



AUTOMOTIVE INNOVATION FUND

AUDIT AND EVALUATION BRANCH

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and Evaluation Committee on March 29, 2018

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LIST OF ABBREVIATIONS AND ACRONYMS

AIF	Automotive Innovation Fund
CAFE	Corporate Average Fuel Economy
Ford	Ford Motor Company of Canada
GDP	Gross Domestic Product
Honda	Honda of Canada Manufacturing
ICT	Information and Communications Technology
ISED	Innovation, Science, and Economic Development Canada
Linamar	Linamar Corporation
Magna	Magna International
NAFTA	North American Free Trade Agreement
OAG	Office of the Auditor General
OECD	Organisation for Economic Co-operation and Development
PERDC	Powertrain Engineering and Research and Development Centre
R&D	Research and Development
SIF	Strategic Innovation Fund
Toyota	Toyota Motor Manufacturing Canada
VOC	Volatile Organic Compounds

LIST OF FIGURES

FIGURE 1: DISTRIBUTION OF AIF COMMITTED CONTRIBUTION, BY FIRM (\$ MILLIONS)

FIGURE 2: AUTOMOTIVE INNOVATION FUND LOGIC MODEL

EXECUTIVE SUMMARY

PROGRAM OVERVIEW

The Automotive Innovation Fund (AIF) was launched in 2008 to fund large-scale private research and development (R&D) and manufacturing projects. It was designed to strengthen the competitiveness of the automotive industry in Canada by building R&D capacity and serving as a catalyst for private sector investments.

In 2008, the Government provided the AIF with an initial program budget of \$250 million over five years. The program was renewed in 2013 with an additional \$250 million. In 2014, the Government added a further \$500 million to the program budget. In 2017-18, AIF funding was consolidated into the Strategic Innovation Fund.

The AIF funded ten projects between 2008-09 and 2016-17 with five companies (Ford, Toyota, Linamar, Honda and Magna). The total committed funding was \$569.8 million and as of March 31, 2017, the program disbursed \$341.3 million.

EVALUATION PURPOSE AND METHODOLOGY

The objective of this evaluation was to address the issues of relevance and performance in accordance with the *Policy on Results*. It was calibrated to focus on the extent to which the AIF contributed to its expected longer-term results, as the 2012 evaluation concluded that the program had achieved its immediate outcomes. The evaluation employed four data collection methods: a document and literature review, a project document and data review, interviews and case studies.

FINDINGS

RELEVANCE

Canada's automotive sector is of strategic importance to the Canadian economy and there is a demonstrable need for a program to build R&D capacity and continue to support a strong automotive sector.

PERFORMANCE

Evidence showed AIF funding played a significant role in enhancing automotive sector R&D in Canada. It secured R&D investments that contributed to the development, production and commercialization of innovative products and to production efficiency gains. It also enhanced R&D capacity through collaborations between automotive manufacturers, major suppliers, and research institutions.

It is not possible to conclusively assess the achievement of environmental benefits but based on available information, it appears that the AIF made a more limited contribution on this front. This was primarily through the development of clean technologies to improve fuel efficiency and reduce the environmental impact of vehicle manufacturing.

By attracting and retaining investment, the AIF helped to strengthen the competitiveness of the Canadian automotive industry. It assisted in securing the automotive footprint, retaining product mandates from parent companies and contributed to job retention and creation.

In terms of factors that facilitate the achievement of outcomes, interviewees noted that the recent amendments to and flexibility of the program terms and conditions, the highly skilled Canadian workforce, and the partnership with the Government of Ontario assisted the AIF in achieving its intended outcomes. Other factors, such as stiff jurisdictional competition, government taxation policy, and the lengthy payment process can act as impediments.

LESSONS LEARNED

Given that the AIF was terminated, the following lessons learned were developed to inform the design and delivery of grant and contribution programs providing support to key sectors of the Canadian economy, including the Strategic Innovation Fund.

Lesson Learned 1: Flexible and Responsive Programming

Industry support programs that are flexible and responsive have a greater chance of achieving their intended outcomes. For the AIF, flexible terms and conditions allowed programming to be adapted to each company's particular needs. Changes to the funding mechanism, for example from repayable to non-repayable contributions, also allowed the AIF to respond to changing conditions in the industry.

Lesson Learned 2: Performance Measurement and Reporting

Performance measurement to inform medium- and longer-term outcomes needs to be planned from the inception of a program and data should be collected on an ongoing basis to ensure performance and impact can be fully assessed. Programs need to identify common indicators and clear definitions across projects and ensure participating firms provide the required information as part of their agreements for government support.

1.0 INTRODUCTION

1.1 REPORT OVERVIEW

This report presents the results of an evaluation of the Automotive Innovation Fund (AIF). The purpose of the evaluation is to assess the relevance and performance of the AIF. The report is organized into four sections:

- Section 1 provides the program context, description, target population and stakeholders, and logic model;
- Section 2 presents the evaluation context and evaluation methodology, along with a discussion of the evaluation limitations;
- Section 3 presents the findings; and
- Section 4 summarizes the conclusions and lessons learned.

1.2 PROGRAM CONTEXT

The AIF was launched in 2008 in the aftermath of the economic downturn, alongside major financial assistance for restructuring of the automotive industry in Canada. It provided repayable funding for automotive R&D and manufacturing projects valued at more than \$75 million¹ that involved advanced, innovative, and/or clean technologies. To improve its effectiveness, the program terms and conditions were amended in June 2016 to allow for non-repayable contributions and to expand the list of eligible costs to include land and buildings.

In Budget 2017, the Government of Canada announced the Strategic Innovation Fund (SIF). The Fund consolidates and simplifies direct funding support programs for the automotive, aerospace and defence sectors (specifically, the AIF, Automotive Supplier Innovation Program, Strategic Aerospace and Defence Initiative, and Technology Demonstration Program), and expands funding to all sectors. As a result, the AIF was officially closed for new applications on June 30, 2017.

1.3 PROGRAM DESCRIPTION

The AIF was created to fund large-scale private research and development (R&D) and manufacturing projects in order to help strengthen the competitiveness of the automotive industry in Canada.

¹ Originally this amount was \$300 million and changed to \$75 million in 2009.

The objectives of the AIF were to:²

- Build automotive R&D capacity in Canada and secure knowledge-based jobs through the growth of a strong automotive industry;
- Enhance the government's inclusive innovation, science and technology, and environmental agendas;
- Support the development and/or implementation of innovative, fuel efficient technologies and processes;
- Promote long-term economic benefit to Canada including significant job creation/retention; and
- Serve as a catalyst for private sector investments to foster Canadian competitiveness, including investments in production equipment or processes and next-generation manufacturing technologies.

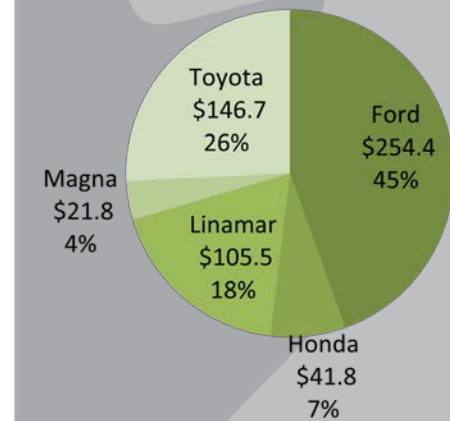
AIF Project Highlights as of March 31, 2017:

- 10 funded projects since 2008.
- 5 participating companies (Ford, Toyota, Linamar, Honda, Magna).
- The Government of Canada committed \$569.8 million to projects.
- Funding commitments for each project range from \$16.9 million to \$102 million.

The initial program budget was \$250 million over five years (2008–09 to 2012–13). The program was renewed in January 2013 with an additional \$250 million available over the next five years. In February 2014, the Government added a further \$500 million to the program budget. In 2017-18, AIF funding was consolidated into the Strategic Innovation Fund, which has a total budget of \$1.26 billion from 2017-18 to 2021-22.

In total, the AIF provided funding for ten different projects between 2008-09 and 2016-17 with five companies (Ford Motor Company of Canada, Toyota Motor Manufacturing Canada, Linamar Corporation, Honda of Canada Manufacturing and Magna International). This represented \$569.8 million in federal funding commitments (see Annex A for a description of the projects). In addition, the Government of Ontario committed \$577 million and the funding recipients committed \$4.9 billion, bringing the total committed funding from all sources to \$6.0 billion. As of March 31, 2017, the AIF disbursed a total of \$341.3 million.

Figure 1: Distribution of AIF Committed Contributions, by Firm (\$ millions):



1.4 TARGET POPULATION AND STAKEHOLDERS

The AIF targeted major automotive manufacturers and the automotive supplier community. Knowledge-based workers in the automotive industry, including future workers enrolled in colleges and universities, were expected to benefit from the opportunities created by AIF projects, as were research institutions, universities and colleges.

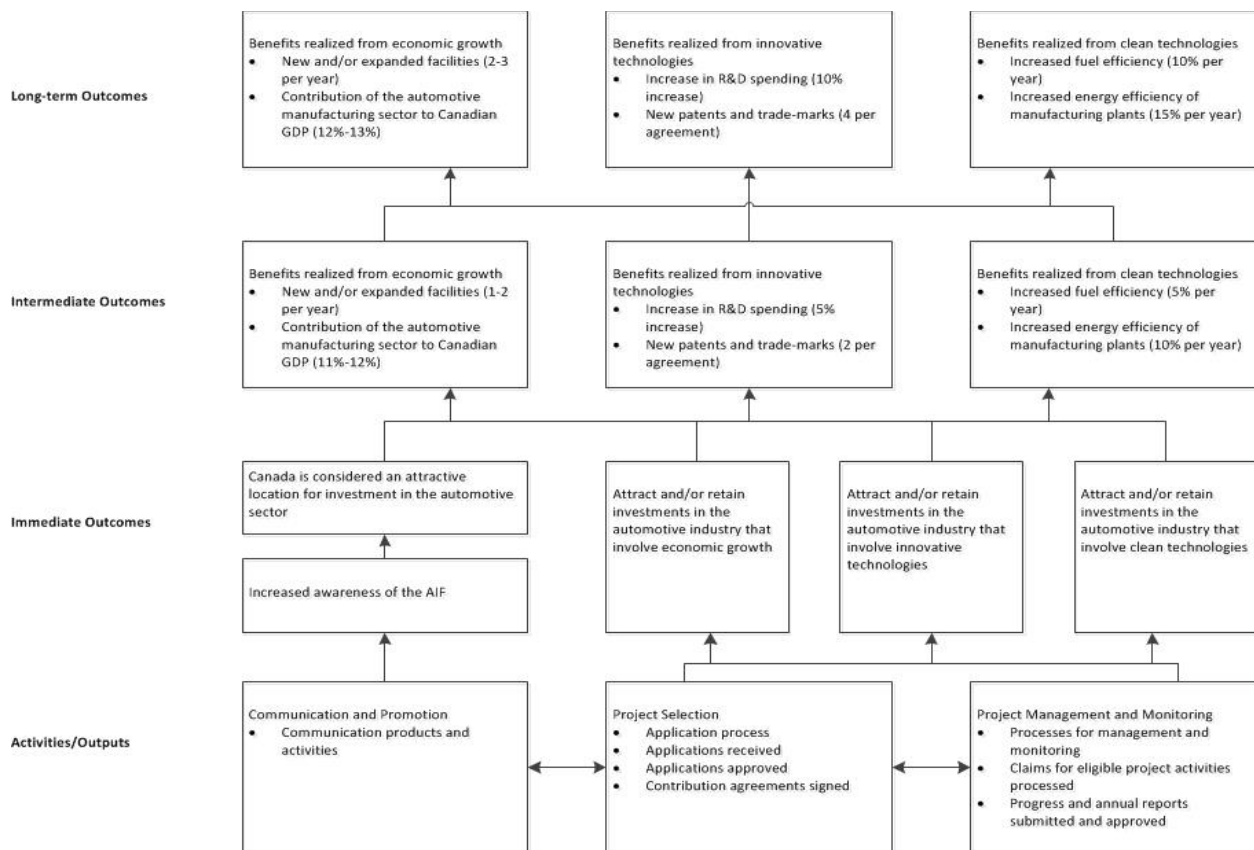
² Automotive Innovation Fund – program details and criteria, <https://www.ic.gc.ca/eic/site/aut-auto.nsf/eng/am02258.html>.

Other stakeholders included government organizations that support the automotive industry, including the National Research Council, the Natural Sciences and Engineering Research Council of Canada, Environment and Climate Change Canada, Natural Resources Canada, Global Affairs Canada, and regional development agencies. The provincial governments of Quebec³ and Ontario were also stakeholders as those provinces have significant employment in the automotive sector.

1.5 LOGIC MODEL

The AIF logic model is presented below (Figure 2). It provides a visual representation of the program’s activities, outputs and outcomes to show how the AIF was expected to achieve its objectives. The logic model was last updated in 2016, with targets expected to be realized many years later. The evaluation therefore did not assess the achievement of these specific targets and instead focused on progress towards the longer-term outcomes.

Figure 2: Automotive Innovation Fund Logic Model



³ According to *A Profile of the Automotive Manufacturing Industry in Canada, 2012-2016* by B. Sweeney (2017), there are approximately 4,000 people employed in automotive parts manufacturing in Quebec.

2.0 METHODOLOGY

This section provides information on the evaluation context, approach, objective and scope, the evaluation issues and questions that were addressed in this evaluation, the data collection methods, and limitations for the evaluation.

2.1 EVALUATION CONTEXT

An evaluation of the AIF was conducted in 2012-13.⁴ It concluded that the AIF had largely achieved its immediate results. The target population was aware of and understood the program, duplication between the AIF and Ontario application processes was minimized, and participating firms had leveraged other sources of funding and were undertaking innovative technology and R&D mandates in Canada related to fuel efficient vehicle production. The AIF had also encouraged Canadian companies to make further investments in facilities, product lines, and/or R&D facilities. The evaluation concluded that the AIF was on track to achieve its expected outcomes.

In 2014, an Office of the Auditor General (OAG)⁵ report noted that except for the 2012 evaluation, ISED had not compiled the performance information it received from participating firms to determine if the program was achieving its long-term objectives. The OAG report recommended that ISED continue to monitor the performance of the projects and use this information to report on whether the AIF is achieving its long-term objectives of bringing innovation, environmental, and economic benefits to Canada, and fostering the competitiveness of the automotive sector. ISED's response to the OAG report was that the organization would continue to monitor the performance of the AIF projects and would report on program results in a 2017-18 evaluation.

2.2 EVALUATION APPROACH

The evaluation was managed and conducted by ISED's Audit and Evaluation Branch and adopted a goal-based approach, addressing the program's stated longer-term outcomes.

2.3 OBJECTIVE AND SCOPE

An evaluation of the AIF was required to be completed in 2017-18 to address the issues of relevance and performance in accordance with the Treasury Board *Policy on Results* and the *Financial Administration Act*. Given that the 2012 evaluation concluded the program had largely achieved its immediate outcomes, this evaluation focused on the extent to which the AIF contributed to its expected longer-term results. It also examined the extent to which the program addressed a demonstrable need.

⁴ *Evaluation of the Automotive Innovation Fund, Final Report*, Industry Canada, October 2012

⁵ *Chapter 5 – Support to the Automotive Sector*, 2014 Fall Report of the Auditor General of Canada

The evaluation examined nine projects, eight of which were funded from 2009 to 2015 as well as one project funded in 2017 (Ford Caribou), since this project was related to earlier Ford projects funded by the AIF.⁶ The other project funded in 2017 (Honda 13th Mid Term project) was excluded from the evaluation scope as it was too early to assess its results.

2.4 EVALUATION ISSUES AND QUESTIONS

The evaluation addressed the following questions:

Relevance

1. To what extent did the AIF address a demonstrable need?

Performance

2. To what extent has the AIF contributed to realizing benefits from innovative technologies?
3. To what extent has the AIF contributed to realizing benefits from clean technologies?
4. To what extent has the AIF contributed to realizing economic benefits?
5. Have there been any factors that facilitate or hinder the achievement of outcomes?

2.5 DATA COLLECTION METHODS

Multiple lines of evidence were used to address the evaluation questions. The data collection methods included a program document and literature review, a project document and data review, interviews, and case studies of AIF projects. The Audit and Evaluation Branch conducted three of the four lines of evidence, with a consultant conducting the case studies.

Document and Literature Review

Program and departmental documents were reviewed to provide insight into the relevance and performance of the program, as well as to gain an understanding of any modifications made to the AIF since its last evaluation in 2012. In light of the creation of the Strategic Innovation Fund, the document review also provided insight into the policy priorities of ISED and the government as a whole. The literature review provided the context and profile of the automotive industry.

Project Document and Data Review

Project documents and data related to the AIF projects were reviewed to assess the results of the program, including due diligence reports, progress reports, and annual performance reports.

Interviews

The objective of the interviews was to gather in-depth information on the automotive sector and AIF projects from a range of stakeholders. Interviews were semi-structured in nature and were conducted with the following stakeholder groups:

⁶ While the Magna Changing Gears project (2012-2015) was included in the scope of this evaluation, limited reporting meant that it was not possible to draw any conclusions about the results it achieved. At the time of the evaluation, Magna had only accessed a portion of the funding available under its agreement with ISED.

-
- Program staff and senior management (7),
 - Automotive industry experts (4), and
 - A representative of the Ontario government.

Case Studies

Three case studies were conducted as part of this evaluation to assess progress towards the longer-term results as well as factors that facilitate or hinder success. Two of them, the Ford Renaissance project (2009) and the Linamar Green and Fuel Efficient Powertrain project (2010), were follow-up case studies from the 2012 evaluation. The third case study focused on the Toyota Green Light project (2012). These projects were selected because they encompassed three of the five companies that received funding through the AIF. They were also more likely to have realized longer-term impacts because they had been underway for at least five years.

2.6 LIMITATIONS

Weak Performance Reporting

Participating firms were asked to self-report, on an annual basis, performance-related information for their projects. While ISED provided templates for these reports, they were not well-defined and the reporting was often incomplete. This was especially true for reporting related to environmental benefits, rendering it difficult to determine if, and to what extent, such benefits have been realized. Further, the program lacked standardized methods of measuring benefits, such as the number of jobs created and retained. These gaps made it difficult to roll up the reporting provided at the individual project level. This was consistent with the findings of the 2014 OAG report, where it was found that the program did not regularly compile and analyze the performance information provided by participating firms to report on whether the AIF as a whole was achieving its expected results. To help mitigate these issues a project document and data review, as well as case studies, were used to validate and help interpret the performance information.

Program Maturity

The longer-term impact of large-scale projects, such as the ones funded under the AIF, may extend many years beyond the project life-span. It has been nine years since the AIF was created. As four projects were funded by March 2012, only these four projects have been underway for at least five years. Further, four of the nine projects reviewed are still active. Therefore, not enough time has elapsed for these projects to have fully realized their longer-term impacts.

Attribution

While project results may be more clearly linked to the performance of the firms, they may be less directly attributable to the automotive industry and to the economy at large. In addition, the AIF program is one of many factors that could have affected the longer-term success of the industry, making it challenging to directly attribute AIF support to impact on the industry.

3.0 FINDINGS

3.1 RELEVANCE

3.1.1. *To what extent did the AIF address a demonstrable need?*

Key Finding: Canada's automotive sector is of strategic importance to the Canadian economy and there is a demonstrable need for a program to build R&D capacity and continue to support a strong automotive sector.

The evaluation examined whether there is a need for government support for R&D and manufacturing projects in the automotive sector and whether the AIF met that need. The 2012 AIF evaluation concluded that there was a continued need for the AIF, as Canada has become a high-cost jurisdiction for automotive manufacturing, and investment is needed for Canada to be competitive in the sector. Further, as automotive and parts manufacturers must continue to adapt to changes in environmental standards and consumer demand, there is a need for support focusing on R&D initiatives to develop and build greener, more fuel-efficient vehicles.

The current environment suggests that the AIF addresses a demonstrable need, as the challenges noted in the 2012 evaluation (i.e., environmental concerns, changing consumer demand, and competition for automotive manufacturing investments) remain. In terms of the latter, increasing global competition for securing automotive manufacturing plants (via government infrastructure funding assistance, incentives, tax breaks, etc.), particularly from Mexico and the United States, has magnified the need for assistance for the Canadian automotive sector to help retain and grow R&D, employment and manufacturing.

Further highlighting the need for the AIF is the importance of Canada's automotive industry to the overall economy:

- 126,000 direct jobs⁷, with each automotive manufacturing job estimated to create more than five additional jobs;⁸
- \$9.6 billion in wages to workers;
- \$18.2 billion contribution to Gross Domestic Product (GDP); and
- \$86.5 billion in exports.⁹

It is one of the largest manufacturing industries in Canada, accounting for about 10 percent of manufacturing sector GDP.¹⁰ It is Canada's second largest export (after oil), representing almost 14 percent of total merchandise exports in 2017.¹¹

⁷ *Drive to Win: Automotive Advisor Report*, Réal Tanguay, 2018.

⁸ Statistics Canada

⁹ *Drive to Win: Automotive Advisor Report*, Réal Tanguay, 2018.

¹⁰ Source: Statistics Canada, CANSIM Table 379-0031, November 2017 data.

¹¹ This is based on the combined value of exports for: (1) automobile and light-duty motor vehicle manufacturing; (2) motor vehicle parts manufacturing; and (3) motor vehicle body manufacturing. Source: Statistics Canada Trade Data Online.

Canada is a significant automotive player, with Ontario representing one of the two largest automotive producing regions in North America (along with Michigan¹²), each producing about 2.3 million units in 2016¹³ or about a combined 26 percent of total North American production. Further, the automotive industry creates significant demand and spillover benefits in other industries. Automotive manufacturers purchase over \$45.7 billion in commodities (direct inputs), services and parts in Canada each year.¹⁴

The AIF has advanced and supported the automotive industry in Canada by investing strategically in R&D and manufacturing projects. The Program is aligned with Government of Canada and ISED objectives related to the development of innovation, environmental and economic benefits.

Going forward, the Strategic Innovation Fund will continue to provide support for projects and investments put forward by companies from a range of sectors, including automotive, to encourage and accelerate the development of innovative and/or growth-oriented initiatives.

3.2 PERFORMANCE

In addition to the AIF, the Government of Canada supported the automotive industry through the Program for Strategic Industrial Projects (the predecessor to the AIF) and the Automotive Supplier Innovation Program (2015 to June 2017). The Government of Ontario also launched the Ontario Jobs and Prosperity Fund in 2015 (Annex B). Cumulatively, these and other initiatives, including the AIF, have supported innovation, clean technology and economic growth of the automotive industry. The following findings should be viewed within this broader context of overall government support.

3.2.1 *To what extent has the AIF contributed to realizing benefits from innovative technologies?*

Key Findings: AIF funding played a significant role in enhancing automotive sector R&D in Canada. It secured R&D investments that contributed to the development, production and commercialization of innovative products and to production efficiency gains. It has also enhanced R&D capacity through collaborations between automotive manufacturers, major suppliers, and research institutions.

R&D Investments, R&D Activities and Commercialization

Based on available information, AIF projects appear to have encouraged significant investment in R&D. Information was available on R&D spending for three projects (Ford Renaissance, Ford Northern Star, and Linamar Transmission). The data showed that as of September 2017, those AIF projects had together supported \$237.9 million in new and retained R&D spending over nine years – surpassing their planned R&D spending by close to \$50 million.

¹² *Michigan Automotive Industry Update*, Center for Automotive Research, 2016.

¹³ *A Profile of the Automotive Manufacturing Industry in Canada, 2012-2016*, Automotive Policy Research Centre, Brendan Sweeney, 2017.

¹⁴ Source: Statistics Canada 2010 Input-Output Account.

As a point of comparison, business R&D spending by the entire automotive industry in Canada was \$215 million in 2016-17. However, despite the support of the AIF and other programs, automotive industry R&D spending in Canada is only half of what it was in 2008-09, when R&D spending totalled \$425 million.¹⁵

The document review showed that Ford has made the most significant commitments to R&D through its AIF projects, and has also produced the most significant results. Ford's Powertrain Engineering and Research and Development Centre (PERDC), funded by Project Renaissance in 2009 and then again in later projects, has evolved into an advanced research facility capable of testing a broad range of engine technologies. According to program reporting, the facility has become a global leader in engine testing for Ford. It operates 24 hours a day, with engines being sent in from all over the world for testing. Over the years PERDC's R&D mandate has expanded, with the Centre working in areas such as lightweight engine materials, alternative fuels, battery testing, and key areas of engine development and manufacturing processes. Under Ford's most recent project, the PERDC was tasked with key aspects of development, design and engineering of an important new engine for Ford. This makes the Windsor site, where PERDC is based, the only plant in Ford's global family responsible for the entire scope of engine-related activities, from R&D to production for one engine.

In addition, Ford's latest AIF project in 2017¹⁶ includes a multi-million dollar investment to establish a Connectivity Innovation Centre of Excellence that will bring together Ford's largest group of connectivity researchers outside of the United States. Work will focus on research and advanced technology for the next generation of vehicles. While the innovation benefits from this commitment have yet to materialize, the project is working towards vehicular connectivity.

Case study findings suggested that Linamar's *Green and Fuel Efficient Powertrain Project* (2010-2015) also led to a significant increase in R&D activity at the parts supply firm. Under the project, Linamar worked with North American manufacturers to develop and commercialize components of a 6-speed transmission to replace the 4-speed transmission previously used. Additional speeds allow for improved energy efficiency and control. The 6-speed transmission was adopted by all of Linamar's automotive manufacturing clients and many of the transmission components are now produced in Linamar facilities in Canada.

Linamar's later AIF project¹⁷ built on this work to develop components for more complex and more fuel-efficient 9- and 10-speed transmissions. As a result of this R&D, the company was able to more than double the amount of Linamar components included in the 9 and 10-speed transmissions compared to the earlier 6-speed version, resulting in an increase in revenue.

R&D Capacity – Intellectual Property and Collaboration

The document review indicated that the AIF also contributed to the development of intellectual property and research collaborations. There were patents, trademarks and/or industrial designs

¹⁵ Statistics Canada CANSIM Table 358-0024 and 358-0510. Due to a number of plant closures since 2008-09, the R&D spending declined along with it.

¹⁶ Project Caribou (2017)

¹⁷ Project Transmission (2015)

registered related to AIF projects, including 34 by Ford and 6 by Linamar. Ford also reported that PERDC published close to 100 research papers between 2012 and 2014. Toyota has not applied for intellectual property registration related to its AIF projects.

R&D capacity was further enhanced by the formation of collaborations and partnerships. For example, the Linamar case study showed that the company partnered with a wide range of suppliers on various aspects of R&D and production. It also collaborated with McGill University on research related to electric vehicles and McMaster University on coatings research. According to Ford, PERDC has collaborated with McMaster University, the University of Windsor, and the University of Toronto, and the company has hired graduates and PhD students from these schools. Toyota also committed to working with Canadian post-secondary institutions and R&D centres, and reported partnering with the University of Waterloo in hiring engineering students to support project activities. Additionally, interviewees noted that funding these types of large-scale R&D projects creates R&D spillover into the supplier community and, particularly with Ford's new Connectivity Centre of Excellence, the Information and Communications Technology (ICT) community.

Production Efficiency

In addition to R&D-related activities, the AIF also supported innovation related to production efficiency gains. According to industry experts, this is an area where Canada is known for innovation and leadership. Evidence showed that Toyota's three AIF projects focused largely on production efficiency. These projects contributed to the retooling of existing assembly lines to manufacture the new RAV4 and Corolla models. They also contributed to the modification of the Lexus assembly line to allow the production of both the Lexus RX350 and RX450h (hybrid) on one retrofitted "blended" assembly line. The modifications allowed for more efficient assembly of both the gas and hybrid Lexus models. Industry monitoring showed that Toyota's assembly line upgrades led to reductions in the time needed to produce a vehicle.¹⁸

The number of vehicles manufactured by Toyota also grew over the time period of the AIF projects. The production of the RAV4 nearly tripled from approximately 78,000 vehicles in 2009-10 to over 250,000 in 2016-17. Further production at Toyota's Cambridge facilities (including the Corolla, Lexus RX350 and Lexus RX450h) increased by 20% from 283,000 vehicles in 2008-09 to 351,000 in 2016-17.¹⁹ This demonstrates that Toyota produced approximately 25% of all vehicles manufactured in Canada.²⁰

¹⁸ WardsAuto Infobank

¹⁹ WardsAuto Infobank

²⁰ WardsAuto Infobank; *A Profile of the Automotive Manufacturing Industry in Canada, 2012-2016*, Automotive Policy Research Centre, Brendan Sweeney, 2017.

The innovations at Toyota's Canadian manufacturing facilities were recognized by its parent company. In 2013, Toyota Motor Manufacturing Canada had the distinction of being the first non-Japanese "global leader" for the Corolla manufacturing process. The Canadian team provided design and manufacturing guidance for Toyota plants all over the world for the Corolla model.

With regards to Ford, an engine plant in Essex, Ontario that had been planned for shutdown in 2007 was instead converted into a flexible manufacturing plant, in part due to AIF funding. This enabled the plant to produce any engine in Ford's North American mix, with the capacity to build 325,000 engines annually. Following its conversion, the plant was given the lead mandate to produce the 5.0L V8 engine used in Ford's F-150 truck and Mustang, two of Ford's flagship vehicles.

A later project²¹ contributed to a major conversion of Ford's Oakville Assembly Complex that added manufacturing flexibility and increased production efficiency via the introduction of a global vehicle platform. The platform allows the plant to switch production rapidly among 11 high-volume mid-sized vehicles²² in response to changing market conditions, thereby making the plant more competitive for future opportunities.

3.2.2 To what extent has the AIF contributed to realizing benefits from clean technologies?

Key Findings: It is not possible to conclusively assess the achievement of environmental benefits but based on available information, it appears that the AIF made a modest contribution. This was primarily through the development of clean technologies to improve fuel efficiency and reduce the environmental impact of vehicle manufacturing.

There was not enough evidence to conclusively assess the extent to which the AIF contributed to realizing environmental benefits. Available evidence suggests that the results of AIF support for clean technologies have been modest. That said, there are two areas where the AIF appears to have contributed to advances, specifically in increased fuel efficiency of vehicles and the greening of vehicle manufacturing.

Improved Fuel Efficiency of Vehicles

The document review indicated that all nine AIF-funded projects reviewed have components that involve improved fuel efficiency. For the most part, environmental innovation in fuel economy is driven by the need to meet increasingly stringent regulatory requirements, including

²¹ Projet Northern Star (2014).

²² Currently with this global platform, the plant has the ability to produce any combination of the four vehicles (Ford EDGE, Ford FLEX, Lincoln MKX et Lincoln MKT) on the same assembly line.

the United States Corporate Average Fuel Economy (CAFE) standards.

One of the most direct ways to improve fuel efficiency lies in lightweighting; that is, reducing the weight of vehicles through the development of lighter components. Of the nine AIF projects reviewed, at least seven had a lightweighting component and according to interviewees this is an area where Canadian-based producers are taking a global leadership role. Evidence showed that the AIF contributed to increasing Ford's capacity in this area through its ongoing support to PERDC. There is also evidence to show that AIF provided support for Linamar and Magna in their R&D efforts on lightweighting of car components.²³ Toyota's projects also involved the manufacture of lighter aluminum parts and the use of high-strength steel.²⁴

Ford also reported that the AIF Renaissance project contributed to the reduction of CO₂ emissions across North America, via the production of the lighter, more fuel efficient 5.0-liter V8 engine for use in the Mustang and the F-150 truck series. According to annual project performance reports, there were CO₂ emission reductions of 29,916 metric tonnes from the Mustang by 2013-14, and a cumulative reduction of 343,916 metric tonnes from the F-150 that same year. However, reporting on CO₂ reductions was not included in Ford's subsequent annual performance reports.

In addition, the AIF contributed to projects related to electric and hybrid technologies, which resulted in a reduction in vehicle fuel consumption:

- The AIF supported Toyota's pilot to produce a limited number (2,600 units) of the electric RAV4 vehicle in Canada through a partnership with Tesla under *Project Green Light*. This was Toyota's first electric vehicle manufactured in North America.
- In two subsequent projects, the AIF supported Toyota's production of the hybrid Lexus RX450h vehicle,²⁵ which was the only hybrid vehicle manufactured in Canada until 2016 (and the only Lexus produced outside of Japan). Based on data provided by the program, the production of the Lexus RX450h vehicle nearly tripled, from 3,646 units since it was first introduced in 2014-15 to 10,243 units in 2016-17. Comparing between pre- and post-AIF funding, the Lexus RX450h exhibits a fuel efficiency gain of about 2%²⁶, and if the volume of production continues to increase there may potentially be additional environmental benefits.
- Linamar worked on developing electric and hybrid driveline components throughout its two AIF-funded projects. With this work Linamar developed and is commercializing an eAxle (mainly for use in electric and hybrid vehicles, but it can be used in all vehicles). Linamar continues to develop a portfolio of eAxle solutions.

Greening of Automotive Manufacturing

There was evidence that the AIF contributed to the reduction of pollutants from automobile manufacturing. Toyota reported a reduction of the volatile organic compounds (VOCs) emissions in the paint operations at both its Woodstock and Cambridge manufacturing plants.

²³ Linamar – Project Transmission (2015), Magna – Changing Gears Project (2012).

²⁴ Toyota Project Green Light (2012), Project Innovation (2015)

²⁵ Toyota – Project Lexus (2013) and Project Innovation (2015).

²⁶ WardsAuto Infobank, Natural Resources Canada, Office of Energy Efficiency

In these projects, Toyota applied a new technique using water-based paint on manufactured vehicles. Traditional paints are solvent (chemical) based and lead to VOC emissions. According to the OECD, Canada is the third highest producer of VOCs of all OECD countries.²⁷

Ford has also been working on reducing its VOC emissions through AIF's contributions to the development of the "fumes to fuel" technology. This technology allows for waste fumes from its paint shop to be converted into fuel that can be used to generate electricity.²⁸ According to the literature review, Ford's use of this technology appears to be unique among automakers. The "fumes to fuel" technology is currently only being used within Ford, but once it is fully developed the company expects that it could be commercialized and applied to other industrial sectors.

Both Toyota and Ford reported that the AIF helped in making their manufacturing processes more efficient and environmentally sound, through the reduction of water, energy, and raw materials used (e.g. paint shops in Toyota's Woodstock and Cambridge plants, Ford's Essex Engine Plant), as well as a reduction in solid waste produced.

3.2.3 *To what extent has the AIF contributed to realizing economic benefits?*

Key Findings: By attracting and retaining investment, the AIF played a role in strengthening the competitiveness of the Canadian automotive industry. It assisted in securing the automotive footprint, retaining product mandates from parent companies and contributed to job retention and creation.

Attract and Retain Investment

To remain globally competitive, Canada needs to attract automotive investment. International automotive manufacturers and suppliers make investment decisions based on a multitude of factors of which government support could be one. There is evidence to indicate that the AIF contributed to attracting or retaining R&D and manufacturing investments in Canada.

Ford and Linamar indicated that without the financial support from the AIF, their parent companies might have chosen to conduct the supported projects in other countries, or these projects could have been reduced in scope and size, and/or delayed. Aside from the financial incentive, industry experts and program management uniformly agreed that through the AIF the government was signaling Canada's commitment to the success of the industry. In Toyota's case, this is considered particularly important because interviewees indicated that government involvement is one of the determining factors for the company in deciding where to invest.

Secure the Automotive Footprint

In Canada, the automotive industry is centred around its manufacturing plants, with global

²⁷ https://stats.oecd.org/Index.aspx?DataSetCode=AIR_EMISSIONS

²⁸ Prior to receiving support from the Government of Canada via the two projects under AIF (Northern Star – 2014, Caribou – 2017), Ford also received support for the "fumes to fuel" technology through the Centennial project (2004) under the Program for Strategic Industrial Projects.

Tier-1²⁹ automotive suppliers, smaller suppliers, and research institutions clustering in close proximity (mainly in Southwestern Ontario). This forms an ecosystem in which innovation and manufacturing activities are performed.

According to interviewees, the presence of the manufacturing plants and Tier-1 suppliers is crucial to anchoring the automotive footprint, because the existence of the smaller Tier-2 and Tier-3 suppliers hinges on the success of these larger players. This was reinforced when automotive manufacturers enacted policies a decade ago requiring suppliers to be located nearby their plants, for the purpose of just-in-time delivery,³⁰ a reduction in transportation costs, and responsiveness. An industry expert further noted that it is crucial to maintain a strong presence of manufacturing facilities, because without it, Canadian subsidiary firms will not be considered by their parent companies for R&D investment.

The impetus of the AIF was to provide support for large-scale R&D and manufacturing projects to contribute to the sustenance of the automotive footprint of the country. Industry experts noted the importance of the AIF in encouraging R&D, explaining that the AIF was one of the only automotive-specific government R&D funding mechanisms available. Evidence shows that the AIF also assisted Canadian companies to retain product mandates from their parent companies, and in the case of Tier-1 suppliers, assisted them to gain contracts from the manufacturers. The program was less successful in assisting the manufacturers to attract new product mandates. However, it contributed to the expansion of production and research facilities in the case of Ford's Essex and Windsor Engine Plants, PERDC, and the new Connectivity Innovation Centre.

Job Retention/Creation

A review of the AIF contribution agreements indicated that six projects out of the nine had specific job target commitments.³¹ With these commitments, companies agreed to maintain and create jobs in the facilities involved in the projects, and/or to maintain the company's footprint in their Ontario facilities. These job target commitments ranged in length from seven years to more than ten years. While the commitments for all six projects are still ongoing, reports from Ford, Linamar, and Toyota show that they have been successfully fulfilling their job targets. Further, Ford and Linamar have been substantially exceeding their job targets.

According to Statistics Canada, there is a job multiplier effect in the automotive manufacturing industry, such that every Canadian automotive manufacturing job supports more than five other jobs and each job at an automotive parts supplier supports almost two additional jobs. This means that the job retention and creation impact of the AIF-funded projects may be magnified beyond the direct jobs at recipient facilities.

²⁹ Tier 1 suppliers supply directly to the manufacturers, and are responsible for delivery of finished parts and product R&D. Tier 2 suppliers produce sub-assembly parts (that is, assembled units to be incorporated with other components of a finished part). Tier 3 suppliers supply engineered materials and special services, such as rolls of sheet steel, bars and heat treating, surface treatments. (https://www.ic.gc.ca/eic/site/auto-auto.nsf/eng/h_am00614.html#T)

³⁰ Just-in-time delivery refers to the manufacturers' attempt to increase efficiency and decrease waste by receiving automotive-parts only as they are needed in the production process, thereby reducing inventory costs.

³¹ These six projects include the three Ford projects, one Linamar project (Transmission), and two Toyota projects (Lexus, Innovation). The other three projects examined do not have job targets specified.

Due to the lack of standardized reporting, the evaluation was unable to calculate the total number of jobs retained and created through AIF support to date. However, program reporting did show that both Ford's PERDC and Linamar have seen an increase in the number of R&D specialists employed. Before the AIF, PERDC was scheduled to eliminate 24 research and engineering jobs, and in 2017, had 49 employees. At Linamar, the number of scientists, engineers and technologists nearly tripled from 116 in 2009 to 291 in 2016.

3.2.4 *Have there been any factors that facilitate or hinder the achievement of outcomes?*

Key Findings: Recent amendments to and flexibility of the program terms and conditions, the highly skilled Canadian workforce, and the partnership with the Government of Ontario assisted the AIF in achieving its intended outcomes. Other factors, such as stiff jurisdictional competition, government taxation policy, and the lengthy payment process can act as impediments.

Program officials, industry experts, and funding recipients interviewed identified the following factors that facilitate and hinder the achievement of outcomes.

Facilitating

With regards to program terms and conditions, there were some elements that facilitated the achievement of outcomes. The introduction of a non-repayable contribution as an option was one such factor. When the AIF was launched in 2008, companies had a need for capital and the AIF was able to provide funding with fairly generous repayment terms. When access to capital became less of an issue and other jurisdictions became more competitive, Canada's ability to compete for automotive investments was hindered. The perceived value of the repayable contribution was therefore eroded, and some companies decided not to apply for AIF funding. It was recognized that the AIF needed to be better able to compete with other jurisdictions, and thus the Government of Canada made non-repayable contributions available. This demonstrated the program's responsiveness to the changing needs of the automotive industry.

Furthermore, interviewees noted the flexibility of the program terms and conditions in making provisions to tailor each company's contribution agreement to its specific needs. For example, some companies have cash readily available but need a short term injection to do some R&D and want to pay it back quickly, whereas others require a longer repayment period. As well, costs for infrastructure (e.g., buildings) were initially not eligible under the AIF, meaning that a company seeking funding for these types of projects would have to look at other jurisdictions. A change to program eligibility criteria in 2016 allowed the AIF to be used to fund more 'brick and mortar' projects.

Other facilitating factors include the highly skilled Canadian workforce. This, along with its strong universities, helped to attract and retain automotive investment in Canada and contributed to

the success of AIF projects. As well, the federal-provincial partnership model whereby the AIF worked together with the Government of Ontario to broaden investments was viewed very positively. If Ontario were not involved, the success of the AIF would be significantly diminished, and vice versa.

Hindering

Geopolitical factors can have a significant impact on Canada's ability to compete and the value proposition the country can present. Canada faces stiff competition in attracting and retaining automotive manufacturing and R&D investments, especially from the U.S. and Mexico. Automotive manufacturers compare the different jurisdictions in terms of factors such as incentives, business environment, and the exchange rate.

In addition, there were some elements of the program terms and conditions that may have hindered the achievement of outcomes. It was noted that according to the Canada Revenue Agency, the AIF repayable contribution constituted taxable income to the recipient when received, thus creating cash flow hardship. This was unexpected and caused issues for multiple recipients. As well, the AIF operated under a reimbursement model, meaning that recipients were reimbursed for eligible expenses after they were incurred. One recipient noted that the amounts provided by the program were paid about six to eight months after being expended. This was seen as a shortcoming of the program, as it too can cause cash flow challenges. Lastly, projects involving buses and large trucks were excluded from receiving AIF funding, though there were some potentially good projects.

4.0 CONCLUSIONS AND LESSONS LEARNED

4.1 CONCLUSIONS

Relevance

- Canada's automotive sector is of strategic importance to the Canadian economy and there is a demonstrable need for a program to build R&D capacity and continue to support a strong automotive sector.

Performance

- Evidence showed AIF funding played a significant role in enhancing automotive sector R&D in Canada. It secured R&D investments that contributed to the development, production and commercialization of innovative products and to production efficiency gains. It also enhanced R&D capacity through collaborations between automotive manufacturers, major suppliers, and research institutions.
- It is not possible to conclusively assess the achievement of environmental benefits but based on available information, it appears that the AIF made a more limited contribution on this front. This was primarily through the development of clean technologies to improve fuel efficiency and reduce the environmental impact of vehicle manufacturing.
- By attracting and retaining investment, the AIF helped to strengthen the competitiveness of the Canadian automotive industry. It assisted in securing the automotive footprint, retaining product mandates from parent companies and contributed to job retention and creation.
- Recent amendments to and flexibility of the program terms and conditions, the highly skilled Canadian workforce, and the partnership with the Government of Ontario assisted the AIF in achieving its intended outcomes. Other factors, such as stiff jurisdictional competition, government taxation policy, and the lengthy payment process can act as impediments.

4.2 LESSONS LEARNED

Given that the AIF was terminated, the following lessons learned were developed to inform the design and delivery of grant and contribution programs providing support to key sectors of the Canadian economy, including the Strategic Innovation Fund.

Lesson Learned 1: Flexible and Responsive Programming

Industry support programs that are flexible and responsive have a greater chance of achieving their intended outcomes. For the AIF, flexible terms and conditions allowed programming to be adapted to each company's particular needs. Changes to the funding mechanism, for example from repayable to non-repayable contributions, also allowed the AIF to respond to changing conditions in the industry.

Lesson Learned 2: Performance Measurement and Reporting

Performance measurement to inform medium- and longer-term outcomes needs to be planned from the inception of a program and data should be collected on an ongoing basis to ensure performance and impact can be fully assessed. Programs need to identify common indicators and clear definitions across projects and ensure participating firms provide the required information as part of their agreements for government support.

ANNEX A – AIF FUNDED PROJECTS

	Start Date	End Date	Participant Firm	Project Description	Maximum AIF contribution
1.	March 31, 2009	March 31, 2018	Ford Motor Company of Canada	Renaissance Project - flexible engine assembly plant, create an advanced powertrain research centre in Windsor, Ontario	\$80.0 million
2.	March 20, 2010	March 31, 2013	Linamar Corporation	Green and Fuel Efficient Powertrain Project - components and modules within three product areas: transmissions, engines and drivelines	\$54.8 million
3.	March 16, 2012	March 31, 2013	Toyota Motor Manufacturing Canada	Project Green Light - maximize production efficiency, reduce emissions, upgrade equipment to enable the production of more fuel-efficient vehicles	\$70.8 million
4.	March 14, 2012	March 31, 2015	Magna International	Changing Gears Project - energy-efficient components for vehicles and innovative powertrain components for next-generation vehicles	\$21.8 million
5.	March 11, 2013	March 31, 2014	Toyota Motor Manufacturing Canada	Project Lexus - assembly line for the new Lexus RX450h (hybrid) model, increase the capacity for the RX350 model in Cambridge, Ontario	\$16.9 million
6.	March 28, 2014	March 31, 2018	Ford Motor Company of Canada	Project Northern Star - install a global manufacturing platform at the Oakville Assembly Plant, conduct R&D on fuel consumption and emissions	\$71.6 million
7.	February 24, 2015	March 31, 2018	Linamar Corporation	Project Transmission - R&D and build prototypes, install equipment of powertrain components for all next-generation vehicle transmissions	\$50.7 million
8.	June 30, 2015	March 31, 2016	Toyota Motor Manufacturing Canada	Project Innovation - tooling and equipment for the production of the new Lexus RX350 and RX450h (hybrid) models, add new stamping line	\$59.0 million
9.	March 31, 2017	March 31, 2020	Honda of Canada Manufacturing	13th Mid Term project - new energy-efficient paint shop, prepare the main assembly lines for the next generation of Civic and CR-V models	\$41.8 million*
10.	March 31, 2017	March 31, 2021	Ford Motor Company of Canada	Project Caribou - new energy efficient engine, support R&D on advanced powertrain technologies and vehicle connectivity	\$102.4 million*
Total					\$569.8 million

Note: *Indicates that AIF funding is a non-repayable contribution. For all other projects, AIF funding is a repayable contribution.

ANNEX B – COMPLEMENTARY FUNDING PROGRAMS

Program for Strategic Industrial Projects: This \$355 million federal program was created in October 2005 to strengthen the Canadian automotive industry through support for the implementation of flexible manufacturing capacity at Canadian assembly plants. The program was the precursor to the AIF and ran until March 31, 2011 (when all projects funded under this program were completed).

Automotive Supplier Innovation Program: Started in 2015-16, this \$100 million federal program over five years was designed to help Canadian small- and medium-sized automotive suppliers gain a competitive edge through new innovative products and processes and help R&D projects to become commercially viable by supporting product development and technology demonstration on a cost-shared basis with participating firms. As was the case for the AIF, the program was subsequently folded into the Strategic Innovation Fund in 2017.

Jobs and Prosperity Fund: This \$2.5 billion, 10-year Ontario program was launched in 2015 to help businesses across the province to enhance their productivity, innovation and export activities. Although the program is broader than just the automotive sector, recipients have included Toyota Motor Manufacturing Canada, Ford Motor Company of Canada, Linamar Corporation and Honda of Canada Manufacturing.