

# **Industrial Policy Options and Tools for the Development of the Alternative Fuel Vehicle Industry in Canada**

by

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## **Abstract**

The current condition of the automotive industry in Canada is unsustainable, particularly due to growing global competition, the volatile price of oil, and environmental concerns. The solution to resolving these pressures and creating new competitive advantages within the Canadian automotive industry may be found in innovation targeting the development of alternative fuel vehicles. Based on the insights on innovation from Schumpeter and Porter, this research employs an institutional policy analysis approach. Historical analysis (Section I) highlights the factors of success for a dominant vehicle type and the importance of industrial policy in Canadian automotive manufacturing; while trade policy analysis (Section II) delineates the current scope of industrial policy in Canada, given the restraints of bilateral and multilateral trade agreements. Within this context, this research proposes that Canadian policy-makers can build on existing industrial policy for the automotive industry by refocusing it on the alternative fuel vehicle sector and implementing the following industrial policies within a cohesive national strategy: a) research and development subsidies; b) demand-side promotion; c) coordination and collaboration activities; and d) legal and regulatory frameworks reform.

**Keywords:** industrial policy; Canadian automotive industry; alternative fuel vehicles; innovation policy; institutional policy analysis; automotive manufacturing

## **Dedication**

With the most sincere appreciation and most true admiration, I joyously dedicate this project to my late-mother, Shaheen Zafar.

Mom, your strength, your grace, your benevolence, your charm, your faith in goodness, and your thirst for knowledge are all magnificent gifts that I have inherited from you. While I may not carry these everlasting gifts as elegantly as you did, I persistently strive to honour you each day as a better man than the one I was the day before.

Your untimely departure from this physical world did not prevent you from providing me with all the resources I will ever need in my life. You taught me to walk, to read, to write, to learn, to appreciate, and to love every person and every day through opportunities and challenges, and through blessings and troubles.

I may wander astray every so often, but I will always find my path when I hear your soft voice that resonates wise, cherished, encouraging, and beautiful. Your legacy guides me through the peaks and valleys of my life journey, as I could never dream of any miracle more powerful or any condition more giving than the treasure of being your son.

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## **Section I.**

# **Historical Factors of a Successful Vehicle Type and the Role of Industrial Policy in the Canadian Automotive Sector**

## **Introduction**

The overall purpose of this project will be to determine the most effective industrial policy tools currently available for Canadian policy makers to promote the development of a national alternative fuel vehicle sector. As a key industry to many economies, the vitality of an automotive industry is a priority of many industrial policy makers as a source of national income and employment. While the development of this industry has spurred the industrialized growth of economies, it has, more importantly, generated the high-paying employment and encouraged the social mobility associated with many manufacturing sectors. The manufacture of an automobile – its components production, assembly, and maintenance services – encompasses a major source of employment in the global economy. The global automotive industry accounts for approximately sixty-million jobs worldwide (OICA 2009). A large source of this employment cascades from the actual manufacture of automobiles into offshoot jobs within a national economy. As a specific example, it is estimated that one of six jobs in Canada is associated to the automotive industry, as Canada's automotive industry accounts for the single biggest contributor (over 12%) to its manufacturing GDP (Reuters 2009; Parliament of Canada 2009).

Long-standing and emerging automotive-producing nations have vested a considerable amount of public policy and resources into developing and sustaining automotive sectors. Such development affects a large pool of stakeholders across national borders, including multi-national corporations, unionized and non-unionized

workers, other businesses linked to the automotive supply chain including commodity industries, and citizens (consumers and non-consumers alike). As such, the global automotive industry has historically been highly politicized, as policy-makers have enacted both supply-side and demand-side public policy initiatives – often to linked to energy and labour interests. Historically, the initiatives of state intervention, including within Canada, have sought to increase the competitiveness of one automobile-manufacturing nation versus another, and ultimately, seek to reap the rewards of an internationally competitive auto-manufacturing sector (i.e. through employment, tax revenues, favourable balance of trade, etc.). In Canada, World War II industrial policy increased automotive production; the 1965 Auto Pact revived the national automotive industry from bankruptcies; and the 2008 bailout of North American automotive manufacturers saved two major automotive producers from insolvency. Industrial policy, thus, has been historically crucial to national automotive production in Canada.

Notably, the current condition of the automotive industry in Canada is unsustainable, particularly due to environmental concerns, the volatile and increasingly high price of oil, and global competition.

Anthropogenic climate change, pollution, and environmental damage caused from the extraction and consumption of fossil fuels have motivated regulatory pressures and environmental policy from governments to support programs and industries that will reduce greenhouse gas emissions over the medium- and long-term. Currently, transport comprises over 26% of global CO<sub>2</sub> emissions, as total greenhouse gas emissions continue to increase in this industrial sector. Due to the growing demand and consumption of fossil fuels in automotive operation, petroleum-powered vehicles can be considered environmentally unsustainable in the long-run. (Chapman 2007)

The short-term volatility of oil prices and long-term rise in oil prices have progressively created energy policy pressures from government to seek the development of new alternative fuels. From 1986 to 1999, oil prices generally fluctuated between \$20 and \$30 per barrel on the New York Mercantile Exchange. In February 2012, oil prices reached levels of approximately \$110 per barrel, fluctuating between \$79 per barrel and \$110 in the first half of 2012. This market instability and non-renewable

nature of oil also add further reason to how petroleum-powered vehicles are unsustainable in the long-run. (NYSE.TV 2012)

Perhaps the most pressingly immediate threat to Canada's automotive industry is fast-growing global competition. China, whose automotive production reached over 1-million vehicles in 1992, produced approximately 14.5-million vehicles in 2011 which encompassed 24.2% of the world's total automobile production. Additionally, India is now Asia's third largest exporter of automobiles, behind Japan and South Korea, producing more automobiles than the United States in 2011. North America (USA, Canada, and Mexico) collectively produces less than 10% of the world's automobiles. (OICA 2012) In contrast to environmental concerns and the volatile price of oil, increasing global competition is a direct threat to Canada's automotive manufacturing future.

The solution to resolving these pressures and protecting the Canadian automotive industry from complete elimination by global competitors may be found in innovation.

In using insight from business and innovation theory, particularly innovation frameworks from Schumpeter (Schumpeter 1976) and Porter (Porter 1990; Porter and van der Linde 1995), this research assumes several key theoretical tenets. Firstly, innovation is the driving force of economic change, creating and sustaining real economic growth, as true market power is generated from new processes or products yielded from continuous innovation, not static price competition (Schumpeter 1976). In fact, in highly-competitive markets, firms should use innovative processes and design to achieve real competitive advantages in the market (Porter 1990). Secondly, government can influence demand conditions, factor conditions, related and supporting industries for an industry, and firm strategy, structure, and rivalry within a national economy (Porter 1990). Thirdly, strict regulations – particularly environmental regulation – can yield innovation that increases competitiveness (Porter and van der Linde 1995). Lastly, innovation through industrial clusters – which generate the necessary institutional thickness to increase productivity – can increase global competitiveness for an industry (Porter 1990). All these tenets give theoretical support to the development of an innovative alternative fuel vehicle sector in Canada as one approach to combating the

pressures of climate change, volatile oil prices, and increasing global competition, while creating real economic growth in Canada's automotive industry.

On the basis of the importance of industrial policy supporting innovation in the automotive sector, this paper asks the following research question: What are the most effective industrial policy tools currently available for Canadian policy makers to promote the development of the alternative fuel vehicle industry in Canada?

In examining this research question, this paper will employ an institutional policy analysis approach, with historical analysis (Section I) and trade policy analysis (Section II). It is outside the scope of this research to provide an analysis of individual actors or to determine the overall viability of the alternative fuel vehicles industry in Canada as a business case. This research will assume that there is sufficient political will and capacity to develop an industrial policy program for alternative fuel vehicle development.

Currently, transformative innovation in the automotive industry has focused on the development of alternative (alternative to petroleum, that is) fuel vehicles. The result has been the creation of several new types of alternative fuel vehicles, which may ultimately compete for market dominance, just as the petroleum-powered car, steam-engine car, and electric car vied to become the dominant automobile type during the automobile's initial development from the nineteenth century to the turn of the twentieth century.

In examining the dominance of the petroleum-powered automobile in Section I and the history of industrial policy in Canada's automotive sector, the factors of a successful vehicle type become evident and the important role of active public policy in the Canadian automotive sector is highlighted within the context of the global automotive industry. Section I thus poses the following questions:

- Why did the petroleum-powered automobile become the dominant type of automobile? How did industrial policy affect/determine automobile production in Canada? What lessons does this provide for the role of Canadian industrial policy in promoting the auto-sector today?
- How have global economic integration and the rise of emerging economies affected automobile production?

A significant turn in the history of Canadian industrial policy for the automotive sector was the abolishment of the 1965 bi-lateral agreement with the United States known as the Canada-United States Automotive Products Agreement (Auto Pact) that allowed Canada to develop a strong automotive-manufacturing sector, in spite of being limited by its own small, domestic market. Due to bilateral and multi-lateral trade agreements, Canada's options for industrial trade policy have become increasingly limited since the late 1980s. As the history of Canada's automobile industry development experience gives significant credence to the crucial role of industrial policy in the automotive sector, the industrial policy options that are now available pose new challenges for the development of the alternative fuel vehicle industry. Section II goes onto pose the question:

- How do CUSFTA/NAFTA and WTO membership limit possible industrial policy tools that Canada can implement to support the alternative fuel vehicle industry? What industrial policy tools are available?

It becomes evident that while trade agreement obligations constrain Canada's industrial policy options to encourage the national development of an alternative fuel vehicle sector, Canada still has sufficient policy space for effective industrial policy in the automotive sector and other industries. From this understanding, the research can take the factors of the successful emergence of an automotive type including industrial policy (as realized in Section I) and propose targets for industrial policy in Canada for the alternative fuel vehicle industry, based on the historically successful industrial policy targets for the automotive industry in Canada (also realized in Section I). With the different industrial policy landscape in Canada, in terms of what is available as delineated in Section II, Section III then proposes the following questions in order to achieve the overall research objective:

- What are the factors for successful promotion and development of an alternative fuel vehicle manufacturing sector in Canada?
- What should the targets be of industrial policy in Canada for the alternative fuel vehicle sector?
- How can these targets be met given the current Canadian industrial policy for the alternative fuel vehicle industry and within the scope of possible industrial policy options?

- Is the alternative fuel vehicle design and manufacturing industry viable in Canada?

This research thus proposes that Canadian policy-makers can build on existing industrial policy for the auto-sector by refocusing it on the alternative fuel vehicles sector and implement the following industrial policies within a cohesive national strategy:

- a) Research and development subsidies, including tax benefits and investment incentives
- b) Demand-side promotion, including the implementation of regulation favourable to consumer adoption of alternative fuel vehicles
- c) Coordination and collaboration initiatives to strengthen the financing, research, production, and energy institutions of the automobile sector
- d) Legal and regulatory frameworks that eliminate barriers to innovation

To reach this conclusion, Section I will 1) determine the historical factors of a successful vehicle type and 2) provide the historical basis for how industrial policy has been crucial to automotive production in Canada and can be used to promote the development of the alternative fuel vehicle sector in a highly competitive global automotive market.

## **Historical Overview of the Dominance of the Petroleum-Powered Vehicle**

During the development of the self-propelled vehicle in the 19<sup>th</sup> and early 20<sup>th</sup> century, the three developed engine models (steam, electric, petroleum) competed with each other for supremacy of adoption in Europe and the United States. Since automotive production in Canada did not begin until approximately 1910 with the onset of branch plants of US companies, Canadian automobile manufacturing and development will be excluded from this examination.

While the dominance of the petroleum vehicle over its steam and electric counterparts developed, the outcome was not clear as the three models fiercely competed with each other at the turn of the 20<sup>th</sup> century. Eventually, a market tendency

towards a multicylinder, four-cycle, and water-cooled gas engine car began to emerge (Rae 1965). The petroleum car would eventually become the dominant self-propelled vehicle due to its technical and socio-economic comparability and advantages over the other vehicle types, its more developed network of fueling stations outside major cities, and the active support it received from its respective energy producer, in addition to some favourable industrial policy measures. In order to effectively analyze the emergence of the petroleum-powered vehicle over its steam and electric counterparts, all three vehicles will be briefly assessed over five key factors:

- Technical factors
- Socio-economic factors
- Infrastructural factors
- Investment factors
- Political / industrial policy factors

In assessing the technical advantages and disadvantages of the steam, electric, and petroleum-powered vehicles, petroleum-powered vehicles seem to have a slight superiority in technical operation, in spite of some notable disadvantages including its complicated mechanisms and emission of exhaust fumes. Nonetheless, it is evident that it was not technical superiority alone that accounted for the dominance of the petroleum-powered vehicle. As the first self-propelled vehicle, the steam engine vehicle benefited from many more years of technical development to resolve many of its initial shortcomings, such as its cost, steering control, speed, and the time it took the boiler to raise a sufficient amount of steam for optimal engine operation (Rae 1965). Initially, the steam engine vehicle drew operational comparison with horse carriages (Beasley 1988) as its competitive development, at least initially, was against this form of transportation. As the electric and gas vehicles developed, the steam engine then had to compete with these alternative self-propelled vehicles. Over time, the steam engine became the easiest of the three engines to manufacture (Flink 1988). Comparatively, it had fewer “moving parts” and did not stall in its operation (Flink 1988, 8). A much more efficient and simpler transmission of power from the engine to the wheels made shifting gears much easier compared to its electric and petroleum counterparts, as shifting gears was viewed as a challenge in overall vehicle operation (Rae 1965; Flink 1988)

However, the steam engine required high pressures needed to power increasingly smaller engines (so as to gain more engine power in less engine weight) causing many mechanical problems that required “constant skilled maintenance” (Flink 1988, 14). This made it challenging for mass consumption (Rae 1965). In addition, the steam-powered vehicle’s poor suspension was unable to protect the vehicle and its mechanisms from the rough, undeveloped roads of the era causing further mechanical problems (Laux 1982). The steam engine also had a low thermal efficiency, losing a lot of generated energy to heat transfer while consuming a comparable amount of fossil fuel to the petroleum engine (Flink 1988).

The electric-powered vehicle, in contrast, boasted some competitive advantages against the steam-powered and petroleum-powered vehicles. The electric storage battery was invented by the mid-19<sup>th</sup> century (within the same period of the development of the internal combustion engine) in the midst of the rapid progress of electrical science and engineering. Primarily developed in France and later gaining prominence in the USA, the electric vehicle’s development centered on the power and longevity of its storage battery. Its quiet operation, free of exhaust fumes (and hence, odour) gave the electric car several advantages over its steam and petroleum counterparts (Flink 1988). In addition, the electric car tended to be much easier to operate and control than petroleum vehicles, while also having a similar range (50-80 miles) (Flink 1988; Rae 1965).

However, the cost of electric vehicles was its biggest concern. As electric storage batteries were expensive to manufacturer, electric vehicles were also up to three-times more expensive to operate than the petroleum vehicle (Flink 1988). More strikingly, the electricity generated from the primary battery cost up to twenty-times more than steam power (Beasley 1988). Another cost concern was the operational life of the storage battery, which tended to deteriorate quickly (Flink 1988; Rae 1965). The battery itself did not generate fast speeds, especially considering the heavy weight of the batteries relative to the horsepower generated; this also made uphill driving difficult in an electric car (Flink 1988; Rae 1965).

In spite of complicated mechanisms and the emission of exhaust fumes, the petroleum-powered vehicle was more versatile, perceived as more durable, and more

economical based on value for consumers. The internal combustion engine, as used in the petroleum-powered car, was initially developed on similar principles to the steam engine. Gottlieb Daimler's new design in 1876 for the Deutz Gas Motor Factory would resolve the gas engine's initial issue of generating more power for less weight (Laux 1982), generating a much greater thermal efficiency than its steam-engine counterpart (Rae 1965). As a result, by the turn of the 20<sup>th</sup> century, petroleum vehicles would be the most versatile for uneven and undeveloped roads (including everyday inclines), best handling sand, mud, and snow (Flink 1988). They would maintain good, constant speeds over long-distances, while gas mileage averaged 70-miles per full-tank in the average gasoline vehicle (Flink 1988).

While providing a favourable review of the petroleum vehicle, the American Monthly Review of Reviews noted in 1900 that the gas engine vehicle was of "clumsy and complicated mechanisms" (Flink 1988, 10). Another major problem in this period was the exhaust fumes of the gas engine vehicle, which generated concerns of toxicity and odour (Rae 1965). In spite of these problems, the technical disadvantages of the petroleum vehicle, at the time, paled in comparison to those of the steam engine vehicle and the electric vehicle.

Similar to technical factors, socio-economic factors, encompassed by consumer perceptions and demand conditions, help to explain the dominance of the petroleum-powered vehicle, but do not comprise the determining factors of its dominance on their own. While the purchase and operating costs may have been a consumer consideration, automobiles were generally purchased by the elites of Europe and America – at least, in the early stages of development – making cost advantages (as previously noted) less significant.

In general, a major problem of automobiles was market mechanically complex, unfamiliar, and unreliable products to European and American consumers (O'Brien 1997). Between the types of engine and transmission, the purchase of an automobile was often "bewildering to a consumer" (Rae 1965, 11). As a result of its quiet operation, free of exhaust fumes, and its easy operation, the electric vehicle was greatly favoured among women who began to drive cars for city travel as an alternative for family carriage transportation (Flink 1988; Rae 1965). In fact, the electric car gained early popularity for

its ease of use and its perceptions of safety, in spite of its high costs, as consumers enjoyed the peace of mind of not “sitting over an explosion” as was the case of the steam-powered and petroleum-powered vehicles (Rae 1965, 12).

In contrast, many poorly constructed steam carriages were often exhibited to the public, hurting its general reputation among consumers who feared large, unmanageable explosions from the high-pressure mechanisms (Beasley 1988).

In the United States, the automobile was later marketed as a durable consumer good for mass consumption, not just of the elites. As a result, cost then developed as a primary concern in the American market (Rae 1965, 56). This favoured the petroleum car, which was not as expensive to manufacture and operate as electric vehicles, as gasoline prices also decreased.

As such, the petroleum-powered car may have been perceived as the most reliable car among American consumers, given its versatility and durability for different types of weather (Flink 1988). Still, the petroleum-powered vehicle did suffer from perceived risks to consumers while combating the popularity of the electric-powered vehicle amongst affluent elites and women. Furthermore, there are two main infrastructural factors when examining the development of the automobile: roads and access to fuel. As roads developed throughout Western Europe and the USA, the disadvantage of electric and steam vehicles being less reliable on rugged terrain gradually reduced. Industrial policy in the development of roads, did not favour the adoption of a single vehicle type, but it did lessen the requirement for an automotive to be rugged for all terrain. In contrast, fueling stations outside major cities gave petroleum-powered vehicles a distinct advantage since petrol depots were common.

During the 19<sup>th</sup> century, there were a limited number of working roads in Western Europe and the USA, as the development of roads was stalled in large part due to the efficiency of rail (Rae 1988). As the dissemination of bicycle technology swept Europe, roads began to develop (Flink 1988). This development helped all automobiles, but particularly favoured steam and electric cars since they did not perform well on underdeveloped roads (Laux 1963).

Over the same period in the USA, roads were generally poor (Rae 1965). As such, petroleum vehicles may have been naturally favoured in the US – and presumably, Canada – since its suspension and mechanical design could better handle diverse terrain and climate than the steam or electric vehicles, which tended to have difficulties on rough, undeveloped roads and even modest inclines. As American car producers began to outpace European producers in production and development in the early 20<sup>th</sup> century, the conquest of the petroleum-powered vehicle could be greatly attributed to the demands of the American landscape and consumer.

In all, the research suggests that road development would benefit all self-propelled vehicle types by creating easier driving conditions (Beasley 1988; Flink 1988; Laux 1982; Rae 1965).

Fueling networks and accessibility was another large infrastructure concern. As the better electric, steam, and petroleum cars had similar mileages, the distance that could be traveled on a single fueling or charge was not that disparate in providing clear advantages to either vehicle. However, petroleum-powered vehicles enjoyed a much greater accessibility to fueling stations than the other vehicle types.

The fueling of a steam engine would prove to be problematic, especially in regions where horse troughs and soft water – water that is low in calcium, magnesium, and other metals – were not easily available. Soft water was needed for the steam engine in order to avoid mineral build-up and corrosion of the engine's mechanisms, while horse troughs were the only way to serve the engine. Some regions, such as the Southwest USA, did not have these handy, as they would need to have service stations with boiler water, which would need be brought in from distance points, as was the case for railroads and their steam locomotives (Rae 1965, 14).

The electric car suffered from a similar problem. Though widely popular in Paris during the 1890s, it could not be taken far away from the city itself, which had virtually all of the recharging centers (Beasley 1988). Petroleum vehicles, in contrast, benefited from having petrol depots outside of the major cities of the Western World, especially throughout the American countryside, due the use of petroleum in metallurgy and glass manufacture (Beasley 1988, 112).

In sum, the continuing development of roads and highways ultimately benefited all vehicle types, while fuel accessibility was only an issue outside of the major metropolises in the US and Western Europe, benefitting petroleum-powered vehicles which enjoyed vast networks of petrol depots outside major cities.

In examining the role of related and supporting industries, the research notes two important features: competitive supplier industries that create advantages in value-added industries by providing cost-effective inputs and competitive related-industries that share similar production activities and experience (Porter 1990). However, aside from the energy industries, the other supporting industries of the automobile industry provided no clear advantage to the petroleum-powered, electric-powered, or steam-powered vehicles.

Many innovations in the automobile industry, including steel-tube framing, the chain drive, ball and roller bearings, differential gearing, and pneumatic tires, were borrowed from the bicycle industry (Rae 1965, 6; Laux 1982). The methods of production were also used from the bicycle industry, such as sheet metal stamping, electric resistance welding, and the use of special machine tools (Flink 1988). Other light metal manufacturers, such as producers of sewing machines, hardware, and watches, also lent manufacturing methods to the automotive industry, including the assembly of parts and the technical precision of machine tools (Laux 1963; Laux 1982). Tool and machine manufacturers played an especially important role in developing metal-cutting and drilling tools for the manufacture of automobiles (Beasley 1988). The discovery and innovation in the manufacture of aluminum in the 19<sup>th</sup> century also contributed to increasing the efficiency of automotive designs (Rae 1965). In addition, the manufacturing of an automobile involved several parts adopted from other industries: woodworking, undercarriage manufacturing, wheel manufacturers, blacksmithing, leather and cloth trimming, and painting industries heavily influenced the development of the automobile (Beasley 1988, 108).

Nonetheless, these complementary industries provided no clear advantage any type of self-propelled vehicle being produced.

In examining investment factors that affected each type of vehicle, the role of energy sectors and the climate of capital markets seem to favour the development of the petroleum-powered vehicle.

In the energy sectors, “particular factions of capital and... political forces” favoured the development of the petroleum-powered vehicle, particularly as petroleum-producers used the petroleum-powered vehicle as an avenue to develop their own industries (Beasley 1988, 131). Primarily, the oil industry had generated a use for gasoline, which prior to the petroleum automobile, was thrown out as waste (Rae 1965) at a time when a glut of supply and the declining use of kerosene (which was being substituted for electricity) made petroleum producers much less profitable (Beasley 1997).

Petroleum producers, particularly the large conglomerates (Standard Oil, BNITO, and the Nobel brothers) had faced an industry-wide crisis: electricity had begun to be used in place of kerosene, competition had escalated into a worldwide supply glut particularly in Europe, and price wars including rebates to local refineries, railroads, and inland water navigation had begun to undercut profitability (Beasley 1997, 116).

Initially, refining crude oil had a gasoline production of only 20%; it was not until Standard Oil introduced the Burton Cracking Process in 1913 that this yield was doubled (Rae 1965). Petroleum producers favourably increased their support of the gas engine car in the United States as the rising demand for automobiles drove up prices from 9.5 cents to 17 cents a gallon from 1910 to 1913 (Rae 1965). This was especially important in the United States where the discovery of cheap oil in Texas spurred petroleum producers to find new markets and consumer outlets (Shirouzu and Ball 2004).

Financing for the petroleum-powered vehicle was not just limited to petroleum producers. In fact, Karl Benz – inventor of the high-speed motor which became the forerunner to the modern automobile engine – was heavily funded by a retailer of benzene (petroleum ether) (Beasley 1988).

The interlinked relationships between large banks and petroleum producers such as those between the European Rothschild family and the American Rockefeller family also resulted in the support for gas engine vehicle development from banks and financial

institutions. As “petro capitalists” began to finance petroleum automobiles to expand consumer markets, large financial institutions also heavily backed the development of the petroleum-powered vehicle (Beasley 1988). For example, Kilian von Steiner, co-founder of Württembergische Vereinsbank (a forerunner of Deutsche Bank), privately invested and spurred bank investment into the automotive industry (Beasley 1997). The involvement of large banks had an exponential effect as competing banks (such as rival Swiss banks, The Banque de Paris et des Pays-Bas) immediately began to finance petroleum car developers in competing for similar commercial clientele (Beasley 1988).

An interesting concern is why the electric companies did not become involved as financiers or lobbyists to government on behalf of electric car producers, as petroleum producers did for the gas engine car. Essentially, market conditions between the two industries were vastly different, with petroleum producers desperately seeking new avenues for revenue it was losing to electricity. Also, since the primary battery in an electric vehicle cost twenty times more than steam power, electric companies were further discouraged from actively supporting the development of electric vehicles. As a result, electricity companies who were developing their own grids did not support electric vehicles, in contrast to the petroleum producers that supported the petroleum vehicle in order to seek new revenues in their declining market (Beasley 1988).

The restructuring of capital markets in the 1890s, particularly the major stock exchanges (NYSE, London, and Berlin) allowed for greater investor education, the expansion of financial markets, and the greater involvement of banks with newer, innovative firms (Neal and Davis 2007). In addition, the emergence of many American and German joint-stock banks allowed American and German industries respectively to compete with the large merchant banks of Britain, which were already able to generate larger pools of capital for investment (Neal and Davis 2007). While financing from major banks was not initially required for automobile manufacturers, once automobiles began mass production for mass consumption in the United States, banks began to play a much larger role. For example, in 1910, after the horizontal and vertical integration of 27 different firms, General Motors’ poor management and practices would result in it being taken over by a bankers’ trust (Klepper 2007, 102). Due to the linkages between large banks and petroleum producers, these developments in capital markets actually tended to favour the petroleum-powered vehicle.

The role of petroleum-producer support included political lobbying for industrial policy initiatives that spurred the promotion of the development and adoption of the petroleum-powered vehicle.

The power of petroleum producers would become evident by the turn of the century, particularly in lobbying for the navies of the United States and Britain switching from coal-powered vessels to petroleum-powered vessels. With the benefits of “safe [energy source] storage” and “smoke control”, Britain would transform its naval fleet from coal power to petroleum power. In the United States, Congressional inquiries into the viability of petroleum as a fuel source for navy fleets from as early as 1898, in addition to pressure from trade publications, allowed the United States to make a similar state-sponsored transformation (DeNovo 1955, 641-643). This state-sponsored endorsement of petroleum power as a means to power self-propelled vehicles on sea, surely bolstered the case for the use of petroleum power on the road.

Another major political lobby in the USA was large agricultural holders that had sought alternatives to the monopoly of the railroad companies (Flink 1988). The Farmers' Association would help to lobby the federal government to create the Office of Road Inquiry within the Department of Agriculture in 1904 that helped develop roads with federal and state aid and further spur the development of the petroleum vehicle, which was already outpacing the steam and electric cars (Flink 1988).

The support and political lobbying of petroleum producers for the petroleum vehicle, in addition to the petroleum vehicle's own intrinsic advantages (as discussed above), resulted in such rapid technological development that steam and electric producers could no longer compete (Flink 1988). In fact, Gardner-Serpollet steam vehicles, which developed lightweight, high-pressure, self-condensing engines, set speed records in Britain and France by the turn of the 20<sup>th</sup> century, but could not keep pace with the petroleum car's concurrent development (Flink 1988). It was thus due to support from oil producers, which lobbied for state support through industrial policy, that aided the petroleum-powered internal combustion engine become the dominant automobile, in spite of the earlier development and experimentation of the steam-powered car and electric powered vehicles.

## ***Lessons of the Dominance of the Petroleum-Powered Vehicle***

There are several relevant implications of the above analysis that provide a guideline for the successful adoption of one vehicle type over another. The first is that while not the wholly determining factors, the technical factors and socio-economic factors of a dominant vehicle type must have some competitive advantage over or comparability with its competitors. In overall operation, cost, maintenance requirements, and adoption for current roads, the dominant vehicle type should provide some advantages, or at least be equal to other vehicle types.

The second lesson is that access to fueling stations, particularly when those fueling stations are complemented by the use from other industries, is important in the widespread adoption of a vehicle type. Similarly, the third lesson is that the energy industry that caters to the vehicle type must have an active role in generating finance for research, development, and manufacture of that vehicle type while also lobbying for the interests of its widespread adoption.

Lastly, state initiatives – directly or indirectly – can be instrumental to automotive development, which will further be evidenced in the next subsection. Industrial policy, which historically had been lobbied for by energy interests, can cater to supporting the development of competitive advantages in the technical factors and socio-economic factors of a vehicle type, in addition to generating the financial and strategic support of energy industries for the development of such vehicles.

## **The History of Industrial Policy in the Canadian Automotive Industry**

The existence of industrial policy in Canada predates Confederation. Industrial policy in Canada has had a long history of state supporting the development of industry. However, the most significant industrial policy developments occurred after Confederation, with aims of national industry development and nation-building. The Canada-United States Automotive Products Agreement (Auto Pact) of 1965, a bilateral agreement between Canada and the United States, provides the most significant

industrial policy for the Canadian automotive sector, and will be overviewed in a following sub-section. Industrial policy in Canada assumed a very significant role in national economic development by providing direct benefits to economic expansion, stimulus to Canadian industry, a greater demand for a wider range of Canadian skills (i.e. jobs), and greater long-run tax revenue stream (MacDonald 1982).

As part of an imperial trade network, British North American trade colonies closely monitored tariffs and restricted the use of Canadian ports by foreign ships (Pomfret 1981). The tariffs acted as a means of revenue generation, while also being preferential based on the needs of the colonies. By the 1850s, protectionist policies also sought to protect Canadian manufacturers while raising employment levels (Pomfret 1981).

While import tariffs were a significant component of Canadian fiscal structure prior to 1867, the first comprehensive industrial policy was established in the National Policy of 1879 (MacDonald 1982). This policy introduced sweeping tariff duties on manufactured products, not only to support agricultural, mining, and manufacturing sectors, but also to encourage trade between provinces and prevent emigration to the United States (Young 1957). The strategy also aimed to promote western settlement and development, while financing the national railway (Canadian Pacific Railway) with tariff revenue as part of the same strategy (Hatton and Williamson 2005). The overall purpose of the Canadian Pacific Railway was to link the manufacturing sectors in central Canada (Ontario and Quebec) with the raw materials in western Canada (Walker 1980) while providing defensive measures to American 'Manifest Destiny' expansion (Fowke 1956). In addition to collecting tariff revenues for this development, the state also provided significant land grants in western Canada, among other incentives to promote westward economic development (Walker 1980). The federal government would provide state contracts that granted public funds and lands to the railway builder. The federal government also provided surveying costs and exempted the railway from taxes for 20 years, as the passing of the final legislation for the project effectively created the Canadian Pacific Railway Company (Walker 1980).

While protectionist economic policies peaked during the 1930s, Canada continued to use tariffs and non-tariff barriers for the promotion of domestic industry.

Subsidies and “buy-Canadian” incentives in the iron and steel industries are one example of post-WWII industrial policy measures in Canada (Pomfret 1981) while being particularly important to the development of the automobile industry. Quotas and voluntary export restraints also persisted well into the 1960s for the promotion of such diverse industries as “textiles, footwear, bicycles, and canned tomatoes” (Pomfret 1981, 74).

During the late-1970s and 1980s, the Canadian view of active industrial policy greatly shifted to increased emphasis on augmenting bilateral agreements with the United States in conjunction with multi-national corporations, in order to stimulate investment for the expansion of Canadian manufacturing while preferential US market access for exports (Morici 1990). In examining the Canadian automotive industry from the turn of the 20<sup>th</sup> century to the 1965 Auto Pact, the importance of industrial policy is emphasized in the following sections.

### ***The Canadian Automotive Industry Before 1965***

Prior to the Canada-United States Automotive Products Agreement (Auto Pact) of 1965, industrial policy – particularly trade policy and industrial policy during World War II – spurred the creation and subsequent expansion of the Canadian automotive industry by providing favourable economic conditions for Canadian entrepreneurs and US automotive manufacturers to invest into the automotive industry in Canada.

At the turn of the 20<sup>th</sup> century, the Canadian automotive industry consisted of private Canadian entrepreneurs partnering with existing US automotive companies to establish branch plant operations that were concentrated in southern Ontario (White 2007; Yates and Vrankulj 2006). Southern Ontario was an attractive industrial base since it included the largest segment of Canadian consumers and because of its proximity to US markets and ports to reach European markets (Yates and Vrankulj 2006). By 1914, the automotive industry in Canada was well-established, in particular due to its focus on exports to the US (White 2007). Nonetheless, the defining development of the automotive industry was still limited to the United States and Western Europe.

As the Canadian domestic market grew and Canada enjoyed the Imperial tariff structure of the British Empire, the industry experienced boom throughout the 1920s (White 2007). While perhaps somewhat passively, Canada's export trade policy (a component of industrial policy) was the driving force towards the development of the industry. As the industry grew with nearly 50% of its output being exported in some years, US automobile manufacturers bought out their Canadian partners to own and control these large branch plants during the 1920s (White 2007).

The onset of World War II and the Canadian government's industrial policy to supply military vehicles for the Allied Forces would spur the rapid expansion of the Canadian automotive industry's production capacity (White 2007; Yates and Vrankulj 2006), which was absolutely crucial to automotive production in Canada. Canadian policy-makers had an increasingly active role in the development and growth of the industry from this time onwards. With economic prosperity after World War II, the automotive industry in Canada became an important industry for Canadian jobs and wealth generation. Unfortunately, during 1957 and 1960, the proportion of imports being used in Canadian auto manufacturing rose from 13% to 28%, bankrupting several Canadian auto parts producers and laying off approximately 20% of Canada's automotive labour force (Yates and Vrankulj 2006). Canada would also lose the benefits of the Imperial trade network (and thus, the preferential treatment within Commonwealth countries) and face greater competition from European manufacturers which produced smaller and more efficient vehicles (White 2007). As such, the industry saw its production volumes decrease in a growing market of automobile purchasing (White 2007).

It was at this point that the federal government in Canada would appoint a Royal Commission to investigate the necessary changes in industrial policy, particularly to the automotive industry's import tariff structure, in order to support growth in the national industry in spite of its small domestic market (White 2007; Yates and Vrankulj 2006). This response from Canadian policy-makers would yield the most significant industrial policy for the Canadian automotive sector.

## ***Canada-United States Automotive Products Agreement (Auto Pact)***

In 1965, Canada and the United States entered into a bi-lateral agreement centered on the production of automotives and automotive parts known as the Canada-United States Automotive Products Agreement (Auto Pact). The purpose of this agreement for Canada was to develop a strong automotive-manufacturing sector, in spite of being limited by its own small, domestic market; Canada would thus manufacture automotives and automotive parts, not only for its own domestic consumption, but also for export to the United States (Krikorian 2003). Prior to the agreement, as noted in the preceding subsection, the expansion of Canada's automotive manufacturing sector was limited by low production volumes and significant duties on imported parts (Krikorian 2003).

The Auto Pact essentially mandated American automotive manufacturers to increase production in Canada, while being able to export this production duty-free into the American market. The agreement had support from automobile manufacturers who attached letters of understanding to the agreement committing to specific levels of investment in the Canadian industry in exchange for tariff-free trade of parts and vehicles between the US and Canada (Yates and Vrankulj 2006). It included a minimum production-to-sales ratio (trade balancing requirement) and local-content requirement for a certain level of Canadian value-added (CVA) in order to sustain local production and employment (Irish 2003). The result was almost immediate, reducing production duplication between the US and Canada while "increasing efficiency through specialization and the achievement of greater economies of scale" (Yates and Vrankulj 2006, 4) that brought down costs of manufacture, boosted production levels, and employed more Canadians within the industry. As such, the Auto Pact was the most significant industrial policy measure undertaken by Canadian policy-makers in the promotion of the domestic automotive industry.

With the implementation of the WTO, the Auto Pact would later be in violation of both the national treatment principle and non-discriminatory principle of the multi-lateral agreement, and would eventually be ended. This marked a new era of industrial policy landscape for Canada, which will be covered in the following sections. It is evident from this review that Canada's use of industrial policy not only has long-standing historical

ties, but also has been a significant tool for economic development and the protection of infant industries and declining ones.

Section II will cover will cover the restrictive implications of the Canada-United States Free Trade Agreement, the North American Free Trade Agreement, and the membership in the World Trade Organization. Section III will cover Canada's current industrial policy support the automotive sector, with a particular focus on industrial policy supporting the development of alternative fuel vehicles.

## **International Movement in the Automotive Industry**

Of course, the global automotive industry today is far different than it was in 1965. Industrial policy, while adopting historical lessons, must also be adaptable to the current global automotive market, which includes far more economies than before. Moreover, industrial policy has more restrictions now than it has had in the past due to bilateral and multilateral trade and investment agreement, limiting the overall scope of available industrial policy.

Major automotive manufacturers are spread across four continents encompassing highly developed economies (Japan, USA/Canada, Germany), newly-industrialized economies (South Korea), and emerging economies (China, Brazil, India, Russia). While catering to a large, global market, the sheer geographical spread of automobile manufacturers demonstrates the highly competitive and dynamic nature of the global automotive industry. This highlights the widespread importance of the research subject, particularly to the largest automobile producers. The top ten largest producers in 2011, in terms of number of vehicles produced follows (including their respective number of cars produced):

- China – 14.49 million cars
- Japan – 7.16 million cars
- Germany – 5.87 million cars
- South Korea – 4.22 million cars
- India – 3.05 million cars
- USA – 2.97 million cars

- Brazil – 2.53 million cars
- France – 1.93 million cars
- Spain – 1.93 million cars
- Russia – 1.74 million cars
- Canada – 0.99 million cars (15<sup>th</sup> largest automotive producer) (OICA 2012)

With implications for national employment, the role of the state in development in the automotive industry has assumed a guardianship function, where state capital finances many automobile manufacturing activities. This is evident in the bailout of General Motors and Chrysler in the United States and Canada, in addition to the several state-owned automobile manufacturers in China, including China FAW Group, Chang'an Motors, and Chery Automobile.

Several late-entrants to the automobile manufacturing industry have used three broad areas of industrial policy (direct financing, indirect financing and assistance, and trade / foreign direct investment policy) to develop their industries. These global competitors include Thailand, India, Malaysia, Korea, Brazil, and China (Fuangkajonsak 2006; Doner et. al 2006).

Given the highly competitive nature of the global automotive industry, which includes developed economies, newly industrialized economies, and emerging economies, it is reasonable to assume that industrial policy in the automotive sector will be scrutinized according to global trade regimes and rules. As such it is vital that in forming a national industrial policy strategy for the development of alternative fuel vehicles, Canada cautiously creates policy within the policy space defined by its trade and investment agreements, which will be discussed in the following section. Certainly, industrial policy options have changed in their range and flexibility, but they still do exist, and have never been as important.

## **Section II.**

### **The Scope of Canada's Industrial Policy Landscape**

In Section I, the research determined that the Canadian automotive industry has historically been driven by industrial policy, while prior to that, the development of the petroleum-powered vehicle as the dominant vehicle type benefited from the active role of its respective energy producer. In Canada, active industrial policy supported the rapid expansion of production capacity in the Canadian automotive industry from World War II onwards. Then, as Canada would also lose the benefits of the Imperial trade network and face greater competition from European manufacturers, thus losing its automotive production volumes in a market of growing demands for automobiles, Canadian industrial policy sought to re-develop a strong automotive-manufacturing sector, in spite of being limited by its own small, domestic market. The Canada-United States Automotive Products Agreement (Auto Pact) essentially mandated American automotive manufacturers to increase production in Canada, while enabling Canadian-manufactured vehicles to be exported duty-free into the American market.

Given that major automotive manufacturers are now spread across four continents encompassing highly developed economies (Japan, USA/Canada, Germany), newly-industrialized economies (South Korea), and emerging economies (China, Brazil, India, Russia), international competition has spurred the greatest need for sound industrial policy in the Canadian automotive sector. However, the landscape of industrial policy tools has changed since the early- and mid- 20<sup>th</sup> century. It is the endeavor of this section to answer the following question: How do NAFTA and membership in the WTO limit possible industrial policy tools that Canada can implement to support the alternative fuel vehicle industry? What industrial policy tools are available?

As such, this section will conclude that while international trade obligations constrain Canada's industrial policy options to encourage the national development of alternative fuel vehicles, there is still sufficient policy space for effective industrial policy in the automotive sector.

In understanding the possibilities of industrial policy within the frameworks of NAFTA and the WTO, this research can then determine the most effective industrial policy tools currently available for Canadian policy makers to promote the development of the alternative fuel vehicle sector in Canada if they choose this strategy for the automotive industry.

## **Conceptualizing Industrial Policy**

In order to understand Canada's policy space for the automotive industry, it is important to first conceptualize industrial policy. The literature on industrial policy does not share a universally accepted definition of industrial policy (Bora et al, 2000), though its conception is understood in several general components. The World Bank (1992) incorporates these components by defining industrial policy as "government efforts to alter industrial structure to promote productivity-based growth."

It is important to note the objective, process, and industrial reconfiguration that are assumed in industrial policy. The overall objective of any industrial policy can be assumed to meet development goals, be they employment growth, output expansion, income redistribution, or improvements in technological capacity, which often, but not necessarily always, support domestic firms (Bora et al 2000). The process of industrial policy features "strategic collaboration between the private sector and the government" (Rodrik 2004, 2) that leverage existing national competitive advantages or creates new ones (Shadlen 2005). The restructuring of industrial configuration is generally from that of low-productivity activity to high-productivity activity (UI-Haque 2007).

## **Restrictive Implications of CUSFTA / NAFTA on Industrial Policy**

Canadian industrial policy for the automotive sector, including the Auto Pact, was first affected and constrained by Canada's implementation of the 1989 Canada-United States Free Trade Agreement (CUSFTA) and by its successor, the 1994 North American Free Trade Agreement (NAFTA). As Japanese automotive exports aggressively penetrated the North American market, US policymakers and auto manufacturers feared that Canada and Mexico would be used as production bases for Japanese firms to more intensely penetrate the US market (Johnson 1993). The major Canadian policy objective was to secure the continuation of its export access to the US market. As a result, policymakers in North America sought to protect their interests in automotive production by creating free trade agreements.

Under CUFSTA, Canadian industrial policy and the Auto Pact were affected in two ways. Firstly, Canada relinquished its future industrial policy option to remit import duties as an incentive for production performance in Canada to firms that were not already Auto Pact manufacturers, firms designated (or expected to designated prior to the signing of CUFSTA) by the Canadian Government as Auto Pact beneficiaries (Johnson 1993; World Trade Organization 2000). Only General Motors, Ford, Chrysler, and CAMI (a General-Motors and Suzuki joint venture) would enjoy Auto Pact status (Johnson, 1993), which limited Canada's ability to attract foreign direct investment. The only way a non-Auto Pact firm could import parts for automobile manufacture and remit the import duties was to be acquired by, or acquire, an Auto Pact firm (World Trade Organization 2000).

Secondly, as CUSFTA eliminated tariffs and duties on automotive products by 1998 – as long as the CUSFTA origin rules were met – Canada would lose the remittance of duties as a policy incentive to Canadian value-added production since such duties would not exist within the CUSFTA by 1998 anyway (Stanford 2003; Johnson 1993; World Trade Organization 2000). It should be noted, however, that the Auto Pact was still preserved under CUSFTA, but it would be the start of the restrictive implications for Canadian industrial policy for the automotive sector.

With the implementation of NAFTA, an extension of CUSFTA that now included Mexico, the conditions of CUSFTA for the automotive sector were sustained (World Trade Organization 2000). As the elimination of all tariffs and duties on automotive products between the US and Canada was still slated for completion in 1998, the value of the Auto Pact was largely eliminated while its terms could not be extended to firms other than General Motors, Ford, Chrysler, and CAMI (Stanford 2003). Nonetheless, the Auto Pact was still in existence, only to be abolished in 2001 after being found to violate World Trade Organization rules, as discussed in the next section.

Also, NAFTA effectively restricted import restraint, in addition to investment and performance requirements, effectively phasing them out by 2004. While this immediately affected Mexico's industrial policy regime for the automotive industry, it also affected Canada's industrial policies for the future (Morici 1993).

As a result, while CUSFTA and NAFTA affected Canada's industrial policy options for the automotive industry, it only affected trade and investment with the United States (granted, Canada's biggest export market for automobiles) and later, Mexico. It would be, in fact, the requirements of World Trade Organization membership that would completely alter the scope of Canadian industrial policy in the automotive industry.

## **Restrictive Implications of the WTO on Industrial Policy**

As a member of the World Trade Organization, Canada was also a key proponent of its creation in 1995. Canadian legislators viewed the multilateral trade agreement, rules, and dispute settlement mechanism as protective measures against its substantially more economically-dominant, yet most important, trade partner, the United States. The expectation of export promotion also encouraged Canadian support for the WTO. When the Parliament of Canada passed legislation to implement the Uruguay Round of trade negotiations in 1994, there was virtually no opposition. (Krikorian 2003)

In examining the restrictive effects of WTO obligations on the industrial policy options for the development of Canada's alternative fuel vehicle sectors, each of the three broad categories of industrial policy will be examined on its own. Due to the scope of the research, not every specific industry policy tactic will be addressed. Only those

industry policy tactics that have been restricted or fundamentally changed in scope under WTO rules will be reviewed.

Any industrial policy that has a negative effect on another member's trade is prohibited as is any industrial policy in violation of the national treatment principle or the nondiscriminatory principle whereby foreign goods and firms are subject to equal treatment as domestically-produced goods and firms.

### ***Direct Financing***

Amongst direct financing industrial policies, the WTO is most explicitly restrictive against subsidies. Under the Subsidies and Countervailing Measures Agreement (SCM), the WTO has restrictions on subsidies, with some exceptions. Notably, export subsidies are strictly prohibited under WTO rules, except in the case of the least-developed countries, no longer making it a legal industrial policy option for Canada. This prohibition includes the ban of free loans and export credits through institutions like Technology Partnerships Canada and the Export Development Corporation (Lee 2002).

The importance of the export subsidies industrial policy option is the ability to provide incentives for industries and firms that are competitive in international markets (Rodrik 2004). Instead of having the state make risky public investments in “picking winners”, export subsidies actually provide assistance by “rewarding winners”. The removal of this industrial policy option is particularly significant for alternative fuel vehicles where it is unclear which type of alternative fuel vehicle<sup>1</sup> will replace the petroleum-powered vehicle in the future. Therefore, it makes direct investment in alternative fuel vehicles a more precarious gamble.

The WTO also prohibits subsidies that provide partiality to domestic inputs and goods over imported inputs and goods (Bora et al 2000). In Canada, it can be expected that subsidies would be provided to domestic vehicle and auto-parts firms that generate

<sup>1</sup> Types of alternative fuel vehicles identified by Natural Resources Canada (2009): battery electric, biofuel, ethanol, fuel-cell/hydrogen, natural gas, and propane

local employment and whose manufactures compete with imported substitutes. Therefore, such a restriction may effectively eliminate any form of subsidization that Canadian policymakers can provide to domestic alternative fuel vehicle manufacturers.

These prohibitions on subsidies are not without exemptions: disadvantaged region initiatives, research and development, and environment initiatives were exempted from ban under the SCM (Bora et al 2000; Lee 2002). Certainly, the exemption of research and development and environmental initiatives may have provided an opportunity for the subsidization of Canadian alternative fuel vehicle manufacturers. The research and development exemption is particularly important to the capacity-building investment efforts of knowledge-based sectors, such as alternative fuel vehicles, which could have received science and technology-based subsidies (Amsden and Hikino 1994). Notably, the non-actionable provision of the WTO membership for subsidies for research and development and environmental protection has effectively expired, as “subsidy programs are [no longer] explicitly protected as non-actionable” (Howse 2010, 1). However, subsidies for research and development and environmental protection still exist, in part since they are considered to be less trade-distortive than other measures, such as export subsidies, domestic-content requirements, or other trade-balancing requirements (Howse 2010). With most automobile industries in the world being heavily embedded in industrial policy, including subsidies, Canadian subsidies or tax incentives for alternative fuel vehicle technology producers would be a lot less vulnerable to claims under the WTO. Nonetheless, any policy that inhibits foreign imports (through export subsidies, domestic-content requirements, or other trade balancing requirements, as mentioned above) should to be avoided.

Under the guise of an explicitly environmental protection (“green”) industrial policy strategy – for which alternative fuel vehicle technology could be categorized – Canada could provide subsidies while deterring action from other WTO members, so long as the policy does not include trade-distortive measures. Even while previously non-actionable subsidies for research and development and environmental subsidies have expired, this research will treat these subsidies as still viable policy options as they still currently exist throughout the world.

In determining the viability of subsidies, this research stresses that trade distortion remains the most important factor: If a member country can prove that such subsidies have had adverse effects on its trade, the subsidies will be deemed illegal and may be justification for compensation to the affected member (Shadlen 2005). As a result, if subsidies for alternative fuel vehicles are made to Canadian firms that manufacture goods that can be substituted by imports, they may be illegal if another member country can demonstrate injury (and discrimination) as a result of the subsidy. The subsidy, however, may not be actionable if they are provided to domestic firms that produce goods that cannot be imported, i.e. new technology, which will need to be created in the fairly new and developing sector of alternative fuel automobiles.

In the realm of direct financing, the restrictive features of the SCM focus on subsidies that directly alter trade with other members. This coincides with the WTO's overall national treatment policy, whereby foreign-produced goods must be treated in the same manner as domestically-produced goods.

### ***Indirect Financing***

Import tariffs and licensing, regulatory policy in the form of local content requirements, performance requirements linked to trade, and national interpretation of intellectual property rights are limited by WTO agreements. As was the case with direct financing policy options, the restrictions on indirect financing are generally defined by the principle of national treatment.

While tariffs are not prohibited under WTO rules, nor even lowered substantially in some cases, some tariffs are "bound", i.e., subject to maximum levels. Developed countries, including Canada, have currently applied bound-tariffs to 99% of product lines including those in the automotive sector. While bound-tariffs do restrict the limit of this industrial policy tactic, they do not completely prohibit its application and do provide some flexibility (albeit, a narrower flexibility) to fluctuate import tariff levels. Still, preferential treatment is prohibited as part of the most-favoured nation clause, which requires trade norms of reciprocity and nondiscrimination (World Trade Organization 2011).

Tariff levels can be raised but must include compensatory concessions to parties with “substantial interests” that are equivalent to the value of the tariff increase (Lee 2002). But, tariff rates above the bound-levels can be temporarily implemented to protect infant industries (Bora et al 2000). Nonetheless, it is highly unlikely that the alternative fuel vehicle industry would qualify for this exception, given the long-standing and established players in both automotive production and automotive-parts production. While the specific sector is an “infant industry” in so much as the alternative fuel vehicle sector is fairly new, the industry will most likely be lumped into the traditional automotive industry, negating any claim to industry infancy. However, specific “new” components of an alternative fuel vehicle (i.e., fuel-cell technology) could perhaps seek some protection under this clause. Nonetheless, Canada’s long-standing history as an automobile producer compared to other emerging economies may not allow for its use of this exception to bound-tariffs.

While tariff reduction is central to the free trade principles of the WTO, tariffs are actually being encouraged as an alternative to non-tariff barriers. The WTO mandates that non-tariff measures, such as import licenses be replaced by tariffs as a regulatory mechanism for imports (Shadlen 2005). As a result, quantitative restrictions (i.e. import quotas) on imports are completely prohibited for developed countries (Rodrik 2004). This prevents any industrial policy that would completely ban imports of any goods.

The exception to these import rules is the case of safeguard actions. WTO members can restrict imports of products for three specific purposes: 1) “to protect a specific domestic industry from an increase in imports of any product which is causing, or which is threatening to cause, serious injury to the industry” (Rodrik 2004, 35); 2) to remedy balance-of-payments instability; and 3) to preserve levels foreign reserves (Shadlen 2005). The first purpose may only be invoked in a dire context, and may only provide emergency relief as opposed to being any sort of legal means to apply the industrial policy of an import ban. As such, it is evident that Canada cannot prohibit the import of any goods for industry policy purposes.

In addition to quantitative restrictions on imports, the WTO also prohibits domestic content requirements and protection. Such protections have traditionally been applied to automotive manufacturing industries around the world, in order to ensure that

a specific percentage of an automobile is domestically produced and a minimum level of employment is generated from the industry (Bora et al 2000).

Canada has already had to modify its industrial policy towards the automotive industry due to this obligation. Starting from 1996, Japan and the EU challenged Canada on the preferential tariff treatment it provided domestic firms General Motors, Chrysler, and Ford based on Canadian value added (CVA) content requirements (Iida 2007; Johnson 2003; Steadman 2000). The challenge eventually led to the abolishment of the Canada-United States Automotive Products Agreement (Auto Pact) in 2001.

The Auto Pact was also challenged on Canada's application of trade balancing requirements (performance requirements linked to trade), specifically the minimum production-to-sales ratio condition of the Auto Pact which was the second condition for preferential tariff treatment of General Motors, Chrysler, and Ford (Iida 2007; Johnson 2003; Steadman 2000). Essentially, the performance requirement required that "for every car sold in Canada, one had to be produced in Canada" – in addition to the CVA requirement – in order to import automobiles and auto parts into Canada, while only extending this benefit to General Motors, Chrysler, and Ford (Krikorian 2003). Such performance requirements when linked to trade, as was the case with the Auto Pact, are also completely prohibited by the WTO (Rodrik 2004).

Both local content requirements and trade balancing requirements have historically been used to "generate backwards linkages from foreign investors to local manufacturers" (Shadlen 2005, 759). As a result, these industry policy tools increased local employment, local value-added industries, and technological capabilities. Unfortunately, these requirements are technically no longer industrial policy options for Canada's alternative fuel vehicle industry if they violate the nondiscriminatory principle of the WTO. Provinces in Canada, particularly Ontario and Newfoundland, have established local content requirements in specific industries that provide subsidies to any manufacturer, domestic or foreign. However, as Canada has already been disciplined on the use of CVA and trade-balancing requirements, it is unlikely that policy-makers will attempt to even defy the WTO prohibition and revive these industry policy tools, especially in the automotive sector.

In all, the scope for protection from imports has been noticeably narrowed by WTO obligations. Non-tariff barriers have been prohibited, downward pressure has been applied to tariff rates which are already limited by bound-levels, local content requirements have been prohibited and performance requirements that are linked to trade are also illegal.

In the special case of intellectual property rights, which is covered under the Trade-Related Aspects of Intellectual Property Rights (TRIPS), the WTO has aimed to create a global patent regime that prohibits states to adopt patent-law systems that do not meet the standards of TRIPS. With regard to industrial policy options, TRIPS prohibits reverse engineering and imitation that allow industries to rapidly develop and diffuse the latest technologies and processes at relatively lower costs (Rodrik 2004; Bora et al 2000). TRIPS essentially increases the barriers to entry in technologically intensive sectors, thus discouraging technological learning (Shadlen 2005).

It should be noted that TRIPS does provide positive incentives for advanced firms that do innovate new technology. While SCM allows for research and development subsidies and successful output can be protected by TRIPS, domestic subsidies for science and technology in tandem with the WTO patent regime provide a powerful combination of industrial policy tools since they extend the competitive advantage of new technology development for local firms. This is especially true for Canada and other developed countries which tend to have a leading advantage in high technology sectors, compared to late-industrializing and developing countries (Shadlen 2005). The advantage is assumed only if Canada has the capacity to produce new technology for a sector like alternative fuel vehicles more effectively than emerging economies (including increasingly technologically advanced ones, such as China and India) and at a similar level to other developed economies.

By requiring localized production or creating restrictive and complicated licensing processes, other countries may manipulate WTO rules to legally reverse-engineer or imitate the technology, as Brazil and China have done historically (Shadlen 2005).

Depending on Canada's relative technological progress in the alternative fuel vehicle market, TRIPS can either provide a great advantage to Canadian industrial

policy, or it can severely limit Canada's policy space to develop technology if proprietary technology is developed elsewhere.

### ***Foreign Direct Investment Policy***

The WTO's prohibitions on industrial policy for foreign direct investment (FDI) are generally covered by its restrictions on industrial policy for direct and indirect assistance.

The restriction on most foreign direct investment (FDI) incentive policies are included in the SCM under subsidies (Bora et al 2000). The basic principle of the SCM is that FDI incentive policy should not directly violate the nondiscriminatory principle or the national treatment principle. In addition, export subsidies are not permissible as FDI incentives.

Any domestic content or trade balancing requirements, including those applied to FDI are in violation of WTO rules, specifically, the principles of Trade-Related Investment Measures (TRIM) Agreement (Bora et al 2000; Lee 2002). However, states can implement industrial policy that applies some performance requirements to FDI, specifically technology transfer clauses, a requirement for joint venture, and/or regulations for employment and hiring practices (Shadlen 2005).

### ***Other Allowed Industrial Policies***

While the WTO has a restrictive effect on discriminatory industrial policy options, it also has the effect to promote specific industrial policies over others. Development policies that are relatively generic within a specific industry, without favour to any specific firm or country of origin of a firm, are still very much possible. General fiscal allowances are allowed under the WTO, so long as they do not violate the principle of national treatment and the nondiscriminatory principle, and do not displace existing trade. Included in such policies are subsidies for general research and development, the promotion of corporate investment (such as nondiscriminatory tax transfers), the development of infrastructure, the expansion of human capital capacity (i.e. general education or training institutions and training), and coordination activities between multi-tiered suppliers (so long as foreign firms are treated the same as national ones) (Bora et al 2000).

Other indirect policies are also allowed. The discouragement of dividend payments and the management of a stable exchange rate are permissible under WTO rules (Bora et al 2000). Public health coverage and public education are other examples of indirect industrial policies that would make a state more competitive in the global economy, as identified by the WTO itself (World Trade Organization 2011). In addition, creating and maintaining the legal environments of property rights and contract enforcement will also aid act as industrial policy to encourage corporate investment, including FDI (UI-Haque 2007).

## **Implications of Trade Agreements for Canada's Industrial Policy**

Given the highly competitive nature of the global automotive industry, which includes developed economies, newly industrialized economies, and emerging economies (albeit, largely limited to BRIC countries), it is reasonable to assume that industrial policy in the automotive sector, especially of those in the developed world, will be scrutinized. As such it is vital that in forming a national industrial policy strategy for the development of alternative fuel vehicles, Canada cautiously creates policy within the policy space defined by the WTO trade and investment rules. Certainly, as evidenced above, industrial policy options have changed in their range and flexibility, but they still do exist.

There are several general implications from examining the effect of WTO and NAFTA's rules on Canada's industrial policy options for the alternative fuel vehicle sector:

- Subsidies are still possible industrial policy options, so long as they are applied to research and development or environmental initiatives and cannot be proven to affect another country's trade, particularly by mandating local-content performance requirements or trade-balancing requirements.
- Policy options that seek protection from imports are becoming increasingly limited and narrow.
- TRIPS provides a powerful safeguard for the investments of industrial policy and the development of new technology, which is advantageous if Canada is superior in technological development.

- FDI incentive policies are treated in the same manner as subsidies and domestic content and trade balancing performance requirements. Nonetheless, so long as the national treatment principle and nondiscriminatory principle are not violated, states can use technology transfer clauses, mandatory joint venture clauses, and regulation for employment practices in its treatment of FDI.
- WTO obligations allow generic development policies that do not violate the national treatment and nondiscriminatory principles, including general fiscal concessions, the management of stable macroeconomic and legal environments, infrastructure spending, and the social spending on healthcare, education, and training programs.

The enforcement of WTO rules is relatively effective, given the dispute settlement mechanism that contests challenges from member nations (Shadlen 2005). Discipline is essentially created by restricting export market access to a transgressing member. As the abolishment of the Auto Pact exemplifies, even historically long-standing industrial policies can be forced to end by WTO enforcement. The only real requirement is that the industrial policy be successfully challenged by another member.

Notably, while NAFTA and the WTO provide a legalistic framework for Canada's industrial policy scope, affordability and capability to enact industrial policy options will ground discussion of policy options in Section III.

Nonetheless, while trade agreement obligations constrain Canada's industrial policy options to encourage the national development of alternative fuel vehicles, Canada still has sufficient policy space for effective industrial policy in the automotive sector and other industries.

## **Section III.**

# **A National Industrial Policy Strategy for the Development of an Alternative Fuel Vehicle Sector in Canada**

The crux of this research has been determining what industrial policy tools Canada can employ in supporting the development of an alternative fuel vehicle industry. The foundation of concluding upon a national industrial policy plan has been established in the prior sections. Section I established the historical importance of industrial policy in the Canadian automotive industry and the factors of the emergence of a dominant vehicle type during the nascent years of automotive development, including active involvement from an energy industry.. Section II then delineated the scope of industrial policy options for Canadian policy-makers given the restrictions of NAFTA and WTO membership.

This final section of the research intends to build on the conclusions of the previous sections to achieve the central purpose of this research: identifying the most effective industrial policy tools currently available to policy makers in Canada that can be implemented to promote the development of an alternative fuel vehicle industry in Canada.

In order to realize this central purpose of the research, this section will cover the following key questions:

- What are the factors for successful promotion and development of an alternative fuel vehicle manufacturing sector in Canada?
- What should the targets be of an industrial policy in Canada for the alternative fuel vehicle sector?
- How can these targets be met given the current Canadian industrial policy for the alternative fuel vehicle industry and within the scope of possible industrial policy options?

- Is the alternative fuel vehicle design and manufacturing industry viable in Canada?

As evidenced in this research, the automotive industry in Canada – like other competitor countries – has historically been reliant on active state industrial policy. While industrial policy tools have become increasingly difficult to implement as a result of multi-lateral trade agreements, there is sufficient policy space to support the development of alternative fuel vehicle technology and rejuvenate the automobile industry as a national sector for economic growth. As such, Canadian policy makers can recognize the substantial role of a national industry policy in the automotive sector, and implement the following industrial policy in order to effectively promote the development of the alternative fuel vehicle industry in Canada:

- a) Research and development subsidies, including tax benefits and investment incentives
- b) Demand-side promotion, including the implementation of regulation favourable to consumer adoption of alternative fuel vehicles
- c) Coordination and collaboration initiatives to strengthen the financing, research, and production institutions of the automobile sector
- d) Legal and regulatory frameworks that eliminate barriers to innovation

In sum, the Canadian alternative fuel vehicle industry can be a viable sector in the Canadian national economy. Canada is quite capable of adopting a cohesive national industry policy plan for the alternative fuel vehicle sector in order to be successful and competitive in the long-term as automobile manufacturers shift away producing traditional, internal combustion engine vehicles.

## **Factors of the Successful Emergence of an Alternative Fuel Vehicle in Canada**

In Section I, several factors of successful development and adoption of the internal combustion engine were established:

- Technical factors
- Socio-economic factors
- Infrastructural factors
- Investment factors
- Industrial policy factors

In examining these same dimensions against the possible emergence of an alternative fuel vehicle over the traditional internal combustion vehicle, this research applies the historical lessons of the dominance of the petroleum-powered vehicle over the original electric vehicle design and steam-powered vehicles. As was realized in Section I, the petroleum-powered vehicle emerged as the dominant vehicle type due to its technical and socio-economic comparability and advantages over the other vehicle types, its more developed network of fueling stations outside major cities, and the active support it received from its respective energy producer, in addition to some favourable industrial policy measures. In addition, the development, growth, and even survival of automotive production in Canada have always relied on industrial policy support.

In terms of technical factors, the overall cost of manufacture of an alternative fuel vehicle, its maintenance requirements and durability, comfort and ease of operation, thermal efficiency and horsepower must be comparable (if not, superior) to that of a petroleum-powered vehicle. In fact, it was the overall durability, versatility, and efficient use of energy that advantaged the petroleum powered vehicle in spite of its relatively complicated mechanisms and emissions of pollutant. Notably, for that reason, it is evident that battery-electric plug-in vehicles may be the most viable alternative fuel vehicle to challenge the supremacy of the internal combustion engine automobile. In addition to its long-standing historical development, the battery-electric vehicle is the most developed alternative fuel vehicle in the market, with several (albeit, expensive and technically limited) offerings in the market today.

Socio-economic factors generally encompass consumer perception and affordability in the context of favourable demand conditions. While the perceived durability and reliability of the petroleum-powered vehicle garnered some consumer preference over the electric-powered and steam-powered competitors, its perceived risks to consumers and the popularity of the original electric vehicle exemplified how a vehicle type could overcome unfavourable socio-economic factors to a certain degree in emerging over other vehicle types in the market. Certainly, the cost to consumers will assume a large role for any alternative fuel vehicle, as rapid innovations in alternative fuel vehicle production will need to shrink manufacturing costs for such a vehicle to compete in today's market.

An extremely influential factor of success for a vehicle type is infrastructure, both in terms of road development and access to fueling stations. Any alternative fuel vehicle must be adaptive to current roads and highways, which most vehicles are. However, accessibility to fueling stations may impede the will to develop some alternative fuel vehicles. Notably, also in this circumstance, the battery electric vehicle which may require an upgrade of home electric outlets at most, may be the least costly vehicle to introduce to the mass market since advanced electric grids exist (and will be the basis of fueling infrastructure) in most of Canada (and the developed world).

Investment factors assume two general conditions in the market. Firstly, a macroeconomic climate that supports investment in competitive markets will be necessary for alternative fuel vehicle development to rapidly advance for the vehicle to compete with petroleum-powered vehicles. Capital markets and access to finance will be crucial for any alternative fuel vehicle. Canada does boast strong, supportive macroeconomic conditions, which may require some feasible regulatory changes to fully support such high technology development. Secondly, the role of supporting industries, particularly energy, will play a major role in alternative fuel vehicle production. With shared components (plastics, metals, rubber) and a developed energy source in the case of electric-powered vehicles, alternative fuel vehicles are well positioned to compete with petroleum powered vehicles.

Lastly, but most historically important for Canada, industrial policy factors will assume the largest and most influential factor in the successful promotion of alternative

fuel vehicle technology development and comprise the focus of this research. Political will, including funding, and sound industrial policy tactics can affect most of the aforementioned factors, and can be the deciding factor in the success of a new, dominant vehicle type. Public endorsement, funding, and regulatory frameworks, in the development of an alternative fuel vehicle will boost the favourability of an alternative fuel vehicle's technical factors, socio-economic factors, infrastructural factors, and investment factors. The possible industrial policies for the future dominance of an alternative fuel vehicle are the focus of this research.

## **Targets of Canadian Industrial Policy in the Alternative Fuel Vehicle Sector**

In Section I, the research established the purpose for Canada's most significant industrial policy for the automotive industry, the 1965 Auto Pact: to develop a strong automotive-manufacturing sector, in spite of being limited by its own small, domestic market. In general, the Auto Pact assumed three overall goals: Higher overall production of alternative fuel vehicles, lower duties on imported components (necessary to increase overall production), and the creation of a highly competitive industrial sector in automobile manufacturing.

Similarly, Canadian industrial policy for the alternative fuel vehicle sector can assume the three following goals:

- Higher production of alternative fuel vehicles in Canada
- Decreased restriction of inputs necessary for production of alternative fuel vehicles in Canada (including and particularly, capital)
- The creation of a globally competitive alternative fuel vehicle industry

Canadian industrial policy in the alternative fuel vehicle industry will need to stimulate both supply (development of vehicles) and demand, which will require some adjustments in Canada's overall regulatory framework and macroeconomic conditions that affect the industrial sector.

## **Current Canadian Industrial Policy Supporting the Automotive Industry**

In spite of the end of the Auto Pact, Canada's current industrial policy for the automotive industry, including the development of an alternative fuel vehicle industry, persist in several ways: the 2008 automotive-industry bailout, general research and development subsidies across all industries, the Automotive Innovation Fund, Automotive Partnership Canada, AUTO21, and other industrial policy initiatives for the automotive sector that focus on human resource development, infrastructure development, and demand-side promotion of the automotive sector. These policy measures will be examined as a starting point for policy recommendations for the development of the alternative fuel vehicle.

### ***2008 Automotive Industry Bailout***

In response to the automotive crisis in 2008, the Canadian government, in conjunction with the US government, demonstrated its political will to keep Canadian automobile manufacturing viable. Notably, the federal government of Canada and the provincial government of Ontario extended \$3.775 billion to Chrysler, in addition to working-capital and restructuring loans, to maintain its North American operations, as the company was approaching insolvency. The federal government and provincial government of Ontario also provided restructuring loans and debtor-in-possession financing to General Motors totaling upwards of \$9.5 billion and resulting in a 12% ownership stake in General Motors (Parliament of Canada, 2009). Additionally, over the same time period, Toyota Motor Manufacturing Canada also received \$141-million in loans and grants from the federal government and Ontario provincial government to upgrade its two Ontario plants in order to produce electric vehicles (Chase and Keenan 2011).

The automotive bailout not only exemplified the political will in Canada to invest large blocks of capital to keep the automotive manufacturing industry operating, but it also further highlights the historical importance of industrial policy for the automotive sector in Canada. As the industry has already depended on industrial policy to be competitive and grow, policy measures – beyond that of emergency funds – will be

needed to ensure the industry's long-term sustainability. The support to develop alternative fuel vehicles can be a sound strategy for Canadian policy-makers in the next phase of Canada's industrial policy towards the automotive industry.

### ***General Research and Development Subsidies***

In Canada, investment incentives and subsidies, including those for research and development activities, are largely policy matters on the provincial level. Notably, however, for much larger industries, particularly the automobile industry, incentives from the federal government – in conjunction with provincial participation – are much more common (Thomas 2007). The federal government has outlined some general subsidies towards research and development activities, regardless of the industry.

Currently, the federal government of Canada has a scientific research and experimental development expenditure of approximately \$3.5 billion. The federal government extends a full tax deduction to all qualified scientific research and experimental development activities, while extending a 20% tax credit to Canadian corporations and foreign-controlled companies that can be used to offset federal taxes payable in the current year, in the previous three years, or in the next 20 years without any ceilings when claiming this tax credit. This suits the research cycles of many research and development-intensive activities that will not generate immediate revenues. (Government of Canada 2012)

In addition, smaller Canadian-controlled private companies, with taxable income of up to \$500,000 and taxable capital of up to \$10-million, can receive a refundable tax credit of 35% of qualified research and development activities to a maximum of \$3-million worth of such expenditures per year. Expenditures exceeding the \$3-million threshold are then extended the tax credit rate of 20%, 40% of which can be refundable. While this does account for a direct subsidy for Canadian-owned companies and seemingly seems to violate provisions under WTO membership, there does not seem to be any current dispute. (Government of Canada 2012; KPMG 2002)

Provincial governments also offer their own additional tax incentive programs for qualified scientific research and experimental development expenditures, which are generally extended to all companies operating in Canada (locally owned or foreign

owned) (Government of Canada 2012). As such, small Canadian-controlled private corporations enjoy a combined tax credit rate ranging from 35% to 61% including some provincial and federal refunds depending on the province in which they operate; while large Canadian companies and foreign-controlled corporations enjoy a combined tax credit ranging from 20% to 36% including some provincial refunds depending on the province in which they operate (Government of Canada 2012).

While these available tax credit rates and refunds establish highly competitive tax treatments for innovation activities for the alternative fuel vehicle industry, they are not focused solely on that industry, let alone the automotive industry in general. Instead, these subsidies represent a strong starting point for a policy strategy to support the development of alternative fuel vehicles, but should be augmented with more industry-specific policy measures.

### ***Automotive Innovation Fund***

As part of the 2008 Federal Budget, specifically the mandate to invest in Canada's manufacturing base, the Automotive Innovation Fund (AIF) was established to provide automotive firms with \$250-million over five years to "support strategic large-scale research and development projects to build innovative, greener, and more fuel-efficient vehicles" (Industry Canada, 2008). Essentially, the AIF considers funding proposals that provide over \$300-million of private sector investment in automotive innovations and research and development projects in Canada. In 2009, the Ministry of Industry lowered the total investment threshold required to qualify for AIF funding to \$75-million over five years (Industry Canada, 2009). Any proposals for funding were assessed based on their overall contribution to the following:

- "automotive R&D capacity and knowledge-based jobs in Canada;
- the government's S&T Strategy and environmental agenda;
- the development of innovative, fuel-efficient technologies or processes;
- the long-term economic benefit to Canada, including significant job creation/retention; and
- their potential to attract further investments to foster Canadian competitiveness." (Industry Canada 2008)

The focus of AIF funding centers on the research and development of automotive innovation to develop more fuel-efficient vehicles:

- “new product development (e.g., advanced emissions technologies, energy-efficient engines and transmissions, advanced materials, including engineered plastics, and lightweight components and materials);
- leading-edge engineering and design, and prototype development;
- advanced product testing that ensures cleaner, more efficient automotive performance, and reduces greenhouse gases;
- the development of new production methods and process technologies, including advanced flexible manufacturing techniques;
- new or expanded facilities to produce leading-edge and more energy efficient vehicles and powertrains;
- substantive investments in new flexible manufacturing processes; and
- introduction of other new transformative production technologies to substantially increase productivity and efficiency (e.g., robotics and advanced IT systems).” (Industry Canada 2008)

Notably, ineligible proposals included “replacement technology”, which assumingly includes alternative fuel vehicle development (Industry Canada 2008). As of writing, the AIF has nearly been exhausted as its term approaches, allocating over \$227-million over four different projects. Only one project, the Ford Motor Company of Canada Renaissance Project, included research into new fuel technologies though largely limited to powertrains. The bulk of this project is focused on greater fuel efficiency for petroleum-powered vehicles, particularly the creation of a flexible-engine assembly plant in Windsor, Ontario.

The AIF provides a good source for research and development subsidies; however, it excludes research into alternative fuel technologies. The greater focus of this fund has been on fuel efficiency and the manufacturing process of automobiles and their components. As the fund is nearly exhausted and possibly up for renewal, it may provide policy-makers with an opportunity to refocus its mandate towards alternative fuel vehicles.

## ***Automotive Partnership Canada***

In 2009, the Federal Government of Canada announced the creation of Automotive Partnership Canada (APC) as a five-year, \$145-million fund to support collaborative research and development activities focused on automotive innovation in general (Automotive Partnership Canada 2009). The focus of the APC is on “transformative, integrated projects or programs that will give Canadian industry and academia the resources required to further automotive research and development” (Automotive Partnership Canada 2009). In fact, one of the ten priority areas that the APC identifies as a research priority includes the “application of alternative fuels” (Automotive Partnership Canada, 2009). Many of the APC’s funded projects have included the development of fuel cell technology and electric car battery technology, in addition to general fuel-efficiency research for petroleum-powered vehicles.

The APC is a partnership between five federal agencies of Industry Canada: Natural Sciences and Engineering Research Council of Canada, National Research Council, Canada Foundation for Innovation, Social Sciences and Humanities Research Council of Canada, and Canada Excellence Research Chairs (Automotive Partnership Canada 2009). The Industry Task Force of the APC, which is meant to provide guidance for APC activities including the priority of research areas, determines the allocation of APC resources. The APC’s Industry Task Force includes academia partnerships with the University of Ottawa, McMaster University, the University of Windsor, and the University of Waterloo collaborating with industry partners such as General Motors of Canada, Toyota Motor Engineering and Manufacturing North America, 3M Canada, Ford Motor Company of Canada, and Magna International. (Automotive Partnership Canada 2009)

Notably, the APC accepts funding proposals that arise from industry needs (thus being driven by private sector development strategy) without any minimum or maximum dollar amounts and allowing projects to range from six months to five years in duration. Projects must be collaborative with university and/or government researchers, include more than one member within the automotive supply chain (Tier 1, 2, or 3 parts suppliers), or must be of a high-risk nature that has a profound or disruptive impact on the automotive sector in Canada. (Automotive Partnership Canada 2009)

The APC, as a result, has provided a model for research and development subsidies that directly support the development of alternative fuel vehicle technology, based on industry needs. The emphasis on collaboration between industry, university research institutions, and public research organizations, with the inclusion of alternative fuel vehicle technology in its mandate, allows for riskier research and development activities in the automotive industry and a greater propensity towards the type of institutional thickness that can generate innovation, which will be discussed later. As the APC nears its expiry, its renewal with more specific tactics to achieve institutional thickness will be a great component to an overall national policy supporting the development of alternative fuel vehicles.

## ***AUTO21***

AUTO21 is a research and development initiative within the automotive sector established by the Canadian Networks of Centres of Excellence (NCE) funded by public sector members and private sector (industry) partners. Public sector partners include federal governments (primarily Canada, but also notably Saudi Arabia) and various Canadian provincial and municipal governments. (AUTO21 2011)

The annual research budget of AUTO21 is approximately \$11-million directly supporting approximately 200 Canadian researchers and over 400 students from 46 universities in Canada working on applied automotive-related research focused on innovation (AUTO21). The research mandates fall into six broad categories: health, safety and injury prevention; societal issues and the future automobile; materials and manufacturing; design processes; powertrains, fuels and emissions; and intelligent systems and sensors. Within these categories, there is no research directly supporting alternative fuel vehicle technology.

In contrast to the Automotive Innovation Fund and Automotive Partnership Canada, AUTO21 focuses on research-driven projects. It provides much smaller research and development subsidies that go to universities and research institutions (instead of industry), but it does not mandate alternative fuel technologies as a priority. If it were to increase its research budget, the increase of which being focused toward alternative fuel vehicle research, it could certainly draw on its institutionally-thick

organization and coordination as a very significant component of a national strategy to develop alternative fuel vehicles.

### ***Other Current Industrial Policy Measures for the Automotive Industry***

Currently, other industrial policy measures for the automotive industry fall into three broad categories: human resource development, infrastructure development, and demand-side promotion of the automotive sector. They provide some policy support for the development of alternative fuel vehicles and will be good starting points for additional policy measures as part of a national strategy.

In terms of human resource development, Parliament of Canada (2009) has outlined several federal initiatives to support the development of human capital in the automotive industry. The Canada Excellence Research Chairs is mandated to attract the world's top researchers and develop research projects for Canadian industry, including the automotive sector. The Human Resources and Skills Development Canada (HRSDC) through the Sector Council Program, provides two sector councils in the automotive sector, "one for manufacturing – Council for Automotive Human Resources (CAHR) – and one for the aftermarket – Canadian Automotive Repair and Service Council (CARS)". These programs include workplace training and development resources for the automotive sector. (Parliament of Canada 2009)

However, the development of human resources in the automotive sector has no priority or mandate for alternative fuel vehicles. If these human resources and skills development programs would include support for research and human capacity building specifically within the alternative fuel vehicle industry with strong linkages throughout research institutions and industry, these existing expenditures could support the development of the alternative fuel vehicles.

While infrastructure development is a much more broad category and beyond the general scope of this research, the federal government has included alternative energy as a priority for national infrastructure projects. The Building Canada Plan, which allocates \$33 billion to infrastructure investments, includes investment in green energy.

The federal government has also instituted some demand-side promotion programs for the automotive industry. The Canadian Secured Credit Facility lends support for vehicle financing for dealers, allowing for more favourable purchasing terms for Canadian consumers. The Motor Vehicle Scrappage Incentive Program and Canadian Warranty Commitment Program provide incentives to consumers to accelerate the retirement of older vehicles and to purchase new vehicles (from Canadian manufacturers, Chrysler and General Motors) with guaranteed warranties (Parliament of Canada 2009).

Moreover, the Canadian federal government had instituted a rebate program for the purchase of electric cars and plug-in electric hybrids, which ended in March 2009. Five provinces also instituted their own rebate programs for these vehicles (Scrimgeour 2009).

As part of a national policy to support the development of alternative fuel vehicles, demand-side promotion will be extremely important, in addition to supply-side policy measures. As noted with many of the current industrial policy actions for the automotive industry, some of these can be reconfigured or refocused to favour alternative fuel vehicle development. In addition, other demand-side promotion activities can be adopted to further bolster consumer adoption of these new vehicles.

## **Industrial Policies for the Development of the Alternative Fuel Vehicle Sector in Canada**

Drawing lessons from the petroleum-powered vehicle's dominance over other vehicle types and the history of successful industrial policy in the Canadian automotive sector, there are four broad categories of industrial policies that can be implemented for the successful development of the alternative fuel vehicle industry in Canada: .

- a) Research and development subsidies, including tax benefits and investment incentives

- b) Demand-side promotion, including the implementation of regulation favourable to consumer adoption of alternative fuel vehicles
- c) Coordination and collaboration initiatives to strengthen the financing, research, and production institutions of the automobile sector
- d) Legal and regulatory frameworks that eliminate barriers to innovation

These would be designed to meet the targets of higher production; decreased restriction of necessary inputs for production including capital; and global competitiveness within Canada's industrial policy scope.

In order to be successful, supply-side funding, demand-side promotion, coordination and collaborative initiatives to strengthen institution thickness within the sector, and redefined legal and regulatory frameworks must be implemented together in one cohesive, national industrial policy plan.

### ***Research and Development Subsidies***

In Canada, investments incentives, including those for research and development activities, are largely policy matters on the provincial level. Notably, however, for much larger industries, particularly the automobile industry, incentives from the federal government – in conjunction with provincial participation – are much more common (Thomas 2007). Thus a national industry program for alternative fuel vehicles is not only necessary, but viable considering current industrial policy dedicated to the automotive industry, in general.

The need for government expenditures on research and development in the alternative fuel vehicle industry must exist as a result of market failure and the market being unable to generate the necessary funding required to initiate a successfully large-scale alternative fuel vehicle sector. Nonetheless, industrial policy that extends investment incentives and subsidies to automotive manufacturers are a common (if not, standard) practice in the automobile industry, whether it be the Canada, the United States, United Kingdom, France, Germany, India, China, Brazil, or Eastern Europe (Thomas 2007). Worldwide, automobile manufacturing simply does not invest in new facilities or an upgrade of facilities without some form of subsidies (Thomas 2007).

In Canada, the need and urgency for subsidies in the automotive sector may be even more significant due to increased global competition. Notably, in spite of a wealth of human capital and institutions, several authors note Canada's underperformance in innovation, otherwise known as the "innovation gap" (Munroe-Blum and MacKinnon 2009; McFetridge 2008). This reflects the fact that Canada has a poor record of business expenditure on research and development and percentage of total research and development performed by business, in spite of the fact that Canada's national research and development undertaken by universities is only second to Sweden amongst OECD countries (Munroe-Blum and MacKinnon 2009). Canada also has a "higher proportion of smaller and medium enterprises than the United States", which have less of a propensity to engage in costly research and development activities than larger enterprises (Gafni 2005). However, due to the "long-term and uncertain results" of research and development expenditures, even large private enterprises have an inclination to invest less than what is required to spur new scientific and technological advances (Niosi and Bas 2004).

As a result, due to Canada's low business expenditure on research and development, direct state investment in commercial research and development activity would best support parallel government and industry goals (Munroe-Blum and MacKinnon 2009). In order to bridge this innovation gap, in lieu of the low business expenditure on research and development, Canadian industrial policy must include direct funding and tax incentives for investment. This would not only supplement the lack of funding in research and development activities, it would also help to encourage more investment from the private sector.

With the effective expiry of the non-actionable provision of the WTO membership for subsidies for research and development and environmental protection, "subsidy programs are [not] explicitly protected as non-actionable" (Howse 2010, 1). However, subsidies for research and development and environmental protection still exist, in part since they are considered to be less trade-distortive than other measures, such as export subsidies, domestic-content requirements, or other trade-balancing requirements (Howse 2010). As noted in Section II, any subsidies must be as least trade-distortive as possible.

Canadian subsidies for the alternative fuel industry should be focused on correcting market failures, in particular by increasing the public good of technology development and environmental protection innovations (even if under the latter's guise). This program of subsidies should support "market-driven, incremental" innovation conducive to inter-firm cooperation with subsidy incentives for entrepreneurship (McFetridge 2008). Since most alternative fuel vehicle technology, particularly battery electric vehicle technology, are already well under development, supporting incremental advances in development is feasible. In fact, these research and development subsidies would not even have to account for new government spending, as the renewal of the Automotive Innovation Fund and Automotive Partnership Canada with a mandated focus on alternative fuel vehicle technology would be sufficient.

Canadian policy-makers have heavily invested in industry-driven research and development to improve the fuel efficiency of internal combustion engines through the Automotive Innovation Fund and Automotive Partnership Canada. As these funding bodies of industry research and development set to expire, they should be renewed for another five years but eliminate eligibility for proposals directed towards the research of fuel efficiency of petroleum-powered vehicles. Instead, both funding bodies should mandate a focus on alternative fuel vehicle technology. The Automotive Innovation fund will cover large-scale proposals from industry actors directly, still requiring the total investment from industry proposers to meet a threshold of \$75-million over five years. A lot of this funding will go towards projects that are already well-advanced from the initial research stages, but require large amounts of capital to deliver transformative projects. In contrast, the Automotive Partnership Canada will cover more collaborative industry projects without a minimum investment threshold from industry proposers. This will be more oriented towards research in the earlier stages where investment is much more risky.

For AUTO21, which focuses on research-driven projects (as opposed to industry-driven projects), funding should be increased by an amount that will be solely dedicated to alternative fuel vehicle technology. Currently, AUTO21 lacks any research mandate in this field, and it is imperative that funds are available for universities and research-institutions to engage in research focused on the technological development of alternative fuel vehicles. As AUTO21 has a relatively smaller budget compared to the

Automotive Innovation Fund and the Automotive Partnership Canada, even a 50% increase in annual funding amounting to approximately \$5.5 million should be feasible and dedicated purely to research into alternative fuel vehicle technology. There would be no compromise of research initiatives for other research priorities, as a result, but a significant mandate for alternative fuel vehicles.

The recent case of Singapore's policy makers in creating a sustainable and successful biomedical industry provides some guidelines for Canadian policy-makers to encourage the high-technology development of alternative fuel vehicles and parts. In fact, Singapore was able to extend incentives to foreign and domestic investors in the biomedical sector without any industrial policies on performance or local content requirements (Lim and Wei 2010), which comprised the basis of the Auto Pact. Seven key tactics to attract high-technology investments could be implemented in Canada's alternative fuel vehicle sector:

- Pioneer status – exempting manufacturing investments on new, highly-advanced, high technologies from corporate tax on profits from those manufacturing operations for a period of five years.
- Development and expansion incentives – providing concessionary tax rates for firms upgrading and expanding current operations for the manufacture or development of innovative products.
- Investment allowance incentives – exempting research and development activities from corporate tax as a specified proportion of fixed investments.
- Approved loan schemes – wholly exempting a withholding tax on the interest payable to an institutional lender for alternative fuel technology developers and manufacturers.
- Approved royalties – wholly exempting a withholding tax on royalties of an innovation created within Canada for a period of five years.
- Operational headquarters incentive – partially exempting alternative fuel vehicle and parts developers whose global headquarters are located within Canada.
- Accelerated depreciation allowance – manufacturers and developers can claim a larger percentage for plants and machinery, with the option to claim 100% in year one for specific high-technology equipment. (Lim and Wei 2010, 5-6)

These policy measures would be on top of the federal government's current tax credit rate system for research and development activities, while only being applicable to alternative fuel vehicle operations so as to promote transformative innovation activities,

not the general automotive industry or fuel-efficiency improvement activities for petroleum-powered vehicles. This would allow Canadian policy-makers to directly attract local and foreign investment in the high-technology sectors of alternative automotive production which require high levels of research and development to achieve innovation.

All of these investment incentives are non-actionable under the WTO agreement and should be made available to the alternative fuel vehicle industry. Unlike “front-end” performance requirements that mandate specific targets to be met in order for a firm to operate – and have consequently been challenged under NAFTA and the WTO – these investment incentives act as “back-end” rewards. They do not prevent the operation of any firm, but rather, reward firms that meet a certain threshold of research and development or innovation activity performance with tax benefits.

In addition, explicit thresholds for these incentives should be established, including specific performance requirements. This would include the number of employees that must be hired to receive the tax credits or exemptions (Thomas 2007). Such performance requirements also do not violate the World Trade Organization agreement, since they do not consist of export and domestic-content requirements (Thomas 2007), once again providing “back-end” rewards in the form of tax incentives for high-performing firms. Monitoring, disclosure requirements, and penalties for breach of transparency once tax credits have been availed can also be established (Thomas 2007). As such, upfront incentives are avoided, as incentives or subsidies are only paid out when the performance of specific industrial policy objectives are achieved.

While these incentives seem to comprise a large amount of expenditure, they will still pale in comparison to the bailout programs of 2008 while driving the industry towards a global competitiveness that will (if successful) no longer need such large bailouts. Costs for such an undertaking are difficult to estimate given the scope of this research, especially across the broad sector of alternative fuel vehicles. In the case of battery electric vehicles, however, the Electric Vehicle Technology Roadmap for Canada, produced by national academics, labour leaders, and industry leaders, recommends that the Canadian federal government invest upwards to \$1.4 billion dollars if it is to achieve 500,000 electric car vehicles (excluding hybrids) on Canadian roads by 2018 (Natural Resources Canada 2009). While the cost of expenditure might seem high, the current

cost of industrial policy programs for the automotive sector in Canada comprises a significant amount as other governments around the world also continue to support their national automotive industries with subsidies, financial incentives, and other resources, making such a large commitment to the automotive industry a necessity for success.

Subsidies alone will not necessitate technological development. In fact, investment incentives should be packaged within a national policy that should involve domestic firms and energy producers, which have a greater propensity to absorb spillovers from research and development activities (Thomas 2007) without excluding foreign firms that establish operations in Canada, so as to not violate the tenets of the WTO agreement. In all, a comprehensive package of subsidies for research and development (and the manufacture of innovative new products in the alternative fuel vehicle industry) helps to achieve all three targets of industrial policy for the sector as outlined above. Subsidies correct market failures that impede greater domestic production of alternative fuel vehicles by supporting innovative developments. Moreover, tax incentives help to decrease barriers to innovation by incentivizing increased investment and providing capital. The innovation that will follow in Canada's alternative automotive industry will lend Canadian alternative fuel vehicle developers to be globally competitive, as other economies in the world continue to invest in new technologies.

### ***Demand-Side Promotion***

In addition to the supply-side support of alternative fuel vehicle development, the basis of which can be drawn from the Auto Pact, industrial policy should also focus on consumer adoption of alternative fuel vehicles which entails support for consumers to effectively purchase, fuel and operate these types of vehicles (Girard 2011). As evidenced in Section I, socio-economic factors, particularly consumer attitudes, were a determinant for the petroleum-powered vehicle's dominance, as policymakers should support initiatives that make alternative fuel vehicles more attractive to consumers. Currently, demand-side promotion in Canada has been limited to battery electric or plug-in hybrid vehicles, as this is the only alternative fuel vehicle type available to the mass market.

In the US, the federal government granted tax credits up to \$7,500 for the purchase of an electric or plug-in hybrid vehicle (Scrimgeour 2009). However, Canada's national incentive program for electric vehicles expired in March 2009, while some provinces have acted alone on instituting incentives for the purchase of such vehicles (Scrimgeour 2009). This is not sufficient, as federal policy-makers should renew incentive programs for the purchase of alternative fuel vehicles, while orienting the Motor Vehicle Scrappage Incentive Program towards the purchase of alternative fuel vehicles when older vehicles are scrapped.

The federal government should also support and mandate municipal governments (particularly of large metropolises) to adopt demand-side promotion of alternative vehicles. This promotion can be implemented through a multi-pronged program that supports preferred parking spots, access to transit or high-occupancy vehicle lanes, and exemption from certain vehicle operation taxes (Scrimgeour 2009). In addition, the federal government can provide grants or incentives for larger municipalities to institute new construction by-laws that require new homes to have dedicated electric plug-in outlets or infrastructure for such vehicles. In fact, in July 2009, the City of Vancouver passed such by-laws, "requiring all new single-family homes and off-street bicycle storage rooms to have dedicated electric plug-in outlets... and requir[ing] charging infrastructure for 20 percent of all parking stalls in new condo buildings" (Scrimgeour 2009, 6). As evidenced in Section I, access to fueling stations is an important determinant in the successful adoption of a vehicle type, as the federal government must encourage the expansion of such fueling networks, particularly in new construction or other municipal planning projects.

In aiding municipal governments, the federal government can also standardize outlets for plug-in electric vehicles and charging stations, thus providing clear guidelines for municipalities lacking resources on how to implement such new by-laws. Currently, there are no universally accepted standards for these outlets, though the Society of Automotive Engineers is working to establish such rules and standards for North America (Scrimgeour 2009).

A federal carbon tax program could also be implemented so as to discourage the consumption of petroleum, by raising its overall cost to consumers. Such a policy,

however, would be politically controversial and potentially, not viable. Instead, regulating vehicle emission requirements (as discussed in Legal and Regulatory Frameworks section) may be less politically challenging and viable.

The federal government should also implement mandatory adoption of these vehicles for their own use where appropriate, while mandating or incentivizing provincial and municipal governments to purchase alternative fuel vehicles. By adopting alternative fuel vehicles in government operation, all three levels of government demonstrate state-commitment to alternative fuel vehicle adoption while having these vehicles as “mobile billboards”, as well (Scrimgeour 2009).

Demand-side promotion specifically meets the target of higher production of alternative fuel vehicles over the long-term, by stimulating local demand for alternative fuel vehicles.

### ***Collaboration and Coordination Policies (Institutional Thickness)***

As evidenced in Section I, petroleum producers played a major role in supporting the development of the petroleum-powered vehicle as the dominant vehicle type. The lobbying interests of petroleum producers, in fact, spurred a lot of industrial policy. In absence of a strong alternative fuel lobby, federal policymakers must create industrial policy that includes and empowers alternative fuel producers to support development of such vehicles. In addition, federal policy-makers must ensure that other institutions necessary for such technological development (education and research facilities, automotive vehicle and parts businesses) are not only included, but can also build institutional synergies through coordination, cooperation, and support.

Commercial research and development funding does not necessitate innovation, as fiscal incentives are only one component of an industrial policy for innovation. In fact, Canada has experienced an innovation gap – a relatively low-yield of innovation in spite of high government support of business research and development (Monroe-Blum and MacKinnon 2009; McFetridge 2008; Gafni 2005). The Council of Canadian Academics and the Science, Technology, and Innovation Council found Canada to be strong in academic research, but lacking in “converting [this] strength in basic science into commercial success” (Munroe-Blum and MacKinnon 2009, 8).

It is, in fact, “how specific formal institutions (firms, research institutions, universities) interact with each other” that determines the yield of innovation (Godin, 2006, 19). The cooperative linkages between the aforementioned institutions that enable an efficient diffusion of information, otherwise known as “institutional thickness”, characterize successful knowledge sectors in any economy (Amin and Thrift 1995). Institutional thickness is the means to the dissemination of knowledge, the act of which is the key activity in any knowledge economy (Powell and Snellman 2004). Essentially, institutional thickness in this context is the systemic coordination between “institutions of learning” that allow for collaboration, while effectively disseminating knowledge for industrial application (Houghton and Sheehan 2000, 4; Amin and Thrift, 1995; Powell and Snellman 2004; Harding 2001).

Research coordination and collaboration between the businesses and universities in Canada is evidently weak based on the low amount of technology licenses being issued and a decline in spin-off activity from university research (Munroe-Blum and MacKinnon 2009). This gap provides a role for public policy makers in Canada to create strong links in the innovation chain, and leverage the strengths of both business and university sectors to help spur innovative activities.

The overarching solution is a long-term government investment in institutional thickness within the Automotive Innovation Fund, Automotive Partnership Canada, and AUTO21. The capabilities both on the research side and the business side exist and continue to develop, but could develop much more rapidly with the proper linkages.

In broad terms, institutional thickness can be promoted by employing interrelated tactics:

- Supporting research and development, especially in the later stages of the research cycle
- Fostering coordination and cooperation across the research and production supply chain
- Investing in education and applied skills training (Gafni 2005, p. 21)

The foundation of establishing strong institutional links is research. As such, Canadian policy-makers for the alternative fuel vehicle industry should sustain current

levels of basic research while actively funding all stages of the scientific research cycle relevant to the industry. Fong (1998) outlines these stages:

- Basic research – original investigation that advances scientific knowledge
- Applied research – scientific investigations orientated towards developing commercial applications of scientific knowledge
- Exploratory research – technical research activities to meet practical or commercial purposes, including assembly of hardware used to test technologies
- Prototype development – technical research activities to develop prototypes of materials, devices, systems, or processes for experimental and operational testing
- Engineering development – technical activities concerned with mass production engineering of specific materials, devices, systems, or processes (Fong 1998, 353)

In improving institutional thickness, the federal government should focus on exploratory research, prototype development, and engineering development for commercial application to best link institutions of basic research with industry to achieve nearer-term results with more immediate industrial relevancy to the overall industrial policy goals (Fong 1998). The more direct the government investment in the later stages of research, the better the “alignment of government and industry goals” (Munroe-Blum and MacKinnon 2009, 10).

The Automotive Innovation Fund currently has no linkages or collaborative requirements. As it is more industry-driven, it could include an industry task force (such as that of the Automotive Partnership Canada) which provides guidance to the allocation of funding and the approval of projects. This industry task force would include research institutions and universities to further increase their involvement in the research and development subsidies that are being spent. As such, the Automotive Innovation Fund could facilitate activities known with increasing institutional thickness between science and industry:

- Employment of students in co-op programs
- Orientating graduate programs in science and engineering for employment in specific industrial sectors
- Fellowship programs to employ recent post-secondary graduates of science faculties in the business sector

- Interchanging of university (engineering and science) faculty and business executives
- Easier access of research science for commercial users (McFetridge 2008).

Automotive Partnership Canada currently accomplishes some degree of institutional thickness through its linkages in its industry task force, but approved proposals should focus more on the three latter phases of the research cycle to ensure deeper involvement of direct industry goals and research capacities.

AUTO21, which primarily focuses funding for research institutions and universities, includes industry in many of its findings through conferences and completed research projects. However, approved research projects should be further geared towards direct industry adoption, targeting specific Canadian companies, for a greater propensity towards scientific research adoption. Nonetheless, basic and applied research funding should still be sustained with students having access to state-of-the-art research facilities (Munroe-Blum and MacKinnon 2009).

The advancement of key linkages through the Automotive Innovation Fund, Automotive Partnership Canada, and AUTO21 involving knowledge transfer between research phases will help to link stakeholders in the supply-chain of automobile production, including research universities, research laboratories and firms, energy producers, and technology producers for alternative fuel vehicles (McFetridge 2008).

These programs should lend themselves to “exposure to scientific and technical publications, employee mobility, licensing, joint venturing, and reverse engineering” (McFetridge 2008, 14). In fact, by investing in higher education and applied skills training by subsidizing a portion of these activities, Canadian industrial policymakers will leverage strengths from both research institutions and commercial institutions (Gafni 2005).

Moreover, the Science, Technology, and Innovation Council in 2008 suggested that Canadian university students in science and technology need to be given more opportunities for international experiences, in addition to career placements in research and technology development (Munroe-Blum and MacKinnon 2009). Concurrently, international scholarships sponsored by both government and industry to attract the best

foreign scholars to Canadian universities would also help to forge great linkages (McFetridge 2008).

Several government initiatives have been undertaken in the past to foster these linkages in the past to disappointing results, partially due to a lack of business support and scientific research that had commercial application (McFetridge 2008). However, the federal government's Networks of Centres of Excellence (NCE) program "introduced in 1989, its objective to link the academic, private, and volunteer sectors to create commercial opportunities" found some success in knowledge generation and technology transfer (McFetridge 2008, 15). By targeting a specific sector, the alternative fuel vehicle industry, with a basis of encouraging new types of employment in research and development (Harding 2001), the other industrial policy measures will reap greater rewards against their objectives.

As one example of effective institutional thickness, Canada's biotechnology sector had developed into the one of the world's largest biotechnology industries, in spite of a relatively smaller science research base compared to Japan, the United Kingdom, Germany, and France (Niosi and Bas 2004). This suggests that an institutionally-thick sector can yield greater results from a smaller base of research, which would advantage Canada since it would lack the financial resources of much larger OECD economies.

When successful, institutional thickness acts as an enabler, as sound macro-economic and fiscal environments are not sufficient to induce business expenditure on research and development (Harding 2001). In fact, investment incentives for research and development activity also do not necessitate positive spillover effects, though they can exist (Thomas 2007). Without a cohesive institutional thickness program, the subsidies and funding for research and development will not realize their full potential.

Perhaps the most crucial element of a national industrial policy, the promotion of institutional thickness links all phases of research and their respective institutions by supporting the dissemination of knowledge and technology. This supports higher production of alternative fuel vehicles, decreases impediments for inputs of alternative fuel vehicle production (particularly those of knowledge and capital), and makes Canada

globally competitive as an institutionally-thick sector that can rely on a smaller scientific research base for technological development compared to an institutionally-thin sector.

### ***Legal and Regulatory Frameworks***

In the post-World War II period, knowledge-based technology industries have developed largely by utilizing the research and development in research universities and government-based research institutions, though the economic conditions and regulatory parameters created by industrial policy largely contribute to the development and success of these industries (Niosi and Bas 2004). The alternative fuel vehicle industry requires similar reconfigurations of legal and regulatory frameworks that target fuel emissions, venture capital markets, and the protection of intellectual property rights.

In the case of Canada's emergence and success in the biotechnology industry, legal and regulatory frameworks assumed an important role. It was not only federal policy that promoted collaboration and coordination (institutional thickness) amongst different biotechnology institutions, but an ever-adaptive regulatory environment that protected intellectual property rights in this technology field and rapid growth in venture capital institutions and engagement in the industry – in addition to tax incentives and government laboratories in biotechnology research (Niosi and Bas 2004).

In the case of the alternative fuel vehicle industry, Canada should adopt several industrial policies – as part of a national policy – to create a legal and regulatory system conducive to the industry's development.

Firstly, Canada should implement a national program that targets fuel emissions, incrementally incentivizing the development and production of alternative fuel vehicles. In encouraging the adoption of alternative fuel vehicles, Canada must adopt a “demand through regulation” approach to spur consumer adoption of such new vehicles, as well. As an example, throughout the 1970s, both the US and Japan adopted strict federal regulation for the sale of new cars that used oxidation catalysts and three-way catalysts that dramatically reduced the emissions of automobiles (Bauner 2005). While this approach did not regulate the point of sale of automobiles or fuel, it did press producers to adopt new technologies in automobile manufacturing. New standards that incentivize new vehicle production of alternative fuel vehicles for both developers will help incline

producers towards forging deeper linkages with energy producers and research facilities, while investing more in their own research and development activities (Electric Mobility Canada 2010).

Secondly, institutions of venture capital have also spurred many research and development, particularly information technology and biotechnology (Niosi and Bas 2004). Relative to the United States, Canada lacks the number of “angel investor” and venture capitalist institutions that assume risk on innovative start-up companies, many of which, given the large automobile manufacturing base in Canada, could be in automobile parts development. One tactical solution could be a federal tax credit on investments in start-up companies. However, as the case of the Quebec Business Investment Company Program suggests, it is “poorer quality opportunities that seek out government finance” (Carpentier and Suret 2005, 17).

As the creation of venture capital institutions may be a large undertaking, particularly in the short to medium-term, policy-makers should seek to adapt the regulatory tax and investment regimes for a freer flow of capital. In addition to the initiatives outlined in the research and development subsidies, policies to reduce the barriers to participation of US venture capital investors in the Canadian market should be reduced, as recommended by the Expert Panel on Commercialization in 2006 (McFetridge 2008). The Income Tax Act currently “delays the realization of the proceeds of the disposal of shares in Canadian private corporations by foreign investors” (McFetridge 2008, 14). By reforming this regulatory framework and recognizing how imbedded Canada’s automotive sector is with the US automotive sector, policy-makers can attract more experienced and more voluminous venture capital into innovative Canadian firms advancing technologies in the alternative fuel vehicle industry. As an extension to creating an institutionally-thick environment in the alternative fuel vehicle sector, regulatory framework should also seek to create conditions that are more conducive to fostering linkages with international venture capital, as well. This will allow for more accessible sources of risk capital for the different stages of business development (Munroe-Blum and MacKinnon 2009).

In addition to international venture capital investment reform, Canada must also seek to modernize its legal system to protect intellectual property rights in order to

eliminate disincentives of investment in high-technology and innovative sectors, such as the alternative fuel vehicle sector (Gafni 2005, 21). As noted in Section II, the Trade Related Aspects of Intellectual Property Rights contained in the WTO agreement does provide positive incentives for advanced firms that innovate for new technologies. As a basis for a revised patent regime, TRIPS provides guidelines for protecting the yields of research and development (including that which is subsidized as recommended above) and helps a developed country, such as Canada, maintain a leading advantage in high-technology sectors over emerging markets. Of course, this assumes that Canada will continue to have the capacity to produce new technology for the alternative fuel vehicle sector more effectively than emerging economies (including increasingly technologically advanced ones, such as China and India).

Reconfiguring the legal and regulatory frameworks of fuel emission standards, venture capital markets, and the protection of intellectual property rights meet the targets of industrial policy in two ways. Firstly, they reduce many restrictions and disincentives for inputs in the production of alternative fuel vehicle. And, secondly, they help create a sound legal and macroeconomic climate that allows Canada's alternative fuel vehicle sector to be globally competitive.

## **The Viability of Canada's Alternative Fuel Vehicle Sector**

Supply-side subsidies, demand-side promotion, increased collaboration between institutions, and changes to national legal and regulatory frameworks as part of a cohesive industrial policy strategy for alternative fuel vehicle development and production in Canada cannot be implemented blindly without assessing the viability of Canada achieving an alternative fuel vehicle design and manufacturing industry. In establishing a national industry policy plan, this research has had one underlining assumption: the alternative fuel vehicle industry is viable in Canada. While it is outside the scope of this research to establish a business case for the viability of Canada's alternative fuel automotive industry, it can, however, be argued that Canadian policy-makers have the ability to successfully support an alternative fuel vehicle industry.

Canada's automotive sector can draw on much strength, while rectifying weaknesses of the overall national economy. A focus of the industrial recommended policy tactics have already targeted the weaknesses – Canada's low business expenditure in research and development, an innovation gap, low levels of institutional thickness, and impediments in legal and regulatory frameworks concerning fuel emissions and foreign venture capital flows.

A sound macro-economic environment conducive towards globally competitive production, political will, and human capital are the key determinants of whether or not the Canadian government can support alternative fuel vehicle design and manufacturing. In 2011, the Canadian federal government announced plans to study the viability of the Canadian automotive manufacturing industry, as Ford, Chrysler, and General Motors are expected to propose for federal funding on plant upgrades (specifically, retooling for alternative fuel vehicle production) (Chase and Keenan 2011). However, this research proposes that by examining Canada's ability to support the alternative fuel vehicle industry across economic, political, and social dimension, it becomes evident that alternative fuel vehicle design and manufacturing is an industry that can be successfully supported in Canada.

### ***Economic Factors***

In terms of importance to the national economy, Canada's automotive sector ranks as a key economic driver of exports and employment. In 2008, it was noted that the automotive sector accounted for 12% of manufacturing gross-domestic product and 18% of manufacturing exports. In addition, every automotive assembly job accounts for 4.9 indirect jobs, which is far above the general manufacturing average of 1.2 indirect jobs created (Parliament of Canada 2009).

The historical success of the Canadian automotive industry reflects several key advantages that Canada currently possesses. Canada boasts a 6.4% cost advantage in automobile production over the United States, including a higher level of labour productivity than the United States or Mexico (Invest in Canada 2012). Canada also already has the second lowest corporate tax rate on automotive companies compared to

the top-10 automotive-producing economies in the world, with transparent and strong legal systems for economic security (Invest in Canada 2012).

In terms of alternative fuel vehicle production, Canada also has many promising indicators to support industrial policy in the specific sector. Notably, all of the major automobile manufacturers are currently at some stage of development of an alternative fuel vehicle, particularly battery electric vehicles (Girard 2011; Scrimgeour 2009). In all, Canada has nine automobile assembly plants, in addition to over 750 automobile parts manufacturers encompassing 160,000 workers in automotive and automotive parts production (Girard 2011; Parliament of Canada 2009).

This is significant, since Canada's auto-manufacturing base is long-standing, well-experienced, and established to upgrade to alternative fuel vehicle design and manufacture. In addition, Canada also hosts many of the supporting industries that will allow it to support the creation of alternative fuel vehicles. For shared components among traditional petroleum-powered vehicles and alternative fuel vehicles, Canada nationally produces rubber products, plastic products, rolled steel, and fabricated metal producers that make automobile production, in general, viable in Canada (Girard 2011). Moreover, the Canadian automotive industry hosts hundreds of companies currently developing alternative fuel vehicle technology – primarily focused on electric vehicle technology (Girard 2011).

### ***Political Factors***

Throughout the body of this research, the political will in Canada to support the automotive industry has been evident. From Canada's supply of military vehicles for Allied Forces during World War II, the creation of the Auto Pact, the 2008 automotive bailouts, and the creation of the Automotive Innovation Fund, Automotive Partnership Canada, and AUTO21, Canada has historically supported automotive manufacturing. As the industry shifts towards alternative fuel vehicles, policy-makers must also shift their focus to this area of the industry for the long-term survival and success of Canadian automotive manufacturing within a cooperative North American automanufacturing base.

## ***Social Factors***

In examining Canada's workforce, it becomes evident that Canada boasts a highly-skilled labour pool that continues to grow through sound immigration policy, in addition to a prominent base of academic research and higher-education institutions.

In 2006, Toyota, Honda, and Linamar (Canada's second largest automotive parts manufacturer) all cited the Canadian labour force as the key driver for their multi-billion dollar investments in Ontario (Yates and Vrankulj 2006) in spite of a rising Canadian dollar and heavy losses in Canada's manufacturing sectors (Canadian Labour Congress 2006). In addition to high labour productivity (Invest in Canada 2012), 40-50% of Canadian labour in automobile manufacturing communities in Ontario have some level of post-secondary education (Yates and Vrankulj 2006).

The advantages of the Canadian labour market can also be attributed to Canada's immigration policy, which has "contributed to the available supply of labour" as a disproportionate amount of immigrants from Asia are employed in the Canadian auto parts sector (Yates and Vrankulj 2006, 29). Canada's immigration policy to attract highly-skilled and literate immigrants ensures that its labour pool is competitive based on skills, experience, and education (Yates and Vrankulj 2006).

Additionally, Canada's automotive workforce has also demonstrated organized will to support the alternative fuel vehicle industry. The Canadian Auto Workers union, which represents a large proportion of workers in the industry, has become a strong advocate for upgrades auto assembly plants to produce alternative fuel vehicles, and for these upgrades to be supported by the federal government, particularly since most of alternative fuel vehicles will require more parts than traditional internal combustion vehicles (which, potentially, could create more Canadian jobs) (Girard 2011).

In terms of academic research, the Council of Canadian Academics and the Science, Technology, and Innovation Council have also found Canada to be strong in academic research (Munroe-Blum and MacKinnon 2009). In fact, Canada's national research and development undertaken by universities is only second to Sweden amongst OECD countries (Munroe-Blum and MacKinnon 2009). Moreover, The Science, Technology, and Innovation Council 'State of the Nation 2008' report indicates that

Canada produces a high amount of published scientific research, of which its total citation indices indicate this published research to be of high quality and value (Munroe-Blum and MacKinnon 2009).

With a highly skilled labour pool and a highly educated research base, Canada has the human capital to support expansive development in the alternative fuel vehicle sector.

## Summary of Policy Recommendations

In summarizing the policy recommendations for the Canadian federal government to support the development of the alternative fuel vehicle industry, it becomes evident that a national policy may be required if Canadian policymakers seek to make Canadian automotive manufacturing successful in the long-term through alternative fuel vehicle development:

- Renew the Automotive Innovation Fund for five more years with a mandate focused on alternative fuel vehicles that excludes proposals focused solely on fuel efficiency improvements for petroleum-powered vehicles
  - The renewed AIF will cover large-scale proposals from industry actors directly, still requiring the total investment from industry proposers to meet a threshold of \$75-million over five years.
  - The renewed AIF should include an industry task force, similar to that of Automotive Partnership Canada, which includes industry (including alternative energy producers), research institutions, and universities mandated to engage in the following activities:
    - Employment of students in co-op programs
    - Orientating graduate programs in science and engineering for employment in specific industrial sectors
    - Fellowship programs to employ recent post-secondary graduates of science faculties in the business sector
    - Interchanging of university (engineering and science) faculty and business executives.
    - Easier access of research science for commercial users.
- Renew Automotive Partnership Canada for five more years with a mandate focused on alternative fuel vehicles that excludes proposals focused solely on fuel efficiency improvements for petroleum-powered vehicles

- APC will cover more collaborative industry projects without a minimum investment threshold from industry proposers. This will be more oriented towards research where investment is much more risky.
- Approved proposals should focus more on the three latter phases of the research cycle to ensure deeper involvement of direct industry goals and research capacities.
- Expand the annual budget of AUTO21 by 50% (approximately \$5.5 million) with the increase mandated towards research in alternative fuel vehicles
  - Approved research projects should be further geared towards direct industry adoption, targeting specific Canadian companies, for a greater propensity towards scientific research adoption.
- Add several direct financing policies only for alternative fuel vehicle industry operations, in addition to Canada's current tax credit rates and treatment of taxes for scientific research and experimental development activities:
  - Pioneer status – exempting manufacturing investments on new, highly-advanced, high technologies from corporate tax on profits from those manufacturing operations for a period of five years.
  - Development and expansion incentives – providing concessionary tax rates for firms upgrading and expanding current operations for the manufacture or development of innovative products.
  - Investment allowance incentives – exempting research and development activities from corporate tax as a specified proportion of fixed investments.
  - Approved loan schemes – wholly exempting a withholding tax on the interest payable to an institutional lender for alternative fuel technology developers and manufacturers.
  - Approved royalties – wholly exempting a withholding tax on royalties of an innovation created within Canada for a period of five years.
  - Operational headquarters incentive – partially exempting alternative fuel vehicle and parts developers whose global headquarters are located within Canada.
  - Accelerated depreciation allowance – manufacturers and developers can claim a larger percentage for all plants and machinery, with the option to claim 100% in year one for specific high-technology equipment.
- Restore incentives for the purchase of alternative fuel vehicles by consumers by matching US tax credits of \$7500 for electric vehicles (but expand to all alternative fuel vehicles)
- Change the Motor Vehicle Scrappage Incentive program so that incentives are only realized with the purchase of an alternative fuel vehicle

- Standardize charging stations and outlet requirements for alternative fuel vehicles for municipalities, as the first step to expanding accessibility to fueling stations for such vehicles
- Aid municipalities to support demand-side incentives for alternative fuel purchases:
  - Exemptions from certain vehicle operation taxes for alternative fuel vehicles
  - Promotion of municipal-parking stalls for alternative fuel vehicles only
  - Promotion of access to high-occupancy vehicle lanes for alternative fuel vehicles only
- Mandate the adoption of alternative fuel vehicles for all new purchases of vehicles for federal government use
- Adopt a national program for decreasing fuel emissions in newly-produced vehicles that incrementally incentivizes the development and production of alternative fuel vehicles
- Reform the Income Tax Act so to minimize the delay in the realization of the proceeds of the disposal of shares in Canadian private corporations by foreign investors
- Modernize the current intellectual property rights regime in order to eliminate the current disincentives of investment in high-technology and innovative sectors

As part of a national industrial policy strategy for alternative fuel vehicles, the above recommendations not only fall within the requirements of Canada's current industrial policy landscape (given the restrictions of NAFTA and the WTO), but they also help meet the three key industrial policy targets that can be outlined for the alternative fuel industry: higher production of alternative fuel vehicles in Canada; decreased restriction of inputs necessary for production of alternative fuel vehicles in Canada (including capital); and the creation of a globally competitive alternative fuel vehicle industry.

## **Conclusion**

The automobile industry in Canada has historically been reliant on government support. While industrial policy tools have become increasingly difficult to implement as a result of bi-lateral and multilateral trade agreements, there is still policy space to

support the development of alternative fuel vehicle technology and rejuvenate the automobile industry as a national industrial sector for economic growth. In order to effectively promote the development of the alternative fuel vehicle industry in Canada, policy-makers can build on existing industrial policy for the auto-sector by refocusing it on the alternative fuel vehicles sector and implement the following industrial policies within a cohesive national strategy:

- a) Research and development subsidies, including tax benefits and investment incentives
- b) Demand-side promotion, including the implementation of regulation favourable to consumer adoption of alternative fuel vehicles
- c) Coordination and collaboration initiatives to strengthen the financing, research, and production institutions of the automobile sector
- d) Legal and regulatory frameworks that eliminate barriers to innovation

While the existing industrial policy for the automotive sector in Canada can be reconfigured to focus on the alternative fuel vehicle industry, new policy measures can also be adopted, as part of a national strategy toward the successful development of an alternative fuel vehicle sector within the automotive industry in Canada. As Canada's automotive industry is currently unsustainable due to environmental concerns, the rising and volatile price of oil, and global competition, this strategy towards alternative fuel vehicles may be the key to the industry's overall, long-term prosperity.

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