CONFIDENCE REPORT: Low Rolling Resistance Tires

ABSTRACT

This report documents the confidence that North American Class 8 trucking should have in pursuing Low Rolling Resistance Tires. The study team engaged the entire industry in the data that is presented here. Thanks to all of those who contributed to this important work.

The North American Council for Freight Efficiency (NACFE) works to drive the development and adoption of efficiency enhancing, environmentally beneficial, and cost-effective technologies, services, and operational practices in the movement of goods across North America. NACFE provides independent, unbiased research, including Confidence Reports on available technologies and Guidance Reports on emerging ones, which highlight the benefits and consequences of each, and deliver decision-making tools for fleets, manufacturers, and others. NACFE partners with Rocky Mountain Institute (RMI) on a variety of projects including the Run on Less fuel efficiency demonstration series, electric trucks, emissions reductions, and low-carbon supply chains.

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LOW ROLLING RESISTANCE TIRES CONFIDENCE REPORT

This report is an update of a previously published report on low rolling resistance tires in order to examine new technology that has emerged in the meantime. See NACFE's reports here**.**

The COVID-19 pandemic has illustrated the important role the trucking industry plays in bringing us critical goods. And although fuel costs have dropped due to the virus, they are still a significant part of the expense to operate a tractor-trailer in North America. Fuel costs are now approximately $0.43 per mile, accounting for 24% of a fleet's total operating costs—the second largest expense for fleets behind only driver wages. The price per gallon for diesel as of April 2020 is around $2.48 and all indications are that fuel prices will continue to be volatile. Therefore, the industry needs solutions that reduce its fuel dependency if it is to stay profitable.

In addition, the United States Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) have enacted greenhouse gas emissions regulations on commercial vehicles extended to 2030 that require manufacturers to develop and sell technologies to improve efficiency. These factors have driven fleets, manufacturers, and others to improve the efficiency of over-the-road tractor-trailers.

Fortunately, myriad technologies that can cost-effectively improve the fuel efficiency of Class 8 trucks are readily available on the market today. Unfortunately, multiple barriers have stymied industry adoption of such technologies, including a lack of data about the true performance gains these technologies offer, and a lack of confidence in the payback for investment into these technologies. To overcome those barriers and facilitate the industry's trust in and adoption of the most promising cleaner operating technologies, the North American Council for Freight Efficiency (NACFE) produces a series of Confidence Reports, of which this report on tire rolling resistance is one. It is an update to the original *Low Rolling Resistance Tires* Confidence Report published in 2015.

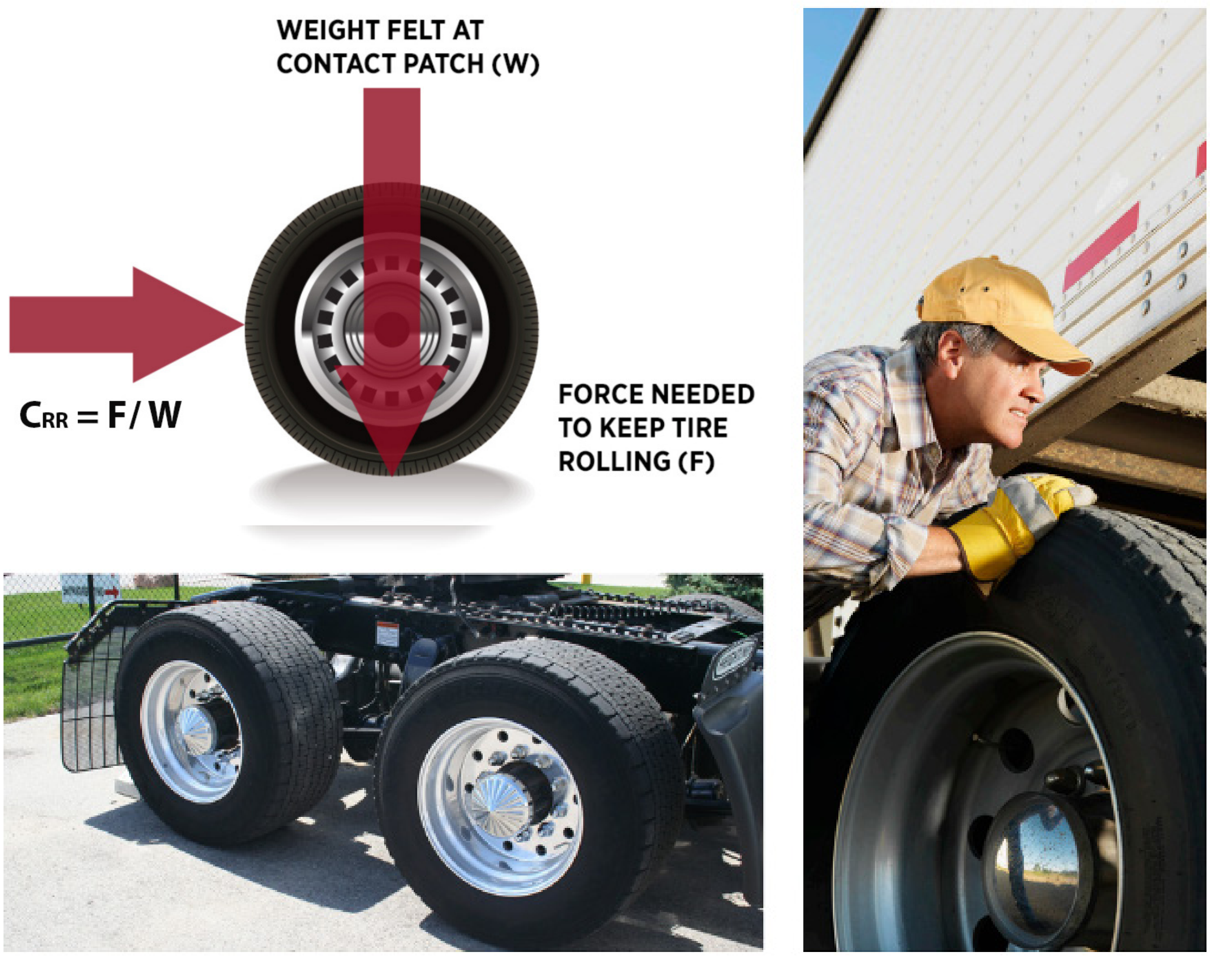
FUEL EFFICIENCY TECHNOLOGIES COVERED IN THIS REPORT

Two features—rolling resistance and tire configuration—distinguish between the tires considered in this Confidence Report. 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 (CRR). (See Figure ES1.)

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. Low rolling resistance (LRR) tires refer to any tire on the SmartWay verified tire list, though some tires on that list will have an even lower resistance than others. Tire configuration refers to if the tires of a truck are spec'd in either a dual or a wide-base configuration. All the wide-base tires available today qualify for the SmartWay verified tire list as having low rolling resistance. So, while the report distinguishes between LRR and non-LRR dual tires, there is no such thing as a non-LRR wide-base tire.

FIGURE ES1

ROLLING RESISTANCE COEFFICIENT



METHODOLOGIES

This report's conclusions were generated through desk research, conversations at a variety of trucking industry events around the country, and a series of structured interviews with the tire manufacturers, tractor and trailer OEMs, fleets, and others. NACFE conducted confidential, over-the-phone interviews with 11 large fleets, all of whom had significant experience with low rolling resistance tires. Insights from medium and smaller fleets were generated via an online Fleet Forum—53 fleets participate, 36 of which had direct experience with low rolling resistance tires.

The report instead considers an emerging class within the SmartWay list of super low rolling resistance tires, both wide-base and duals.

KEY FINDINGS OF THIS REPORT

1. **Rolling Resistance:** Low rolling resistance tires, whether in a dual or a wide-base configuration, will save significant amounts of fuel when compared to tires that are not designed for low rolling resistance.

2. **Tire Configuration:** Tire configuration should be assessed based on total cost of ownership, including fuel consumption.

3. **Industry trends:** More and more fleets are recognizing that the benefits of low rolling resistance tires outweigh the challenges, and that LRR tires represent a good investment for managing fuel economy.

ROLLING RESISTANCE

This report finds that low rolling resistance tires, whether in a dual or a wide-base configuration, will save significant amounts of fuel when compared to tires that are not designed for low rolling resistance. Some of the costs to operate LRR tires may be higher than those of non-LRR tires, but these costs are recovered over the tire's operational lifetime.

Calculating the life cycle cost of tire ownership is critical. Traditionally, tire per-mile cost is defined solely in terms of their initial purchase price, and as tire replacement may be more frequent with LRR than with non-LRR tires, the value of the LRR options has been under recognized by the industry.

In fact, the cost of the fuel that a tire consumes due to its rolling resistance is five times greater than the initial purchase price of the tire. Rolling resistance accounts for 30-33% of the total fuel cost of a modern, aerodynamic, Class 8 truck, or about $0.012 per mile with dual tires, the typical upfront purchase cost of tire tires is only $0.04 per mile. But given the range in rolling resistance among dual tires on the market today, tires could be claiming anywhere from $0.14/mile to $0.28/mile in fuel costs. Put simply, fleets that are purchasing tires without considering the fuel expenditure impacts of those tires are going to be miscalculating the impact of their tires on their bottom line.

Not only do LRR dual tires reduce fuel consumption, their upfront purchase price is equivalent to non-LRR duals of similar makes and models, and by adopting them fleets will enjoy the benefits of increased regulatory compliance.

"Rolling resistance accounts for 30% to 33% of a truck's fuel cost. Low rolling resistance tires are an easy way for fleets to reduce fuel consumption with little or no incremental cost."

— Yunsu Park, Director of Engineering, North American Council for Freight Efficiency

However, LRR duals do come with some challenges. As mentioned, tire replacement may be more frequent, since one of the primary characteristics of LRR tires is a thinner tread. Fleets and drivers also express concerns that LRR tires sacrifice traction. This study finds that while concerns around tread life and traction are not baseless, continual advances in tire design and rubber compounds make them less and less important with each new tire model. Already today, a new non-LRR dual tire would need double tire tread life of a comparable LRR model for the cost savings of that longer tread life to surpass the fuel savings of the decreased rolling resistance. And tire manufacturers predict that differences in tread life between LRR and non-LRR tires will soon disappear altogether.

"Low rolling resistance tires can save fleets significant amounts of fuel. Just how much is based on the tire's rolling resistance coefficient and other factors such as rotational mass. The lower the coefficient the greater the savings."

— Bill Walmsley, Product Category Manager: Line Haul - Business to Business, Michelin North America

TIRE CONFIGURATION

Fleets seeking to maximally reduce the fuel consumption caused by their tires will not only consider the rolling resistance of their tires, but also will compare between two available tire configurations—duals or wide-base singles. The Confidence Report finds that the benefits of wide-base tires compared to duals include lower rolling resistance, an up-to-1% reduction in overall vehicle weight, an equivalent upfront purchase price (one wide-base tire will cost about the same as a similar pair of dual tires), and the potential for reduced maintenance.

On the other hand, the industry perceives the challenges associated with wide-base tires to include limited product availability, an increased cost for on-road breakdowns, a decrease in resale value, a reduction in the ability to retread the tires, and poor driver acceptance. Additionally, as wide-base tires have low rolling resistance, they face the same concerns around a decrease in traction and tread life as LRR duals. The Confidence Report discusses each of these concerns, and finds that some of them are more real than others today. Considering purely the fuel economy associated with the rolling resistance of a tire, the Confidence Report finds that wide-base tires generally display lower rolling resistance when compared with a similar dual tire with the same tread pattern and rubber compound. However, not all wide-base tires will outperform all LRR dual tires, as a range of rolling resistance coefficients exist in both tire configurations.

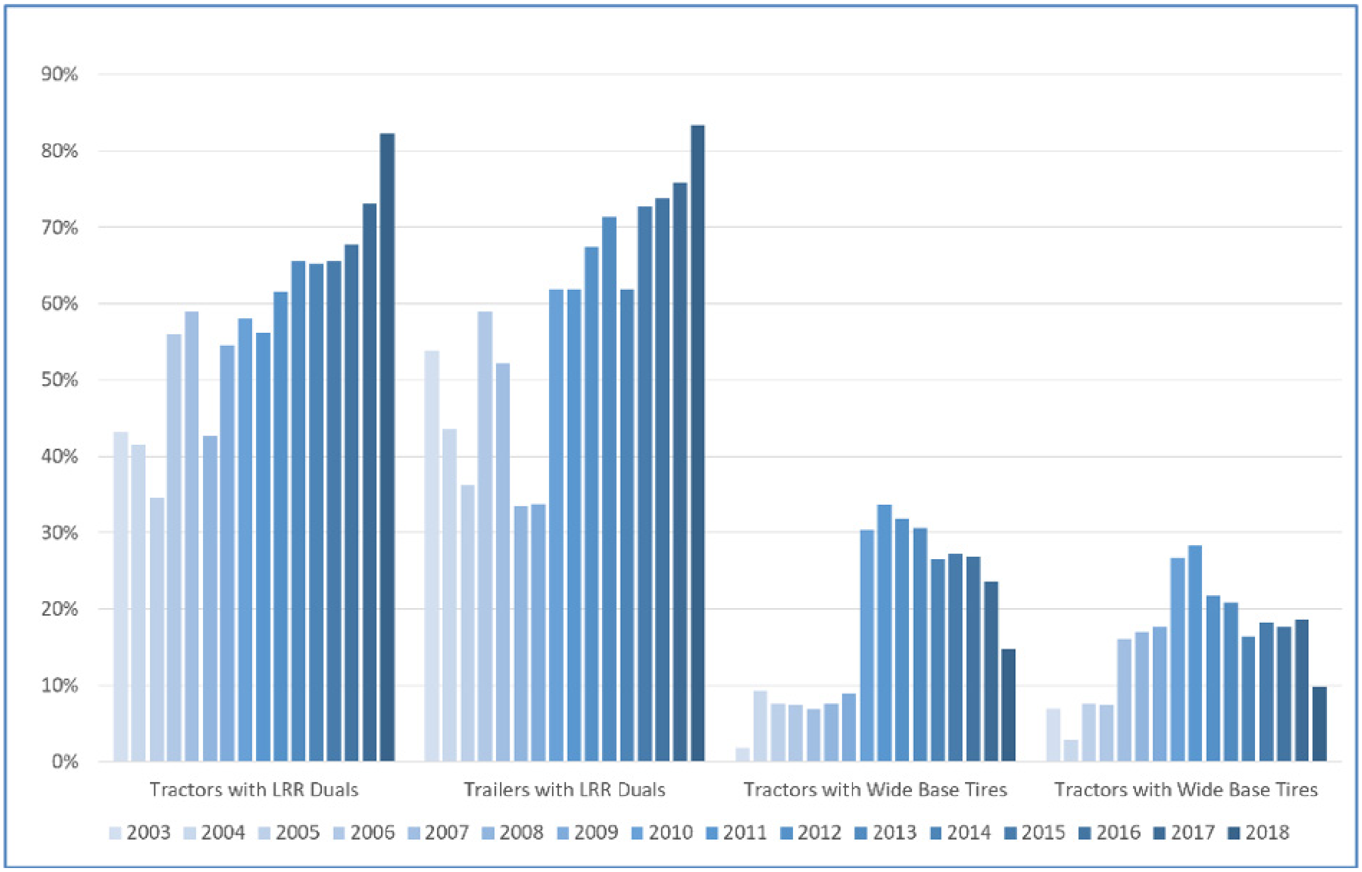
INDUSTRY TRENDS

There is a definite trend among on-highway truck fleets to increase their use of low rolling resistance tires. ES Figure 2 shows the results of NACFE's most recent Annual Fleet Fuel Study, in which all 21 of the fleets involved are moving toward low rolling resistance tires, both dual and wide-base.

This trend is also apparent in the growth of the EPA SmartWay verified tire list, launched in 2004 to accelerate adoption of fuel-saving technologies. By 2010 the list contained only eight tire brands. But in the last 10 years the list has grown dramatically, and as of mid-2020, the list contains more than 300 tire brands, and continues to grow. SmartWay does not track verified purchases but agrees that anecdotal evidence indicates that more truck fleets are specifying verified LRR tires.

FIGURE ES2

LOW ROLLING RESISTANCE TIRE ADOPTION RATES



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 tractor-trailers. In fact, there is a significant range of rolling resistance coefficients among the tires on that list—some are now much lower than others. But since manufacturers do not publicly share the coefficients of their tires, it can be difficult for fleets to fully assess their options.

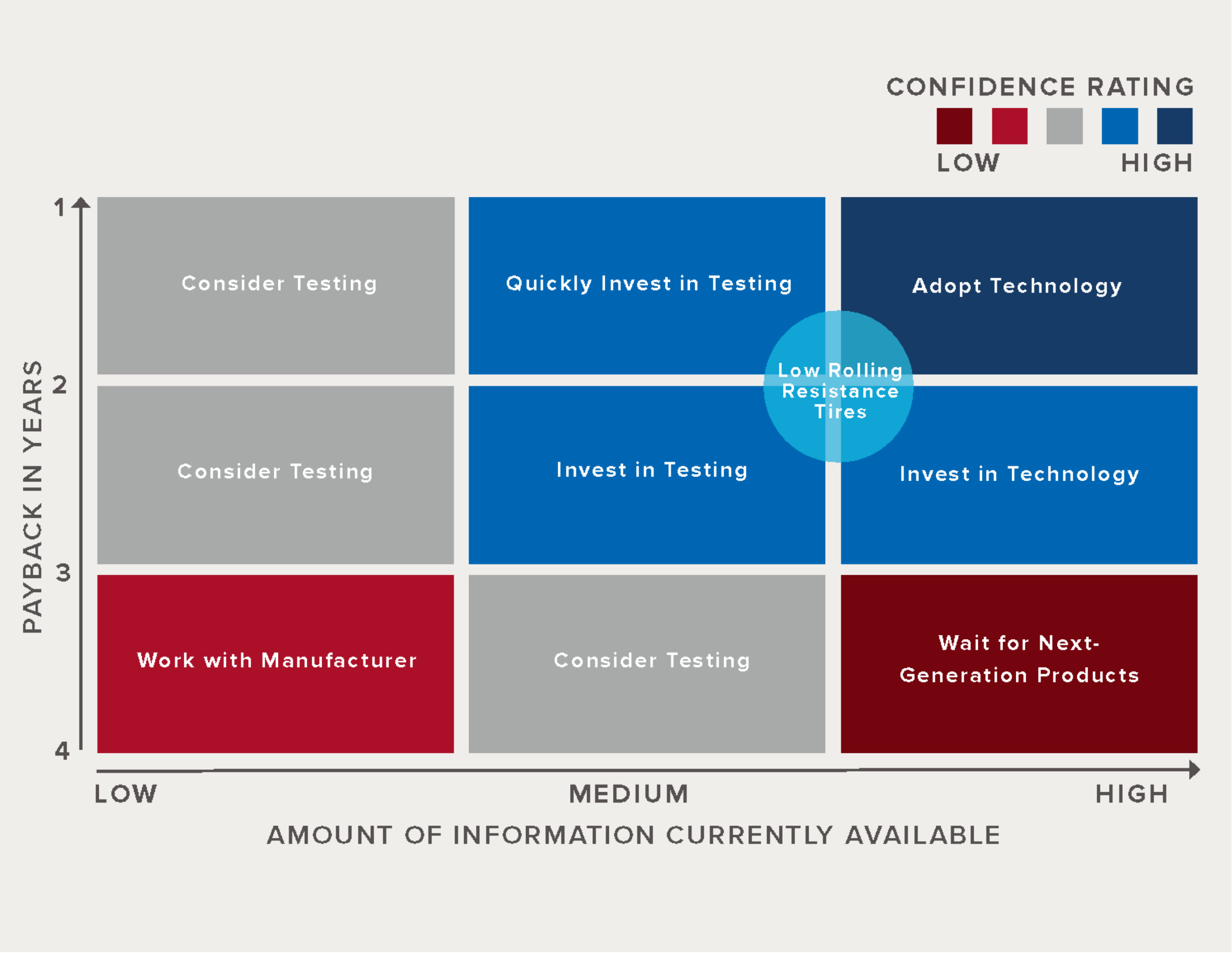
In sum, industry trends prove that more and more fleets are recognizing that the benefits of low rolling resistance tires outweigh the challenges, and that LRR tires represent a good investment for managing fuel economy.

CONFIDENCE RATING

The confidence matrix (Figure ES 3) illustrates the NACFE study team's confidence in the investment case for low rolling resistance tires. This Confidence Rating indicates a high confidence that low rolling resistance tires, in both dual and wide-base configurations, are proven to save on fuel costs, and

FIGURE ES3

CONFIDENCE MATRIX



have a good case for adoption.

RECOMMENDATIONS

Fleets should begin to investigate their rolling resistance options in greater detail than simply asking whether their tires are SmartWay verified. (See Figure ES4) 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.

In addition to using the most fuel efficient tires possible, following some best practices for adoption and use of those tires—including with respect to alignment, wheel balance, mounting and wheel-end issues, and tire inflation will help to optimize their performance. Fleets are not the only actors in this space, however. Tire manufacturers need to contribute greater transparency to the rolling resistance discussion

FIGURE ES4

FLEET DECISION GUIDE

RECOMMENDATIONS AND TOOLS FOR FLEETS

THE FOLLOWING DECISION GUIDE SUMMARIZES THE RECOMMENDATIONS OF THE CONFIDENCE REPORT, AND SERVES TO ASSIST FLEETS IN MAKING CHOICES ON ROLLING RESISTANCE AND TIRE CONFIGURATION:

DESCRIPTION OF THE FLEET AT PRESENT	SUGGESTED FLEET ACTION	
	OVER THE SHORT TERM:	OVER THE LONG TERM:
Does not purchase SmartWay verified LRR tires and does not consider a tire's impact on fuel consumption.	Spec SmartWay verified LRR dual tires from a trusted brand.	Test several SmartWay verified LRR dual tires to find the one with minimal trade-offs for your fleet.
Only purchases and wants to stay with SmartWay verified LRR dual tires, but does not know if there is a difference between any of the listed tires.	Ask your tire representative or distributor for more information on super LRR SmartWay verified tires with even lower rolling resistance.	Test one or several super LRR SmartWay verified tires to see if they lower your fleet's fuel costs further.
Purchases wide-base tires for their weight savings.	Ask your tire representative or distributor for information about his or her lowest rolling resistance wide-base tire.	Test one or several super LRR SmartWay verified wide-base tires to see if they lower your fleet's fuel.
Purchases super LRR SmartWay verified dual tires, and has the resources to test wide-base tires.	Investigate the impact of wide-base tires on your fleet, taking into consideration the challenges listed in this report.	Spec some of your next vehicles with wide-base tires to test their impact on your fleet's costs.
Purchases super LRR SmartWay verified wide-base tires but is not satisfied with their performance or impact on residual value.	Make sure the tires are maintained as well as possible and issues are well supported with data.	Test some of the newest super LRR SmartWay verified dual tires to see if they can exceed the performance of the wide-base tires.
Purchases super LRR SmartWay verified wide-base tires and is satisfied with their performance.	Continue to stay up to date with the latest tire technology.	Continue to test the newest tires of all types with the lowest rolling resistance, to achieve the greatest fuel efficiency.

Currently, rolling resistance is not a publicly available data point for tires. Some major manufacturers, like Michelin and Goodyear, offer tools for comparing the rolling resistance of different tires, but their tools are not comprehensive. and it can be hard to make comparisons between options. Making it easier for the fleets to understand and compare the rolling resistance of different tire options will move the industry forward towards greater fuel economy

NACFE hopes this report will catalyze significant additional interest in low rolling resistance tires. Reducing the rolling resistance of a truck's tires is a proven method for the industry to profitably increase its fuel efficiency and thereby reduce its greenhouse gas emissions. NACFE always is seeking to expand the data or case studies that we can provide to the industry. We invite you to share with us your own experiences with low rolling resistance tires.

Visit www.NACFE.org to download this and other reports

NACFE NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

NACFE

The North American Council for Freight Efficiency (NACFE) works to drive the development and adoption of efficiency-enhancing, environmentally beneficial, and cost-effective technologies, services, and operational practices in the movement of goods across North America. NACFE provides independent, unbiased research, including Confidence Reports on available technologies and Guidance Reports on emerging ones, which highlight the benefits and consequences of each, and delivers decision-making tools for fleets, manufacturers, and others. NACFE partners with Rocky Mountain Institute (RMI) on a variety of projects including the Run on Less fuel efficiency demonstration series, electric trucks, emissions reductions, and low-carbon supply chains.

www.nacfe.org

NACFE welcomes outside views and new partners in our efforts to help accelerate the uptake of profitable, emissions-reducing trucking technologies.

ROCKY MOUNTAIN INSTITUTE

ROCKY MOUNTAIN INSTITUTE

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; the San Francisco Bay Area; Washington, D.C.; and Beijing.

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GET INVOLVED

NACFE provides an exciting opportunity for fleets, manufacturers, and other trucking industry stakeholders.

Learn more at: www.nacfe.org
Or contact: Mike Roeth at mike.roeth@nacfe.org

1 Introduction

This Confidence Report forms part of the continued work of the North American Council for Freight Efficiency (NACFE) and Rocky Mountain Institute (RMI) highlighting the potential of fuel efficiency technologies and practices in over-the-road (OTR) goods movement. Prior Confidence Reports and initial findings on nearly 85 available technologies can be found at www.nacfe.org.

The fuel costs faced by the trucking industry have been extremely volatile over the past decade. By 2015, through an unexpected combination of world political and economic forces, fuel prices dropped to 50% of their 2008 levels.

Fuel costs have ranged between $2 and $4 over the past 15 years with a period of high fuel prices in the 2011 to 2014 time frame averaging $3.89 per gallon. Relief from these high fuel prices arrived in 2015 and 2016, with fuel prices declining to $2.31 in 2016. Costs rose again returning to $3.18 in 2018, but more recently have fallen again. These significant swings in fuel cost are expected to continue in the future, and make fuel costs the least predictable aspect of freight operations. Figure 1 shows the impact of fuel prices on fleets' operating costs. [1]

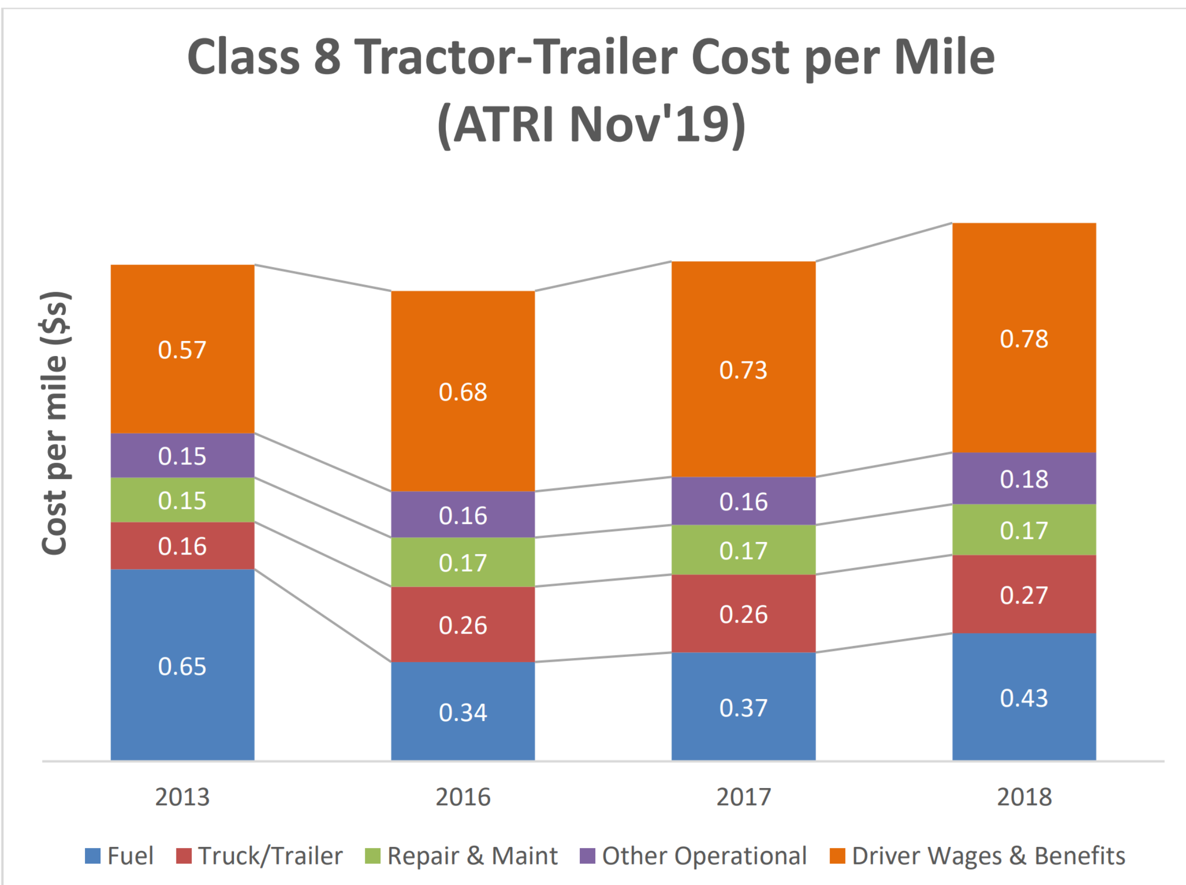


Figure 1: Trucking Operational Costs per Mile

Investment into proven technologies and practices that allow a fleet to increase its fuel efficiency — meaning it can do the same amount of business while spending less on fuel — is a very promising option for the industry in light of this trend.

To understand, and thereby better facilitate, the uptake of such technologies, NACFE conducts an annual review, the Annual Fleet Fuel Study, of the industry-wide adoption rates of nearly 85 fuel efficiency technologies currently available for Class 8 tractors and trailers. [2] Rob Reich, Executive Vice President and Chief Administrative Officer, Schneider commented on the report, saying, “I look forward to this report and read it each year within days of it being published. It is important to Schneider’s efforts and it can be a critical resource to any fleet or owner/operator as well as manufacturers and others who are working to improve Class 8 efficiency.”

The primary finding of the *2019 Annual Fleet Fuel Study* is that the 21 fleets studied are increasing their rate of adoption of these technologies, and that they are enjoying improved fuel economy as a result. (See Figure 2 for the names of fleets that participate in the study.) [2] The overall adoption rate for the technologies studied in this report has grown from 17% in 2003 to 45% in 2018. Not all technologies can be applied to a single tractor-trailer, as some are clearly an either/or decision. In 2018, there was an increase in fuel cost at the pump with diesel fuel, which powers a large majority of this fleet, averaging $3.18 per gallon for 2018, up from 2017 at $2.65. [2] This is a 20% increase, year over year and $0.88 per gallon increase from 2016. The 2011 to 2014 four-year average was $3.89, meaning that fuel costs annualized in 2018 is within $0.71 of that level. (See Figure 3.)

Figure 2: Fleet Fuel Study Participants

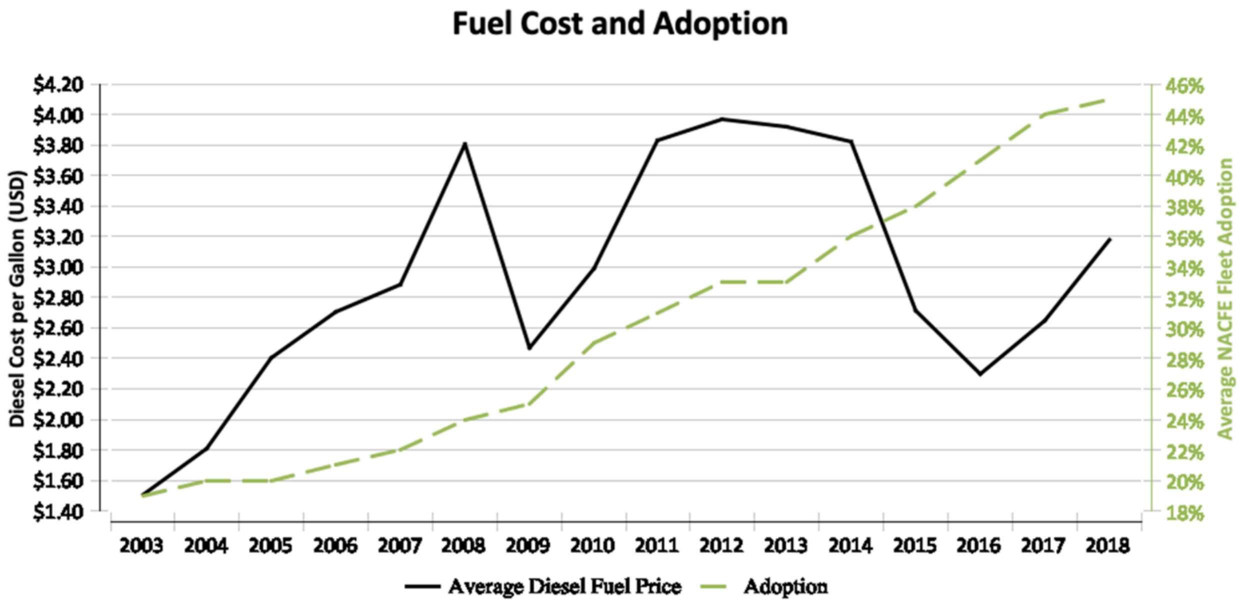
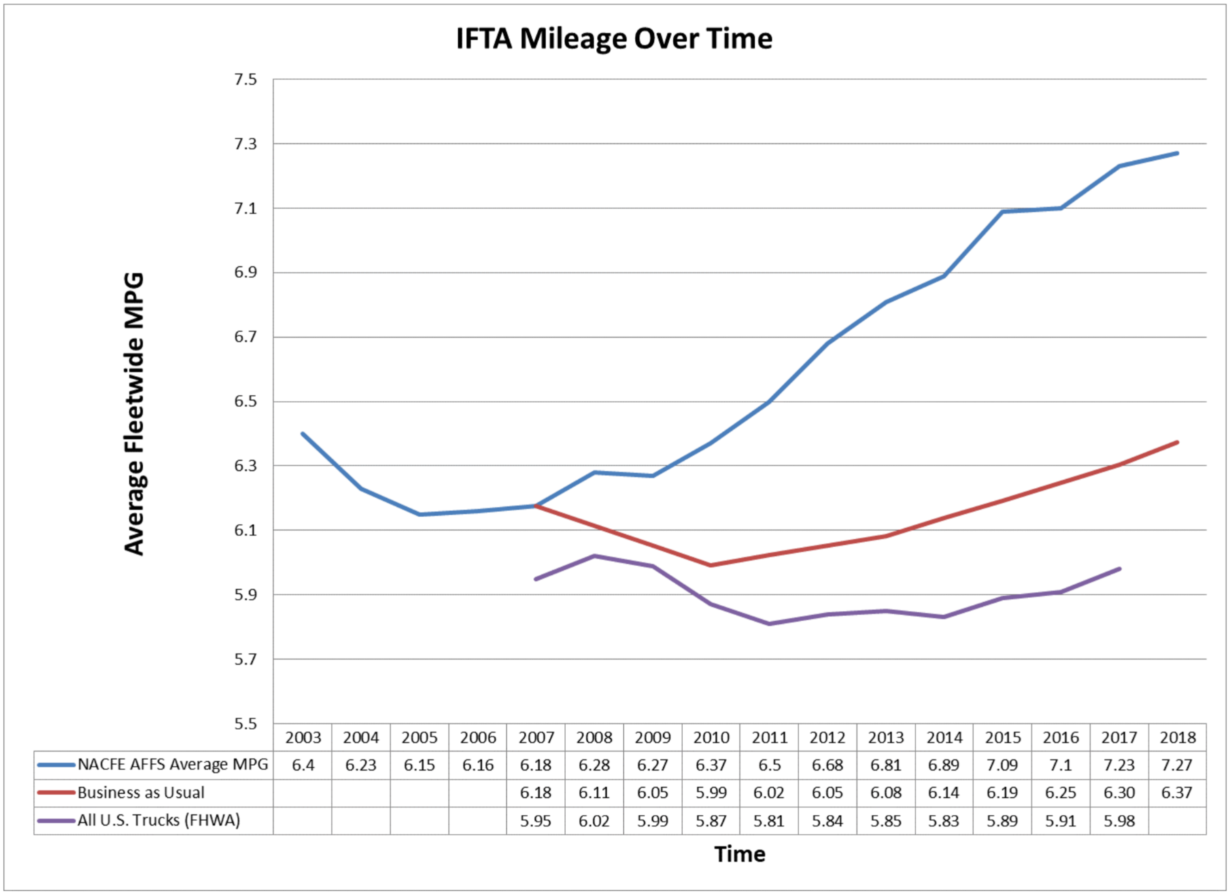


Figure 3: Price of Diesel and NACFE Fleets Adoption

The average fleet-wide fuel economy of the trucks in the Fleet Fuel Study was 7.27 MPG in 2018 — a slight increase from the 7.23 in 2017. There is variability in each fleet's yearly fuel efficiency depending on many factors. [2]

For the last 10 years, the average rate of improvement in MPG has been 2.0%. Figure 4 shows the average fleet-wide fuel economy for the combined population of trucks in this study compared to the overall U.S. truck population. A business-as-usual (BAU) line is included for comparison. The BAU shows a projection of what average MPG might have been given the combined impact of 2002, 2007, and 2010 emission regulations, and the effect of the 2014 and 2017 Greenhouse Gas (GHG) base powertrain improvements. In other words, this suggests the level of efficiency had the 21 fleets not purchased the technologies that are available to them as options. [2]



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
NACFE AFFS Average MPG	6.4	6.23	6.15	6.16	6.18	6.28	6.27	6.37	6.5	6.68	6.81	6.89	7.09	7.1	7.23	7.27
Business as Usual					6.18	6.11	6.05	5.99	6.02	6.05	6.08	6.14	6.19	6.25	6.30	6.37
All U.S. Trucks (FHWA)					5.95	6.02	5.99	5.87	5.81	5.84	5.85	5.83	5.89	5.91	5.98	

Figure 4: Fuel Savings per Truck

The fuel savings in 2018 between the BAU of 6.37 MPG and the NACFE fleets' average of 7.27 MPG amounts to $6,492 per year per truck, at the $3.18 per gallon fuel cost over the average tractor mileage of 105,041. The fleets are saving $9,912 over the national average of 5.98 MPG. If fuel costs had been at the four-year average of $3.89 per gallon, the savings would have been $7,941 and $12,124, respectively. And finally, the 21 fleets operating 73,844 trucks saved $895,318,953 in 2018 compared to the average trucks on the road. [2]

The study reached the following conclusions:

- Multiple factors are influencing fleet adoption. New factors have emerged that influence decisions by fleets to improve efficiency, including the current cost of fuel, potential future cost, federal and local regulations and increasing public demand for more sustainable operations.
- Fleets continue to adopt fuel-saving technologies. Specific technologies adopted vary by fleet duty cycle, business models, fleet size and other factors.
- Manufacturers accelerated delivery of technologies.
- Other advancements come both as novel technologies that provide the same function in a different way and as new technologies that address areas not considered in the past.

- A significant gap between average and best-of-the-best still exists.

NACFE's goal is for the information shared in this study to provide fleets a roadmap for navigating the many available technologies that can have a positive impact on lowering fuel expenses.

1.1 NACFE's Confidence Reports

NACFE's Fleet Fuel Studies provide useful insights into adoption trends in the industry, as well as into the specific practices of different major fleets. NACFE hoped that this information could alone spur additional investment, particularly by fleets that may be lagging behind the overall industry when it comes to certain widely-adopted technologies. However, in the course of conducting the studies, it became clear that some technologies are still only being adopted by the most progressive or innovative fleets in spite of their showing strong potential for achieving cost-effective gains in fuel efficiency.

Confidence Reports provide a concise introduction to a promising category of fuel efficiency technologies, covering key details of their applications, benefits, and variables. The reports are produced via a data mining process that both combs public information and collects otherwise-private information (which is shared with NACFE for the purpose of the reports), in order to centralize an unparalleled range of testing data and case studies on a given technology set.

Low rolling resistance (LRR) tires, both in a traditional dual setup or in a wide-base format, are one such technology set. The core objective of this Confidence Report, therefore, is to provide the leadership of fleets with a comprehensive overview of the total cost of ownership for low rolling resistance tires for improved fuel efficiency. As this report will demonstrate, there are many (sometimes competing) factors which a fleet must weigh in its decision-making process for tire purchasing. This report therefore does not conclude with a guide of which tires will be right for which fleets, but rather with a decision tree that fleets can use as they asses their own duty cycles, business models, supplier relationships, and other considerations.

Tires are where fuel economy truly "hits the road," but the fuel economy benefits of operating tractors and trailers with LRR tires in some or all locations must be compared against factors including wear/tire life, retreadability, traction, and a fleet's tire pressure practices, when determining the total cost of ownership of the tires.

1.2 Technologies Considered in this Confidence Report

There are two features — the rolling resistance coefficient and the tire configuration or width — which distinguish between the tires considered in this Confidence Report, creating three essential categories of tires. For the purposes of this report, low rolling resistance (LRR) refers to any tire on the SmartWay verified technologies list, though it is recognized that some tires on that list will have lower resistance than others. In terms of tire width, the terms "dual" and "wide-base" are used. Most wide-base tires (also sometimes referred to as wide singles or super singles; although super singles are actually another type of tire and are described as385/65R22.5 or 315/80R22.5) available today for over-the-road line haul applications do fall on the SmartWay verified technology list, so this report only briefly distinguishes a class of extremely low rolling resistance wide-base tires from among wide-base tires generally. The wide-base tire nomenclature commonly used is 445/50R22.5 or 455/55R22.5 for an LRR wide-base single.

Therefore, this report discusses and compares:

1. Non-LRR dual tires
2. LRR dual tires
3. LRR wide-base tires

Note that when the term dual is used without a qualifier as to rolling resistance, this report is distinguishing only the tire width and is referring to both LRR and non-LRR dual tires. Also note that, in this report, common terms like standard, traditional, or conventional are not used, as those may refer to either the rolling resistance or the width of the tires.

1.2.1 What is Rolling Resistance?

The rolling resistance of a tire is defined as the force needed to keep a tire rolling at a constant speed on a level surface and usually is expressed in the form of a rolling resistance coefficient (C_{RR}). An easy way to think about C_{RR} is as the ratio given by the force needed to keep a tire rolling to the weight on the contact patch. The tire's rolling friction increases as more weight is put on the contact patch since in the real world, the rolling frictional coefficient of a tire is always greater than zero. (Figure 5).

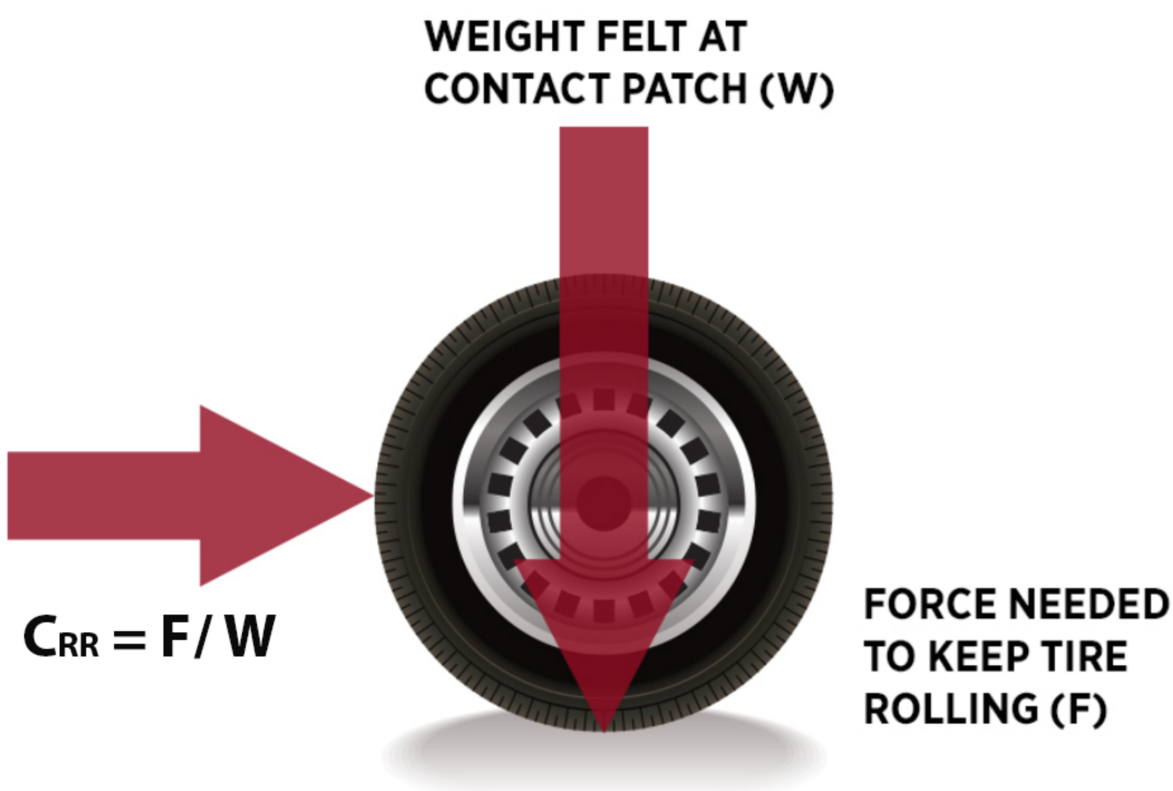


Figure 5: Rolling Resistance Coefficient

There are several standard methods for calculating a tire's C_{RR}. One common method is prescribed by ISO 28580, which specifies the test rig and conditions under which a tire is tested. [3] A C_{RR} resulting from an ISO 28580 test is expressed in the unit "kg force per metric ton." Since there are 1,000 kg in a metric ton, this can be used with any unit of measure divided by 1,000. For example, a tire with a rolling resistance of 10 and a load of 10,000 lbs. requires 100 lbs. of force to keep it rolling at a constant speed (10,000 lbs. x 10/1000 = 100 lbs.). For a tire to be accepted as SmartWay verified, at least three tires must be tested using the ISO 28580 or equivalent method and the average of the tests must be below the SmartWay target values for the tire position. (Figure 6.)

	Steer	Drive	Trailer
SmartWay Target C_{RR}(ISO28580)	6.5	6.6	5.1

Figure 6: SmartWay C_{RR} Targets

1.3 Methodology

NACFE's Confidence Reports are researched by an unbiased team of trucking industry experts.

In December 2014, the original study team began assessing the current state of low rolling resistance tires for improving the fuel efficiency of Class 8 tractor trailers. The team used a "360 degree" technique to gather existing data on tires to uncover any points of industry-wide agreement or areas of confusion. The first step in this research was for the team to meet with or use phone interviews to speak with heavy-duty tire suppliers, tractor and trailer builders, and many large and small fleets with experience in low rolling resistance tires. The team also used the spring 2015 truck shows: specifically, the Technology & Maintenance Council Annual Meeting & Transportation Technology Exhibition, the Mid-America Trucking Show, the National Private Truck Council Annual Conference and the Alternative Clean Transportation Expo, to meet with and learn from many of the key industry stakeholders.

Eleven large fleets and five major tire manufacturers were confidentially interviewed by the study team. All 11 fleets had significant experience with LRR tires, usually for multiple duty cycles. Finally, the study team used a Fleet Forum to survey medium and smaller fleets about their perceptions of and experiences with LRR tires, both duals and wide base. Fifty-three fleets participated in that survey, 36 of which had first-hand knowledge of LRR tires.

The original study team presented its initial findings, drawn from these interviews and surveys, to groups of fleets, manufacturers and others — participants in NACFE Workshops held in mid-November, 2014, in Allentown, PA, one in Dallas, TX in early May 2015 and another in Salt Lake City, UT in June 2015. These workshops were quarterly, regional meetings where small groups discuss and even debate the findings of NACFE's reports. A schedule of upcoming workshops can be found at http://www.nacfe.org/events

The update team reviewed the data from the initial report and verified the information using websites and industry contacts. Some of the findings from the interviews and surveys conducted by the original study team have been left in place where the update team felt it supplemented the reader's understanding of the current state of the industry and transitions that are occurring.

1.3.1 Study Questions Used in Original Study Team Interviews

Sample Questions:

- What is meant by low rolling resistance tires?
- Is lower rolling resistance just created by less tread? To what degree does the reduced tread cause a tire to wear more quickly, requiring more frequent tire replacements?
- What is a SmartWay tire, and are they all the same?
- Do they deliver fuel savings?
- How much of an effect do tires have on fuel expense?
- What are the advantages and disadvantages of wide-base tires?
- What tradeoffs do tire manufacturers make to get lower rolling resistance?
- Do new tires being offered wear better?
- What is the total cost of ownership?
- How will Greenhouse Gas Phase 1 or Phase 2 regulations change tire designs, availability, etc.?

2 Why Rolling Resistance Matters

There was a time when knowing the upfront cost and predicted life of the tire was enough for most fleets to make a purchasing decision. Tire costs were a maintenance item and fuel was an operating cost, and the two had little to do with one another. If there was any awareness of a tire's impact on fuel consumption, it was assumed to be negligible, unknowable, or perhaps both.

Today, many parties including tire manufacturers, truck builders, EPA SmartWay, and others, are working to raise awareness of the hidden cost of fuel in each tire purchase. A typical fleet's average cost for fuel is approximately $0.433 per mile. [1] The tire's average contribution to that cost varies depending on road speed, vehicle aerodynamics and other factors. For an aerodynamic long-haul truck operating at highway speed, tire manufacturers interviewed by the study team typically attribute about 30-33% of total fuel cost to rolling resistance, or about $0.13 per mile. On the other hand, a typical fleet's costs for the upfront purchase of the tires are approximately $0.038 per mile. [1] Therefore, as Figure 7 shows, for a typical OTR fleet, the cost of the fuel a tire consumes due to its rolling resistance outweighs the initial purchase cost of the tire by a factor of 3.4. Only a small portion of a tire's true cost is visible in the purchase price. Purchase Price = $0.038 per mile; Rolling Resistance = $0.13 per mile.

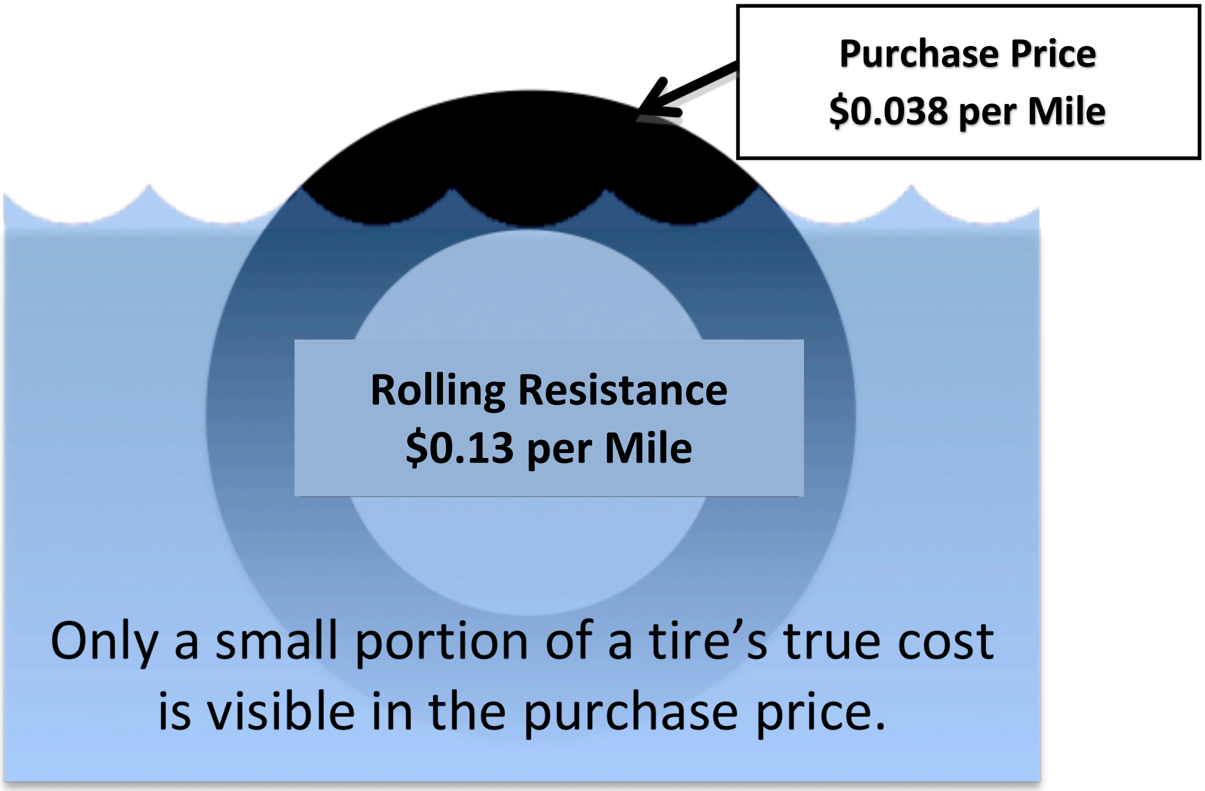


Figure 7: Cost of Tires

According to one major U.S. tire manufacturer that has tested many of the tires available in the U.S. from the various manufacturers at an independent lab, the C_{RR} for an on-highway truck tires varies from a low of 4.4 to over 9, with the lower figure of 4.4 indicating lower rolling resistance. This means that not only is the hidden cost of fuel far greater than the tire's price, but that the difference in the impact on fuel economy that one tire versus another can have is also greater than those tires' initial cost. Put simply, fleets purchasing tires without considering the fuel expenditure that will be driven by their tire choice are missing the biggest impact on the fleet's bottom line that the tires will have.

Today, tire manufacturers do not disclose a tire's rolling resistance to the general public, though it may be revealed selectively to some large fleets. [4] The best indication of a tire's C_{RR} comes from EPA SmartWay, which has a list of tires it has verified as low rolling resistance. [5] For a tire to qualify for the SmartWay list, it must meet a rolling resistance threshold set by SmartWay 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 tractor-trailers.

A consequence of this SmartWay list is that it only incentivizes tire manufacturers to make sure their tires fall below the threshold, but not to decrease their rolling resistance any further than that. Finally, while lower rolling resistance will improve fuel economy, it is not without its trade-offs. 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. For fleets weighing those trade-offs, it is important to keep the relative costs in mind. A 3% reduction in fuel (the SmartWay target) equates to nearly $0.012 per mile (3% x $0.433 per mile). For an average fleet incurring $0.04 per mile in tire cost (upfront purchase price), a tire with higher rolling resistance would have to have a tread life that is twice as long as that of a SmartWay-verified LRR tire to offset the gains in fuel efficiency achieved by the lower rolling resistance.

3 What Makes a Tire More Fuel Efficient?

An analogy to rolling resistance came to the study team from Tim Miller, formerly of Goodyear Tire & Rubber Co. He likened the benefits of low rolling resistance to walking on the beach in wet and dry sand, saying, "Notice how much easier it is to walk on the stiffer wet sand than the loose, dry sand. Using tires with high rolling resistance is equivalent to constantly walking on loose, dry sand."

With a non-low rolling resistance tire or a tire designed for high traction, the treads are deep, and the tread blocks are separated by wide gaps. As the tire rolls, the tread blocks deform and compress, and the energy required to make those treads deform comes directly from the fuel tank. In the case of a low rolling resistance tire, characterized by a thinner and firmer tread and stiffer compounds, there is less material in the tread face to wiggle and squirm at the contact patch as the tire rolls along the pavement.

The tire that rolls along the road with a minimum of wasted energy is the more efficient tire. The best example of rolling efficiency would be a steel train wheel on a steel rail — two smooth polished surfaces, no deformation to speak of, and very little friction between the two surfaces to inhibit rolling. But because steel on steel provides a very low coefficient of friction, traction is quite poor. And while steel wheels on a truck might last forever, the ride quality would be appalling.

3.1 History of Low Rolling Resistance Tires

Historically, cost and tread life were the top considerations when specifying tires; fuel efficiency was not a big concern when diesel was $1 per gallon. Nevertheless, fuel-efficient tires with lower rolling resistance appeared on the market back in the early 1980s, known then as low-profile tires. We know similar tires today by their metric nomenclature, i.e. 295/75R 22.5.

Characterized by a lower aspect ratio — the difference between the height and width of the tire — and shallower tread, they boasted 3% to 4% better fuel efficiency. They also were about 15% more expensive and the tread life was about 30% less than a non-LRR dual tire. At that time, fuel cost about $1.50 per gallon, so the extra cost of the tire combined with the reduced tread life was difficult to make up in fuel savings. Consequently, few of those tires were purchased.

High fuel prices reignited interest in such tires, but there remains lingering doubt about their cost effectiveness, as rolling resistance is only one of three major considerations in tire design, along with traction and service life. Underlying those are secondary considerations such as retreadability, durability, ride quality, and cost. The historic view of tire engineering is that dramatic improvement in one of the three primary considerations usually will result in compromises to the other two. That remains the case, but advancing technologies today make possible substantial improvements in efficiency with less compromise to traction and tread life. In fact, a non-LRR dual tire would have to have double the tread life of the LRR model for the cost savings of that longer tread life to surpass the cost of the fuel savings achieved by a 10% decrease in rolling resistance.

Today's LRR tires are much improved over those early examples. Tread mileage in particular is much better due mostly to new materials and production methods that reduce or eliminate the trade-offs that tire manufacturers had to make in the early years. Design philosophy and technical approaches vary with the manufacturers, but all claim that advances in rubber compounding have extended the tread life of LRR tires.

3.2 Components of a Tire

Every component of a tire has a role to play in determining rolling resistance, traction, and tire life. In addition, every component of a tire can be manipulated in some way to affect those variables. 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, according to Michelin. (See Figure 8.)

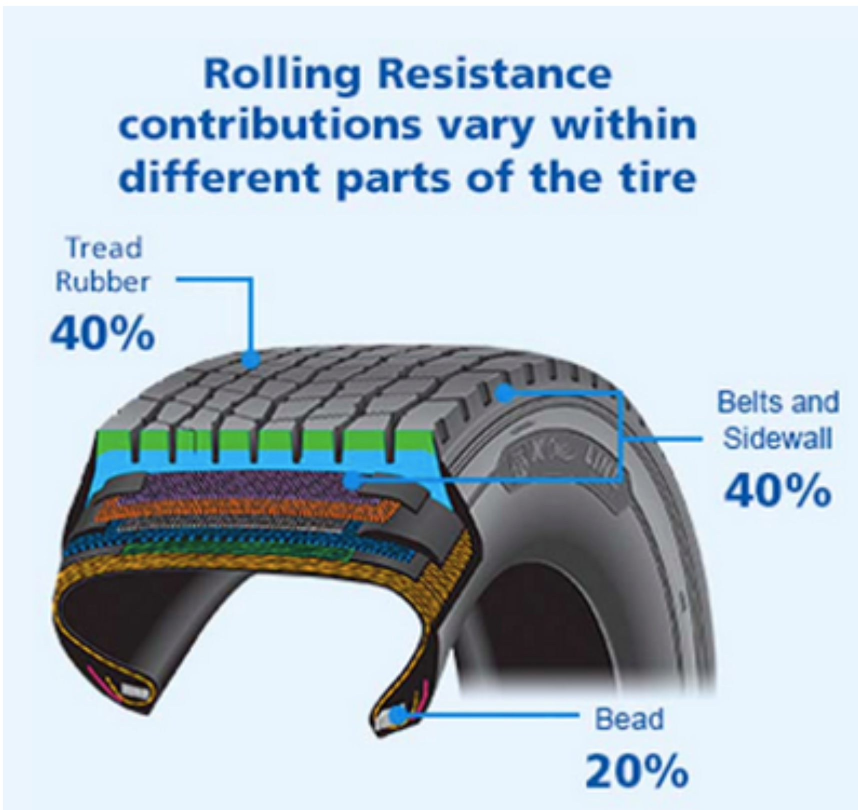


Figure 8: Rolling Resistance Contributions
(Source: Michelin)

3.2.1 Tread Design

Rib-type tread designs roll more easily than lug treads, offering less resistance because they have less movement (squirming and wiggling) of the individual tread blocks as the tire contacts the pavement. (The distortion of the tread as it contacts the pavement consumes energy; the more the tread blocks are supported by each other, the less distortion occurs.)

Figure 9: Low Rolling Resistance Tire Tread Designs

(Source: **Left:** Yokohama 101ZL Spec 2 siped center ribs; **Center:** Goodyear G572 tight-packed lugs with closed shoulder; **Right:** Michelin x-line-energy-d siped rib tread with closed shoulder.)

The current trend in LRR tires is moving toward a closed shoulder with a tighter tread pattern. Manufacturers are building tires with tightly packed lugs that not only bear a strong visual resemblance to a rib design, they function similarly as well. When tread lugs are packed tightly together, they support one another, and squirming is minimized. This is a good example of how engineers can lower rolling resistance with minimal traction reduction. (See Figure 9.)

3.2.2 Tread Depth

Treads are typically shallower on LRR tires for the same reason — to minimize tread movement at the contact patch. There is a general belief that shallower tread provides less traction and will run fewer miles to removal, simply because there is less rubber there to begin with. In the early days of LRR tires, when many tire manufacturers relied heavily on reduced tread depth to meet the SmartWay requirements, this was mostly true. 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 per 32^{nd} of an inch of rubber with minimal impact to traction. One leading tire manufacturer indicated that early data received on its newest LRR tires actually have improved tread life, up to 400,000 miles in the drive position.

3.2.3 Sidewalls

While their contribution to fuel efficiency may be small, the sidewall is a critical part of tire design. In a drive tire, sidewalls must be able to withstand the tremendous torque output of today's engines, while remaining supple enough to absorb incidents like curb strikes.

Manufacturers can lower the rolling resistance of a tire by making the sidewall stiffer, as it will consume less energy as 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.

The number of sidewalls at each wheel end, only two vs. four, gives wide-base singles a slight rolling resistance advantage.

3.2.4 Rubber Compounds

Today, 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 — or hysteresis — overall so that less energy is consumed in the process of the tires deforming and then returning to their original shape.

3.2.5 Tire Weight

The weight of the tire, and by extension, the weight of other wheel-end components such as wheels, hubs, axle spindles, etc. has only a minute impact on overall vehicle fuel efficiency. Therefore, weight is not an issue in choosing between non-LRR and LRR dual tires. However, a second option is available in the LRR category — wide-based tires, which offer weight savings of about 800 lbs. per truck/trailer, over dual tires.

3.2.6 Wide-Base Tires

Wide-base tires are tires designed to replace two dual tires with one tire on drive or trailer axle wheel ends for OTR applications. (See Figure 10.) The design has advantages over dual tires in reducing rolling resistance since two sidewalls are eliminated and the size of the overall contact patch is reduced.

Figure 10: Wide-Base Tires and Wheels

When Michelin introduced the first wide-base tire, the X One, to the North American market in 2000, it was seen as a radical departure from traditional tire design. Though popular in Europe some years prior, they were slow to gain acceptance in the U.S., and after 20 years of exposure, wide-base tires have not exactly taken this market by storm. When originally launched, they offered proven fuel economy benefits of about 3% to 5%, depending on the application. But with recent improvements in duals, the benefit has been reduced to 1% to 2%.

Much of that efficiency advantage comes from doing away with two sidewalls per wheel end. Depending on the make and model, many of the tread patterns and tread depths found on dual tires also are available on wide-base tires, with some thread patterns unique to the wide-base tires.

Low rolling resistance dual tires make up about 80% of the truck market today, while wide-base tires currently make up about 15% of the market. [2] The specific challenges and benefits achieved by adopting wide-base tires instead of duals are discussed in Section 7 and 8 of this report.

4 Measuring Rolling Resistance

While the precise contribution of reductions in rolling resistance to overall fuel economy improvements can be calculated fairly accurately using measured rolling resistance data and assumptions about the rolling resistance component of fuel consumption, highly accurate real-world data are harder to come by. Weather, driver habits, varying weights and other vehicle condition parameters can sway the results, meaning that certain inaccuracies likely will arise when measuring actual fuel burned without temperature compensation and precise mileage inputs. Fleets must be very diligent not to overlook any changes or miss recording a single fill-up when collecting this type of data.

The principle challenge in any testing is calculating the uncertainty value of the test, which is expressed as a confidence interval. In the case of rolling resistance, the improvement is likely to be small, so an uncertainty value of ±2% could negate or overstate the amount of improvement.

On top of that, in long-term on-road tests such as TMC's Type IV test (RO 1103), the actual rolling resistance of the tires under evaluation improves as tread rubber is scrubbed away. Meanwhile, in short-term testing, such as an SAE J-1321 track test, weather and a number of other variables can impact the outcome. [6, 7]

For these reasons, fleets testing tires on their own do not always achieve statistically accurate results, thus fleets' tire-buying decisions may be skewed by inaccurate, incomplete, or corrupt data.

Tire manufacturers test their tires to determine rolling resistance using one of two recognized test procedures: ISO 28580 or SAE J1269. [3, 8] The actual results of these tests, usually expressed numerically, are not publicly available, but are used by OEMs and various regulatory agencies when calculating, for example, GHG reduction credits. The finding in isolation may not be that useful to a tire buyer as it speaks only to its rolling resistance, which is not the only factor to be considered in a tire specification decision.

Michelin's website allows users to compare the LRR values of almost any make and model tire to a baseline. [4] Users can choose their own baseline tire and the model for comparison. Michelin presents relative rolling resistance on a scale where the baseline tire has a value of 100. Customer can select the brand and model. The compared tire has a plus/minus value (again, customer can select the brand and model), e.g., baseline = 100, compared tire = 91, or perhaps 110. The lower number indicates less rolling resistance than the baseline. (In this example, the compared tire has a 9% lower C_{RR}.)

Michelin also offers a fuel economy tool, which allows a user to provide information on their vehicle, and then gets information on the fuel economy gains or losses that would result from a given tire selection.

Goodyear provides a total potential fuel savings tool using recommended Goodyear tires based on the fleet's tractor and trailer configurations. Other manufacturers offer similar tools to help fleets make decisions. [9]

Finally, the aforementioned EPA SmartWay Verified Tire List offers some guidance in the availability and selection of LRR tires. SmartWay does not reveal the actual C_{RR} values for any tires but lists the tires that meet its target threshold for a given axle position. [5]

5 Trends in Tire Purchasing

There is a clear trend among on-highway truck fleets to low rolling resistance tires. Figure 11 shows results of NACFE's 2019 Annual Fleet Fuel Study where all 14 of the fleets involved continue to specify low rolling resistance tires on tractors and trailers. [2] The trend is expected to continue throughout the highway market and the expectation is that the vocational market will experience the same as OEMs attempt to improve their Greenhouse Gas Emissions Model (GEM). [10] Recent discussions with tire manufacturers indicate that the market for wide-base tires overall continues to grow because of weight savings associated with wide-base tires and technological improvements.

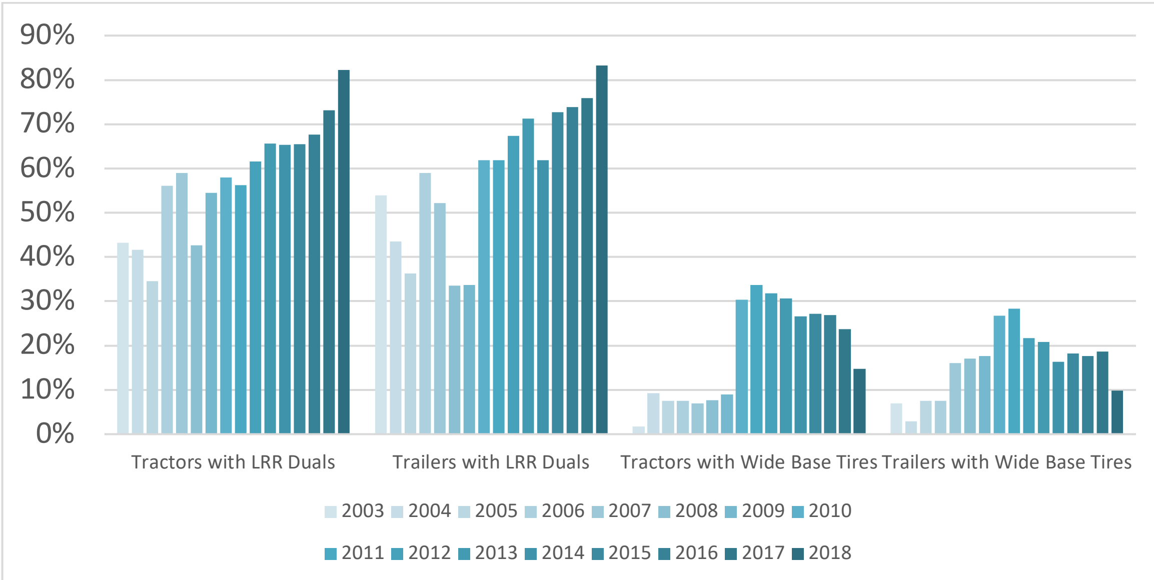


Figure 11: LRR Tire Adoption NACFE 2019 Annual AFFS

Figure 12 shows a sharp rise in 2010 of wide-base tire purchases and nearly mirrors the fuel cost increases through 2014. One may assume customers saw the value of wide-base tires' lower rolling resistance and improved fuel economy as the price of fuel increased during that time. Then, as the tire manufacturers improved their dual tire rolling resistances to the same levels as wide-base tires, customers returned to duals because of the fleet's familiarity in handling of duals and asset consolidation. [2]

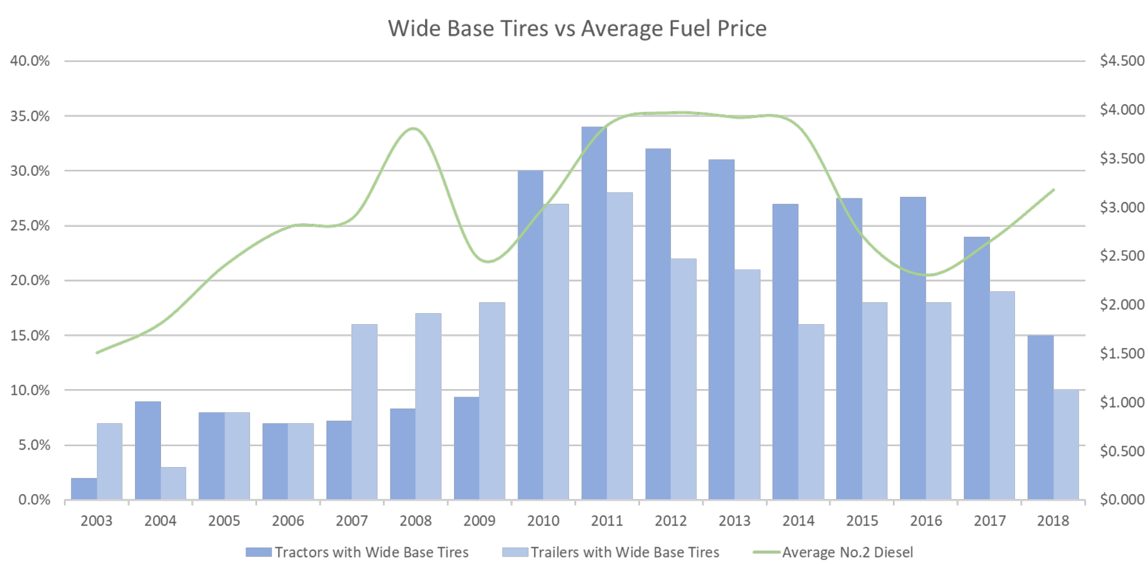


Figure 12: Wide-Base Tires vs. Average Fuel Price

Another place where this trend is apparent is in the growth of the *SmartWay Verified List of Low Rolling Resistance New and Retread Tire Technologies* (hereafter referred to as the SmartWay 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; six years later, only eight tire brands were listed. But in the last five years the list has grown dramatically, and as of mid-2020, the list contains more than 300 tire brands with many models from each of those brands, and it likely will continue to grow. The presence of a tire on the SmartWay List is no guarantee of its quality in terms of traction, tread life, or retreadabilty, but it is an indication of the increasing awareness of the importance of the fuel-efficiency impact of tires. SmartWay does not track verified purchases but agrees that anecdotal evidence indicates that more truck fleets are spec'ing verified LRR tires. [5]

Tire manufacturers do not discuss sales by tire model, but some have gone so far as to say that there is no reason to produce a non-SmartWay verified tire for the on-highway long-haul market. This may have been a generalization, as all tire manufacturers are quick to point out that correct application is critical, and that rolling resistance is only one of several criteria for selecting the right tire. But by their having made this observation, it emphasizes the recognition that the SmartWay List has received in the industry.

Truck OEMs also indirectly confirm this trend. To meet Phase 1 requirements of EPA Greenhouse Gas (GHG) regulations, truck manufacturers are required to document the rolling resistance coefficient of the tires fitted to the vehicles they produce. [11] The truck OEMs interviewed by the study team indicated that so far the specs the customers desire have allowed the OEMs to meet the standards. In other words, the OEMs have not needed to push for more fuel-efficient tires than already were requested by the customer. As one manufacturer said, "Customers seem to know which tire is best for their application," providing as evidence the fact that the average C_{RR} for the tires the customers specified was lowest in the sub-category associated with on-highway sleeper trucks.

The trend is likely to continue, for it is one that should benefit most on-highway truck fleets. By 2027, the C_{RR} targets in Phase 2 of the GHG regulations decrease by 8% to 27% (depending on vehicle type and axle position) from the Phase 1 levels and will meet or exceed the SmartWay threshold by 2021 for non-vocational vehicles. Truck and tire manufacturers continue to educate their customers on the benefits of LRR tires, new tire technology will continue to diminish the traction and tire life trade-offs associated with LRR tires, and SmartWay and other organizations will continue to look for ways to educate tire buyers about the fuel impact of tires.

6 Tire Regulations

Recent environmental regulations are playing an important role in fleets' tire selection, as tires are a part of determining and improving a vehicle's fuel efficiency.

6.1 EPA and NHTSA

On October 25, 2016, the EPA and NHTSA jointly published Phase 2 of the *Greenhouse Gas (GHG) Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles*. [11]

The Phase 2 rule set emission standards for tractor-trailers, vocational vehicles, and heavy-duty pickup trucks and vans. The rule expanded on the Phase 1 standards (published on September 15, 2011, for model years 2014 through 2018) and introduced first-ever controls on trailers and glider vehicles.
As of the fall of 2020, the trailer portion of this rule remains in limbo. A stay on the implementation of the GHG Phase 2 rules for trailers was issued b, the U.S. Court of Appeals. This stay may have the effect of suspending the trailer rules indefinitely. [15]

The standards phase-in is between MY 2021 and MY 2027 for engines and vehicles and between MY 2018 and MY 2027 for trailers and gliders. The agencies outline several benefits of the rule, including reducing carbon dioxide (CO_2) emissions and fuel consumption from new on-road vehicles, reducing the costs for transporting goods, and spurring innovation in the clean energy technology sector.

The Phase 2 rule maintains the underlying regulatory structure developed in Phase 1, however, unlike Phase 1, the rule puts forth "technology advancing standards" (i.e., standards based "not only on currently available technologies but also on utilization of technologies now under development or not yet widely deployed"). These may include advancements in the engine, transmission, driveline, aerodynamic design, lower rolling resistance tires, and extended idle reduction technologies.

The agencies estimate that the Phase 2 standards will achieve vehicle fuel savings of up to 25% beyond Phase 1 when fully implemented and depending on the vehicle category. (See Figure 13.) [12] Overall, the agencies estimate it could cut GHG emissions by 1.1 billion metric tons of CO_2 and conserve 2 billion barrels of oil over the lifetime of the vehicles sold in the regulatory time frame. [13]

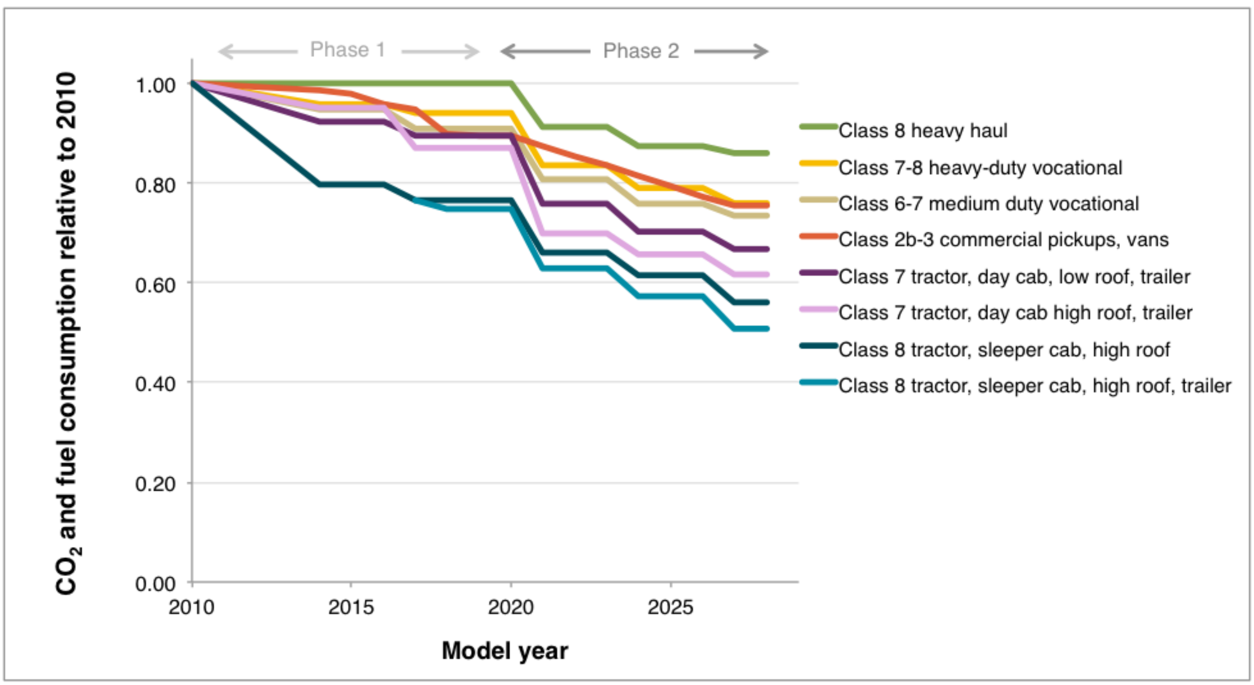


Figure 13: CO_2 and Fuel Consumption

To deliver on this overall stringency of the rule, the EPA detailed rolling resistance for various vehicle categories and years in the GHGp2 rule, shown here in Figure 14.

Tire Location	Day Cab Low Roof	Day Cab Mid Roof	Day Cab High Roof	Sleeper Cab Low Roof	Sleeper Cab Mid Roof	Sleeper Cab High Roof		
Steer	6.99	6.99	6.87	6.87	6.87	6.54	**2014**	**GHG P1**
Drive	7.38	7.38	7.26	7.26	7.26	6.92		
Trailer	(none)							
Steer	7.0	7.0	6.9	6.9	6.9	6.5	**2018**	**GHG P2**
Drive	7.4	7.4	7.3	7.3	7.3	6.9		
Trailer	5.1	5.1	5.1	5.1	5.1	5.1		
Steer	6.0	6.0	6.0	6.0	6.0	6.0	**2021**	**GHG P2**
Drive	6.6	6.6	6.6	6.6	6.6	6.3		
Trailer	4.7	4.7	4.7	4.7	4.7	4.7		
Steer	5.9	5.9	5.8	5.9	5.9	5.8	**2024**	**GHG P2**
Drive	6.4	6.4	6.0	6.4	3.4	6.0		
Trailer	4.7	4.7	4.7	4.7	4.7	4.7		
Steer	5.8	5.8	5.6	5.8	5.8	5.6	**2027**	**GHG P2**
Drive	6.2	6.2	5.8	6.2	6.2	5.8		
Trailer	4.7	4.7	4.7	4.7	4.7	4.7		

Figure 14: Greenhouse Gas Rolling Resistance Coefficient by Implementation Year

Although the regulations apply only to original equipment manufacturers as they earn credits toward their overall compliance goals by including LRR tires in vehicle specifications, truck buyers still have the option of specifying non-low rolling resistance tires. But truck purchasers recognize the value of LLR tires and now specify them on more than 80% of their vehicles. One consequence of this regulation for the truck buyer may be that manufacturers will encourage buyers to continue to spec low rolling resistance tires even when fuel prices are low and to switch to lower rolling resistance tires as they become available.

Trucks and trailers sold under the GHG rule are required to have a compliance label indicating which, if any, fuel-saving technologies were installed on the truck when it was delivered. Those devices or technologies must remain on the truck for its “useful life,” deemed to be 435,000 miles for Class 8 vehicles, 185,000 miles for Class 6 and 7, 105,000 miles for Class 3-5 and 10 years for trailers. These requirements would prevent a user from switching to non-low rolling resistance tires sometime after the truck or trailer was put into service if it were originally equipped with LRR tires. Truck and trailer dealers are not considered manufacturers and therefore would be required to replace new vehicle tires with the same level tire even if the changeover occurs prior to the delivery to the end-user (customer).

The Truck Trailer Manufacturers Association (TTMA) filed suit against the EPA and NHTSA in December 2016 because trailers are included in GHG Phase 2 rules. TTMA argued that trailers do not have engines and therefore should not be regulated as “motor vehicles” as defined by the Clean Air Act. The EPA, NHTSA and California Air Resources Board (CARB) did not oppose lifting the long-standing temporary suspension which means trailers are not required to meet the regulations, however, the industry recognizes the value of low rolling resistance tires and other components of GHG Phase 2 like aerodynamics.

CARB also adopted GHG Phase 2 trailer standards identical to the EPA GHG trailer standards except that California standards were slated to start with the 2020 model year. In December 2019, CARB announced that it would “suspend its enforcement” of the California GHG trailer standards for a period of at least two calendar years (2020 and 2021). California cited the uncertainty around the litigation and the imminence of the January 2020 effective date as reasons for the suspension. California will continue to administer the California GHG trailer regulation on a voluntary basis. [14]

On September 30, 2020, the U.S. Court of Appeals granted a stay on the implementation of the GHG Phase 2 rules for trailers which may have the effect of suspending the trailer rules indefinitely. [15]

7 Benefits

There are a number of benefits of using low rolling resistance tires on OTR vehicles. Those benefits include reduced fuel consumption, sustainability gains and initial purchase price.

7.1 Benefits of Low Rolling Resistance Dual Tires

Dual tires — those run on a steer axle or fitted into a dual assembly for drive and trailer axles — are generally available from all tire manufacturers in both conventional, non-low rolling and low rolling resistance varieties. (See Figure 15.)

Figure 15: LRR Dual Tires and Wheels

7.1.1 Reduced Fuel Consumption

Although non-LRR tires may be the best choice for certain applications which particularly value long service life, resistance to irregular wear or enhanced traction above fuel economy, LRR tires offer a presumed fuel saving advantage over a similar non-LRR tire. Fleets with a higher percentage of off-road miles tend to prefer non-LRR tires in order to protect the casings from rock damage when operating off-road.

Because direct comparisons between two specific tires can be difficult to make and can be application dependent, an LRR lug-type tire is typically not as efficient as a tire with a rib design, but it may not incur a very large rolling resistance penalty if used at low speeds.

In all cases, current understanding puts the tires' contribution to total truck fuel consumption at roughly 30-33%. The remaining portions can be attributed to internal powertrain component friction, mechanically induced parasitic drag, energy draw from on-board systems such as electrical and HVAC, and aerodynamic drag.

It's important to note that the tires' contribution relative to other types of drag changes with the application and type of equipment as well as with the weight and speed of the truck. At lower speeds aerodynamic losses will not be as great, while tire-related rolling resistance will remain nearly the same, meaning it will assume a larger percentage of the total drag on the vehicle. (See Figure 16.)

Vehicle Speed - MPH	Rolling and Accessory Losses	Aerodynamic Losses
20	72%	28%
40	64%	36%
50	50%	50%
60	38%	38%
65	33%	33%
70	30%	70%

Figure 16: Tire Impact on Fuel Economy
Source: National Research Council of Canada, Centre for Surface Transportation Technology

In the years before aerodynamic trucks became popular, tire rolling resistance accounted for about 15%-20% of total fuel consumption. As truck designs became more aerodynamic, tire rolling resistance, proportionately, grew to more than 30% of fuel used. As aerodynamic refinements continue, and powertrains likewise become more and more efficient, the relative contribution of the rolling resistance of the tires will expand even further.

According to Bridgestone calculations, of the fuel used in moving the vehicle, rolling resistance accounts for about one-quarter to one-third of a truck's fuel consumption. So, if rolling resistance decreases by 10% the result is about a 3% decrease in fuel consumption. (1/4 x 10% =) 2.5% to (1/3 x 10% =) 3%. [16]

7.1.2 SmartWay & CARB Sustainability Benefits

In addition to regulatory compliance, there are some voluntary environmental programs that fleets should be aware of as they are factored into a fleet's sustainability efforts.

7.1.2.1 SmartWay

Unlike the GHG standards, SmartWay is not a regulation but a voluntary program for shippers and carriers. In order to meet SmartWay Tire Verification, tire manufacturers must demonstrate that a tire model has a rolling resistance coefficient at or below the target values (in kg force/metric ton) shown in Figure 17, using SAE J1269 tire rolling resistance test method (with the conditions established in table 3 of SAE J1269) or the ISO 28580 rolling resistance test method. Since tire manufacturers are reluctant to make public rolling resistance values, SmartWay List is the one public list which at least assures that a particular tire model meets a certain rolling resistance threshold. [5]

At last count, there are 828 tires on the SmartWay List. This can make it difficult for the fleet to make a proper decision about which tires to purchase, especially since not all tires on the list offer acceptable performance levels even though they meet the qualifications to be called low rolling resistance tires.

Rolling Resistance Coefficient measured in kg force/metric ton

	Steer	Drive	Trailer
J1269 Application Test Point (1.7 meter drum)	6.6	7.0	5.5
J1269 Test Point 2 (1.7 meter drum)	6.7	6.9	5.5
J1269 5 point average (1.7 meter drum)	6.9	7.0	5.6
ISO 28580 (2 meter drum)	6.5	6.6	5.1

Figure 17: SmartWay Tire Verification Rolling Resistance Coefficient

7.1.2.2 California

In California, under CARB requirements, imposed for trucks, tractors, and trailers — that came into effect in 2013 — certain vehicle configurations must use LRR tires. (See Figure 18.) The rule applies to various model year trucks and is being phased in on a sliding scale. As of mid-2020, the vast majority of long-haul highway trucks operating in that state are required to have LRR tires on both the tractor and the trailer.

	LRR Tires Required	Compliance Deadline	Exempt from LRR Tire Requirement
Tractors (Sleepers and day cabs)			
2011 MY and newer	Yes	1/1/2010	Registered short haul
2010 MY or older	Yes	1/1/2013	
Trailers			
2011 MY and newer	Yes	1/1/2010	Registered storage or pulled by short haul tractor
2010 MY and older	Yes	1/1/2017	

Figure 18: CARB Requirements

7.1.3 Initial Purchase Price

Actual tire pricing is difficult to determine as manufacturers offer preferential pricing to fleets based on fleet sizes, commitment to the brand, and various other concessions. Retail pricing is likely to provide a better model-to-model comparison but will differ greatly from negotiated pricing.

While any fuel-saving technology is often assumed to come with a price premium, a very limited review of tire retail pricing shows that although LLR tires are usually more expensive, the difference is within reason. (See Figure 19.) [17]

Make	Model	Size	Tread	Price	Higher/(lower)
Bridgestone	*M710 Ecopia	295/75R22.5	26/32	$649.75	$26.62
	M726ELA	295/75R22.5	32/32	$623.13	Base
Michelin	*XDA ENERGY+	275/80R22.5	26/32	$549.04	$11.97
	XDN2	275/80R22.5	27/32	$537.07	Base
Yokohama	*TY517MC2	11R22.5	28/32	$379.54	($133.32)
	TY527	11R22.5	32/32	$512.86	Base

*Denotes SmartWay verified model

Figure 19: Tire Pricing Examples
(Source: Speedy Tire) [17]

7.2 Benefits of Wide-Base Tires

One wide-base tire is designed to replace two dual tires. There are a number of benefits of wide-base low rolling resistance tires, including reduced fuel consumption, weight reduction, initial purchase price and reduced maintenance.

7.2.1 Reduced Fuel Consumption

Wide-base tires are widely assumed to be more fuel efficient than low rolling resistance dual tires, meaning they should have a lower rolling resistance coefficient than a pair of tires in a dual assembly. In reality, not all wide-base tires compare favorably to a given dual tire in all product lineups when it comes to fuel economy.

In a comparison of two similar tires, i.e., the same tread pattern and rubber compound, the wide-base tires generally display lower rolling resistance when compared to a dual tire. The difficulty arises when trying to make such a comparison if similar tread patterns and compounds do not exist between two tire models at a given manufacturer. To compare rolling resistance between two dissimilar tires would be to invite an apples-to-oranges comparison.

However, where an appropriate comparison can be made, wide-base tires do often exhibit lower rolling resistance than their dual counterpart, as shown in Figure 20. [4]

	Tire Model	Rolling Resistance Index
Example 1	Michelin X Line Energy D dual	100
	Michelin X One Energy D wide-base	82
Example 2	Michelin XDN2 dual	100
	Michelin X One Line Grip D wide-base	83

Figure 20: Wide-Base vs. Dual Rolling Resistance
(Source: Michelin) [4]

On other manufacturer's websites where fuel efficiency or rolling resistance calculators exist, dual tires can be found that outperform wide-base tires when fuel efficiency or rolling resistance is expressed as a percentage of improvement in fuel saved over a number of miles as shown in Figure 21. [9]

	Tire Model	Fuel Economy
Example 1	Goodyear Endurance LHD	Base
	Fuel Max SSD wide-base	18% Better
Example 2	Fuel Max LHD G505D	Base
	Fuel Max SSD wide-base	3% Better
Example 3	G392A Duraseal+Fuel Max	Base
	Fuel Max SSD wide-base	6% Better
Example 4	G572 1AD Fuel Max	Base
	Fuel Max SSD wide-base	13% Better

Figure 21: Wide-Base vs. Dual Fuel Economy Delta
(Source: Goodyear Truck Tires) [9]

In several comparisons across brands and models, relying on nothing more than model designations, the study team found many examples where a dual tire outperformed a wide-base tire. It is important to note, however, no attempt was made to compare similar tires. Comparisons were with leading examples of a given manufacturer's tires against a competitive model. Again, tire decisions are made on the total cost of ownership when investigating fuel efficiency, tread life, traction and retreadability.

Fleets reported that as wide-base tires entered the market, they had a significantly better fuel performance than the best of the dual tires. But, in recent years, new improved low rolling resistance dual tires have become available that have decreased this gap. Therefore, the fuel economy of today's LRR duals are now closer in fuel economy to wide-base tires than their predecessors.

7.2.2 Weight Reduction

There is no disputing the fact that specifying wide-base tires and wheels will reduce vehicle tare weight. Depending on the baseline weight of your tires and wheels, savings could be in the range of 800 lbs. to 1,400 lbs. Lighter equipment typically gets better fuel mileage, not to mention increased payload capacity. It is estimated by the Aluminum Association's Aluminum Transportation Group that a 1% weight reduction can reduce fuel consumption by about 1%. The EPA estimates that a 3,000-lb. weight reduction could save about 240 gallons of fuel per year — or about 1.3%. A previous NACFE Confidence Report covering 6x2 drive axle configurations places the fuel savings resulting from a 1,000 lb. weight reduction at about 0.8%.

While 1% is a relatively minor saving in and of itself, the lower vehicle tare weight makes higher payloads possible in some weight sensitive applications. This can produce a greater cumulative reduction in fuel consumption, thanks to the fewer trips required to deliver a given amount of product. For example, if a fuel hauler could haul an additional 1,000 lbs. of product, it would be the equivalent of an additional full load of product over 50 trips.

Figure 22 illustrates the weight-savings potential from a sample of tire makes and models. [16, 18, 19]

Make	Model	Size	Load Range	Tread	Weight
Bridgestone	M713 Ecopia	11R22.5	G	24/32	120
	M726ELA	11R22.5	G	32/32	133
	Greatec M835A (WB)	445/50R22.5	L	23/32	173
Goodyear	Marathon LHD	11R22.5	G	24/32	121
	Endurance LHD	11R22.5	G	18/32	113
	Fuel Max SSD (WB)	445/50R22.5	L	24/32	190
Michelin	XDN2	11R22.5	G	27/32	133
	Energy D	11R22.5	G	23/32	132
	X One Line Energy D (WB)	445/50R22.5	L	24/32	179

Figure 22: Tire Weight Examples
(Source: 2020 Manufacturer Tire Manufacturers' Data Books) [16, 18, 19]

Potential weight saving scenarios for tractor trailer combination as shown in Figures 23 and 24: [20, 21]

- Switching from dual tires on steel wheels to wide-base tires on aluminum wheels will save 1,284 lbs.
- Switching from dual tires on aluminum wheels to wide-base tires on aluminum wheels will save 768 lbs.
- Switching from dual tires on steel wheels to wide-base tires on steel wheels will save 627 lbs.

Wheel Weights in Pounds		
Wheel Dimensions	**Aluminum - Alcoa**	**Steel - Acurride**
22.5 x 8.25 (dual)	39	65
22.5 x 14 (WBS)	52	127

Figure 23: Wheel Weight Examples
(Source: Alcoa and Accuride) [20,21]

Wheel Material	Style	Tire Average Weight (lbs.)	Wheel Average Weight (lbs.)	Total Average Weight (lbs.)	Savings Wide-Base vs Dual	Savings Wide-Base Al vs Dual Fe
Steel	Dual	2304	1170	3088	627	1284
	Wide-Base	1701	1146	2472		
Aluminum	Dual	2256	702	2629	768	
	Wide-Base	1696	494	1861		

Figure 24: Possible Transition Examples for Tractor-Trailer Combinations

Note: Savings include changing front axle wheels and tires to the same material as the tandems NS includes the trailer.

7.2.3 Initial Purchase Price

When purchasing new equipment, the price differential between a truck spec'd with wide-base tires and one spec'd with dual tires is negligible. Pricing will vary with OEM tire availability and preferred pricing arrangements. And as with retail pricing, premium tires command higher prices than Tier 2 or Tier 3 tires. This applies to dual as well as wide-base tires.

There are additional costs associated with a mid-life transition from dual tires to wide-base tires. These costs are related to axle and hub modifications, but they are a one-time cost.

Regarding the tires themselves, just as for dual tires, actual tire pricing is difficult to determine, as manufactures offer preferential pricing to fleets of different sizes, commitment to the brand, and various other concessions. Retail pricing is likely to provide a better model-to-model comparison but will differ greatly from negotiated pricing.

OEM tire pricing can vary considerably as well, especially where a captive tire brand is offered at preferred pricing. Switching away from the house brand can add cost that might not be reflected in a similar retail brand-to-brand comparison.

Still, the study team's sampling of retail pricing revealed that individual wide-base tires generally were close to double the price of similar individual dual tires within the same brand — meaning that fitting a given wheel hub with one wide-base tire would cost the same as fitting it with a pair of duals. There were notable exceptions in a few cases, where what is perceived as a manufacturer's top-of-the-line dual tire was priced at more than half of the price of a single wide-base tire, meaning a pair of the duals would be more expensive.

A review of retail pricing at one nationwide retailer (Figure 25) similarly, found that in most cases wide-base tires are very close to double the price of a comparable pair of dual tires. [17]

Make	Model	Size	Price	Higher/(Lower)
Michelin	X LINE ENERGY T	11R22.5	$502.03	$44.38
	X LINE ENERGY T	275/80R22.5	$491.45	$23.22
	X One Line Energy T	445/50R22.5	$959.68	Base
Bridgestone	M713 ECOPIA	11R22.5	$681.89	($5.04)
	M726ELA	11R22.5	$623.13	($122.56)
	GREATEC M835	445/50R22.5	$1,368.82	Base
Goodyear	FUEL MAX RTD	11R22.5	$642.17	$51.24
	G316 LHT Fuel Max	295/75R22.5	$508.46	($216.18)
	Fuel Max SSD	445/50R22.5	$1,233.10	Base

Figure 25: August 2020 Retail Tire Pricing Examples
(Source: Speedy Tire) [17]

The original study team's 2014 survey found that more than half of responding fleets (58.3%) cited concerns over the initial tire and wheel purchase price as a reason for deciding not to test wide-base tires.

When it comes to wheel pricing at the retail level, the study team for this Confidence Report found that the purchase price of two dual aluminum wheels is consistently higher than the cost of one wide-base wheel. Prices can vary slightly from brand to brand probably because of core competency. (See Figure 26.) This holds true even in 2020. [22]

Make and type	Material	Finish	Size	Price	Higher/(Lower)
Alcoa 10 x 285mm Hub Pilot	Aluminum	Polished	22.5 x 8.25	$249.00	$39.00
	Aluminum	Polished	22.5 x 14	$459.00	Base
Accuride 10 x 285mm Hub Pilot	Steel	Painted	22.5 x 8.25	$269.00	$144.00
	Steel	Painted	22.5 x 14	$394.00	Base
	Aluminum	Polished	22.5 x 8.25	$299.75	$174.50
	Aluminum	Polished	22.5 x 14	$425.00	Base

Figure 26: August 2020 Retail Wheel Pricing Examples
(Source: buytruckwheels.com) [22]

7.2.4 Reduced Maintenance

None of the fleets surveyed for this Confidence Report detailed any maintenance problems related to the use of wide-base tires compared with dual tires; it is believed that wide-base tires do not impose an additional maintenance burden on fleets. In fact, it was noted by several respondents that wide-base tires can reduce the overall maintenance workload simply because there are fewer of them to service. Specifically, fleets said the time it takes to conduct routine yard surveys and pressure and condition checks reporting is reduced significantly. Additionally, several fleets cited reduced inventory carrying and record keeping requirements as net benefits to the wide-bases tires.

There are no reported maintenance practices unique to wide-base tires that would add cost, except perhaps for handling equipment designed exclusively for wide-bases, such as warehouse racking, storage bins or dollies designed to facilitate easier handling of the heavier tire and wheel assemblies.

Wide-base tires eliminate the need to match tire heights and diameters, as is the case with dual tires. How many fleets pay great attention to this aspect of tire and wheel installation is unknown, but tire manufactures say that a difference in excess of 1/4” in height can put more load on the taller tire and have negative effects on tire life.

On the operational front, several fleet respondents noted an intriguing fact; they experienced fewer roadside service calls related to maintenance (i.e., pressure related failures, as opposed to road hazard related failures). The exact number of wide-base tire failures compared to dual tire failures was not shared with the study team. But for a large fleet to notice a decline in the number of service calls after installing wide-base tires is compelling supporting evidence of the claim.

The reason for the decline is unclear, but several respondents put it down to increased vigilance on the drivers' part. It has been suggested that drivers, knowing they no longer have the opportunity to "limp in" on a single tire, are paying greater attention to the condition and pressure of their tires.

Most purveyors of tire pressure monitoring and inflation systems suggest that payback on their systems can be realized if they prevent just two blowouts and their related service costs. Preventing blowouts is particularly important for wide-base tires, because of the loss of limping capability and the threat that the replacement tire of choice might not be available at all service locations. (Tire companies generally dispute this, but lack of availability is cited by many respondents as a major concern when considering switching from dual to wide-base tires.)

The study team also received several survey responses suggesting that wide-base tires reduce brake service costs and offer longer reline intervals. (See Figure 27.) This is likely related to the position of the brake drum relative to the wheel — the drum is almost entirely covered by the wheel in a dual arrangements, while the outboard mounting position of the wide-base wheel means that more of the brake drum is exposed to the air stream, thus allowing brakes to run cooler and ultimately longer. Note that no documentation was offered to support this claim.

Figure 27: Wide-Base Brake Drum
(Source: Jim Park)

Anecdotally, wide-base tires do appear to be more susceptible to inner shoulder wear. Bearings play an important role in tire life. Fleets that pay careful attention to bearing adjustment when reinstalling wheels claim they reduce inner-shoulder wear on wide-base tires. Duals also are susceptible to inner shoulder wear related to loose bearings, which can cause a negative camber condition. Proper bearing adjustment is highly recommended as a means of extending tire life.

Many instances of bearing failures were noted about 10 years ago, and at the time were thought to be related to increased load on the outboard bearing on axles with wide-base tires. Extensive investigation by axle and bearing manufacturers concluded that offset wheels (commonly 2" of offset), may have been partially responsible for the increased load on the outboard bearings in axles with tapered axle spindles. On a tapered axle, the outboard bearing is physically smaller than the inboard bearing. Offset wheels were mainly used in order to enable the retrofitting of dual wheels at some point, usually at resale.

To reduce these instances of bearing failure, the axle and bearing makers now recommend using parallel spindles rather than tapered spindles on axles fitted with wide-base tires, as well as using 1" or zero-offset wheels to reduce the cantilever load on the outer bearing.

8 Challenges

While there are many benefits to low rolling resistance tires, like any technology, there are also challenges.

8.1 Challenges of Low Rolling Resistance Dual Tires

The challenges of rolling resistance dual tires include irregular/premature tread wear and life-cycle cost vs. initial purchase price.

8.1.1 Irregular/Premature Tread Wear

One of the primary characteristics of LRR tires is a thinner tread. Because of the shallower tread, 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. At least one leading tire manufacturer shared information with the study team indicating that tread life now meets or even exceeds that of its non-LRR tires. It can safely be said that tire design will continue to evolve presumably extending tire life even further. Still, proving the cost case for lost tire life is easier said than done and requires diligent record keeping — a capacity many fleets still lack. Measuring is made even more difficult by the fact that tire life is inextricably linked to many other complicating factors, such as maintenance, application, driver habits, vehicle speed, etc.

Despite these difficulties, the findings of the original study team's 2014 fleet survey suggest that fleets are willing to give up some mileage if the cost of the lost miles can be made up in fuel savings. Acceptance of LRR tires appears to be high, with 56.8% of respondents indicating they currently use the tires, with an additional 4.5% currently testing them. Conversely, 31.8% said they do not use LRR duals, while only 6.8% of respondents said they had tested or were using LRR tires but planned to discontinue their use going forward.

Interestingly, of the fleets the original study team surveyed that are using LRR tires, the level of satisfaction with the non-fuel performance metrics was high. Slightly more than 68% of respondents said they were very or somewhat satisfied with tread life, while 13.6% had a neutral position on the matter. Almost 64% indicated they were somewhat or very satisfied with traction; 13.6% were neutral, while the same number said they were somewhat dissatisfied.

From these results it can be inferred that LRR tires are meeting expectations more often than not, and by a good margin.

In the original 2014 survey, the fleets that responded they were not using LRR tires cited several reasons why they were not using LRR tires. Those reasons included:

- 28.6% said they were skeptical of the fuel savings
- 21.4% said purchase price was a factor
- 28.6% cited lack of awareness of product availability

- 14.3% named traction concerns as a reason for not adopting LRR tires, but it is not known in which part of the country these fleets were operating. Northern climates have more challenges with slick surfaces.

Data from the *NACFE 2019 Annual Fleet Fuel Study* shows the adoption rate for LLR tires has increased dramatically (more than 80%) for tractors and trailers, indicating the concerns expressed in the initial study have diminished significantly. [2]

8.1.2 Life Cycle Cost vs. Initial Purchase Price

The study team has included cost as a challenge as well as a benefit because there are concerns surrounding cost, particularly as it relates to life cycle cost. The value proposition of an LRR dual tire lies in the fuel savings. But confidence around those fuel savings is often hard to determine. Several fleets responding to the study team's 2014 survey indicated they lacked the resources to conduct fuel economy tests on new tires. Others expressed a need for some impartial test data that would help quantify potential fuel savings (specific fleet factors notwithstanding).

Fleets responding to the study team's 2014 questions around the upfront purchase price suggested they expect to pay a premium of about 10% for an LRR dual tire. The study team's limited review of retail pricing did not come to the same conclusion, and in 2020 the cost for LLR tires usually is less than just a few percent more or even less than non-LLR tires. There may be issues yet to be explored surrounding tire pricing, and possibly a need to make it more transparent. Paying an additional 10% for a tire that is expected to run fewer miles-to-removal does not make a good adoption case unless fuel savings can be factored into the equation. And as noted earlier, that exercise can be notoriously difficult to perform accurately. More recent anecdotal conversations with fleet managers indicate that there has been no change in the replacement mileage and in fact it may have improved.

8.2 Challenges of Wide-Base Tires

The challenges of wide-base tires include irregular/premature tread wear, availability, increased cost of on-road breakdowns, decrease in residual/resale value, ability to retread, and driver acceptance

8.2.1 Irregular/Premature Tread Wear

The tire wear on wide-base tires is a perennial concern among fleets. Data from the study team's survey for the 2014 version of this Confidence Report revealed that very few of the fleet respondents had experienced worse-than-anticipated tire wear. In fact, of fleets using wide-base tires that responded to the question "how satisfied or unsatisfied have you been with tread life," more than 68% said they were either very satisfied (31.8%) or somewhat satisfied (36.4%) with tread life (22 fleets responding).

In a fleet survey conducted by the American Trucking Association's Technology & Maintenance Council released in February 2015, responses indicated wide-base tires actually outlasted dual tires in most wheel positions, and sometimes by quite a margin. The survey showed that in single drive-axle applications, wide-base tires ran to 192,857 (weighted average) miles, while LRR dual tires were pulled at 155,882 miles. On tandem drive axles, the wide-base tires went 218,750 miles before being removed, while the dual tires ran 212,500 miles. At trailer positions, the split was even closer, 169,828 for dual tires versus 166,667 for wide-base tires. Trailers are harder to compare tire-to-tire because maintenance practices vary so widely.

The vast majority of the 51 fleets that responded to the TMC survey were line haul and regional operators running Class 7-8 vehicles. Of the responding fleets, 43% had 100-499 power units while 41% had 500 or more power units.

Tires removed from service with little or no irregular wear can be said to have lived a normal productive life. Fleets that the study team interviewed indicate that even-wearing wide-base tires can last from 200,000 miles to over 300,000 miles in a drive position.

The difficulty in quantifying tread life or the tire's susceptibility to irregular wear lies in determining the root cause of the wear. Irregular wear almost always results from some external factor, such as an alignment or balance problem, or some other mechanical issue. Therefore, it's difficult to isolate the cause of the premature removal without knowing something about the mechanical condition of the truck, its maintenance history, and the application in which the tire is operated.

Additionally, since tires begin life with varying tread depths, it is reasonable to assume that tires with thinner treads will come off sooner, making miles-per-32nd-inch of rubber the most accurate metric for determining good or bad tire life. However, various tire manufacturers use different rubber compounds — often weighted toward either traction or long life — which can react differently in distinct applications or even exposure to certain types of pavement (concrete vs. asphalt).

The data that the study team collected on tread wear did not reveal any of the above factors or conditions, making it difficult to come to firm conclusions about which type of tire is likely to last the longest, in wide-base or dual configuration.

There is, however, anecdotal evidence that suggests some wide-base tires are less tolerant of certain maintenance shortcomings, such as bearing adjustment and inflation pressure. This would be difficult to prove in a field study because it would be natural to assume that as problems are detected they would be rectified — saving the tire but spoiling the data.

8.2.2 Availability

Product availability was a genuine concern in the early days of wide-base tires, but it now seems to be resolved. It remains a commonly expressed concern among non-users, but fleets that currently use or have used wide-base tires for several years do not share this concern. There have been reports of difficulty in obtaining specific tires, particularly newer models, but this can be said of dual tires as well.

According to recent discussions that the study team had with tire manufacturers and dealers, more than 90% of tire dealers now stock at least the more popular models of wide-base tires.

When asked specifically about their experience with replacement tire availability, respondents to the study team's survey were very positive. More than 66% of respondents said they were either very or somewhat satisfied with the availability of wide-base tires nationwide. Only 19% said there were somewhat unsatisfied. None reported being very unsatisfied.

8.2.3 Increased Cost of On-Road Breakdown

Since the labor and service charges connected to a tire failure road call are roughly the same for wide-base or dual tires, this challenge is not necessarily connected to tire cost but more connected to the increased likelihood of wheel damage. Fleets have indicated typical wheel cost for an on-road purchase can range between $400 and $600 (compared to $250 to $275 retail). If a wide-base tire is operated underinflated or flat, wheel damage may be more likely, as there is no companion tire to hold the wheel off the pavement.

When fleets running wide-base tires were questioned about on-road wheel damage, respondents indicated very few instances connected to tire failure where new wheels had to be purchased. The study team’s survey indicated 38% of respondents were either very or somewhat satisfied with wheel damage issues. An additional 38% reported being neither satisfied nor unsatisfied. Fewer than 24% said they were somewhat or very unsatisfied with the likelihood of wheel damage — likely this group of respondents had previously experienced some wheel damage.

Given that a wheel replacement would be an incremental cost not associated with tires in dual assemblies, fleets should watch this metric carefully, as at some point the cost of the wheels would wipe out any fuel savings associated with wide-base tires for that specific truck (but would likely not be greater than the fuel savings fleet-wide). If a fleet were experiencing an inordinate number of on-road failures, the cause of those failures would need to be determined. If they were deemed to be inflation related, a change to the fleet's maintenance practices should resolve the problem.

8.2.4 Residual/Resale Decrease

Another challenge to the adoption of wide-base tires is that secondary markets in some regions see wide-base tires as a negative when considering trade-in value. When fleets using wide-base tires were queried by the study team, their responses were mixed regarding resale value. Several fleets that concurred that this is a challenge, said that it is necessary to change the tires and wheels back to duals upon retirement of equipment. Only 14.3% of respondents were very satisfied with the residual values of trucks and trailers equipped with wide-base tires, while 23.8% were very or somewhat unsatisfied. However, the majority (61.9%) claimed they were neither satisfied nor unsatisfied, suggesting that wide-base tires do not in fact generally have an impact on anticipated residual values.

Several truck dealerships that the study team spoke with indicated that they preferred trade-ins to have dual tires as they seemed to sell better.

Conversations in 2020 with used truck professionals from the Used Truck Association indicate there continues to be a deduction of approximately $3,000 for trucks traded with wide-base tandems. Used truck dealers with both duals and wide-base tires find the duals are preferred and often replace wide-base singles with duals to make the trucks more marketable rather than take the loss. Customers trading are suggested to do the same.

8.2.5 Ability to Retread

Retreading can dramatically lower a tire's life cycle cost. Typically, a well-maintained long-haul dual tire will be retreaded twice, or perhaps three times over the course of its life if a fleet has a regional or local operation in which to run the tire out. Fleets using wide-base tires told the study team that generally wide-base tires are retreaded only once and then scrapped.

Of the respondents to the study team's 2014 survey, only 14.3% expressed dissatisfaction with the ability to retread wide-base tires. Fully 52.3% said they were satisfied with retreadability, and 33.3% were neutral on the question.

The brand of tire to be retreaded seems to be significant. Several fleets told us they had better experiences retreading one manufacturer's wide-base tires, claiming the reason lay in the design of the casing, something which (for patent reasons) other manufacturers have not yet managed to replicate.

The study team for this Confidence Report spoke with a major regional retreader that said in the early years of wide-base tires, there were issues with the retreading process and the machines. He went on to say that these issues have largely been resolved, but stressed that he has better success retreading certain brands of wide-base tires than others. Furthermore, he said that a second retread is possible with good casings, provided the customer is prepared to limit the exposure of the tire to lighter service, such as regional or local operation.

Like dual tires, wide-base tires are subject to several inspections prior to retreading, including checking for previous repairs, ensuring they were done properly, that the number of repairs doesn't exceed allowable limits and there is no evidence the tire had been run underinflated.

The three major tire manufacturers interviewed by the study team for this Confidence Report all agreed that limited retreadability was perceived as a barrier to the adoption of wide-base tires.

8.2.6 Driver Acceptance and Familiarity

Driver acceptance is an important consideration for the adoption of any technology. While only 14.2% of the fleets surveyed by the study team in 2014 said that driver acceptance was a real challenge to introducing wide-base tires, 61.8% indicated that their drivers were happy with them. So, while many tire manufacturers still are quick to acknowledge that driver acceptance is a barrier to adoption, the survey results indicate that acceptance has not been a problem in practice.

The most commonly expressed driver concerns about wide-base tires surround traction and stability. Curiously, both are subjective values in the real world. Many drivers express concerns about traction with dual LRR tires as well. Clearly there's something about the thin tread, ribbed, closed shoulder designs seen on both LRR duals and wide-base tires that worry drivers. Specifically, for wide-base tires, drivers express concerns about roadside service and the time involved in getting the tires serviced. As previously noted, those concerns are mostly hearsay, but the impression among drivers remains. In reality, availability isn't a concern for wide-base tires any longer and limping in on a dual tire is illegal. Driver concerns can be addressed with training and education, as well as actual experience driving trucks equipped with wide-base tires.

9 Best Practices

Today's new generation of low rolling resistance tires require no new or additional maintenance, however proper and diligent maintenance has proven to be critical to the life and performance of these tires. Wide-base tires are included in that statement, with the proviso that poor maintenance is even more likely to reduce tire life and performance than might be the case with dual tires.

The premature pulling of a tire is usually accompanied by much cursing and carrying on, with epithets hurled in the general direction of the tire maker. The truth, however, is that premature tire wear often is merely the symptom of some other problem, such as bad alignment, poor balance, loose wheel bearings, failed shock absorbers, etc. Simply replacing a prematurely worn tire with a new tire without rectifying the problem consigns that second tire to the same early grave as the first.

Moreover, any condition that causes irregular tire wear also is hurting fuel economy. Fuel must be burned to produce the energy needed to carve those cups or wavy lines into a truck’s tires.

The list of mechanical tire killers is a long one. Fortunately, dying tires usually exhibit telltale signs of what's killing them. One of the best resources for tracking down mechanical faults via the tire's wear signature is TMC’s *Radial Tire Conditions Analysis Guide*. Every shop should have a copy. [23]

The most common faults with tractor and trailer maintenance are as follows:

- **Alignment:** Improper alignment not only chews rubber off of a tire, it hurts fuel economy in the process. Some studies have concluded that serious misalignment can decrease fuel mileage on a tractor-trailer by 2% or more. Many leading fleets conduct regular alignment checks on tractors, but trailers often are overlooked or done only after a tire wear issue has been identified. In many cases it's too late for that trailer tire by then, as it is difficult to change irregular wear once it starts. Keeping both the tractor and the trailer in alignment will help support the reduction of two of the highest costs of any fleet — tires and fuel.

- **Balance:** For some time, wheel balance has only been used in an attempt to correct wheel vibration and to address driver ride complaints. Recent studies, however, have shown a direct connection between wheel balance and tire wear — there was even a study done at an accredited testing facility that linked balanced tires to a slight increase in fuel economy. Any evenly worn tire will have less rolling resistance than a tire with irregular tread wear, and any reduction in rolling resistance typically improves fuel mileage.

- **Mounting and Wheel-end Issues:** Non-concentric tire mounting is not uncommon, especially when insufficient or improper bead lubricant is used. Tire technicians should be trained or reminded of proper tire mounting practices, and mounts should be checked using at least the mounting ring embossed in the tire sidewall, though a runout gauge would be preferable. Loose wheel bearings are another source of out-of-round running conditions, though usually lateral (side-to-side) rather than radial (up-and-down), in the case of non-concentric mounting. Bearings should be installed properly and checked with a runout gauge.

- **Tire Inflation:** All of the tire manufacturers the study team interviewed for this report said correct tire inflation pressure is the most important element of a tire maintenance program.

  Underinflation increases irregular tread wear and can damage the casing, as it is not the tire that supports the load but the air inside the tire. Without enough air to support the load, the tire is in an overloaded condition, which causes excessive flexing of the sidewall and the tread area. That flexing generates heat which can damage the rubber compounds in the tread, the under-tread area and the inner liner. Additionally, the flexing of the sidewall weakens the steel cord within the sidewall, which can lead to zipper ruptures or the outright destruction of the tire. (Blowouts remain the leading cause of on-road tire replacements and service calls.)
  A lesser consequence to underinflation is uneven tread wear, which can lead to premature removal of the tire, and degradation in fuel mileage.

  According to the U.S. Department of Energy, there's a direct link between underinflation and reduced fuel mileage. While exact numbers vary with the application, tests have shown that a reduction of just 10 psi from a tire's recommended air pressure can decrease fuel mileage by about 1%. Simply put, softer tires require more energy to roll along the pavement due to the flexing of the casing and the tread. The energy needed to overcome that reluctance to roll comes from the truck's fuel tank.

- **Matching Duals:** For dual assemblies, maintaining correct and equal inflation pressure helps ensure the tires' diameters are matched. Mismatched dual tires can impact both tire longevity and fuel mileage. Tests have shown that a mismatch in the height of a tire of as little as 1/4" causes the shorter of the two tries to drag the equivalent of about 13' for every mile traveled — or about 246 miles per 100,000 miles traveled. That obviously shortens the usable life of the tire, not to mention increases rolling resistance, thereby reducing fuel economy. [24]

  These recommendations are the same as dozens of other tire recommendations that have been written over the years. That's because basic tire maintenance does not have to change to accommodate LRR or wide-base tires. It should be noted here that some LRR tires and even some wide-base tires are more susceptible to certain wear-causing conditions. If anything, fleets need to be more vigilant with the more expensive fuel-efficient tires if they want to get the best return on their investment.

10 Decision Making Tools

NACFE developed several tools including a Confidence Matrix, decision guide and payback calculator to assist fleets in evaluating low rolling resistance tires.

10.1 Confidence Rating

For each of the Confidence Reports completed by NACFE, the various technologies assessed therein are plotted on a matrix in terms of the expected payback in years compared to the confidence the study team has in the available data on that technology — that is, not only how quickly fleets should enjoy payback on their investment but how certain NACFE is in the assessment of that payback time. Technologies in the top right of the matrix have a short payback, usually thanks to their low upfront cost, and moreover are found to have high confidence in those short payback times, usually because the technology is more mature or otherwise has a more substantial track record.

The matrix shown in Figure 28 summarizes the findings of the desk research, interviews, and surveys conducted for this Confidence Report by indicating how confident the NACFE study team is in the investment case for low rolling resistance tires.

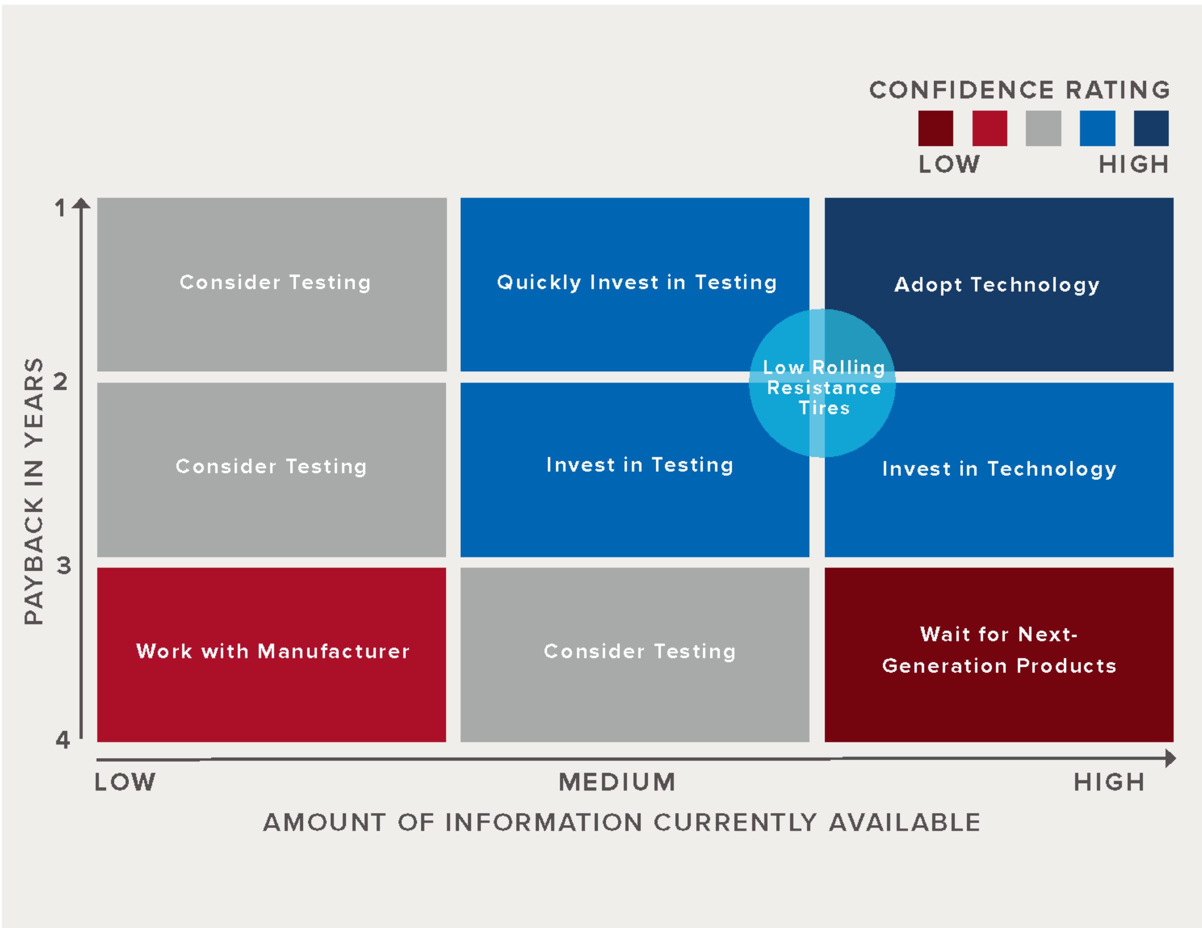


Figure 28: Confidence Matrix for LRR Duals and Wide-Base Tires

This Confidence Rating indicates that NACFE is highly confident that low rolling resistance tires, in both dual and wide-base configuration, are proven to save on fuel costs, and have a good case for adoption.

10.2 Decision Guide

The study team has developed the decision guide entitled *Recommendations and Tools For Fleets* to assist fleets in making choices on low rolling resistance and wide-base tires, by defining a starting point for fleets. (See Figure 29.)

RECOMMENDATIONS AND TOOLS FOR FLEETS

THE FOLLOWING DECISION GUIDE SUMMARIZES THE RECOMMENDATIONS OF THE CONFIDENCE REPORT, AND SERVES TO ASSIST FLEETS IN MAKING CHOICES ON ROLLING RESISTANCE AND TIRE CONFIGURATION:

DESCRIPTION OF THE FLEET AT PRESENT	SUGGESTED FLEET ACTION	
	OVER THE SHORT TERM:	OVER THE LONG TERM:
Does not purchase SmartWay verified LRR tires and does not consider a tire's impact on fuel consumption.	Spec SmartWay verified LRR dual tires from a trusted brand.	Test several SmartWay verified LRR dual tires to find the one with minimal trade-offs for your fleet.
Only purchases and wants to stay with SmartWay verified LRR dual tires, but does not know if there is a difference between any of the listed tires.	Ask your tire representative or distributor for more information on super LRR SmartWay verified tires with even lower rolling resistance.	Test one or several super LRR SmartWay verified tires to see if they lower your fleet's fuel costs further.
Purchases wide-base tires for their weight savings.	Ask your tire representative or distributor for information about his or her lowest rolling resistance wide-base tire.	Test one or several super LRR SmartWay verified wide-base tires to see if they lower your fleet's fuel.
Purchases super LRR SmartWay verified dual tires, and has the resources to test wide-base tires.	Investigate the impact of wide-base tires on your fleet, taking into consideration the challenges listed in this report.	Spec some of your next vehicles with wide-base tires to test their impact on your fleet's costs.
Purchases super LRR SmartWay verified wide-base tires but is not satisfied with their performance or impact on residual value.	Make sure the tires are maintained as well as possible and issues are well supported with data.	Test some of the newest super LRR SmartWay verified dual tires to see if they can exceed the performance of the wide-base tires.
Purchases super LRR SmartWay verified wide-base tires and is satisfied with their performance.	Continue to stay up to date with the latest tire technology.	Continue to test the newest tires of all types with the lowest rolling resistance, to achieve the greatest fuel efficiency.

Figure 29: Decision Guide – Recommendations and Tools for Fleets

10.3 Total Cost of Ownership Calculator

An MS Excel-based "total cost of ownership" tool has been developed and is available at the NACFE website. Users may input various operational features such as the axle configuration of their tractor and trailer and associated miles driven as well as tire-specific data for the steer, drive, and trailer tires that are under consideration. The tool then calculates the total cost of ownership impact of various user supplied alternatives. Figures 30 and 31 provide two example results from this model; one moving from high rolling resistance tires to very low and another from low rolling resistance tires to even lower ones.

Truck Information	Truck	6x4
	Trailer	4x0
	Annual Miles	120,000
	Cost of Fuel	$2.60
	Labor cost to Replace Tire	$50
	Gross Vehicle Weight (lbs)	80,000

	Current Tires		**Best Tire Combination**		**Fuel $/mi** Better/(Worse)	**Repl. $/mi** Better/(Worse)	**Total $/mi** Better/(Worse)
Steer	*Michelin*	*XZA2 Energy*	**Michelin**	**XZA2 Energy**	**0.000**	**0.000**	**0.000**
Drive	*Michelin*	*XDA5+*	**Michelin**	**XZA2 Energy**	**0.027**	**(0.003)**	**0.024**
Trailer	*Michelin*	*X Line Multi Energy Z*	**Michelin**	**XZA2 Energy**	**0.009**	**(0.003)**	**0.005**
Total					**0.036**	**(0.006)**	**0.029**
					Annual Savings per Truck	**$**	**3,510**

Figure 30: TCO Model Example 1

Truck Information	Truck	6x4
	Trailer	4x0
	Annual Miles	120,000
	Cost of Fuel	$2.60
	Labor cost to Replace Tire	$50
	Gross Vehicle Weight (lbs)	80,000

	Current Tires		**Best Tire Combination**		**Fuel $/mi** Better/(Worse)	**Repl. $/mi** Better/(Worse)	**Total $/mi** Better/(Worse)
Steer	*Michelin*	*X Line Multi Energy Z*	**Michelin**	**XZA2 Energy**	**0.004**	**(0.001)**	**0.002**
Drive	*Michelin*	*X Line Multi Energy Z*	**Michelin**	**XZA2 Energy**	**0.010**	**(0.003)**	**0.006**
Trailer	*Michelin*	*X Line Multi Energy Z*	**Michelin**	**XZA2 Energy**	**0.009**	**(0.003)**	**0.005**
Total					**0.022**	**(0.008)**	**0.014**
					Annual Savings per Truck	**$**	**1,683**

Figure 31: TCO Model Example 2

11 Study Conclusions

As the study team completed this Confidence Report, some high-level findings emerged that are shared here in order to help educate and accelerate the adoption of low rolling resistance duals and wide-base tires among Class 8 over-the-road tractor-trailers.

- Low rolling resistance tires, whether in a dual or a wide-base configuration, save significant fuel:
  - When compared to tires that are not designed for low rolling resistance, LRR tires help the vehicle use less fuel. The amount of fuel saved is directly related to the rolling resistance coefficient — the lower the coefficient the higher the fuel efficiency of the tractor and trailer.
  - Ever greater reductions in rolling resistance are being developed, helping deliver even higher fuel savings with fewer trade-offs in traction and tread life.
- The purchase price of LRR tires may be higher than non-LRR tires, but these costs can be overcome through fuel savings when considering life cycle cost:
  - Traditionally, tire cost-per-mile is defined solely in terms of the initial purchase cost and tire replacement, which may be more frequent than for non-LRR tires. But to account for the fuel

savings, this report strongly suggests that fleets use a total life cycle cost of ownership to make tire decisions.
    - As tire manufacturers create better LRR tires with advanced material compounds and innovative tire designs, LRR tires actually will wear longer than non-LRR tires, further reducing one element of the total cost of ownership for LRR tires.
- Adoption of LRR tires in the over-the-road trucking is high and will continue to increase:
    - Purchases of LRR tires will continue to grow, and as even lower, “super” low rolling resistance tires are developed, their demand and adoption will grow as well.
- The perception of traction issues or driver acceptance problems is worse than the reality:
    - For general over-the-road goods movement, these LRR tires are performing well in terms of traction and driver acceptance.
    - Traction for LRR tires may not be acceptable in certain applications, and as tread wears, traction will be further reduced, but this is true for any tire.
- The MPG gap between the lowest LRR dual tires and the best wide-base tires continues to narrow:
    - Tire companies continue to develop tires in pursuit of lower life cycle cost and improved traction. Recent innovations have improved the fuel efficiency of duals to the point where dual tires may have a lower total cost of ownership than wide-base tires, considering wear, replacement cost and fuel cost.

12 Recommendations

The study team developed the following recommendations for fleets to follow:

- Fleets should understand the total life cycle cost for tires in their specific operation, including the up-front purchase price, weight, wear, retreadability, etc.
- Fleets should use the lowest rolling resistance tires for their specific needs from a trusted manufacturer. Tires on the *SmartWay Verified List of Low Rolling Resistance New and Retread Tire Technologies* meet only a specific rolling resistance threshold and can encompass a wide range of quality, fuel efficiency and service life.
- Tire manufacturers should continue to develop even lower LRR tires while continuing to lessen the tradeoffs in traction and tread life.
- Tire manufacturers should work to agree on a testing protocol, with the goal of making C_{RR} data widely available to tire purchasers.
- Tire manufacturers should publicly share the rolling resistance coefficient (along with wearability and wet traction) for all their tires once industry-wide collaboration and agreement on a standard testing protocol is achieved.
- Tractor and trailer makers and their dealers, industry associations, EPA SmartWay, TMC, NACFE and others can better assist fleets in these decisions by making data more accessible to tire purchasers.
- EPA SmartWay should develop tiers of rolling resistance tire categories to encourage early adopters to utilize the best tires for their needs.

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14 Appendix – Case Study: Wide-Base Tire Adoption

Adoption stories provide interesting insight into a technology and are one source of information for NACFE’s Confidence Reports. The following is one such adoption case study that includes many of the challenges, benefits and best practices discussed in this report.

14.1 Fleet Description

- Private fleet attached to a manufacturing and distribution operation
- Four distribution/maintenance centers, several smaller satellite terminals
- Lower 48-state operation, some exposure in western Canada
- Fully loaded outbound with diminishing loads, typically 5-6 drops per load
- Raw materials and some general freight, mostly lighter loads inbound
- Average length of haul 500-600 miles, mostly expressway and four-lane roads
- Annual fleet mileage: 40 million plus
- 350 power units, 700 trailers
- Owned equipment, five-year trade cycle for power, 10 years for trailers
- Retired trucks are well maintained and sought after by repeat buyers
- Company standards for resold trucks include at least 50% tire life left

14.2 Background

Fleets toying with the idea of a major change in truck specification have much to consider beyond getting used to new sales reps calling at the door. Dissimilar inventory, new installation and maintenance procedures, technician training, new condition checks and go/no-go criteria; there are a lot of adjustments to be made. This case study explores the experiences of an early adopter of wide-base tires.

This fleet began considering adoption in 2004, when wide-base tires were still new to the market —largely untried and widely untrusted. Being an early adopter meant that certain challenges which are minimal today, like wide availability of replacement tires and diminished residual values, were very real barriers at the time. Still, the fleet went ahead and is now fully transitioned to wide-base at all drive and trailer positions. The fleet is now testing “super” low rolling resistance wide-base tires. Those tires have not been without issues, but the evaluation continues.

As this fleet is a private fleet, transportation is a pure cost with no opportunity to recover expenses through fuel surcharges, pass-throughs, etc. Consequently, this fleet strives for maximum fuel efficiency; tires are part of its fuel-cost management strategy.

In 2004, the fleet began testing wide-base tires on a small group of tractors. Up until that point, it was using dual tires considered to be fuel efficient. Some concerns the fleet articulated going into the test, such as the availability of replacement tires and possible wheel bearing failures, proved to be unfounded. However, another concern, that of driver acceptance did continue to be a challenge after testing.

While increased fuel mileage was the main motivation behind testing wide-base tires, the test results revealed fuel economy on the tractors equipped with wide-base tires had increased by at least 0.1 MPG with some showing an increase of almost 0.2 MPG. Moreover, the additional payload opportunities soon became apparent.

14.3 Proceeding with Adoption

Once the decision had been made to switch from dual tires to wide-base, it took about four years for the fleet to fully transition its tractors, ordering each subsequent generation with wide-base tires, but not retrofitting any of the in-service units. The trailer fleet took longer to fully transition because of the trade cycles. The fleet was 100% wide-base by 2011, seven years after the first tests began.

As wide-base equipped trailers were cycled into the fleet, fuel savings increased, proving that the wide-base tires were having the desired effect. Some of that gain was believed to have resulted from eliminating some of the fuel economy concerns associated with dual wheels, such as matching tire size and inflation pressures.

Reported maintenance issues were minimal and manageable, mostly associated with the early days of the transition when technicians, maintenance staff, and drivers were unfamiliar with the new tires. No extraordinary tire failures were noted, just the usual run of curb strikes, punctures and blowouts. Nor were any undue hardships reported from a lack of tire availability arising from roadside service calls.

The biggest challenge faced by this fleet in the early days (and it still exists today but to a lesser extent), was driver acceptance. The company and the tire supplier reduced this challenge by providing some driver training to familiarize drivers with the tires.

Along with driver training, the fleet had to adjust its tire management practices and inventories. Half of the number of tires and wheels now had to be stocked at any one time compared to dual tires, but carrying costs were slightly higher. Tire pressure checks and inspections became less time-consuming because there were fewer tires to inspect per wheel position, and the other traditional concerns associated with inside-dual tires were eliminated. But since wide-base tires do not carry a 20 psi inflation pressure safety margin as duals tires often do, more emphasis had to be placed on inflation pressure verification.

This fleet now has more than 200 million miles on wide-base tires and has no plans to resume using dual tires. It did not report any decline in residual value at sell-off due to the wide-base tires.

14.4 Fuel Savings Realized

Actual fuel savings were not what the tire manufacturer had claimed they would be.

As mentioned, the initial testing of the wide-base tires showed a fuel economy improvement of between 0.1 and 0.2 MPG. Fuel prices in 2004 averaged $1.81 per gallon, so the fuel savings across the portion of the fleet then equipped with wide-base tires was about 420 gallons per year per truck, or $750 per unit annually (calculated with the average price at the time.)

So, small though it was, the fleet did see a fuel cost savings, which when coupled with the weight savings, made wide-base tires a compelling alternative to dual tires.

14.5 Looking Ahead: Super Low Rolling Resistance Wide-Base Tires

In 2011 the fleet chose to test "super" low rolling resistance wide-base tires against the wide-base tires its vehicles were by then uniformly equipped with. The super LRR tires showed an additional savings of 0.2 MPG over the wide-base tires. Fuel prices were slightly more than double those of 2004, so the savings were better, $1,650 dollars per truck on 433 gallons of fuel — but still less than forecast by the tire manufacturer.

A few issues arose in testing the super LRR wide-base tires against the fleet's current wide-base tires. The acquisition cost of that first batch of super LRR tires was (and remains), higher than the wide-base tires they replaced. On top of that, tire life was shortened due to the generally thinner tread on the new tires. Miles per 32nd decreased slightly as well. As the tires wore, lack-of-traction complaints from some of the drivers resurfaced, though that is believed to be more a matter of perception rather than a genuine safety issue.

The overall shorter mileage-to-takeoff did pose a problem for this fleet, but a suitable workaround was implemented. This fleet disposes of its own equipment. Its tractors typically have about 600,000 – 625,000 miles at retirement. Drive tires in this fleet typically last about 250,000 miles. In this scenario, a tractor would get tires at 250,000 miles, again at 500,000 miles and be retired with approximately 50% rubber left on the tire. The loss of some tire life seen with the super LRR wide-base tires would have forced the purchase and installation of a third set of tires during the tractors' life cycle to meet the resale requirements in some cases. To solve this problem, units with about 50% tread left on them were identified and those tires were put on the soon-to-be-retired trucks, while the donor truck got the new tires. There were additional labor costs and downtime associated with the tire transplants, but they were less than the cost of putting a third set of tires on each truck.

Ultimately, it was determined that while the super LRR wide-base tires did reduce fuel consumption, those savings were offset by the additional initial cost, the loss of usable tire life, and the possibility of having to purchase an additional set of tires — including labor to install — during a tractor's life cycle.

Therefore, the use of super LRR wide-base tires still is under consideration at the time of this writing. Fleet management says it is open to more testing, and acknowledges that the test it ran was a small sample on early-generation super LRR wide-base tires. To that end, the fleet currently has a small group of trailers on order which will be equipped with the latest generation LRR wide-base tires. These tires will be closely audited for fuel efficiency and miles-per-32nd as the fleet continues in its quest of gaining MPGs and lowering operating costs.