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MAKING DRIVING LESS ENERGY INTENSIVE THAN FLYING

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16. Abstract

This report analyzes recent trends in the amount of energy needed to transport a person in the U.S. a given distance either in a light-duty vehicle or on a scheduled airline flight. After observing that the energy intensity of driving (BTU per person mile) is 57% greater than that of flying, calculations were made to estimate how much improvement would need to be achieved in either vehicle fuel economy or passenger load to make driving the less energy intensive of these two modes of transportation.

The main findings are that to make driving less energy intensive than flying, the fuel economy of the entire fleet of light-duty vehicles would have to improve from the current 21.5 mpg to at least 33.8 mpg, or vehicle load would have to increase from the current 1.38 persons to at least 2.3 persons.

The report briefly discusses the difficulties in achieving these improvements. Furthermore, it points out that, because the future energy intensity of flying will be better than it currently is, the calculated improvements underestimate the improvements that need to be achieved for driving to be less energy intensive than flying. Finally, it is emphasized that, although flying is less energy intensive than driving, flying is a viable alternative to driving only for a subset of driving trips that involve relatively long distances.

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Introduction

This report analyzes recent trends in the amount of energy needed to transport a person in the U.S. a given distance either in a light-duty vehicle or on a scheduled airline flight. After observing that the energy intensity of driving is greater than that of flying, calculations are made to estimate how much improvement would need to be achieved in either vehicle fuel economy or passenger load to make driving the less energy intensive of these two modes of transportation.

Recent trends in the energy intensities of driving and flying

Approach

The variable of interest was BTU per person mile. For flying, "person mile" refers to passenger mile, while for driving it refers to occupant mile.

For flying, domestic operations of all certified air carriers were considered (RITA 2013a). For driving, all light-duty vehicles (cars, SUVs, pickups, and vans) were included; the data were calculated from the information in RITA (2013b).

Results

Table 1 presents the energy intensities of flying and driving from 1970 to 2010.

Table 1
Energy intensities of flying and driving, 1970-2010.

Year	BTU per person mile	
	Flying	Driving
1970	10,185	5,067
1975	8,532	5,029
1980	6,029	4,628
1985	4,950	4,443
1990	4,767	4,006
1995	4,282	4,011
2000	3,892	3,926
2005	3,232	3,782
2010	2,691	4,218

The data in Table 1 indicate that in 1970 the energy intensity of driving was about half that of flying. However, the advantage of driving decreased with each five-year increment examined. Indeed, the situation reversed in 2000, and the advantage of flying increased from then on. For the latest year analyzed (2010), the energy intensity of driving was 57% greater than that of flying.

Over the course of the 40 years examined, the energy intensities of both driving and flying decreased. However, the improvement for driving (17%) was substantially less than for flying (74%).

To place driving and flying in the context of other modes of transportation, the 2010 energy intensities for five modes are shown in Table 2. The information for all modes except driving is from RITA (2013a); the information for driving is from Table 1.

Table 2.
Energy intensities of five transportation modes, 2010.

Transportation mode	BTU per person mile
Amtrak (train)	1,668
Flying	2,691
Motorcycle	2,675
Transit bus	3,347
Driving	4,218

How to improve the energy intensity of driving

Recent changes in vehicle fuel economy and vehicle load

The energy intensity of driving (as well as of other means of personal transportation) depends on two primary variables: vehicle fuel economy and vehicle load (the number of persons aboard). As vehicle load increases, the amount of fuel consumed per person mile decreases (even after taking into account the increased weight to be carried). The fuel economy of the U.S. fleet of all light-duty vehicles (as loaded) improved from 13.0 mpg in 1970 to 21.5 mpg in 2010 (calculated from the information in RITA [2013b]). However, during the same period vehicle load decreased from 1.90 persons to 1.38 persons (calculated from the information in RITA [2013b]).

Improving vehicle fuel economy

One way for driving to be less energy intensive than flying is to improve vehicle fuel economy by more than the current ratio of the energy intensities of driving and flying. That ratio is 1.57 (4,218/2,691). Consequently, at the current vehicle load, vehicle fuel economy would have to be at least 33.8 mpg ($21.5 \times 1.57 = 33.8$).

Increasing vehicle load

The calculations in this section provide an estimate of the needed vehicle load to yield an equal energy intensity for driving and flying. The following assumptions were made in these calculations:

(a) average vehicle curb weight with fuel: 3,500 pounds

(b) average weight of a person with luggage: 250 pounds

(c) vehicle fuel economy: a linear function of total vehicle weight

The results indicate that a vehicle load of 2.3 persons would yield an energy intensity of driving that is the same as the current energy intensity of flying. Therefore, without any improvement in vehicle fuel economy, an average vehicle load of more than 2.3 persons would result in the energy intensity of driving to be less than that of flying.

Discussion

Improvements needed

The necessary improvements in vehicle fuel economy or vehicle load for driving to match the current energy intensity of flying are summarized in Table 3.

Table 3
Necessary improvements in vehicle fuel economy or vehicle load for the energy intensity of driving to match the current energy intensity of flying.

Vehicle fuel economy	57% (from 21.5 mpg in 2010 to 33.8 mpg)
Vehicle load	67% (from 1.38 persons in 2010 to 2.3 persons)

It would not be easy to achieve either of the two changes outlined in Table 3. Let us first consider vehicle fuel economy. Although the fuel economy of new vehicles is continuously improving (Sivak and Schoettle, 2014), and these improvements are likely to accelerate given the new corporate average fuel economy standards (NARA, 2012), changes in fuel economy of new vehicles take a long time to substantially influence the fuel economy of the entire fleet (Sivak, 2013). This is the case because it takes a long time to turn over the fleet. For example, the 14.5 million light-duty vehicles sold in 2012 (Reuters, 2013), accounted for only about 6% of the entire fleet of light-duty vehicles (FHWA, 2013).

A historical perspective illustrates the daunting task. Table 3 indicates that an improvement of at least 57% in vehicle fuel economy of the entire fleet of light-duty vehicles would be required. In comparison, during the 40 years that were examined in this study (from 1970 to 2010), vehicle fuel economy improved by only 65% (RITA, 2013b).

The required increase in vehicle load of at least 67% might be even more difficult to achieve. This is the case because vehicle load has recently been continuously dropping, from 1.90 in 1970 to 1.38 in 2010 (RITA, 2013b).

It is important to recognize that the energy intensity of flying will continue to improve. Indeed, from 1970 to 2010, the energy intensity of flying decreased by a larger percentage than that of driving (74% vs. 17%). Consequently, because the future energy intensity of flying will be better than it currently is, the improvements outlined in Table 3 underestimate the improvements that need to be achieved for driving to be less energy intensive than flying.

Electric vehicles

The presented energy intensities of driving slightly underestimate the actual intensities because the electric energy consumed by plug-in hybrid electric vehicles or fully electric vehicles was not included. However, such vehicles currently represent less than 1% of all vehicles on the road (EDTA, 2013; FHWA, 2013).

Driving trips vs. flying trips

The average length of a driving trip is currently about 9 miles (Krumm, 2012). On the other hand, the average domestic flying trip is currently about 100 times longer (914 miles; RITA, 2013c). Thus, driving and flying serve different general purposes, with driving used mostly for trips that are too short for flying. However, long-distance driving represents a subgroup of driving trips for which flying is a viable alternative.

As the trip length increases, so does the average fuel economy of driving. This is the case because long-distance driving is frequently done on limited-access highway where vehicle fuel economy is better than the average fuel economy over all roads that were included in this analysis. Similarly, as the trip length increases, so does the average fuel economy of flying. This is the case because airplanes use a disproportionate amount of fuel during takeoffs. For example, one estimate is that on short trips, takeoffs are responsible for as much as 25% of the total fuel consumed (Worldwatch Institute, 2013).

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