

## Executive Summary

Each year Americans spend about \$20 billion replacing the tires on their passenger cars and light trucks. Although passenger tires last far longer today than they did 30 years ago, most are replaced every 3 to 5 years because of wear. A total of about 200 million replacement passenger tires are purchased in the United States annually. Each time they replace their tires, motorists spend several hundred dollars and must choose among tires varying in price, style, and many aspects of performance. The tires they do buy will affect not only the handling, traction, ride comfort, and appearance of their vehicles but also fuel economy.

Tires affect vehicle fuel economy mainly through rolling resistance. As a tire rolls under the vehicle's weight, its shape changes repeatedly as it experiences recurring cycles of deformation and recovery. In the process, mechanical energy otherwise available to turn the wheels is converted into heat and dissipated from the tire. More fuel must be expended to replace this lost energy. Combinations of differences in tire dimensions, design, materials, and construction features will cause tires to differ in rolling resistance as well as in many other attributes such as traction, handling, noise, wear resistance, and appearance. Once they are placed in service, tires must be properly maintained to perform as intended with respect to all attributes. The maintenance of proper inflation pressure is especially important.

The collective outcomes of the choices consumers make when they buy tires are matters of public interest. The 220 million passenger cars and light trucks in the United States consume about 130 billion gallons of motor fuel annually. Finding ways to reduce this energy consumption is a national goal for reasons ranging from ensuring economic and national security to improving local air quality and reducing greenhouse gas emissions. Maximizing the wear life of tires is also important from the public standpoint of controlling the population of scrap tires that can burden landfills and recycling programs. While the handling, traction, and other operating characteristics of tires are of particular interest to tire buyers, they are also matters of broader public interest inasmuch as they may influence the safety performance of vehicles on the nation's highways.

This study was conducted at the request of Congress with funding from the National Highway Traffic Safety Administration (NHTSA). It examines the rolling resistance characteristics of passenger tires sold for replacement and how differences in rolling resistance relate to other tire attributes. Specifically, Congress asked the National Research Council (NRC) to assess the feasibility of reducing rolling resistance in replacement tires and the effects of doing so on vehicle fuel consumption, tire wear life and scrap tire generation, and tire operating performance as it relates to motor vehicle safety. Congress asked that the assessment include estimates of the effects of reductions in rolling resistance on consumer spending on fuel and tire replacement.

To conduct the study, the Transportation Research Board, under the auspices of NRC, assembled a committee of experts in tire engineering and manufacturing, mechanical and materials engineering, and statistics and economics. The study committee reviewed the technical literature and analyzed data on passenger tire rolling resistance and other characteristics. Many aspects of tire design, construction, and manufacturing are proprietary, which limits the availability of quantitative information, particularly on the effects of specific changes in tire design and construction to reduce rolling resistance. Nevertheless, enough quantitative and

technical information exists in the public domain to assess and reach some general conclusions about the feasibility of reducing rolling resistance in replacement tires and the implications for other tire attributes. Effects on consumer spending on fuel and tire replacement can also be approximated.

The study findings and conclusions are summarized below. Taken together, they persuade the committee that the influence of passenger tires on vehicle fuel consumption warrants greater attention by government, industry, and consumers. A recommendation for congressional action is offered in light of this conclusion.

## **FEASIBILITY OF LOWERING ROLLING RESISTANCE IN REPLACEMENT TIRES**

**Reducing the average rolling resistance of replacement tires by a magnitude of 10 percent is technically and economically feasible.** A tire's overall contribution to vehicle fuel consumption is determined by its rolling resistance averaged over its lifetime of use. A reduction in the average rolling resistance of replacement tires in the fleet can occur through various means. Consumers could purchase more tires that are now available with lower rolling resistance, tire designs could be modified, and new tire technologies that offer reduced rolling resistance could be introduced. More vigilant maintenance of tire inflation pressure will further this outcome. In the committee's view, there is much evidence to suggest that reducing the average rolling resistance of replacement tires by a magnitude of 10 percent is feasible and attainable within a decade through combinations of these means.

Rolling resistance varies widely among replacement tires already on the market, even among tires that are comparable in price, size, traction, speed rating, and wear resistance. Consumers, if sufficiently informed and interested, could bring about a reduction in average rolling resistance by adjusting their tire purchases and by taking proper care of their tires once in service, especially by maintaining recommended inflation pressure. The committee does not underestimate the challenge of changing consumer preferences and behavior. This could be a difficult undertaking, and it must begin with information concerning the tire's influence on fuel economy being made widely and readily available to tire buyers and sellers. A significant and sustained reduction in rolling resistance is difficult to imagine under any circumstances without informed and interested consumers.

**The committee observes that consumers now have little, if any, practical way of assessing how tire choices can affect vehicle economy.**

## **INFLUENCE ON VEHICLE FUEL ECONOMY**

**Tires and their rolling resistance characteristics can have a meaningful effect on vehicle fuel economy and consumption.** A 10 percent reduction in average rolling resistance, if achieved for the population of passenger vehicles using replacement tires, promises a 1 to 2 percent increase in the fuel economy of these vehicles. About 80 percent of passenger cars and light trucks are equipped with replacement tires. Assuming that the number of miles traveled does not change, a 1 to 2 percent increase in the fuel economy of these vehicles would save about 1 billion to 2 billion gallons of fuel per year of the 130 billion gallons consumed by the entire passenger vehicle fleet. This fuel savings is equivalent to the fuel saved by taking 2

million to 4 million cars and light trucks off the road. In this context, a 1 to 2 percent reduction in the fuel consumed by passenger vehicles using replacement tires would be a meaningful accomplishment.

## **EFFECTS ON TIRE WEAR LIFE AND SCRAP TIRES**

**The effects of reductions in rolling resistance on tire wear life and scrap tires are difficult to estimate because of the various ways by which rolling resistance can be reduced.** The tread is the main factor in tire wear life and the main component of the tire contributing to rolling resistance. Reductions in tread thickness, volume, and mass are among the means available to reduce rolling resistance, but they may be undesirable if they lead to shorter tire lives and larger numbers of scrap tires. Various tread-based technologies are being developed and used with the goal of reducing rolling resistance without significant effects on wear resistance. The practical effects of these technologies on tread wear and other tire performance characteristics have not been established quantitatively. However, continuing advances in tire technology hold much promise that rolling resistance can be reduced further without adverse effects on tire wear life and scrap tire populations.

## **EFFECTS ON TRACTION AND SAFETY PERFORMANCE**

**Although traction may be affected by modifying a tire's tread to reduce rolling resistance, the safety consequences are probably undetectable.** Changes are routinely made in tire designs, materials, and construction methods for reasons ranging from noise mitigation and ride comfort to steering response and styling. All can have implications for other tire properties and operating performance, including traction capability. Discerning the safety implications of small changes in tire traction characteristics associated with tread modifications to reduce rolling resistance may not be practical or even possible. The committee could not find safety studies or vehicle crash data that provide insight into the safety impacts associated with large changes in traction capability, much less the smaller changes that may occur from modifying the tread to reduce rolling resistance.

## **EFFECTS ON CONSUMER FUEL AND TIRE EXPENDITURES**

**Reducing the average rolling resistance of replacement tires promises fuel savings to consumers that exceed associated tire purchase costs, as long as tire wear life is not shortened.** A 10 percent reduction in rolling resistance can reduce consumer fuel expenditures by 1 to 2 percent for typical vehicles. This savings is equivalent to 6 to 12 gallons per year, or \$12 to \$24 if fuel is priced at \$2 per gallon. Tire technologies available today to reduce rolling resistance would cause consumers to spend slightly more when they buy replacement tires, on the order of 1 to 2 percent or an average of \$1 to \$2 more in tire expenditures per year. These technologies, however, may need to be accompanied by other changes in tire materials and designs to maintain the levels of wear resistance that consumers demand. While the effect of such accompanying changes on tire production costs and prices is unclear, the overall magnitude

of the fuel savings suggests that consumers would likely incur a net savings in their combined fuel and tire expenditures.

## **RECOMMENDATIONS TO INFORM CONSUMERS**

As a general principle, consumers benefit from the ready availability of easy-to-understand information on all major attributes of their purchases. Tires are no exception, and their influence on vehicle fuel economy is an attribute that is likely to be of interest to many tire buyers. Because tires are driven tens of thousands of miles, their influence on vehicle fuel consumption can extend over several years. Ideally, consumers would have access to information that reflects a tire's effect on fuel economy averaged over its anticipated lifetime of use, as opposed to a measurement taken during a single point in the tire's lifetime, usually when it is new. No standard measure of lifetime tire energy consumption is currently available, and the development of one deserves consideration. Until such a practical measure is developed, rolling resistance measurements of new tires can be informative to consumers, especially if they are accompanied by reliable information on other tire characteristics such as wear resistance and traction.

Advice on specific procedures for measuring and rating the influence of individual passenger tires on fuel economy and methods of conveying this information to consumers is outside the scope of this study. Nevertheless, the committee is persuaded that there is a public interest in consumers having access to such information. The public interest is comparable with that of consumers having information on tire traction and tread wear characteristics, which is now provided by industry and required by federal regulation.

It is apparent that industry cooperation is essential in gathering and conveying tire performance information that consumers can use in making tire purchases. It is in the spirit of prompting and ensuring more widespread industry cooperation in the supply of useful and trusted purchase information that the committee makes the following recommendations.

**Congress should authorize and make sufficient resources available to NHTSA to allow it to gather and report information on the influence of individual passenger tires on vehicle fuel consumption. Information that best indicates a tire's contribution to vehicle fuel consumption and that can be effectively gathered, reported, and communicated to consumers buying tires should be sought. The effort should cover a large portion of the passenger tires sold in the United States and be comprehensive with regard to popular tire sizes, models, and types, both imported and domestic.**

**NHTSA should consult with the U.S. Environmental Protection Agency on means of conveying the information and ensure that the information is made widely available in a timely manner and is easily understood by both buyers and sellers. In the gathering and communication of this information, the agency should seek the active participation of the entire tire industry.**

**The effectiveness of this consumer information and the methods used for communicating it should be reviewed regularly. The information and communication methods should be revised as necessary to improve effectiveness. Congress should require periodic assessments of the initiative's utility to consumers, the level of cooperation by industry, and the resultant contribution to national goals pertaining to energy consumption.**

Finally, even as motorists are advised of the energy performance of tires, they must appreciate that all tires require proper inflation and maintenance to achieve their intended levels of energy, safety, wear, and operating performance. As new technologies such as tire pressure monitoring systems, more energy-efficient tire designs, and run-flat constructions are introduced on a wider basis, they must have the effect of prompting more vigilant tire maintenance rather than fostering more complacency in this regard. Motorists must be alerted to the fact that even small losses in inflation pressure can greatly reduce tire life, fuel economy, safety, and operating performance. A strong message urging vigilant maintenance of inflation must therefore be a central part of communicating information on the energy performance of tires to motorists.

