We’ll take you there
Contents

Perspectives—Fuel 2018

2 Smart choices for a lower emissions future
A strategic path to significant reductions.
Peter Boag

4 The dominant power
The proven and improving internal combustion engine.
Canadian Fuels staff

10 Making partnerships work
Opening doors to collaboration.
Brian Ahearn

10 Petro profiles
Three industry pros who make a difference.
Dana Codding 11 // Martine Pêloquin 21 // Greg Rockwell 27
Canadian Fuels staff

12 It’s complicated: Canadian opinion and the fuels sector
Compromise, not conflict.
Allan Gregg & Doug Andoer, Earnscliffe Strategy Group

15 Window Seat 150 photo contest
Canadian talent, travel and beauty.
Canadian Fuels staff

16 Freight aerodynamics
Small modifications are just the beginning.
Erin Brophy

17 Partnering with Pembina to help curb freight emissions
No silver bullet solution.
Lisa Stilborn

18 The high price of lower emissions
Following the yellow brick road.
Peter Boag

22 Driving down the numbers
Where driving and technology meet efficiency.
Canadian Fuels staff

24 A ripple effect
Understanding Canada’s fuel infrastructure.
Jason Parent

26 A pure expression of democracy
Industry insight for a better Canada.
Carol Montreuil

28 More than mileage in Detroit
Bright minds, big effort, mega mileage.
Canadian Fuels staff

30 Tomorrow’s transportation fuel
Relentless ingenuity.
Kris Smith

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Whenever we travel, we’re faced with a variety of decisions. What mode of transport will get us where we’re going? What route will we take? How long will it take to reach our destination? The governing concern is usually cost—how much and who’s paying.

So I am puzzled by decisions that are being made on our way to a lower emissions future—decisions that seem to ignore who’s footing the bill (taxpayers), as if Canadians are willing to forgo affordability and automatically travel first class. Clearly, we don’t have that sort of pocketbook. Yet some Canadian policymakers are zealously—often with taxpayers’ money—advancing a costly transportation electrification agenda.

Ontario is a case in point, although hardly the only jurisdiction in which this fixation on costly electrification holds true. The province’s Electric Vehicle Incentive Program rewards early adopters with taxpayer-funded incentives of between $6,000 and $14,000 on the purchase of each vehicle, depending on battery size and seating capacity.

My point is not that electrification is wrong (I believe it’s an important component in a long-term shift in transportation modes). It is that this trend is disturbing for its disregard of the scientific and engineering literature, which strongly suggests a less expensive way to achieve greater greenhouse gas (GHG) reductions.

The Massachusetts Institute of Technology (MIT) released a report in November 2015 that points to improvements in mainstream technologies as promising the greatest near-term impact to reduce petroleum transportation fuel consumption and GHG emissions. MIT’s research shows that improvements in internal combustion engines, transmissions, and in-vehicle technology through reducing
weight, aerodynamic drag and tire resistances, provide the largest fuel consumption and GHG emissions reductions for the next 20-plus years”.

The report highlights the time it takes for new technologies to achieve major fleet penetration. Two conclusions are worth noting: first, that “the impact of alternative energy sources such as electricity and hydrogen, even going out 30 years or so, [will be] modest”; and second, that in projections of vehicle sales by engine type, internal combustion engine (ICE) vehicles will still make up 60 percent of sales in 2050.

MIT’s work aligns with findings of the U.S. Environmental Protection Agency (EPA). As recently as January 2017, the EPA observed that auto manufacturers have been developing and adopting fuel economy technologies at unprecedented rates. Based on various sources, including the U.S. National Academy of Sciences, the EPA concluded that “a wide variety of effective technologies are available to reduce GHG emissions from cars and light trucks.” Focusing on the evolution of these technologies is positioning automakers to meet increasingly strict fuel efficiency and emission standards through the 2025 model year at lower costs than predicted.

What are the best strategies to achieve our goal?
Cumulatively, the research tells me that if we are aiming for significant reductions in road transportation GHG emissions, we need to consider three broad strategies:

1. **Pursue continuous, ongoing improvements to ICE engine and vehicle technology.**
2. **Conserve energy by operating vehicles and fleets more efficiently.**
3. **Shift over time to alternative energy sources.**

The success of these strategies hinges on at least three fundamental questions:

1. **How much can transformative technologies accomplish, and at what pace?**
2. **What will it cost, and what are the affordability implications for Canadians?**
3. **How much are Canadians willing to change behaviour to meet reduction targets?**

Technology, affordability and behaviour are the wild cards in the current high aspirations to eliminate GHG emissions. In this issue of Perspectives, we touch on each. “The dominant power” (page 4) reminds us of the long arc of research and development that underpins the development of all automotive technology. In “The high price of lower emissions” (page 18), we dig for the true cost of GHG mitigation policies and the best possible pathways to lower GHG emissions. Finally, Earnscliffe Strategy Group presents key insights from its surveys on energy and the environment in “It’s complicated: Canadian opinion and the fuels sector” (page 12).

In fact, I believe this issue features an impressive range of columns and articles that, together, present clear and balanced insight to help Canadians make informed decisions about our transportation fuels future.
As alternative automotive fuels and technologies attempt to challenge the petroleum-powered internal combustion engine (ICE), don’t imagine it hasn’t stared down competition before. More than a century of technical advances have extracted impressive refinements from, and secured the supremacy of, a proven and basic mechanical system. With the ICE now poised for a new era of innovation, there are lessons to be learned from the automobile’s past and the evolution of a technology that revolutionized transportation and the world economy.

BY CANADIAN FUELS STAFF
The Achates Power opposed-piston engine is able to efficiently manage engine airflow for improved combustion and thermal management.

NO EARLY VICTOR

“I’m always living in the 1920s here,” says Alexander Gates, manager and curator at the Canadian Automotive Museum in Oshawa, Ontario. The museum’s impressive collection includes many outstanding examples of early automotive technology, including a 1925 Brooks Steamer, a 1923 Rauch & Lang Electric, and a 1914 Galt Gas-Electric hybrid. Visitors are often surprised to learn that the vehicle market in the early 20th century featured such a variety of engine options.

“Steam-powered machinery has mostly disappeared from our lives today,” explains Gates, “but you have to remember that steam locomotives and steamships were among the most reliable and advanced transportation options in the early 20th century.” Applying the technology in automotive engineering was simply the logical next step—although steam technology had its shortcomings.

“The process of getting one of these old steam cars up and running was horrendous,” says Gates. “The steam wasn’t ready to go at all times. You needed a secondary source of energy—a kerosene or gasoline burner—to generate the steam. Pre-heating the car in winter months could be excruciatingly long. Steam also involved having a constant flame burning, which made many owners uncomfortable. As one enthusiast told me, ‘If you don’t like fire, you won’t like a steam car.’

The 1925 Brooks Steamer, one of more than 90 historically significant cars featured at the Canadian Automotive Museum in Oshawa, Ontario. Since 1963, the museum has been dedicated to preserving and sharing the history of the Canadian automotive industry. canadianautomotivemuseum.com

Steam-powered machinery has mostly disappeared from our lives today, but you have to remember that steam locomotives and steamships were among the most reliable and advanced transportation options in the early 20th century.
Early electric vehicles were prized for their quiet performance and ease of operation—two reasons these cars were marketed to and popular primarily with women at the time.

"Most early internal combustion engines (ICE) had to be cranked by hand to be started," observes Gates. "Wealthy women in particular did not perform that kind of work. Cranking was actually a tricky process for everyone, with a number of engine adjustments, such as spark timing, that had to be just right."

Cranking could also be dangerous. Backfires inflicted countless injuries over the years, including broken thumbs and wrists known collectively and colloquially as "Ford fractures".

Women, to their credit, preferred vehicles they could simply switch on and drive. Electric vehicles were quiet and, although lacking the power of ICE-powered vehicles, fast enough for city driving. Excursions to the countryside, however, were usually out of the question.

"Many people forget that much of rural North America lacked electricity until after the Second World War," says Gates. The limited range of electric vehicles, which hampers sales today, was just as much of a hurdle a century ago.
THE FUEL PLAYS A ROLE

The number of Ford fractures dropped once the electric starter appeared around 1912, enabling anyone to fire up an internal combustion engine with relative ease.

But the decline of other motive sources cannot be ascribed to that one innovation, remarkable as it may have been. So why did the petroleum-fuelled ICE survive and thrive in the coming decades? Why did other technologies vanish from the automotive market by the 1930s? After all, the ICE was hardly fault-free. It was noisy, smelly and temperamental—although the distinctive rumble of many internal combustion engines has always been part of their lure.

Dr. Dipal Patel, assistant professor in the faculty of engineering and applied science at the University of Ontario Institute of Technology, points to the growing petroleum infrastructure—the rapid improvements in refining and distribution, and the inherent qualities of the product itself.

“The main reason an electric vehicle doesn’t have the same range as a petroleum-fuelled ICE is due to the incredible energy density of hydrocarbon fuels,” explains Patel. Energy density refers to the amount of energy contained in a given fuel mass. The chemistry of the hydrocarbon molecule delivers immense energy in comparatively small amounts. This is the key to petroleum’s portability, fast refuelling time, and the greater range it delivers to ICE-powered vehicles.

DRIVEN BY INNOVATION

ICE technology’s rise was driven in part by the First World War—the first mechanized war. Manufacturers in Europe and North America escalated research and production to support the war effort. The economic boom of the 1920s further boosted vehicle consumption and production, arguably securing the ICE as the automotive engine of choice before the Great Depression set in.

The ICE’s success can also be credited to the technology’s remarkable flexibility and untapped potential. Across more than a century, engineers have always been able to pivot the technology to meet the pressures of the day and the demands of the market.

Early innovations—from overhead camshafts to superchargers, multi-valve heads and V-configuration engines—aimed to propel the vehicle from point A to point B faster and with greater power. More recent innovations make that journey more efficient and less harmful to the environment. Positive crankcase ventilation (PCV) valves recycled exhaust gases beginning in the 1960s. In the 1970s, manufacturers installed catalytic converters to scrub tailpipe emissions. Onboard diagnostic computers began simplifying the process of fine-tuning various aspects of ICE performance in the 1990s.

“Modern engine control units deploy a range of sensors and perform millions of calculations per second to manage ignition timing, air–fuel mixture, injection, idle speed and other parameters,” says Dr. Patel. “And any list of recent innovations should include direct injection, variable valve timing and lift, and cylinder deactivation, which reduces total engine displacement and uses less fuel when less power is required.”
FUTURE PROSPECTS

The automobile is so essential to modern life in North America that the technology is under constant pressure to improve—to become safer, more durable and reliable, more efficient and more environmentally friendly. Modern engines are built to clock more than 200,000 kilometres with only minimal routine maintenance—a remarkable achievement in design and engineering.

Automakers currently spend more than $100 billion globally each year on research and development, ranking these investments among the largest in industry. A portion of this R&D targets one of the main weaknesses of the ICE: its inefficiency, the unlocking of which may further secure its superiority.

“Engineers are nowhere near close to extracting 100 percent of the energy within the combustion process,” says Patel. “In fact, most petroleum-powered ICEs have a mechanical efficiency in the range of only 20 percent. Most energy is lost as heat, exhaust, and friction. Capturing that lost energy—and putting it to work for propulsion—is what drives a lot of ICE engineering research.”

There are hundreds of parameters—from fuel chemistry to combustion chamber design and improved mechanical processes—that can still be configured to optimize the ICE and make it the greenest engine possible. So what are some of the innovations on the horizon that hold the most promise for continued market dominance for the ICE?

“Homogeneous-charge compression-ignition (HCCI) engine, certainly,” says Patel. HCCI combines the strengths and operating principles of gasoline and diesel engines to deliver up to 20 percent greater fuel economy while keeping particulate emissions relatively low.

“Opposed-piston (OP) engines, free-piston engines, even no-crankshaft designs have the potential to greatly increase the efficiency of the slider-crank architecture, which is dominant in current engines, and potentially double the fuel economy,” says Patel.

The opposed-piston architecture is clearly a case of what’s old being new again. An OP-powered automobile was the first to break the 150km/hr speed mark in 1904, and the technology was widely applied up to and during World War II, when it powered American submarines and German aircraft, among other machinery.

OP engines feature two pistons per cylinder instead of one. A two-stroke version is currently under development by Achates Power in California. With fewer moving parts, the engine is simpler, less expensive to manufacture, and reduces friction by up to 40 percent, contributing to as much as 50 percent greater fuel efficiency.

STAYING POWER

“Despite all the hype that surrounds electrics, hydrogen fuel cells and other fuel alternatives, innovations continue to improve every aspect of ICE performance,” says Patel.

“The ICE is so integrated into our lives,” adds Alexander Gates. “We know how far it can take us. We understand how much it costs. I think it may be another generation before we’re really comfortable not pulling into the gas station.”

The ICE is an engine in which fuel is burned in a confined combustion chamber.

This exothermic process produces hot gases that expand in the chamber and propel the piston and crank assembly at the heart of most automotive drivetrains.

In its earliest forms, the ICE was used in industrial applications. Early compression-less versions appeared late in the 17th century, but the first patent is thought to have been issued to English engineer Samuel Brown in 1823.

Nikolaus Otto is credited with developing the four-stroke ICE in the 1870s. Karl Benz built his own four stroke just a few years later—the engine that would power the first automobiles in production.
Partnerships are an important way for Canadian Fuels to initiate and take part in national discussions on transportation energy and the economy. We regularly work with other trade associations, non-profit research groups, non-government organizations (NGOs), and multi-stakeholder groups to find common ground on the issues that are of interest to, and influence, policy makers.

For example, Canadian Fuels is an active partner with Alberta’s Clean Air Strategic Alliance (CASA), a group that brings together representatives from industry, government and NGOs. CASA focuses primarily on air quality issues, building consensus and crafting recommendations to government that are particularly powerful, given that they reflect the collective position of stakeholders.

We also work closely with the Canadian Energy Research Institute (CERI), which conducts economic studies on key energy and environment issues. Canadian Fuels is a trusted data source for CERI and occasionally peer reviews the organization’s research. The resulting studies are highly valued by industry, government and academia for their sound, principled science.

**Challenge and reward**

Partnering with NGOs can be challenging—and to be fair, they would likely say the same thing about working with us. Yet in our experience, we inevitably find common ground with our partners, which strengthens our mutual respect and often opens doors to further collaboration. Our work with Clean Energy Canada (CEC) is a good example. At first glance, there appears little on which we could agree with a think tank focused on transition to renewable energy systems. Yet, like us, CEC believes in bringing differing points of view together.

Canadian Fuels has worked with CEC to understand its position; its people have had the opportunity to learn about the practical real-life market implications that are clear in ours. Working together is helping us both refine our thinking, which better positions our organizations to advise regulators effectively and objectively.

I pinpoint two keys to effective partnerships. The first is upfront agreement on key principles, such as commitments to free markets and science-based research. Second, it’s essential to be open to opposing ideas and to listen in good faith. That’s when good things happen, ensuring partnerships survive and flourish.
Petro Profile

Building a National Presence

Dana Codding eliminates growing pains at Parkland.

Parkland Fuel Corporation’s rank as one of North America’s fastest growing fuel marketers is earned in part through an ambitious acquisition strategy. The company has welcomed more than 20 others into its family in just ten years. With the acquisition rate increasing—and the structure of deals becoming more complex—Parkland built a dedicated team to smooth the integration of each new purchase.

“We joke that our goal is a boring transition—no drama,” says Dana Codding, Parkland’s Director of Acquisition Integration. “Our first focus is the day one priorities, things like business continuity so there is no disruption in service and customers don’t even realize the company changed hands.”

Codding’s career began in the Alberta oil fields. Trained as a geologist, she soon moved from oil rig to office tower, eventually landing a marketing position with a major software and data company. “I began to work on deals,” explains Codding, who soon took on acquisition and integration responsibilities in the firm’s energy division. She stepped into the integration role with Parkland in 2015.

Beginning in August 2016, Codding was instrumental in one of Parkland’s largest deals to date: acquisition of the Canadian assets of CST Brands Inc., including retail operations of Ultramar in Quebec and Atlantic Canada. The deal adds more than three billion litres in annual fuel volume and gives Parkland retail presence from Vancouver Island to Nova Scotia.

The CST deal challenges Parkland to bridge geographic and cultural divides between Calgary and Quebec. “Previously, we had a limited presence in Quebec,” says Codding, “so a central aim was to engage with and show our support for the communities affected by the acquisition.”

Senior Parkland executives spent a lot of time in the province introducing the company and getting to know the people. “Ultramar is a highly respected brand in Quebec, and one of our goals has been to make sure everyone understands that we respect the brand just as much.”

As the CST deal moves from integration to operations after closing in June this year, Codding also will move into an operational role at Parkland, taking over leadership of Parkland’s Western Commercial Operations. She will focus on growing Parkland’s safe and sustainable delivered diesel, gasoline, and propane business.
Canadian views on energy, the environment and addressing climate change have evolved dramatically—and in many surprising ways—in recent decades. Arguably, there is no part of the economy that has been more directly implicated and impacted by these changes than the fuels sector. This article explains how we got here and how opinion may evolve in the future.

In recent months, Earnscliffe has undertaken multiple studies on Canadian public opinion on issues of relevance to the fuels sector and we have also reviewed recent studies published by others. Taking it all together, several insights emerge.

Environment is a value, not a department. While important divisions in opinion remain, there has been a steady move towards consensus on some core themes relating to addressing climate change, growing the economy in general, and the role of Canada’s energy resources in particular. One of the most important is that regardless of their views on specific policy alternatives, Canadians agree that protecting the environment is a value that must be pursued. Put simply, any meaningful debate surrounding the environment is now likely to revolve around the means of achieving this goal, not the end.
Put simply, any meaningful debate surrounding the environment is now likely to revolve around the means of achieving this goal, not the end.

Canadians now seek compromise not conflict. The public has been presented with a forced choice in recent decades as advocates and experts have pitted environmental interests directly against economic interests. Today however, we find that there are very few Canadians left feeling that it is a zero-sum game between the environment and the economy and fewer still believe that one deserves attention while the other deserves none.

Indeed, most Canadians now agree there is a moral obligation to address climate change and a majority reject the notion that “protecting the environment means less economic growth.” On the other side of the ledger, Canadians also recognize the significant contribution that natural resources bring to employment and the economy and loathe to support any measures that debilitate these sectors.

With this increasing tendency to recognize the benefits and drawbacks of both pro-environment and pro-development arguments, the bulk of Canadians are now much more inclined to prefer compromised approaches—what has sometimes been called Canada’s preference for “pragmatic incrementalism”—that make some progress towards the goal of a cleaner environment while embracing compromises that would avoid causing harm to the economy.

Emission reduction is necessary, but not necessarily “that” way. The vast majority of Canadians agree that there needs to be at least a partial replacement of traditional fuel sources with clean energy sources, even as they recognize that cleaner energy may be more expensive. There is also a widespread belief that a move towards clean energy represents more economic opportunity than risk for Canada.

However, any specific policy initiative designed to promote such a transition invariably raises doubts that tend to erode initial levels of enthusiasm or support for a move towards clean tech.

So we note, for example, that while Canadians are favourably disposed to a transition away from combustible engines to electric vehicles, they find it completely “unrealistic” that this change could happen any time soon and balk at any forced measures that might artificially shorten this timeline.

The current example of the federal government’s announcement on pricing carbon is another excellent example of where there is initial consensus on the objective, but eroding support for the measures necessary to implement the policy.
Canadians reject the notion that nothing can be done and at the same time seem uncertain about the options available and the role they can play in finding solutions.

Three-legged stool: effectiveness, cost, and consumer sacrifice.

In our recent syndicated study, Earnscliffe Insights on Energy, the Environment and Clean Growth, we found that while the majority displayed a willingness to see a price put on carbon, the level of endorsement of this approach is closely tied to the sense that pricing carbon will actually make a difference.

If the efficacy of pricing carbon is credibly shown to be lower than expected or promised, Canadian support for doing so will, in all likelihood, begin to decline.

Similarly, if the “ask” is that polluters pay, and if it turns out that the definition of “polluters” include consumers rather than exclusively corporations, Canadian support for pricing carbon also erodes.

And if it turns out that effectively and cost-effectively achieving emissions reductions requires a change in lifestyle or behaviour that poses a significant sacrifice on the part of the consumer, the consensus around taking action will be similarly threatened.

Each of these perceptions of effectiveness, cost and personal sacrifice represent legs on a three-legged stool. Removing any one results in a collapse. Success in the form of public consensus results when all three are seen as adequately balanced.

In the end, because of these conflicting impulses and divided opinions, we can expect the public to apply continued pressure on government but not in a particularly focused or coherent way. Leadership will come, not from the general public, but from those who can convince the public that their preferred path forward is superior to the status quo.

Seeking a preferred path forward. Besides being conflicted and cross-pressured, Canadians also freely acknowledge that they possess little knowledge about various solutions that governments, businesses or they themselves should pursue to solve a problem that clearly concerns them. They want to “do the right thing” but their emotional commitment to this course is tempered by both pragmatism and worries about the cost implications for them of pursuing little-understood alternatives. They reject the notion that nothing can be done and at the same time seem uncertain about the options available and the role they can play in finding solutions.

Leadership will come, not from the general public, but from those who can convince the public that their preferred path forward is superior to the status quo.
What better way to celebrate a country than to explore it? That’s what so many Canadians did in 2017 to celebrate Canada 150. Cameras and phones in hand, thousands of road trippers also participated in Window Seat 150—a photo contest celebrating not just destinations, but also ‘getting there’.

From 12 national finalists, one winner was selected by open vote on Instagram in September. A big congratulations to Monish Comar from Markham, Ontario whose photo of Reversing Falls Bridge over the Saint John River in Saint John, New Brunswick won by open vote on Instagram.

An avid photographer, one of Monish’s favourite places he’s visited in Canada is Banff. On his bucket list remains Newfoundland, where he will likely capture more great shots. For his prize, Monish chose $500 in gift certificates from Esso. More road trips ahead!

VISIT WINDOWSEAT150.CA

OTHER FINALISTS INCLUDED:

1. Nicholas Timm
   Québec

2. Jade Trinh
   Ontario

3. Robin Thorneycroft
   Alberta

4. Jim Smith
   Ontario
For frequent flyers out of Ottawa International Airport, it’s a routine landmark that eventually goes unnoticed. If you’re Brian McAuliffe, Adjunct Professor in Mechanical and Aerospace Engineering at Carleton University and Lead Aerodynamics Researcher at the National Research Council of Canada (NRC)—the giant white wind tunnel is a ‘playground’. “I’m a bigger kid playing with bigger trucks” says McAuliffe as he walks toward the towering test area of the tunnel. “I started my career with an interest in aviation, never thinking that I’d end up working with trucks”.

‘Boxes on wheels’
McAuliffe’s research area is called Bluff-Body Aerodynamics. In other words, it’s research on surface vehicles that produce significant pressure drag and wakes—the opposite of airplanes. His specialty is testing the drag effects and fuel efficiency of freight trucks.

“The fact is that freight is going to remain ‘boxes on wheels’ pulled by diesel engines for a long time” says McAuliffe about the future of freight. Trailers, he explains, are a new addition to the proposed Canadian amendments to the Heavy-Duty Vehicle (HDV) and Engine Greenhouse Gas Emission Regulations beginning in 2018 and out to 2027.

This is where McAuliffe and the team at NRC step in.
“We provide HDV aerodynamic testing, data and analysis for both Environment and Climate Change Canada (ECCC) and for the US Environmental Protection Agency (EPA) to build policy; most recently, for the American Phase II GHG standards on HDVs as well as, EPA’s SmartWay verification testing,” says McAuliffe.

The NRC’s clients are both government and private, domestic and international. This is no surprise given that the NRC’s wind tunnel is one of only three in the world of its size. “There aren’t a lot of places where you can drop in a full size cab and trailer to do testing, so we get an interesting mix of international clients,” explains McAuliffe.

Proven and upcoming efficiencies
Not all fuel saving technology is what you would think of as ‘high tech’. “It’s amazing how simple adjustments to configuration can make a significant impact to fuel savings,” he says, “even moving the cab and trailer one foot closer together can mean a difference of 1–2% in fuel efficiency—clients are surprised to learn this.”
Side panels and boat tails (also known as trailer tails) are components that can be added to existing trailers and can be seen on trucks today, he explains. “Individually, side panels and boat tails each provide about 5% in fuels savings. Interestingly, when used together—they provide 11%.”

Trailer specifications such as these are examples of what could be mandated designs for new trailer sales, as part of Canada’s HDV and Engine Greenhouse Gas Emission Regulations in 2018.

McAuliffe is also looking at ‘Fleet Platooning’, also known as electronic distancing between trucks. “Fleet platooning is essentially close-proximity driving between moving freight trucks on the road that allows for the greatest efficiency” explains McAuliffe. “What we’ve seen so far is that at a distance as far as 60 feet apart, there is greater than 5% increase in fuel efficiency, with up to 10% fuel savings at much shorter distances.”

These are promising developments. With diesel freight vehicles looking to pull their weight for the foreseeable future, it’s up to scientists like McAuliffe to test ways to improve fuel efficiency so that Original Equipment Manufacturers (OEMs) and freight companies can remain competitive, while at the same time meeting or exceeding environmental standards.

The transportation sector accounts for approximately a quarter of Canada’s GHG emissions, and even more in my home province of Ontario. What many Canadians may not know is that the fastest growing source of emissions is not passenger vehicles, but freight. The error is understandable. Governments have tended to focus emission-reduction efforts on passenger vehicles through regulation and by offering fuel-switching incentives, for example, such as expensive rebates for electric vehicles.

Truck transport currently makes up nine percent of Canada’s total emissions and is set to overtake passenger vehicle emissions by 2030. Several factors are driving this growth: a healthy economy, increasingly dynamic global trade markets, and rising population numbers, especially in large urban areas. Consumer preferences also have a role to play—particularly our growing preference for online shopping, which adds to shipping activity.

The search for solutions
So what can realistically be done to reduce truck transportation emissions? Canadian Fuels recently partnered with the Pembina Institute to find out. We co-sponsored a Pembina report that underscores the complexity of addressing freight emissions and makes it clear that there is no silver bullet solution. State of Freight: Understanding greenhouse gas emissions from goods movement in Canada highlights the need for a multi-pronged approach that engages industry, consumers and all three levels of government to achieve meaningful reductions. The report mentions regional and municipal governments in particular for the key role they can play by fully integrating the movement of goods into land-use planning decisions.

State of Freight notes that emissions reduction solutions already exist, such as the current Phase 2 Heavy Duty Vehicle regulations that will continue to impact new trucks until 2027. The report also encourages governments to continue with efforts to roll out energy efficiency measures.

Perhaps most important, the report highlights the value of climate policies that broadly impact the Canadian economy. The federal carbon pricing proposal, for example, is expected to drive long-term GHG reductions in the freight sector once it comes into effect in 2018.

Canadian Fuels looks forward to continued collaboration with Pembina, which is engaged in a range of projects to support freight emissions reductions at the national and regional levels.

For more than 30 years, the Pembina Institute has collaborated with communities, businesses and civil society groups to develop effective environmental solutions. The State of Freight report is available on the Pembina website at pembina.org/reports/state-of-freight-report.pdf.
Canada’s First Ministers set the target in March 2016: a 30 percent reduction below 2005 levels of greenhouse gas (GHG) emissions by 2030. They gave the nod to carbon pricing as a policy approach to reduce GHG emissions. Two carbon pricing options have gained favour: a carbon tax levied on the volume of emissions (typically per tonne), and a cap-and-trade system that sets a limit on GHG emissions and requires emitters to buy allowances from a fixed supply. The federal government has proposed that the price per tonne should start at $10 in 2018 and rise to $50 per tonne by 2022.
So we have a target. We have the carbon pricing tools. We have the price. All of that is reasonably clear. What is not so clear is how the price will impact individuals and businesses across Canada. What will be the real cost of meeting our GHG reduction targets, especially in the context of the multiple complementary policy initiatives being pursued by the federal and provincial governments?

In search of transparency

There is a yawning information gap between the abstract idea of a price per tonne of CO$_2$e (carbon dioxide equivalent) and a dollar-figure impact on annual household and business bottom lines. Many economists estimate that the real cost of GHG abatement is a great deal higher than some governments would have us believe. Without question, calculating these costs is highly complex. But that should not be an obstacle to transparency.

Accurate figures are difficult to find from government sources. The Parliamentary Budget Office—an independent body—estimated in April 2016 that reaching the 30 percent reduction target would cost 1 percent to 3 percent of GDP, or between $600 and $1,900 in per capita income by 2030. The Conference Board of Canada estimates carbon pricing will increase household and industry product prices across the board, raise average consumer bills by $1,200 a family, and reduce GDP by 3 percent in 2020, and 2 percent in 2025.

The report also identifies a massive investment requirement that could ‘crowd out’ other important investment in productivity improvements and basic infrastructure that would add to the financial burden on Canadian families.

Macleans magazine did the math in late 2016 and found that a $50 per tonne tax would cost the average Canadian household approximately $1,100 per year, with $600 of that being direct costs related, for example, to transportation fuels and home heating.

It’s no surprise transportation costs factor significantly in GHG reduction equations. The sheer size of our country and our profound reliance on imports and exports mean that any carbon price will impact consumers and businesses with higher costs for fuel and freight—most notably food.

Valuable policy guidance

IPIECA (the global oil and gas industry association for environmental and social issues), recently released a report that offers some vivid insight into the real costs of road transport GHG abatement. IPIECA has been championing best practices in environmental and social performance for more than 40 years. This new report compared three studies, all conducted within the last two years under the auspices of either government bodies or independent experts. All three studies aim to provide guidance to policy makers on the best vehicle and fuel technology choices to reduce road transport GHG emissions at the lowest cost.

The advice is timely. Governments across Canada are considering complementary policies and regulations with embedded costs potentially far higher than those associated with carbon pricing. To date, governments have been stingy with details, and the lack of transparency could be most disturbing with regard to subsidies to buy electric vehicles. The Montreal Economic Institute calculated earlier this year that provincial electric vehicle subsidies in Quebec of between $4,000 and $6,000, and in Ontario up to $14,000 ring up carbon costs of $288 and $523 per tonne respectively.

The IPIECA report sheds further light. All three studies consider the cost of GHG abatement to be the highest among electric vehicles, including plug-ins and fuel cell models, with costs ranging between $300 and $2,200 per tonne over those for gasoline-powered internal combustion engine (ICE) vehicles (see Figure 1). Only one of the

![Figure 1 – Cost of carbon abatement](canadianfuels.ca)

The IPIECA report combines the findings of three independent studies to compare the cost of GHG emission abatement for cars and light trucks, from various emission reduction pathways compared to a gasoline-powered internal combustion engine baseline. The results identify a range of abatement costs for each pathway, based on differing assumptions and country specific circumstances.

<table>
<thead>
<tr>
<th>1st Generation Ethanol</th>
<th>2nd Generation Ethanol</th>
<th>Gasoline HEV</th>
<th>Diesel</th>
<th>FAME</th>
<th>HVO/BTL/Pyrolysis</th>
<th>CNG</th>
<th>PHEV</th>
<th>BEV – short range</th>
<th>BEV – long range</th>
<th>FCEV</th>
</tr>
</thead>
</table>

Cost of avoided GHG emissions vs gasoline ICEV ($/tonne CO$_2$e)

The LEGEND is as follows:

- **Gasoline ICEV**
- **Gasoline HEV**
- **FAME**
- **HVO**
- **BTL**
- **CNG**
- **PHEV**
- **BEV**
- **FCEV**
studies factored in GHG emissions related to vehicle production and end of life. In that case, battery and fuel-cell electric vehicles contributed emissions eight to nine gCO₂e/km (grams of carbon dioxide equivalent per kilometre) higher than ICE vehicles.

Misguided subsidies
The three studies in the IPIECA report reached two other remarkably similar conclusions. First, they found that improvements in ICE technologies will lead to significant future GHG reductions. Second, the studies agree that gasoline hybrid technology has the potential to reduce fuel consumption between 32 percent and 36 percent relative to gasoline ICE vehicles.

Rather than encouraging Canadians to buy vehicles they clearly don’t want, it seems to make more sense to create incentives that promote upgrades of older vehicles to new, fuel efficient, lower emission ICE powered vehicles.

It is difficult to reconcile these independent findings with policies that list heavily toward—for example—costly subsidies for electric vehicles, or Zero Emission Vehicle (ZEV) quotas. ICE vehicle fuel efficiency has improved by more than 20 percent over the past ten years. Engineers estimate a further 65 percent improvement is possible by 2050. Rather than floating on subsidies to encourage Canadians to buy vehicles they clearly don’t want, it seems to make more economic and environmental sense to create incentives that promote upgrades of older vehicles to new, fuel efficient, lower emission ICE powered vehicles.

As Canadians prepare to shoulder the cost of our GHG reduction targets, shouldn’t policy makers opt for the least expensive path—one that minimizes the burden on individuals and the economy?

Setting the terms
The meaning of many climate change terms and expressions often remain imprecise as they seep into the language. For example, the literature is populated with various alternative and abbreviating terms for greenhouse gas emissions reductions. GHG avoidance and GHG mitigation are common replacements, as is GHG abatement (aka carbon abatement). Essentially, GHG abatement is shorthand for any intervention, whether by process or technology, that diminishes the amount or intensity of GHG emissions.

Readers will likely also have encountered CO₂e, or carbon dioxide equivalent. This is a standard GHG emission measurement that enables an emissions footprint consisting of various greenhouse gases—including methane and nitrous oxide—to be expressed as a single number.
PETRO PROFILE

PROMOTING CREATIVE SOLUTIONS

Martine Péloquin’s success is rooted in a life-long fascination with chemistry and an appetite for challenge.

The leisurely bicycle path along the St. Lawrence River in Lévis, Québec includes an arresting artistic embellishment. Storage tanks at Valero Energy’s Jean Gaulin Refinery marine terminal have been adorned with colourful murals that depict the shoreline as it was more than a century ago.

The artworks are part of a $5 million Valero project to enhance the terminal, which juts into the river across from the historic Plains of Abraham. It’s a project Martine Péloquin is particularly proud of. “This project is typical of the collaboration between our refinery and the surrounding area,” says Péloquin, the refinery’s Vice President and General Manager. “Our community liaison committee worked hard to achieve consensus with local partners and find a creative, cost-effective way to enhance the appearance of our facility.”

Hard work and consensus building have been key to Péloquin’s career, which was sparked by love of chemistry in high school. She earned her degree in chemical engineering at Laval University in 1989.

“When I started at Ultramar as a process engineer, I had no idea I would end up where I am,” says Péloquin. With every challenge she took on over the years, she learned she had the capacity to do more.

“I love the process of analyzing and trouble-shooting,” she says. “As an engineer, the problems were technical. As an executive, the problems are different—and much more complicated!”

In a field still dominated by men, Péloquin is one of only a few women to lead a petro-chemical refinery in North America. “Things are changing,” she says, pointing out that her 11-person management team includes seven women. “My success comes from my management style. I am a team worker who believes in bringing everyone into the decision-making process.”

That teamwork is especially essential as Péloquin prepares for two upcoming refinery turnarounds. “We start planning two years in advance,” she says of an operation that will shut down the 270,000 bpd facility for 45 days to enable inspection, cleaning and repairs. “During the shutdown, our permanent staff of nearly 500 employees will be supplemented by up to 1,000 contractors. It is a massive engineering undertaking that requires a steady leadership hand—and a touch of executive artistry—to ensure the refinery resumes operation as soon as possible.

“With every challenge she took on over the years, Péloquin learned she had the capacity to do more.”
THE NUMBERS
BY CANADIAN FUELS STAFF

DRIVING DOWN THE NUMBERS
EcoRun isn’t a race—it’s a challenge. Every spring for the past six years, participating members of the Automotive Journalists Association of Canada (AJAC) have been challenging each other to win the title of ‘most efficient driver’. This isn’t a natural task for a group whose job is to rev motors and test handling as automotive journalists. It’s made even more challenging behind the wheel of a fast, high performance vehicle.

But this is less about the car you drive, and more about how you drive it. EcoRun is where good driving and car technology come together, regardless of what’s under the hood. The 2017 fleet included gas, diesel, electric, hybrid, plug-in hybrid and hydrogen fuel cell cars, each with their own Natural Resources Canada (NRCan) fuel efficiency rating—the number to meet or beat.

As a supporter of EcoRun, Canadian Fuels was able to ride-along with some of the drivers as they made their way from Ottawa to Québec City from June 15–16. Slower accelerations, speed limit maximums and smooth corners were the norm in gas, diesel and hybrid models. In pure electric and hybrid-electric vehicles, drivers were more mindful of using secondary battery zappers like air conditioning, stereo and other cabin comforts.

The results?
After two days of careful driving, the results were pretty impressive. All but two vehicles met or beat their NRCan efficiency ratings, some by a significant margin. ‘Most efficient driver’ went to Wade Ozerhoff who, over the two day period, drove three hybrids, two plug-in hybrids, one diesel and four gasoline-powered vehicles.

“In a nutshell, says Ozerhoff, the EcoRun is essentially a great demonstration not only of new technology and methods aimed at reducing both emissions and fuel consumption… but also a reminder that a lot of cars can yield great fuel economy just by minding your driving habits.”

For more information and complete car and driver results, visit: ajac.ca/eco-run/
A RIPPLE EFFECT

UNDERSTANDING CANADA’S TRANSPORTATION FUELS INFRASTRUCTURE

Jason Parent, Vice President, Consulting, at Kent Group Ltd
HOW FUEL FROM A REFINERY REACHES A LOCAL GAS STATION IS GENERALLY NOT WELL UNDERSTOOD.

We similarly lack awareness about other supply chains, such as those that bring food into our grocery stores—yet we expect to see oranges in the fruit aisle in January.

In much the same way, Canadians have come to expect the seamless availability of gasoline at the pump, and expect this fuel to perform to specific standards, like being able to start our engines on a hot summer day or at -30°C in January.

As with any supply and distribution network, a change or interruption to product manufacturing or logistical processes can have wider implications. This is certainly true in the downstream transportation fuels sector; its infrastructure and supply chain affect the daily movement of people, product, and the economy at large—that’s a wide implication.

Policy activity designed to address both global and domestic climate objectives punctuate the need for better understanding of the infrastructure that powers Canadian drivers. With road transportation emissions comprising roughly 19% of Canada’s GHG emissions, stakeholders are seeking to pull levers in areas like carbon pricing, renewable fuels development and clean fuel standards—all of which have the potential to impact the transportation fuels sector, and consumers.

The importance of understanding the current infrastructure

The refining and distribution of transportation fuels is multi-faceted and complex, delivering around 85 billion litres of fuels to Canadians each year. Writing robust climate policy is also complicated, emphasizing the importance for stakeholders and policy makers to know the system, the processes, and the products they seek to change as they work toward effective and affordable emissions reductions. It’s why Kent Group recently finished a multi-stakeholder report called Canada’s Downstream Logistical Infrastructure.

The report is an inventory of Canada’s refineries, fuel terminals, bulk plant facilities, cardlock sites, and distribution networks by pipeline, rail, sea, and road. Additionally, the report covers biofuel production facilities, biofuel blending, trans-shipment facilities, and airport fuel storage for a more complete capture of the broader network.

Infrastructure is only part of the story

Aside from infrastructure, the products and their markets must also be considered. For example, there is a seasonality to the formulation and demand for transportation fuels in Canada—summer fuels are different than winter fuels. Refineries and the supply chain must accommodate the shifting regional product specifications and market needs throughout the year, all while meeting a range of regulatory requirements and minimizing costs.

(Continued on page 26)
Additionally, transportation fuels often trade openly across both inter-provincial and international borders, and these markets can be altered by regulations that impact either fungibility of the product or price.

There are currently six biofuel blending mandates across Canada—five provincial and one federal, as well as, complex and often incompatible mandates in U.S. markets. This patchwork of regulations can complicate both trade and compliance, and when added to an already non-linear supply and distribution network, presents a regulatory challenge on one hand, and a logistical challenge on the other.

The logistics of biofuel blending, for example

The logistics of biofuels blending in Canada involves a range of stakeholders, a number of transportation modes, and increasingly complex and costly infrastructure; it’s a good example of how regulations impact infrastructure and logistics.

Almost all blending takes place at the primary supply terminal (or rack point) requiring the coordination of inbound logistics from both biofuel producers/importers and conventional fuel producers/importers, then delivery to retail or commercial sites.

Typically, biofuels are blended into gasoline and diesel at the terminal for truck transportation. Ethanol is most often a “proportional blend” to a formulation of 10 percent ethanol and 90 percent octane-adjusted gasoline blend stock, producing an on-specification “E10” blended gasoline. Similarly, biodiesel is typically blended at a rate of 2 to 5 percent biodiesel. Regions that are not sufficiently or reliably supplied with biofuels can face significant logistical challenges if required to blend.

Biofuels are often transported to terminals by rail or by ship. Many terminals lack sufficient rail or ship offloading facilities, requiring investments to build such amenities or the use of trans-loading to allow inter-modal transfer of product (from rail to truck, for example). Conversely, the vast majority of petroleum products are delivered to terminals via pipeline, a much more efficient and cost-effective and less emissions intensive form of transportation.

Any new renewable fuels regulations or clean fuel regulations can have implications throughout the fuel supply chain. For instance, an increase to the regulated blend percentage for ethanol would present challenges for ethanol producers (likely requiring more imports), refiners (adjusting product formulation to be able to blend on specification), shippers and blenders (with both infrastructure and logistics), and potentially retailers as higher ethanol blends can require upgrades to existing pump and tank technology.

As stakeholders and decision-makers move forward with climate action involving transportation fuels, it’s important to understand how this energy is refined, transported, blended, and delivered to Canadians every day. After all, it is what ensures that oranges make it to your local grocery store.

“AS WITH ANY SUPPLY AND DISTRIBUTION NETWORK, A CHANGE OR INTERRUPTION TO PRODUCT MANUFACTURING OR LOGISTICAL PROCESSES CAN HAVE WIDER IMPLICATIONS.”

A PURE EXPRESSION OF DEMOCRACY

Canadian Fuels is just one of many sector groups that regularly advocate and make representations to government in Canada. This lobbying work is important. It helps our political leaders develop a clear understanding of the issues that affect Canadians. Only then are leaders in a position to shape effective public policy.

At Canadian Fuels, we consider our advocacy work to be a pure expression of democracy. It’s why we have a voice. It gives us the chance to deliver insight no one else can provide about our industry—an industry that employs over 100,000 Canadians and affects millions more each day.

Two-pronged approach
We represent just one sector. We’re primarily interested in transportation and energy policy. Yet these are also policy areas of interest to other sectors, such as manufacturing and trade. And this is why it’s important for trade associations like ours to work closely with business councils. They tend to offer broader insight by focusing on various specialties, such as the environment, health and safety, tourism and human resources.

Provincial and federal governments rely on these councils—and for good reason. The positions they bring forward are the results of substantial research and collaboration. They offer a slightly different perspective, helping to refine government’s overall understanding of the economy.

Canadian Fuels places great value on business councils. We actively take part in several roundtables and committees that help develop advocacy positions and make representations before elected officials.

Individual industry advocacy. Collective multi-sectoral collaboration. Our approach combines both to ensure Canadian Fuels is among effective trade associations that balance the concerns of industry, Canada, and Canadians in helping to develop sound, evidence-based government policies.
PURSUING BREAKTHROUGHS IN BIODIESEL

Greg Rockwell works to crack the cold-climate limitations of this renewable fuel.

Considering Greg Rockwell’s doctoral thesis, it is surprising he ended up in the petro-chemical industry. At Dalhousie University, the chemist developed nanostructured films to enable the study of physical processes such as protein binding—primarily for medical devices such as stents.

“My plan was to do a post-doctoral fellowship,” says Rockwell. “I was going to explore different areas of research before deciding whether I wanted a position as a professor or a job in industry.”

But a Dalhousie alumnus at Imperial had seen Rockwell’s résumé online and suggested he apply to the oil giant.

“It was quite a leap,” admits Rockwell. “To uproot my wife and me from Halifax—where both our families lived—to Sarnia, Ontario.”

The gamble paid off. Today, he’s a leading researcher at Imperial’s Sarnia Technology Applications & Research facility. The operation has a strong research record in biofuels, having led projects for the National Renewable Diesel Demonstration Initiative and developed the cold soak filter blocking tendency test for pure biodiesel.

Rockwell also serves as Imperial’s voting member on the Canadian General Standards Board committees for middle distillate fuels and gasoline and alternative automotive fuels. “I provide technical input to these committees, which develop and maintain standards for products such as diesel, biodiesel, gasoline, ethanol, heating oil and propane.”

Yet his primary focus remains a search for ways to make biodiesel use a more feasible option in the cold winter conditions experienced in much of Canada.

“I’ve been exploring biodiesel use in cold climates,” says Rockwell, “particularly potential impacts on product quality.”

In Canada, biodiesel composed of fatty-acid methyl esters (FAME) is the primary renewable component used in diesel fuel. The FAME, however, increases the tendency of the diesel to form wax crystals, gel and plug fuel filters in winter temperatures.

“This is a hot area for us,” he says, “We’re not at the breakthrough stage, but I think we’re accumulating valuable knowledge in low-temperature performance, which is a precondition for pushing past biodiesel’s current limitations.”

“This is a hot area for us... I think we’re accumulating valuable knowledge.”
Alexander Winter was confident for good reason. Heading into Shell’s Eco-marathon in Detroit in April, Winter and the 20 person crew from Université Laval were the team to beat. A year earlier, the Alérion Supermileage team secured top spot in the ultra-energy-efficient gasoline-powered vehicle prototype category.

A fourth year mechanical engineering student and Team Manager at the event, Winter appeared less stressed than some of the other 1,200 student participants feverishly working on passing rigorous technical challenges in order to qualify for the main event. “We’re confident” he said, gesturing to his teammates hovering around the compact vehicle in the pit. “We have plenty of time to improve and pass all the technical requirements” he said. “Our main goal is to improve each year”.

MORE THAN MILEAGE IN DETROIT

BY CANADIAN FUELS STAFF

Canadian Fuels Association | Perspectives—Fuel 2018
**What is**

It’s a unique competition that challenges students around the world to design, build and drive the most energy-efficient car. With three annual events in Asia, Americas and Europe, student teams take to the track to see who goes further on the least amount of fuel.

There are two classes or categories to the event. The **Prototype** class focuses on maximum efficiency. The **Urban Concept** class encourages more practical designs. Cars are also divided by energy type: *Internal combustion engine* vehicles fuelled by gasoline, diesel, liquid fuel made from natural gas and ethanol. In the **electric mobility** category, vehicles are powered by hydrogen fuel cells and lithium-based batteries.

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**Bright minds, big effort**

For many of the students, just getting to the event and passing the technical elements of Eco-marathon is a marathon in itself. The work is year-round.

Beside the Laval group, an empty booth waiting for the team from the University of Toronto was an unusual sight. “I’m not sure where they are, it’s a little weird” said Winter when asked about the missing group—who also happened to be their biggest rival, having placed second the year before. It turned out that the Toronto team couldn’t get into the country with all of their equipment; a reminder of how much effort—and heartache—can go into the event.

**Canadian winners and notables**

When the driving was done, the *Alérion Supermileage* team did not disappoint, taking first place in their category. Recording an impressive 2,713.1 miles per gallon, they also made good on their goal of improving year over year. In 2016, they recorded 2,585 miles per gallon.

Not all winners were a result of on-track performance. Shell awards six ‘off-track’ prizes, from Technical Innovation to Vehicle Design. University of Ottawa’s *Supermileage uOttawa* received the Communications Award for leveraging traditional media and local events to connect with their community, and sharing social media content in both English and French to reach a wider audience.

Of special note, and participating for the first time, was the *ecoMotion* team from the University of Manitoba, led by Team Manager Mihskakwan James Harper. A fourth year mechanical engineering student originally from Sturgeon Lake Cree Nation, it was Mihskakwan’s initial vision to build a team and then a prototype battery-electric vehicle.

Impressively, *ecoMotion* was the only Canadian team to pass the technical requirements needed to participate in their category.

Well done, everyone.

For a complete list of results and to learn more about the event, visit:

shell.com/energy-and-innovation/shell-ecomarathon/americas.html
Some argue that oil is yesterday’s energy source. They’re right. Over the past century and a half, petroleum has fuelled history’s fastest increase in the standard of living—worldwide.

BY KRIS SMITH

But in upholding our economic prosperity and quality of life while we pursue our environmental goals, petroleum is also a key part of our energy future. Yes, innovation is making progress in a variety of alternative fuel and vehicle technologies. It’s also driving ongoing improvements to petroleum products—many of them environmental. For example, today’s petroleum fuels are much cleaner than the fuels of yesterday, with remarkably lower sulphur content and smog causing emissions. And the industry is continuing to push improvement and innovation, the newest challenge being to reduce the carbon intensity of our fuels.

As the world’s predominant transportation fuel, today’s petroleum shoulders a great deal of the responsibility to help us get where we’re going—literally and figuratively. Alternative fuel and vehicle technologies are far from ready to bear more than a small fraction of the transportation load. Their technological progress is not measured in months. It’s measured in years and decades. However, one thing is clear; petroleum fuels can be relied on to meet the demands of a growing population and continue to improve the standard of living of people around the world.

Evolving to meet new challenges

I can tell you, as someone who works in the petroleum sector, I believe that the industry is up to the challenge of reducing carbon emissions. Great engineering minds and resourceful companies are focused on continuous and substantial environmental improvements to the ways petroleum is produced, refined and used. The aim is simple: to make petroleum not only today’s fuel, but also the fuel of tomorrow.

And what better country to show leadership in lowering carbon intensity in the energy system? Canada is endowed with the resource and driven to innovate. We have a vibrant petroleum industry that employs tens of thousands and contributes billions to the economy. We have one of the world’s most progressive environmental regulatory frameworks. And faced with vast geography and a cold climate, we understand the vital importance of fuel efficiency and reliability.

This is not simply blind faith in the power of innovation. Our industry has a proven track record of environmental improvement over the last 50 years and there is more to come. Petroleum will be tomorrow’s fuel, trusted to meet its responsibility as a vital source of transportation energy. It will remain the go-to fuel that helps propel us to the environmental, social and economic outcomes that Canadians ultimately want.