90 Jonathan Burke, *Evidence*, Meeting No. 37, 1st Session, 41st Parliament, May 15, 2012, 1005.

91 Sam Shaw, *Evidence*, Meeting No. 25, 1st Session, 41st Parliament, March 6, 2012, 0850.

operations.[92] Various witnesses mentioned that new aerodynamic treatments for trucks and trailers, such as side skirts and boat-tails, also improve fuel efficiency and reduce emissions in the trucking industry.

Mr. Moore and Mr. Bradley also told the Committee about some innovations that advance safety in the trucking industry. Mr. Moore described how Canadian truck equipment (chassis) manufacturers have developed new safety devices, such as rear impact guards, as well as improved existing safety devices, such as parking brakes, in response to amendments to the *Canadian Motor Vehicle Safety Standards*. Mr. Bradley advised the Committee that two important safety innovations are currently available for the trucking industry to adopt on a voluntary basis: electronic stability control, which prevents roll-overs, and electronic on-board recorders, which can effectively monitor drivers' compliance with the hours-of-service regulations for truck drivers.[93]

1. Obstacles to Innovation in the Trucking Industry

Mr. Moore described for the Committee some of the challenges facing Canadian manufacturers of trucking equipment that wish to, or are required to, bring new products to market. Firstly, he noted that "there's a big disconnect there between the federal government and the provinces" in registering the product because the National Safety Mark issued by Transport Canada when the product is registered is not recognized by the provinces in their registration processes. Mr. Moore also explained that the cost of testing new equipment required by regulation is a burden for smaller companies. In the past, some of these companies were eligible for R&D tax credits but "were unable to apply, more because they don't have the resources in regard to the time, the effort, and the cost involved in trying to deal with the reporting and the details that are demanded of them."[94]

Witnesses also outlined the obstacles in the trucking industry to adopting innovative technologies for the Committee. One such obstacle, highlighted by Mr. Bradley and Claude Robert from Robert Trucking, is that capital decisions in trucking are long-term decisions and therefore new technology is slow to penetrate the market. According to Mr. Robert, "we keep our trailers 20 years, which means that if I make a decision today on equipment, that trailer's going to be on the road until 2030."[95] Another characteristic of the trucking industry that prevents investments in retrofitting existing equipment with innovative technology is that the industry simply lacks the funds to invest. Mr. Bradley told the Committee that "trucking is a very undercapitalized business … three or four trucking companies that are publicly traded; the rest are dependent upon debt financing, and that, of course, has become more difficult in recent years."[96] Yet another obstacle to investing in

92 Jonathan Burke, *Evidence*, Meeting No. 37, 1st Session, 41st Parliament, May 15, 2012, 0910; Alicia Milner, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0925.

93 David Bradley, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0850.

94 Don Moore, *Evidence*, Meeting No. 28, 1st Session, 41st Parliament, March 15, 2012, 0850.

95 Claude Robert, President and Chief Executive Officer, Groupe Robert, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0900.

96 David Bradley, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0850.

trucking innovations is differing size and weight restrictions across Canadian jurisdictions, which make it difficult for interprovincial carriers to use some new technologies on cross-country routes. Mr. Bradley provided the example of wide-base single tires, which are permitted to carry the same weight as conventional dual tires in Ontario and Quebec but not in Alberta.[97]

The obstacles specific to innovation in, or adoption of, natural gas trucks identified by witnesses are generally related to codes and standards and the limited availability of the OEM product. Mr. Burke observed that differences between the laws and codes and standards in the United States and Canada are an obstacle to producing trucks for both markets: "If we've done all of the work to comply in the United States and then we hit a wall when we have to meet certain criteria in Canada, that may not make a lot of sense."[98] Dr. Shaw told the Committee that "part of the problem is the barrier in getting the engines out of Westport Innovations. There is one company in North America; it supplies those engines for Peterbilt, Kenworth, and so forth, and the list goes on, but there is one manufacturer."[99] Mr. Robert told the Committee that because the supply of natural gas trucks is limited, it is difficult to build a critical mass of vehicles to make the investment in central refuelling infrastructure economic. "At 70 trucks, we will have just enough to be able to maintain our two refuelling stations, one in Toronto and one in Montréal; with fewer than that, we can't."[100] Mr. Robert also observed that maintaining his fleet of natural gas trucks is a challenge because there is a shortage of trained technicians and there are gaps in the guidelines, codes and standards for natural gas vehicle maintenance facilities.

2. Innovation in the Trucking Industry: Witness Recommendations

Mr. Moore suggested that streamlining the federal R&D tax credit application process would allow the small- and medium-sized truck equipment manufacturers to benefit from the program.

Mr. Bradley suggested certain measures to increase the rate of adoption of innovations that would make the trucking industry safer and less polluting. He told the Committee that "the technology exists today to help make the industry safer, to help level the playing field, to make the air we breathe cleaner, and to reduce the risk of climate change. The goal has to be to take these technologies that already exist today and accelerate their penetration into the marketplace. We believe this can be accomplished through a combination of regulation and investment incentives."[101] He specifically recommended that federal regulation should require electronic on-board recorders for trucks as well as electronic stability control technology. He also suggested that a federal grant program, potentially repayable grants, for retrofitting trucking equipment with

97 Ibid., 0920.

98 Jonathan Burke, *Evidence*, Meeting No. 37, 1st Session, 41st Parliament, May 15, 2012, 0950.

99 Sam Shaw, *Evidence*, Meeting No. 25, 1st Session, 41st Parliament, March 6, 2012, 0945.

100 Claude Robert, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0955.

101 David Bradley, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0850.

aerodynamic devices would complement upcoming GHG regulations. Mr. Bradley recommended that a portion of federal diesel fuel tax revenues be used to finance the grant program for aerodynamic retrofits. In order to see the new smog-free trucks penetrate the market more quickly, Mr. Bradley recommended that an accelerated capital cost allowance be applied to trucks that comply with upcoming GHG regulations. Mr. Bradley referred the Committee to similar measures taken in Quebec to stimulate investment in new trucking technology.

With respect to natural gas trucks, witnesses made recommendations with the goal of increasing the penetration of natural gas trucks and refuelling infrastructure in Canada. Mr. Robert as well as Mr. Burke suggested that an accelerated capital cost allowance applied to natural gas trucks would stimulate investment in the technology. Mr. Robert added that harmonized provincial size and weight regulations across Canada that allow for the additional length and weight of natural gas trucks would lead to more natural gas trucks operating in Canada. Mr. Robert also recommended that municipalities should be encouraged to develop regulations specifically for natural gas refuelling infrastructure instead of applying propane regulations, which delays construction unnecessarily.[102] Mr. Egan (CGA) and Ms. Milner (Canadian Natural Gas Vehicle Alliance) recommended that the natural gas be included in the Clean Energy Dialogue with the United States to help establish natural gas infrastructure in north-south trucking corridors.[103]

C. Innovation in the Transit Industry

During its study of innovative transportation technologies in Canada, the Committee heard testimony regarding innovation and the adoption of innovation in the transit industry from the two Canadian manufacturers of transit buses as well as transit agencies from the Province of Quebec and the City of Calgary.

One bus manufacturer in Canada is Nova Bus, a division of Volvo Group Canada Inc. Nova Bus reported to the Committee that it has just over 50% of the Canadian market for heavy-duty buses. René Allen, Vice-President of Product Management and Strategy at Nova Bus, told the Committee about an innovative approach to mass transit called bus rapid transit (BRT). BRT involves high capacity, low floor buses operating in dedicated lanes with traffic control giving them priority at intersections. BRT also uses prepayment technology to speed up boarding procedures and provides passengers with real-time information to make the system easier to use. Mr. Allen told the Committee that "the higher commercial speed of BRT has very significant advantages both environmentally and financially in terms of reduced pollution, increased ridership and reduced congestion."[104] According to Mr. Allen, BRT offers comparable passenger capacity to rail transit and Jean-Pierre Baracat, the Vice-President of Business Development at Nova Bus, told the

102 Claude Robert, *Evidence*, Meeting No. 27, 1st Session, 41st Parliament, March 13, 2012, 0935.

103 Timothy Egan, *Evidence*, Meeting No. 38, 1st Session, 41st Parliament, May 17, 2012, 0910.

104 René Allen, Vice-President, Product Management and Strategy, Business Development, Nova Bus, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0855.

Committee that "the costs of setting up the BRT are about 20 times less than for a rail project."[105]

New Flyer Industries Inc. (New Flyer) is the other bus manufacturer in Canada and reportedly has a dominant share of the North American heavy-duty transit bus market overall. New Flyer offers its customers a full range of bus propulsion systems, including diesel, diesel hybrid, electric trolleys and natural gas. Chris Stoddart, Vice-President of Engineering at New Flyer, told the Committee that his company has focused its R&D efforts on reducing the fuel consumption and emissions of its products. Through innovation in lightweight design, New Flyer has achieved approximately a 10% reduction in vehicle weight, which lowers the life cycle costs of its buses for its customers.[106] Mr. Stoddart also mentioned a new information and communications technology, called New Flyer Connect, which New Flyer has developed to collect and interpret operational data. New Flyer Connect supplies data back to New Flyer, allowing the company to optimize the design of its buses, as well as helping bus operators effectively plan bus maintenance. New Flyer Connect also monitors driver performance, which is valuable for New Flyer's customers because, as with all other vehicles, driver behaviour on heavy-duty buses can affect fuel consumption by more than 10%. New Flyer is also working on electrifying power steering, air conditioning, and air compressors in order to improve the fuel economy of its buses.

Both Nova Bus and New Flyer have been working on the deployment and design of electric buses. Nova Bus representatives told the Committee that "among emerging technologies, electric vehicles are the technology of the future."[107] Mr. Stoddart is also optimistic about the electric bus, believing that developments in battery charging technologies will make the buses commercially viable within the next decade.[108] Nova Bus introduced its first electric bus in the North American market in 2011 and New Flyer started testing its first electric bus in the spring of 2012. Their products can each travel between 80 km and 100 km on a single charge. Both Nova Bus and New Flyer witnesses told the Committee that the batteries currently available do not contain enough energy to allow electric buses to operate like a regular bus. The Committee learned that, "on a normal transit bus in heavy operations, like the big cities, the bus will operate for 20 hours a day. With batteries today, there isn't a possibility to power the bus for that long."[109] Nonetheless, Mr. Stoddart predicts that "the battery technology will catch up enough that you'll be able to fit in a rapid charge within the window you need to be able to do that — and recover all of your energy from regenerative breaking with batteries — at some point in the very near future."[110] The Committee learned that many battery recharging

105 Jean-Pierre Baracat, Vice-President, Business Development, Nova Bus, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0940.

106 Chris Stoddart, Vice-President of Engineering, New Flyer Industries Inc., *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0900.

107 Jean-Pierre Baracat, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0920.

108 Chris Stoddart, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0905.

109 Jean-Pierre Baracat, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0915.

110 Chris Stoddart, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0950.

technologies have been developed and work well but, according to both Nova Bus and New Flyer, no particular technology is dominating the market at this point.

The transit agencies that discussed innovation in the transit industry with the Committee have very different strategies for incorporating innovations in their fleets. Serge Carignan, Director, Engineering and Technical Services at Société de gestion et d'acquisition de véhicules de transport, told the Committee that the nine transit agencies in Quebec plan to acquire electric and hybrid electric bus technology going forward. Electric platforms were selected because, among the alternative fuel platforms available, electricity offers the greatest economic and environmental benefits to the province. "We have opted for electricity because electricity is reliable in Quebec. There is an abundance of hydroelectric power. Electricity is also affordable. Quebec's electricity is clean because more than 95% of it is generated by hydroelectric means. We want to reduce that dependence and prevent money from being taken out of our pockets and going outside the province, and outside Canada most of the time."[111] Mr. Carignan said that Transport Canada's Urban Transportation Showcase enabled his organization to evaluate hybrid electric bus technology. "Consequently, in our next call for bids, we will buy 500 hybrid buses with an option for 500 more. In other words, this program has produced positive results. The fact that seven electric buses could be tested in Québec City has opened the door to this technology. This enables us to look into the future and to consider using a vehicle of this kind."[112] The Committee heard that R&D in battery recharging technology is advancing in Canada and electric buses with 300 km range should become available within 10 years.[113] François Chamberland, Director of Engineering Service and Operation at Société de transport de Montréal (STM), reported that his company is working to develop battery charging technology with Nova Bus and Bombardier: "The idea is to recharge a 12-metre electric bus, a standard bus for the STM, by induction, that is to say without contact."[114]

In contrast, Russell Davies from Calgary Transit told the Committee that the City of Calgary intends to purchase a fleet of natural gas transit buses. Calgary Transit evaluated the business cases for natural gas and electric hybrid buses and found that the premium for electric hybrid technology had a much longer payback period. In addition to lower life-cycle costs, the natural gas bus advantages for the City of Calgary include a reduction in noise and other vehicle emissions compared to diesel buses. The City of Calgary is currently conducting an 18-month test of natural gas buses from both Nova Bus and New Flyer. Ultimately, the City of Calgary plans to purchase 200 natural gas buses for the city fleet, construct a new natural gas-compliant maintenance facility, and invest in central refuelling infrastructure.

---

111 Serge Carignan, Director, Engineering and Technical Services, Société de gestion et d'acquisition de véhicules de transport, *Evidence*, Meeting No. 39, 1st Session, 41st Parliament, May 29, 2012, 0900.

112 Ibid., 0910.

113 François Chamberland, Director, Engineering Service, Operation, Société de transport de Montréal, *Evidence*, Meeting No. 39, 1st Session, 41st Parliament, May 29, 2012, 1020.

114 Ibid., 0910.

1. Obstacles to Innovation in the Transit Industry

According to Mr. Baracat (Nova Bus), the high cost of recertifying motors in Europe and the United States is an obstacle to innovation in the transit bus manufacturing industry. It is his view that the tens of millions of dollars that must be spent on recertification every few years divert money from R&D in new technologies. In addition to making more dollars available to R&D, harmonizing international standards would mean that "all sorts of technologies that are available elsewhere could also be available here."[115]

Both Nova Bus and New Flyer witnesses noted that electric bus innovation is impeded somewhat by the fact that there is no common approach or standard for battery recharging technology. According to Mr. Stoddard, "there aren't even defined regulations for the heavy-duty, high-voltage charging that we're dealing with."[116]

With respect to the adoption of electric public transit vehicles in Canada, the limited supply of vehicles in Canada is an obstacle. "There are no electric bus manufacturers in Canada, and that is really a problem. Supply is very limited even in North America. In the case of city buses, a single manufacturer in North America manufactures an electric motor for public transit purposes."[117] Sourcing electric buses from Europe is not possible because, unless they are modified to conform to the *Canadian Motor Vehicle Safety Standards*, Transport Canada prohibits importing bus equipment for more than one year. Mr. Chamberland told the Committee that European bus companies would only invest in complying with *Canadian Motor Vehicle Safety Standards* "if they could sell those buses to the United States, but they will never sell a bus in the United States because of the *Buy American Act*. That's a big problem for us."[118]

Mr. Davies (Calgary Transit) told the Committee that gaps in the guidelines, codes and standards for natural vehicle maintenance facilities has made planning a new maintenance facility that can accommodate natural gas buses more difficult.

2. Innovation in the Transit Industry: Witness Recommendations

Representatives from Nova Bus recommended harmonization of international standards in transit buses to allow companies to avoid the costs of recertification and devote more funds to innovation. Nova Bus also suggested that if Transport Canada harmonized international standards and certifications, the Canadian industry could make better use of globally available technologies for natural gas bus engines. In the words of Mr. Baracat, "If we didn't have to develop different solutions and obtain different certifications for each country, we could invest more money in research and development.

---

115 René Allen, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0855.

116 Chris Stoddart, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0920.

117 Serge Carignan, *Evidence*, Meeting No. 39, 1st Session, 41st Parliament, May 29, 2012, 0915.

118 François Chamberland, *Evidence*, Meeting No. 39, 1st Session, 41st Parliament, May 29, 2012, 0945.

In certain technologies, such as engine emissions, we believe that it would be an enabler to bring in some new technologies here."[119]

With respect to electric buses, Nova Bus' primary recommendation was for the federal government to provide green funds to industry to assist in the development of the buses. Nova Bus also requested support for "companies that work on battery systems, storage elements and charging," which was endorsed by New Flyer. During discussion with the Committee, Nova Bus also recommended that a charging standard be established, but the witness from New Flyer did not think this was a good idea. Mr. Stoddart's thoughts on the subject were that "just by competition and whatever else, it will ultimately funnel down. It will almost self-regulate over time. I don't think you want to be imposing too much stuff right now."[120] Mr. Allen clarified that the federal role should be to help test different technologies to help them "go down the funnel faster."[121]

Representatives of transit companies asked the Committee to consider recommendations that would facilitate the purchase of transit bus innovations. Mr. Davies (Calgary Transit) asked that federal guidance be provided on the construction of maintenance facilities for natural gas vehicles and for some federal assistance, such as interest-free loans, to help with the costs of establishing a fleet of natural gas buses.[122] Representatives of the STM also requested some assistance in transition to a green fleet (an electric fleet in its case) and also recommended that the *Motor Vehicle Safety Standards* should be amended to allow European electric bus technologies to be imported for a period of longer than one year to conduct trials and pilot projects. Étienne Lyrette, Corporate Advisor of Governmental Affairs at STM, recommended that electric transit projects be supported by R&D and showcase programs, and that transit projects generally be eligible for the next infrastructure program.[123] Mr. Carignan, whose organization represented all transit agencies in Quebec, suggested that Canada should adopt European transit bus standards, as South America and Asia have, in order to "open the door to a promising market, in addition to improving the competitiveness of our suppliers in this country relative to other suppliers."[124] Mr. Carignan also told the Committee that federal incentives to attract foreign companies to invest in building buses in Canada would also help the industry.

---

119 Jean-Pierre Baracat, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0920.

120 Chris Stoddart, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0930.

121 René Allen, *Evidence*, Meeting No. 41, 1st Session, 41st Parliament, June 5, 2012, 0930.

122 Russell Davies, Manager, Transit Fleet, Calgary Transit, *Evidence*, Meeting No. 33, 1st Session, 41st Parliament, May 1, 2012, 0910.

123 Étienne Lyrette, Corporate Advisor, Governmental Affairs, External Relations and Strategic Planning, Société de Transport de Montréal, *Evidence*, Meeting No. 39, 1st Session, 41st Parliament, May 29, 2012, 0915.

124 Serge Carignan, *Evidence*, Meeting No. 39, 1st Session, 41st Parliament, May 29, 2012, 0925.

INNOVATION IN RAIL

The Committee held two meetings to discuss innovation in the Canadian rail industry. Representatives from the Railway Association of Canada, Canadian National Railway, Canadian Pacific Railway and National Steel Car, Canada's only freight car manufacturer, appeared at the first meeting. Rail passenger witnesses, Bombardier Inc. and experts in American passenger rail regulation appeared at the second meeting.

A. Freight Rail Innovations

Mike Roney, General Manager of Technical Standards at Canadian Pacific Railway (CP), told the Committee that his railway has invested in next-generation technologies to improve safety and service reliability for its customers. According to Mr. Roney, the mountainous terrain in its approach to the Pacific Gateway has forced the railway to become "experts in the world in the use of distributed power remotely controlled from the lead locomotive."[125] Distributed power refers to additional locomotives positioned within a train, allowing more control over forces acting on the train, better braking, more train capacity and better fuel efficiency. These technologies have led to a reduction in the cost of rail shipping and enabled Canadian producers to become more competitive in global markets. CP also uses automated inspection technologies that feed into predictive technologies and data management. Together, these innovations allow the railway to monitor its network for conditions that require maintenance as they develop, preventing service disruptions or other incidents. "We have detectors that can tell us if a wheel is too hot or too cold — in other words, if the brakes are being applied too hard or the brakes aren't functioning as they should on any particular axle. We measure impacts of wheels on multiple locations across the property. Those give us early warning signs of potentially damaged wheels. We can measure wheel wear at track speed. We can measure brake shoe wear."[126] Electronically controlled pneumatic brakes are another area of innovation adopted by CP, which allows higher capacity trains to stop more quickly and use less fuel. CP has conducted research on fatigue management and uses software to determine whether crew have had the time to get enough rest to work. CP has invested in finding innovative ways to protect bears in the vicinity of their trains, including tracking and mapping bear movements, introducing a sighting reporting system, and installing devices to deter bears from crossing the tracks and to scare them away. Mr. Roney told the Committee that changes in their governing legislation in the mid-1990s made these investments in innovation possible: "All we really needed was the 1996 *Canada Transportation Act* to give us revenue adequacy and allow us to invest in these various potentials, and that's exactly what the railways have been doing."[127]

Dwight Tays, Chief, Engineering Technology, Canadian National Railway Company (CN), spoke to the Committee about rail innovation in the area of fuel efficiency and

125 Mike Roney, General Manager, Technical Standards, Canadian Pacific Railway, *Evidence*, Meeting No. 43, 1st Session, 41st Parliament, June 12, 2012, 0855.

126 Ibid., 0850.

127 Ibid.

sustainability. He told the Committee that the new, more fuel-efficient locomotives used by CN have reduced GHG emissions by more than 30% since 1995. Despite the inherent fuel efficiency of railway operations in relation to all other modes of shipping, he said, "fuel is a major expense for the rail industry, and we work very hard every day to reduce consumption and maximize the value we realize from every litre burned."[128] Mr. Tays told the Committee that CN is actively investigating the potential to use liquefied natural gas as an alternative to diesel fuel. "This evaluation is in the early stages, but if the testing proves successful, it could be a major step forward for the rail industry. We anticipate that use of liquefied natural gas would enable an approximate 20% reduction in emissions, as well as a significant reduction in particulate matter, and all at lower cost to the railways."[129] The liquefied natural gas would be carried in a tender tank car, which would offer an operational benefit of not having to stop to refuel on longer haul routes, such as Toronto to Vancouver.

The question of whether the freight railways planned to pursue electrification in the future was raised by some Committee members. In response, the witnesses gave a few reasons to explain why the industry was not planning to invest in this technology. In the words of Mr. Tays, "there is a major investment requirement to electrify a piece of track. There are also the complexities that go with trying to operate some trains electrified and some trains diesel-powered. You can't just turn the switch one day and suddenly you're electrified." He noted that "some of our lines go through territory where there is no source of electrification. In northern Ontario, for example, we had to put our own power in just to run our CTC and radio equipment. There is no commercial power readily available, so that adds complexity as well."[130] He added that the interlinkages between the Canadian and American diesel rail freight networks are another obstacle to electrification in Canada. Mr. Roney expressed doubt that railway shareholders would approve an enormous infrastructure investment that would take decades to pay off.

The Committee learned that CP's annual R&D spending is in the order of $10 million per year and includes: contributions to the Association of American Railroads' research program; support for the University of Alberta Canadian Rail Research Lab; collaborative research with Transport Canada through the Railway Research Advisory Board; and, collaborative research with government and industry in Australia. Mr. Tays elaborated that the University of Alberta Canadian Rail Research Lab was established recently and "is jointly funded by Transport Canada, CN, CP, and the AAR, and has recently been granted an NSERC industrial research chair in railway geomechanics."[131] The lab is expected to help educate and train the next generation of railway engineers and researchers.

---

128 Dwight Tays, Chief, Engineering Technology, Canadian National Railway Company, *Evidence*, Meeting No. 43, 1st Session, 41st Parliament, June 12, 2012, 0920.

129 Ibid.

130 Ibid.

131 Ibid., 0855.

On the subject of collaborative railway research, Mr. Tays commented that the Railway Research Advisory Board was recently reorganized as per the recommendations from the *Railway Safety Act* Review. The Board is now divided into a Technical Committee, which identifies and prioritizes research opportunities, and a Management Committee, which sets research priorities and ensures that industry and government resources are in place to carry out the research program. According to Mr. Tays, "since this reorganization, considerable progress has been made in developing streamlined research, evaluation, and prioritization processes. In addition, there has been an improvement in the coordination of research activities and consolidation of funding from industry and government."[132]

Michael Bourque, President and Chief Executive Officer of the Railway Association of Canada, suggested that, going forward, innovation in the rail sector should also focus on intermodal aspects of the business. "As we move into the future, we're going to see an even greater need to integrate our supply chain, from our ports to our trucking, rail, shipping, seaways, terminals, intermodal — all of those kinds of investments. We need to keep our eye on that ball, because going into the future, we're going to be moving a lot more goods, and we have a tremendous opportunity in Canada to win new business in that respect."[133]

Gregory Aziz, Chairman and Chief Executive Officer of National Steel Car Limited, told the Committee about his company's innovative grain rail car. According to Mr. Aziz, the car is far superior to the federally owned fleet of grain cars in service today. "Our next-generation fleet provides for a 9% increase in the gross rail load. The cars can be up to 4,000 pounds lighter than the existing fleet. That translates into a carrying capacity or load limit of the car that adds an additional 27,000 pounds more grain. On a train-start basis, there will be nine additional cars in every train start."[134] Mr. Aziz told the Committee that National Steel Car's grain cars require 25% less handling than the existing fleet and last 25% longer. National Steel Car has also invested hundreds of millions of dollars in plant automation and advanced manufacturing technologies in recent years.

1. Obstacles to Innovation in the Freight Rail Industry

Mr. Bourque provided the Committee with a few examples of regulatory impediments to adopting efficiency- or safety-enhancing innovation in the rail industry. The first is a limit on the time a railway may be exempted from provisions in the *Railway Safety Act* to test new technology. "We asked for the exemption to be 12 months instead of 6 months. That's simply because we operate in four seasons, and in order to introduce a new technology, we need to test it in all of those seasons before we can be certain it's

132 Ibid.

133 Michael Bourque, President and Chief Executive Officer, Railway Association of Canada, *Evidence*, Meeting No. 43, 1st Session, 41st Parliament, June 12, 2012, 0935.

134 Michael Hugh Nicholson, Executive Vice-President, Marketing, Sales and Quality, National Steel Car Limited, *Evidence*, Meeting No. 43, 1st Session, 41st Parliament, June 12, 2012, 1005.

going to be effective."[135] Mr. Bourque also observed that innovation in the railway industry allows the companies to operate longer trains, yet there is a rule that imposes an unreasonable restriction on the amount of time a train can stay in a crossing. He illustrates the problem in the following way: "If you pull out of the Vancouver port and you have rules governing the speed that you can come out and you have a long train, if you do the math, length times speed, we're going to be in some crossings longer than 10 minutes."[136] Finally, Mr. Bourque indicated that the railways would like to invest in video technology to monitor employee fatigue, but the *Canadian Transportation Investigation and Safety Board Act* prohibits using video recordings for anything but accident investigation.

2. Innovation in the Freight Rail Industry: Witness Recommendations

In his written submission to the Committee, Mr. Bourque provided two recommendations to accelerate the adoption of innovation by the railway industry. His first recommendation was that Transport Canada should develop a more adaptable and flexible regulatory framework, which both increases the allowances for pilot projects and technology demonstrations, as well as permits the railway companies to pursue electronic or mechanized processes in meeting safety standards. Mr. Bourque's second recommendation to the federal government was to provide additional financial support to short line railways, when tend to be more financially precarious, so that they can adopt innovation that otherwise would be unaffordable.

Mr. Aziz made recommendations to the Committee in regards to the adoption of his innovation rail car by the rail industry. The first recommendation Mr. Aziz made on behalf of National Steel Car was that the federal government should replace its fleet of grain cars with National Steel Car's advanced product. In his words, "We're suggesting that because the government has invested in a railcar fleet now, with the current obsolete fleet, they've essentially provided that equipment for the railroads and for the Canadian farmer … we're suggesting that the government stay involved in order to get a rapid replacement and move Canada essentially up the transportation chain here to a very modern fleet in a short period of time, so that this benefit is provided to the Canadian farmer and helps with Canada's ability to export wheat worldwide."[137] The second recommendation was for there to be an increase in the capital cost allowance applied to railcar equipment to a rate greater than the one that exists in the United States "in order for the Canadian railroads to build equipment in Canada, or to build equipment not only for the Canadian part of their railroad, but also for the American part of their railroad."[138]

---

135 Michael Bourque, *Evidence*, Meeting No. 43, 1st Session, 41st Parliament, June 12, 2012, 0925.

136 Ibid.

137 Gregory Aziz, President and Chief Executive Officer, National Steel Car Limited, *Evidence*, Meeting No. 43, 1st Session, 41st Parliament, June 12, 2012, 1015.

138 Ibid., 1045.

B. Passenger Rail Innovations

Representatives from Bombardier Inc., a Canadian manufacturer of passenger rail equipment, told the Committee about the company's progress in improving the safety and performance of its rail products. Bombardier has commercialized a commuter rail car that is equipped with the best passenger protection in case of a collision, called "crash energy management". Bombardier has added regenerative braking to its vehicle designs, to save and re-use energy wasted as heat during braking, and introduced lighter power modules that deliver the same power to its trains. Bombardier is also working to develop a wireless electric power supply that uses magnetic induction and could be used by all kinds of electric vehicles.

Experts on American rail regulations discussed regulatory innovation that could allow for increased use of passenger rail for regional travel in Canada.[139] They told the Committee that passenger rail equipment built to European standards (UIC [Union internationale des Chemins de fer] standards) is lighter weight and less expensive to operate and maintain than railway equipment that meets North American standards. The lower life-cycle costs of the European equipment could potentially improve the viability of the business case for some new passenger rail projects in Canada. The U.S. Federal Railroad Administration is currently conducting an analysis of how UIC standard passenger rail equipment and North American standard freight rail equipment can safely operate on the same track.

1. Obstacles to Innovation in Passenger Rail

Canadian rules and regulations under the *Railway Safety Act* generally require rail equipment to meet North American standards. The Committee learned that the UIC standards are substantially lower than the North American standards and therefore the European passenger rail equipment would require considerable engineering redesign in order to use it in Canada.[140] Most passenger rail services in Canada must share track with freight railway operations, which makes using less sturdy equipment particularly dangerous in the case of a collision.

2. Innovation in Passenger Rail: Witness Recommendations

Paul Larouche, Director of Marketing and Product Planning for Bombardier, noted that the *Railway Safety Act* provides the Minister with some discretion to allow rail equipment that meets other standards to operate in Canada under certain conditions. One example of this is the Ottawa O-Train (UIC standard equipment) which is exempted from the regular operating rules for mixed services because it has an exclusive operating window during which the freight services using the same infrastructure do not operate.

---

139 Garry Fuller, President, GF Rail Consulting, *Evidence*, Meeting No. 46, 1st Session, 41st Parliament, October 16, 2012, 1105.

140 George Binns, Equipment Engineer, Paladin Consulting, *Evidence*, Meeting No. 46, 1st Session, 41st Parliament, October 16, 2012, 1105.

According to Mr. Larouche, “since there is no possibility of the trains meeting, that doesn't cause a problem.”[141] Nonetheless, Mr. Larouche suggested that Transport Canada follow the progress of the Federal Railroad Administration in the United States in looking at mixing European technology with North American technology and adapting Canadian regulations in a similar way. “Now that the European designs include Crash Energy Management Technology, and you have a lot of improved crash avoidance technology, it turns out that you can mix and match quite safely.”[142]

INNOVATIONS IN AEROSPACE

The Committee invited stakeholders from civil air navigation and civil aviation in Canada to discuss trends in, and obstacles to, innovations in aerospace technologies. The Committee also convened two meetings with stakeholders to discuss the potential viability of an innovative new element in Canadian aerospace: heavy-lift cargo airships. The testimony the Committee received concerning various aspects of the aerospace industry, including witness recommendations, are summarized in the sections below.

A. Innovations in Civil Air Navigation

NAV CANADA is the sole provider of civil air navigation services in Canada. NAV CANADA is a private, non-share capital, not-for-profit corporation that was created under the *Civil Air Navigation Services Commercialization Act*. The corporation purchased Canada’s civil air navigation system from Transport Canada in 1996 for $1.5 billion and has been operating and investing in the system ever since.

John Crichton, the President and Chief Executive Officer of NAV CANADA, told the Committee that, as a result of the company’s innovative technologies and practices, there have been many improvements in the civil air navigation system and in services offered to its customers. One example of such a technology is Performance-Based Navigation (PBN), which uses satellite information to design arrival and departure procedures, airways and airspace and has improved airport safety, capacity and accessibility while reducing fuel costs for airlines and operating costs for the company. The Committee also learned that new aircraft surveillance technologies (i.e., Automatic Dependent Surveillance-Broadcast [ADS-B] and multilateration) have allowed airspace surveillance for the first time over Hudson Bay, the safe reduction of separation between aircraft in the air, as well as more flexible, fuel-saving routes for aircraft equipped with the technology. New video surveillance technologies are in use to improve air traffic controllers’ situational awareness of aircraft and vehicle movements on the ground. NAV CANADA has also commenced the deployment of an improved automated weather observation system (AWOS), which cost the company millions of dollars to develop, that provides more accurate and reliable weather reporting for pilots. NAV CANADA’s in-house engineers and controllers have also created efficiency and safety-enhancing air traffic management

141 Paul Larouche, Director, Marketing and Product Planning, Bombardier Transportation North America, Bombardier Inc., *Evidence*, Meeting No. 46, 1st Session, 41st Parliament, October 16, 2012, 1205.

142 Ibid.

software to be used in Canada and sold to other air navigation systems around the world. Examples of air traffic management software developed by NAV CANADA include direct electronic communication between pilots and controllers and a minimum safe altitude warning system. In Mr. Crichton's words, "NAV CANADA's adoption of new technologies … go a long way toward addressing specific challenges in our industry, namely: improving safety and efficiency in increasingly congested skies and airports; strengthening operational capabilities in the North; improving the cost-effectiveness of our customer's operations; and reducing aviation-related greenhouse gas emissions."[143] Mr. Crichton also told the Committee that NAV CANADA was innovative in the way it ran the business and introduced new technology allowing the company to keep rates for its customers stable for eight years in spite of a major downturn in air traffic.

1. Obstacles to Civil Air Navigation Innovations

Mr. Crichton noted that the regulation-making process in Canada can be lengthy and inflexible at times. While the process has not prevented NAV CANADA from developing or adopting new technology, it has caused some delay. Mr. Crichton provided the example that, "because the regulations specifically stated 'radar,' we could not initially use ADS-B and multilateration for surveillance."[144]

2. Civil Air Navigation Innovations: Witness Recommendations

In order for NAV CANADA to use new technology as it becomes available, Mr. Crichton recommended that Transport Canada remake the regulatory structure in harmonization with global standards and in accordance with a performance-based model. Mr. Crichton said, "We believe a performance-based model of regulation would be more sustainable, giving Transport Canada the ability to create regulation that focuses on safety performance, but does not need amendment to reflect each new emerging technology."[145]

Mr. Crichton also suggested that federal infrastructure programs be used to share the cost of introducing new technology in certain areas of the country where the technology would generate substantial public benefits but have a weak business case. According to Mr. Crichton, "AWOS is expensive technology to install in the North due to construction costs. Consequently, it may not be feasible to deploy on a wide-scale basis without government assistance."[146] Mr. Crichton suggested that government assistance in the order of $45 million would be required over 5 years to install AWOS at 50 sites in the North.

---

143 John Crichton, President and Chief Executive Officer, NAV CANADA, *Evidence*, Meeting No. 40, 1st Session, 41st Parliament, May 31, 2012, 0900.

144 Ibid., 0905.

145 Ibid.

146 Ibid.

B. Civil Aviation Innovations

Rénald Fortier and Steven Quick, from the Canadian Aviation and Space Museum (CASM), told the Committee that Canadian aerospace innovations are usually developed for export markets because the internal market is very small. Mr. Fortier said that "the idea is to export our aerospace products. You have to develop something that is either so simple, like a utility airplane that everyone buys, or something that is so new and revolutionary, like a regional jet, that everyone will want it, too."[147] They explained that the internal market has driven innovation in the Canadian aerospace industry only during times of war (particularly World War II, the Korean War and the Cold War) when the federal government entered into large contracts with aircraft manufacturers to build up Canada's aerial defence. Examples of important innovations that have emerged from the Canadian aerospace industry for export markets include a regional jet product and flight simulator technology, which are both in high demand globally.

Mr. Fortier and Mr. Quick briefed the Committee on the key aspects of federal government support that the aviation industry has received during the past century. The Committee learned that the Canadian aerospace industry has always benefited from, and at times its survival depended upon, federal government support and intervention. The Canadian aircraft manufacturing industry was established by British government policy and procurement during the Great War and survived post-war downturns through nationalization by the Canadian federal government during the 1970s. The federal government built airfields and the air navigation system, trained aircrew during World War II, and built flying clubs to maintain aviation skills during peace time. Today, the aerospace manufacturing industry is in the private sector again, but relies on federal tax credits and repayable loan programs to pursue innovation. Mr. Quick articulated the industry's present relationship with the federal government in the following way: "This environment is supported by a number of key elements, namely education, research, training, infrastructure, certainly public policy, support for domestic and foreign markets, and active retention of expertise, which is really key especially given the ebb and flow of the market needs in conflicting sales and operating conditions."[148]

The testimony from some witnesses suggests that one of the directions aerospace innovation will take into the future, like in other transportation industries, will be the pursuit of better fuel efficiency. Mr. Fortier suggested that engine and flight simulator technologies are strengths in the Canadian aerospace industry, and that innovation in these areas is also a possibility for the future.

---

147 Rénald Fortier, Curator, Canadian Aviation and Space Museum, *Evidence*, Meeting No. 34, 1st Session, 41st Parliament, May 3, 2012, 1020.

148 Steven Quick, General Director, Canadian Aviation and Space Museum, *Evidence*, Meeting No. 34, 1st Session, 41st Parliament, May 3, 2012, 0850.

1. Obstacles to Innovation in Civil Aviation

Mr. Quick told the Committee that there is a shortage of engineers in Canadian aerospace, which slows technological advance in civil aviation.

2. Civil Aviation Innovations: Witness Recommendations

Mr. Fortier stated that the federal government has helped the aerospace industry since the early days and should continue to do so. He recommended that continuity of the support policies is very important to innovation in the aerospace sector "because nowadays developing an aircraft program in the CSeries, for example, takes years."[149] Mr. Quick added that "continuity is paramount to success given the longer gestation periods of such high-tech machinery, and the fragility of the infrastructure and markets that support it."[150]

C. Airship Innovations

An airship is a lighter-than-air vehicle that can be steered and propelled through the air. Airships obtain their lift through the filling of a large cavity with a lighter-than-air gas. Airships were popularly used for transportation in the 1930s but were set aside in favour of passenger aircraft when transportation by aircraft became safer and widely available after World War II. Since then, the few airships in operation around the world have mainly been used to serve niche transportation markets such as tourism, sport viewing and advertising services.

Stakeholders in the prospective airship industry told the Committee that global research and development in airship technologies, which includes hybrid technologies, is on the rise. There is heightened interest in airships because they appear to offer a lower cost alternative for cargo shipments to areas without all-season access by any means other than conventional aircraft or with no access at all. Barry Prentice, President of ISO Polar, explained the interest in airship technology in the following way: "Fuel is no longer inexpensive. The pollution and the carbon dioxide emissions are things we care about now. And of course we want to get places where we don't have infrastructure, such as runways. So now the interest in this technology that has basically been ignored for 65 or 75 years has returned."[151] The theoretical advantages of modern airships over conventional aircraft are that they can carry very large and bulky items, they require very little infrastructure other than shared hangars for maintenance, and they are expected to use far less fuel per kilo of cargo. It is expected that high winds and extreme cold would limit airship operations in the North but Dr. Prentice expects that airships would "be about as useful as airplanes."[152] The relatively low speed of airships compared to jet aircraft is

149 Rénald Fortier, *Evidence*, Meeting No. 34, 1st Session, 41st Parliament, May 3, 2012, 0910.

150 Steven Quick, *Evidence*, Meeting No. 34, 1st Session, 41st Parliament, May 3, 2012, 0850.

151 Barry Prentice, President, ISO Polar, *Evidence*, Meeting No. 35, 1st Session, 41st Parliament, May 8, 2012, 0905.

152 Ibid., 1025.

not expected to be an issue, as, according to Dr. Prentice, "very little cargo has to move at 500 miles an hour. The railway's average speed, by the way, is about 25 miles an hour. If you can go 80 miles an hour in an airship, that's actually quite fast and reliable."[153] The competitiveness of airships for cargo shipments relative to aircraft remains to be proven, however, as modern airships have never been used for cargo operations. Dr. Potter (NRCC) commented that "the prospect of alternative technologies such as heavy-lift airships is also an intriguing possibility for some cargo, such as super-sized mining equipment, for locations that are inaccessible by road or water."[154]

Representatives of Discovery Air Innovations Inc. (an operating company of Discovery Air Inc., which is a Canadian aviation company with extensive operations based in the Northwest Territories) told the Committee that they would like to bring hybrid air vehicle technology from the United Kingdom and use it for cargo shipments in northern Canada. "The initial hybrid air vehicle we plan to introduce to Canada can carry 50,000 kilograms over more than 5,000 kilometres."[155] According to Gary Venman, Vice-President of Government Services, "for the development phase we're probably looking at $60 million to $80 million to get the first vehicle approved and certified."[156]

If successful, Discovery Air Innovations would be the first company in the world to demonstrate the hybrid air vehicle technology for cargo and plans to lever that experience into becoming a global leader in the technology. Dr. Prentice told the Committee that "if we can do it in Canada, we can export it around the world. We're not the only place with these kinds of difficult conditions. Certainly with places like the Amazon, the Congo, Siberia, and the outback, there are many places in the world that need this technology."[157] Mr. Venman told the Committee that, based on his company's market research, global demand for hybrid air vehicles is in the order of 200 to 300 units.[158]

The proponents of creating an airship industry in Canada told the Committee that airships could have a very positive impact on the lives of Canada's northern residents and serve Canada's environmental and national interests in the North. Supplying the North with commercial goods by airships/hybrid air vehicles instead of aircraft would result in a lower cost of living for northern residents and provide all-season access for goods that are too large to bring in by aircraft. It is also expected that employment opportunities would arise for northern residents both in the airship industry itself as well as in the resource industry, as airships could permit the development of stranded resource plays. Hybrid air vehicles could also be used to transport people and supplies to respond to environmental

---

153 Ibid., 1020.

154 Ian Potter, *Evidence*, Meeting No. 23, 1st Session, 41st Parliament, February 28, 2012, 0900.

155 Didier Toussaint, Group President Government Services, Discovery Air Inc., *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0905.

156 Gary Venman, Vice President Government Services, Discovery Air Inc., *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0930.

157 Barry Prentice, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 1030.

158 Gary Venman, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0940.

disasters, such as an oil spill, and to increase Canadian surveillance in the North for the purposes of sovereignty.

1. Obstacles to Airship Innovations

Witnesses told the Committee that one major obstacle to airship or hybrid air vehicle innovations in Canada is the lack of financing to develop one suitable for cargo operations in the North. The Committee learned that even though there are large multinational corporations that could be well served by airships or hybrid air vehicles once they are on the market, they are not willing to contribute to the R&D of the technology until they see it demonstrated. Didier Toussaint, Group President for Government Services at Discovery Air Innovations, reported that "interest in this technology is very high. However, no resource company is willing to initiate years of environmental approval based on a conceptual air transportation system, and very few companies are willing to invest the required capital to develop this technology. To move ahead with the commercialization of the hybrid air vehicle, we need to design, build, and certify a demonstrator and prove that the technology works."[159] Mr. Toussaint also told the Committee that banks are unwilling to finance the demonstration of a new technology because, at the early stage of development, there is no consumer commitment to provide cash flow to secure the debt. Mitch Davies (Industry Canada) confirmed that "the question in technology financing is that it's more venture financing, meaning the ability to evaluate the business plan in an area of completely new breakthrough products and innovation. The sophistication to make those decisions is not generally available in all the banks."[160] Discovery Air Innovations told the Committee that it is not eligible for federal financial assistance normally offered to the aerospace industry because international collaborations are not eligible under the Strategic Aerospace and Defence Initiative.

Dr. Prentice identified many other obstacles to innovation and the adoption of airship technologies in Canada. He noted that Canada's cabotage restrictions prevent a technology demonstration using a foreign-owned airship. "Unless you have a Canadian company willing to purchase it, willing to train pilots, willing to do everything, it wouldn't happen."[161] It was also noted that the necessary infrastructure does not exist. "If you don't have a place to put an airship to maintain it or to do a safety check, you can't operate an airship. So one of the problems is we don't have any hangars in this country."[162] Both Dr. Prentice and representatives from Discovery Air Innovations observed that regulatory gaps respecting airship certification and pilot training are another obstacle to airship operators in Canada. Dr. Prentice explained that the current regulatory framework for licensing airship pilots does not reflect the state of the technology and that there are no regulations relating to the construction and airworthiness of large airships. He told the Committee that Transport Canada does not seem very engaged in the idea of airships, as

159 Didier Toussaint, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0905.

160 Mitch Davies, *Evidence*, Meeting No. 24, 1st Session, 41st Parliament, March 1, 2012, 1030.

161 Barry Prentice, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0940.

162 Ibid., 0910.

"we've not been able to get any response from that group in terms of taking this topic seriously and investigating it, and actually finding out what is the truth and where does it stand."[163]

2. Witness Recommendations: Airship Innovations

Representatives from Discovery Air Innovations recommended to the Committee that the federal government should help fund their hybrid air vehicle technology demonstration. Mr. Venman told the Committee: "We are going to be looking for risk-sharing partners. We do see government as being a part of that because there is a lot of upside for Canada."[164] They assured the Committee that any money that would flow into this program would be repaid through the commercialization of the technology. They also noted that the federal Aerospace Review is expected to generate a series of recommendations regarding access to funding for international collaborative efforts and urged the government to seriously consider the recommendations from this study.

Witnesses from Discovery Air Innovations and ISO Polar recommended that Transport Canada address the regulatory gaps preventing adequate training for pilots and technical crew members, as well as the certification of modern airships.

Dr. Prentice had two other recommendations for the Government of Canada. He recommended that Transport Canada make a policy statement regarding airships for northern transportation, which would be a signal to industry players that their efforts to develop an industry would be accommodated, and to further support industry players by conducting some research on the cost effectiveness of airships as a mode of transport. He also recommended that the federal money spent on seasonal transportation in the North should be redirected to establishing a year-round airship industry. In his words, "Rather than spending on ice roads year after year and seeing the benefits melt away every spring, if we put some investment into hangars and perhaps into a pilot program to demonstrate the airships and build that business confidence, the private sector will carry this away."[165]

INNOVATION IN ALTERNATIVE FUELS FOR TRANSPORTATION

A. Innovation in Bio-Fuels

The Canola Council of Canada and the Canadian Canola Growers Association co-authored a written submission to the Committee advocating for the use of canola as a feedstock in renewable biodiesel and "bio-jet" fuel production. According to the brief, "canola-based biodiesel meets stringent international certification standards for greenhouse gas reduction and land and water use." The canola associations suggest that commercial-scale production of bio-fuel for use in aviation has been achieved in the United

163 Ibid.

164 Gary Venman, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0925.

165 Barry Prentice, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0915.

States, Finland, the Netherlands and Indonesia. The proponents for the expansion of the canola-based renewable diesel industry also argue that rural Canada would benefit in terms of economic growth and jobs and a stronger agricultural sector, and the rest of Canada would benefit from lower greenhouse gas emissions, among other things.

Geoffrey Tauvette from WestJet told the Committee that "aviation has globally committed to some pretty aggressive goals: 2% improvement on fuel efficiency year over year up to 2020; from 2020 on, carbon neutral growth; and then by 2050 to reduce our emissions by 50% compared to 2005 levels. For us, bio-fuels represent a solution to the carbon-neutral growth perspective."[166] Mr. Tauvette explained that, as fuel represents 30% or more of an air carrier's operating costs, airlines are hoping that bio-fuels will help them reduce their dependence on conventional jet fuel and better manage their fuel costs and reduce emissions. According to Mr. Tauvette, there are already specifications for aviation bio-fuels and they have been certified for use in aircraft in Canada and the United States.

1. Obstacles to Innovation in Bio-fuels

On the increased use of bio-fuels in the aviation industry, both Mr. Tauvette and the canola associations noted that technology does not yet permit large-scale production at a cost that is affordable for consumers. From WestJet's standpoint, another challenge to the production of aviation bio-fuels is securing a feedstock that does not compete with food. Both Mr. Fortier (CASM) and Dr. Potter (NRCC) indicated that there are non-food plants and algae available in Canada that could be used as feedstock for aviation bio-fuel production.

2. Innovation in Bio-fuels: Witness Recommendations

In order to foster a domestic canola bio-fuel industry, the Canola Council of Canada and the Canadian Canola Growers Association recommended to the federal government that:[167]

1. Renewable diesel mandates increase to 5% nationwide by 2015;
2. Testing of high-blend (>5%) canola biodiesel be conducted;
3. Emerging markets, such as "bio-jet" fuels, be strategically supported;
4. Competitive fiscal measures (e.g., refundable tax credits) be considered to stimulate private sector investment in R&D, pilot and demonstration plants and commercialization of renewable diesel production in Canada.

---

166 Geoffrey Tauvette, Director, Fuel and Environment, WestJet, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0945.

167 Canola Council of Canada and the Canadian Canola Growers Association, Submission to the Committee, April 26, 2012, p 1.

On the part of WestJet, Mr. Tauvette told the Committee that "Canada has all the right ingredients and know-how to become a global technological leader in advancing non-food feedstock and aviation bio-fuel commercialization."[168] In order to do so, Mr. Tauvette recommended that Canada develop a policy framework, perhaps based on the U.S. model, to guide aviation bio-fuels into production and use. According to Mr. Tauvette, the federal aviation bio-fuel policy framework should identify a lead department to consolidate the efforts of other government and industry stakeholders.

B. Innovation in Electric Mechanical Batteries for Vehicles

The Committee learned that an electric mechanical battery (flywheel) is being developed by a Canadian private sector company, which could potentially serve as the default energy storage for all kinds of hybrid vehicles. Greg Tarasco, President and Chief Executive Officer of Blueprint Energy Inc., explained that his company's energy storage technology offers 50% lower cost power storage than the chemical batteries available currently. Furthermore, Blueprint Energy's electric mechanical battery has some important operational advantages including: no capacity, efficiency or power fade; a 20-year operational life; a wide range of temperature tolerance; and no end-of-life disposal issues since it is made of steel and recyclable.[169] The flywheel technology recaptures waste energy generated from deceleration and braking and is therefore best suited to stop-and-go vehicles such as transit buses, garbage trucks and other vehicles used in chronically congested road networks. Mr. Tarasco blames the limitations of chemical batteries for "a lowly 3.7% hybrid adoption rate over two decades of research and hundreds of billions of dollars spent globally by governments in this industry, with very little result."[170] Blueprint Energy is currently developing a flywheel for heavy-duty transit buses specifically and expects that the technology will be commercially ready in 2014.

1. Obstacles to Innovation in Electric Mechanical Batteries for Vehicles

Mr. Tarasco told the Committee that there is not enough private investment in transportation technologies and noted that venture capital funds in Canada are very small. According to Mr. Tarasco, "the average size of a Canadian fund is about $400 million. The average size of a fund in the U.S. is $7 billion."[171] Mr. Tarasco advised the Committee that "the best way, the most efficient way, [to mobilize private investment] is to have the investor who is directly linked to the company get the synergies going there. Remove the barriers, the administration, the red tape, facilitate the investor, develop a relationship, and the result is something like Silicon Valley."[172]

---

168 Geoffrey Tauvette, *Evidence*, Meeting No. 36, 1st Session, 41st Parliament, May 10, 2012, 0850.

169 Greg Tarasco, President and Chief Executive Officer, Blueprint Energy Inc., *Evidence*, Meeting No. 45, 1st Session, 41st Parliament, October 4, 2012, 1105.

170 Ibid.

171 Ibid., 1220.

172 Ibid.

Mr. Tarasco also commented that, while federal commercialization programs are very good, they are not responsive enough for entrepreneurs to take advantage of opportunities as they tend to expire quickly. Mr. Tarasco called it "the timing misalignment between the commercial window of opportunity and the capital requirements of a company. If a company was to be vetted for private capital, the due diligence process typically takes 30 to 90 days to get a term sheet. The government can take 6 to 12 months, depending on the program, if not longer. For an early stage company with commercial-ready technologies, this is a challenge."[173]

2. Innovation in Electric Mechanical Batteries for Vehicles: Witness Recommendations

Mr. Tarasco recommended that the federal government make tax credits available for investments by friends and family in order to increase the flow of private risk capital into transportation technology. He also recommended that federal program support be delivered within the same window as the opportunity which can be as short as between 30 and 90 days.[174]

C. Innovation in Recycled Motor Oil

Todd Habicht, President and Chief Executive Officer of HD Petroleum Inc., told the Committee that the vast majority of motor oil used in Canada, reportedly some 1.1 billion litres in 2011, is burned, inappropriately disposed of or stored. HD Petroleum's technology offers a regionally based, cost-effective technology to recycle waste motor oil and turn it into transportation diesel. Mr. Habicht said that his company "can provide a locally generated source of energy while cleaning up a locally generated source of contamination."[175] The Committee learned that HD Petroleum's commercialized facility could produce between 7 to 8 million litres of diesel fuel containing less than 100 parts per million of sulphur per year as an alternative to burning used motor oil and generating between 3,500 and 6,000 parts sulphur per million.

1. Obstacles to Innovation in Recycled Motor Oil

The main obstacle to the commercialization of HD Petroleum's recycling technology is environmental regulation. Despite reducing sulphur emissions by up to 96%, there is a limited consumer market for HD Petroleum's diesel product. The new diesel, which tested at just under 100 parts per million of sulphur, exceeds the amount of sulphur permitted by the new ultra-low *Sulphur in Diesel Regulations* (SOR 2002-254), which require less than 15 parts per million of sulphur content from diesel fuel. Representatives from HD Petroleum told the Committee that they are confident that their technology will

173 Ibid., 1110.

174 Ibid.

175 Todd Habicht, President and Chief Executive Officer, HD Petroleum Inc., *Evidence*, Meeting No. 45, 1st Session, 41st Parliament, October 4, 2012, 1120.

ultimately comply with the new sulphur regulations, but reaching the ultra-low sulphur diesel fuel requirements is not feasible on a micro scale.

2. Innovation in Recycled Oil: Witness Recommendations

Witnesses from HD Petroleum recommended that recycling technologies for plastics and oils that produce marketable transportation fuels "be permitted to meet the less demanding, low sulphur designation, rather than the ultra-low sulphur designation in cases where the overall net emission reduction is significant."[176] By providing an alternative to burning used motor oil, HD Petroleum expects that its diesel product will generate a considerable net sulphur emission reduction in Canada, despite the slightly higher sulphur content in the diesel fuel produced.

COMMITTEE ANALYSIS AND RECOMMENDATIONS

During 19 meetings in Ottawa, Committee members participated in wide-ranging discussions with government officials and stakeholders from the automotive, rail, aerospace and alternative fuel industries about the barriers to commercialization and adoption of transportation innovation in Canada. The Committee members then proceeded to consider dozens of policy recommendations for the Government of Canada that had emerged during these conversations. At the outset, Committee members reaffirmed that their aim was to identify federal policies that prevent commercially viable transportation technology from entering or being taken up by the marketplace and to make changes to them if possible and practical. The Committee held two more meetings with officials from Transport Canada, Public Works and Government Services Canada, Natural Resources Canada, Finance Canada and Environment Canada to probe departmental perspectives on the various federal policy changes witnesses had proposed.

This chapter provides the Committee's recommendations to the Government of Canada concerning the barriers to innovation or adoption of innovation in the on-road vehicle, rail, aerospace and alternative fuel industries. Before addressing recommendations for specific industries, the Committee presents two general recommendations that it believes could help address financial and regulatory challenges facing innovators and the early adopters of innovation across the entire transportation sector.

3. **In order to address the financial difficulties of innovators in financing R&D and subsequent stages of innovation and of transportation companies purchasing advanced technology in Canada, the Minister of Finance should direct departmental officials to analyze the potential advantages and disadvantages of financial incentives such as tax rebates or accelerated capital cost allowance on the development or purchase of all lower**

176 Ibid., 1125.

emission technologies in transportation and to report their findings back to the Committee.

4. **Where it is shown that safety can be maintained or improved, the Minister of Transport should pursue a transition to performance-based regulation in all modes of transportation.**

A. Innovation in On-Road Vehicles: Analysis and Recommendations

Throughout the Committee's meetings with stakeholders from the automotive industry, private and public sector witnesses stressed the importance of innovation in this globally competitive industry. The Committee learned that light-duty vehicles produced in North America must, on average, be more than twice as fuel-efficient by 2025 and that the automotive industry must innovate aggressively in order to meet this challenge. Another important aspect of automotive innovation is advances in vehicles and infrastructure that would eventually allow for driverless vehicles and increased traffic density, while achieving a lower collision rate. The Committee learned that Canada has public sector, academic and private sector scientists working on advances in these key areas of automotive technology. Furthermore, these scientists are eligible for several federal innovation support programs that offer financial, technical and commercial assistance.

Witnesses told the Committee that existing and past federal support innovation programs (e.g., Technology Partnerships Canada, ecoFreight, ecoTechnology for Vehicles, Sustainable Development Technology Canada, AUTO21 Network for Centres of Excellence, etc.) have served the automotive industry well. Nonetheless, various witnesses suggested that changes to the program delivery mechanisms would precipitate better outcomes in automotive innovation. The Committee supports finding ways to spend existing program funding better and therefore recommends that:

5. **The Government of Canada should redirect a portion of its existing research and innovation budget away from institutions and towards substantial prize money for innovations which meet well-defined public goals. Government should clearly define the hoped-for invention, discovery or innovation, and offer financial rewards to the first Canadian innovator who achieves it. Prizes should be large enough to deliver a return on investment for the innovator.**

6. **The Government of Canada should reallocate a portion of existing granting council funding to pilot a new automotive R&D model to replace AUTO21 as it sunsets in 2015. This model should: (i) focus on the priorities of industry; (ii) require industry funding and a commercialization plan before committing public funds; and (iii) help small- and medium-sized businesses connect to public research labs.**

7. **In order to allow early-stage companies with commercially ready automotive technologies to respond within a narrow window of market opportunity, the Government of Canada should endeavour to receive and process applications quickly.**

8. **In order to facilitate the participation by small- and medium-sized businesses in the Scientific Research and Experimental Development tax credit program, the Government of Canada should reduce the administrative burden on smaller companies.**

9. **In order to reduce the complexity of the R&D and commercialization efforts in the Canadian automotive industry, which may depend on the intellectual property of public sector scientists, the Government of Canada should encourage the simplification and harmonization of intellectual property policies across the country with respect to public sector science.**

The Committee learned that electric vehicle battery technology is not advanced enough to deliver an economic, practical, and purely electric alternative for most consumers at this time. An additional challenge for operators of heavy-duty transit buses is finding a battery charging technology that provides enough of a charge within the short windows of opportunity available to sustain 20-hour-per-day operations.

Automotive innovation has led to many advances in lower emission on-road vehicles, such as natural gas- and propane-powered vehicles as well as hybrids, and the development of aerodynamic equipment available for heavy-duty trucks. Many witnesses told the Committee that there is a shortage or a complete absence of these lower emission technologies in Canada, however. The Committee learned that many transportation service providers, as well as individual consumers, would like to import some of the lower emission vehicle technologies from Europe or elsewhere in the world, but can only do so temporarily unless the vehicle is certified to meet Canadian standards. Officials from Transport Canada told the Committee that they have chosen to focus their limited resources on harmonizing vehicle standards in Canada with those of the United States or with Global Technical Regulations for safety and emissions, which are currently being developed. Officials from Transport Canada noted that the Minister of Transport has the power to allow for the importation of rail equipment and marine vessels that do not meet Canadian standards under the *Railway Safety Act* and the *Canada Shipping Act, 2001*. Before making a decision on whether to allow the importation and operation of a foreign rail or marine vehicle, the Minister receives expert advice on the safety of the proposed technologies. The Committee believes that Canadians should have greater access to lower emission on-road vehicles and therefore recommends that:

10. **Transport Canada should establish a mechanism to promptly allow the importation of yet-to-be-approved transport technologies that have been proven safe and successful in comparable jurisdictions such as the European Union and the United States.**

The Committee also learned that regulatory inconsistencies respecting transportation innovations within Canada make the early adoption of new technology difficult. For example, differing regulations concerning truck dimensions and weights across the provinces inhibit the interprovincial operation of heavy-duty natural gas trucks (which are longer than others) and the use of aerodynamic treatments, such as boat tails and single-wide tires. The Committee also heard that lack of, or confusion regarding, provincial/municipal building codes for natural gas-compliant vehicle maintenance facilities is causing delays in these construction projects. The Committee would like to make it easier for early adopters of lower emission vehicles to take them across provincial borders and therefore recommends that:

11. In order for interprovincial inconsistencies in vehicle regulations that have a negative impact on the adoption of innovations in on-road vehicles to be addressed, federal representatives at the next meetings of the Canadian Council for Ministers Responsible for Transportation and Highway Safety and the Canadian Council of Motor Transport Administrators should raise the issues of harmonizing provincial regulations respecting:

a) The use, marking and inspection of alternative fuel vehicles;

b) Certification and installation standards for converted natural gas and propane vehicles;

c) Certification and construction standards for natural gas and propane refuelling infrastructure and maintenance facilities;

d) Truck dimensions and weights to allow larger natural gas trucks and trucks with aerodynamic treatments to operate across the country.

With regards to the recommendation that propane be included in the Canadian Natural Gas Deployment Roadmap, an official from Natural Resources Canada explained to the Committee that the roadmap process was concluded and therefore, it would be impossible to include propane at this time.

During its discussions with stakeholders from the trucking industry, the Committee heard about inconsistencies between Canadian and American regulations respecting heavy-duty natural gas trucks and fuelling parts. Stakeholders from the Canadian trucking industry explained that differences between the standards in Canada and the United States effectively limit the supply of heavy duty natural gas trucks available for purchase in Canada. When the issue was discussed again with federal government officials, the Committee learned that heavy-duty natural gas trucks certified and owned in the United States are not required to crash test or meet Canadian installation standards in order to do

business in Canada. The Committee would like Canadians to be able to import natural gas trucks from the United States that are as safe as the trucks they can buy in Canada and therefore recommends that:

> **12. The Government of Canada should engage with U.S. authorities through the Regulatory Co-operation Council to close the gap between Canadian and American regulations respecting heavy-duty natural gas trucks.**

Further to the point that natural gas heavy-duty trucks should be able to move freely between Canada and the United States, the Natural Gas Vehicle Alliance of Canada recommended that the Canadian and U.S. governments coordinate to some extent on where natural gas refuelling infrastructure should be established. The Committee notes that bilateral cooperation is taking place with respect to natural gas vehicles within the Advanced Transportation initiative in Phase II of the Canada-U.S. Clean Energy Dialogue and therefore recommends that:[177]

> **13. In order to allow investments in natural gas refuelling infrastructure in key north-south trucking corridors, the Government of Canada should expand the discussion that already exists around natural gas vehicles in its Clean Energy Dialogue with the United States to include privately-financed refuelling infrastructure.**

Many witnesses suggested that the federal government increase consumer awareness of advanced technologies in alternative fuel vehicles by purchasing more of them for their departmental fleets. The Committee supports an increased number of alternative fuel vehicles in the federal fleet if they provide the best value for money for Canadian taxpayers and therefore recommends that:

> **14. Public Works and Government Services Canada should allow alternative technologies to compete on a level playing field for government vehicle fleet contracts. The full life-cycle capital and operating costs should be part of the calculation of best value and the selection of winning bidders.**

B. Innovation in Rail: Analysis and Recommendations

During its meetings with rail industry stakeholders, the Committee learned that there are some federal regulatory barriers to adopting the most advanced rail technology available. Currently, section 22.1(1) of the *Railway Safety Act* does not permit federally regulated railway companies to conduct a four-season test of a new technology, which the railway companies feel is essential. The railway companies would also like the flexibility to replace human inspection or interactions with computerized or mechanized processes

177 Government of Canada, "U.S.-Canada Clean Energy Dialogue: Action Plan II," *Canada's Action on Climate Change*.

when technology for these purposes becomes available. With respect to passenger rail, there are no regulations or rules in place that generally allow foreign railway equipment, which does not meet Canadian safety standards, to operate on infrastructure that is shared with freight operations. While it is possible to obtain an exemption from the Minister of Transport in order to import and operate foreign railway equipment in mixed use with freight rail (Ottawa's O-Train operates rail equipment built to European standards on CP's track by virtue of this process), passenger railway stakeholders would like more certainty as to whether and how foreign passenger rail equipment will be permitted to operate on infrastructure used by freight trains. As the Committee sets out to lower or eliminate regulatory barriers to innovation, and the adoption of innovation, in the transportation sector, it recommends that:

15. In order to allow Canadian railways to conduct testing related to railway transportation over the course of twelve months rather than six, Transport Canada should amend section 22.1(1) of the *Railway Safety Act* to this effect before the provision comes into force by order of the Governor in Council.

16. In order to facilitate the importation of foreign passenger rail equipment and its safe operation on infrastructure used by freight rail equipment built to North American standards, Transport Canada should review the work of the Federal Railroad Administration on this subject in the United States while defining the content of regulations suitable for Canada.

The Committee supports performance-based, or "smart," regulation, generally and reiterates the importance of Recommendation 4 for the purposes of introducing new technology that is proven to be safe in rail operations.

Some Committee members believe that the federal government has a broader role in supporting passenger rail developments in Canada and therefore recommend that:

17. The Government of Canada should develop regulations to allow the use of innovative electric transit systems, including battery, flywheel, contactless charging, etc.

C. Innovation in Aerospace: Analysis and Recommendations

According to the proponents of the technology in Canada, cargo airships (including hybrid air vehicles) have great potential to provide solutions for Canada's numerous transportation challenges in the North. Stakeholders are concerned that there is no clear regulatory route to airship and airship pilot certification in Canada, whereas officials from Transport Canada told the Committee that a path towards certification exists in the *Canadian Aviation Regulations*. Transport Canada officials explained that the regulations are flexible enough to ensure that a company that wished to commercialize the technology would be able to do so, and that it is preferable to wait for a prototype to be built to further define the regulations rather than risk "getting it wrong". Transport Canada officials agreed

that modifying the balloon license currently required to pilot an airship would ensure that an airship pilot has the necessary skills to handle modern airship technology, however. As the Committee is committed to reducing or eliminating regulatory barriers to transportation innovation, it recommends that:

18. Transport Canada should create clear pilot certification rules for airships/hybrid air vehicles.

Airship stakeholders also recommended that the federal government contribute to a hybrid air vehicle demonstration program in Canada. As the Committee does not wish to put taxpayers' money at risk by investing in a business that cannot attract private capital, it focussed on the question of whether the operator of a hybrid air vehicle would have the opportunity to compete for federal shipping contracts. The Government of Canada regularly hires private sector companies to transport large volumes of heavy cargo over long distances. These services are required to transport various supplies to northern and remote communities. Typically planes, trucks and ships are employed.

Examples from Aboriginal Affairs and Northern Development Canada (AANDC)

Transportation method	Item	From	To
Air	Relocation of household effects of a family of four	Vancouver, BC	Iqaluit, NU
Air	Shipment of 4 work stations	Not stated.	Iqaluit, NU
Truck	Relocation of household effects of a family of four	Ottawa, ON	Whitehorse, YT

Examples from Public Works and Government Services Canada (PWGSC)

Transportation method	Item	From	To
Air	Monochrome Photocopier/Printer	A firm operating out of Nova Scotia	Iqaluit, NU
Air	Satellite Weather Transmitters	A firm in Edmonton, AB	Inuvik, NT
Truck	Nordic Ski Equipment	A firm in Whitehorse, YT	Whitehorse, YT
Truck	Aluminum Jet boat	A firm in Red Deer, AB	Whitehorse, YT
Truck	Lumber for Dredge #4	A firm in Vancouver, BC	Dawson City, YT
Ship	Tractors & Loader	Not stated	Kuujjuaq, QC

The Department of National Defence conducts major re-supply operations for its most northern station, Canadian Forces Station Alert in Ellesmere, Nunavut, twice annually with both air force and occasionally chartered aircraft.[178] The resupply mission is called “Operation Boxtop” and transports over one million litres of fuel and over hundreds of thousands of tonnes of freight per year.[179]

The Committee also learned that PWGSC’s procurement policy, which applies to transportation services, is performance-based and any service provider who can meet a need is eligible to compete for the contract. PWGSC has a procurement program, called the Canadian Innovation Commercialization Program, which matches federal needs with pre-commercial technologies.

Hybrid air vehicles may one day provide a superior solution, as they can travel over snowfall, frozen water or impenetrable terrain, and require no roads or rail installations to operate. According to Discovery Air Innovations, hybrid air vehicles can carry “40-50 tonnes of cargo”, have “a 2500 km radius of operation” and use “25% of the fuel of traditional heavy-lift aircraft.”

However, the technology needs testing to ensure reliability. If the government were to abandon existing transportation modes in favour of a new option that failed to work, urgently needed goods might not reach their destination.

178 National Defence, “Who We Are — RCAF in the North,” *RCAF*.

179 National Defence, “Operation Boxtop 2010: the Globemaster’s grand debut,” *News & Events — Newsroom*.

Recommendation:

19. **To avoid risks related to a potential failure of an unproven hybrid air vehicle technology, Public Works and Government Services Canada should consider a "pilot project", involving the transport of non-urgent goods to remote destinations. Such a test run should only happen on a commercial basis, at a price competitive with alternatives, when the government has a need. Payment should only follow successful delivery.**

Recommendation:

20. **That after hybrid air vehicles are proven reliable, Public Works and Government Services Canada allow them to compete on a level playing field with other modes of transportation for federal government contracts delivering heavy cargo over long distances.**

Transport Canada confirmed that there are no international rules for airships or hybrid air vehicles. The Committee therefore recommends that:

21. **Transport Canada should support the development of international regulations for airships and hybrid air vehicle technology.**

This report also discussed the challenges to innovation in civil air navigation. NAV CANADA, Canada's civil air navigation service provider, told the Committee that overly prescriptive regulation had slowed the rate at which it could adopt new technology. The Committee generally supports performance-based, or "smart," regulation and reiterates the importance of Recommendation 4 for the purposes of allowing NAV CANADA to invest in new technology to improve air navigation services in Canada as long as safety is maintained or improved.

NAV CANADA also identified the installation of wind turbines as an operational concern during its discussion with the Committee. Transport Canada officials told the Committee that they are only involved in the location of wind turbines in the case of certified aerodromes that have zoning regulations. The Committee believes there is a gap in the regulation of the location of wind turbines between the provincial and federal governments, which has the unintended consequence of locating wind turbines too close to aviation activities. Therefore, the Committee recommends that:

22. In order to prevent new wind turbines from affecting NAV CANADA operations, the Minister of Transport should review the regulations concerning the location of wind turbines in the vicinity of all aerodromes, including un-registered facilities.

D. Innovation in Alternative Fuels: Analysis and Recommendations

The Committee heard as well as received written submissions from stakeholders promoting innovations in biofuels, recycled motor oil and electric mechanical batteries for use in transportation. The Committee discussed the recommendations from the bio-fuel stakeholders with departmental officials and learned that it would not be practical to increase the renewable diesel mandate at this time, since the current mandate is quite new and due to be reassessed at the end of 2013. The Committee also notes that the bio-fuel industry has received considerable federal support recently and 15 biodiesel producers currently receive a production subsidy under Natural Resources Canada's ecoEnergy for Biofuels program.[180]

The Committee found HD Petroleum's argument for a temporary exemption for recycled fuels from Environment Canada's amended *Sulphur in Diesel Fuel Regulations* that recently came into force compelling. According to HD Petroleum, its mini-refineries can be established to recycle used motor oil and create usable transportation diesel anywhere in Canada. HD Petroleum believes that its technology can solve a problem of local pollution, as well as create a local source of transportation fuel for remote communities. The expected environmental benefits of HD Petroleum's technology are in terms of avoided pollution, because the technology provides an alternative to burning used motor oil, which generates sulphur emissions in the thousands of parts per million, and reduces the emissions generated by transporting diesel fuel into a remote community. Without a temporary exemption from the *Sulphur in Diesel Fuel Regulations* to give the company time to achieve a further reduction in sulphur emissions to meet the regulations for on-road vehicles, HD Petroleum's market for the technology is limited to large marine vessels and stationary vehicles.[181] Departmental officials acknowledged that the recycled diesel is very close to meeting the requirements of the amended *Sulphur in Diesel Fuel Regulations* for on-road vehicles, but were concerned about the effect of the fuel on engines built for the new standard of fuel. The Committee believes that the potential environmental benefits of HD Petroleum, and other recycled fuel technologies, merit a grace period with respect to the amended *Sulphur in Diesel Fuel Regulations* and therefore recommends that:

23. Environment Canada should examine HD Petroleum's claims in regards to recycling petroleum products and the *Sulphur in Diesel Fuel Regulations*, and respond according to its findings.

---

180 Natural Resources Canada, "News and Updates," *ecoEnergy for Biofuels*.

181 Environment Canada, "Summary of the Regulations Amending the Sulphur in Diesel Fuel Regulations," *Sulphur in Diesel Fuel Regulations*.

LIST OF RECOMMENDATIONS

APPENDIX A:
A TIMELINE OF SELECTED TRANSPORTATION TECHNOLOGIES SINCE 1800

Table 1 — Transportation Technology Since 1800

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1800	Electric Battery	Conte Alessandro Volta (Italy)	Volta began experimenting with the conduction of electric current during the 1770s. In 1800, he demonstrated the first battery ("voltaic pile") capable of generating electric current.	Following Michael Farraday's experiments that derived the laws of electrochemistry (ca. 1834), battery technology was commercialized.
1801	Steam Locomotive	Richard Trevithick (Great Britain); George Stephenson (Great Britain)	Trevithick developed the first steam locomotive while Stephenson's design (1814) set the general pattern for all subsequent steam locomotives.	The first practical application of locomotive engines was for the transportation of coal and other mineral ores from mines. The Liverpool and Manchester Railway (1830) was the first fully timetabled railway providing scheduled freight and passenger service powered entirely by steam locomotives. Its opening heralded the so-called "Railway Era" which continued through the First World War (1914–1918).

Funding of Invention (Public, Private or Both)	Role of Government in Invention[1]	Selected References
Likely private.	Likely none.	▪ Franco Decker, "Volta and the 'Pile,'" *Electrochemistry* Encyclopedia, January 2005. ▪ Ernie Tretkoff, "This Month in Physics History – March 20, 1800: Volta describes the Electric Battery," *APS News*, Vol. 15, No. 3, American Physical Society, March 2006.
Likely private.	Unknown.	▪ Richard Cavendish, "Richard Trevithick's First Steam Carriage," *History Today*, Vol. 51, No. 12, 2001. ▪ L. T. C. Rolt, "Richard Trevithick," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ "George Stephenson," *Encyclopædia Britannica, Encyclopædia* Britannica *Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ Samuel Smiles, *The Life of George Stephenson and of His Son Robert Stephenson; Comprising Also a History of the Invention and Introduction of the Railway Locomotive*, Harper & Brother Publishers, New York, 1864.

1 Whether there was public involvement in an invention was rarely documented in the sources consulted. Where there was no specific mention of how an invention was funded, the authors have indicated whether public involvement was likely based on the general historical and/or industrial context.

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1802	Steamboat	William Symington and Thomas Dundas (Great Britain)	Symington and Dundas developed the first practical steamboat. It was used to tow 70-ton barges along the Forth and Clyde Canal to Glasgow; it was abandoned by company managers in 1803.	In 1807, Robert Fulton and Robert Livingston (U.S.A.) launched the first regular passenger steamboat service on the Hudson River (New York). The first transatlantic steamship crossing occurred in 1836 (SS Great Western).
1832–1842	Electric Vehicles	Robert Anderson (Great Britain); Sibrand Acker Stratingh and Christopher Becker (Netherlands); Thomas Davenport (U.S.A.); Robert Davidson (Great Britain)	Various primitive electric-powered road vehicles were developed between 1832 and 1842 in Great Britain, Netherlands and the United States.	The first electric car that was produced in volume was the Henney Kilowatt (1959) which was a Renault Dauphine converted to electric power. Only 120 were sold, mainly to American electric companies for demonstration purposes and for use by electric meter readers. The first electric trucks and buses were developed by the Battronic Truck Company (U.S.A.) during the 1960s and 1970s with little commercial success. More recently, plug in electric vehicles such as the Nissan Leaf have been commercialized by major automobile manufacturers.
1852	Airship	Jules Henri Giffard (France)	Giffard invented a hydrogen-filled airship fitted with a steam engine that powered a propeller. Giffard's airship flew from Paris to Trappes (distance of ca. 30 kilometres).	The first successful operator of rigid airship was Ferdinand, Count Von Zeppelin, who completed his first airship, the LZ-1, in 1900.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Likely private.	Apparently none initially although development of marine steam engine applications was accelerated by the mid-1850s with the adoption of the technology by major navies.	▪ Council for Economic Education, "Transportation Milestones." ▪ J. and W. H. Rankine, *Biography of William Symington, Civil Engineer; Inventor of Steam Locomotion by Sea and Land. Also, a Brief History of Steam Navigation, with Drawings*, 1862. ▪ *American Railroad Journal, and Advocate of Internal Improvements*, Vol. 3, Part 2, January 1835, D. K. Minor, New York, p. 825.
Likely private.	Governments and government agencies were likely among the early users of this technology.	▪ Electric Auto Association, "EV History." ▪ Library of Congress, Researchers, "Who invented the automobile?," *Science Reference Services*.
Likely private.	Likely none.	▪ Tim Sharp, "The First Powered Airship," *Space.com*. ▪ U.S. Centennial of Flight Commission, "First Flights of the Airship."

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1853	Glider	Sir George Cayley (Great Britain)	Cayley's unpowered glider flew less than 1/10th of a mile but represented the first manned, heavier-than-air flight.	Cayley's glider demonstrated numerous aerodynamic principles that were applied to future aircraft by other inventors. Although used to land soldiers and equipment during the Second World War, gliders have been commercialized on a limited scale since 1945 primarily for sport and leisure purposes.
1859	Internal Combustion Engines and Tractors	Étienne Lenoir (Belgium)	Lenoir's coal gas powered engine was the first commercially successful internal combustion engine.	Lenoir sold approximately 1,500 engines mainly for stationary use in pump houses and factories. In 1862, he experimented with a wheeled vehicle powered by a version of his engine modified to run on liquid fuel. Lenoir's concept would be built upon by numerous inventors and would be adapted to automobiles, aircraft and boats among other transportation technologies during the late 1800s.
1863	Subway	Proposed by Charles Pearson, London city councillor (Great Britain)	The first underground urban passenger railway, the Metropolitan Railway in London, England began operation in 1863.	Was a success from opening and carried 9.5 million passengers in its first year of operation.
1867	Motorcycle	Sylvester Howard Roper (U.S.A.)	Though it appears that the idea occurred to many engineers and inventors at the same	In 1894, the Hildebrand & Wolfmüller became the first motorcycle available to the public for purchase.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Likely private.	Limited to government investments in military applications, primarily during the Second World War.	▪ U.S. Centennial of Flight Commission, "Sir George Cayley." ▪ U.S. Centennial of Flight Commission, "Sir George Cayley – Making Aviation Practical."
Likely private.	Likely none.	▪ University of Cambridge, Department of Engineering, "The Early History of Combustion Engines." ▪ David Beecroft, *The History of the American Automobile Industry*, Installment 20, March 1916, pp. 53–55.
Likely both public and private funding.	Parliamentary authorization and likely some funding.	▪ London Transport Museum, "Public transport in Victorian London: Part Two: Underground," *Information resources*. ▪ "London Underground," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012.
Likely private.	Likely none.	▪ Imperial College of London, "Control and dynamic analysis of two-wheeled road vehicles: Hildebrand and Wolfmueller," *Research: Control and Power*.

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1867 (cont'd)			time, Roper invented a two-cylinder, steam engine motorcycle. The first gasoline engine motorcycle was developed by Gottleib Daimler and Wilhelm Maybach (Germany) in 1885.	
1867	Reinforced Concrete	Joseph Monier and François Hennebique (France)	As a gardener, Monier experimented with the use of iron mesh to strengthen cement containers for horticultural use. He patented his idea in 1867 and displayed it at the 1867 Paris Exposition.	The first commercial application of Monier's reinforced concrete was undertaken by François Hennebique, a French engineer, who, after viewing Monier's display at the Paris Exposition, incorporated it into his designs for several buildings during the late 1800s. Early use of reinforced concrete rapidly expanded from horticultural containers (tubs and basins) to other engineering structures such as railways ties (sleeper), pipes, floors, arches and bridges.
1869	Railway Air Brake	George Westinghouse (U.S.A.)	Westinghouse's air brake allowed locomotive engineers to apply the brakes to a train in a fail-safe manner, without relying on the manual application of brakes by human brakemen.	The Westinghouse Air Brake Company (WABCO) was established to manufacture and sell Westinghouse's invention in 1869.
1871	Bicycle	James Starley (Great Britain)	The first two-wheeled, rider propelled machine emerged in 1817 in Germany but Starley's Ariel bicycle set the design standard for the "ordinary" bicycle. There were many bicycle-like inventions in between these two events.	The first two-wheeled riding machines were manufactured for sale in 1817 and 1818 by various inventors. French "velocipedes" were manufactured in 1868 and exported to America, where small manufacturers also filed for patents. Major (500 units+) bicycle production began in Britain around 1868 as well.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
		▪ Mary Bellis, "History of the Motorcycle."
Likely private.	Likely none.	▪ Michael Hein, "Historical Timeline of Concrete," Auburn University. ▪ University of Illinois Urbana-Champaign, Department of Materials Science and Engineering, "The History of Concrete." ▪ "François Hennebique," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012.
Likely private.	Likely none.	▪ European Braking Systems, "History of Air Braking." ▪ "George Westinghouse," *Encyclopædia* Britannica, *Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012.
Likely private.	Likely none.	▪ The Bicycle Museum, "A Quick History of Bicycles." ▪ "James Starley," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012.

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1870s	Refrigerated Rail Cars	Various (U.S.A.) including Gustavus Franklin Swift and Joel Tiffany	Shipping live animals by rail was risky and expensive. A few meat producers in the United States developed ice-cooled railroad cars in order to ship dressed beef long distances to market.	Swift was the founder of a meat-packing empire in the U.S. Midwest. Swift's refrigerated rail cars entered service in 1880 and his fleet grew rapidly. Competitors rapidly copied his innovation
1881	Electric Trolley	Ernst Werner von Siemens (Germany)	Siemens' trolley was a wheeled vehicle powered by overhead electrical wires. It set the pattern for urban streetcar and trolleybus designs.	There is some disagreement on the first successful electric street railway system. Some credit Frank Julian Sprague (Richmond, Virginia, 1888) while others identify Siemens' Gross-Lichterfelde Tramway (Berlin, 1881) as the world's first electric tramway.
1883	Multipurpose Bridge	John Augustus Roebling (U.S.A.)	The first Brooklyn Bridge connecting Brooklyn to Manhattan carried railway tracks, trolley tracks, a roadway and a walkway and was the largest bridge in the world (at 1,595.5 feet) when it opened.	The Brooklyn Bridge set the pattern for large multipurpose bridges around the world.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Likely private.	Likely none.	▪ Carl W. Hall, *A Biographical Dictionary of People in Engineering: From Earliest Records to 2000*, Purdue University Press, 2008, p. 92. ▪ PBS: American Experience, "Made in Chicago: The Refrigerated Rail Car." ▪ "Gustavus Franklin Swift," Encyclopædia *Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012.
Likely private.	Unknown.	▪ Massachusetts Institute of Technology, School of Engineering, "Electric Trolley System." ▪ Siemens, "Inauguration of the first electric streetcar in the world," *History*.
Public.	Public funding was provided by the State of New York and the boroughs of New York City.	▪ Council for Economic Education, "Transportation Milestones." ▪ Library of Congress, "Roebling and the Brooklyn Bridge," *American Memory*.

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1885	Internal Combustion Engine powered truck and bus	Karl Benz (Germany)	Benz developed the first truck powered by an internal combustion engine, some of which were subsequently modified to become the first commercially viable passenger buses.	Buses and trucks powered by gasoline and diesel engines were developed by numerous manufacturers by the early 1900s.
1885–1886	Gasoline Powered Automobiles	Karl Benz, Gottleib Daimler and Wilhelm Maybach (Germany)	Benz's three-wheeled vehicle powered by a gas engine designed by Daimler represents the first practical automobile. Daimler and Maybach subsequently developed a larger four-wheeled gas powered "horseless carriage" in 1886.	The first commercially successful automobile was the curved dash Oldsmobile (U.S.A.) which sold 425 units in 1901 growing to over 5,000 in 1904. The Ford Model T (1908) was the first automobile to be mass produced, making it affordable to the masses. By the time production ended in 1927, over 15 million Ford Model Ts had been sold.
1887	Pneumatic Tire	John Boyd Dunlop (Great Britain)	Dunlop invented the first commercially viable pneumatic tire featuring an inner tube and rubber treads.	Dunlop's invention was quickly adapted for use on bicycles. Michelin & Cie (France) introduced pneumatic tires for automobiles in the 1890s though American Phillip Strauss is also credited with the "successful" marketing of pneumatic tires for automobiles in 1911.
1892	Diesel Engine	Rudolf Diesel (Germany)	Instead of using an electric ignition process, a diesel internal combustion engine uses compressed air to ignite diesel fuel injected into cylinder. In 1892, Diesel received patents in	Diesel engines were originally used as a more efficient replacement for stationary steam engines. The first transport applications were in the 1910s when they were used in submarines and ships. Diesel engines were later used in locomotives, trucks, heavy

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Likely private.	Governments supported this invention indirectly through the construction of road networks.	▪ "Karl Benz," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ Michael MacRae, "Karl Benz," American Society of Mechanical Engineers (ASME), April 2012.
Likely private.	Governments supported this invention indirectly through the construction of road networks.	▪ Council for Economic Education, "Transportation Milestones." ▪ Library of Congress, Researchers, "Who invented the automobile?," *Science Reference Services*.
Likely private.	Governments supported this invention indirectly through the construction of road networks.	▪ Council for Economic Education, "Transportation Milestones." ▪ Dunlop, "History: Where It All Began."
Likely private.	Governments were likely among the first consumers of this innovation.	▪ Council for Economic Education, "Transportation Milestones." ▪ "Rudolf Diesel," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012.

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1892 (cont'd)			Germany, Switzerland, the United Kingdom and filed in the United States for "Method of and Apparatus for Converting Heat into Work." He operated his first successful pressure-ignited heat engine in 1897.	equipment and automobiles.
1898	Hybrid (gas/diesel-electric) Vehicles	Dr. Ferdinand Porsche (Austria)	Dr. Porsche devised a vehicle with an internal combustion engine that provided power to electric motors located in the wheel hubs.	Various manufacturers began to introduce hybrid gas-electric vehicles to market during the 1990s. Several major automakers including Honda, Toyota and General Motors have introduced hybrid passenger vehicles to relative commercial success in recent years. Additionally, hybrid technology has been used increasingly in public transit buses.
1900	Dirigible (Zeppelin)	Count Ferdinand von Zeppelin (Germany)	Zeppelin's dirigible was a rigid but light airframe that set the pattern for future airship designs.	In 1909, the first commercial Zeppelin service was launched in Germany.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
		▪ United States Patent Office, "Method of and Apparatus for Converting Heat into Work," Patent number 542846 (filing date: 26 August 1892, issue date: 16 July 1895).
Modern hybrids – private (with public subsidies, tax credits in certain jurisdictions).	Many governments supported the development of modern hybrids and encouraged their purchase through subsidies and tax credits.	▪ hybridCARS, "History of Hybrid Vehicles." ▪ U.S. Department of Energy, "How Hybrids Work," *Energy Efficiency and Renewable Energy*. ▪ Congressional Budget Office, "Effect of Federal Tax Credits for the Purchase of Electric Vehicles," 20 September 2012. ▪ Honda, Environment, "Hybrid," *Featured initiatives.* ▪ Toyota, Innovation, "Environmental Technology."
Largely private with some public funding.	The German government funded the development of Zeppelins for military applications until 1918 and funded their commercial use until the crash of the Hindenburg.	▪ U.S. Centennial of Flight Commission, "The Zeppelin."

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1903–1905	Airplane	Orville and Wilbur Wright (U.S.A.)	The Wright brothers' first flight in 1903 lasted only 12 seconds but by 1905, they had developed the first practical airplane.	The Ford Trimotor (1926) was the first commercially successful passenger aircraft. However, the Boeing Model 247 and Douglas DC2/3 (1933) represented the first modern commercial airliners as they demonstrated that air travel could be safe, reliable, affordable and profitable for the airlines.
1907	Helicopter	Paul Cornu (France)	Cornu's twin rotor helicopter was the first to successfully rise vertically in powered flight. It was ultimately unsuccessful as it suffered from several control problems. In 1916, Raul Pateras de Pescara (Argentina) conducted the first fully controlled helicopter flight in Buenos Aires. The German Focke-Wulf Fw61 (1934) was the first practical helicopter but remained experimental.	The Sikorsky R-4 (1942) became the first production helicopter and was used primarily by Allied militaries during the Second World War. Post-1945, numerous manufacturers worldwide developed designs and the military and civilian use of helicopters expanded dramatically.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Likely private.	Governments and state-owned airlines were among the initial buyers of aircraft. Governments also developed much of the infrastructure required for aircraft operations.	▪ U.S. Centennial of Flight Commission, "Wright Brothers' Essays."
Likely private.	Initial development was largely conducted by private firms and inventors but commercialization occurred through a military contract.	▪ U.S. Centennial of Flight Commission, "Helicopter Development in the Early Twentieth Century." ▪ Igor Sikorsky Historical Archives, "History."

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1909	Airport	College Park Airport, Maryland (U.S.A.)	The College Park Airport in Maryland, U.S.A., is reportedly the world's oldest continually operated airfield. The airfield was formally established in 1909 after it was used to train military officers to fly the U.S. government's first airplane.	In 1925, Cleveland's Hopkins Airport set the pattern for modern airport design, being the first to feature, among other things, a runway lighting system, ground to air radio and an air traffic control tower.
1911	Electrical Ignition	Charles Kettering and Clyde Coleman (U.S.A.)	General Motors engineers Kettering and Coleman invented the first electric starter motor for automobiles, eliminating the need to hand crank vehicles.	The Kettering and Coleman starter was introduced in 1912 Cadillac automobiles and by 1920 most manufacturers had adopted electric ignition.
1917	Diesel-electric Locomotive	General Electric, Ingersoll-Rand and other firms (U.S.A.)	The first diesel-electric locomotives built by General Electric and Ingersoll-Rand were demonstrated in 1925 by several railroads. They were initially used for switching railcars in its train yards.	In 1929, CN Rail became the first railway in North America to use diesel-electric locomotives on mainline service. By the early 1950s, most major North American railways began to phase out steam locomotives in favour of the more powerful, more efficient and cleaner diesel-electric locomotives.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Unknown.	Unknown.	▪ College Park Airport, "College Park Airport – The World's Oldest." ▪ U.S. Centennial of Flight Commission, "The Earliest Airports." ▪ U.S. Centennial of Flight Commission, "Government Funding of Airports." ▪ American Society of Civil Engineers, "Cleveland Hopkins Airport."
Likely private.	Likely none.	▪ "Charles F. Kettering," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ HISTORY.com, "This Day in History: Charles Kettering receives patent for electric self-starter."
Likely private.	Likely none although the technology was adopted by many state-owned railways.	▪ Geoffrey Freeman Allen and Thomas Clark Shedd, "Locomotive," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ Locomotives and Trains, "Diesel locomotive first uses."

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1926	Liquid-fuelled Rocket	Robert Goddard (U.S.A.)	Type of jet propulsion engine that generates thrust from the controlled explosion resulting from the mixing of liquid fuel and oxidizer within a combustion chamber.	Commercial space transportation services began in the 1980s with the U.S. Space Shuttle offering to send commercial payloads into low Earth orbit. However, after Challenger disaster in 1986, the Space Shuttle was prohibited from launching commercial payloads which provided the private sector with opportunities to use expendable launchers such as Delta, Atlas and Titan to offer commercial payload launching services.
1939	Jet Aircraft	Frank Whittle (Great Britain); Hans von Ohain (Germany)	Whittle filed a patent for a jet aircraft engine in 1930, but his engine was not flown in a prototype aircraft until 1941. Von Ohain developed his own engine unaware of Whittle's experiments and his design flew in 1939.	Several military jet aircraft designs emerged during the mid-1940s, transforming air warfare. The first passenger jet aircraft was the De Havilland Comet (1952) but the turning point for the commercial viability of commercial jet airlines was the introduction of the Boeing 707 (1957) and Douglas DC-8 (1958).
1940	Jeep	Bantam Car Company (U.S.A.)	The Bantam Car Company designed what became known as the Jeep in response to a U.S. Army request for a small multipurpose vehicle. It was an invaluable personnel carrier and facilitated the motorization of Western armies during the Second World War.	Following the Second World War, the Jeep design was manufactured for both military and civilian use, spawning an entire category of motor vehicle: the four-wheel drive off-road vehicle

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Private.	Government Program (most rocket development resulted from military and space exploration activities).	▪ NASA, Goddard Space Flight Center, "About Goddard." ▪ Worcester Polytechnic Institute, "The First Liquid-Fueled Rocket." ▪ HISTORY.com, "This Day in History: First liquid-fueled rocket."
Public and Private.	Development supported through government military expenditures in Great Britain, Germany and later, the United States.	▪ "Sir Frank Whittle," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ "Hans Joachim Pabst von Ohain," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ HISTORYnet.com, "Jet Aircraft Development" (originally published by *Aviation History* magazine, published online: 12 June 2006).
Public and Private.	Government Program.	▪ "Jeep," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ 4Wheel Drive Hardware, "Jeep History: The History of Jeep."

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1946	Computer	J. Presper Eckert and John Mauchly (U.S.A.)	The ENIAC was the first electronic computer capable of performing complex mathematical calculations and operations.	Commercial applications for the computer were led after 1945 by private firms such as IBM. As efforts to miniaturize and increase their power progress during the mid-20th century, computers were progressively integrated into most transportation technologies.
1942	Ballistic Missile	Werner von Braun and others (Germany)	The V-2 was the first rocket capable of being launched from a site on Earth, entering the upper reaches of the atmosphere and returning to another location on Earth while carrying an explosive payload.	While ballistic missile technology was primarily used for military applications after the Second World War, von Braun and other German researchers contributed to the American space program during the 1950s and 1960s.
1947	Supersonic Aircraft	Bell Aircraft Company (U.S.A.)	In 1947, Chuck Yeager in the Bell X-1 rocket aircraft became the first person to fly faster than the speed of sound in controlled level flight.	The Concorde supersonic jetliner was flown for the first time in 1969 and began scheduled commercial service in 1976. Funded jointly by the British and French governments, the Concorde proved difficult to operate profitably and was retired in 2003.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Public.	Government Program.	▪ "J. Presper Eckert, Jr.," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ "John W. Mauchly," *Encyclopædia Britannica, Encyclopædia Britannica Online Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ Jeffrey Shallit, "A Very Brief History of Computer Science," Written for CS 134 at the University of Waterloo, summer 1995. ▪ For an example of the application of information technology to a transportation sub-sector, see M. Kia, E. Shayan and F. Ghotb, "The importance of information technology in port terminal operations," Swinburne University of Technology, Melbourne, Australia.
Public.	Government Program.	▪ "Wernher von Braun," *Encyclopædia Britannica, Encyclopædia Britannica* Online *Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ NASA, "Wernher von Braun," *Marshall Space Flight Center History Office.* ▪ U.S. Centennial of Flight Commission, "The V-2 (A4) Ballistic Missile Technology."
Public and Private.	Government Program.	▪ Richard P. Hallion, "Supersonic Revolution" (originally published by *Aviation History* magazine, published online: 11 May 2011). ▪ British Airways, "Celebrating Concorde," *History and heritage.*

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1953	Practical Solar Cell	Gerald Pearson, Daryl Chapin, Calvin Fuller (U.S.A.)	Building on the research into photovoltaic cells conducted during the late 19th and early 20th centuries, Pearson, Chapin and Fuller demonstrated a silicon solar cell capable of a 6% energy conversion efficiency in direct sunlight.	The first commercially affordable solar cell was developed by Elliott Berman and the Exxon Corporation during the 1970s. In recent years, solar technology has been demonstrated in automobiles and has been increasingly used to generate electricity
1955	Container Ship	Malcom McLean	In 1955, McLean, a trucking operator, purchased a steamship company with the idea of using the ships to transport loaded truck trailers. In 1956, his firm began operations with the first container ship, the SS Ideal-X. Subsequent innovations led to standardized steel shipping containers and large container ships. Containerization yielded significant cost savings in loading and unloading ships.	McLean's firm, Sea-Land Industry, led the development of containerized shipping but progress was slow through the 1950s and 1960s due primarily to the lack of port infrastructure to handle containers. However, by the 1970s, Sea-Land was joined by numerous competitors and containerization became a major element in ocean shipping.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Unknown.	Unknown.	▪ AT&T Labs, "1954: The Solar Cell." ▪ John Perlin, "The Silicon Solar Cell Turns 50."
Private.	Likely limited to government spending on improvements to port facilities to handle containers.	▪ James Ferguson, "The First Container Ship Sets Sail, April 26, 1956," *Financial Times*, United Kingdom, 30 August 2008. ▪ Costamare Inc., "History of Container Shipping."

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1957	Satellite	Soviet Union	Sputnik I.	First commercial application of satellite technology was the communications satellite. The Communication Satellite Corporation (Comsat) was the first authorized by U.S. Congress in 1962 and set up as a private corporation. The first operational commercial satellite providing regular telecommunications and broadcasting services between the United States and Europe was Intelsat 1 (otherwise known as “Early Bird”). It was launched in 6 April 1965.
1961	Manned Space Flight	Soviet Union	Russian cosmonaut Yuri Gagarin became the first human to travel in space in April 1961 aboard the Vostok I.	NASA has recently commissioned a number of private aerospace corporations to develop a crewed space vehicle to be deployed by 2015 to service the International Space Station following the retirement of the Space Shuttle in 2011.
1964	Bullet Train	Japan	Operating at speeds of over 100 mph, the first Japanese Bullet Trains travelled on specially design rail rights-of-way between Tokyo and Osaka.	The Bullet Trains now provide the primary high speed rail service to most major Japanese cities. Similar high speed rail technology has been introduced in France (TGV), Germany, China and the Northeast United States (Amtrak Acela Express).
1969	Manned Moon Landing	United States	Apollo 11 was the first manned spacecraft to land on the surface of the Moon.	Moon exploration technology has not been commercialized to date.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Public.	Government Program.	▪ NASA, "Early History – First Satellites," *Jet* Propulsion *Laboratory, California Institute of Technology*.
Public.	Government Program.	▪ NASA, "Yuri Gagarin: First Man in Space." ▪ Commercial Spaceflight Federation.
Public	Government agencies and public corporations were the primary users and financial backers of this innovation.	▪ Central Japan Railway Company, "Outline: History and Overview of the Tokaido Shinkansen," *About the Shinkansen*. ▪ Yasuo Wakuda, "Japanese Railway History 10: Railway Modernization and Shinkansen," *Japan Railway and Transport Review*, No. 11.
Public research and funding with private sector industrial partners.	Government Program.	▪ "Apollo," *Encyclopædia Britannica, Encyclopædia Britannica* Online *Academic Edition*, Encyclopædia Britannica Inc., 2012. ▪ NASA, "The Apollo Program," *NASA* Histor *Program Office*.y

Year	Invention	Inventor(s)	Description	First Successful Commercial Application?
1969	Jumbo Jet	Boeing Company (U.S.A.)	First flown in 1969, the Boeing 747 was the first commercial jumbo jet capable of carrying over 500 passengers and crew over 6,000 miles non-stop.	The Boeing 747 was very successful commercially, being flown on long-haul flights by airlines around the world for over 40 years. In 2005, the Airbus A380 “superjumbo” was first flown. The A380 can carry over 850 passengers and crew and has recently entered commercial service with several airlines.
1981	Space Shuttle	NASA (U.S.A.)	The first space shuttle mission was launched in 1981. The space shuttle fleet revolutionized space travel as the reusable craft could carry large crews and cargo payloads into orbit and return to Earth under its own power.	The technology was used to carry numerous commercial satellites into orbit until Challenger disaster in 1986 forced NASA to cease providing commercial space services and focus on scientific and application missions, particularly the assembly of the International Space Station. The Space Shuttle program was retired in 2011 without a replacement program being developed.
2001	Segway Human Transporter	Dean Kamen (U.S.A.)	The Segway is the first self-balancing, electric personal transportation machine. Featuring two wheels, it is balanced by a computer and operated by a rider who accelerates and decelerates the vehicle by shifting weight fore and aft.	Although it attracted significant media attention after it was introduced, the Segway was not a major commercial success.

Funding of Invention (Public, Private or Both)	Role of Government in Invention	Selected References
Likely private and public.	Likely some	▪ Boeing, "747 Commercial Transport," *History*. ▪ U.S. Centennial Flight Commission, "The Boeing 747."
Public.	Government Program.	▪ NASA, "Space Shuttle." ▪ NASA, "History of the Space Shuttle," *NASA History Program Office*. ▪ NASA, "The Historical Legacy," *MSFC History Office.*
Likely private.	Likely none.	▪ Segway, "Segway Company Milestones," *About Segway*. ▪ Transport Canada, "Technical Sheet – Segway i2," *ecoTRANSPORT: ecoTECHNOLOGY for Vehicles*. ▪ ICMR, "Segway – Still Off-balance?," *IBS Center for Management Research*. ▪ Ivo Tokarsky, "Segway Inc – Analysis of an innovation that failed to commercialize," 2011.

APPENDIX B
LIST OF WITNESSES

Organizations and Individuals	Date	Meeting
Department of Natural Resources	2012/02/28	23
Geoff Munro, Chief Scientist and Assistant Deputy Minister, Innovation and Energy Technology Sector		
National Research Council Canada		
Ian Potter, Vice-President, Engineering		
Paul Treboutat, Director General, Centre for Surface Transportation Technology		
Department of Industry	2012/03/01	24
Mitch Davies, Associate Assistant Deputy Minister, Science and Innovation Sector		
Mona Frendo, Director, Policy Coordination and Regulatory Affairs, Strategic Policy Sector		
Gerard Peets, Acting Director General, Marketplace Framework Policy Branch, Strategic Policy Sector		
Department of Transport		
Kristine Burr, Assistant Deputy Minister, Policy, Policy Group		
Marc Fortin, Regional Director General, Atlantic Region		
Department of Transport		
Jutta Paczulla, Director, Innovation Policy		
Marc Prévost, Director, Transportation Development Centre		
Canadian Propane Association	2012/03/06	25
Jim Facette, President and Chief Executive Officer		
Encana Corporation		
Sam Shaw, Vice-President, Natural Gas Policy Development		
Auto21 Inc.	2012/03/08	26
PeterR. Frise, Chief Executive Officer and Scientific Director, AUTO21 Network of Centres of Excellence		

Organizations and Individuals	Date	Meeting
Chrysler Canada Inc.	2012/03/08	26
Larry A. Robertson, Manager, Vehicle Environmental and Energy Programs, Engineering and Regulatory Affairs		
Delphi Group		
Bruce Dudley, Senior Vice-President		
Enterprise Holdings Inc.		
Ryan Todd, Vice-President, General Manager, Ottawa Group Headquarters		
Fleet Advantage Inc.		
David Dennis, Managing Director and Executive Vice-President, Business Development		
Mike Greene, President and Chief Executive Officer		
Canadian Trucking Alliance	2012/03/13	27
David Bradley, President and Chief Executive Officer		
Ron Lennox, Vice-President, Trade and Security		
Geoffrey Wood, Vice-President, Operations and Safety		
Groupe Robert		
Claude Robert, President and Chief Executive Officer		
Canadian Transportation Equipment Association	2012/03/15	28
Don Moore, Executive Director		
Calgary Transit	2012/05/01	33
Russell Davies, Manager, Transit Fleet		
Magna International Inc.		
David Pascoe, Vice-President of Corporate Engineering, The Americas, Global Headquarters		
Canada Aviation and Space Museum	2012/05/03	34
Rénald Fortier, Curator		
Stephen Quick, Director General		
ISO Polar	2012/05/08	35
Barry Prentice, President		
Livingstone Range Consulting Services		
Stuart Russell, President		
Moose Cree First Nation		
Guy S. Ginter, Acting Director, Impact and Benefit Agreement		

Organizations and Individuals	Date	Meeting
Discovery Air Innovations	2012/05/10	36
Brian Bower, Vice-President, Fleets and Engineering		
Discovery Air Innovations		
Garry Venman, Vice-President, Government Services		
Top Aces Inc.		
Didier Toussaint, President and Chief Executive Officer		
WestJet Airlines Ltd.		
Geoffrey Tauvette, Director , Fuel and Environment		
Westport Innovations Inc.	2012/05/15	37
Jonathan Burke, Vice-President, Global Market Development		
Canadian Gas Association	2012/05/17	38
TimothyM. Egan, President and Chief Executive Officer		
Canadian Natural Gas Vehicle Alliance		
Alicia Milner, President		
Compression Technology Corporation		
Tim Sanford, Director of Sales		
Société de gestion et d'acquisition de véhicules de transport	2012/05/29	39
Serge Carignan, Director, Engineering and Technical Services		
Société de transport de Montréal		
François Chamberland, Director , Engineering Service, Operation		
Étienne Lyrette, Corporate Advisor, Governmental Affairs, External Relations and Strategic Planning		
NAV CANADA	2012/05/31	40
JohnW. Crichton, President and Chief Executive Officer		
New Flyer Industries Inc.	2012/06/05	41
Chris Stoddart, Vice-President of Engineering		
Nova Bus, a Division of Volvo Group Canada, Inc.		
René Allen, Vice-President , Product Management and Strategy, Business Development		
Jean-Pierre Baracat, Vice-President, Business Development		

Organizations and Individuals	Date	Meeting
Canada Post Corporation	2012/06/07	42
Steve Clark, Director, Fleet Management		
Maxquip		
Cameron Stewart, President		
Roush Cleantech		
Todd Mouw, Vice-President, Alternative Fuels		
Canadian National Railway Company	2012/06/12	43
Dwight Tays, Chief, Engineering Technology		
Canadian Pacific Railway		
Mike Roney, General Manager, Technical Standards		
National Steel Car Limited		
GregoryJames Aziz, Chairman and Chief Executive Officer		
Michael Hugh Nicholson, Executive Vice-President, Marketing, Sales and Quality		
Peter Leigh Scott, Regional Vice-President, Marketing and Sales		
Railway Association of Canada		
Michael Bourque, President and Chief Executive Officer		
Mike Lowenger, Vice-President, Operations and Regulatory Affairs		
Blueprint Energy Inc.	2012/10/04	45
Greg Tarasco, President and Chief Executive Officer		
HD-Petroleum Inc.		
Todd Habicht, President and Chief Executive Officer		
Jack Winram, Vice-President		
Invotronics Inc.		
Earl Hughson, President and Chief Executive Officer		
Better Place	2012/10/16	46
Jason Wolf, Vice-President, North America		
Bombardier Inc.		
Paul Larouche, Director, Marketing and Product Planning, Bombardier Transportation North America		

Organizations and Individuals	Date	Meeting
Bombardier Inc.	2012/10/16	46
Pierre Seïn Pyun, Vice-President, Government Affairs		
GF Rail Consulting		
GarryD. Fuller, President		
Paladin Consulting		
GeorgeP. Binns, Equipment Engineer		
Réseau des ingénieurs du Québec		
Etienne Couture, President		
Jules Hébert, Senior Advisor, Communications and Public Affairs		
Benjamin Laplatte, Director, Strategic Development and Administrative Services		
Department of Finance	2012/10/18	47
Nicolas Blouin, Chief, Economic Development, Business Income tax Division		
Department of Natural Resources		
Carol Buckley, Director General, Office of Energy Efficiency		
Department of the Environment		
Steve McCauley, Director General, Energy and Transportation		
Department of Transport		
Luc Bourdon, Director General, Rail Safety		
MartinJ. Eley, Director General, Civil Aviation		
Gerard McDonald, Assistant Deputy Minister, Safety and Security		
Jutta Paczulla, Director, Innovation Policy		
Merz Rustom, Director, Motor Vehicle Standards, Research and Development		
Department of Finance	2012/10/23	48
Nicolas Blouin, Chief, Economic Development, Business Income tax Division		
Department of Indian Affairs and Northern Development		
Gail Mitchell, Director General, Community Infrastructure Branch, Regional Operations Sector		

Organizations and Individuals	Date	Meeting
Department of Natural Resources	2012/10/23	48
Carol Buckley, Director General, Office of Energy Efficiency		
Department of Public Works and Government Services		
Shereen Benzvy Miller, Director General, Office of Small and Medium Enterprises and Strategic Engagement - Acquisitions Branch		
Pablo Sobrino, Associate Assistant Deputy Minister, Acquisitions Branch		
Department of the Environment		
Steve McCauley, Director General, Energy and Transportation		
Department of Transport		
Walter Carlson, Director of Equipment and Operations		
Gerard McDonald, Assistant Deputy Minister, Safety and Security		
Jutta Paczulla, Director, Innovation Policy		
Merz Rustom, Director, Motor Vehicle Standards, Research and Development		

APPENDIX C
LIST OF BRIEFS

Organizations and Individuals
Auto21 Inc.
Canadian Canola Growers Association
Canola Council of Canada
Department of Industry
Department of Natural Resources
Department of Transport
Discovery Air Innovations
Encana Corporation
Maxquip
National Steel Car Limited
Railway Association of Canada
Société de transport de Montréal

REQUEST FOR GOVERNMENT RESPONSE

Pursuant to Standing Order 109, the Committee requests that the government table a comprehensive response to this Report.

A copy of the relevant *Minutes of Proceedings* (Meetings Nos. 23, 24, 25, 26, 27, 28, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 45, 46, 47, 48, 49, 53, 55, 56, 57 and 58) is tabled.

Respectfully submitted,

Larry Miller, M.P.

Chair

STANDING COMMITTEE ON TRANSPORTATION, INFRASTRUCTURE & COMMUNITIES STUDY ON EMERGING TECHNOLOGIES: NDP MINORITY REPORT RECOMMENDATIONS

Emerging technologies in transportation provides a number of opportunities that the Federal Government should be capitalizing on — in job creation (especially well-paying green jobs), reducing greenhouse gas (GHG) emissions, and better protecting the safety of Canadians. These opportunities are critical in terms of both economic growth and the well-being of Canadians. It is the NDP's view that the Federal Government, particularly Transport Canada, must become pro-active in realizing these opportunities.

Technological change, driven in part by rising fuel costs and pressure to reduce GHG emissions, leads to new jobs — green jobs — not only to meet Canada's domestic market but also in creating exports to other countries facing the same transportation challenges that Canada faces. The Committee's study shows that emerging technologies in the transportation sector provide significant opportunities for job creation for Canadians if the Federal Government moves to support these technologies through investment and appropriate regulation.

Canada's NDP strongly believes that one of the means of reducing greenhouse gas emissions — the major contributor to climate change in our world — is through promoting green technologies that reduce fossil fuel consumption and provides for alternative (and safer) fuels. This is important, as Canada's transportation sector contributes 27% of greenhouse gas emissions in Canada. As well, in an increasingly complex world Canada's NDP strongly supports the adoption of new technologies to better safeguard Canadians from transportation mishaps.

As a result of the presentations made to the Standing Committee on Transportation, Infrastructure & Communities during its study on emerging technologies, it became clear that the Federal Government, in particular Transport Canada, needed to provide leadership to better protect Canadians. Accordingly, Canada's New Democrats make the following 16 recommendations:

General

1. The Federal Government should provide leadership regarding the transition to green technology, and should create a Green Innovation Fund for emerging transportation technologies (similar to the Green Municipal Fund).

2. The Federal Government should develop a streamlined, long term strategy for research and development with clear and transparent funding criteria to help small- and medium-sized companies innovate in green transportation technologies.

Air

1. Transport Canada should consult with stakeholders and assess where GPS landing approaches are not in place across Canada and ensure the timely installation of this life-saving technology.

2. Transport Canada should support research and development of advanced noise mitigation technology and put into place incentives for the installation of noise-mitigation equipment at airports across Canada.

3. Transport Canada should implement stricter quality standards for on-board GPS databases in order to address recurring problems with data lags and errors in identifying key landing features such as flight height, direction, etc.

On-Road Vehicles

1. Transport Canada should make electronic stability control and electronic logging devices mandatory for commercial trucks.

2. Transport Canada should make the installation of truck sideguards mandatory on heavy trucks within a year.

3. The Federal Government should streamline the SR&ED tax credit application process in order to facilitate participation by small- and medium-sized manufacturers, and extend this tax credit on a multi-year basis.

4. Transport Canada should facilitate harmonization of Canadian safety standards with EU regulations to facilitate the importation of European vehicle technology and products.

5. In order to ensure that vehicle batteries and charging systems are eventually available at a price and with an energy density that is affordable and practical for the vast majority of consumers, from transit agencies to individuals, the Government of Canada should encourage Canadian companies working on vehicle battery systems, storage elements and charging.

Rail

1. The Federal Government should encourage the conversion of urban transit systems from fossil fuel-based systems to electrified systems (as is planned for Montreal).

2. The Federal Government should honour its commitment to share the costs of infrastructure investments with other levels of government and maintain the existing formula of providing 1/3 of the funding required for electrifying urban commuter rail lines.

3. Transport Canada should strengthen the rules regarding the use of railroads for passenger service in Canada by :

   a) requiring railroads to give priority status to passenger systems where systems are shared with freight;

   b) requiring railroads to allow the electrification of rail systems for electric passenger rail; and

   c) developing a made-in-Canada regulatory approach (rather than mirroring US regulatory regimes) in order to allow European-style railroads and Positive Train Control (PTC) systems which meet Canadian standards to operate in Canadian urban rail systems.

4. Transport Canada should create regulations to permit the operation of innovative electric transit systems, including battery, flywheel, contactless charging, etc.

5. Transport Canada should encourage innovation in electric vehicle systems through improved regulations and direct subsidy for demonstration projects.

6. Transport Canada should make voice recorders in locomotive cabs mandatory to improve rail safety by April 2013 (acting on a Transportation Safety Board (TSB) recommendation made 9 years ago)

7. Transport Canada should review the implementation hurdles for Positive Train Control (PTC) in Canada, its benefits and costs, and formulate a five-year strategy for phasing in this life-saving technology.

LIBERAL PARTY OF CANADA DISSENTING OPINION

The Liberal Party of Canada is generally supportive of the recommendations in this report of the Standing Committee on Transport, Infrastructure and Communities regarding innovative transportation technologies. We are aware that new transportation technologies are under development and that they can be marketed commercially while pursuing the twin goals of reducing polluting emissions and enhancing the efficiency and safety of ground and air transportation in urban and rural areas and the Far North.

We disagree on two fronts. First, we believe the federal government has a role to play in developing new technologies. Unlike the current government, which swears by the private sector alone, we think that the Government of Canada must, as much as it can, continue to provide financial support to entrepreneurs or research centres that are working to develop new technologies or substantially improve on existing ones. In addition, the Government of Canada can and must be a driving force behind research and development in new technologies, in cooperation with the provinces, universities and other private partners.

Our second disagreement concerns urban public transit and, more specifically, the electrification of public transit systems. According to the Department of Human Resources and Skills Development, the proportion of Canadians living in urban areas has increased continually since 1867. In 2011, some 27 million Canadians (81%) lived in urban areas. (An urban area is defined as an area that is home to at least 1,000 people overall and no fewer than 400 people per square kilometer.) Canada's three largest urban areas — Toronto, Vancouver and Montreal — account for just over one third (35%) of the Canadian population. Electricity is the cleanest form of energy, and we sincerely believe that the federal government has a duty to provide funding to major cities looking to electrify their public transit systems. Electrification will substantially reduce greenhouse gas emissions and decrease noise pollution.