Heavy-Duty Vehicle Tire

Market Analysis Study

Final Report

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Submitted to:

Transport Canada

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1. Executive Summary

1.1 Introduction

In 2015, Canada's total greenhouse gas (GHG) emissions were 722 million metric tonnes on a carbon dioxide equivalent (CO_2 eq.) basis. Approximately 24% of these emissions were from the transportation sector, including 62.5 million tonnes from heavy-duty gasoline and diesel powered vehicles.

Given their contribution to total Canadian GHG emissions, and their growth over time, the Government of Canada has proposed *Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations and Other Regulations Made Under the Canadian Environmental Protection Act, 1999* to further manage GHG emissions from heavy-duty vehicles and engines. The proposed Regulations

One option for improving fuel economy and reducing GHG emissions for heavy-duty trucks and trailers is the use of low rolling resistance tires. The objective of this study is to collect information from the Canadian trucking industry (including Class 7 and 8 vehicles and the trailers they pull) to provide a perspective on the rate of uptake of low rolling resistance tires in Canada.

1.2 The Heavy-Duty Vehicle and Engine Greenhouse Gas Emission Regulations

The *Heavy-Duty Vehicle and Engine Greenhouse Gas Emission Regulations* (the Regulations) were published in the Canada Gazette, Part II, on March 13, 2013. These regulations are now described as "Phase I" of the Regulations. The Phase I Regulations applied to various vehicle classes, including tractors defined as Class 7 or Class 8 heavy-duty vehicles manufactured primarily for pulling a trailer, but not for carrying cargo other than the cargo in the trailer. The Phase I Regulations had requirements for manufacturers, importers, and distributors, including CO_2 emission standards.

Environment and Climate Change Canada proposed amendments to further reduce greenhouse gas emissions from on-road heavy-duty vehicles and their engines for post-2018 model years in the Canada Gazette, Part I, on March 4, 2017. The proposed amendments would introduce more stringent GHG emission standards that begin with the 2021 model year for on-road heavy-duty vehicles and engines. Starting with the 2021 model year, the proposal introduces new CO_2 emission standards for "heavy line-haul tractors" and "heavy-haul tractors". In addition, starting with the 2018 model year, CO_2 emission standards are proposed for trailers that become progressively more stringent up to the 2027 model year.

1.3 Fuel Economy Options and Low Rolling Resistance Tires

The rolling resistance of a tire is defined as the force needed to keep the tire rolling at a constant speed on a level surface and is usually expressed in the form of a rolling resistance coefficient (C_{RR}). Two types of low rolling resistance tires are now relatively widely used by fleets, namely low rolling resistance conventional tires and low rolling resistance wide base single tires. Various design modifications to tread design, tread depth, sidewalls, rubber compounds, and other tire components can contribute to achieving lower rolling resistance and improved fuel economy. These changes can also affect other aspects of the tire's characteristics such as traction in rain or on snow or ice, tread life, and cost.

The U.S. Environmental Protection Agency's (EPA's) Smartway Verified List identifies close to 200 tire brands and over 750 low rolling resistance tire models. These tires are those that reduce fuel consumption by 3% or more relative to the best-selling new tires for line haul Class 8 tractor-trailers. Some empirical evidence from the U.S. suggests that:

- a very high proportion of tires on sales of new trucks and tractors are low rolling resistance duals or wide base singles; and
- over 75% of fleets have some low rolling resistance tires, and nearly 50% have some wide base singles.[1]

1.4 Canadian Fleets

Information was collected from a survey of fifty-four Canadian fleets with Class 7 and 8 tractors. The survey respondents included 42 for-hire fleets, 8 private fleets, and 4 rental fleets. Fleets with head offices in every Canadian province were surveyed. In total, the survey covered nearly 13,000 tractors and 35,000 trailers (an average of over 800 units per fleet). Given an estimate of 402,000 heavy-duty trucks in Canada, the study sample represents about 3.2% of the Canadian inventory of heavy-duty trucks.

The sampled fleets traveled 1,740 million vehicle kilometres in 2016, with over 80% by for-hire fleets. In total, the 12,795 tractors had 115,114 tires and the 34,799 trailers had 306,912 tires. As a core finding from the study, the 422,026 tires were comprised of:

- 41% conventional (non-LRR) tires;
- 49% low rolling resistance dual tires; and
- 10% wide base single tires.

There were variations in the uptake of low rolling resistance tires by fleet type, with for-hire fleets having the highest use of fuel saving tires.

[1] References to materials in the Executive Summary are found in later sections of this report.

1.5 Tire Manufacturers

Efforts were made to understand the 2016 national market for heavy-duty tires, and the shares of those that were low rolling resistance dual tires and wide base single tires, through consultations with tire manufacturers.

Seven North American tire manufacturers with sales in Canada completed surveys on their tire businesses. These businesses had sales of approximately 1 million tires in Canada in 2016, representing about 40% of the market estimate of 2.5 million tires. As a second key finding of the study, these tires were comprised of:

- 58% conventional (non-LRR) tires;
- 40% low rolling resistance dual tires; and
- 2% wide base single tires.

The tire manufacturers anticipated that there would be virtually no change in the shares by tire type in 2020.

1.6 Heavy-duty Truck Manufacturers

Two of the four North American heavy-duty truck manufacturers provided information on their sales of trucks and tires. The Canadian sales of those two manufacturers represented approximately 40% of the estimated market for Class 8 trucks in Canada in 2016. Based on reported sales, Class 7 trucks represented much less than 1% of the heavy-duty market.

The companies provided information on the types of tires found on their 2016 sales of heavy-duty trucks, with:

- 31% being conventional (non-LRR) tires;
- 63% being low rolling resistance dual tires; and
- 6% being wide base single tires.

1.7 Heavy-duty Truck Trailer Manufacturers

Fourteen major North American trailer manufacturers were approached with questions about their sales of tires on trailers, and ultimately eight responded with information. These eight companies reported selling approximately 15,000 trailers in 2016, which is expected to represent about 45% of the annual market for trailers in Canada.

The companies provided information on the types of tires found on their trailers sold into Canada in 2016, with:

- 28% being conventional (non-LRR) tires;
- 66% being low rolling resistance dual tires; and
- 6% being wide base single tires.

While these shares are very similar to those reported by tractor manufacturers, there was diversity in terms of the responses from individual trailer manufacturers.

1.8 Key Findings and Conclusions

The rates of tire uptake found among fleets, tire manufacturers, tractor manufacturers, and trailer manufacturers are summarized in Table 1.

Table 1: Summary of Tire Share Information, By Tire Type

Tire Type	Canadian Fleets	Tire Mfrs.	Truck Mfrs.	Trailer Mfrs.
Non-LRR Conventional	41%	58%	31%	28%
LRR Conventional	49%	40%	63%	66%
Wide Base Single	10%	2%	6%	6%
Total	**100%**	**100%**	**100%**	**100%**

On the basis of this evidence, it is expected that the shares of tire types on Canadian fleets are:

- 45% non-LRR conventional tires;
- 50% low rolling resistance conventional tires; and
- 5% wide base single tires.

This conclusion weighs the inputs from the Canadian fleet relatively highly (but considers the possibility of an unrepresentative sample, particularly in terms of wide base single tires). It also reflects the fact that the inputs from the three manufacturing groups represent the sales for a single year (2016) while the fleet estimates represent a sampling of the fleet across various model years.

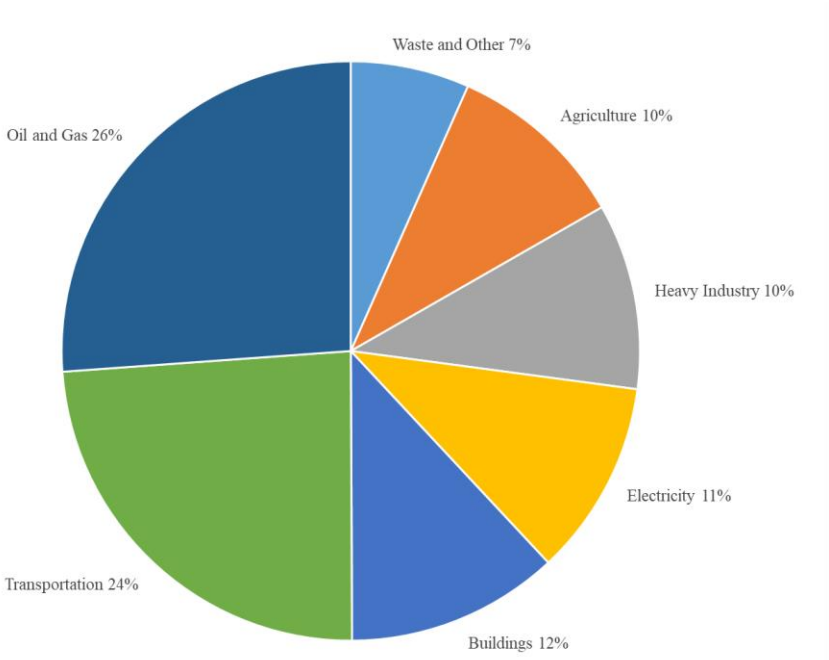
Several perceptions of fleet managers have deterred the uptake of low rolling resistance tires. For low rolling resistance dual tires, these predominantly include concerns over winter traction, off-highway traction, and an uncertain return in terms of fuel savings versus costs. Fleets were also concerned with the weight limits that exist in some provinces for wide base single tires and their availability particularly as replacements.

2. Introduction

2.1 Context

In 2015, Canada's total greenhouse gas (GHG) emissions were 722 million tonnes on a carbon dioxide equivalent (CO_2 eq.) basis.[2] Figure 1 shows that 24% of these emissions were from the transportation sector.

Figure 1: Canada's Greenhouse Gas Emissions, by Sector (2015)
(Total of 722 M Tonnes, CO_2 eq.)



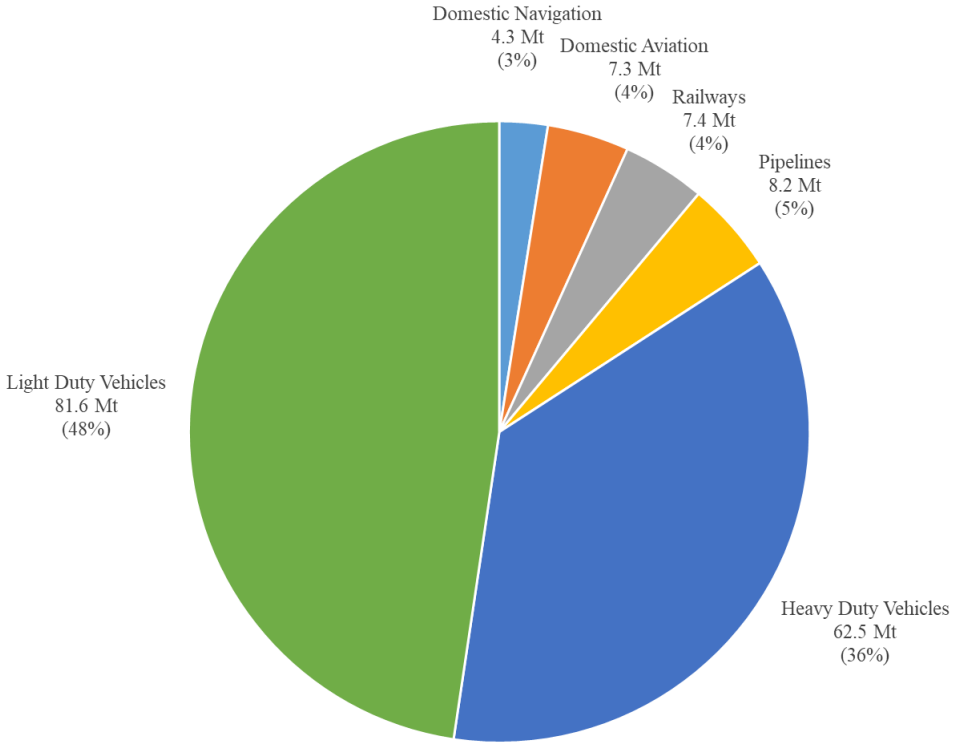
Source: Environment and Climate Change Canada (2017), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, Part 1, Table 2-12.

Figure 2 shows that almost half of the emissions within the transportation sector were from light-duty vehicles, including gasoline and diesel powered cars and trucks, motorcycles, and propane and natural gas powered vehicles. The second largest source of transportation emissions was heavy-duty gasoline and diesel powered vehicles, accounting for over one-third of emissions. Domestic aviation, rail, marine, and pipelines together account for the remaining transportation emissions.

[2] Environment and Climate Change Canada (2017), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, Part 1, Table 2-12.

Figure 2: Greenhouse Gas Emissions from Canada's Transportation Sector (2015)

(Total of 171.2 M Tonnes, CO_2 eq.)

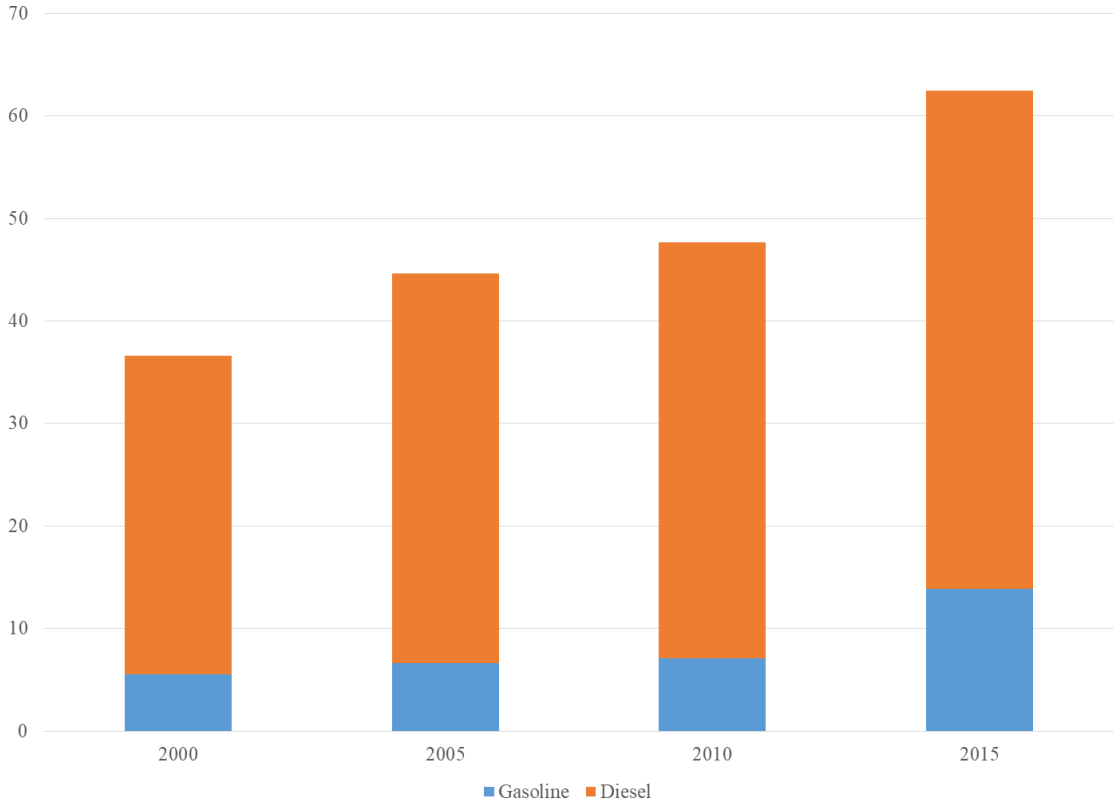


Source: Environment and Climate Change Canada (2017), *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, Part 3, Table A9-2.
Note: Some differences exist between Canadian economic sectors and Intergovernmental Panel on Climate Change (IPCC) sectors. The information in the table above excludes categories of off-road transportation.

The 2015 emissions from heavy-duty gasoline and diesel powered vehicles totalled 62.5 million tonnes (see Figure 3). About 75% of these emissions are from heavy-duty diesel vehicles, and 25% from heavy-duty gasoline vehicles. Notably, releases of greenhouse gases from heavy-duty on-road fleets have been increasing over time, with a compound annual growth rate of over 3.5% between 2000 and 2015.

Figure 3: Greenhouse Gas Emissions from Heavy-duty Vehicles in Canada (2000 to 2015)

(Million Tonnes, CO_2 eq.)



Source: Environment and Climate Change Canada (various years), *National Inventory Report*.

Due to their significant contribution to total Canadian GHG emissions, and their growth over time, there has been a need to regulate GHG emissions from heavy-duty vehicle. In 2013, Environment and Climate Change Canada (ECCC), implemented the *Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations* which established mandatory GHG emission standards for new on-road heavy-duty vehicles and engines. The Regulations applied to companies manufacturing and importing new on-road heavy-duty vehicles and engines of the 2014 and later model years for the purpose of sale in Canada.

A Notice of Intent was published in the *Canada Gazette*, Part I on October 4, 2014, to signal the government's intent to develop a second phase of heavy-duty vehicle and engine greenhouse gas emission regulations. The proposed *Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations and Other Regulations Made Under the Canadian Environmental Protection Act, 1999* was published in the Canada Gazette, Part I, on March 4, 2017.

The proposed Regulations would introduce more stringent GHG emission standards that begin with the 2021 model year for on-road heavy-duty vehicles and engines. Further, the proposed Amendments introduce new GHG emission standards that would apply to trailers hauled by on-road transport tractors for which the manufacture is completed on or after January 1, 2018, starting with model year 2018 trailers. These emission standards for heavy-duty vehicles, engines and trailers would increase in stringency every three model years to the 2027 model year and maintain full stringency thereafter.

2.2 Objectives

Low rolling resistance tires are one option for achieving compliance with the proposed Regulations. As a result, the objective of this study was to collect and analyze data from the trucking industry in Canada, with a focus on Class 7 and Class 8 vehicles and the trailers they pull, in order to estimate the availability and adoption rates of low rolling resistance tires in the Canadian market.

2.3 Methodology

This study was conducted primarily through:

- a literature review investigating low rolling resistance tires and their uptake;
- the distribution of electronic questionnaires to Canadian for-hire, private, and rental fleets (see Appendices A through D);
- the distribution of electronic questionnaires to North American tire manufacturing, tractor manufacturing, and trailer manufacturing companies;
- the further collection of information on tires and tire preferences through telephone consultations with Canadian fleets; and
- analysis of data collected through the questionnaires.

In total, 54 fleets provided information for this study, along with 7 tire manufacturers, 2 tractor manufacturers, and 8 trailer manufacturers. Both the Canadian Trucking Alliance (CTA) and Private Motor Truck Council of Canada (PMTCC) assisted in the collection of information from their respective members.

2.4 Structure of this Report

The remainder of this report proceeds as follows:

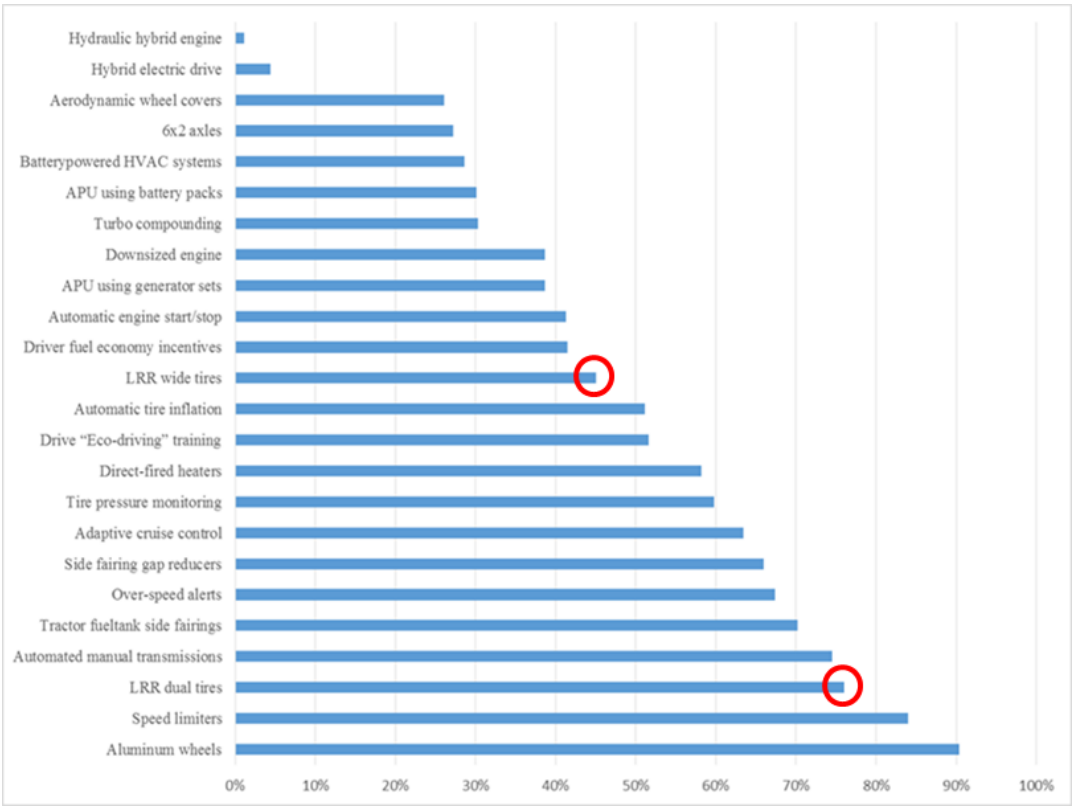
- Section 3 provides an overview of fuel economy options employed by heavy-duty trucks and the trailers they pull, including low rolling resistance tires;
- Section 4 summarizes information from a sampling of Canadian fleets focused on their tire choices;
- Section 5 provides information from North American tire manufacturers and the tires they sell;
- Section 6 includes information from North American heavy-duty truck manufacturers and the tires on those trucks;
- Section 7 presents information from North American heavy-duty truck trailer manufacturers and the tires on those trailers; and
- Section 8 reviews key findings and offers conclusions.

3. Fuel Economy Options and Low Rolling Resistance Tires

3.1 Fuel Economy Technologies and Measures

A 2016 survey from the U.S. provides information on market attitudes towards fuel saving technologies.[3] The survey was conducted from June 2016 through August 2016. The 96 fleets surveyed operate a combined total of just over 114,500 truck-tractors and approximately 350,000 trailers, hauling a total of 9 billion tons of freight across 1.8 billion miles annually. A summary of the uptake of various fuel saving measures is provided in Figure 4. The study suggests that 76% of fleets are currently using LRR dual tires and 45% are using wide base single tires. These results show the percentage of fleets currently using LRR tires, not the percentage of LRR tires on those fleets.

Figure 4: Current Uptake of Fuel Saving Measures



Source: Data from Schoettle, B., M. Sivak, and M. Tunnell (2016), *A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets*, Table 7.

[3] Schoettle, B., M. Sivak, and M. Tunnell (2016), *A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets*.

3.2 Low rolling Resistance Tires

The rolling resistance of a tire is defined as the force needed to keep the tire rolling at a constant speed on a level surface and is usually expressed in the form of a rolling resistance coefficient (C_{RR}). Tires are made of flexible materials, and as they move underneath the weight of the truck they deform against the ground. Overcoming that deformation and keeping a tire rolling forward requires energy and therefore fuel. Design features incorporated within certain tires mitigate the impacts of this deformation and therefore contribute to the LRR of that tire.

Historically, cost and tread life were the top considerations when specifying tires. Fuel efficiency was not a large concern when diesel was relatively inexpensive. Nevertheless, fuel-efficient tires with LRR appeared on the market in the early 1980s, known then as low-profile tires. Characterized by a lower aspect ratio (aspect ratio is the ratio of tire section height to tire section width) and shallower tread, they reportedly resulted in a 3-4% increase in fuel efficiency. However, they were also approximately 15% more expensive and the tread life was about 30% less than a non-LRR dual tire. At that time, due to the inexpensive price of fuel, the extra cost of the tire combined with the reduced tread life was difficult to make up in fuel savings. Consequently, sales of LRR tires when they were first introduced were sparse.

However, high fuel prices and greenhouse gas regulations in Canada and the United States have renewed interest in LRR tires. Two types of low rolling resistance tires are now relatively widely used by fleets:

- low rolling resistance dual tires; and
- low rolling resistance wide base single tires.

3.2.1 Dual Tire Design Modifications Leading to Low Rolling Resistance

Every component of a tire has a role to play in determining rolling resistance, traction, and tire life, and every component of a tire can be manipulated in some way to affect these and other characteristics. In terms of rolling resistance, the tread normally contributes about 40% to a tire's rolling resistance, the sidewalls and belts another 40% and the bead area about 20%.

Design modifications to these tire components that contribute to lower rolling resistance are as follows:

- Tread Design - the current trend in LRR tires is moving toward closed shoulder with a tighter tread pattern. Manufacturers are now building tires with tightly packed lugs. When tread lugs are packed tightly together, they support one another and squirming is minimized. This lowers rolling resistance with minimal traction reduction.

- Tread Depth - treads are typically shallower on LRR tires in order to minimize tread movement at the contact patch. There has been a belief that shallower tread provides less traction and will run fewer miles to removal, simply because there is less rubber on the tread to begin with. However, tread compounds and manufacturing processes developed by the leading tire manufacturers have improved over the years, enabling engineers to specify stiffer, more resilient rubber for the tread faces that is capable of running more miles with minimal impact to traction.

- Sidewalls - manufacturers can lower the rolling resistance of a tire by making the sidewall stiffer, as it will consume less energy if it flexes less. This is only possible up to a point however, as making a sidewall stiffer also means sacrificing some of its ability to withstand impact.

- Rubber Compounds - different materials are mixed and blended to produce the rubber used not just in the tread, but also the under-tread, the sidewalls, the bead, and the interior of the tire. Engineers are designing rubber compounds to suit each application, and for LRR tires they are striving for less elasticity overall so that less energy is consumed in the process of deforming and then returning to their original shape.

3.2.2 Wide Base Single Tires Leading to Low Rolling Resistance

A second option available in the low rolling resistance tire category is wide base single tires. Wide base tires are tires designed to replace two dual tires with one tire on drive or trailer axles for over-the-road applications. Michelin introduced the first wide base tire to the North American market in the year 2000. Though popular in Europe from some years prior, they were slow to gain acceptance in North America.

The design has some advantages over dual tires in reducing rolling resistance since two sidewalls are eliminated and the size of the overall contact patch is reduced. Depending on the make and model, many of the tread patterns and tread depths found on dual tires (outlined directly above) are also available on wide base tires, with some tread patterns unique to the wide base singles.

3.2.3 Potential Advantages and Disadvantages of LRR Tires

The primary benefit of LRR tires is lower fuel use and corresponding reduced fuel costs and greenhouse gas and other emissions. Savings will depend on unitary fuel costs, the extent of annual travel, and the life of the tire. In addition, the savings will be depend on the fuel saving impacts of moving from one tire to another, a function of the rolling resistance of the two tires. Moreover, any savings and return to investment must be considered in the light of other costs, such as those arising from changes in purchase price, maintenance costs, air pressure optimization costs, logistics effects, etc. As a result, fleets face complex decisions in terms understanding the full financial impacts of their tire choices.

A simple model was developed to show the relationships between the uptakes of various types of tires, their fuel economy, and corresponding fuel use and CO_2 emissions. A summary of this model and its results are presented in Appendix E to this study. For example, the model suggests that a 0.3 megatonne reduction in CO_2 emissions may be achievable by increasing the uptake of low rolling resistance tires from 50% to 70% (offset by a corresponding reduction in use of conventional tires). This represents a reduction of about 0.8% relative to estimated CO_2 emissions from heavy-duty trucks (40 megatonnes).

One of the primary perceived disadvantages of LRR tires is irregular/premature tread wear and consequently more frequent tire replacements. Nearly every tire manufacturer has achieved a degree of its rolling resistance reductions by sacrificing tread depth, which has negative effects on tire life and perhaps traction. One of the primary characteristics of LRR tires is a thinner tread. Because there are simply fewer inches of rubber on the tread face, it is logical to assume the tire will run fewer miles overall before the tread reaches the removal point. Early versions of LRR tires certainly suffered from shorter than desired tread life. More recently, advances in tire design and manufacturing, as well as tread compounding have succeeded in extending tire life. Some tire manufacturers have indicated that tread life now meets or even exceeds that of its non-LRR tires.

A second perceived drawback of low rolling resistance tires comes in terms of reduced traction in snow. Because there have been concerns and limited data available to assess this issue, Transport Canada asked the National Research Council (NRC) to undertake a preliminary study of LRR tire traction for Class 8 long-haul vehicles based on a cross-section of commercially available LRR tires in Canada.[4] Based on the testing performed, it was found that, on average, tires marketed as low rolling resistance had 29% lower rolling resistance than their conventional counterparts. In addition, laboratory and vehicle-based track testing of LRR tires demonstrated comparable levels of snow traction to non-LRR tires. That said, concerns remain over the winter performance of at least some LRR times, and their performance in some applications.

[4] National Research Council (2012), *Packed Snow Performance of Low Rolling Resistance Class 8 Heavy Truck Tires*, Document #: ST-GV-TR-0002.

Other advantages and disadvantages of low rolling resistance dual tires and wide base single tires are considered later in this report from the perspectives of Canadian fleets, and North American tire, truck, and trailer manufacturers.

3.2.4 The SmartWay Program and SmartWay Verified Tires

In 2004, fifteen companies and freight sector associations worked with the U.S. Environmental Protection Agency (EPA) to create the SmartWay program as a way of using market-based incentives and technology solutions to address long-term trends, changes and challenges in the freight transportation sector. One of the initiatives under the SmartWay program is LRR tires. The program has been duplicated in Canada as Natural Resources Canada's SmartWay Transport Partnership.

Within the heavy-duty trucking industry, LRR tires are widely viewed as referring to tires on the SmartWay verified tire list. For a tire to qualify for the SmartWay list, it must meet a rolling resistance threshold for each type of tire. According to SmartWay, the threshold is set at a level that reduces fuel consumption by 3% or more relative to the best-selling new tires for line haul Class 8 tractor-trailers. However a limitation of the SmartWay list is that it creates only one threshold for distinguishing between LRR and non-LRR tires, that of a decrease in rolling resistance that reduces fuel consumption by 3% or more relative to the comparable best-selling new tires for line-haul Class 8 tractor-trailers.

A consequence of the SmartWay list is that it only incentivizes tire manufacturers to reduce rolling resistance to meet the threshold, but not any further than that. In fact, there is a significant range of rolling resistance co-efficients among the tires on the SmartWay list, and some are now much lower than others. As a result, it has been suggested that fleets should begin to investigate their rolling resistance options in greater detail than simply asking whether their tires are SmartWay verified. Though that list is a great starting point for addressing rolling resistance, tire manufacturers are now offering tires with substantially lower resistance than the SmartWay threshold. Those super LRR tires will allow fleets to save even more on fuel costs (and to achieve even greater reductions in GHG and other air pollutant emissions). However since tire manufacturers do not publically share the LRR coefficients of their tires, it can be difficult for fleets to fully assess their options.

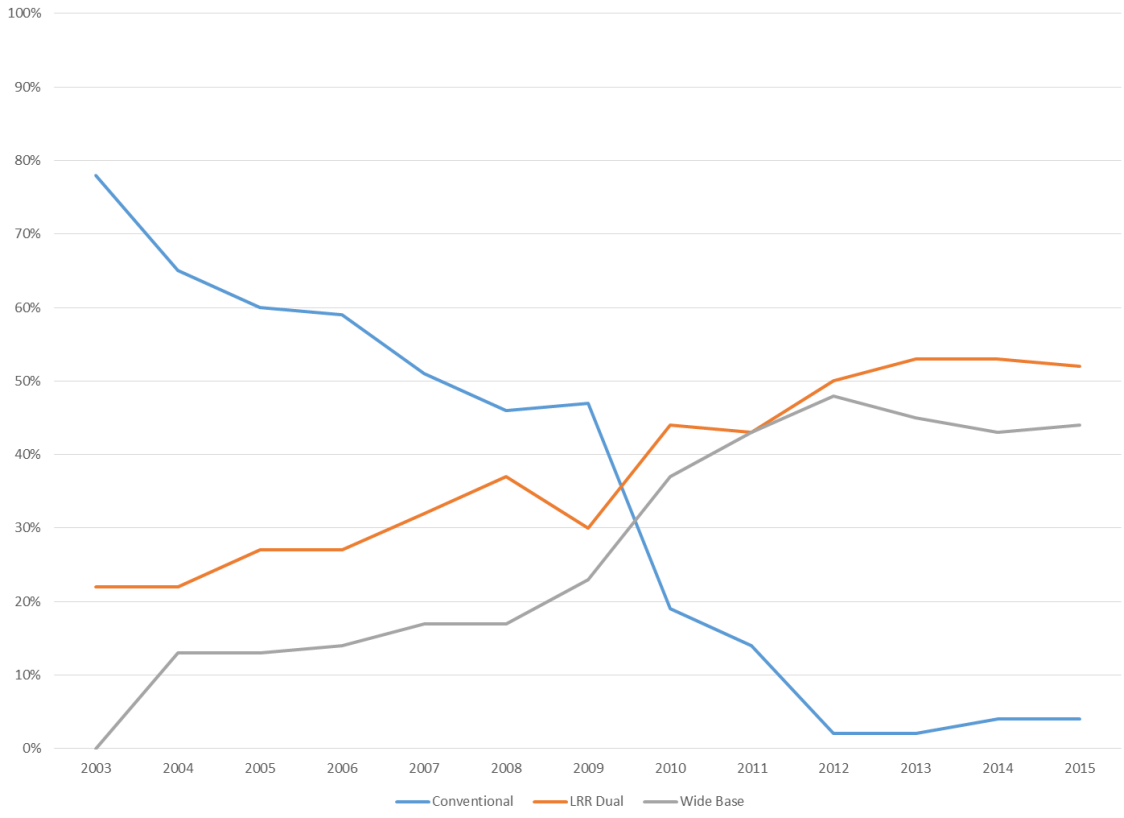
3.2.5 Adoption Rate for LRR Tires Among North American Truck Fleets

One measure of the trend in increasing penetration rates for LRR tires is in the size of the U.S. EPA's SmartWay verified tire list. The verified tire list was launched as part of the technology program in 2004 with the aim to accelerate adoption of fuel-saving technologies. However by 2010, only eight tire brands were listed. But in the last 5 years the list has grown dramatically, and today the list contains close to 200 tire brands and over 750 tires.

Adoption rates for LRR tires among Class 8 trucking fleets in North America has been undertaken by the North American Council for Freight Efficiency (NACFE). Based on the work of NACFE, there is a clear trend in North America among on-highway truck fleets toward LRR tires. The two figures below show the results of NACFE's most recent *Annual Fleet Fuel Study* which finds that fleets have been moving toward LRR tires, both duals and wide base singles. The majority of the fleets surveyed were in the U.S., however some Canadian fleets are included in these data. This increasing LRR tire adoption rate is true for both tractor tires and trailer tires.

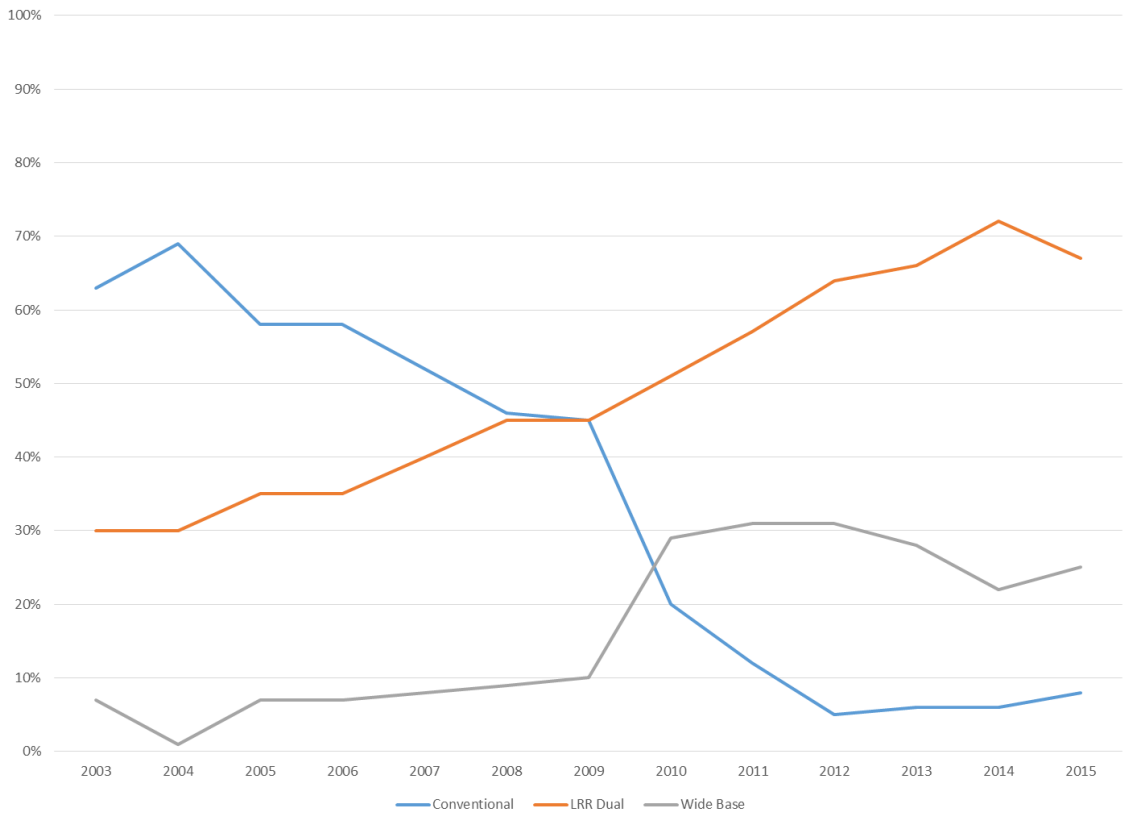
Uptake of LRR duals and wide base singles has grown considerably over the past decade. For example, the information in Figure 5 is drawn from NACFE's *Annual Fleet Fuel Study* and shows that the uptake of conventional tires has fallen dramatically on tractors since 2003. A similar pattern is shown for trailer tires in Figure 6.

Figure 5: Adoption of Low Rolling Resistance Truck Tires by North American Fleets



Source: NACFE (2016), *Annual Fleet Fuel Study*, data drawn from Appendix A.

Figure 6: Adoption of Low Rolling Resistance Trailer Tires by North American Fleets



Source: NACFE (2016), *Annual Fleet Fuel Study*, data drawn from Appendix A.

The technology adoption rates in the *Annual Fleet Fuel Study* is for the North American fleets (17 fleets were surveyed in 2015) that participate in the NACFE study. In total, these fleets operate 62,000 tractors and 217,000 trailers and are considered to be more progressive in their adoption of fuel-saving technology than the industry as a whole. The purpose of the survey is to track changes in purchasing behavior as it relates to various fuel saving technologies. Fleets are asked to complete the survey based solely on their purchases for the prior year. Therefore, if a fleet only purchased equipment with LRR conventional tires in the prior year, they would state 100% LRR conventional tire adoption even if their inventory includes older tractors that may be equipped with non-LRR tires. The individual responses are then weighted based on total miles travelled by the entire fleet, to provide a view of how quickly technology use is changing in the survey group.

In addition to the NACFE estimates, *A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets* suggests that over three-quarters of fleets (76%) are currently using low rolling resistance dual tires on at least some of their units (see Table 2). In contrast, less than half of the fleets were currently using wide base singles (45%), and a large share (40%) indicated they would "never" use wide base tires. The study is based on U.S. fleets, though some of these move goods in Canada and/or Mexico. For clarity, the statistics do not indicate that, for example, 76% of tires on surveyed fleets are currently low rolling resistance duals. Rather, they indicate that 76% of fleets are currently using the low rolling resistance duals on some of their fleet vehicles. As such, the information is not immediately comparable with Canadian data presented later in this report.

Table 2: Truck-Based Fuel-Saving Technologies and Strategies, by Fleet Size

Technology	Fleet Size	Currently Using	Considering Using in the Next Year	Considering Using in 2 or More Years	Would Never Use
Low Rolling Resistance Dual Tires	1-20	60%	0%	20%	20%
	21-100	73%	0%	9%	18%
	101-500	83%	4%	13%	0%
	501 or more	85%	8%	0%	8%
	All fleets	**76%**	**3%**	**10%**	**11%**
Low Rolling Resistance Wide Base Tires	1-20	38%	10%	14%	38%
	21-100	38%	0%	5%	57%
	101-500	48%	4%	8%	40%
	501 or more	54%	11%	7%	29%
	All fleets	**45%**	**6%**	**8%**	**40%**

Source: Schoettle, B., M. Sivak, and M. Tunnell (2016), *A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets*, Table 7.

4. Canadian Fleets

4.1 Introduction

This section provides information on Canadian for-hire, private, and rental fleets of Class 7 and Class 8 trucks and trailers. Information on fleet size, characteristics, and tire preferences is provided based on a sampling of 54 fleets. The surveyed fleets include companies headquartered in all ten provinces of Canada, and cover over 10,000 tractors that pulled over 30,000 trailers more than 1.7 billion vehicle-kilometres in 2016. The main finding is that the 420,000 tires on the tractors and trailers are comprised of 40% conventional tires, 50% low rolling resistance tires, and 10% wide base single tires.

4.2 Methodology

Fleets were identified and contacted to participate in the study through three channels.

- Canadian Trucking Alliance - The Canadian Trucking Alliance made numerous requests to its membership to participate in the study. This included broad e-mail distributions to members, discussions with provincial associations, and requests directly to individual members. Fleets that identified themselves as being interested in participating were contacted by telephone and e-mailed an electronic survey instrument (see Appendix A). Several rounds of follow-up calls were made to companies for clarifications and to request a completed questionnaire. This channel resulted in approximately 50% of the responses received during the study.

- Private Motor Truck Council of Canada - The Private Motor Truck Council of Canada distributed several e-mail communications to its membership asking for participation in the survey process. In addition, all Council members were contacted multiple times by telephone. Private fleets indicating they would participate through the Council e-mails or consultant telephone calls were e-mailed an electronic survey instrument (see Appendix A). Several rounds of follow-up calls were made for clarifications and to request completed questionnaires. This channel resulted in approximately 15% of the responses received during the study.

- Random Selection - Cheminfo Services Inc. randomly identified trucking fleets across Canada based on a provincially-disaggregated Internet search. These companies were contacted by telephone and asked to participate in the study through a telephone consultation. The telephone consultation guide was an abbreviated version of the full survey instrument sent to for-hire and private fleets. This channel resulted in approximately 35% of the responses received during the study.

4.3 Geographic Distribution of the Fleets

Efforts were made to understand the geographic distribution of the 54 fleets surveyed. In terms of head office location, almost half of the companies surveyed had head office locations in Ontario and Quebec (see Table 3). Fleets with head offices in every Canadian province but not every territory were surveyed.

Table 3: Survey Sample Head Office Locations

Region	Number of Fleets	Share of Head Office Locations	Share of Cdn. Population
Atlantic Canada	11	20%	7%
Ontario and Quebec	25	46%	61%
Saskatchewan and Manitoba	6	11%	7%
British Columbia and Alberta	12	22%	25%
Territories	0	0%	<1%
Total	**54**	**100%**	**100%**

Source: Share of Canadian Population from Statistics Canada, CANSIM Table 051-0001.

4.4 Types of Fleets

Three types of fleets provided inputs on their characteristics and tires, namely for-hire fleets, private fleets, and rental fleets. Table 4 shows that the majority of fleets participating in the consultations were for-hire fleets (42 of 54 fleets). These for-hire fleets owned almost 85% of the total tractors and trailers surveyed (with an average of about 950 units per fleet). Eight private fleets and four rental fleets (renting power units and tractors to others on short- and long- term contracts) comprised the remainder of the sample. Rental fleets tended to have significantly fewer units per fleet (about 260) than the for-hire and private fleets.

Table 4: Size of the Fleets, By Type

	Number of Fleets	Total Trucks	Total Trailers	Total Units	Share of Units
For-Hire	42	10,620	29,337	39,957	84%
Private	8	1,826	4,777	6,603	14%
Rental	4	352	685	1,037	2%
Total	**54**	**12,798**	**34,799**	**47,597**	**100%**

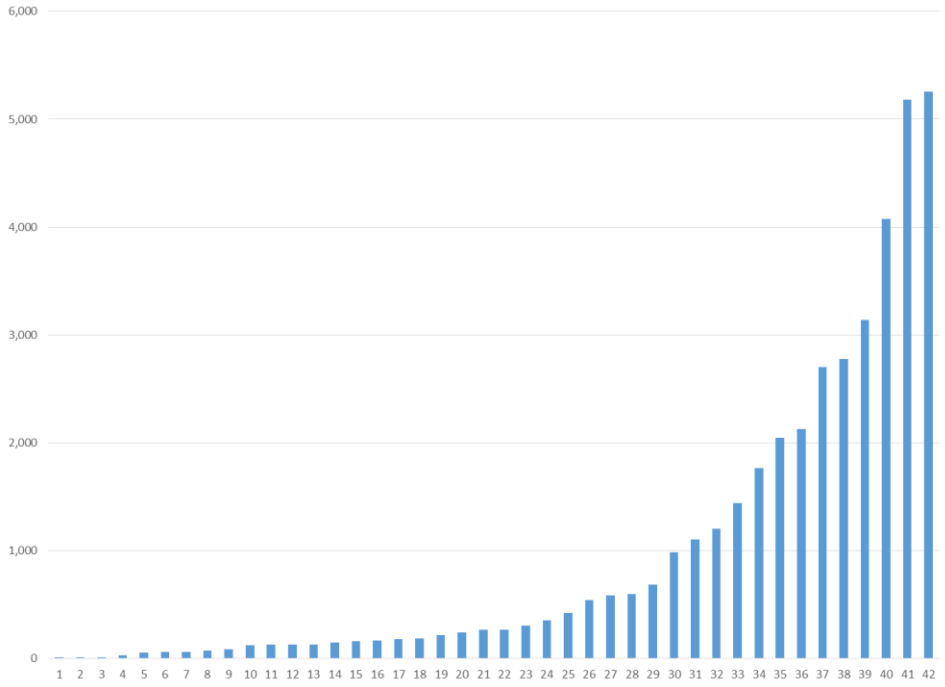
Note: Units include Class 8 and Class 7 tractors as well as trailers pulled by those vehicles.

Information from the most recent (2009) *Canadian Vehicle Survey* indicates that there were 317,219 (in-scope) vehicles (Table 3-1) weighting 15 tonnes or more on provincial and territorial registration lists. The Survey (Table 3-3) also reports that 202,890 of these were tractor trailers, and 110,607 are straight trucks (with 3,022 other body types). More recent information from Environment and Climate Change Canada suggests that there were approximately 402,000 heavy-duty tractors in Canada in 2015.[5] Information from Statistics Canada indicates that there are about 463,000 vehicles weighing 15,000 kg or more in Canada.[6] Based on these estimates, the data collected as part of this study represent approximately 3% of the national heavy-duty truck fleet.

4.4.1 For-Hire Fleets

Figure 7 shows the sizes of the 42 sampled for-hire fleets, with a total of almost 40,000 units (10,620 tractors and 29,337 trailers). The smallest for-hire fleet had fewer than ten total units (Class 7 and Class 8 tractors, plus trailers) while the largest had over 5,000 units. In total the five smallest for-hire fleets had approximately 100 units (about 0.2% of the sample of 54 fleets). The largest five for-hire fleets had approximately 20,000 units (about 40% of the sample of 54 fleets). As such, the results of this study are heavily influenced by a relatively small number of large for-hire fleets.

Figure 7: Number of Units Owned by For-Hire Fleets
(Fleets Arranged from Smallest to Largest)

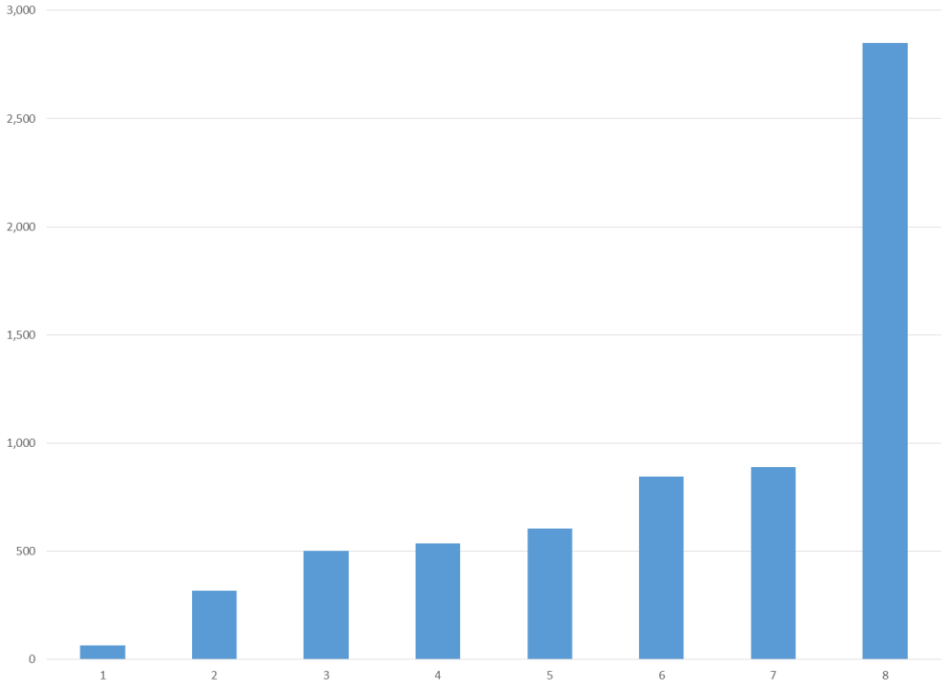


[5] E-mail from Environment and Climate Change Canada to Cheminfo Services Inc., July 2017.
[6] Statistics Canada, *Motor Vehicle Registrations*, CANSIM Table 405-0004.

4.4.2 Private Fleets

Figure 8 shows the sizes of the eight sampled private fleets, with a total of over 6,500 units (1,826 tractors and 4,777 trailers). The smallest private fleet had fewer than one hundred total units, while the largest had over 2,500 units. In total the eight private fleets comprised about 15% of the units across the sample of 54 fleets.

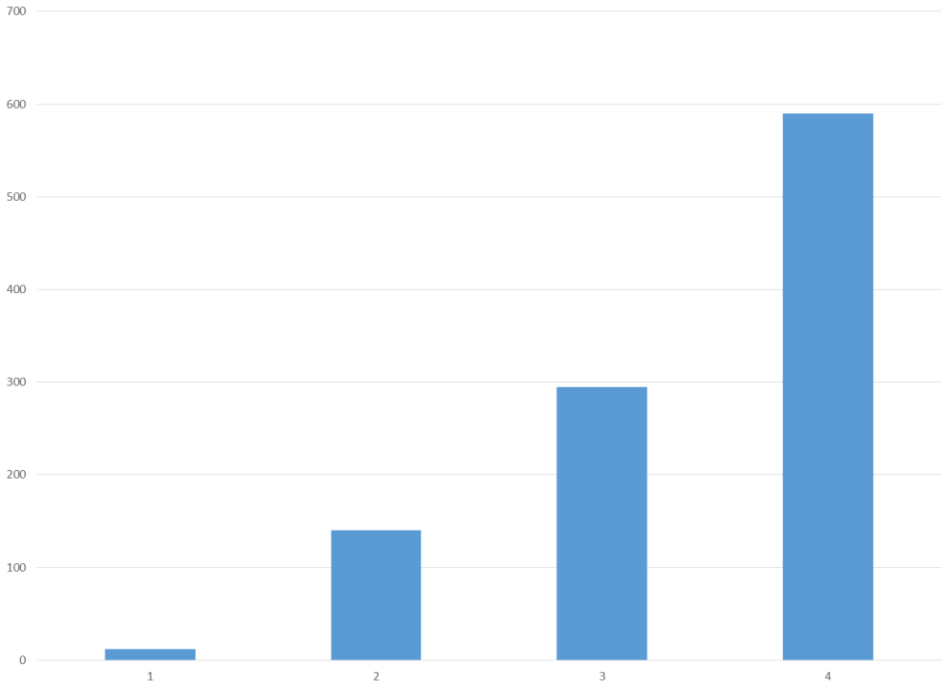
Figure 8: Number of Units Owned by Private Fleets
(Fleets Arranged from Smallest to Largest)



4.4.3 Rental Fleets

Figure 9 shows the sizes of the four sampled rental fleets, with a total of about 1,000 units (352 tractors and 685 trailers). The smallest private fleet had approximately ten units in total, while the largest had over 500. In total the four private fleets comprise less than 2% of the units across the sample of 54 fleets.

Figure 9: Number of Units Owned by Rental Fleets
(Fleets Arranged from Smallest to Largest)



4.5 Total Travel

Forty-one of the fifty-four fleets surveyed provided information on total miles of travel (in Canada) for 2016. Annual travel for eleven of the other fleets was estimated on the basis of the number of power units owned and the average travel per tractor for the companies that reported travel (one of the four rental companies provided travel data, and this information was applied on a per-tractor basis for the other three rental fleets). Two of the fleets were trailers-only, and did not have information on travel.

Total travel of the sampled fleets was estimated to be 1,740 million vehicle kilometres of travel in Canada in 2016. This was comprised of:

- 1,539 million vkt by for-hire fleets;
- 148 million vkt by private fleets; and
- 53 million vkt by rental fleets.

Not surprisingly, for-hire fleets accounted for the majority of travel (88%), and had the most average travel per tractor by a considerable margin (almost 80% more travel than private fleets at approximately 145,000 km compared to 85,000 km). This finding provides an expectation that there may be a propensity by (some) for-hire fleets to prefer low rolling resistance tires as they are better positioned to recoup investment costs through fuel savings over a shorter period of time.

There were also significant differences in terms of the total travel by individual fleets (see Table 5). Ten of the fleets surveyed travelled less than 2.5 million vehicle kilometres per year. In contrast, four fleets had more than 100 million kilometres of travel.

Table 5: Distribution of Distance Travelled by Fleets

Travel (VKT)	Number of Fleets
Less than 2.5 Million	10
2.5 - 5.0 Million	8
5.0 - 10.0 Million	7
10.0 - 20.0 Million	8
20.0 - 50.0 Million	8
50.0 - 100.0 Million	7
More than 100 Million	4
Total	**52**

Note: Two of the fleets are excluded from the information above as they own trailers only.

4.6 Distribution of Fleet Travel

Fleets were also asked to provide information on their share of travel by region. Some fleets did not provide this information, and some where not asked this information (i.e., those surveyed by telephone). Some fleets did not know this information (in particular, the rental fleets) and others did not track the share of travel in “northern” and “southern” areas. Otherwise, “northern” and “southern” areas were subjectively established by the survey respondents.

About two-thirds of the fleets provided regional travel information, with a national total of over 1.4 billion vehicle kilometres of travel in Canada (Table 6). Not surprisingly, southern areas of the provinces spanning Quebec through British Columbia saw the majority of travel given the extent that populations are located in those areas.

Table 6: Regional Shares of Fleet Travel (2016)

Region	Million VKT	Share
NL, NS, PE, NB	137	10%
Southern QC, ON, MB, SK, AB, BC	1,021	72%
Northern QC, ON, MB, SK, AB, BC	242	17%
NU, NT, YT	9	1%
Canadian Total	**1,410**	**100%**

Note: Information is provided only for the companies identifying regional shares of travel, which represents 1.41 billion km of the total travel of 1.74 billion km.

4.7 Fleet Tires

The 54 sampled fleets reported having 422,026 tires, as shown in Table 7. These included 115,114 tires on tractors and 306,912 tires on trailers. Almost 85% of tires were reported on for-hire fleet vehicles.

Table 7: Numbers of Tires on Tractors and Trailers, By Type of Fleet

Fleet	Tractor Tires	Trailer Tires	Total
For-Hire	94,576	260,328	354,904
Private	17,018	40,092	57,110
Rental	3,520	6,492	10,012
Total	**115,114**	**306,912**	**422,026**

As the primary finding from this study, Table 8 describes the findings relating to uptake of conventional dual tires, low rolling resistance tires, and wide base single tires. Across the entire sample of 422,026 tires spanning 54 fleets:

- 41% were conventional dual tires;
- 49% were low rolling resistance dual tires; and
- 10% were wide base single tires.

As anticipated, the uptake of fuel saving tires (low rolling resistance duals or wide base singles) was highest among for-hire fleets. It is notable that the data for rental fleets is based on a very small sample of fleets.

Table 8: Uptake of Tires, By Tire and Fleet Type

		Conventional Tires	Low Rolling Resistance Tires	Wide Base Single Tires	Total Tires
For-Hire Fleets	#	136,293	177,848	40,763	354,904
	%	38%	50%	11%	100%
Private Fleets	#	34,832	22,178	100	57,110
	%	61%	39%	0%	100%
Rental Fleets	#	4,171	5,841	0	10,012
	%	42%	58%	0%	100%
Total	**#**	**175,296**	**205,866**	**40,863**	**422,026**
	%	**41%**	**49%**	**10%**	**100%**

The 95% confidence interval for each tire type was estimated as follows. The number of tires by type for each fleet was converted to a percentage of the total number of tires (422,026) in the sample. The mean and standard deviation of the percentage shares were estimated across the 54 fleets. The 95% confidence intervals were calculated using z-values, and are shown in Table 9.[7] The confidence intervals are relatively large because there is considerable variability in the rates of uptake for the various tire types across the 54 fleets (ex., some fleets had no low rolling resistance tires, while some fleets had all low rolling resistance tires).

Table 9: 95% Confidence Intervals

Tire Type	Lower Limit	Mean	Upper Limit
Conventional	23%	41%	60%
LRR Dual	21%	49%	76%
Wide Base Single	1%	10%	18%

Most fleets did not expect a significant change in this mix through 2020, though a small number of fleets indicated they may take incremental steps towards low rolling resistance dual tires.

[7] The formula applied is 95% confidence limits = sample mean ± z-value × (standard deviation / square root of sample size) where the sample mean was calculated for each tire type, the z-value was 1.96, the standard deviation was calculated for each tire type, and the sample size was 54 fleets.

4.8 Tires and Travel

Table 10 describes the amount of travel in Canada by the surveyed fleets, by tire and fleet type. Conventional tires are used for 37% of travel. This is less than their 41% share of all tires, because private fleets (which have relatively more conventional tires) tend to travel less per tractor. LRR tires are used for 52% of travel. This is somewhat higher than their 49% uptake, because of the strong use by for-hire fleets and the relatively extensive travel by for-hire tractors. Wide base singles are used for 12% of travel, which is again higher than their 10% uptake share due to the uptake an extensive travel by for-hire fleets.

Table 10: Travel by Tire Type (2016)

		Conventional Tires	LRR Tires	Wide Base Single Tires	Total Tires
For-Hire Fleets	km	524,393,355	808,938,214	205,210,482	1,538,542,052
	%	34%	53%	13%	100%
Private Fleets	km	96,728,521	51,460,432	195,918	148,384,872
	%	65%	35%	0%	100%
Rental Fleets	km	16,300,000	36,700,000	0	53,000,000
	%	31%	69%	0%	100%
Total	**km**	**637,421,877**	**897,098,646**	**205,406,401**	**1,739,926,924**
	%	**37%**	**52%**	**12%**	**100%**

4.9 Perspectives on Low Rolling Resistance and Wide Base Single Tires

Fleet representatives were asked to provide their views on the advantages and disadvantages of [i] low rolling resistance duals and [ii] wide base singles relative to conventional (non-LRR) tires.

4.9.1 Low Rolling Resistance Duals

Twenty-nine fleet representatives provided perspectives on various attributes of low rolling resistance tires relative to conventional dual tires (see Table 11). Ten characteristics were rated as being either “poor”, “average”, “good”, or “excellent”. The following table shows the share of responses being in each rating category for each characteristic. Some of the notable results are highlighted, included:

- a purchase price often seen as equivalent to conventional dual tires;
- generally good or excellent availability on original equipment or as replacements;
- an understanding of the fuel economy benefits of the tires;
- a tread life tending to be seen as at least as good as conventional duals;
- good re-treadability;
- a diversity of views of relative traction in the rain;
- a strong view of poor traction in snow; and
- ride comfort similar to conventional duals.

Table 11: Views of Low Rolling Resistance Dual Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	10%	52%	34%	3%
Availability - On Original Equipment	7%	14%	38%	41%
Availability - Replacement	3%	21%	41%	34%
Fuel Economy	0%	32%	44%	24%
Tread Life	10%	38%	41%	10%
Re-treadability	4%	25%	57%	14%
Maintenance Costs	10%	31%	52%	7%
Traction in Rain	28%	28%	31%	14%
Traction in Snow	48%	21%	21%	10%
Ride Comfort	0%	45%	45%	10%

Note: Numbers may not sum to 100% due to rounding.

4.9.2 Wide Base Singles

Twenty-one fleet representatives provided perspectives on various attributes of low rolling resistance tires relative to conventional dual tires (see Table 12). This sample was smaller than for low rolling resistance dual tires because of the smaller uptake of wide base single tires by fleets. The same ten characteristics were rated as being either “poor”, “average”, “good”, or “excellent”. Notably:

- a purchase price again often seen as equivalent to conventional dual tires;
- generally good availability on original equipment;
- diverse views relating to availability as replacements;
- a strong view of outstanding fuel economy;
- a tread life comparable or better than conventional duals;
- concerns about re-treadability and maintenance costs;
- traction in the rain similar to conventional duals;
- somewhat divergent views on traction in snow;
- a strong view of poor traction in snow; and
- good ride comfort.

Table 12: Views of Wide Base Single Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	29%	38%	29%	5%
Availability - On Original Equipment	5%	14%	57%	24%
Availability - Replacement	43%	10%	43%	5%
Fuel Economy	0%	11%	32%	58%
Tread Life	20%	30%	35%	15%
Re-treadability	37%	32%	21%	11%
Maintenance Costs	35%	30%	30%	5%
Traction in Rain	10%	45%	35%	10%
Traction in Snow	30%	25%	40%	5%
Ride Comfort	0%	20%	60%	20%

Note: Numbers may not sum to 100% due to rounding.

4.9.3 Comments from Fleets

Nineteen of the fleets provided comments on their views of low rolling resistance dual and wide base single tires. These comments fell into five categories.

- Weight Limits - Seven fleets identified concerns with the weight limits for wide base single provinces. They indicated that these weight limitations reduced their uptake of wide base single tires.

- Winter Traction - Six fleets identified concerns with the winter traction of low rolling resistance tires. Two fleets provided further commentary, with one indicating it replaced the original LRR tires on its fleet with other tires as a result of winter safety issues. The second fleet indicated that it replaces its original equipment LRR tires with traction tires in the winter, then replaces the traction tires with LRR tires for the summer.

- Replacement Availability - Four of the fleets indicated that they do not use wide base singles due to their relative unavailability. This was a concern in the case of blowouts, particularly in rural and remote areas.

- Return - Three fleets indicated that low rolling resistance tires do not have positive returns. Reasons included higher purchase prices, higher maintenance and repair costs, lower travel by the companies, and a need for continuous pressure optimization.

- Applications - Two of the fleets engaged in a combination of travel on highways and resource (forestry and mining) roads. These companies had concerns with traction in all seasons, premature wear, blowouts, and corresponding repair costs and safety issues.

5. Tire Manufacturers

5.1 Introduction

Efforts were made to understand the 2016 national market for heavy-duty tires, and the share of those that were low rolling resistance dual tires and wide base single tires through consultations with tire manufacturers. Prior to calling any tire manufacturer directly, the Tire and Rubber Association of Canada (TRAC) was contacted. The goal was to inform TRAC of the study and enlist their help in identifying contacts at the target tire manufacturers. TRAC took a role in supporting the study by contacting their members directly and encouraging their participation in the study. If a member agreed to complete a survey, the project team was given their contact information and then distributed a questionnaire (see Appendix B) to the company for completion. In total, eleven companies were solicited for participation, and seven completed surveys were returned. In total, the seven companies sold approximately one million heavy-duty truck tires in Canada in 2016.

5.2 Sales of Tires for Heavy-duty Trucks in Canada

The size of heavy-duty tire market in Canada is somewhat difficult to ascertain. To start, it should be noted that the replacement market outweighs the new market by a significant margin. Additionally, many tire sizes are common across several weight classes of trucks. While most Class 8 on-highway vehicles are equipped with 22.5 inch wheels, many heavier medium-duty vehicles can also be equipped with that wheel size.

The Tire and Rubber Association of Canada publishes historic replacement tire shipments for Canada on their website. Unfortunately the latest year for which data are available is 2012 (see Table 13). In 2012, medium and heavy truck replacement tire shipments totaled 1.57 million units with an average five-year annual compound growth rate of 5.4%. Projecting this number forward to 2016 would indicate that the replacement market for medium & heavy truck tires to just over 1.9 million units.

An April 2016 article in *Tire Business* (tirebusiness.com) roughly confirms these industry units. They show 2014 Canadian replacement volume at 1.7 million units and 2015 at 1.9 million units. 2016 is not shown, although for 2014 and 2015, their data indicates that the Canadian replacement market was about 10% of the US market. Projecting that to 2016 (when the US market is shown at 18.2 million units indicates that the Canadian replacement market may have been in the range of 1.8 million units.

Table 13: Projected Sales of the Canadian Medium/Heavy Tire Industry (2016)

	2012	2014	2015	2016 Projected
TRAC	1.57 million (with a 5.4% CAGR)			1.9 million based on CAGR
Tire Business		1.7 million based on percentage of US	1.9 million based on percentage of US	1.8 million based on percentage of US

Based on unit sales, original equipment (OE) sales by the tractor and trailer manufacturers could add an additional 0.6-0.7 million tires to the market, increasing the total medium-heavy tire market in 2016 to 2.4-2.6 million units.

The tire manufacturers reported Class 7 and 8 unit shipments that totaled approximately 1 million tires, indicating that they represent about 40% of the total Canadian medium-heavy tire market.

5.3 Percentage of Annual Sales in Canada Estimated to be LRR Tires (2016)

Seven tire manufacturers provided estimates of their sales of tires (for OEM and replacement) by type (conventional dual, low rolling resistance dual, and wide base single tires). Based on the responses, nearly 60% of heavy truck tires sold in 2016 were conventional dual tires (see Table 14).

Table 14: Weighted Average Tire Sales, By Type (2016)

Type of Tire	2016 Sales
Non-LRR Conventional	58%
LRR Conventional	40%
Wide Base Single	2%

However, as stated above, tires sized for Class 8 will also be sold to the upper end of the medium duty market. As such, there is an element of uncertainty in these estimates as they apply strictly to Class 8 trucks. Wide base tires are a very small portion of Canadian tire sales. Again, the caveat regarding medium and heavy-duty application applies.

5.4 Range of Rolling Resistance Coefficients (C_{RR}) Offered on LRR Tires in the Canadian Market

Tire manufacturers were asked for information regarding the coefficient of rolling resistance (C_{RR}) of their tires sold into the Canadian market. Even though anyone is able to purchase tires on the open market and measure a C_{RR} directly, tire manufacturers regard C_{RR} to be a highly confidential value and will typically not reveal the coefficient for any specific tire.

Surveyed companies were asked whether Canadian customers have quantitative information of the rolling resistance coefficient of their tires. Three of the seven answered yes, and in all three cases customers are able to use an online tool to compare relative C_{RR} (either as an index or percentage) but do not have the actual coefficients.

There are several reasons tire manufacturers are reluctant to reveal C_{RR} values. One is that rolling resistance is only one of several measurements of a tire's performance (tire traction, wear, comfort, durability, ability to isolate payload from road irregularities, steering, lateral stability, and noise being among other performance characteristics). Another is that measurement of rolling resistance is highly dependent on many variables, some of which can be manipulated to achieve a favorable outcome. These influences can make comparisons of results conducted by different parties difficult, although tests that are conducted by a verified lab using a standardized test method on equipment that has been calibrated against an accepted reference can eliminate much of this variability. Currently, however, there is not an established reference lab or reference tire(s) for measuring truck tire rolling resistance. The US EPA has stated that Smithers-Rapra and Standards Testing Lab were both used for rolling resistance testing during GHG Phase 1 and Phase 2 Rulemaking. While they may therefore be considered de-facto reference labs, no official designation has been made. Another factor may be that the C_{RR} is not static but will decrease as the tread wears and often at different rates for different tires. Tread deformation under load is a contributor to increased rolling resistance. As tread height is reduced, tread deformation and rolling resistance decrease. Therefore, while the initial C_{RR} is important, what is more relevant for a fleet is the average C_{RR} over the life of the tire, a value that is more difficult to ascertain. Given these concerns and the fact that reported C_{RR} values were not verified during this study, comparison of rolling resistance across companies must be approached cautiously.

Five of the seven participants provided the average coefficients in their product portfolio, and these are shown in
Table 15. The values provided by the respondents are simple averages (as opposed to sales weighted). For clarity, the "Average C_{RR}" column shows the average of the five average CRRs reported by the manufacturers. The "Average C_{RR}" column shows the average of the five average C_{RR} values reported by the manufacturers. The "Lowest C_{RR}" column shows the average of the five lowest product C_{RR} values reported by the manufacturers.

Table 15: Averaged C_{RR} Provided by Five Survey Respondents

Type of Tire	Average C_{RR}	Lowest C_{RR}
Non-LRR Conventional Tire	7.4	5.5
LRR Conventional Tire	5.9	4.6
Wide Base Single Tire	6.2	4.8

Caution is warranted here, as respondents were not asked to identify C_{RR} values by axle position. It is very likely that the tire with the lowest C_{RR} is a trailer tire, the design of which typically allows for a lower rolling resistance than tires intended for steer or drive axles. The average C_{RR}, on the other hand, includes most if not all of a manufacturer's heavy-duty portfolio, which would automatically average to a higher C_{RR}.

A further factor to be considered is that LRR wide base single tires targeted by the survey (e.g., sizes 445/50 R22.5 and 455/55/R22.5) are typically not offered in the same range of performances as conventional tires. Some tire makers may sell wide base tires providing lower C_{RR}, plus offer an additional wide base tire model that is more multi-functional but with higher C_{RR}, even though both tire models qualify for the SmartWay designation. Other tire manufacturers may choose to "split the difference" between the lowest C_{RR} and the mix of other performances to offer a single wide base tire model focusing on a balance of performances that can appeal to the broadest customer base. Given the potential special needs of Canadian applications, it is possible that these more multi-functional wide base tire products are preferred in this market at the expense of lower C_{RR} wide base tire models.

5.5 Advantages and Disadvantages of LRR and Wide Base Tires

All seven survey participants provided information on their expectations of customer views on LRR tires, and five provided information for wide base single tires. Ten tire characteristics were listed and respondents were asked to rate each based on their knowledge of their customer's preferences by placing a check in columns corresponding to 'Poor', 'Average', 'Good' or 'Excellent' ratings.

In each case, respondents were asked to rate either LRR conventional or wide base against a conventional non-LRR dual tire with the results shown in Table 16 and Table 17.

For low rolling resistance dual tires, fuel economy and availability on original equipment rated most above average. In contrast, traction in snow and tread life rated poorest.

Table 16: Summary of Anticipated Customer Views on LRR Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	14%	57%	29%	0%
Availability - On Original Equipment	0%	14%	29%	57%
Availability - Replacement	0%	71%	29%	0%
Fuel Economy	14%	0%	71%	14%
Tread Life	29%	29%	29%	14%
Re-treadability	0%	43%	43%	14%
Maintenance Costs	0%	43%	43%	14%
Traction in Rain	14%	43%	43%	0%
Traction in Snow	43%	14%	43%	0%
Ride Comfort	0%	43%	43%	14%

For wide base singles, availability on original equipment and as replacement tires rated most above average. Tread life and re-treadability rated the poorest.

Table 17: Summary of Anticipated Customer Views on Wide Base Single Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	40%	40%	20%	0%
Availability - On Original Equipment	0%	40%	40%	20%
Availability - Replacement	40%	0%	40%	20%
Fuel Economy	20%	60%	0%	20%
Tread Life	60%	20%	20%	0%
Re-treadability	60%	20%	20%	0%
Maintenance Costs	40%	20%	20%	20%
Traction in Rain	0%	60%	40%	0%
Traction in Snow	60%	20%	20%	0%
Ride Comfort	0%	80%	0%	20%

5.6 Future Production of LRR Tires

All seven of the survey participants provided their expected mix of non-LRR and LRR tires for 2020. The responses from individual manufacturers varied greatly, with some predicting a decline in non-LRR tires and others projecting an increase, resulting in an overall projection (weighted by sales volume) that is essentially unchanged from 2016 (see Table 18).

Table 18: Comparison of 2016 to 2020 Sale Shares
(Averages Weighted by Sales)

Tire Type by all Respondents	2016	2020
Non-LRR Conventional	58%	57%
LRR Conventional	40%	40%
Wide Base Single	2%	3%

Three of the seven tire manufacturers predicted an increase in LRR (LRR conventional and wide base) tires of 5% or more while only one predicted a decrease of 5% or more. However, several larger tire manufacturers predict essentially no change in LRR to non-LRR mix by 2020.

6. Heavy-duty Truck Manufacturers

6.1 Overview of the Manufacturers of Heavy-duty Trucks

After a consolidation in the 1990s, only four companies serve the North American heavy truck market:

- Daimler Trucks North America (Freightliner and Western Star brands);
- Paccar (Peterbilt and Kenworth brands);
- Volvo Trucks North America (Volvo and Mack brands); and
- Navistar (International brand).

In terms of heavy truck market share, Daimler Trucks North America (DTNA) is the largest, followed by Paccar. Volvo Trucks North America (VTNA) is next, followed by Navistar.

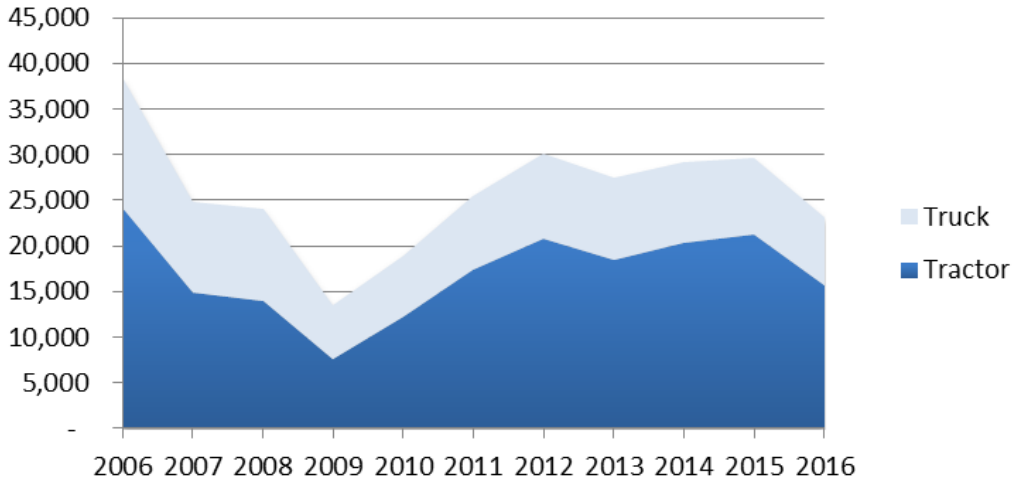
The heavy truck industry typically reports sales in North America grouped by gross vehicle weight rating (GVWR) classification. Class 8, the largest of the heavy classifications, is often reported separately, while Classes 4-7 are normally combined (anything below Class 4 is reported in the light vehicle categories). Within Class 8, vehicles are classified either as straight truck or tractor. For 2016, Table 19 shows that Class 8 retail sales in Canada totaled 23,037 units of which 15,629 were tractors and 7,408 were straight trucks. Figure 10 shows 2016 sales were somewhat less than over the previous five years.

Table 19: Canadian Class 8 Retail Sales (2016)

Type	Sales
Tractor	15,629
Truck	7,408
Total	**23,037**

Source: ACT Research (proprietary data used with permission).
Note: Volumes in 2016 were slightly lower than the prior four years, when Class 8 sales averaged nearly 30,000 units annually.

Figure 10: Class 8 Retail Sales in Canada (2006-2016)



Source: ACT Research (propriety data used with permission).

All four companies were contacted with requests to participate in the study by providing information on their respective brands. Of the four companies, two completed the heavy-duty truck tire survey. The self-reported sales indicate that the two companies represented approximately 40% of the Class 8 tractors sold in Canada in 2016.

6.2 Adoption Rate of LRR Tires on Heavy-duty Trucks Sold in Canada (2016)

Companies were asked to identify the number of Class 7 and 8 units sold (see Table 20). Based on the sales units reported, Class 7 represents less than 1% of the combined units sold in Canada in 2016. The companies report selling approximately 30% of the Class 8 trucks sold in Canada in 2016 (shown in Table 19).

Table 20: Total Number of Units sold in Canada by Respondents

Class	2016 Sales	Share
Class 7	17	0.2%
Class 8	6,962	99.8%
Total	**6,979**	**100.0%**

In terms of low rolling resistance (LRR) tires, the survey results indicate that LRR tires are widely installed in Class 8 tractors sold in Canada (see Table 21). Using a weighted average by number of tires sold, LRR tires were installed on 86% of steer axles and 66% of drive axles (conventional and wide base combined) of Class 8 tractors sold in Canada in 2016.

Table 21: Weighted Average Share of Sales by Tire Type and Axle Position (2016)

	Steer	Drive	Total
Non LRR Conventional Tires	14%	34%	31%
LRR Conventional Tires	86%	58%	63%
Wide Base Single Tires	-	8%	6%
Total	**100%**	**100%**	**100%**

There is consistency among the survey respondents on the adoption of LRR tires for steer axles, with only a 6% difference in the survey results, but less consistency for the drive axles (23% difference). It is possible that one or two large customers that constitute a significant portion of a smaller manufacturer's sales in any given year may drive the difference and that this difference reverses itself in other years. Another possibility is that the manufacturers have a significantly different product mix, such as between day cabs and sleeper cabs. Day cab tractors are typically used on shorter regional routes or by certain applications such as tanker, logging, and others that may place a greater value on traction than rolling resistance. Sleeper cabs are most often purchased by line-haul dry van and refrigerated fleets that typically see the most miles and therefore place greater value on fuel efficiency.

As in the rest of North America, dual tires predominate in Class 8 tractor applications in Canada. Less than 10% of trucks sold in Canada in 2016 by the survey respondents were equipped with wide base tires and there is not much difference among the survey responses. On average, the manufacturers reported installing wide base tires on 8% of drive tires, with only a 2% difference between the respondents. Comments regarding wide base tires indicate that adoption of wide base tires appears to have passed a near term peak. One respondent wrote that the "[t]ake rate for (wide base) has slowed…" while another wrote that "[t]he fad is over". Both companies credited the reduction in the gap in fuel economy between dual and wide base tires combined with higher replacement cost as the reasons customers have stayed away from wide base single tires.

6.3 Perceived Advantages and Disadvantages of LRR Tires

Table 22 and Table 23 show truck manufacturer views on LRR dual and wide base single tires. In both cases the manufacturers identified:

- fuel economy and availability on original equipment and as replacements as being most above average; and
- traction in snow as the poorest rating characteristics.

Table 22: Summary of Manufacturer Views on LRR Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	0%	50%	50%	0%
Availability - On Original Equipment	0%	0%	50%	50%
Availability - Replacement	0%	0%	100%	0%
Fuel Economy	0%	0%	50%	50%
Tread Life	0%	100%	0%	0%
Re-treadability	0%	100%	0%	0%
Maintenance Costs	0%	100%	0%	0%
Traction in Rain	0%	100%	0%	0%
Traction in Snow	50%	50%	0%	0%
Ride Comfort	0%	50%	50%	0%

Table 23: Summary of Manufacturer Views on Wide Base Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	0%	50%	50%	0%
Availability - On Original Equipment	0%	0%	50%	50%
Availability - Replacement	0%	0%	100%	0%
Fuel Economy	0%	0%	50%	50%
Tread Life	0%	100%	0%	0%
Re-treadability	0%	100%	0%	0%
Maintenance Costs	0%	100%	0%	0%
Traction in Rain	0%	100%	0%	0%
Traction in Snow	50%	50%	0%	0%
Ride Comfort	0%	50%	50%	0%

6.4 Trends in the Adoption of LRR Tires (2020) on Heavy-duty Trucks Supplied to the Canadian Market

Table 24 shows the views of heavy truck manufacturers on the future uptake of tires. Compared to the 2016 estimates presented earlier, the manufacturers expect a significant decrease in sales of non-LRR tires, and a large increase in sales LRR dual tires.

Table 24: Weighted Average Share of Sales by Tire Type and Axle Position (2020)

	Steer	Drive	Total
Non LRR Conventional Tires	10%	25%	22%
LRR Conventional Tires	90%	66%	71%
Wide Base Single Tires	-	9%	7%
Total	**100%**	**100%**	**100%**

Some concerns have been expressed that LRR tires will be the only offering on heavy-duty trucks. All North American tractor OEMs continue to offer a large variety of tires in the Canadian and North American markets, including non-LRR conventional and wide-base single tires for many applications and duty cycles. The expectations of the truck manufacturers surveyed and shown in Table 24 suggest that at least 20% of tire sales will be non-LRR.

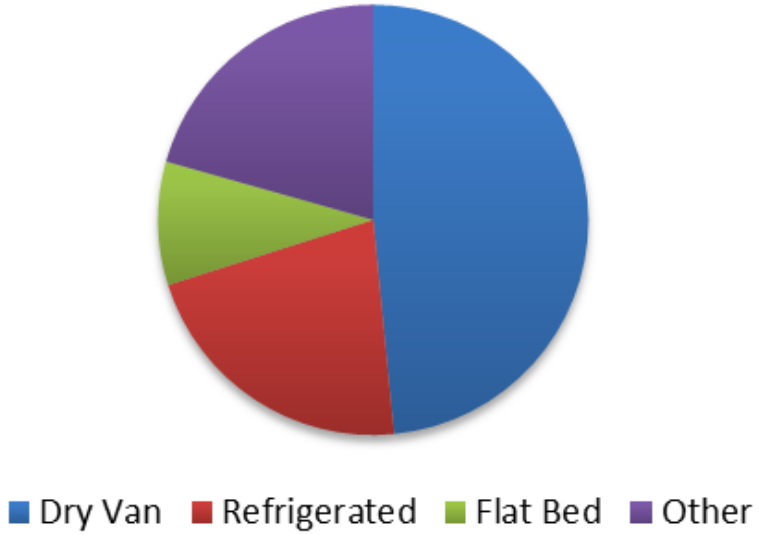
7. Heavy-duty Truck Trailer Manufacturers

7.1 Overview of the Manufacturers of Heavy-duty Truck Trailers

Heavy-duty trailer sales are typically reported as a total North American market, with Canada historically representing about 9-10% of the market. In 2015, total North American heavy-duty trailer production, as reported by Trailer-Body Builders Magazine, totaled 340,000 units, indicating that sales in Canada was likely about 34,000 units. This is supported by a market analysis released by the International Council on Clean Transportation (ICCT) in their working paper *Market Analysis of Heavy-Duty Commercial Trailers in Canada* (March 9, 2017) which is based on data from IHS Automotive. The ICCT study, which covers a 10-year period from 2005-2014, indicates that heavy-duty trailer sales totaled 33,000 in Canada in 2014.

The number of trailers by type indicates that over 75% of the units are either dry van (47%), refrigerated (21%), or flatbed (9%) as shown in Figure 11. The regulations for these trailer types are generally fairly uniform across North America and in fact they often cross the Canadian-US border, allowing these types to be produced and sold by a large number of manufacturers located almost anywhere in North America.

Figure 11: 2014 Heavy-Duty Truck Trailer Sales, by Type



Source: International Council on Clean Transportation (2017), *Market Analysis of Heavy-Duty Commercial Trailers in Canada*.
Note: The share of sales by type in Canada is based on U.S. data.

The 25 largest heavy-duty truck trailer manufacturers in North America are identified in Table 25 based on 2015 production.

Table 25: North American Trailer Production for 2015

Trailer Manufacturer	Production
Wabash National Corporation	62,950
Great Dane Limited Partnership	51,500
Hyundai Translead	49,713
Utility Trailer Manufacturing	49,187
Vanguard National Trailer & CIMC Intermodal	42,594
Stoughton Trailers LLC	16,000
Manac (St.-Georges, QC)	8,200
Fontaine Trailer Company	7,655
Wilson Trailer Company (estimate)	5,300
MAC Trailer Manufacturing	4,880
Heil Trailer International, Co.	4,610
Strick Corporation	4,300
Pitts Enterprises	4,100
Timpte Inc.	3,924
Reitnouer Inc.	3,609
East Manufacturing Co.	3,289
XPO Logistics Mfg	2,600
Polar Tank Trailer	2,500
Trail King Industries	2,500
Doepker Industries Ltd. (Anaheim, SK)	1,850
Western Trailer	1,326
Towmaster Trailers	1,301
Tremcar Inc. (St-Jean-sur-Richelieu, QC)	1,222
Kentucky Trailer	1,216
Felling Trailers	1,140
Travis Trailers	912
Doonan Specialized Trailer	787
Talbert Manufacturing	783
Total	**339,948**

Source: Trailer-Body Builders.

The ICCT working paper supports the information on the largest manufacturers. Market share by manufacturer as estimated by ICCT is shown in Table 26.

Table 26: Market Share by Trailer Manufacturer (2014)

Trailer Manufacturer	Market Share
Hyundai Translead	12%
Vanguard National Trailer	10%
Manac	9%
Utility Trailer	9%
Max-Atlas	7%
Lode King	6%
Wabash National	5%
Doepker	5%
Great Dane	4%
Stoughton	4%
Others	29%
Total	**100%**

Source: International Council on Clean Transportation (2017), *Market Analysis of Heavy-Duty Commercial Trailers in Canada*.

With the exception of Max-Atlas, based in Saint-Jean-sur-Richelieu, the seven largest trailer manufacturers based on North American sales were also among the seven largest in the ICCT analysis.

Prior to calling the trailer manufacturers directly, the Canadian Transportation Equipment Association (CTEA) was contacted to inform the association of the study and to ask the association if any major members had been overlooked. Fourteen major trailer manufacturers were approached, and ultimately eight responded with totally or partially completed questionnaires (see Appendix D).

7.2 Adoption Rate of LRR Tires on Heavy-Duty Truck Trailers sold in Canada

The companies that responded reported a total of approximately 15,000 units sold in 2016. Most did not know their market share, but assuming a similar total market in 2016 as in 2014, this represents approximately 45% of total Canadian heavy-duty trailer sales. Their shares of sales, by trailer type, are shown in Table 27.

Table 27: Survey Respondent Sales by Trailer Type

Type	Respondents	Market
Dry Van	72%	47%
Refrigerated	17%	21%
Flat Bed	8%	9%
Other	3%	23%
Total	**100%**	**100%**

All of the respondents provided information on the total number of tires sold in 2016 and percentage breakdown by conventional (non-LRR) dual, LRR dual, and wide base single tires. Almost two-thirds (66%) of installed tires were reported to be conventional LRR, followed by conventional non-LRR (28%) and wide base (6%) as shown in Table 28.

Table 28: Share of Tires, by Type (Weighted Average, 2016)

Tire Type	Sales
Conventional (Non-LRR) Dual Tire	28%
LRR Dual Tire	66%
Wide Base Single Tire	6%
Total	**100%**

There is divergence among the manufacturers on the type of installed tires. Even among manufacturers that produce only or predominantly dry van trailers, two respondents reported installation of 90+% non-LRR conventional tires while two others reported that 100% of the installed tires were LRR conventional. However, as a group, manufacturers of dry van and refrigerated trailers did install more conventional LRR tires than the survey respondents as a whole (see Table 29).

Table 29: Share of Tires, by Type for Dry Van and Refrigerated Trailer Manufacturers (, 2016)

Tire Type	Sales
Conventional (Non-LRR) Dual Tire	17%
LRR Dual Tire	76%
Wide Base Single Tire	6%
Total	**100%**

There is consistency among the trailer manufacturers on the predominance of conventional tires versus wide base singles. It is estimated that in the US, wide base single tires are installed on less than 10% of the line-haul vehicles and the results from the trailer manufacturer surveys are consistent with that estimate. The fleet survey and tire manufacturer results presented earlier in this report also suggest that wide base singles are installed on less than 10% of units. For vehicles sold in Canada, only one trailer manufacturer reported installing wide base singles in any significant quantity (25%). The next highest response was 5%. Three respondents reported no wide base single tires.

7.3 Discussion of Advantages and Disadvantages of LRR Tires

Six trailer manufacturers provided information on perceived customer opinions on low rolling resistance conventional tires (see Table 30). The manufacturers rated fuel economy and maintenance costs as the attributes most above average. Purchase price and traction in rain and snow were rated poorest.

Table 30: Summary of Perceived Customer Views of LRR Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	33%	0%	50%	17%
Availability - On Original Equipment	0%	33%	50%	17%
Availability - Replacement	0%	50%	33%	17%
Fuel Economy	0%	17%	67%	17%
Tread Life	0%	33%	50%	17%
Re-treadability	0%	33%	50%	17%
Maintenance Costs	0%	0%	83%	17%
Traction in Rain	17%	33%	17%	33%
Traction in Snow	20%	60%	0%	20%
Ride Comfort	0%	33%	67%	0%

Table 31 shows the manufacturer ratings of wide base singles. A number of attributes rated as being above average. The poorest ratings were for purchase price, and for availability on new equipment and as replacements.

Table 31: Summary of Perceived Customer Views of Wide Base Tires

Characteristic	Poor	Average	Good	Excellent
Purchase Price	67%	17%	17%	0%
Availability - On Original Equipment	33%	33%	33%	0%
Availability - Replacement	50%	33%	17%	0%
Fuel Economy	0%	33%	67%	0%
Tread Life	0%	33%	67%	0%
Re-treadability	0%	33%	50%	17%
Maintenance Costs	20%	40%	40%	0%
Traction in Rain	0%	33%	67%	0%
Traction in Snow	0%	60%	40%	0%
Ride Comfort	0%	33%	67%	0%

NACFE's 2015 *Confidence Report: Low Rolling Resistance Tires*, premature tread wear, particularly irregular tread wear, was reported by fleets as one of the challenges of low rolling resistance dual and wide base tires. That report listed fuel consumption and initial acquisition cost as benefits of low rolling resistance duals and wide base tires.

7.4 Trends in the Adoption of LRR Tires on Heavy-duty Truck Trailers Supplied to the Canadian Market

Seven of the eight trailer manufacturers that responded provided information about the anticipated sale of tires for the year 2020. A significant increase in the LRR category is anticipated from 66% in 2016 to 86% anticipated in 2020 (see Table 32).

Table 32: Current and Expected Future Tire Sales, By Type

Tire Type	2016	2020
Non-LRR Conventional	28%	7%
LRR Conventional	66%	86%
Wide Base Single	6%	7%
Total	**100%**	**100%**

8. Key Findings and Conclusions

8.1 Context

High fuel prices and greenhouse gas regulations in Canada and the United States have renewed interest in low rolling resistance tires. Some statistics -- primarily covering U.S. fleets -- suggest that:

- a high percentage of fleets (76%) currently use some low rolling resistance dual tires, and almost half (45%) use some wide base single tires;[8]
- a high percentage of new heavy-duty truck sales for some fleets have low rolling resistance dual tires (about 52%) or wide base singles (about 44%);[9] and
- a high percentage of new heavy-duty truck tractor sales for some fleets have low rolling resistance dual tires (67%) or wide base singles (25%).[10]

These data do not, however, provide indications of the total number of tires in North America, the U.S., or Canada that are low rolling resistance dual or wide base single tires. As a result, while insightful, they are not comparable with the estimates developed in this study.

8.2 Canadian Fleets

Fifty-four Canadian fleets were contacted to gather, among other information, perspectives on their trucks, trailers, and tires. The sampling included:

- 42 for-hire fleets with 10,620 trucks and 29,337 trailers;
- 8 private fleets with 1,826 trucks and 4,777 trailers; and
- 4 rental fleets with 352 trucks and 685 trailers.

The mix of trailers included 44% dry box, 18% refrigerated, 5% flat bed, 15% tanker, and 16% other trailers.

[8] See Schoettle, B., M. Sivak, and M. Tunnell (2016), *A Survey of Fuel Economy and Fuel Usage by Heavy-Duty Truck Fleets*, Table 7.
[9] NACFE (2016), *Annual Fleet Fuel Study*, data drawn from Appendix A.
[10] NACFE (2016), *Annual Fleet Fuel Study*, data drawn from Appendix A.

The 12,798 trucks represent roughly 3% of the national inventory of 462,908 registered vehicles weighing more than 15,000 kg (excluding buses, off-road vehicles, and construction vehicles).

The fifty-four fleets reported a total of 422,026 tires on their trucks and trailers. Of these:

- 41% were conventional dual tires (with a 95% confidence interval ranging from 23% to 60%);
- 49% were low rolling resistance dual tires (with a 95% confidence interval ranging from 21% to 76%); and
- 10% were wide base single tires (with a 95% confidence interval ranging from 1% to 18%).

There was considerable variability in the uptake of different types of tires between fleets. For example, some fleets had no low rolling resistance tires, while some fleets had all low rolling resistance tires. As a result wide confidence intervals exist around the mean estimates identified above. In addition, some differences exist in terms of the types of tires on for-hire, private, and rental fleets. The high uptake of fuel saving tires (low rolling resistance duals and wide base singles) on for-hire fleets was a primary example of these differences.

Fleets provided ratings of ten aspects of low rolling resistance and wide base tires compared to conventional tires. Two findings were particularly notable for low rolling resistance tires beyond their fuel saving potential. First, the tires were generally viewed as being widely available on new equipment and as replacements. Second, they tend to be seen as having poor traction in snow. Wide base singles were seen as being widely available on new equipment, but less so as replacements. In contrast, they were seen as having higher purchase prices and maintenance costs.

It is notable that two fleets reported that they bought equipment with LRR tires and replaced them. One fleet indicated it replaced the original LRR tires on its fleet with higher traction tires as a result of winter safety issues. The second fleet indicated that it replaces its original equipment LRR tires with traction tires in the winter, then replaces the traction tires with LRR tires for the summer.

8.3 Tire Manufacturers

Seven tire manufacturers provided information on the heavy-duty truck and tractor tires they sold. These seven manufacturers sold approximately one million tires in 2016, estimated to be about 40% of the Canadian heavy-duty truck and tire market.

Of these:

- 58% were conventional dual tires;
- 40% were low rolling resistance dual tires; and
- 2% were wide base single tires.

These estimates of new tire sales for 2016 are somewhat different from those derived from Canadian fleets, but all fall within the estimated 95% confidence intervals reported above for Canadian fleets.

When comparing fleets in 2016 to tire manufacturing sales in 2016, it is clear that fleets are composed of vehicles from 2016 and earlier years whereas new tire manufacturing sales are from only 2016. Several other reasons may explain the differences in the sales / uptake of conventional and low rolling resistance tires between the tire manufacturers and fleets. Two reasons may be sampling bias of the tire manufacturers (estimated to be 40% of 2016 sales sales) or of the fleets (estimated to be about 3% of heavy-duty vehicles). In addition, some Canadian fleets may be buying low rolling resistance dual tires from U.S. sources (perhaps due to international price differences). A further reason may be that some fleets are replacing low rolling resistance dual tires and wide base single tires delivered on original equipment with conventional tires at the end of their lives or earlier.

For example, two fleets provided comments in this respect, with one having entirely replaced low rolling resistance tires provided as original equipment on their trucks and a second replacing low rolling resistance tires with traction tires in the winter as a result of safety issues. These two fleets have a total of about 150 heavy-duty trucks and over 300 trailers. One of them does approximately 40% of its travel in northern parts of Canada, while the other does about 2% in northern areas.

The much lower share of wide base single tires found in the tire manufacturer survey compared to the fleet survey can be largely explained by the choices of two large fleets. If the survey results from those two large fleets are removed from the sample, the share of wide base single tires on fleets falls from 10% to 4%, closer to the estimate provided by the tire manufacturers.

Tire manufacturers generally had positive views of low rolling resistance tires compared to conventional tires. The results from two manufacturers suggest that low rolling resistance duals are viewed as superior to wide base singles in all ten categories considered. However, the tire manufacturers predict very little change in the mix of tire types through 2020.

8.4 Truck Manufacturers

Two of the four major North American truck manufacturers provided information on their 2016 sales of trucks and the tires on those trucks. The truck sales of those two companies represented about 40% of the estimated 2016 sales (23,000 heavy-duty vehicles) in Canada. Of these:

- 31% were conventional dual tires;
- 63% were low rolling resistance dual tires; and
- 6% were wide base single tires.

These results are reflective of the results from the fleet survey. The share of sales of new LRR tires on trucks (63%) is more than the reported fleet average (41%), reflecting increased uptake of LRR tires over time. The sale of wide base single tires on trucks (6%) is at the mid-point of the results of the fleet survey and tire manufacturers survey, and equal to the result on trailers.

The truck manufacturers surveyed expect further declines in the sale of conventional (non-LRR) tires through 2020, with low rolling resistance dual tire sales seeing large gains.

8.5 Trailer Manufacturers

Eight North American trailer manufacturers provided information on their sales of trailers and tires. The sales of trailers, by type, of these manufacturers are shown in Table 33.

Table 33: Sales of Trailers by Survey Respondents

Type	Respondents
Dry Van	72%
Refrigerated	17%
Flat Bed	8%
Other	3%
Total	**100%**

These manufacturers are estimated to have supplied about 45% of the Canadian market in 2016. Of the tires on their trailers:

- 28% were conventional dual tires;
- 66% were low rolling resistance dual tires; and
- 6% were wide base single tires.

These inputs are similar to those of the tractor manufacturers. Compared to the fleet results, they show a tendency of new sales moving towards low rolling resistance dual tires and wide base singles. Similar to truck manufacturers, the trailer manufacturers anticipate large decreases in the sales of conventional (non-LRR) tires with nearly all these losses offset through increased sales of low rolling resistance dual tires.

8.6 Conclusions

The rates of tire uptake found among fleets, tire manufacturers, tractor manufacturers, and trailer manufacturers are summarized in Table 34.

Table 34: Summary of Tire Share Information, By Tire Type

Tire Type	Canadian Fleets	Tire Mfrs.	Truck Mfrs.	Trailer Mfrs.
Non-LRR Conventional	41%	58%	31%	28%
LRR Conventional	49%	40%	63%	66%
Wide Base Single	10%	2%	6%	6%
Total	**100%**	**100%**	**100%**	**100%**

On the basis of this evidence, it is expected that the shares of tire types on Canadian fleets on the road (including 2016 model year and earlier tractors and trailers) for 2016 were:

- 45% non-LRR conventional tires;
- 50% low rolling resistance conventional tires; and
- 5% wide base single tires.

This conclusion weighs the inputs from the Canadian fleet relatively highly (but considers the possibility of an unrepresentative sample, particularly in terms of wide base single tires). It also reflects the fact that the inputs from the three manufacturing groups represent the sales for a single year (2016) while the fleet estimates represent a sampling of the fleet across various model years. It is notable that the results from tire manufacturers are an outlier showing a relatively high rate of conventional (non-LRR) tire sales. This may simply be due to sampling bias, given that information was provided by tire manufacturers companies with an estimated 40% share of the market.

Several reasons were identified by fleets as having deterred the uptake of low rolling resistance tires. For low rolling resistance dual tires, these predominantly include concerns over winter traction, off-highway traction, and an uncertain return in terms of fuel savings versus costs. Fleets were most concerned with the weight limits that exist in some provinces for wide base single tires, and their availability as replacements.

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Appendix A: Fleet Survey Instrument

Adoption Rates of Low Rolling Resistance Tires
-- Questionnaire for Heavy Truck Fleets --

This questionnaire has been designed to collect information on the adoption rate and experience of Canadian heavy truck fleets (for-hire and private) with respect to low rolling resistance (LRR) tires. Please complete the questionnaire and return it no later than May 22, 2017. Throughout, please focus on Class 7 and 8 tractors, trailers, and tires using 2016 as the base year. As described in the letter accompanying this questionnaire, your inputs will be combined with others and reported to Transport Canada at the aggregate level. Your inputs will not be used for other purposes or released to other parties.

Part A: Company Details

Please provide the following details on your company and a contact person.

Company Name	
Head Office City	
Head Office Province/State	
Contact Name	
Contact Title	
Contact E-Mail	
Contact Phone Number	
Fleet (For Hire or Private)	

Part B: Fleet Size

How many heavy trucks does your business own?

Type	# of Trucks
Class 7 Trucks	
Class 8 Trucks	

How many heavy trailers does your business own?

Type	# of Trailers
Dry Box	
Refrigerated	
Flat Bed	
Tanker	
Other	
Total Trailers	

Part C: Current Numbers and Types of Tires

Please identify the total number of tires on your heavy (Class 7 and 8) tractors and trailers.

	Tractor - Steer	Tractor - Drive	Trailer
Total Number of Tires			

Please identify the approximate shares of tires by type on your heavy trucks in 2016. LRR tires are defined by the SmartWay Verified List for low rolling resistance tires. Ensure that the shares sum to 100%.

2016	Tractor - Steer	Tractor - Drive	Trailer
Non-LRR Conventional			
LRR Conventional			
Wide Base Single			
Total	**100%**	**100%**	**100%**

Note: The Smartway Verified List can be found at:
https://www.epa.gov/verified-diesel-tech/smartway-verified-list-low rolling-resistance-lrr-new-and-retread-tire

Part D: Future Numbers and Types of Tires

In comparison to the above, please identify what you believe those shares will be in 2020. Ensure that the shares sum to 100%.

2020	Tractor - Steer	Tractor - Drive	Trailer
Non-LRR Conventional			
LRR Conventional			
Wide Base Single			
Total	**100%**	**100%**	**100%**

Part E: Fleet Travel

Please identify the approximate distance traveled (vehicle kilometres) by your fleet in Canada in 2016.

Total vehicle kilometres traveled (km)	

Please identify the approximate share (%) of travel in Canada by region in 2016.

NL, NS, PE, NB	
Southern QC, ON, MB, SK, AB, BC	
Northern QC, ON, MB, SK, AB, BC	
NU, NT, YT	
Total travel in Canada	100%

Part F: Fuel Economy

What was your estimated fleet-wide fuel economy in 2016? Please ensure that you identify the units (ex., litres per hundred kilometres, miles per gallon, etc.).

Fuel economy	
Units	

Do you have an estimate of the fuel economy savings (%) you are achieving or could achieve by replacing conventional dual tires with [i] LRR dual tires or [ii] wide base single tires on a tractor-trailer unit?

Fuel Savings with LRR Dual Tires	
Fuel Savings with Wide Base Single Tires	

Part G: Views of LRR Dual Tires

You are in a unique position to understand tire preferences for and opinions relating to LRR dual tires. Please rate LRR dual tires relative to conventional tires on the characteristics below based on your knowledge of fleet owner and operator preferences.

Characteristic	Poor	Average	Good	Excellent
Purchase Price				
Availability - On Original Equipment				
Availability - Replacement				
Fuel Economy				
Tread Life				
Re-treadability				
Maintenance Costs				
Traction in Rain				
Traction in Snow				
Ride Comfort				

Part H: Views of Wide Base Single Tires

Similarly, please rate wide base single tires relative to conventional dual tires on the characteristics below based on your knowledge of fleet owner and operator preferences.

Characteristic	Poor	Average	Good	Excellent
Purchase Price				
Availability - On Original Equipment				
Availability - Replacement				
Fuel Economy				
Tread Life				
Re-treadability				
Maintenance Costs				
Traction in Rain				
Traction in Snow				
Ride Comfort				

Part I: Other Comments

If you have any other comments on the advantages or disadvantages of low rolling resistance dual tires, or the Canadian availability or use of these tires, please identify them below.

If you have any other comments on the advantages or disadvantages of wide base single tires, or the Canadian availability or use of these tires, please identify them below.

-- Thank you for your assistance --

Appendix B: Tire Manufacturers Survey Instrument

CHEMINFO

NACFE

Adoption Rates of Low Rolling Resistance Tires
-- Questionnaire for Heavy Tire Manufacturers --

This questionnaire has been designed to collect information on the experience of heavy tire manufacturers with respect to low rolling resistance (LRR) tires. Please complete the questionnaire and return it no later than May 22, 2017. Throughout, please focus on tires used on heavy (Class 7 and 8) tractors and trailers using 2016 as the base year. As described in the letter accompanying this questionnaire, your inputs will be combined with others and reported to Transport Canada at the aggregate level. Your inputs will not be used for other purposes or released to other parties.

Part A: Company Details

Please provide the following details on your company and a contact person.

Company Name	
Head Office City	
Head Office Province/State	
Contact Name	
Contact Title	
Contact E-Mail	
Contact Phone Number	

Part B: Canadian Sales

How many tires designed for heavy (Class 7 and 8) tractors and trailers did your business sell into Canadian markets in 2016?

Number of Tires	

What were the shares of those tires by type? LRR tires are defined by the SmartWay Verified List for low rolling resistance tires. Ensure that the shares sum to 100%.

2016	Share
Non-LRR Dual Tires	
LRR Dual Tires	
Non-LRR Wide Base Tires	
LRR Wide Base Tires	
Total	**100%**

Part C: Future Numbers and Types of Tires

In comparison to the above, please identify what you believe those shares will be in 2020. Ensure that the shares sum to 100%.

2020	Share
Non-LRR Dual Tires	
LRR Dual Tires	
Non-LRR Wide Base Tires	
LRR Wide Base Tires	
Total	**100%**

Part D: Information on Rolling Resistance

Do your customers have access to quantitative information on the potential fuel savings or the rolling resistance coefficient of your heavy tires (yes / no)?

	Yes / No
Potential Fuel Savings	
Rolling Resistance Coefficient	

What were the average and lowest rolling resistance coefficient (C_{RR}) of the heavy tires sold by your company in Canada in 2016?

	Average C_{RR}	Lowest C_{RR}
Non-LRR Dual Tires		
LRR Dual Tires		
Non-LRR Wide Base Tires		
LRR Wide Base Tires		

Part E: Customer Views of LRR Tires

As a heavy tire manufacturer, you are in a unique position to understand the tire preferences and views of your heavy fleet customers. Please rate LRR tires for heavy trucks relative to conventional tires on the characteristics below based on your knowledge of customer preferences.

Characteristic	Poor	Average	Good	Excellent
Purchase Price				
Availability - On Original Equipment				
Availability - Replacement				
Fuel Economy				
Tread Life				
Re-treadability				
Maintenance Costs				
Traction in Rain				
Traction in Snow				
Ride Comfort				

Part F: Other Comments

If you have any other comments on the advantages of low rolling resistance tires, or the Canadian market for those tires, please identify them below.

If you have any other comments on the disadvantages of low rolling resistance dual tires, or the Canadian market for those tires, please identify them below.

-- Thank you for your assistance --

Appendix C: Tractor Manufacturers Survey Instrument

Adoption Rates of Low Rolling Resistance Tires
-- Questionnaire for Heavy Tractor Manufacturers --

This questionnaire has been designed to collect information on the experience of heavy tractor manufacturers with respect to low rolling resistance (LRR) tires. Please complete the questionnaire and return it no later than May 22, 2017. Throughout, please focus on Class 7 and 8 tractors and tires using 2016 as the base year. As described in the letter accompanying this questionnaire, your inputs will be combined with others and reported to Transport Canada at the aggregate level. Your inputs will not be used for other purposes or released to other parties.

Part A: Company Details

Please provide the following details on your company and a contact person.

Company Name	
Head Office City	
Head Office Province/State	
Contact Name	
Contact Title	
Contact E-Mail	
Contact Phone Number	

Part B: Canadian Sales

How many heavy tractors (Class 7 and 8) did your business sell into Canada in 2016?

Number of Class 7 Tractors	
Number of Class 8 Tractors	

What was your estimated share of the Canadian heavy tractor market in 2016?

Estimated Market Share (%)	

Part C: Current Numbers and Types of Tires

Please identify the total number of tires installed on the Class 7 and 8 tractors you sold in Canada in 2016.

	Tractor - Steer Tires	**Tractor - Drive Tires**
Total Number of Tires		

Please identify the approximate shares of tires by type on your tractors sold in Canada in 2016. LRR tires are defined by the SmartWay Verified List for low rolling resistance tires. Ensure that the shares sum to 100%.

2016	Tractor - Steer	Tractor - Drive
Non-LRR Dual Tires		
LRR Dual Tires		
Non-LRR Wide Base Tires		
LRR Wide Base Tires		
Total	**100%**	**100%**

Part D: Future Numbers and Types of Tires

In comparison to the above, please identify what you believe those shares will be in 2020. Ensure that the shares sum to 100%.

2020	Tractor - Steer	Tractor - Drive
Non-LRR Dual Tires		
LRR Dual Tires		
Non-LRR Wide Base Tires		
LRR Wide Base Tires		
Total	**100%**	**100%**

Part E: Customer Views of LRR Tires

As a heavy truck manufacturer, you are in a unique position to understand fleet tire preferences and opinions relating to LRR tires. Please rate LRR tires relative to conventional tires on the characteristics below based on your knowledge of customer preferences.

Characteristic	Poor	Average	Good	Excellent
Purchase Price				
Availability - On Original Equipment				
Availability - Replacement				
Fuel Economy				
Tread Life				
Re-treadability				
Maintenance Costs				
Traction in Rain				
Traction in Snow				
Ride Comfort				

Part F: Other Comments

If you have any other comments on the advantages of low rolling resistance tires, or the Canadian market for those tires, please identify them below.

If you have any other comments on the disadvantages of low rolling resistance dual tires, or the Canadian market for those tires, please identify them below.

-- Thank you for your assistance --

Appendix D: Trailer Manufacturers Survey Instrument

Adoption Rates of Low Rolling Resistance Tires
-- Questionnaire for Heavy Trailer Manufacturers --

This questionnaire has been designed to collect information on the experience of heavy trailer manufacturers with respect to low rolling resistance (LRR) tires. Please complete the questionnaire and return it no later than May 22, 2017. Throughout, please focus on heavy trailers for Class 7 and 8 trucks using 2016 as the base year. As described in the letter accompanying this questionnaire, your inputs will be combined with others and reported to Transport Canada at the aggregate level. Your inputs will not be used for other purposes or released to other parties.

Part A: Company Details

Please provide the following details on your company and a contact person.

Company Name	
Head Office City	
Head Office Province/State	
Contact Name	
Contact Title	
Contact E-Mail	
Contact Phone Number	

Part B: Canadian Sales

How many heavy trailers did your business sell into Canada in 2016?

Type of Trailer	Number of Trailers
Dry Box	
Refrigerated	
Flat Bed	
Tanker	
Other	
Total	

What was your estimated share of the Canadian heavy trailer market in 2016?

Estimated Market Share (%)	

Part C: Numbers and Types of Tires

How many tires were fitted on the trailers sold into Canada in 2016?

Number of Tires	

Please identify the approximate share of tires by type on your trailers sold in Canada in 2016. LRR tires are defined by the SmartWay Verified List for low rolling resistance tires. Ensure that the shares sum to 100%.

2016	Share
Non-LRR Dual Tires	
LRR Dual Tires	
Non-LRR Wide Base Tires	
LRR Wide Base Tires	
Total	**100%**

Part D: Current and Future Numbers Types of Tires

In comparison to the above, please identify what you believe those shares will be in 2020. Ensure that the shares sum to 100%.

2020	Share
Non-LRR Dual Tires	
LRR Dual Tires	
Non-LRR Wide Base Tires	
LRR Wide Base Tires	
Total	**100%**

Part E: Customer Views of LRR Tires

As a heavy trailer manufacturer, you are in a unique position to understand fleet tire preferences and opinions relating to LRR tires. Please rate LRR tires relative to conventional tires on the characteristics below based on your knowledge of customer preferences.

Characteristic	Poor	Average	Good	Excellent
Purchase Price				
Availability - On Original Equipment				
Availability - Replacement				
Fuel Economy				
Tread Life				
Re-treadability				
Maintenance Costs				
Traction in Rain				
Traction in Snow				
Ride Comfort				

Part F: Other Comments

If you have any other comments on the advantages of low rolling resistance tires, or the Canadian market for those tires, please identify them below.

If you have any other comments on the disadvantages of low rolling resistance dual tires, or the Canadian market for those tires, please identify them below.

-- Thank you for your assistance --

Appendix E: Description of LRR and GHG Model

Introduction

This appendix provides an overview of the LRR Tire and GHG Emissions model prepared for Transport Canada. This model is designed to provide simple estimates of GHG emissions reductions based on changes in the uptake of low rolling resistance tires (LRR).

Structure of the Model

The model is made in MS Excel. It is comprise of 6 worksheets.

- **Trucks Module** - The trucks module identifies the number of heavy-duty trucks (15,000 kg or more), by province. The heavy-duty truck data is for 2016, from CANSIM Table 405-0004. The data is for "Heavy duty truck (vehicles weighing 15,000 kilograms or more)", and excludes "Buses" and "Off-road, construction, farm vehicles". The default input is 462,908 heavy-duty trucks. This worksheet allows the user to change the number of heavy-duty trucks.

- **Tires Module** - The tires module provides estimates of the number of conventional, low rolling resistance, and wide base single tires. It makes estimates of the number of truck tires, trailer tires, and total tires. The worksheet allows the user to make changes to the number of tires per truck and per trailer, and to the ratio of trucks to trailers which are set by default based on the Fleet Survey. Default values are 9 tires per truck, 9 tires per trailer, and 2.7 trailers per truck based on the Fleet Survey. Under the baseline, there are 15.4 million tires on heavy-duty trucks and trailers.

- **VKT Module** - The vkt module provides estimates of the total travel (million vehicle km) in each province, by tire type. The worksheet allows the user to change the average annual travel per truck, which is set to 90,000 km per year by default. This estimate is a blend of information from the Fleet Survey (135,000 km), from Environment and Climate Change Canada (~75,000 km), and from Natural Resources Canada's National Energy Use Model. Under the baseline, there are 41.7 billion vkt travelled by heavy trucks.

- **Fuel Module** - The fuel module estimates the fuel consumed by the heavy-duty trucks based on inputs of fuel economy and travel. Estimates are made for units on conventional tires, low rolling resistance tires, and wide base single tires. Fuel economy inputs are themselves found in the Simulation Module. Under the baseline, 14.7 billion litres of fuel are consumed.

- **GHG Module** - The GHG module makes estimates of CO_2 emissions. The default emission factor is 2,690 grams of CO_2 per litre of diesel fuel consumed (per the *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*, Part 2, Table A6-12). This emission factor can be adjusted, for example to estimate emissions of other pollutants. Emissions are estimated for units on conventional tires, low rolling resistance tires, and wide base single tires. Under the baseline, CO_2 emissions are 39.5 megatonnes. This estimate is broadly balanced with heavy truck GHG emissions in the *Comprehensive Energy Use Database* that were 36.5 megatonnes in 2014).

- **Simulation Module** - The Simulation Module allows the user to change model inputs and provides estimates of outputs. The model inputs that can be changed for a baseline and simulation are:

  - uptake of tires by type;
  - overall fuel economy; and
  - fuel economy by tire type.

  The outputs of the model for a baseline and simulation are, for the baseline and simulation:

  - fuel consumed (mega litres); and
  - CO_2 emissions (mega tonnes).

  The difference between the baseline and simulation for each output is calculated.

Example

The outputs of a simple simulation are provided in Table 35. The simulation is based on a reduction in the uptake of conventional (non-LRR) tires from 45% to 25%, with a corresponding increase in the uptake of LRR dual tires from 50% to 70%. No change is made to the uptake of wide base single tires, or the fuel economy of conventional, low rolling resistance, or wide base single tires. The scenario shows a reduction in fuel consumption of 120 megalitres and a reduction in CO_2 emissions of about 323,000 tonnes.

Table 35: Simulation Results

Easy Report	Baseline	Simulation	Impact
Uptake of Conventional Tires	45%	25%	
Uptake of LRR Tires	50%	70%	
Uptake of Wide Base Single Tires	5%	5%	
Average Fuel Economy (litres / 100 km)	36.00	36.00	
Fuel Savings of Conventional Tires	0%	0%	
Fuel Savings of LRR Tires	4%	4%	
Fuel Savings of Wide Base Single Tires	4%	4%	
Fuel Consumed (Mega Litres)	14,668	14,548	-120
CO2 Emissions (Tonnes)	39,457,615	39,134,853	-322,762