Chapter 1

Greening Transportation

Unless you've been in a coma for the last decade, you very likely won't need convincing that the world needs to find a way to "green" its transportation system — that is, to make it more environmentally sustainable. Much more sustainable. Global climate change, our heavy dependence on declining oil reserves, and high fuel prices should be enough to convince even the most stalwart opponents of all things green that we must do something — and soon — to create a leaner, greener mode of transportation.

I won't recite the catalogue of facts and figures here to make the case to you. You're reading this book because you very likely already know them and feel the need to make changes. Chances are you are responding to a deep conviction that it's time you did something — or perhaps more — to green your own transportation. This book will help enormously. It covers three basic areas: (1) ways you can drive less "fuelishly," (2) green vehicles options like plug-in hybrids, and (3) green fuels such as biomethane, ethanol, and hydrogen.

While my emphasis since the early 1970s, when I became actively involved in energy efficiency and renewable energy, has been on residential energy efficiency and renewable energy, I

have also studied green transportation extensively. It's been one of several "side passions" of mine since 1971. It all started when I was nearly 20. I had just gotten married. After the ceremony, my wife and I drove from western New York State where I grew up, back to college in eastern Kansas, where we were both finishing our senior year. My parents had given us a Chrysler 300 as a wedding present. It was a large, sprawling ocean liner of a car! As we drove west along Interstate 70, we watched in horror as the needle on the gas gauge plummeted. We could actually see the needle move as we were driving. A few days after we returned, we traded in the monster for a fuel-efficient Volkswagen Beetle.

My next vehicle, which I bought after graduating with a Ph.D. in reproductive physiology, was a relatively efficient Datsun pickup truck. Efficient as it was, I chose to commute by bus or bicycle to the University of Colorado in Denver for my first teaching job. Every car I've driven since then has been fuel-miserly. Today, I drive a fuel-pinching Toyota Prius and, more recently, an electric Chevy S-10 pickup truck. My brother-in-law and I converted the former gas-engine truck to electricity at The Evergreen Institute's Center for Renewable Energy and Green Building, my educational center in east-central Missouri (Figure 1.1).

In addition to pursuing ways to green my own transportation, I've attended workshops and numerous lectures on green cars and green fuels over the years and read every article that crossed my desk as well. This book is the culmination of much of my informal research — my green car hobby. Its focus is on *personal* transportation, not transportation *systems*, so it doesn't include much information on trains and buses or other very green options. Although I briefly discuss mass transit and car-sharing programs, I focus primarily on what *you* can do to green up your act.

Fig. 1.1: *My latest, most sustainable transportation: a former gas-engine truck that my brother-in-law and I converted to electricity. This vehicle is used for short trips to town and around the farm and The Evergreen Institute.*

Before I start, though, I will discuss some criteria to consider when attempting to green personal transportation. These rules of the road, so to speak, will help you discern what makes a truly sustainable fuel or vehicle. With these guidelines, you can proceed quickly, not wasting time and energy on ideas that really have no long-term future.

Guidelines for Sustainable Fuel Transportation

When it comes to green transportation, you'll find that there's a plethora of options. When you're choosing among them, it is important to make selections that are socially, economically, and environmentally sustainable. Green fuels and vehicles, that is, must make sense from all three perspectives to be truly sustainable. That's the first rule. If an option doesn't make sense from these perspectives, it is not worth our time or effort. Period.

With that principle in mind, we will begin with criteria by which we can judge green fuels, such as hydrogen and ethanol.

First, when considering green fuels, the most sustainable are those that have a positive net energy yield. *Net energy* refers to the energy we obtain from an energy resource after subtracting the energy it takes to make it — that is, to extract, refine, and process a fuel. The higher the yield, the better. The most sustainable fuels are therefore those with the greatest net energy yield.

Second, a sustainable fuel must be clean — in every possible way. That is, it must be produced in ways that do no harm to people or the environment — for example, to be sustainable, biofuels must come from crops that are sustainably grown and harvested. When burned or consumed, a truly green fuel should produce little, if any, harmful pollution. The cleaner and more environmentally benign, the better. We can't build a sustainable future by turning to fuels whose production and consumption poison people and other living creatures that grace our world or to fuels whose production and use threaten our atmosphere, waters, climate, and ecosystems, which are the life support system of the planet.

Third, for a fuel to be sustainable it must be abundant and renewable. We can't build a long-term transportation system on short-term fuels. That's the bind we're in now. Gasoline- and diesel-fueled vehicles rely on a resource (oil) that's quickly going the way of the dinosaurs, and is, in the process, causing severe economic turmoil. For economic stability, we need fuel we can count on forever. Building any transportation system based on fuel that's going to give out in the near future is a waste of very precious energy, resources, and time.

Fourth, we must select options that are affordable — if not now, then clearly in the near future as economies of scale kick in or as improvements in production processes drive costs down. If subsidies are required now, fine, but in the long run,

affordable fuel is vital to the long-term economic health of nations and their citizens.

The rules of the road for green *vehicles* overlap nicely with my four *fuel* guidelines. First and foremost, green vehicles must be powered by sustainable fuels. They should also be durable and safe. We don't want people dying on the highways in their quest for a greener world.

Truly green vehicles must be made from recyclable materials and designed for ease of recycling. Moreover, we must establish the infrastructure to ensure that they *can* and *will* be recycled when their useful lives are over. Even better, green cars and trucks should be made from renewable resources, for example high-strength plastics made from chemicals derived from sustainably harvested plants.

In crowded urban centers, mass transit will very likely be the most sustainable form of transportation. Such systems service large numbers of people with much less impact on the environment than single occupancy vehicles. The amount of fuel consumed per passenger mile is much lower, as is the amount of pollution produced. Still, people will very likely cling tenaciously to their cars and trucks — even if they choose to rent a car from a local car cooperative or a private company that provides the convenience of private transportation without the hassles of ownership. Rest assured, private passenger vehicles will not disappear quickly from the urban landscape in many countries, making green fuels and green cars imperative.

Keep Your Brain Engaged

Over the years, I've heard many cockeyed schemes aimed at greening transportation. While many new ideas appear great at first blush, most don't hold up to scrutiny. As you no doubt have found out, it is very easy to become swayed by novel fuel sources or novel types of vehicles, like air-powered cars that

the ill-informed media proclaim will revolutionize transportation. Enjoy the creative ideas, but employ your critical faculties. The most important question you can ask when presented with a new fuel or vehicle is this: is it truly sustainable? Sustainability should be measured by the criteria just presented, among them net energy efficiency. Inquire about the net energy efficiency of exciting new developments. Does it take more energy to make a fuel or vehicle than you get out of it? Don't be swayed by pro-oil interests who muddy the waters with falsehoods (Figure 1.2). Critics of green fuels are fond of pointing out the seemingly unfair subsidies required to support production of green fuels and new green vehicles. What they're less forthcoming

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Fig. 1.2: *Don't be fooled by lies. Contrary to the media's representation, ethanol has a* much higher *net energy efficiency than gasoline. When all the energy surrounding production and delivery is taken into account, we get a lot more energy from ethanol than we do from gasoline.*

about, however, is that gasoline and diesel require huge amounts of energy to extract, refine, and transport to market. The net energy efficiency of gasoline is very likely under *one* — meaning you get less energy out of a gallon of gasoline than it takes to make it. You won't find oil companies passing that information around. Moreover, the oil industry and their legions of followers don't say a whole lot about the amazing subsidies that continue to flow into company coffers. So don't let critics win the debate with their lies!

Remember that we're in an experimental phase on the path to a green energy future. Lots of new ideas are emerging. Some will work; others will fail miserably. Some will work because there are powerful lobby groups that stand to benefit from them. Seemingly good ideas will fail because they lack financial or political support. It will take time to sort through the options, to see what works and what doesn't. In the meantime, enjoy the ride.

To speed up the evolutionary process, though, we should apply some sensible guidelines to help us judge what is truly green. After all, we were endowed with marvelous brains, so let's use them. On a personal level, while you may not be able to influence public policy, you can make wise choices for yourself based on your understanding of what makes a fuel and a vehicle truly sustainable.

With these ideas in mind, let's get started where all journeys of sustainable transportation should begin, with what you can do *right now* to green your wheels. That's the subject of Chapter 2.

Easy Green:

Changing Driving Habits, and Other Simple Measures to Green Your Machine

When most people ponder ways to green their personal transportation, they contemplate grand schemes like futuristic hydrogen-powered cars. Or they may contemplate purchasing a hybrid or electric car or truck or converting their diesel vehicle to run on straight vegetable oil. While most of these are legitimate options, they require considerable thought and, in some cases, a substantial monetary investment.

If these and other green transportation options are more than you want to pursue right now, don't let your dream of greening your transportation idle. There are a great many ways you can reduce fuel consumption and help build a sustainable transportation system — right now, at little or no cost. You can, for instance, increase your use of mass transit or join a carpool or vanpool to commute to work. You can ride a bike or walk when going to work or when running errands near your home or office. If you live in a major city, you could sell your car and subscribe to a service like Zipcar that rents cars to members when they need one, saving members a ton of money (Figure 2.1).

You could even embark on the nearly unspeakable act of altering your driving habits. It may be hard to believe, but driving

Fig. 2.1: *Cars like this one supplied by Zipcar can be rented by city dwellers on an as-needed basis, greatly reducing the cost of personal transportation and the environmental impact of private vehicle ownership.*

your existing vehicle more efficiently can achieve the same level of fuel savings you could achieve by pursuing more costly options, like buying a more fuel-efficient car or truck. Moreover, there are a number of simple things you can do to improve the fuel efficiency of your vehicle, like keeping the tires properly inflated. Driving more efficiently and improving the efficiency of your car save gas and money, reduce pollution, and reduce the wear and tear on your vehicle. And, on top of that, fuel-efficient driving can make you a *safer* driver.

In this chapter, you will find a number of simple, practical suggestions that can help you improve fuel economy.

Wise Driving Habits

A couple of years ago, I took a road trip with some colleagues from Denver, Colorado, to Greensburg, Kansas, with the hopes of building some energy-efficient homes. The homes were to serve as a model to the community and the rest of the world

in our collective effort to combat global warming — which had no doubt contributed to the devastating 1.7-mile-wide tornado that ripped through Greensburg in 2007, wiping out 95% of the homes and killing 11 people. For most of the trip, I was behind the wheel, with my colleagues chiding me for driving 60 miles per hour (mph) on the wide-open highways. After a while, I tired of their joking and said, "Hey guys, I don't get it. You're complaining because we're driving at a slower speed, which increases mileage. That, of course, reduces carbon dioxide emissions, which reduces global warming. Global warming, of course, contributes to violent storms like the one that destroyed Greensburg."

There wasn't a word of rebuttal.

One of my friends, a green architect I work with frequently, later said he was going to drive more slowly in the future — and has kept his promise, too!

Over the years, many environmentalists — the people who presumably care the most about global warming and other environmental issues — have shamelessly admitted to having a "lead foot." One after another has confessed to me that when it comes to the need for speed, they're like most Americans: when they hit the road, getting from point A to B in the least amount of time is their number one priority. If environmentalists can't slow down to save the Earth, how can the rest of us?

If you're one of those people for whom speed is a given, you should know what your aggressive driving habits are costing you. Aggressive driving dramatically lowers fuel economy — both in the city and on the highway. In the city, it easily reduces fuel consumption by 5%. On the highway, it can lower fuel economy by up to 30%. If you're getting 300 miles per tank of gas, driving more sensibly could add another 75 miles to your range. That means you can go longer between fill-ups, saving time and money. If you're spending $2,000 a year on gasoline,

an easily achieved 25% savings is a whopping $500. If you earn $25 per hour, you'll be able to work 20 hours a year less! In addition, more sensible habits reduce the release of pollutants and our dependence on foreign oil. So, how can you tame those aggressive habits?

Maintain a Constant Speed. When driving on the highway, use the cruise control to maintain a constant speed. Set it at the speed limit, or a little below, then sit back and relax. Relying on cruise control is a simple measure that saves gas (and reduces strain on the muscles of your leg and foot). According to the experts at Edmunds.com, cruise control can improve fuel mileage by 7–14%, except in mountainous terrain.

If you prefer to control speed yourself, be sure to keep a steady foot on the gas pedal. This method is more challenging and results in more muscle strain, especially on long trips. And few people find it easy to maintain a constant speed.

While maintaining a constant speed is ideal, it's not always practical. There are times when you need to speed up. If you must accelerate, it helps to wait until you are on a downhill section. Let gravity assist your car's engine — and help save gas. You'll be amazed at how many declines there are on seemingly flat highways, even in the Midwest.

Avoid Tailgating. When driving in traffic, be sure to leave sufficient space between your car and the car in front of you. If the driver in front of you speeds up, don't feel compelled to follow suit. Chances are the driver will soon slow down. If you are following too closely, you'll need to step on the brake too, wasting all that fuel you just spent speeding up. In essence, you've just allowed the anonymous driver in front of you to be in charge of your own gas mileage.

Avoid Jackrabbit Starts. Many people accelerate from a stop light or stop sign as if they're on the starting line of the Indy 500. With the pedal pressed to the floor, they dart off like

a race car driver intent on winning the trophy. These are called jackrabbit starts.

Unfortunately, quick starts waste a tremendous amount of fuel, especially when traveling on roads with frequent stop lights or stop signs. When the light turns green, resist that urge to step on the gas.

You don't have to be the first off the line. Chances are, the few seconds you think you are saving will be lost at the next stop light anyway. The more conservative driver in your rear view mirror will very likely catch up to you, reaching the same destination having used a lot less fuel. By driving more efficiently, you'll spend less time at the gas pump during your life. Any time you "save" by driving like a maniac will eventually be offset as you mindlessly wait at the gas pump for the tank to fill. And you'll spend more of your life working to pay for the fuel you burn unnecessarily.

Slow Down, You Move too Fast. Simon and Garfunkel's advice is as relevant to driving as it is to us in our everyday lives. Numerous studies show that fuel mileage decreases dramatically the faster a car goes. In most cases, fuel mileage begins to plummet at speeds over 50–55 mph. One study by *Consumer Reports,* for instance, showed that fuel mileage fell 12.5% when a car's speed increased from 55 to 65 mph. It dropped another 12.5% when speed increased from 65 to 75 mph. Why does speed increase fuel consumption?

The main reason is something engineers call *aerodynamic drag.* This is the force on a car that resists its motion through air. One of the sources of aerodynamic drag is skin friction. Skin friction occurs between the air molecules and the exterior of a car. Because the skin friction is an interaction between a solid and a gas, its magnitude depends on the properties of both. The smoother the surface, for instance, the lower the drag. The denser the air, the greater the drag.

Drag is also generated by the resistance air molecules pose to an object in motion through it. This source of drag depends on the shape of the object (it's called *form* drag). In cars, then, drag is affected by the frontal area of a car, its design (how sleek and aerodynamic it is or isn't), and the density of the air.

As a general rule, drag increases as a function of the square of the speed. That means if the speed doubles, drag quadruples. And, while drag is important, we're even more interested in power requirements and fuel consumption. As a general rule, the horsepower required to move a vehicle forward increases as the *cube* of the speed. If the speed doubles, the horsepower required to move the vehicle increases five to six times. For example, a hypothetical medium-sized SUV that requires 20 horsepower at 50 mph might require 100 horsepower at 100 mph. Does that mean the fuel consumption increases accordingly?

No, things are a bit more complex than that. While power increases as a function of the cube of the speed, fuel consumption doesn't necessarily increase in step. That's because engines are very complicated machines and efficiency is a function of other factors besides drag. For one thing, most engines normally operate most efficiently near 80% of their full throttle.

So what's the bottom line? Driving at high speeds dramatically increases fuel consumption. Driving more slowly substantially reduces fuel consumption. Those who drive more slowly consistently get better gas mileage than the ratings provided by the EPA on every new vehicle. You can take that to the bank.

How much fuel economy declines depends on the design of the vehicle and the engine, but you can count on a substantial decrease at speeds over 60 mph — from 7–23%, depending on the vehicle. The faster you go, the lower the fuel economy. If your car averages 30 miles per gallon (mpg) at 60 mph, fuel mileage could plummet to 23 mpg — or even lower — at 75

mph. You're essentially throwing away about one fourth of the fuel that you put into the tank, fuel for which you paid dearly.

Because engines vary with respect to efficiency, and the aerodynamics of vehicles also vary considerably, the sweet spot for each car varies. For example, Jeep Cherokees operate most efficiently at 55 mph, while Toyota 4Runners operate most efficiently at a slightly slower 50 mph. Some stick shifts with small engines operate most efficiently at around 35 mph!

It may take some experimentation to figure out your vehicle's sweet spot. If your car comes with a fuel economy gauge (like the Ford Fusion or Chevy Cobalt), it's relatively easy to find the sweet spot. To do so, select a very flat section of highway (a 2–5 mile section is best) and let 'er rip. Try 50 mph for 5 minutes, then turn around and go back to the starting point. Record the fuel economy. Now drive the same section at 55 mph. Record your fuel economy. Repeat at 60, 65, 70, and perhaps even 75 mph, provided high speeds are permitted, of course.

Some cars, like the Toyota Prius and Honda Civic Hybrid, have fuel mileage gauges that indicate the immediate mileage but also keep track of long-term fuel mileage, which will make your experiment run a little smoother. Prius owners have found that this car performs best at speeds below 50 mph, perhaps even as low as 40 mph. I notice a substantial increase in mileage in my 2004 Prius when cruising at 55–60 mph compared to 65 or 70.

I'm *not* advocating dangerously slow speeds, especially on major highways, but you should know the facts. For most cars, you'll find that fuel mileage decreases fairly substantially at speeds over 60 mph.

Shift Properly. Most passenger cars and light trucks these days are automatic that is, they shift on their own. But there

are a number of vehicles on the road that require the driver to shift gears. As a rule, vehicles with manual transmissions are more fuel efficient than those with automatic transmissions. Those who drive cars with manual transmissions, however, can improve their fuel economy even more by paying attention to when they shift and the gear they are operating in. Shifting a few hundred rpm lower than you normally do, for instance, can save on fuel. Operating in fourth gear when the car should be in fifth gear is wasteful, too, as it increases the rpm and uses more fuel. So pay close attention. If the engine's racing, you should be in a higher gear.

Selecting the right gear depends on the engine, the transmission, and the driving conditions. If you're going up a hill, for instance, you may want to shift into a lower gear to provide more power. On the open highway, though, your car will generally operate most efficiently in the highest gear.

When stopped, watch your foot on the gas pedal. There's no need to race the engine. And when taking off, press on the gas pedal slowly. Give the car only enough gas to maintain the idle rpm as you let off the clutch. As any experienced manual shift driver knows, there's no need for a heavy foot when just starting off.

Smart Braking. As you approach a stop sign, a stop light, or highway congestion, you can save gas by removing your foot from the accelerator pedal well before you need to stop. This

Shopping Tip

When buying a new car, look for one with a *continuous variable transmission* (CVT). It does not shift from one gear to another, but changes the gear ratio constantly so you're always in the right gear.

allows your vehicle to decelerate gradually, essentially gliding to a stop. Planning ahead for braking in stop-and-go traffic saves a lot of fuel over the long haul. There's no sense speeding up to a stop light, then slamming on the brakes. Although it's a common habit, it's extremely wasteful. As an additional suggestion, if you drive a manual transmission, you may want to slip the car out of gear as you glide to a halt or downshift to use your engine to brake the car.

Get Up and Go. One time when impatience pays is in the morning when you're on your way to work or school or off to run errands. Many people are under the false impression that letting their car idle for several minutes helps the engine. Although gas engines should be given a short period to warm up, 30 seconds is usually sufficient. Letting the car idle for 5 or 10 minutes while you pack your briefcase or slam down your coffee wastes a lot of fuel.

The best way to warm up a car in the morning is to start your engine, let it run for 30 seconds, then take off, driving slowly until the engine reaches the proper operating temperature. It only takes a few minutes. If your car has an engine temperature gauge, you can tell by watching it.

Shut 'er Down. You can also reduce fuel consumption by reducing engine idling at stop lights, railroad crossings, and fast-food drive-up windows. If you expect your car will idle longer than 10 seconds, save gas by turning the engine off and then restarting when traffic starts up. Don't go crazy on this, as stopping and starting an engine too frequently may result in excessive wear and tear on the starter and the car's wiring.

Smart Trip Planning Improves Fuel Efficiency

How you drive affects fuel consumption, but good trip planning can also help, often substantially. To reduce fuel consumption, consider better planning.

Combine Trips. To save gas, I routinely maintain a list of errands I need to run each week, then I run as many as I can in one trip. Doing so decreases the number of miles I drive each week and thus reduces the amount of fuel my car burns. Combining trips, in turn, reduces emissions and pollution and wear and tear on my car, saving additional money. And it saves a lot of time.

Combining trips not only cuts vehicles miles traveled (VMT), it also boosts the fuel economy of a car by reducing the number of engine starts and the amount of time a car spends "running cold." As you may know, starting a car uses a lot of fuel, so reducing engine starts reduces waste. Cold engines also operate less efficiently than warm engines, so combining trips, especially in cold weather, increases the fuel efficiency of your vehicle. Because warm engines operate more efficiently, they produce less pollution, too.

My advice is to combine errands into one or two trips a week, whenever possible, especially if each of the short trips involves cold starts. Be especially diligent about combining trips in cold weather. And, whenever possible, eliminate short trips followed by long intervals during which the engine cools. For nearby errands, you may want to consider walking, riding a bike, or taking a bus.

To avoid frequent errands, consider buying staples and other supplies, such as toilet paper, in bulk. Having a backup supply will cut down on "emergency runs." A pantry full of food is a great energy-saving resource.

Plan Your Route Carefully. You can reduce fuel consumption by planning routes that require the least amount of time on the road and the fewest number of stops. As you no doubt have found, you spend a lot of time waiting for traffic to clear to make left turns. When I run errands, I try to plot paths that require only right turns. (It's really quite simple.) This strategy

is used by United Parcel Service (UPS). When their drivers leave in the morning, they're assigned deliveries in an order that reduces the number of left turns. This simple strategy saves UPS a fortune in fuel costs and driver time. You'll be surprised at how much time and money it can save you, too.

When plotting routes, also remember that it's usually best to drive on the highway rather than on city streets. Highways generally have less stop-and-go traffic, which reduces idle time and fuel waste. (One exception may be during "rush hour" traffic, perhaps the greatest misnomer in the human language, as traffic often moves at a snail's pace and frequently comes to a complete halt.)

Finally, when shopping, avoid the impulse to secure the closest parking spot. Shoppers waste a lot of gas cruising parking lots of malls searching for prime parking spaces. To save time and fuel, park on the periphery. The exercise will be good for you, and you'll save a lot of fuel — and probably some time — in the long run.

Modifying Your Vehicle to Improve Fuel Efficiency

Smart driving and trip planning can save a lot of costly fuel and help reduce pollution, but there's much more you can do to improve fuel efficiency.

Remove Roof Racks and Roof Carriers. One way to make your vehicle more fuel efficient is to remove unused rooftop racks. Racks for skis and boats and rooftop luggage carriers are handy, but they decrease fuel economy by increasing aerodynamic drag, which slows vehicles down and reduces gas mileage.

Rooftop racks and carriers counteract the millions of dollars auto manufacturers have spent in recent years to make their vehicles more aerodynamic. If possible, remove racks and rooftop carriers when they're not being used. Doing so could increase your fuel mileage by 1–5%. Even flags, banners, and

toys attached to antennas can increase drag and reduce fuel mileage. Remove the banner of your favorite football team after the Sunday game and save gas!

Air Conditioner or Open Windows? Driving with the windows open increases drag and lowers fuel mileage, so many people drive with their air conditioner running. Unfortunately, operating a car's air conditioner increases the work an engine must perform, which increases fuel consumption. So what's a smart driver to do?

The rule of thumb is to drive with the windows open at lower speeds (below 50 mph) unless it is swelteringly hot, of course. At higher speeds (over 50 mph), close the windows and turn on the air conditioner to stay cool. Studies show that when traveling at highway speeds, fuel efficiency increases (but only slightly) if the windows are rolled up and the air conditioner is running.

Repair Body Damage. The aerodynamics of cars are compromised by dents in the body, so repair body damage as soon as possible. Keep your car clean, too, as mud on the body can increase drag and reduce fuel mileage.

Slow Down on Wet Roads. Road conditions also affect fuel economy. Water on the highway, for instance, increases the resistance the tires encounter, reducing fuel economy. Although you may not be able to avoid driving when roads are wet, consider slowing down. This is not only safer (it reduces

Advice on Air Conditioning

Whenever possible, avoid using the air conditioner in stop-and-go city traffic. Operating the air conditioner causes the engine of a car to work harder, causing it to consume a lot more fuel.

hydroplaning), it also reduces resistance to forward movement, thus saving gas.

Lose the Weight. Many people routinely carry a lot of additional weight in their cars — in rooftop carriers or in the back seat or trunk. Because the weight of a vehicle affects how hard an engine must work to accelerate or maintain speed, extra weight reduces fuel economy. An additional 100 pounds, for instance, can decrease fuel consumption by 1–2%.

Whenever possible, remove unnecessary cargo from your car or truck. I thoroughly unpack my car after each trip, putting items away that I don't need to haul around on errands or short trips. Be sure to remove your chains and ice scrapers at the end of the winter.

Some energy conservation zealots have been known to remove unused seats in their vehicles (especially vans) to reduce weight. Although this may be too extreme for most people, you can easily trim the weight of your car by emptying your trunk or back seat or the bed of your pickup of unnecessary items. And if you've been looking for an excuse to lose those additional pounds, this might be just what the doctor ordered!

Keep Your Car Tuned. A well-tuned car is an efficient one. Keeping your car tuned can increase fuel mileage by up to 4%. A properly tuned engine also maximizes power. (Tell your mechanic you do *not* want efficiency measures disabled when your car is being tuned for power.)

Car Buying Tip

While excess cargo weight is important, overall vehicle weight is an even more important factor in determining fuel economy. When buying a car, pay attention to vehicle *curb weight.* Purchase the lightest, safest car you can.

When a car is tuned, mechanics typically replace the fuel and air filters to improve the efficiency of the engine. (A very dirty air filter can reduce fuel mileage by 10% and can make an engine stall when it's idling.) Be sure to replace the fuel and air filters according to the manufacturers' recommendations.

Be sure your mechanic checks the oxygen sensors, engine emissions system, and evaporative emissions control systems when tuning your fuel-injected vehicle. (The vast majority of the cars and light trucks on the road today are fuel injected.) Resist the temptation to ignore warning lights. Take your car in for service if the "check engine" light comes on. This is usually an indication that there is a problem with one of the vehicle's sensors. All are important to the proper and efficient functioning of the computer-controlled engines of modern vehicles. A

Tire Buying Tips

When buying new tires, be sure to ask the supplier for their most fuel-efficient tires. They are known as "low-rolling resistance tires." These tires are slightly harder than others, which reduces friction between the tires and the surface of the road. Fuel-efficient tires often come with a new vehicle — they're the same tires the manufacturer puts on its cars to rate the car model for fuel efficiency, and manufacturers use every trick they can to boost their fuel economy ratings. If you are satisfied with how they wear, consider buying the same model when it comes time to replace them. I've been disappointed with the performance of the original tires on one of my cars in the past. Although they did help reduce fuel consumption, they didn't last long. In fact, I didn't get a full season out of them. (I can't say for sure, but I suspect the tread was too thin.) Whatever you do, be sure new tires ☛

damaged oxygen sensor, for instance, may throw off the fuel mixture, decreasing fuel mileage by 20% or more.

When your mechanic tunes your car, ask him or her to look for fouled fuel injectors. Clean or replace them when necessary.

Maintain Proper Tire Pressure. You've heard the advice a million times: maintain proper tire pressure. According to several sources, properly inflated tires can improve the fuel mileage of a car or truck by up to 3%. Although this is a small savings, when you add it to other measures like saner driving habits, combining trips, and keeping your car tuned, the cumulative effect can be quite substantial.

Your tires can lose up to one pound per square inch (psi) in pressure per month. Air pressure inside a tire also decreases

will last. Ask the supplier for projected wear data. Michelin and Goodyear have recently released fuel-efficient tires that could save a significant amount of fuel over the lifetime of a set of tires. I put the Goodyear tires on my Prius and noticed an immediate increase in fuel economy.

When buying tires, select the narrowest possible tires that will work with your driving style (aggressive vs. mild-mannered, for instance). Aggressive driving requires wider tires. Narrow tires reduce the frontal area, the amount of surface area that contacts the wind. Reducing the frontal area reduces aerodynamic drag. Narrow tires are therefore typically more fuel efficient. Avoid the tendency to oversize tires. If a tire supplier is out of the right size, they may try to sell you a wider tire. Remember, however, that narrow tires provide less traction, so you don't want to go overboard. ■

when outside temperatures plummet. Cold temperatures cause the air inside the tires to contract and pressure to drop, reducing the efficiency of the car.

Most experts on fuel efficiency recommend that car owners check the air pressure in their tires at least once a month, preferably weekly. When you get a new set of tires installed, ask what the recommended tire pressure is. Write the number down. (Your owner's manual should also list proper tire pressure.) You may want to consider buying a portable electric compressor to fill your tires. It's a lot easier than running to the gas station once a month to top off your tires.

Besides saving fuel, proper inflation also helps avoid uneven wear and tear on the tread of a tire, saving you money in the long run.

Change Your Oil on Schedule. To improve fuel economy, change the oil of your car frequently. Clean oil allows the engine to operate more smoothly.

You may receive conflicting advice about when to change your oil. The 3,000-mile oil change recommended by the guys who are profiting is excessive according to several car experts; 6,000 to 8,000 miles is probably a good range. (Extending oil change intervals too much can damage your engine and could reduce fuel mileage.)

Changing oil on a set (but reasonable) schedule can improve fuel mileage by an additional 1–2%. That's because oil gets dirty and its chemical composition changes with use. Both dirt and chemical changes in the oil increase its viscosity (thickness). Increased viscosity means the engine operates under a heavier load — so it's harder for the internal components like the pistons to move. This, in turn, reduces fuel efficiency.

While you are at it, you may want to consider adding an oil additive to your oil, which is available at auto supply stores, or using a low-friction synthetic oil. Both can improve fuel mileage.

Because synthetic oils have a lower viscosity than conventional engine oil, they can increase fuel economy, on average, by 5% (in some cases by up to 15%). Also, because they are less subject to chemical breakdown, they will outlast conventional oil and won't need to be replaced as often.

Unfortunately, synthetic oils are substantially more expensive than standard engine oil — three to four times more! The higher cost, though, may be offset by less frequent oil changes — you can easily go 8,000 miles between oil changes. Some synthetic oils don't need to be changed for 25,000 miles.

Synthetic oil is better on a number of other levels as well. It keeps the engine cleaner through improved sludge and varnish protection and reduces engine wear at high temperatures. It also protects engines that are running under severe conditions at high temperatures. Synthetic oil provides better cold-temperature starts with faster oil flow at ignition, and thus improves fuel efficiency.

Fill 'er up. Some people operate their vehicles near empty much of the time, putting only a few dollars worth of gas in at any time. Unfortunately, running on fumes can reduce fuel economy. Why?

Gas splashes around in the fuel tank as we lumber along highways and byways and can splash away from the opening through which gasoline flows to the fuel line. If your tank runs low, splashing means that the engine does not receive a steady supply of gasoline. This, in turn, can reduce the efficiency of your engine. Whenever possible, try to keep your tank at least one third full at all times.

Keep a Log. I calculate fuel economy in my head every time I fill up my car, and have done so for years. Unfortunately, my mind is not a perfect calculator. I round up or down or drop numerals to the right of the decimal point to make the math easier.

If you want to monitor your fuel mileage to see if changes you've made are working, consider starting a log. Keep track of the number of gallons you add each time you fill your tank, write down the odometer reading, and calculate the number of miles you traveled. Keep track of fractions (fuel) and decimals (mileage). If you have the time, you may even want to put this information on a spreadsheet. Or if you have an iPhone, yes, "there's an app for that." Actually, several of them. One is called Vehicle Log Book.

Without a precise way of tracking mileage and fuel consumption, you'll never know for certain whether you are reducing fuel consumption or increasing it.

Conclusion

Clearly, there are a lot of easy, inexpensive ways to improve fuel economy in cars, trucks, SUVs, and vans. If you are serious about doing your part to reduce our dependence on foreign oil and combat climate change and other environmental problems, rest assured you don't have to lay down $30,000 for a new hybrid. You can start today by becoming a more fuel-conscious driver.

Why not join the tiny band of responsible drivers who are cruising the highways, driving at or below the speed limit on their carefully planned routes, combining errands whenever possible, and keeping their cars tuned, saving the world one gas tank at a time?