

TAG January 2011 Classroom Intervention
Resources for the Climate Change Unit
1st December 2010

Introduction to Climate Change

Climate change is an important topic that many people around the world are talking about. The United Nations has sponsored a series of climate change talks. One of the ones that people know best is the United Nations Climate Change Conference. The most recent talk was held in Cancun, Mexico in 2010.

One kind of climate change that has been the focus of United Nations conferences is global warming. Over the last 100 years, the average [global temperature](#) has increased by about 0.75 degrees Celsius (1.3 degrees Fahrenheit). [Global temperature](#) could rise another 1.1 to 6.4 degrees Celsius (2.0 to 11.5 degrees Fahrenheit) over the next century. This might sound like a small change, but it can greatly affect the environment.

If the temperature of the Earth increases, we might have more extreme weather patterns such as hurricanes, [droughts](#), and [coastal floods](#). This is because [global temperature](#) indirectly affects the amount of [precipitation](#) the Earth receives.

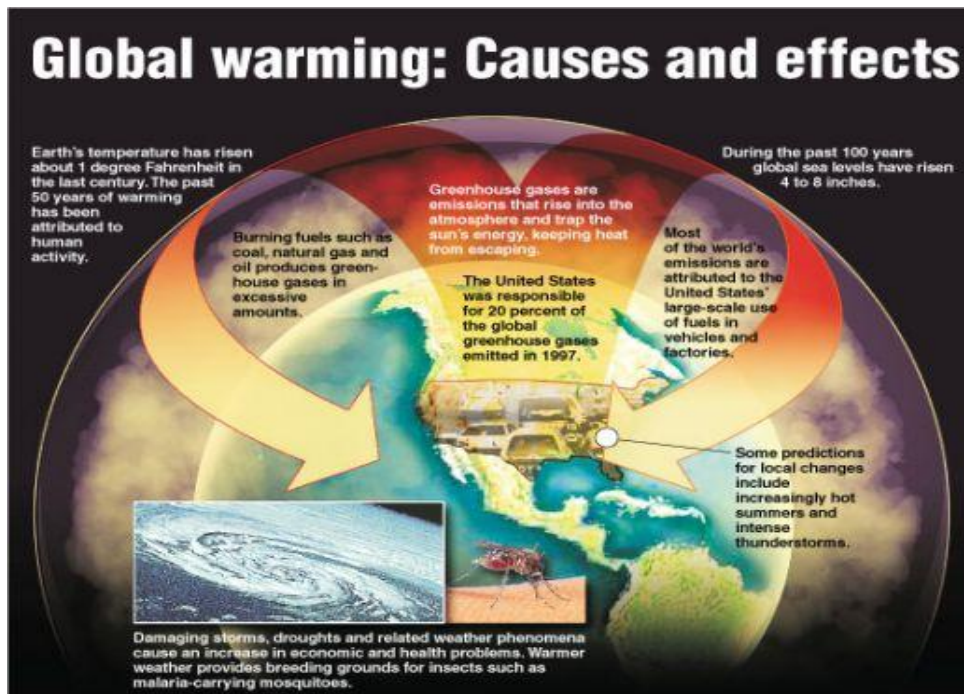
So, why are these changes happening?

A lot of evidence suggests that humans are affecting the environment through their lifestyles. **We burn a lot of fossil fuels, which add greenhouse gases to the atmosphere.** We also generate tons of [garbage](#) that we do not recycle. A lot of this trash goes into [landfills](#) and decays to produce methane, another [greenhouse gas](#). Through [deforestation](#), we also cut down a lot of trees and other [vegetation](#). [Deforestation](#) also indirectly affects the amount of [greenhouse gases](#). These [greenhouse gases](#) reflect heat to the Earth, and they eventually lead to increasing [global temperatures](#).

What should we do?

We need to find ways to reduce [greenhouse gases](#). Here are some important things to remember:

1. [Human activities](#) produce [greenhouse gases](#) such as carbon dioxide and methane.
2. [Greenhouse gases](#) cause the [greenhouse effect](#) that may result in global warming.
3. Global warming is causing extreme weather patterns such as [drought](#) and flooding along the sea coasts.



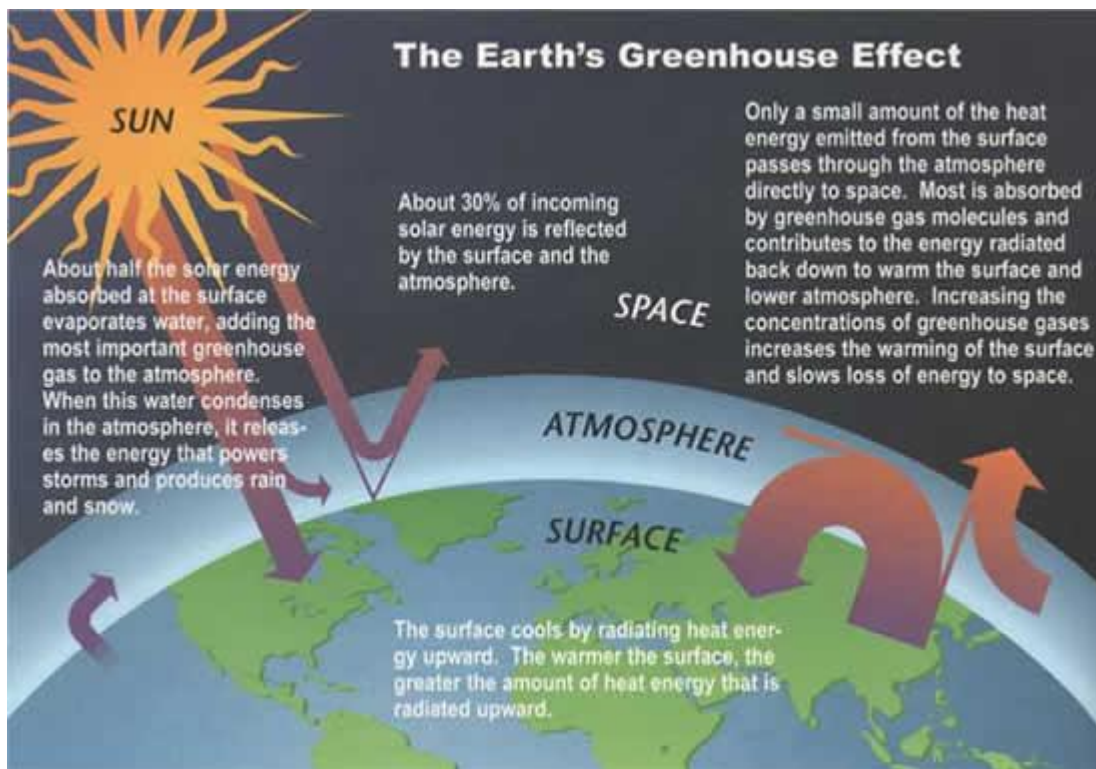
Greenhouse Effect

You might have heard about the greenhouse effect on television or in your science classes. That is because the greenhouse effect is important to how the world normally works. By trapping heat generated by the sun, the greenhouse effect prevents the earth from becoming too cold. A cold Earth would not support life, but when the greenhouse effect becomes too strong it can lead to global warming.

The surface of our Earth is surrounded by a layer of different gases called the atmosphere. Normally, the Earth is hit with a lot of [energy from the sun](#). The Earth's surface [absorbs some of this light energy](#) and the rest bounces back to space. Some gases in our atmosphere, called [greenhouse gases](#), trap the heat after it bounces off of the Earth's surface and [reflect it back to the Earth](#), eventually making the Earth warmer. In this way, the atmosphere acts like a blanket that prevents the Earth from getting too cold for living things. This is how the greenhouse effect works.

So what is the problem? Why are so many people worried about global warming and the greenhouse effect if the greenhouse effect is a normal part of the world?

A major problem is that [human activity](#) has greatly increased the amount of carbon dioxide and methane in the atmosphere, and this has made the greenhouse effect stronger. [The greenhouse effect has increased the heat reflected back to the Earth](#), and so the Earth has more [absorbed heat energy](#) which has led to higher average [global temperatures](#).



Solar Energy

The sun is a star at the center of our solar system. Even though it is far away, solar energy from the sun is the major source of energy for the planet Earth. This energy keeps our planet warm enough for things to live and grow.

How does the sun produce so much energy?

Most of the sun is made of hydrogen gas. Through a process called **nuclear fusion**, some of the hydrogen in the sun is turned into helium. This releases a huge amount of energy! The energy from nuclear fusion in the sun is radiated into space as electromagnetic waves. **Solar energy** is electromagnetic radiation that carries the energy of the sun to the Earth.

Absorbed light energy

The ground and water that make up the earth's surface absorbs about 50% of the light energy the Earth receives. The energy absorbed by the Earth is called [absorbed light energy](#). The more solar energy that the Earth receives, the more light energy it will absorb. The Earth does not absorb all of the solar energy that reaches it: [Sea ice](#) located around the world can act like a giant mirror. We have a lot of [sea ice](#) in the Arctic and the Antarctic! The sea ice, then, reduces the amount of Earth's [absorbed light energy](#).



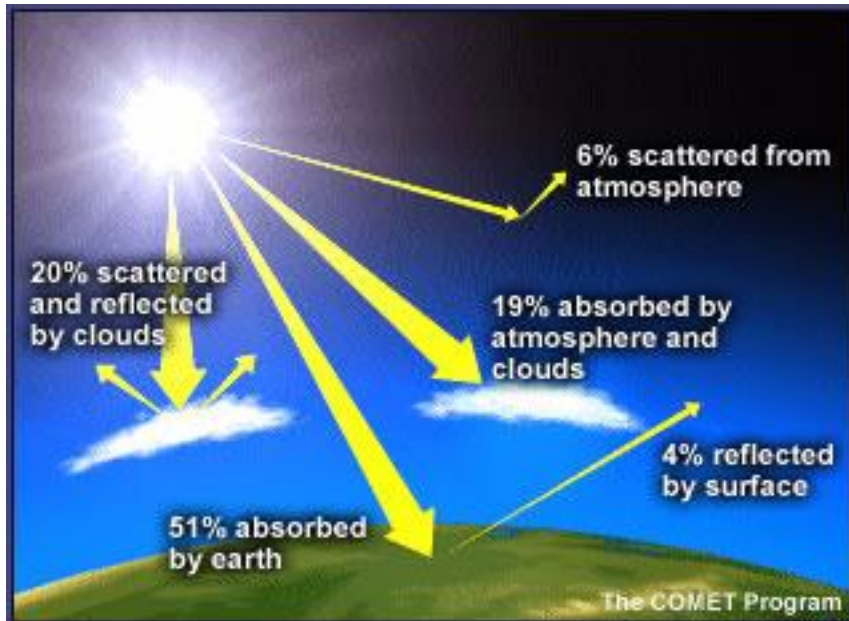
Absorbed Light Energy

When [solar energy](#) reaches the Earth's surface, the Earth absorbs it. Once it has been absorbed, we call it absorbed light energy.

Some absorbed light energy excites the molecules of the Earth's surface and becomes heat energy. We call this energy [absorbed heat energy](#), and it raises the temperature of the Earth and atmosphere.

Some [solar energy](#) is reflected back into space by the atmosphere before ever reaching the Earth's surface. Other [solar energy](#) is reflected back into space by [sea ice](#), which is a good reflector of heat. This means that [sea ice](#) reduces the amount of [absorbed light energy](#).

The sun shines on the Earth all the time. An increase in [absorbed light energy](#) leads to more [absorbed heat energy](#), which in turn increases the average [global temperature](#). So why doesn't the Earth keep getting hotter? One reason is that the Earth doesn't absorb all of the [solar energy](#). Only about 50% of the [solar energy](#) received by the Earth is actually absorbed.



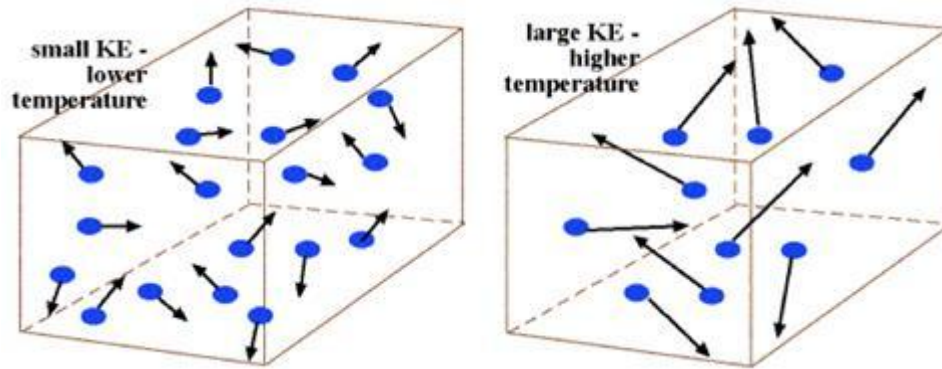
Absorbed Heat Energy

Everything in the universe is made of atoms and molecules. These particles are always moving around. Heat energy comes from the motion of these particles. The more they move, the more energy they have.

The energy of motion is called kinetic energy (KE). Why do we call this "heat" energy? Well, objects with more kinetic energy feel hot to us because when they touch us, some of the kinetic energy is transferred to us, making us feel hotter.

When [solar energy](#) hits a surface like the Earth, some of it is absorbed and is called [absorbed light energy](#). Once absorbed, this energy can excite molecules in the earth's surface, causing them to move faster. As the molecules move around faster, they produce heat energy. This is why an increase in [absorbed light energy](#) produces more [absorbed heat energy](#), in turn causing an increase in the average [global temperature](#). This is also why [solar energy](#), or sunlight, feels warm on our skin. Solar energy excites the molecules of our skin!

[Greenhouse gases](#) like carbon dioxide and methane indirectly affect [absorbed heat energy](#) through the [greenhouse effect](#). The greenhouse gases trap heat radiation before it can escape into space, increasing the [heat reflected to the Earth](#).

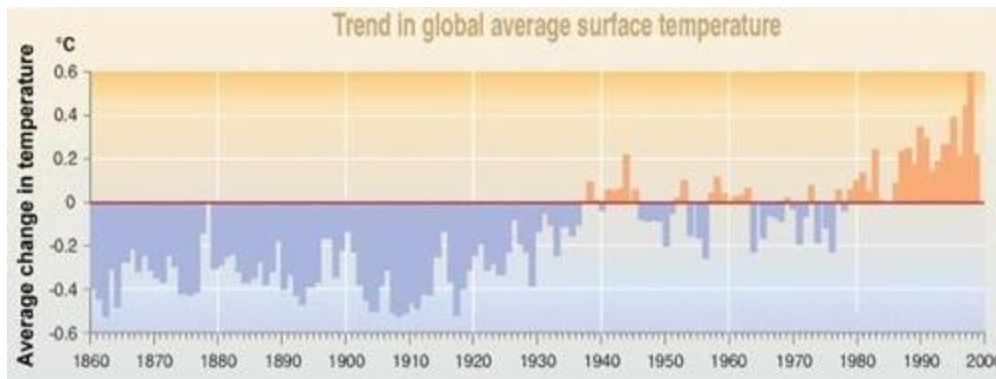


Global Temperature

Temperatures in our local region change based on day and season. Temperatures in places around the world might be very different from each other. It's often freezing in Antarctica and hot in the Sahara desert at the same time.

So why do people say that the Earth is getting warmer?

When we talk about global warming and climate change, we are not talking about the temperature of just one place. Instead, we are talking about the average global temperature of the whole world. Some places may be hotter or colder, but the global temperature tells us how hot or cold the whole Earth is on average.



As the temperature of the Earth increases, it can directly lead to more extreme weather patterns such as hurricanes, [droughts](#) and coastal flooding. Higher global temperatures also melt some of the [sea ice](#). The decrease in [sea ice](#) from melting causes an increase in ocean levels and may cause coastal flooding. A decrease in the amount of [sea ice](#) can also indirectly cause higher global temperatures. This is because when there is less [sea ice](#), less solar energy gets reflected and more of it can become [absorbed light energy](#).

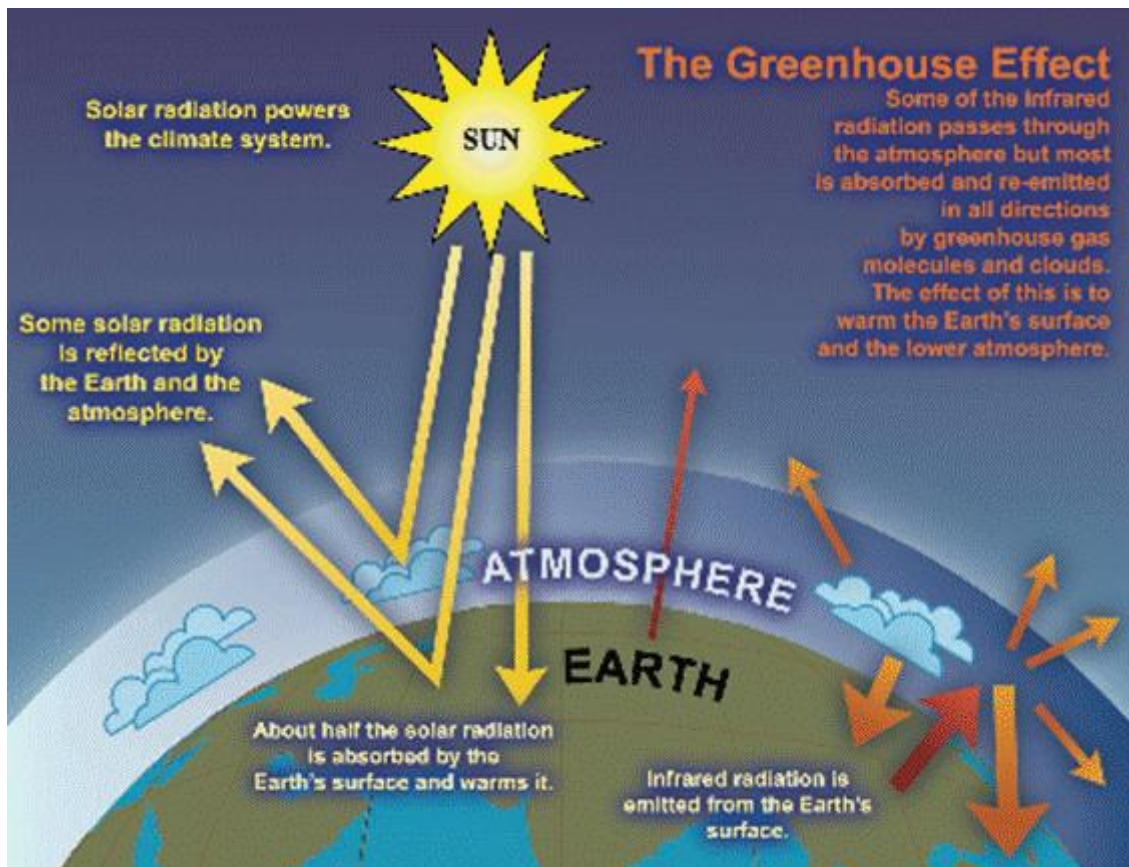
Heat reflected to the Earth

The Earth absorbs about half of the [solar energy](#) it receives. Once absorbed, this [absorbed light energy](#) is converted to [absorbed heat energy](#). The [absorbed heat energy](#) makes the Earth warmer. Until recently, the average [global temperature](#) has mostly stayed the same.

The Earth receives energy from the sun constantly. Why doesn't the Earth keep getting hotter? Some of the [absorbed heat energy](#) is radiated back into space.

The remaining heat is reflected back to the Earth. This [reflected heat](#) causes increased [absorbed heat energy](#) and indirectly leads to higher [global temperatures](#).

Normally, there is a balance between [absorbed light energy](#) and heat radiation. [Absorbed light energy](#) indirectly increases [global temperature](#), but heat radiation indirectly lowers it. Some of the heat radiation is prevented by the [greenhouse effect](#). The [greenhouse gases](#) like carbon dioxide and methane increase the [heat reflected to the Earth](#).



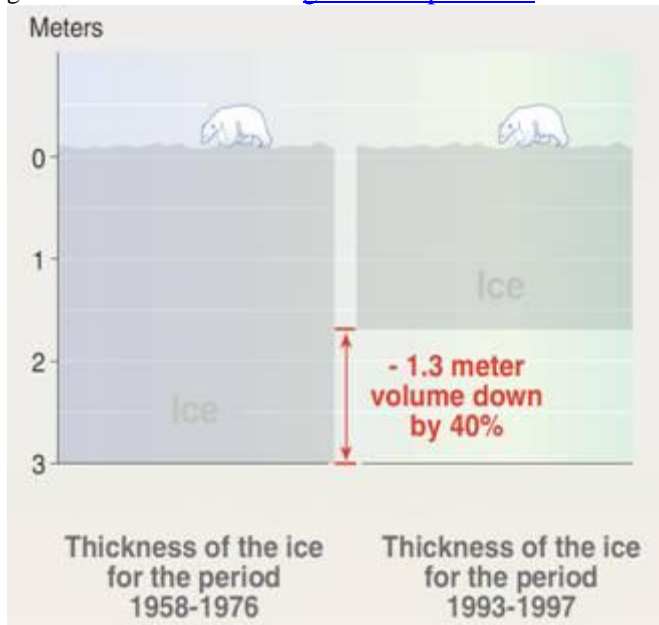
Sea Ice

Sea ice can take several forms. Some of it is seen as giant icebergs floating in the ocean. Near the polar regions of the Earth, there are large ice masses attached to the land. The polar ice caps are the size of whole continents! Sea ice is the main habitat for polar bears, ringed seals, and ice algae.

Sea ice reflects a lot of the light that hits it. This reduces the amount of [absorbed light energy](#) on the Earth. In other words, the ice acts like a giant mirror that bounces light energy from the sun back into space.

As the [global temperature](#) rises due to global warming, one side effect is that sea ice starts to melt. It's like putting an ice cube in a cup of hot water. As the sea ice melts, the Earth loses some of its reflectivity. With less sea ice, the Earth [absorbs more light energy](#), which indirectly increases the [global temperature](#). Melting sea ice also ends up causing higher [ocean levels](#). This is bad news, because if the [ocean levels](#) rise too much, the coasts of the Earth's continents might get flooded.

Sea ice has been shrinking by about 5% per decade. By the later part of the 21st century, a lot of Arctic ice may be gone. This could mean that [global temperatures](#) could continue to go up.



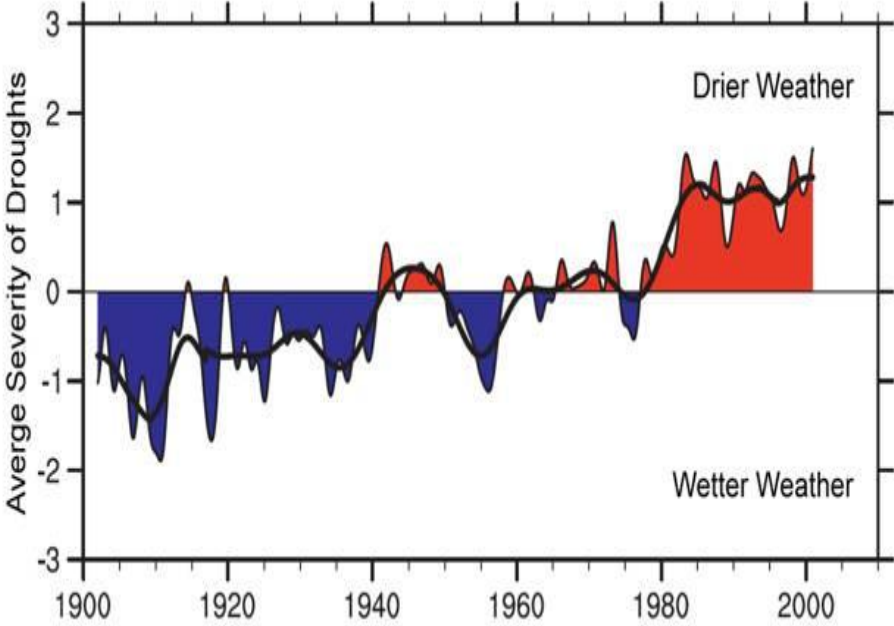
Drought

One of the consequences of global warming and climate change is that weather patterns around the world may become more damaging.

For example, increases in [global temperatures](#) tend to increase droughts. A drought is a long period of lower than normal rainfall in a region. When there is a drought, [vegetation](#) does not get the water it needs to survive and begins to die off. [Precipitation](#) or rainfall helps reduce drought.



Occasional droughts are normal for the Earth's climate. However, droughts may become more common because of increased [greenhouse effects](#). The table below shows how droughts have become more severe in recent years.



Human activity

The Earth's population is steadily increasing, and the increase in population has increased our overall needs: we need more homes to live in, more electricity to power those homes, more vehicles to travel in, and more essential goods like food, clothing, tools, and toys. At the same time, we create much more [garbage](#) than we used to.

All of these activities add more [greenhouse gases](#) to our environment. When we build new homes, we often add to [deforestation](#), which removes forests and other [vegetation](#) from the planet. [When we create electricity or use vehicles, we burn fossil fuels.](#) When we produce essential goods, we create more [garbage](#).

The increased amounts of [greenhouse gases](#) in the atmosphere contribute to the [greenhouse effect](#) and indirectly raise [global temperatures](#). Since humans are causing this increase in [greenhouse gases](#), scientists call it the human impact on global warming.

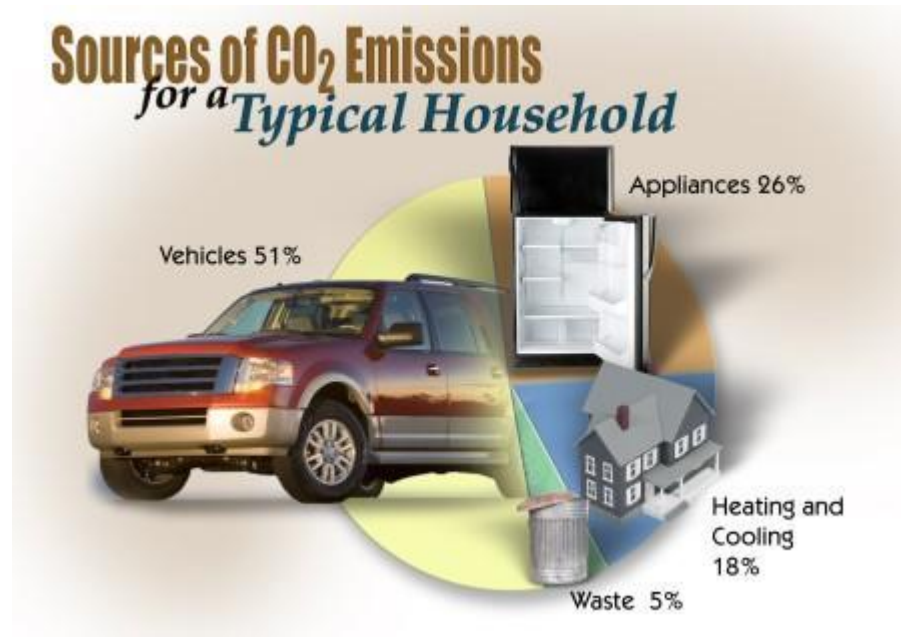


Vehicle Use

The vehicles we drive use about 378 million gallons of gasoline every day. Vehicles indirectly produce [greenhouse gases](#) when they burn gasoline. Gasoline is an example of a [fossil fuel](#). [Our cars burn fossil fuels, which release large levels of greenhouse gases into the atmosphere.](#) [Vegetation consumes some of these gases during](#)

photosynthesis, but the amount of [vegetation](#) we have today is not able to keep up with the amount of [greenhouse gases](#) we are currently producing.

Each gallon of gasoline you burn creates about 3 times as much carbon dioxide by weight. Carbon dioxide is a primary [greenhouse gas](#) responsible for the [greenhouse effect](#). The increased [greenhouse effect](#) is ultimately responsible for the increase in average [global temperatures](#).



Factories

Most factories burn [fossil fuels](#) like coal, oil and natural gas. [When fossil fuels are burned, they increase the levels of carbon dioxide in the atmosphere.](#) Carbon dioxide, being a [greenhouse gas](#), is responsible for the increased [greenhouse effect](#).

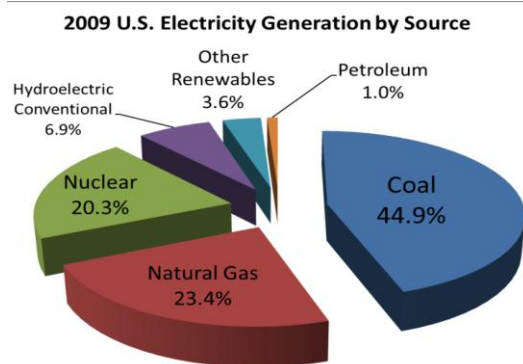
In the U.S., power plants and factories are the second largest producer of [greenhouse gases](#). Only [electricity generation](#) produces more. We use our factories to produce many different things people use every day. For example, we have factories that make cement, steel, aluminum, cars and computers. In order to make these things, we use machines that need to [burn fossil fuels](#) as they work.

Remember, factories [burn fossil fuels](#) in order to produce the things we use every day. Because of this, the level of carbon dioxide in the air has increased from 290 parts per million (ppm) to 320 ppm, an increase of just over 10 percent.



Electricity generation

Electricity generation is the process of creating electricity from other sources of energy. The first power plants ran on water power or coal. Today, we rely mainly on coal, petroleum, natural gas, and nuclear and hydroelectric power. We also create a small amount of electricity from renewable resources like [solar energy](#), oceanic tidal waves, wind generators, and geothermal energy.



Most electricity is generated by [burning fossil fuels](#) like coal, natural gas, and petroleum to produce heat. The heat boils water, creating steam. The steam then passes through a turbine to generate electricity.

Like using vehicles and factories, generating electricity creates more [burned fossil fuels](#), and this increases [greenhouse gas](#) levels in the atmosphere. A single coal plant generates about 1,322,719 megawatt-hours of electricity every year, which equates to roughly 1.2 million metric tons of carbon dioxide or 2.6 billion pounds of carbon dioxide.

Most scientists agree that emissions of pollutants and [greenhouse gases](#) from fossil fuel-based electricity generation account for a significant portion of world [greenhouse gas](#) emissions. In the United States, electricity generation accounts for nearly 40% of [greenhouse gas](#) emissions, the largest of any source.

Burned Fossil Fuels

Fossil fuels include things like coal, oil, and natural gas. These fuels contain lots of carbon. This is because they are made of organic matter that has been buried under pressure and heat for millions of years. About 90% of the energy used in the U.S. comes from burning fossil fuels.

Unfortunately, when we [burn these fossil fuels](#) to create energy, they add a lot of [greenhouse gases](#) into the atmosphere.

In the past 100 years, humans have used more fossil fuels. In the United States, most of our [electricity is generated](#) by power plants that burn coal and natural gas. [All these power plants burn large amounts of fossil fuels each year to generate electricity](#) for things like lights, heaters, televisions, and computers.

The more electricity we use, the more [greenhouse gases](#), especially [carbon dioxide](#), are indirectly added to the atmosphere. [All these extra greenhouse gases increase the heat reflected to the earth.](#) This makes the [greenhouse effect](#) stronger.



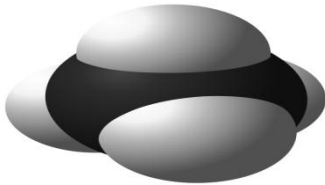
Greenhouse Gases

Greenhouse gases are the main source of the [greenhouse effect](#). Remember, the Earth's temperature stays normal because it doesn't absorb all of the [solar energy](#) that hits it. Instead, it reflects some of this energy back to space. When the gases are reflected to space, some of them are able to escape the Earth's atmosphere, but the rest becomes [heat reflected to the Earth](#). Greenhouse gases are gases in the atmosphere that increase the amount of [heat reflected to the Earth](#). Therefore, these gases make the [greenhouse effect](#) stronger.

Examples of common greenhouse gases are carbon dioxide and methane. Both carbon dioxide and methane are colorless and odorless gases. Carbon dioxide molecules have two atoms of oxygen and one atom of carbon. The chemical formula for carbon dioxide is CO_2 . In the diagram below the carbon is colored black and the two oxygen atoms are colored red.

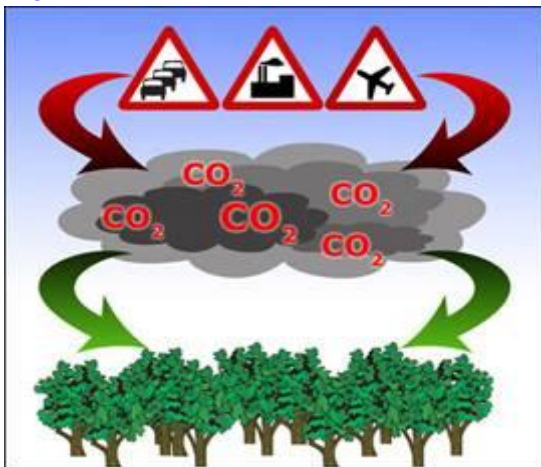


On the other hand, methane molecules have four atoms of hydrogen and one atom of carbon. The chemical formula for methane is CH_4 . In the diagram below the carbon is colored black and the four hydrogen atoms are colored white.



Greenhouse gases enter the atmosphere in several ways. Most living things (like people, plants, and animals) produce carbon dioxide through respiration. The process of respiration helps break down food and nutrients to make energy for the human body. Humans also create greenhouse gases when they [burn fossil fuels](#). We [burn fossil fuels](#) when we [use vehicles](#), [factories](#), and [electricity](#). In other words, using these things increases the amount of [burned fossil fuels](#). Another greenhouse gas, methane, is produced in [landfills](#) when garbage decays.

Our [trees and other vegetation](#) reduce the amount of greenhouse gases in the atmosphere. This is because [vegetation](#) normally absorbs carbon dioxide from the air during photosynthesis.



Garbage and Landfills

The typical American throws away about five pounds of trash a day. This adds up to about 251 million tons of garbage a year, almost twice as much trash per person as most other major countries. Americans are making waste products faster than nature can break them down.

Garbage isn't just the old food, drink containers, and food boxes that we throw away in our homes. Regular household trash is only a part of the garbage people create. We use a lot of special equipment and materials in our jobs. For example, when we build or fix buildings, we throw away a lot of construction materials, and when we mine rocks from the ground, we use up and eventually throw away tools and equipment that help us get the job done.

What happens to all of this trash? Some gets recycled and some gets burned, but most of it gets buried in landfills. A landfill is a place where we bury large amounts of garbage underground. Landfills are dangerous for the environment. **In landfills, garbage decays. When it decays, the greenhouse gas called methane is released into the environment.**



As more and more of our garbage piles up, it becomes harder to figure out where to put it all! Many of the landfills we are using now are filling up, so we will have to find new places to put our trash. We can help this problem by finding ways to reduce the amount of trash we generate. One way to reduce our trash is to recycle it instead. When people recycle, they take the useful pieces of their garbage, clean them, and use them to create new things. Recycling helps conserve natural resources, reduces landfills, saves energy and prevents pollution. According to eHow.com, a “How-To” website, “Over 70 percent of landfill waste could easily be recycled.”

Vegetation

Vegetation includes all trees, plants, shrubs and grass that grow on the Earth. While every plant is different, they all use sunlight, [carbon dioxide](#) and water for their normal life processes.



Vegetation is important for the global climate. During the process of photosynthesis, plants absorb the [greenhouse gas](#) carbon dioxide from the air. So, the more vegetation there is, the less [greenhouse gases](#) there will be in the atmosphere. This is why [deforestation](#) is such a problem.

In addition to reducing [carbon dioxide](#), vegetation also affects the atmosphere through the process of transpiration. In transpiration, extra water in vegetation is released onto its leaves. When this water evaporates, it becomes [water vapor](#).

Deforestation

Deforestation is a process by which humans reduce the amount of [vegetation](#) in an area. **The more deforestation there is, the less [vegetation](#) there is.**

Humans are rapidly cutting down forests in order to create more farmland and expand cities. Because of this, there is less [vegetation](#) on our planet. This is dangerous for the planet because [vegetation](#) consumes [greenhouse gases](#) and prevents them from increasing the [greenhouse effect](#).

