

# Efficiency and Conservation



## Selected Countries and Energy Consumption, 2016

| Country            | Population (millions) | Total Primary Energy Consumption (Qbtu) | Energy per capita (MBtu/person) |
|--------------------|-----------------------|---|---------------------------------|
| World              | 7,503.83              | 579.54                                  | 77.23                           |
| China              | 1,384.69              | 139.20                                  | 100.53                          |
| India              | 1,296.83              | 29.04                                   | 22.39                           |
| United States      | 329.26                | 97.41                                   | 295.85                          |
| Indonesia          | 262.79                | 7.25                                    | 27.58                           |
| Brazil             | 208.85                | 12.48                                   | 59.75                           |
| Pakistan           | 207.86                | 3.11                                    | 14.99                           |
| Nigeria            | 203.45                | 1.59                                    | 7.81                            |
| Russia             | 142.12                | 31.49                                   | 221.53                          |
| Japan              | 126.17                | 19.65                                   | 155.74                          |
| Mexico             | 125.96                | 7.94                                    | 63.05                           |
| Germany            | 80.46                 | 13.86                                   | 172.32                          |
| Iran               | 83.02                 | 11.26                                   | 135.62                          |
| Thailand           | 68.62                 | 5.42                                    | 78.97                           |
| France             | 67.36                 | 10.15                                   | 150.68                          |
| United Kingdom     | 65.11                 | 8.77                                    | 134.70                          |
| South Africa       | 55.38                 | 6.07                                    | 109.67                          |
| South Korea        | 51.42                 | 12.96                                   | 252.07                          |
| Canada             | 35.88                 | 14.68                                   | 409.02                          |
| Saudi Arabia       | 33.09                 | 10.83                                   | 327.42                          |
| Australia          | 23.47                 | 5.99                                    | 255.15                          |
| Netherlands        | 17.15                 | 0.19                                    | 11.32                           |
| Chile              | 17.93                 | 1.48                                    | 82.56                           |
| Honduras           | 9.18                  | 0.17                                    | 18.21                           |
| Haiti              | 10.79                 | 0.05                                    | 4.42                            |
| Libya              | 6.75                  | 0.65                                    | 95.65                           |
| Iraq               | 40.19                 | 1.90                                    | 47.32                           |
| Dominican Republic | 10.30                 | 0.36                                    | 34.56                           |
| Kuwait             | 2.92                  | 1.60                                    | 548.09                          |
| Angola             | 30.36                 | 0.36                                    | 11.89                           |
| Zimbabwe           | 14.03                 | 0.16                                    | 11.27                           |
| Mauritius          | 1.36                  | 0.08                                    | 60.70                           |

\*2017 Global Data not yet available for all nations.  
Data: Energy Information Administration, The World Bank

## Introduction

The United States uses a lot of energy— over 2.8 million dollars worth of energy each minute, 24 hours a day, every day of the year. With less than five percent of the world’s population, we consume a little less than one-fifth (16.88 percent) of the world’s energy. We are not alone among industrialized nations; average-world energy use per person continues to grow at a rate of approximately 10% per year, while population also continues to increase.

The average American consumes 3.91 times the world average per capita consumption of energy. Every time we fill up our vehicles or open our utility bills, we are reminded of the economic impacts of energy.

## Energy Efficiency and Conservation

Energy is more than numbers on a utility bill; it is the foundation of everything we do. All of us use energy every day—for transportation, cooking, heating and cooling rooms, manufacturing, lighting, water-use, and entertainment. We rely on energy to make our lives comfortable, productive, and enjoyable. Sustaining this quality of life requires that we use our energy resources wisely. The careful management of resources includes reducing total energy use and using energy more efficiently.

The choices we make about how we use energy—turning machines off when not in use or choosing to buy energy efficient appliances—will have increasing impacts on the quality of our environment and lives. There are many things we can do to use less energy and use it more wisely. These things involve energy conservation and energy efficiency. Many people use these terms interchangeably; however, they have different meanings.

**Energy conservation** includes any behavior that results in the use of less energy. **Energy efficiency** involves the use of technology that requires less energy to perform the same function. A compact fluorescent light bulb that uses less energy to produce the same amount of light as an incandescent light bulb is an example of energy efficiency. The decision to replace an incandescent light bulb with a compact fluorescent is an example of energy conservation.

As individuals, our energy choices and actions can result in a significant reduction in the amount of energy used in each sector of the economy.

## Residential/Commercial

Households use about one-fifth of the total energy consumed in the United States each year. The typical U.S. family spends about \$1,850 a year on utility bills. At least 55 percent is in the form of electricity, the remainder is mostly natural gas and oil, depending on the systems in the home.

Much of this energy is not put to use. Heat, for example, pours out of homes through doors and windows and under-insulated attics, walls, floors, and basements. Some idle appliances use energy 24 hours a day. The amount of energy lost through poorly insulated windows and doors equals the amount of energy flowing through the Alaskan oil pipeline each year.

Energy efficient improvements cannot only make a home more comfortable, they can yield long-term financial rewards. Many utility companies and energy efficiency organizations provide energy audits to identify areas where homes are poorly insulated or energy inefficient. This service may be free or at low cost.

The residential and commercial sectors generate more than 10 percent of greenhouse gas emissions that contribute to global climate change. The three main sources of greenhouse gas emissions from homes are electricity use, space heating, and waste. Using a few inexpensive, energy efficient measures can reduce your energy bill and, at the same time, reduce air pollution.

### ■ Heating and Cooling

Heating and cooling systems use more energy than any other systems in American homes. Natural gas and electricity are used to heat most American homes, electricity to cool almost all. Typically, about half of the average family's utility bills goes to keeping homes at a comfortable temperature.

With all heating, ventilation, and air-conditioning systems, you can save money and increase comfort by installing proper insulation, maintaining and upgrading equipment, and practicing energy efficient behaviors. By combining proper maintenance, upgrades, insulation, weatherization, and thermostat management, you can reduce energy bills and emissions by half.

A seven to ten degree adjustment to your **thermostat** setting for eight hours a day can lower heating bills by ten percent. Programmable thermostats can automatically control temperature for time of day and season for maximum efficiency.

### ■ Insulation and Weatherization

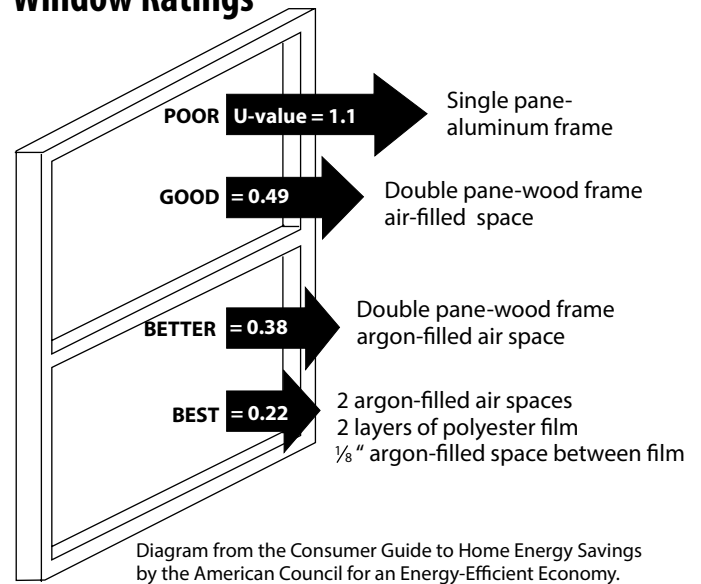
Warm air leaking into your home in cooling seasons and out of your home in heating seasons can waste a substantial amount of energy. You can increase home comfort and reduce heating and cooling needs by up to 20 percent by investing a few hundred dollars in proper **insulation** and weatherization products. Insulation is rated using an R-value that indicates the resistance of the material to heat flow. You need a minimum **R-value** of 26, or more than three inches of insulation, in ceilings and walls. In very cold climates, a higher R-value is recommended.

Insulation wraps your house in a nice warm blanket, but air can still leak in or out through small cracks. Often the effect of the many small leaks in a home is equivalent to a wide open door. One of the easiest money-saving measures you can perform is to caulk, seal, and weather strip all seams, cracks, and openings to the outside. You can save 10 percent or more on your energy bill by reducing the air leaks in your home.

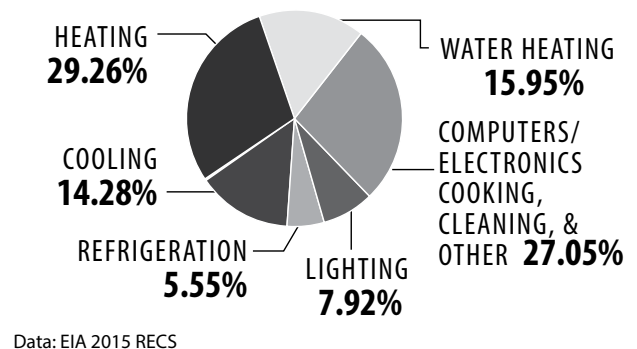
### ■ Doors and Windows

About one-quarter of a typical home's heat loss occurs around and through the doors and windows. Energy efficient doors are insulated and seal tightly to prevent air from leaking through or around them. If your doors are in good shape and you don't want to replace them, make sure they seal tightly and have door sweeps at the bottom to prevent air leaks. Installing insulated storm doors provides an additional barrier to leaking air.

## Window Ratings



## Home Energy Expenditures



Most homes have more windows than doors. Replacing older windows with energy efficient ones can significantly reduce air leaks and utility bills. The best windows shut tightly and are constructed of two or more pieces of glass separated by a gas that does not conduct heat well. The National Fenestration Rating Council has developed a rating factor for windows, called the **U-factor**, that indicates the insulating value of windows. The lower the U-factor, the better the window is at preventing heat flow through the window.

Windows, doors, and skylights are part of the government-backed **ENERGY STAR**® program that certifies energy efficient products. To meet ENERGY STAR® requirements, windows, doors, and skylights must meet requirements tailored for the country's three broad climate regions. Windows in the northern states must have a U-factor of 0.30 or less; in the central climate, a U-factor of 0.35 or less; and in the southern climate, a U-factor of 0.60 or less. They must also meet other criteria that measure the amount of solar energy that can pass through them.

# Efficiency and Conservation

## Appliance Energy Consumption

| Appliance                     | Average annual expenditure | kWh/yr |
|-------------------------------|----------------------------|--------|
| Electric stove, oven or range | \$31                       | 241    |
| Ceiling fan                   | \$36                       | 285    |
| Clothes dryer                 | \$98                       | 776    |
| Clothes washer                | \$8                        | 59     |
| Dishwasher                    | \$15                       | 113    |
| Microwaves                    | \$17                       | 123    |
| Refrigerator                  | \$103                      | 756    |
| Second freezer                | \$69                       | 537    |
| TV and related components     | \$103                      | 760    |

Data: EIA 2015 RECS

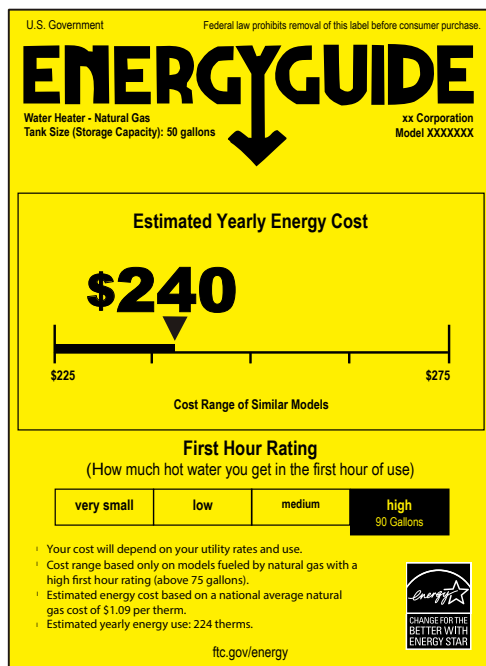
\*Average yearly consumption data accounts for devices used in different modes, i.e. idle, charging, etc.

## ENERGY STAR® Logo

Energy efficient products are labeled with the ENERGY STAR® logo. Appliances include the EnergyGuide label allowing for easy energy comparisons between products.



## EnergyGuide Label



If you cannot replace older windows, there are several things you can do to make them more efficient. First, caulk any cracks around the windows and make sure they seal tightly. Add storm windows or sheets of clear plastic to create additional air barriers. You can also hang insulated drapes. During heating seasons, open them on sunny days and close them at night. During cooling seasons, close them during the day to keep out the sun.

### Landscaping

Although it isn't possible to control the weather, certain landscape practices can modify its impact on home environments. By strategically placing trees, shrubs, and other landscape structures to block the wind and provide shade, residents can reduce the energy needed to keep their homes comfortable during heating and cooling seasons. If the landscaping is well done, residents receive the additional benefits of beauty and increased real estate values. A well-planned landscape is one of the best investments a homeowner can make.

### Appliances

In 1987, Congress passed the National Appliance Energy Conservation Act. The Act required certain home **appliances** to meet minimum

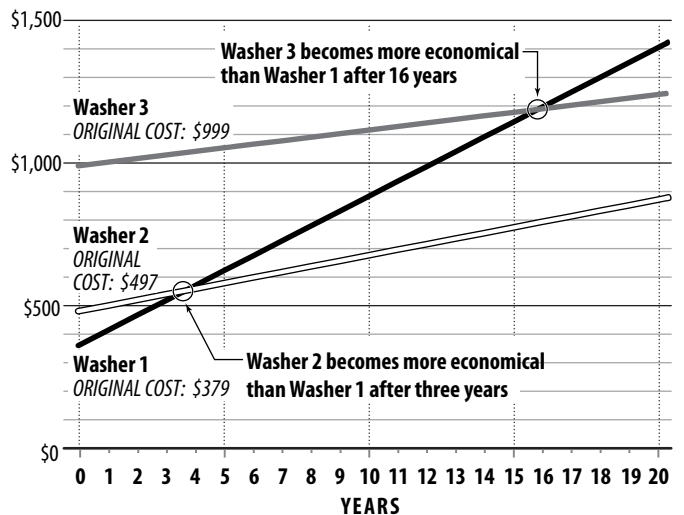
## Washing Machine Payback Period

Spending a little bit more money on an energy efficient appliance could save you several hundred dollars over the lifetime of the product. The payback period could be shorter than you think!



|                                  | WASHER 1 | WASHER 2 | WASHER 3 |
|----------------------------------|----------|----------|----------|
| Original Cost                    | \$379    | \$497    | \$999    |
| Estimated Annual Electricity Use | 427 kWh  | 160 kWh  | 102 kWh  |
| Price of Electricity (per kWh)   | \$0.12   | \$0.12   | \$0.12   |
| Operating Cost per Year          | \$51.24  | \$19.20  | \$12.24  |

COST OVER THE LIFETIME OF THE MACHINE



Data: NEED analysis of washing machine EnergyGuide labels

energy efficiency standards. The Act set standards for seven major home appliances that were already required to have EnergyGuide labels, plus it set standards for heat pumps, central air conditioners, and kitchen ranges. Most of the standards took effect in 1990. Appliances that contribute significantly to a typical household's energy consumption, are refrigerators, laundry machines, and cooking appliances.

When you shop for new appliances, you should think of two price tags. The first one covers the purchase price—consider it a down payment. The second price tag is the cost of operating the appliance during its lifetime. You'll be paying that second price tag on your utility bill every month for the next 10 to 20 years, depending on the appliance. Many energy efficient appliances have higher initial purchase costs, but they save significant amounts of money in lower energy costs. Over the life of an appliance, an energy efficient model is always a better deal.

When you shop for a new appliance, look for the ENERGY STAR® logo—your assurance that the product saves energy. ENERGY STAR® appliances have been identified by the Environmental Protection Agency and U.S. Department of Energy as the most energy efficient products in their classes. These appliances incorporate advanced technologies that use 10-50 percent less energy and water than standard models. A list of these appliances can be found on the ENERGY STAR® website at [www.energystar.gov](http://www.energystar.gov).

Another way to determine which appliance is more energy efficient is to compare energy usage using **EnergyGuide labels**. The Federal Government requires most appliances to display bright yellow and black EnergyGuide labels. Although these labels do not tell you which appliance is the most efficient, they will tell you the annual energy consumption and average operating cost of each appliance so you can compare them.

Refrigerators, for example, account for about five percent of household energy use. Replacing an older refrigerator with a new energy efficient model can save significantly on energy bills, as well as emissions. With older models, a large amount of electricity can be saved by setting the refrigerator temperature at 37 degrees, the freezer temperature at five degrees, and making sure that the energy saver switch is operational and in use.





Refrigerators should also be airtight. Make sure the gaskets around the doors are clean and seal tightly. Close the door on a piece of paper—if you can easily pull out the paper when the door is closed, you need to replace the gaskets.

### ▪ Lighting

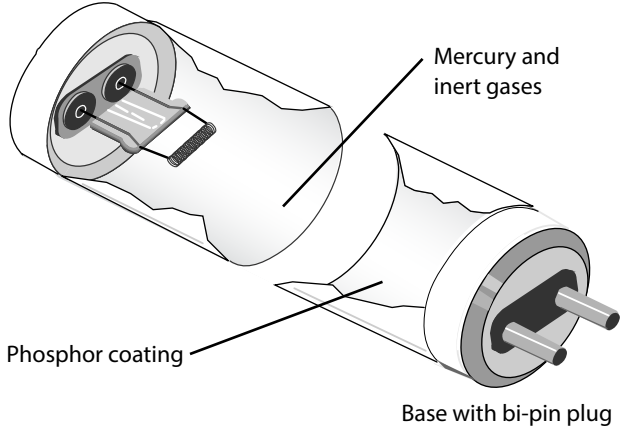
In the typical home, lighting accounts for almost eight percent of the total energy bill. Much of this expense is unnecessary, caused by using inefficient incandescent light bulbs. Only 10 percent of the energy consumed by an incandescent bulb produces light; the remainder is given off as heat.

To help combat this waste, the Energy Independence and Security Act of 2007 changed the standards for the efficiency of light bulbs used most often. As of 2014, most general use bulbs needed to be 30 percent more efficient than traditional, inefficient incandescent bulbs.



| INCANDESCENT BULB  | HALOGEN BULB  | CFL BULB  | LED BULB  |
|--|---|---|---|
|   |  |  |  |
| <p>LEDs offer better light quality than incandescent bulbs and halogens, last 25 times as long, and use even less energy than CFLs. LEDs now have a wide array of uses because technology has improved and costs have decreased.</p> |   |   |   |

### Fluorescent Tube Lamp



In fluorescent tubes, a very small amount of mercury mixes with inert gases to conduct the electric current. This allows the phosphor coating on the glass tube to emit light.

What do the new standards mean for consumers? The purpose of the new efficiency standards is to give people the same amount of light using less energy. There are several lighting choices on the market that already meet the new efficiency standards.

Energy-saving incandescent, or halogen bulbs, are different than traditional, inefficient incandescent bulbs because they have a capsule around the filament (the wire inside the bulb) filled with halogen gas. This allows the bulbs to last three times longer and use 25 percent less energy.

Compact fluorescent light bulbs (CFLs) provide an equivalent amount of light as incandescents, but use up to 75 percent less energy and last ten times longer.

Light emitting diodes (LEDs) use even less energy than a CFL and last 25 times longer than traditional incandescent bulbs. This means life cycle emissions for an LED will be far fewer than any other type of bulb. LEDs have become the more affordable, efficient option for homes and businesses and are more durable than other bulb options. LEDs have many uses in the home and can be utilized in mainly technical applications.

# Efficiency and Conservation

## Water Heating

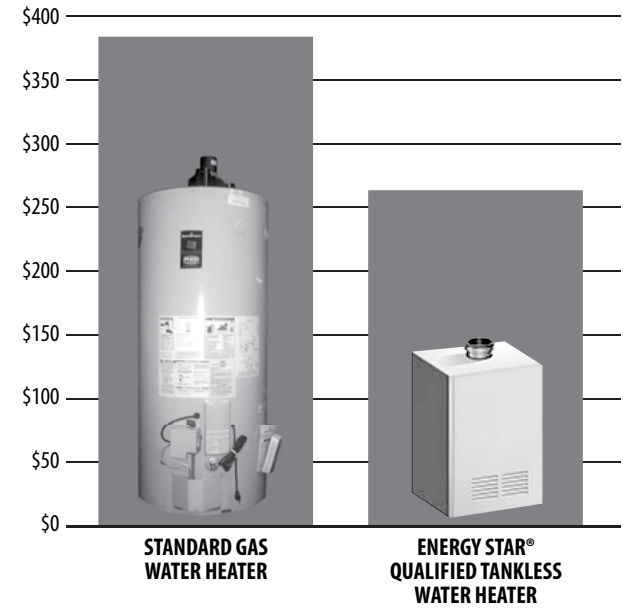
Water heating is one of the largest energy expenses in your home after space heating and cooling appliances. It typically accounts for about 16 percent of your utility bill. Heated water is used for showers, baths, laundry, dishwashing, and general cleaning. There are four ways to cut your water heating bills—use less hot water, turn down the thermostat on your water heater, insulate your water heater and pipes, and buy a new, more efficient water heater.

One of the easiest and most practical ways to cut the cost of heating water is to simply reduce the amount of hot water used. In most cases, this can be done with little or no initial cost and only minor changes in lifestyle. A family of four uses roughly 260 gallons of water per day. You can lessen that amount simply by using low-flow, aerating showerheads and faucets. Other ways to conserve hot water include taking showers instead of baths, taking shorter showers, fixing leaks in faucets and pipes, and using the lowest temperature wash and rinse settings on clothes washers.

Most water heater thermostats are set much higher than necessary. Lowering the temperature setting on your water heater can save energy. A new, energy efficient tankless water heater can save \$100 or more annually in water-heating costs. A solar water-heating system can save up to \$250 a year.

## Water Heater Comparison

ANNUAL ENERGY COSTS PER YEAR



## Transportation

Americans own about 15% of the world's automobiles. The transportation sector of the U.S. economy accounts for 28.75 percent of total energy consumption and 71.22 percent of petroleum consumption each year. America is a country on the move. We love the freedom provided by our vehicles. The average price of gasoline in 2017 was \$2.35 per gallon and at the time of print was \$2.45. If the average vehicle is driven 11,300 miles each year, with an average fuel efficiency of 29.2 miles per gallon, the average driver spent more than \$900 per year per vehicle on gasoline. A person driving a small, fuel-efficient car will have spent as little as \$800 per year, while a person driving a larger vehicle that is less efficient could spend \$4,000 or more each year on fuel.

Most people must use a personal vehicle. The key is to use it wisely. When you are on the road, you can achieve 10 percent fuel savings by improving your driving habits and keeping your car properly maintained.

Improvements in the average fuel economy of new cars and light trucks from the mid-1970s through the mid-1980s were significant. The average fuel economy of cars almost doubled in that time period and for trucks it increased by more than 50 percent. These improvements were due mainly to the Corporate Average Fuel Economy (CAFE) standards enacted in 1975. The standards were met largely through cost-effective technologies such as engine efficiency improvements and weight reduction, not downsizing. The safety and environmental performance of new vehicles improved along with fuel efficiency during this period.

## Fuel Economy Label



Label source: www.fueleconomy.gov

Today CAFE standards for brand new cars are set at over 40 miles per gallon, which is more than double the fuel economy of 1974 passenger vehicles. Standards for light trucks are slightly lower. Many manufacturers are meeting or exceeding these standards. Despite this, not all cars meet these standards. Manufacturers must pay a fine for each model that does not meet CAFE standards. The U.S. imports about 40 percent of the oil we use. Our dependence on foreign oil for gasoline will be greatly lessened by these standards.

When buying a vehicle, significant savings can be achieved by selecting a fuel-efficient model. All new cars must display a mileage performance label, or Fuel Economy Label, that lists estimated miles per gallon for both city and highway driving. Compare the fuel economy ratings of the vehicles you are considering and make efficiency a priority. Over the life of the vehicle, you can save thousands of dollars and improve air quality.

## Industry

Manufacturing the goods we use every day consumes an enormous amount of energy. The industrial sector of the U.S. economy consumes a little less than one-third of the nation's total energy demand.

In the industrial sector, energy efficiency and conservation measures are not driven so much by consumers as by the market. Manufacturers know that they must keep their costs as low as possible to compete in the global economy.

Since energy is one of the biggest costs in many industries, manufacturers must use energy efficient technologies and conservation measures to be successful. Their demand for energy efficient equipment has driven much of the research and development of new technologies in the last decades as energy prices have fluctuated.

Individual consumers can, however, have an effect on industrial energy consumption through the product choices we make and what we do with the packaging and the products we no longer use.

## A Consumer Society

Not only is America a consumer society, it is also a 'throw away' society. In 2015, the U.S. produced about 262 million tons of solid waste. The average citizen generates over 1,600 pounds of trash each year.

The most effective way for consumers to help reduce the amount of energy consumed by the industrial sector is to decrease the amount of unnecessary products produced and to reuse or repair items in their original form whenever possible. Purchasing only those items that are necessary, as well as reusing and recycling products wherever possible, can significantly reduce energy use in the industrial sector.

The four "Rs" of an energy-wise consumer are easy to put into practice. Reducing waste saves money, energy, and natural resources, and it helps protect the environment.

### Reduce

Buy only what you need. Purchasing fewer goods means less to throw away. It also results in fewer goods being produced and less energy being used in the manufacturing process. Buying goods with minimal packaging also reduces the amount of waste generated and the amount of energy used.

## Fuel Economy

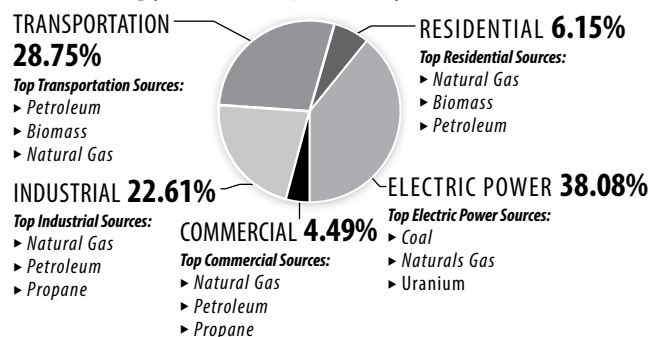
### Follow these tips to increase fuel economy:

- Combine errands into one trip.
- Turn the engine off rather than letting it idle for more than a minute.
- Have your car serviced as described in the maintenance manual.
- Keep tires inflated to recommended pressures.
- Anticipate traffic stops.

### These behaviors lower fuel economy:

- Quick acceleration.
- Traveling at high speeds. Traveling at more than 60 mph lowers fuel economy.
- Carrying unnecessary weight in the vehicle.
- Revving the engine.
- Operating the vehicle with the suspension out of alignment or with the wheels and tires out of balance.
- Using electrical accessories that require high amperage when they are not needed.

## U.S. Energy Consumption by Sector, 2017



The residential, commercial, and industrial sectors use electricity. This graph depicts their energy source consumption outside of electricity.

Data: Energy Information Administration

\*Total does not equal 100% due to independent rounding.

## Waste Generation Around the World



Data: Organisation for Economic Co-operation and Development

# Efficiency and Conservation

## ▪ Reuse

Buy products that can be used repeatedly. If you buy things that can be reused rather than disposable items that are used once and thrown away, you will save natural resources. You'll also save the energy used to make them, and reduce the amount of landfill space needed to contain the waste.

Savings also result when you buy things that are durable. They may cost more initially, but they last a long time and don't need to be replaced often, saving money and energy.

## ▪ Repair

Many people throw away products when they break and buy new ones. Many of these products could be easily and cheaply repaired. Always consider repairing a product before throwing it away. It saves energy, money, and natural resources.

## ▪ Recycle

Make it a priority to **recycle** all materials that you can. Using recycled material as the feedstock for manufacturing almost always consumes less energy than using virgin (raw) materials. Reprocessing used materials reduces energy needs for mining, refining, and many other manufacturing processes.



Recycling a pound of steel can save 1.25 pounds of iron ore. Recycling aluminum cans saves 95 percent of the energy required to produce aluminum from bauxite. Recycling paper cuts energy usage by 60 percent.

## Energy Sustainability

Efficiency and conservation are key components of energy **sustainability**—the concept that every generation should meet its energy needs without compromising the needs of future generations.

Sustainability focuses on long-term energy strategies and policies that ensure adequate energy to meet today's needs as well as tomorrow's. Sustainability also includes investing in research and development of advanced technologies for producing conventional energy sources, promoting the use of new and renewable energy sources, and encouraging sound environmental policies and practices.



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