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WHAT INDIVIDUAL AMERICANS CAN DO TO ASSIST IN MEETING THE PARIS AGREEMENT

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16. Abstract

This report was prepared in support of the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change, which calls for each country to "aim to reach global peaking of greenhouse gas emissions as soon as possible…and to undertake rapid reductions thereafter." The focus of this study was on actions individual Americans can take without a major change in lifestyle to assist in meeting the Paris Agreement, and how these actions compare in their effectiveness across different areas of daily living.

There are five man-made sources of greenhouse gas emissions: industry, transportation, residential, commercial, and agriculture. Individuals can contribute to reductions of emissions in each of these sectors. However, the largest contributions that an individual can make are in the transportation, residential, and agriculture sectors—the sectors of focus in this study. Consequently, the study tabulates the impact of selected actions in these three sectors both on the emissions generated by the respective sector, and also on total U.S. emissions.

Four target levels of reduction in emissions were considered: 0.2%, 1%, 5%, and 10%. The report outlines several actions that, if taken by each American, would reduce *total* U.S. emissions by 0.2%. These actions relate to the transportation sector (how much, what, and how we drive, and how much and how we fly), residential sector (how much we heat, and what we use for lighting), and agriculture sector (how much and what food we consume and discard). However, to achieve larger reductions in emissions—on the order of 5% to 10%—there is only one realistic action that, by itself, would accomplish the goal: driving a more fuel-efficient vehicle. Specifically, the actual, on-road fuel economy of light-duty vehicles currently averages 21.4 mpg. Instead, if the average fuel economy were 31.0 mpg, total U.S. emissions would be reduced by 5%. Analogously, if the average fuel economy were 56.0 mpg, total U.S. emissions would be reduced by 10%.

This study estimated the effects of selected individual actions. However, reducing emissions does not have to be implemented by just one action. Nevertheless, the analysis indicates that improving vehicle fuel economy is by far the most effective action that an individual can take, and it would require several other actions to equal the effect of improved vehicle fuel economy.

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Contents

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This research was inspired by David MacKay's book entitled *Sustainable Energy—Without the Hot Air* (MacKay, 2009). In this enlightening book—freely available for download—MacKay provides a standardized look at energy use in the United Kingdom in a variety of activities in the daily lives of individuals.

Introduction

The Paris Agreement of the United Nations Framework Convention on Climate Change, adopted in December 2015, calls for each country to "aim to reach global peaking of greenhouse gas emissions as soon as possible…and to undertake rapid reductions thereafter (United Nations, 2015)." This white paper discusses what each American can do to assist in meeting this goal.

The Paris Agreement discusses aggregate emissions per each party to the agreement (i.e., countries), and not emissions per capita. Therefore, it is important to keep in mind the expected population growth when considering peaking of emissions.

For the purpose of this study, potential actions for reducing emissions were assigned to one of two major categories: actions that require governmental interventions, and actions that depend on individual initiatives. Examples of governmental interventions include legislative mandates concerning minimum vehicle fuel economy and concerning minimum energy efficiency of appliances such as furnaces and air conditioners. Examples of actions requiring individual initiatives include considering vehicle fuel economy among vehicle-purchasing parameters, and adjusting home thermostat settings for heating and air conditioning. The focus of this study is on the latter—actions individuals can take, and how these actions across different areas of daily living compare in their effectiveness in reducing total emissions.

The underlying philosophy of this paper is that individuals should be given the comparable information required to help them select those emissions-saving actions in their daily lives that have the least impact on their current lifestyle. For example, for some people, turning down the thermostat in winter would be the least bothersome action that they could take to contribute to reducing emissions, while for others it might be buying a vehicle with better fuel economy, etc.

Background

The U.S. population grew 0.8% from January 1, 2015 to January 1, 2016 (U.S. Census Bureau, 2016). If we assume that this population-growth rate will continue in the near future, just to keep the status quo in the absolute amount of emissions (while keeping everything else constant) would require reductions of 0.8% in emissions per person every year. That translates into compounded reductions of 4.1% over 5 years, and 8.3% over 10 years. These three values (0.8%, 4.1%, and 8.3%) should be kept in mind in the exposition to follow.

The latest inventory of U.S. greenhouse emissions by sector is shown in Table 1 (EPA, 2015a). (Each sector includes the corresponding emissions from electricity generation required to support that sector.) Each of the sectors will be briefly examined in terms of possible actions that an individual could take and the effects of these actions on emissions.

Table 1
Share of greenhouse gas emissions by sector.

Sector	% of total emissions
Industry	29
Transportation	27
Residential	17
Commercial	17
Agriculture	10

Industrial emissions

Industry currently produces 29% of all greenhouse-gas emissions (see Table 1). Information about the energy required to manufacture a specific model of a product is generally not available (although information does exists on the amount of energy needed to manufacture some types of products [e.g., Ciceri, Gutowski, and Garetti, 2010]). Consequently, an individual cannot easily shop for models that require the least amount of energy to produce.

On the other hand, what an individual can frequently do is to keep a product longer, and thereby reduce the prorated annual emissions associated with manufacturing the product. For example, the current average age of a light-duty vehicle in the U.S. is 11.5 years (IHS, 2015). Keeping a vehicle longer would spread the amount of energy required for material recovery and production, vehicle-component fabrication, vehicle assembly, and vehicle disposal and recycling over a longer period, with consequent reductions in annual emissions.

Burnham, Wang, and Wu (2006) estimate that the manufacture of a typical light-duty vehicle with an internal-combustion engine requires about 104 million Btu. This is approximately equivalent to the energy obtained by burning 863 gallons of gasoline, as compared to 524 gallons consumed annually while driving an average light-duty vehicle in the United States (Sivak, 2015). Thus, producing a vehicle emits about 14% of the total emissions from driving the vehicle during its average lifetime (11.5 years).

Another example relates to cell phones. In the United States, people replace them, on average, every 22 months (Entner, 2011). This compares to, for example, 33 months in Canada and 75 months in Finland—two countries where the quality and capabilities of cell phones are likely to be very similar to those in the United States.

Many new products are purchased because they improve on the quality or capabilities of the products they are meant to replace. However, many products are replaced because they break down completely, or are no longer functional without an expensive repair. Furthermore, repairing a product consumes some energy too (in the manufacture of the materials, etc.). Consequently, it would be difficult to estimate the total net effect of maintaining a specific product longer.

Transportation emissions

Transportation currently produces 27% of all emissions (see Table 1). A further breakdown of transportation emissions by source is shown in Table 2 (EPA, 2015b). Also shown in Table 2 are the corresponding percentages of total emissions.

Table 2
Share of greenhouse gas emissions from transportation by source.

Source	% of transportation emissions	% of total emissions
Light-duty vehicles*	60	16.2
Medium- and heavy-duty trucks	23	6.2
Aircraft†	8	2.2
Rail	2	0.5
Ships and boats	2	0.5
Other$^{\Delta}$	4	1.1

* Includes cars, SUVs, pickup trucks, vans, and crossovers.
† Includes both passenger and cargo operations.
$^{\Delta}$ Includes buses, motorcycles, pipelines, and lubricants.

Individuals can have the most influence on emissions from light-duty vehicles and aircraft. Therefore, the next two sections will deal with these two sources of emissions. (Heavy-duty trucks consume the majority of fuel used in the medium- and heavy-duty-truck category [FHWA, 2016]. There are four main aspects related to heavy-duty trucks that substantially influence their fuel economy [Woodrooffe, 2014]: tires, aerodynamics, engine efficiency, and size-and-weight regulations. However, none of these aspects are under the control of individuals, so medium- and heavy-duty trucks were not included in this analysis.)

Light-duty vehicles

How much we drive

A reduction of 1% in driving would reduce emissions from driving by 1%.[1]

What we drive

A vehicle that gets 50 mpg (2 gal/100 mi) produces 50% less emissions than a vehicle that gets 25 mpg (4 gal/100 mi), because the former uses 50% less fuel than the latter.

Rolling resistance of tires has an effect on vehicle fuel economy. According to TRB (2006), for each 10% decrease in rolling resistance there is about a 1.5% improvement in fuel economy of light-duty vehicles.

How we drive

Drivers can take a variety of actions to improve vehicle fuel economy (Sivak and Schoettle, 2012). Here we highlight two such actions with relatively large effects. The first action relates to aggressive driving (frequent hard stops and rapid accelerations). Reed (2006) found that, in test conditions, eliminating very aggressive driving can lead to a maximum fuel savings of 37%. Given the range and frequency of aggressivity in actual driving, we will assume that the average driver can reduce overall fuel consumption by 5% by eliminating aggressive driving.

The other action to be addressed here is driving at very high speeds. For most vehicles, the best fuel economy is obtained at moderate speeds, with fuel economy declining at very high speeds. However, different vehicles have different "sweet spots" and different sensitivities to speed. Leblanc, Sivak, and Bogard (2010) found that, for a particular car, fuel consumption was lowest at about 61 mph, and it increased by 34% at 87 mph. Here we will assume that, given the range and frequency of high-speed driving, the average driver can reduce overall fuel consumption by 5% by eliminating very high-speed driving.

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[1] The contributions of rental vehicles (less than 1% of all light-duty vehicles [Auto Rental News, 2016]) and other commercially owned light-duty vehicles were disregarded.

Examples of actions

Table 3 presents example actions related to light-duty vehicles and their benefits in terms of reductions in driving emissions, transportation emissions, and total emissions. To illustrate how the entries in Table 3 were calculated, consider the values in the first row. Reducing the amount of driving by light-duty vehicles by 10.0% (without replacing it with other motorized transportation) will reduce the emissions from driving by 10.0%, as shown in column 2. Because emissions from light-duty vehicles represent 60% of transportation emissions (see Table 2), the entry in column 3 is 6.0% (10.0 times 0.60). In turn, because transportation emissions represent 27% of all emissions (see Table 1), the entry in column 4 is 1.6% (6.0 times 0.27).

Table 3
Examples of actions related to light-duty vehicles and their effects on emissions.

Action	% of driving emissions	% of transportation emissions	% of total emissions
Reducing the amount of driving by 10% without replacing it with other motorized transportation	10.0	6.0	1.6
Buying a vehicle that gets 26 mpg (3.85 gal/100 mi) instead of a vehicle that gets 25 mpg (4.00 gal/100 mi)	3.8	2.3	0.6
Buying a vehicle that gets 50 mpg (2.00 gal/100 mi) instead of a vehicle that gets 25 mpg (4.00 gal/100 mi)	50.0	30.0	8.1
Using passenger tires with rolling resistance that is 30% better than the average tire	4.3*	2.6	0.7
Eliminating very high-speed driving and thus reducing overall fuel consumption by 5%	5.0	3.0	0.8
Eliminating aggressive driving and thus reducing overall fuel consumption by 5%	5.0	3.0	0.8

* Based on a 4.5% improvement in fuel economy (in terms of mpg).

Aircraft

Fuel efficiency

The two primary factors that influence the amount of jet fuel spent per passenger-mile are the inherent fuel efficiency of the aircraft and the number of passengers carried per flight. In turn, the inherent fuel efficiency of the aircraft is strongly influenced by the age of the plane, with newer planes tending to be substantially more fuel efficient than older planes.

The other important factor for fuel efficiency—the number of passengers carried per flight with a given model of an aircraft—depends on seat configurations (with discount carriers generally having more seats per specific aircraft model) and the load factor (the proportion of seats being occupied): As the number of persons per flight with a given aircraft model increases, the amount of fuel spent per passenger-mile decreases (even after taking into account the additional weight being carried.) Obviously, fuel-efficiency gains on a specific aircraft model that are due to the increased number of passengers carried come at the expense of decreased passenger comfort.

A recent comparison of the fuel efficiency of U.S. domestic airlines by Li, Kwan, and Rutherford (2015) took into account both the inherent fuel efficiency of the aircraft model and the number of passengers carried. Their findings show that, in 2014, the most and least fuel-efficient airlines differed by 25%. (A caveat: This study, apparently, did not take into account differences in the proportional amount of freight being carried on different airlines.)

Several new airplane models, all scheduled to be introduced into service in the very near future, are expected to improve fuel efficiency by 15% to 30%. Consequently, the future differences in airline fuel efficiency are likely to increase further, as airlines upgrade their fleets at different rates.

Trip length

Not all airplane trips involve nonstop flights. For example, in 2011, about 32% of all domestic trips involved a change of plane (Borenstein and Rose, 2014). Obviously, if a nonstop flight is available, it will result in a shorter total distance flown and consequently lower emissions per person trip than taking connecting flights. An additional important advantage of nonstop flights is that a disproportionate amount of fuel is used during takeoffs (Worldwatch Institute, 2013).

If a nonstop flight is not available, shorter connections (in terms of distance flown) would result in lower emissions than longer connections. Let's consider two examples—one with a nonstop flight available and one without a nonstop flight available. The first example involves flying from Detroit to San Diego—a trip that currently has nonstop flights available. On December 31, 2015, Google Flights (Google, 2015) listed for January 15, 2016 two nonstop flights, and 39 connecting flights that (a) involve one layover, and (b) are less than 9 hours long. The nonstop flight is 1,950 miles (WebFlyer, 2015). The longest one-layover connection listed was 52% longer at 2,970 miles. The second example is for Detroit to Jackson, WY—a city pair that currently does not have nonstop flights. For January 15, 2016, Google Flights listed 10 connecting flights with the same two constraints as above (one layover, and less than 9 hours long). The shortest routing was 1,394 miles, while the longest routing was 45% longer at 2,026 miles.

Examples of actions

Table 5 presents sample actions that a passenger can take to reduce emissions from flying. Note that a given percentage of emissions from flying will have a smaller effect than that from driving on both transportation emissions and total emissions, because emissions from flying currently represent a smaller percentage of transportation emissions than emissions from driving (8% vs. 60%; see Table 2). Also, because aircraft emissions in Table 2 include both passenger and cargo operations, the actual benefits of actions listed in Table 5 would be slightly lower than shown.

Table 5
Examples of actions related to flying and their effects on emissions.

Action	% of flying emissions	% of transportation emissions	% of total emissions
Reducing the amount of flying by 10% without replacing it with other motorized transportation	10.0	0.8	0.2
Flying on a plane that consumes 10% less fuel per passenger-mile	10.0	0.8	0.2
Flying nonstop whenever possible (assuming that of the 32% of trips that involve a change of planes, 25% do have a nonstop available, and that a nonstop flight is 40% shorter than an average connection)*	3.2	0.3	0.1†
If a connection is required, selecting the shortest available routing (assuming that of the 32% of trips that involve a change of planes, 75% do not have a nonstop available, and that an average reduction of 25% in length is feasible with a shorter connection for these trips)	6.0	0.5	0.1†

* The disproportionate amount of fuel used during takeoffs was not included in these calculations.
† These two values differ if shown to two decimal places.

Residential emissions

Residential emissions currently account for 17% of all emissions (see Table 1). A further breakdown of residential energy use (and thus, approximately, of emissions as well) is shown in Table 6 (EIA, 2013).

Table 6
Residential energy consumption by end use.

End use	% energy
Space heating	42
Appliances, electronics, and lighting	35
Water heating	18
Air conditioning	6

Space heating

The largest residential energy user is space heating (42%). The U.S. Department of Energy (DOE, 2015b) estimates that turning down the thermostat 1 °F for 8 hours a day reduces the average energy consumption to heat a home by about 0.75% (0.5% to 1%).

Air conditioning

We will assume that turning the thermostat up 1 °F for 8 hours a day reduces energy consumption to air condition by the same amount as turning the thermostat down 1 °F for heating—0.75%.

Lighting

Electricity used for residential lighting represents about 14% of total residential electricity consumption (EIA, 2015). In turn, emissions from electricity represent 69% of all residential emissions (EPA, 2015a).

Current LEDs use about 25% (20% to 30%) of the energy used by corresponding incandescent bulbs (DOE, 2015a).[2] Let's assume that currently 50% of bulbs in residential use are still incandescent, and that each of the existing non-incandescent bulbs

[2] Another energy-saving option is florescent bulbs, but they are less preferable because they contain small amounts of mercury.

uses 25% of the energy of a comparable incandescent bulb. In that case, incandescent bulbs currently consume 80% of all electricity used for residential lighting. Replacing all remaining incandescent bulbs with LEDs would then reduce the amount of electricity used for residential lighting by 60%.

Examples of actions

Table 7 lists examples of actions that an individual can take to reduce residential emissions.

Table 7
Examples of actions related to one's residence and their effects on emissions.

Action	% of residential emissions	% of total emissions
Turning the thermostat down 5 °F for 8 hours a day during the heating season	1.6	0.3
Turning the thermostat up 5 °F for 8 hours a day during the cooling season	0.2	<0.1
Replacing all remaining incandescent bulbs with LEDs* (assuming that 50% of bulbs are currently incandescent)	5.8	1.0

* Incandescent lamps convert most of the energy into heat. Consequently, replacing them with LEDs will increase the demand for heating and decrease the demand for air conditioning, with a net effect of increasing the demand for combined heating and air conditioning. However, there will still be an overall net benefit on emissions, albeit somewhat smaller than calculated here.

Commercial emissions

Emissions from the commercial sector currently account for 17% of all emissions (see Table 1). The influence that an individual has on energy use in the commercial sector is somewhat limited. Examples of actions that one can take include energy conservation in heating, air conditioning, and lighting of one's office space. However, the available actions in these three areas are generally more limited than the corresponding actions in the residential sector. Consequently, the proportion of the energy used that is under one's control, albeit not negligible, is likely to be relatively small compared to the overall energy consumption of the commercial sector.

Agricultural emissions

How much we eat

Given that 69% of American adults are overweight (CDC, 2015), most of us could safely lose some weight. Reducing caloric input by 1% (a reduction of about 25 calories per day for adult men and 20 calories per day for adult women) would reduce emissions from agriculture by about 1%.[3]

What we eat

The energy required to produce food varies greatly, with meat (especially beef and pork) requiring more energy than plant-derived foods. For example, it takes about 31.5 kWh to produce a pound of beef, compared to 4.4 kWh for chicken, 6.8 kWh for cheese, and 0.4 kWh for corn (Ghanta, 2010). Taking into account the caloric content of foods, the energy efficiency of producing beef is 4%, compared to 15% for chicken, 31% for cheese, and 102% for corn (Ghanta, 2010). Consequently, it is not surprising that an average vegetarian diet is estimated to reduce emissions per person by about 32% compared to an average diet consisting of both meat and plant-derived foods (Scarborough et al., 2014).[4]

What we throw away

The U.S. Department of Agriculture estimates that 31% of the available food supply at the retail and consumer level goes uneaten (Buzby, Wells, and Hyman, 2014). Reducing the amount of wasted food by 10% would result in a 3.1% reduction in the amount of the food required to be produced, with a consequent reduction of 3.1% in the amount of emissions from agriculture. An individual has full control over discarded food at home, partial control over discarded food in restaurants, and no control over discarded food in grocery stores.[5]

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[3] Weight has also an indirect effect on fuel economy of all transportation modes. For example, an extra 100 pounds in a light-duty vehicle reduces fuel economy by about 1% (EPA, 2011).

[4] These data are for the United Kingdom, but they are unlikely to be grossly different from those applicable to the United States. A vegetarian diet usually includes dairy and egg consumption (i.e., not strictly vegan).

[5] An additional problem with discarded food is that, when decomposing in a landfill, it produces methane—a potent greenhouse gas (Scientific American, 2010).

Pet food

Pet food was not included in the present calculations. However, it represents only a very small percentage of the total agricultural output. For example, in 2011, an average household spent $183 on pet food (U.S. Bureau of Labor Statistics, 2013), compared to $6,458 for human consumption (ProQuest, 2013).

Exports and imports

Agricultural exports and imports of foods, feeds, and beverages are similar (in 2013 $136 billion vs. $115 billion; U.S. Census Bureau, 2015a; 2015b). They were not taken into account in this analysis.

Examples of actions

Table 8 presents sample actions related to agriculture that one can take and their effects on emissions. (The entry for reducing discarded food assumed that 50% of discarded food is under one's control.)

Table 8
Examples of actions related to agriculture and their effects on emissions.

Action	% of agricultural emissions	% of total emissions
Reducing food consumption by 5%	5.0	0.5
Reducing consumption of meat by 35%; assuming that 90% of persons are neither vegetarian nor vegan*	10.1	1.0
Reducing the amount of discarded food by 20% (10% of the total discarded food)	3.1†	0.3

* Switching to a vegetarian diet would reduce agricultural emissions by 29% and total emissions by 2.9%.
† Currently, 31% of food is discarded. A 20% reduction of the discarded food that is under one's control (assuming that only 50% is under one's control) would result in a 3.1% reduction in the amount of the food required to be produced.

Implications

As indicated above, the population of the United States currently increases annually by about 0.8%. Therefore, just to keep the status quo in the absolute amount of emissions (while keeping everything else constant) would require reductions of 0.8% in emissions per person every year. That translates into compounded reductions of 4.1% over 5 years, and 8.3% over 10 years.

Keeping these population-based increases in emissions in mind, below are actions related to transportation, residential, and agriculture that, if taken by each American, would result in emissions reductions of 0.2% (Table 9), 1% (Table 10), 5% (Table 11), and 10% (Table 12).

Table 9
Actions that would each reduce total U.S. emissions by 0.2%, if performed by each American.

Sector	Action
Transportation	Reducing the amount of driving by 1.25%
	Buying a vehicle that gets 21.7 mpg (4.61 gal/100 mi) instead of the current average of 21.4 mpg (4.67 gal/100 mi)
	Using tires with rolling resistance that is 9% better than the current average resistance
	Reducing the frequency of very high speed driving by 25%
	Reducing the frequency of aggressive driving by 25%
	Reducing the amount of flying by 10%
	Flying on an aircraft with 10% better fuel economy than the average aircraft
Residential	Turning the thermostat down 3 degrees for 8 hours a day during the heating season
	Replacing one fifth of the remaining incandescent bulbs with LEDs
Agriculture	Reducing food consumption by 2%
	Reducing consumption of meat by 7%
	Reducing the amount of discarded food by 13%

Table 10
Actions that would each reduce total U.S. emissions by 1%, if performed by each American.

Sector	Action
Transportation	Reducing the amount of driving by 6%
	Buying a vehicle that gets 22.8 mpg (4.39 gal/100 mi) instead of the current average of 21.4 mpg (4.67 gal/100 mi)
Residential	Replacing all remaining incandescent bulbs with LEDs
Agriculture	Reducing consumption of meat by 35%
	Reducing the amount of discarded food by 67%

Table 11
Action that would reduce total U.S. emissions by 5%, if performed by each American.

Sector	Action
Transportation	Buying a vehicle that gets 31.0 mpg (3.23 gal/100 mi) instead of the current average of 21.4 mpg (4.67 gal/100 mi)

Table 12
Action that would reduce U.S. total emissions by 10%, if performed by each American.

Sector	Action
Transportation	Buying a vehicle that gets 56.0 mpg (1.79 gal/100 mi) instead of the current average of 21.4 mpg (4.67 gal/100 mi)

The information in Table 9 indicates that there are several actions that each of us could take to reduce total emissions by 0.2%. These actions relate to the transportation sector (how much, what, and how we drive, and how much and how we fly), residential sector (how much we heat, and what we use for lighting), and agricultural sector (how much and what food we consume and discard). However, to achieve larger reductions in emissions—on the order of 5% to 10%—there is only one realistic action that by itself would accomplish this goal: driving a more fuel efficient vehicle. Specifically, the actual, on-road fuel economy of light-duty vehicles currently averages 21.4 mpg (FHWA, 2016). Instead, if the average fuel economy were 31.0 mpg, total emissions would be reduced by 5% (Table 11). Analogously, if the average fuel economy were 56.0 mpg, total emissions would be reduced by 10% (Table 12).

Study limitations

Governmental actions vs. actions by individuals

The focus of this study was to quantify the effects of a variety of actions that an individual can take to reduce emissions of greenhouse actions. Governmental actions were not considered.

Incomplete coverage of possible actions

This study did not exhaustively examine all possible actions that an individual can take to reduce greenhouse gas emissions. The emphasis was on selected actions that do not require substantial effort and time, do not require much in the way of changing one's lifestyle, and are relatively easy to quantify in terms of their effects. Examples of actions not considered are increasing home insulation (takes both substantial effort and time), eliminating the use of drive-through banks and restaurants, and thus eliminating the associated idling (requires a change, albeit small, in one's lifestyle), and buying locally sourced products (effects are not easy to generalize because they vary from product to product).

Effects of an action by an individual vs. by all of us

The calculations performed in this study assumed that all individuals could perform each action *if applicable*. For example, the calculated reductions in emissions from buying a more fuel-efficient vehicle assumed the involvement of all vehicle buyers (persons old enough to drive and own a vehicle). Obviously, annual vehicle sales represent only a small percentage of the vehicles on the road, and thus the full benefits from this action would take many years to accrue. Nevertheless, the present calculations provide a relative assessment of the impacts of different actions that an individual can take to reduce emissions.

Assumptions

The analysis relied, whenever possible, on published data. However, in several instances we had to use assumptions. For example, we assumed that a certain percentage of discarded food is currently under one's control. Analogously, when a range of values existed, such as for power savings using LED bulbs, the average value was used.

For several actions considered in this report, the magnitude of the effect depends on a variety of factors. In such instances, no attempt was made to comprehensively review all available literature. Instead, the calculations relied on one selected source in each such instance. For example, the data that we considered for the effects of speed on fuel consumption were obtained for one particular model vehicle.

Where assumptions were used, the results of the calculations should be considered first-order approximations.

Intended vs. unintended consequences

The intended effects of the discussed actions are clear: to reduce energy consumption and thereby reduce greenhouse gas emissions. However these actions, if performed by most of us, would also likely have unintended consequence, influencing a variety of businesses in different ways and to varying degrees. A cost benefit analysis of the various tradeoff involved was beyond the scope of this study.

Summary

This report was prepared in support of the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change, which calls for each country to "aim to reach global peaking of greenhouse gas emissions as soon as possible…and to undertake rapid reductions thereafter." The focus of this study was on actions individual Americans can take to assist in meeting the Paris Agreement without a major change in lifestyle, and how these actions compare in their effectiveness across different areas of daily living.

There are five man-made sources of greenhouse gas emissions: industry, transportation, residential, commercial, and agriculture. Individuals can contribute to reductions of emissions in each of these sectors. However, the largest contributions that an individual can make are in the transportation, residential, and agriculture sectors—the sectors of focus in this study. Consequently, the study tabulated the impact of selected actions in these three sectors both on the emissions generated by the respective sector, and also on total U.S. emissions.

Four target levels of reduction in emissions were considered: 0.2%, 1%, 5%, and 10%. The report outlines several actions that, if taken by each American, would reduce *total* U.S. emissions by 0.2%. These actions relate to the transportation sector (how much, what, and how we drive, and how much and how we fly), residential sector (how much we heat, and what we use for lighting), and agriculture sector (how much and what food we consume and discard). However, to achieve larger reductions in emissions—on the order of 5% to 10%—there is only one realistic action that, by itself, would accomplish the goal: driving a more fuel-efficient vehicle. Specifically, the actual, on-road fuel economy of light-duty vehicles currently averages 21.4 mpg. Instead, if the average fuel economy were 31.0 mpg, total U.S. emissions would be reduced by 5%. Analogously, if the average fuel economy were 56.0 mpg, total U.S. emissions would be reduced by 10%.

This study estimated the effects of selected individual actions. However, reducing emissions does not have to be implemented by just one action. Nevertheless, the analysis indicates that improving vehicle fuel economy is by far the most effective action that an individual can take, and it would require several other actions to equal the effect of improved vehicle fuel economy.

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