OER
K–5
Reading
Language Arts

ENGLISH

INNOVATION AND INDUSTRY IN ENERGY

GRADE 4 UNIT 9 | READER

EDITION 1

Grade 4 | Unit 9

Innovation and Industry in Energy

Reader

Acknowledgement:

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THE BIG QUESTION
What events led to the oil gusher at Spindletop?

The Spindletop Gusher

Hello. I'm Professor Pietro Leo, and I'm going to tell you about an incredible discovery that changed the history of Texas: a gigantic black gush that came out of the depths of the earth.

The events took place during the cold winter morning of January 10, 1901, on a small hill called Spindletop, on the outskirts of Beaumont. For years, many people had been unsuccessfully digging in the hill's ground searching for oil.

The Hamill Brothers Arrive at Spindletop

At that time, a group of drillers was working on the hill under the command of three men: brothers Jim, Curt, and Al Hamill. They had arrived at Spindletop on October 1, 1900, after being hired by the owner of that land, Pattillo Higgins. As soon as they got there, they looked for a place to put their equipment. They found an abandoned hut, full of rusty tools among armies of spiders and cockroaches. The men looked at one another. This was better than nothing! They all worked together to clean the hut as best they could because that would be their new home until they finished the job. For how long? No one knew.

Once they were settled in, the men got down to work. They dug **trenches** to bring water from a nearby swamp. They built a wooden derrick over what would be the future well. That **derrick** would hold the metal pipes that they would put into the ground as they dug a deep hole. Once the derrick was finished, the men mounted a **boiler** on top of it to power the steam engine that would run their digging tool.

The team planned to use a special tool called a **rotary drill**, a recent innovation as of 1845. Until then, oil had been searched for using a chisel drill, which did not rotate or turn. It pounded the earth to dig the wells. But the Hamill brothers knew that the rotary drill was best for sandy soils like the soil on that hill. The tool consisted of a rotating tube driven by a motor. At the lower end of the tube, there was a piece with sharp teeth called a **bit**. The bit rotated to cut through the sand, rock, and mud in the ground.

The First Attempts

At first, the progress had been slow because the bit would get stuck in the first sandy layers of the ground. The men poured water into the well to carry the sand out, but the sand absorbed much of the water and settled back at the bottom. After twenty days into the job, the team had reached 400 feet deep. But there were still several problems to solve. Sand was still accumulating in the hole. The drill bits were already **blunt**. They had run out of wood to feed the boiler. Wood was a common energy source in Texas during this time, but it required a lot of wood to feed the boiler because it was not an efficient energy source. With all of these problems no wonder the men were exhausted and hopeless.

Curt Hamill thought that if they poured mud instead of water into the well, the sand wouldn't absorb it as much, and the mud would help carry it out. The idea worked, and the team moved forward. At the end of the year, the men stopped work for a few days to celebrate the holidays with their families. But on January 1, 1901, they were all back.

On the morning of January 10, the drill bit got stuck in a layer of hard rocks. The men removed the tool to change the bit. Once the new one was in place, they put the drill down into the well, which had already reached 700 feet deep. And here's what I wanted to tell you about . . .

A Dark Surprise

When the drill reached the bottom, a strange hissing sound filled the air on the hill. Immediately, a thick column of mud gushed from deep in the earth, carrying with it the very heavy pieces of pipe placed inside the well. The men ran in a hurry, trying to dodge the huge pieces of metal falling from the sky toward their heads! After the mud and the pieces of pipe landed all over the place with a loud noise, the place fell silent. The men slowly and cautiously approached the derrick, ready to run away again if anything else happened.

The first thing they saw was the terrible state of the area around the well. The ground was covered by a thick layer of mud with huge pieces of pipe sticking out. Shaking their heads, the workers began to remove the **debris** with their shovels. But while they were focused on the task, knee-deep in mud, they felt the ground begin to shake with a deafening roar. Then a gigantic greenish-black jet gushed from inside the hole! What was it? Nothing less than oil!

The immense gush reached 100 feet high above the derrick. The men were covered in oil from head to toe. Dazed, they tried to wipe the oil from their eyes to see what was happening. The first thing they saw, besides the huge black column, was a fire in the boiler they used to activate the drill. The air was filled with the natural gas and oil spewing from the well. If they didn't put out the fire soon, they all ran the risk of being blown into the air in a loud explosion! So, the men began to work to put out the flames until the fire was extinguished.

Meanwhile . . .

What was going on around Spindletop as the drillers worked to put out the fire, and the gush kept going out and roaring nonstop? First, the animals ran away when they heard the loud noise. Farmers watched in amazement as the thick black liquid rained down. A carpenter building

a barn dropped his tools, mounted his horse, and galloped off to nearby Beaumont to report the news.

The townspeople crowded on the roofs of their houses to catch a sight of the gigantic black column. Hundreds of others wanted to have a closer look and set out immediately, in **buggies** or on horseback, to travel the four miles to the site. Soon, the area around Spindletop was filled with onlookers. Many were probably wondering what opportunities the discovery of oil could mean for their town.

A New Era

The roaring jet that began to gush out at 10:30 a.m. on that cold, clear winter morning continued to flow nonstop for nine days. The drillers built mud dams to contain the oil. Plows were used to bury the oil-soaked ground to decrease the risk of fire. But nothing was able to fully contain the oil flowing from the well. Workers became ill from breathing the oil and fumes that filled the air as they worked. The gusher had to be cut off. Finally, the Hamill brothers succeeded in shutting it off with a risky (but effective) system of pipes and valves. Using these innovations, the Hamill brothers and other oil workers were able to solve the problems they encountered.

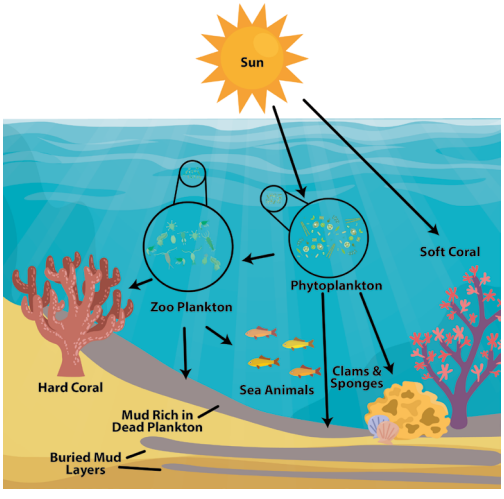
When silence returned, the men realized what had happened: they had just discovered the largest oil well ever seen up to that time. That "black gold" marked the beginning of a new era in the history of oil, but also in the history of Texas. Why did I use the words *black gold* to refer to oil? In the next lessons, we will be answering this question.

THE BIG QUESTION
What events led to the oil gusher at Spindletop?

The Beginnings of Oil in the United States

The First Oil Well

Do you remember the exciting story of Spindletop and the giant jet of oil that gushed from the ground for nine days straight? Now let's look at why the Spindletop drillers were so determined to find that strange liquid.



The Formation of Oil

The Formation of Oil

Today we know that the energy stored in oil started with the sun. Through photosynthesis, the sun's energy is used to make sugar from carbon dioxide and water. This conversion of solar energy to chemical energy is the basis of all food webs for ecosystems with access to the sun. The ocean is filled with billions of tiny plants, algae, and bacteria that undergo photosynthesis. Some of these organisms are eaten by ocean animals, transferring their energy along the way. This transfer of energy flows up through each food chain and gets stored in the cells of living creatures.

When these organisms died, they sank to the bottom of the oceans. Over the years, their remains were buried under multiple layers of rock and sand. The decomposition of these remains raised the temperature of the place where they were buried. The high temperatures, combined with the weight of the countless layers that accumulated, caused a chemical reaction that turned the remains into oil.

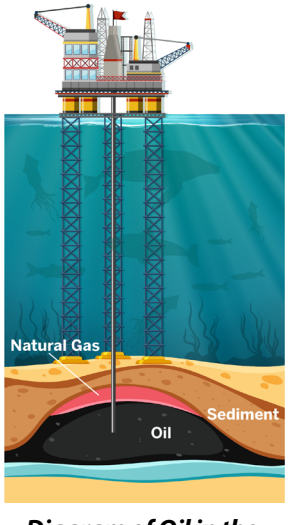


Diagram of Oil in the Ocean

Once the ancient seas dried up, the oil was trapped under tons of earth at great depths. However, the strange oily liquid seeped through rocks and sand to the earth's surface in small quantities.

Sometimes, it accumulated in **depressions** in the ground. Other times, it floated as an oily **film** on the water of lakes and streams.

Oil in History

Over time, people around the world discovered different ways to use the oil that appeared on the surface of earth. For example, the ancient Egyptians used it to make their mummies. Centuries later, medieval knights used oil to shine their metal armor. Native Americans used it in the preparation of skin ointments. Later, oil proved useful for sealing cracks in wooden boats. It was also used to grease the wheels of buggies, and it was even burned in lamps for light. There was no doubt that oil was very useful. However, until the nineteenth century, no one knew how to **extract** it from underground.

Lighting was one of the main uses that oil seemed to offer. In the nineteenth century, the main product used by Americans to light their lamps was whale oil. In spite of its ability to provide light, whale oil had an odor and was not as efficient as other energy sources. Gradually, whales became scarce, and, consequently, their oil became more and more expensive. As a result, many businesspeople began to think about obtaining oil in larger quantities.

Before Spindletop, oil discoveries were made in other parts of the United States. Samuel Kier was an American chemist who owned a salt **deposit** in Titusville, Pennsylvania. One of the nearby streams was leaking oil, which made salt production difficult. Kier decided to study the strange oily and **flammable** compound. After several experiments, he succeeded in refining oil into kerosene, a material that could be used to light lamps without the smoke and odor produced by crude oil. Upon seeing the usefulness and economic potential of the strange black liquid, a businessman named George Bissell partnered with others to found an oil company.

Sprouting Oil

Bissell needed men of action to investigate the sprouting crude oil that was very common in Pennsylvania. He met Edwin Drake, who knew nothing about mining or geology but had a great ability to handle all kinds of tools, possessed a very stubborn character, and liked challenges. Bissell didn't think twice: Drake was the perfect candidate.

Drake began to work in Titusville in early 1858. At first, he made small **excavations** in the form of trenches. After several months without results, Drake realized that he had to think of a more **ambitious** project. In mid-1858, he planned to drill a well many feet deep, similar to those made to extract salt. (One meter is about 3 feet deep.) He built a wooden derrick and bought a tool to strike the rock that was powered by a steam machine. Most steam engines during this time were powered by wood or coal. Coal powered steam engines in heavier machines, such as trains. The rotary drill had not been created yet, and his men worked for almost a year with no results. Bissell and his partners decided to stop funding the project. But Drake didn't want to give up. So, with money from his friends and a loan, he kept working to fulfill his dream. No one believed he could make it. But Drake didn't pay attention to the doubts or ridicule of others and continued to work tirelessly.

In August 1859, when the well was 69 feet deep, the drilling crew encountered a strange crack. The next morning, on August 27, Drake and his workers smelled the unmistakable odor of crude oil. They had found the first oil well in history!

After the Discovery

The discovery attracted countless businesspeople who dug hundreds of wells in Pennsylvania, Ohio, West Virginia, and Indiana. Most of the oil was refined into kerosene. While oil was refined, gasoline also appeared in small quantities. But gasoline couldn't be used for lighting because it produced explosions. (No one yet imagined the use it would have many years later.) As a result, most of the gasoline was dumped into lakes and streams near the refineries.

Spindletop Hill

In the 1890s, workers searching for water in Corsicana, Texas, accidentally discovered a small oil deposit. Meanwhile, on the outskirts of Beaumont, another Texas town, a man named Pattillo Higgins became interested in a small hill called Spindletop. Do you remember it? Higgins had noticed that Spindletop was leaking natural gas, and he knew that natural gas and oil are often found in the same place.

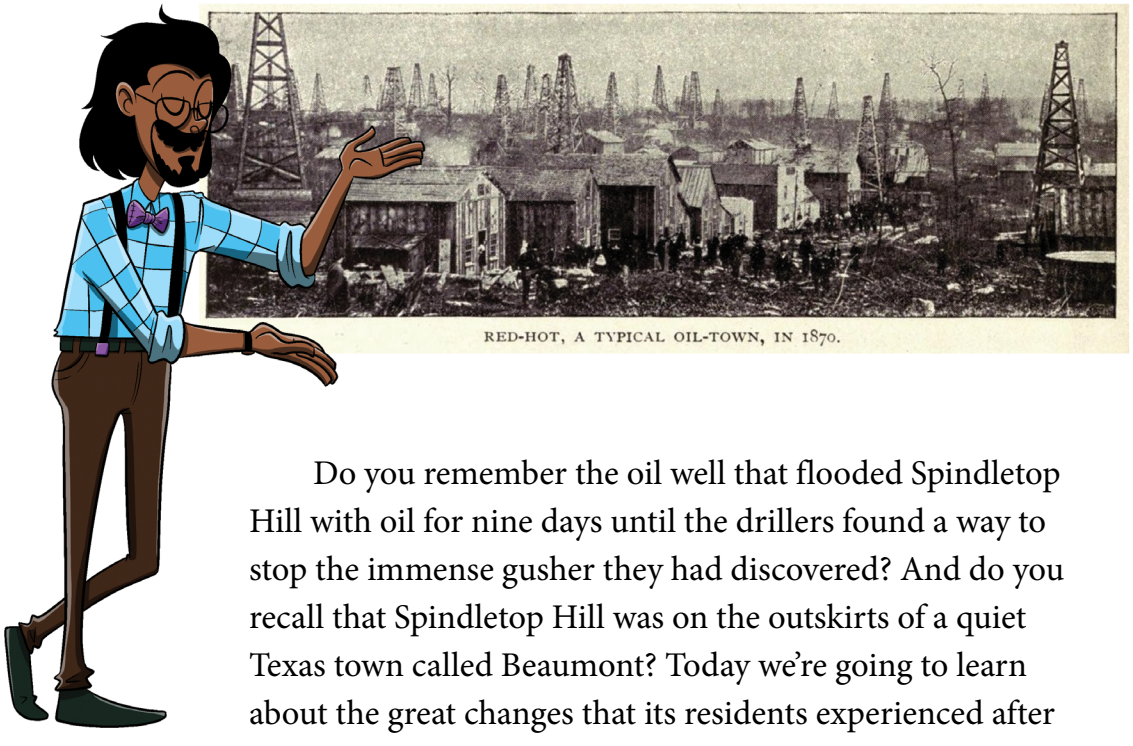
One day, he saw a sign advertising land for sale at Spindletop at a very good price: six dollars an acre. He started buying land with the purpose of searching for oil. Higgins had big plans. However, his excavations between 1883 and 1886 were unsuccessful.

When Higgins ran out of money, he posted an ad looking for an **investor**. Only Captain Anthony Lucas responded. After finding a small amount of oil in 1899, Lucas also ran out of money and went out to look for investors in Pennsylvania. He asked the wealthy businessman John D. Rockefeller, but Rockefeller turned Lucas down because he didn't believe there was oil in that Texan hill. However, other oil exploration businessmen, Guffrey and Galey, decided to take the risk.

Lucas told them that no one had ever been able to dig wells deeper than 400 feet on Spindletop Hill because of the sandy ground. Back then, a chisel drill was used to search for oil. A chisel drill was a very big tool that was used to drill through the rocks. But that only worked in rocky, hard areas. In sandy ground, the chisel drill just **compressed** the earth. Guffrey and Galey told him not to worry because they knew the Hamill brothers. Do you remember that name? Jim, Al, and Curt Hamill were using a new tool, the rotary drill, to dig wells over 1,200 feet deep. Do you remember how the rotary drill worked? The businessmen called Jim, the oldest of the brothers, who was working at Corsicana, to hire him. Jim sent Al and Curt to take on the new job. And you know what happened next!

Big Changes

THE BIG QUESTION
What are the problem and solution relationships between the discovery of oil and the living and working conditions in the town?



RED-HOT, A TYPICAL OIL-TOWN, IN 1870.

Do you remember the oil well that flooded Spindletop Hill with oil for nine days until the drillers found a way to stop the immense gusher they had discovered? And do you recall that Spindletop Hill was on the outskirts of a quiet Texas town called Beaumont? Today we're going to learn about the great changes that its residents experienced after the discovery of the largest oil well known until then.

Beaumont Wakes Up

In the days and months following that discovery, crowds poured into the sleepy town of Beaumont. Many newcomers were tourists who wanted to visit the hill that had suddenly become famous. The road from Beaumont to Spindletop was filled with buggies and horses carrying hundreds of visitors eager to stroll through the oil-saturated fields. Along with the tourists came businesspeople and **speculators** who wanted to buy the neighboring land. Many men

seeking employment also arrived, and they were soon hired by the new oil companies. Even men without any experience in drilling had the chance to earn two or three dollars a day: double the pay earned by workers in the rest of the country.

Exploration derricks increased rapidly all over the hill. By the spring of 1901, there were 138 oil wells. Most were concentrated in an area of 15 acres. That is close to eleven football fields with twelve derricks on each field. Walkways made of wooden planks filled the land flooded with mud and oil. The air on the hill was unbreathable due to the greasy mist of oil, the **fumes** from the boilers that powered the drills, and the smoke from the kerosene-fueled lamps. And, to top it all, many workers fainted from breathing in the natural gas that surfaced along with the oil.

Population Changes

Until January 1901, when the discovery took place, there were nine thousand people living in Beaumont. But in the three months that followed, that number rose to fifty thousand! Soon there were not enough hotels or rooms to accommodate the growing crowds of newcomers. The exhausted oil well workers slept in tents and even rented pool tables, store windows, barbers' chairs, or office desks to spend the night.

It was difficult to satisfy the hunger of the crowds that arrived daily in Beaumont. Many cafeterias and food stores remained open through the night. Another problem was providing enough clean drinking water for everyone. Many newcomers got sick from drinking water from **polluted** streams and rivers. In addition, freshwater sources were breeding grounds for mosquitoes, which feasted on the workers who slept in tents or spent the night in the streets. Some of these mosquitoes spread serious diseases, such as malaria.

This led to another problem: health care. Now there weren't enough doctors to treat all the sick and injured people. Inexperienced oil well workers would often get hurt when handling the huge digging tools. Fires, and even explosions, were also frequent. However, none of these terrible conditions reduced the number of trains arriving daily with people from faraway places like Philadelphia or New York.

New Towns

The land that Pattillo Higgins had bought at six dollars an acre a few years earlier was now selling for as much as a million dollars an acre. Many newcomers made fortunes, but many others were left in ruin from land sale **scams**, which were common.

As the opportunities to make money in Beaumont increased, the newcomers multiplied by the thousands. Among them were many honest people, but there were also gamblers and thieves. Street riots were becoming more frequent. The local police couldn't cope with all the calls for help from the neighbors. Beaumont residents were terrified. The sheriff advised them to stay indoors and padlock their doors if they wanted to stay safe.

In the few months following the discovery of the first well, new towns were formed around the well excavations. One of these was Gladys City, which consisted of a group of wooden buildings that included a post office, a newsstand and candy store, a photography studio, and a general store that sold all kinds of goods needed for daily life. There were also bedrooms and cafeterias to **host** and feed the oil drillers. Drilling for oil had increased nonstop after the discovery of 1901. Where once there were only trees and grass, the number of derricks was growing every day.

Too Much Oil

Prior to 1901, ninety percent of U.S. oil had been produced in the East Coast. But the first Spindletop well went on to produce more oil than all the Pennsylvania wells combined.

By the end of 1901, oil prices had fallen from a dollar a barrel to three cents a barrel. And do you know why? Because there was too much oil available to buy. The main product of oil was kerosene, which was used for lamps. But there weren't enough lamps in the United States to burn the enormous quantities of oil gushing out of Spindletop. New profitable innovations for this **abundant** natural resource had to be discovered urgently.

We are out of time for today. But don't worry—I'll be back so that together we can see what those new uses and innovations were.

Innovations to Fuel

THE BIG QUESTION
What can we infer about the discovery of oil and its resulting innovations?

Do you remember Spindletop? Last time, we saw the great changes that happened in the lives of the local people during the days and months following the discovery of the largest oil well known until then.

Today we're going to look at other changes that took place over time for the people of Beaumont, the rest of the country, and the whole world.

The Oil Industry Grows

During the year following the discovery of Spindletop, the Texas oil industry grew enormously. The United States became the world's major oil producer. Many of the country's most important oil companies were born and grew thanks to this discovery, among them Texaco, the shortened name of the Texas oil company. These companies made money selling oil in the United States and abroad. In fact, after Spindletop oil

production in the United States tripled. Though some countries in Asia and Europe were beginning to find oil too, many relied on the United States to meet their oil needs. They did not become **energy independent** until they were able to produce the oil they needed without buying from other countries.

As we saw in the previous lesson, the oil extracted from Spindletop wells was more than the **demand** for the main product manufactured at that time with this resource: kerosene to light lamps. And what do you think was done with the oil that wasn't used? It was stored in tanks, which weren't well made and **contaminated** the soil and freshwater sources.

Wooden and metal tanks were built throughout Spindletop Hill to store the oil. Tanks were also built that trains and **barges** could use to transport the extra oil to be sold across the country. Although it was known that oil could be a good fuel for steam-powered forms of transportation, train and ship engines were still using coal. Do you know why? Because oil was more expensive, and it was hard to get.

Changes in Transportation

The first type of transportation to switch from coal to oil were trains in Texas and the Southwest. The coal that fueled those trains was bought far away on the East Coast at very high prices because it had to be transported over hundreds of miles. But the discovery of Spindletop changed this situation greatly. From then on, oil became an abundant, cheap, and local resource in Texas.

The Texas train experiment was so successful that other train companies also made the change from coal to oil. Ship companies that transported **goods** to other regions of the country and the world also joined.

The change from coal to oil didn't require **modifying** the engines. Both train and ship engines were powered by boiling water to make

steam. All that was needed was to change the boilers' fuel from coal to oil.

Oil offered great advantages over coal. For example, oil burns cleaner than coal. Another interesting fact is that oil is a more dense form of energy. This means that there is a lot of power in this form of energy compared to other forms. Coal took up much more space, especially for ships that made long trips. Many men were needed to load the coal onto the ships for several days. Once the coal was on board the ship, other men had to take turns shoveling the coal into the furnaces, where the water for the boilers was boiled. The boiler rooms, located below deck, were very hot places to work!

On the other hand, oil was loaded by a few men in a few hours. Once on board, the oil was stored in tanks. The oil furnaces were also smaller and didn't need shovelers.

The replacement of coal with oil, both on trains and ships, freed up much of the space that was previously used to store fuel and power engines. This was an added advantage for companies because now there was more room to transport goods, and they could make more money.

The Automobile Is Born

The U.S. oil market continued to grow steadily during the early twentieth century. New uses for oil spurred new exploration and successful drilling in other parts of the country, but especially in Texas. The oil business was growing, just in time to welcome a new invention: the automobile!

In the late nineteenth century, many inventors experimented with the use of engines to realize the dream of building a "horseless buggy," that is, a buggy capable of moving on its own.

One of the first automobile manufacturers in the United States was Henry Ford. In 1896, Ford built a four-wheeled bicycle, powered by a small engine, but without brakes or a reverse gear. In 1903, when his designs had improved, Ford founded his famous automobile company. But his breakthrough came in 1908 with the creation of the Model T.

The Model T, which reached speeds of 25 miles per hour, was the first American automobile built using the assembly line method. The assembly line was a **conveyor belt** with workers stationed at different locations. Each worker performed a specific task and then passed the product to the worker next to them. This made it possible to produce automobiles at a low cost and very quickly. The production of automobiles boosted the U.S. oil industry.

World War I further strengthened the country's oil industry. Many U.S. ships had oil-fueled boilers. Military vehicles and aircraft ran on gasoline too. By the end of the war, the use of automobiles had increased in every city. This led to the construction of highways throughout the country.

However, gasoline wasn't the only important use of oil. Gradually, oil became a necessary material for many other comforts of modern life. The plastic used today to make toys or to package food is also made from crude oil. So are **synthetic** fabrics, such as polyester and nylon. Oil is also used for heating homes, paving roads, waterproofing roofs, making medical supplies, and in many other products. Today we have become so used to these and many other innovations that it's difficult to imagine a world without oil.

Nuclear Energy

THE BIG QUESTION
What is the science behind nuclear energy and innovations? How do these impact Texas and beyond?

Imagine a tiny marble lying in the palm of your hand. Now imagine this marble breaking apart, releasing enough energy to light up your entire town. The splitting of something small that can release a large amount of energy is a simple way to start thinking of **nuclear energy**.

How Does Nuclear Energy Work?

The marble you were imagining represents an **atom**. Atoms are the very small building blocks of everything on Earth. There are many different types of atoms, which are called **chemical elements**. Approximately ninety-two are found in nature, and about twenty-six elements are made by scientists in labs. At the center of each atom is a structure called the **nucleus**. Atoms last forever but sometimes undergo changes to the nucleus that transform them into different elements. These changes often release enormous amounts of energy.

One example of a nuclear change is when the nuclei of two atoms combine to form one heavier atom. We can see this process, called **nuclear fusion**, whenever we look up at the stars in the sky. For example, the sun is powered by nuclear fusion, and, as a result, large amounts of energy are released. This energy takes the form of heat and **radiation** that make life on Earth possible. Radiation is energy that moves from one place to another in the form of waves or particles. Most of the time, radiation is harmless. For example, some low-energy types of radiation that you are exposed to regularly include light from the sun, radio waves, and microwaves.

The other example of nuclear change is when an atomic nucleus breaks apart and releases a lot of energy. This process is called **nuclear fission**. If the pieces of the broken nuclei hit other atoms and make those atoms break apart, then a chain reaction of nuclear fission might occur that can release energy on an ongoing basis. This is the process that takes place in a special facility called a nuclear **power plant**. Inside most of these plants, **uranium** atoms are split in a nuclear chain reaction within structures known as **nuclear reactor**s. This process releases significant amounts of energy. The energy is used to heat water until it transforms into steam. This steam is used to spin large fans, known as **turbines**. As these turbines spin, they generate electricity. Once produced, this electricity is stored and eventually sent out to power our homes and businesses. From the nuclei of uranium atoms, the energy released in these power plants can make electricity to power our lives.

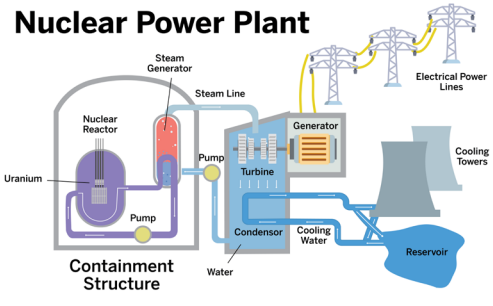


Diagram of a Nuclear Reactor

What Are Disadvantages of Nuclear Energy?

The nuclear fission process produces atoms with unstable nuclei. Scientists call this unstable product **radioactive** waste. The waste product is radioactive because it gives off radiation. If done safely and correctly, nuclear fission can release a lot of clean, controlled energy. If not managed right, the radioactive waste products could be accidentally released. Large amounts of radioactive waste are harmful to our bodies and the environment. People who are exposed to radioactive waste a lot over time can develop long-term sicknesses like cancer or may even die. Radioactive waste can also get into water, soil, plants, and animals.

Nuclear reactors can use the same fuel for about forty to fifty years. Replacing the fuel requires proper handling of the old fuel, which is radioactive. In order to get rid of the radioactive waste safely, it is placed in large tanks of water, where it is cooled. Then it is moved to large concrete structures, where it is stored. The process of transporting the waste can be dangerous if an accident happens along the way and the waste leaks. Once it is safely transported, the waste remains in storage for many years until it is no longer radioactive.

Experts work hard to make sure nuclear power plants run safely and responsibly. Safety rules around nuclear energy include using special protective clothing, thick walls to contain the radiation, and equipment to monitor and control radiation levels. By following safety rules, humans can benefit from the power of nuclear energy. Still, departing from these rules carries big risks. For example, if a person working in a nuclear power plant does not properly discard a rag that they used for work, that rag can hold radioactive waste that is then released to whoever finds it. Further, though nuclear power plants take great steps to ensure safety, accidents and natural disasters can still occur and may prove dangerous. For example, if a catastrophic event disrupts the process of cooling a nuclear plant, it can lead to releases of radioactive materials.

The cost to run nuclear power plants and keep them safe is high. Plus, the process of building a power plant is complicated. Nuclear plants are large and require a lot of money up-front to build. Due to safety concerns and government regulation, the price to build a nuclear power plant is very expensive. In order to run, they need to get approval from local governments. They also need to prove they are prepared to follow safety rules. Thus, it can take a long time and a lot of money to get one nuclear power plant up and running.

Manhattan Project

How Was Nuclear Energy Discovered?

During the early 1900s, a famous scientist named Albert Einstein proposed a groundbreaking idea. This concept would eventually unravel the mystery behind nuclear energy. Einstein came up with a mathematical equation that explains how energy and mass relate to one another: $E=mc^2$. This equation suggests that even a minuscule amount of matter (m) has the potential to release an immense amount of energy (E) because the speed of light (c) is multiplied by itself (2), making it very large. Imagine having a single, tiny light bulb capable of illuminating an entire school! That sums up nuclear energy really well, where small amounts of nuclear matter can release a lot of energy.

United States government leaders at the time recognized the potential of Einstein's ideas. In 1942, the government assembled a team of top scientists from various regions of the country. Under the code name "Manhattan Project," this elite group embarked on a mission to conquer the secret of nuclear energy. They succeeded in splitting the atom, turning Einstein's theory into a reality. Among the achievements at the project's laboratory in Los Alamos, New Mexico, was the creation of the world's first nuclear reactor.

In the aftermath of the Manhattan Project's successes, Texas began to explore the potential of nuclear energy. In 1946, a group called the Texas Research Foundation (TRF) was created. Their goal was to make growing crops easier in Texas. Utilizing nuclear materials in their research, the TRF developed fertilizers to help plants grow quicker and stronger. They were one of the first organizations in the country to explore the uses of nuclear energy.

Admiral Hyman G. Rickover

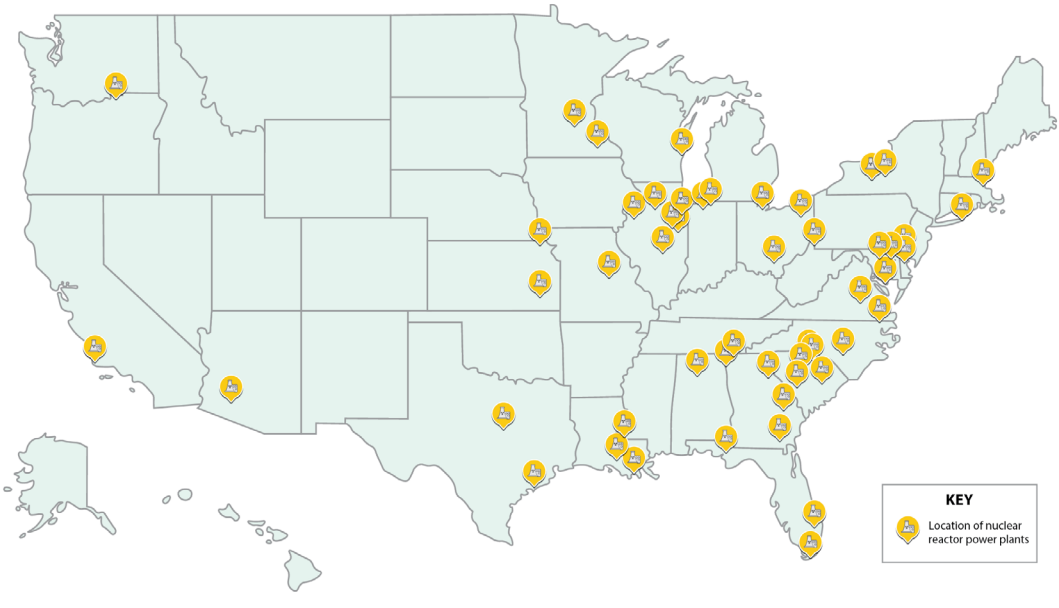
Around the same time, a Texan named Hyman G. Rickover was working hard on nuclear energy. He was an **admiral** in the U.S. Navy who was tasked with a daunting job: to develop ships that could run on nuclear energy. His work led to the first nuclear-powered vessels. While the initial investment in these ships was considerable, they saved money in the long run. Much of the savings came from cutting out the need for frequent refueling. Nuclear vessels only stop to refuel once every twenty-five years! This is especially helpful for submarines, which, before using nuclear energy, relied on diesel for fuel. The exhaust from diesel was more harmful for people to breathe. Thanks to nuclear energy, submarines can now stay underwater for longer

with cleaner air. Astonishingly, the energy potential of these nuclear submarines is so vast that, if needed, they could provide the electricity to power an entire town.

Where Are Nuclear Power Plants?

Nuclear energy plays a big role in powering the United States. According to the World Nuclear Association, the United States operates the largest number of nuclear reactors in the world. There are nearly one hundred nuclear reactors scattered across the nation, providing power to millions. Those reactors produce about twenty percent of the country's electricity, the equivalent of powering one out of every five buildings! Safety has always been paramount for nuclear power plant operators in the United States, which is why many nations look to American procedures and protocols as the gold standard for safely harnessing nuclear energy.

Map of Nuclear Reactor Power Plants



Were you aware that Texas is home to two major nuclear power facilities? One is the Comanche Peak plant in Glen Rose. The other is the South Texas Project plant in Bay City. These plants operate without fail, day in and day out, generating electricity for our homes, schools, and businesses.

Comanche Peak Nuclear Power Plant in Glen Rose

Why Use Nuclear Energy?

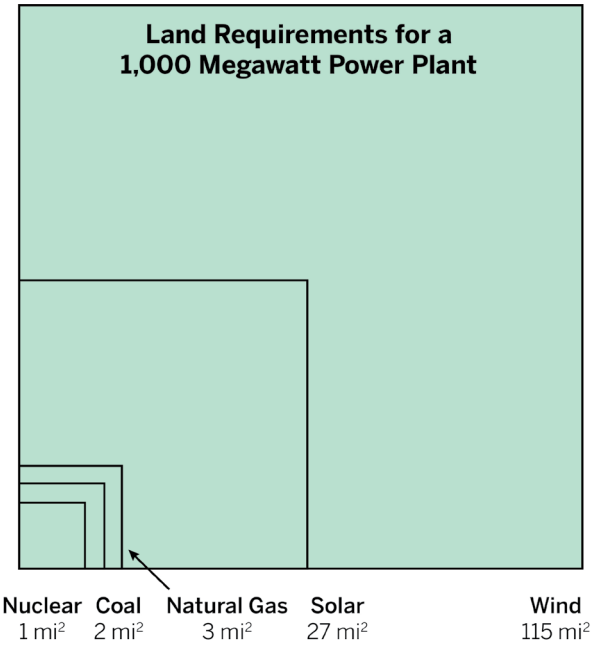
Nuclear energy brings a lot of benefits to the table. The first benefit is that nuclear plants can produce an incredible amount of energy. Consider the two nuclear plants in Texas. In 2023, the Glen Rose and Bay City power plants produced eleven percent of the energy **generated** by the entire state. The South Texas Project plant on its own boasts the capacity to power an astounding two million households.

Another benefit is that the reliability of these Texan nuclear plants is unparalleled. Unlike renewables like wind and solar, nuclear plants produce power day and night, ensuring there is always electricity when it is needed. Notably, during Hurricane Harvey in 2017, the South Texas Project plant remained operational. Even the wrath of a major storm did not stop the nuclear plants!

Nuclear plants are engineered to withstand tornadoes, hurricanes, and earthquakes. During storms, workers monitor the systems to make sure all is running safely. The professionals monitoring nuclear plants are always improving their safety features based on the latest technology. Modern nuclear plants, for instance, employ specialized robots to inspect and perform repairs within reactor chambers. These robots work in areas where it would be dangerous or even impossible for humans to go.

Another key benefit of nuclear power plants is that they don't pollute the air. If you drive past the nuclear plants in Glen Rose or Bay City, you may see what appears to be smoke billowing from their large smokestacks. But it isn't smoke. It is steam used to spin turbines inside the plant. Steam is just heated water and is not much different than clouds already in the air.

Like renewable energy sources, nuclear energy is appealing to many because it produces far less air pollution than fossil fuels. But many of those renewable energy sources do use a lot of one natural resource in particular: land. Nuclear energy doesn't take up much space. According to the Nuclear Energy Institute, one nuclear energy facility can generate 1,000 megawatts of energy on 1.3 square miles of land. If a solar facility were to generate the same amount of energy, it would require 31 times more land. Similarly, a wind farm would require 173 times more land.



Nuclear energy also helps create high-paying jobs. Texas' two nuclear facilities collectively employ around 2,400 individuals. According to the Nuclear Energy Institute, the economic impact of the South Texas Project plant is monumental, injecting over a billion dollars annually into the state's economy. Every one job there creates almost two more jobs in the local area.

There are many types of jobs involved in making nuclear energy. Some of the jobs at nuclear plants are engineers, physicists, plant operators, and safety inspectors. Students who are interested in nuclear energy can study it at many Texas universities. Here, students get hands-on learning, which other schools might not be able to offer!

What Is the Future of Nuclear Energy?

Nuclear energy is clean, powerful, and reliable. The production of nuclear energy already plays a major role in helping Texas make its own electricity. As technology improves, producing nuclear energy will only become cheaper, easier, and safer. In fact, new proposals for small nuclear power plants are underway to reduce the cost and waste of traditional nuclear power plants. This explains why the future of nuclear energy in Texas looks bright.

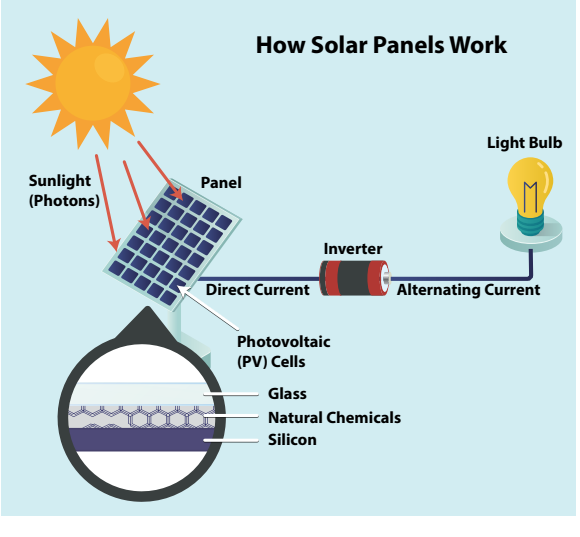
Solar, Wind, and Batteries

THE BIG QUESTION
What is the science behind solar and wind energy and innovations? How do these impact Texas and beyond?

Part 1: Renewable Energy Explained

Think back to the last time you experienced a bright, sunny day. You might have been walking outside and turned your face up to the sun. Imagine the warmth of the sun's light on your face and a cool breeze ruffling your hair. Believe it or not, the sun and the wind can be used to produce electricity. They are sources of what we call **renewable energy**. Renewable energy comes from things that are **replenished** by nature. Let's learn more about the science behind solar and wind energy.

What Are Solar Panels?



Solar energy uses the sun's rays and turns them into electricity. To do this, we use special devices called **solar panels**. Solar panels are designed to absorb sunlight and turn it into electricity. Most solar panels are made up of many **photovoltaic (PV) cells**. The more PV cells on a panel, the more energy the panel can produce. PV cells are like a sandwich with layers of **silicon** and other chemical elements, with glass on top.

These elements are extracted by **mining** them. Mining involves digging deep into the earth to get useful natural resources, like the

silicon used in PV cells. Mining can be an expensive, time-consuming process. It often takes place in countries outside of the United States, which often have fewer rules in place to protect the environment during the process. Scientists are always searching for new ways to make solar panels that reduce the need for mining. Some think mining can be improved to be less harmful to the environment.

Where Do Solar Panels Work?

How many homes and buildings do you see around town with solar panels? Where do you usually see them? Solar panels work best when placed out in the open so they are fully exposed to the sun. They are often put on rooftops or in large, open fields. Because they need sunlight, solar panels can't produce electricity when they are in the shade or at night, so picking a place to install the panels that gets a lot of sunlight is important.

The equation is simple: More solar panels and more sunlight equal more energy production. When a lot of solar panels are placed together to harvest daylight, it is called a **solar farm**. The largest solar farms in the United States are in California, Nevada, Arizona, and Texas—all places where the sun can be relied on to shine brightly for most of the year. One of the largest solar farms in Texas is the Upton 2 Solar Power Plant, which is as large as about 1,455 football fields. This solar farm can generate enough electricity for 56,000 homes all by itself. There are more solar farms being built in Texas each year, adding to the power potential of solar energy in the state.

New technology allows solar energy to be stored and used later, which is helpful because sunshine is **intermittent**. This means that the amount of usable sunlight can change often, such as during the winter or when there is cloud cover. Thanks to this new technology, places can generate solar power during the hours when there is a lot of sunlight. **Batteries** then store the electricity to use on less sunny days. You will

learn more about batteries later on. For now, it's good to know that solar energy can be saved and stored for a literal rainy day.

What Are the Strengths and Weaknesses of Solar Power?

Let's consider the strengths first. Three percent of power in the United States came from solar energy in 2020. This is expected to increase to twenty percent by 2050. This increase could be driven by the fact the sun is the ultimate renewable resource that will not expire or run out. Plus, when solar power is generated, it does not release as many pollutants into the air as other energy sources, making it cleaner. Another strength of solar power is that it helps Texas be energy-independent. That means Texas can create its own electricity without relying on other places. Further, solar panels also help people keep the price of electricity low. When they can generate and store power using their own panels, they do not need to pay for electricity from a utility company.

While there are benefits to solar power, there are also some weaknesses. First, solar panels can be quite expensive for people who want to install them. In 2023, the average cost for solar panels ranged from $10,000 to

Solar Panels in an Open Field

$30,000. Most people cannot afford this high price. Beyond the cost of individual solar panels, generating solar power at any scale could mean higher prices for electricity. Higher electricity prices means that people have less money to spend on food, housing, and any other goods or services. This would mean fewer jobs in the economy and more people living in poverty. Whether any energy source can be helpful to people is always dependent upon how much it costs to generate the energy.

A second weakness is that solar panels only work when there is sun. While there is sunlight everywhere, that does not mean that there is open land without features that could block the sunlight like tall trees and mountains. Also, solar panels take up a lot of space. Whether a homeowner is trying to find enough space on their roof, or a city is trying to find enough land, solar panels require more space than other forms of energy to generate the same amount of electricity.

So far, we've only talked about considerations when the power is generated. There are also impacts when developing the energy source. For example, while the process of generating power from solar panels does not create air pollution, mining the materials to create solar panels pollutes the environment. Also, mining often takes place in countries outside of the United States, which typically have fewer rules in place to protect workers as well as the environment. Another category of impacts we discussed in an earlier lesson are the waste products of energy production. In the case of solar panels, the PV cells are currently non-recyclable.

How Does Wind Energy Work?

Have you ever flown a kite on a windy day? The wind that lifts your kite is the same wind that can generate power. People have been harnessing the wind to make lives easier for centuries. Windmills were once used to grind grain or pump water, especially on the Texas prairie. Windmills are the older version of modern **wind turbines**. Many farms in Texas still use

windmills. Newer versions of wind turbines can be seen throughout the Texas landscape today, capturing the wind's energy and turning it into electricity.

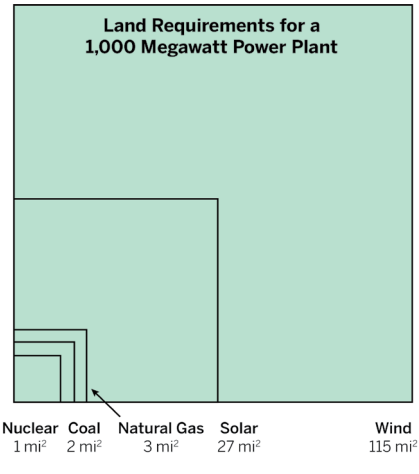
Wind Turbine and Solar Panels

Wind turbines are tall structures with blades that spin in the wind. They look like big fans towering over the ground, standing almost 300 feet tall. When the wind blows, it turns the blades of the turbine. These blades are connected to a **generator**. When the blades turn, the generator spins, and this movement transforms wind energy into electrical energy. Just like with solar panels, when lots of these wind turbines work together, we get a lot of electricity.

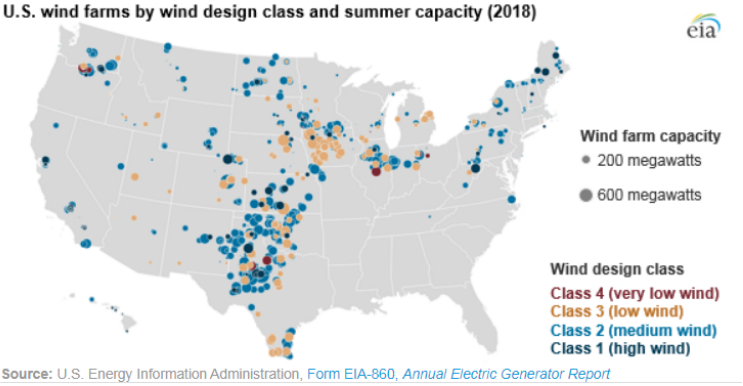
Wind turbines used to be more expensive than they are today. Texans are helping make wind turbines even more affordable. The University of Texas at Dallas has a Wind Energy Center. At this center, researchers try to make wind turbine blades lighter and stronger. This would mean less expensive turbines that could generate more power.

Where Is Wind Power?

Wind turbines can be built in many places. They can be located in fields, on hills, or even in the ocean, but they work best in remote places where the wind blows without obstruction. The largest wind turbines in the United States are located along the coasts, using the wind that sweeps off the ocean waves. States in the center of the continent along the Great Plains, from North Dakota to Texas, also produce a lot of wind energy.



Texas is a windy place. In fact, Texas led the nation in wind-powered electricity in 2022. That means Texas produced more electricity from wind than any other state. Texas is also home to one of the largest **wind farms** in the United States. A wind farm is a collection of wind turbines. The Roscoe Wind Farm, located southwest of Abilene, has 627 wind turbines. Those turbines generate enough electricity to power about 265,000 homes.



What Are the Strengths and Weaknesses of Wind Power?

Let's first explore the strengths, or benefits, of wind power. Like solar power, wind is a renewable resource that doesn't pollute the air when generating power. Wind is considered renewable because wind is caused by the movement of air masses, and we won't run out of air. Wind turbines can be installed in almost any place where there is wind that blows an average of nine miles per hour (mph). Another strength is that the cost to operate the turbines is low. A final benefit is that wind power creates jobs. According to the U.S. Bureau of Labor Statistics, one of the fastest-growing jobs in the U.S. is a wind turbine service technician. However, in many places, these jobs are in part created because of subsidies to wind power producers paid by the government from taxes.

Now let's consider the weaknesses, or limitations, of wind power. The location of a wind turbine is often a source of criticism. For one, wind turbines are large and loud. People do not like them placed where

they can be seen and heard. Second, they can also be a danger to wildlife. Studies show that wind turbines are dangerous to birds and bats in the air and marine life by coastal wind farms. Coastal wind farms can also negatively impact businesses that rely on marine life, such as fishermen and restaurants. Third, for a wind farm to be successful, it must be located where wind is common. Like sunshine, wind can also be intermittent. If there is not enough wind, then the turbines will not generate enough power. Next, since wind turbines work best in remote places, transferring that energy from the wind turbines to the power plant can be challenging. Energy is lost along the miles and miles of power lines, which can lead to wasted resources, including both power and money. Finally, the wind turbine materials become worn down and must be discarded. While there is no air pollution produced while generating power, over time, there is a pollution of the land because a large amount of waste can accumulate.

Since wind turbines work best in remote places, transmitting or transporting power from wind turbines can be a challenge. As a result, leaks can occur in the process of moving the energy from one place to the next. This can lead to wasted resources, including both power and money.

What Are Batteries Made of?

Renewable energy needs batteries. Batteries are devices that can store and release energy. To make batteries, we need special metals. These metals are mined or extracted from digging in the ground, just like mining for silicon for solar panels. Minerals that are mined include lithium, cobalt, and nickel.

There are also strengths and weaknesses to batteries. They are important because they allow us to use energy when we need it. This is the main benefit. Batteries can store the energy from the sun and wind for later use, making these energy sources more **reliable**. This is especially important for times when the sun doesn't shine or the wind doesn't blow. By storing energy in batteries, we can use renewable

energy even when it's dark or calm.

On the negative side, batteries rely on mining, which has the disadvantages discussed earlier. Battery storage can be challenging. Batteries that store a lot of power can be costly and require a lot of space. Small devices, like speakers and phones, work better with battery power because they do not require much energy. Yet, large or heavy machines, such as refrigerators, water treatment facilities, and medical equipment, may require more power than a battery can provide. This may explain why batteries can be useful in moments where power is lost temporarily, but not necessarily for maintaining electricity for long periods of time.

How Have Texans Improved Battery Technology?

Texas has been a key developer in battery technology. Tesla, a company that makes cars that run on electricity, has built a massive battery-making factory in Austin called Giga Texas. This factory produces batteries for Tesla's cars. The technology could also be used for larger energy storage in the future.

In addition to Tesla, there's more innovative battery work being done in Texas. The University of Texas at Austin's Energy Institute has more than 350 people looking at how to make batteries better. They want to find ways to make batteries that can store more power while costing less.

Renewable Energy in Texas

As you've read, there are pros and cons to every energy source. That's why we need a diversity of energy sources to power Texas. Renewable energy helps Texas promote economic growth and energy independence. From fossil fuels to renewable energy sources, innovations are key to education, jobs, and reducing air pollution. Still, there are several issues associated with renewables. To name a few, they require more land both to produce power and in the disposal of their equipment. Many of the materials used by renewables require invasive mining, sometimes done in unsafe ways in other countries, and those materials are not recyclable.

And cost can be a significant issue, especially with solar energy, and sometimes tax dollars are still used to subsidize renewable energy sources. Yet, with so many invested in innovations and improvements, we can look forward to improvements. It's about using our economic and natural resources wisely to keep our great state of Texas strong and independent.

Part 2: An Argument in Favor of Renewable Energy

Energy Sources Led by Texas

Almost one-third of the power Texans used in 2023 came from wind and solar energy. This was over twenty percent more than the entire United States. It is time for all Americans to follow Texas and make the shift to using renewable energy sources. Doing so will help us rely on a source of power that doesn't run out. In the process, it will create jobs.

First, relying on the sun and wind for power is a safe bet for our future. This is because they never run out. The sun shines everywhere on Earth. Any place the sun touches, even in very cold places, people could harness solar energy to make electricity. Like solar power, wind is a renewable resource that is plentiful. Anywhere that the wind blows an average of nine miles per hour (mph), people can transform wind energy into electricity. According to the U.S. Energy Information Administration, nearly every state has enough wind to build wind turbines. As long as the sun warms the planet and the wind blows, there will always be a source of energy.

Second, solar and wind energy offer benefits that go beyond producing electricity. They provide jobs. People can make solar panels, install them, or even fix them. According to the Texas Comptroller, in 2022 Texas was the nation's fourth-largest state for jobs in the solar industry. They also projected a 7.5% employment growth for the next year. Furthermore, the U.S. Energy and Employment Report stated that Texas had over twenty-six thousand wind-related jobs in 2023. The critics rightfully note that many of these jobs are in part a result of **subsidies** from tax dollars. But as underlying costs of renewables come down from additional innovation by industry, those subsidies can be eliminated. As the United States transitions to more renewable energy production, we will see more jobs.

Some people criticize solar and wind power because sunlight and wind are intermittent. This means that solar panels and wind turbines need to be installed in certain places. In order for solar power to work, there must be a lot of sunlight and little cloud cover. Similarly, for wind power, there must be wind. However, new solar panels are designed to reduce the impact of shade. They also can generate electricity during light snow. Technology is improving the design of wind turbines, too. They are being built taller to generate more power. This reduces the need for as many turbines in one area, improving the way they look and sound. People in Texas are also starting to work together to consider impacts on wildlife before placing turbines. In addition to these improvements, batteries make solar and wind power more reliable. Batteries ensure that energy is stored for days that are cloudy or not windy.

People also point out that solar and wind energy require a lot more space to generate the same amount of power as other forms of energy and can generate a lot of land waste in disposal. While this is true, there are many places in Texas and beyond that have enough space to accommodate these renewable technologies. Others raise concerns about the raw materials used by these technologies and the disruptive mining that is required. While this is also true, mining practices, when performed in the United States, have become safer. Taken together, complaints about land pollution from solar and wind do not outweigh the promise of these new technologies.

Texas demonstrates that the shift toward renewable energy is possible for all people in the United States. The sun and wind produce energy that will never run out. As we design materials to generate power from them, we also will create more jobs across the country. So, follow our lead, America, for a more stable and prosperous future.

THE BIG QUESTION
How does the city of Houston balance energy, the environment, and the economy?

Houston: Balancing Energy, the Environment, and the Economy

What do you think of when you think of the city of Houston? Do you think of the Houston Astros or Houston Texans? You may not have known this, but before the Houston Texans, there was a professional football team called the Houston Oilers. Do you know where that name came from? If not, that is okay—we will tell you the answer soon! Sports are one part of Houston's story. The city also has a reputation as a place for **innovators**, especially those who work to balance energy production and the environment.

Houston Earns a New Name

Houston is proud to call itself the "Energy Capital of the World." The title isn't just for show; Houston has been at the heart of energy production since 1901. In January of that year, something big happened at the oil **derrick** called Spindletop in the town of Beaumont not far from Houston. A derrick is a tall tower-like structure used to get oil from the ground. Geologists began to think that oil was underneath Spindletop Hill in the late nineteenth century. When drilling finally began at the derrick at Spindletop, it gushed oil and attracted a rush of oil prospectors into the area. It was the start of what became known as the oil boom. Growing right alongside the number of derricks and wells was Houston, the nearest city with a port for shipping out the oil.

Houston has been a center for energy production ever since, and that is why Houston is known as the "Energy Capital of the World."

Energy production has always been a key factor in Texas' economic success. Oil derricks pull petroleum from the ground, wind turbines spin and generate power, and solar farms convert sunlight to energy. From the Permian Basin to the Gulf Coast, energy production has been a large part of the lives of Texans for over a hundred years. But the city of Houston has a special connection with energy. It is a **hub** for oil, gas, and renewable energy. Remember the professional football team mentioned earlier called the Houston Oilers? While most teams use animals as their logos, the Oilers used an oil derrick as a logo!

While Houston produces a lot of energy, it also has high energy needs. As the fourth-largest city in the United States, Houston needs a lot of energy. The **Port** of Houston is one of the busiest ports in the world. It alone requires vast amounts of energy. This has led leaders to ask: *How can we create energy for ourselves and the world, while also protecting our city?* In recent years, protecting the city has involved both the economy and the environment.

Supporting Energy, the Economy, and the Environment

Have you ever stopped to think about how big a part energy plays in daily life? Oil is used to heat buildings and power vehicles. It is also a part of everyday items like computers, phones, and medical supplies. Energy powers electricity that lights up homes. Batteries run everything from toys to mobile devices. Behind every switch and every spark is energy! Producing and using energy also impacts the natural world around us.

Houston's leaders are aware of this balance. They've set goals to produce energy and protect nature at the same time. For example, when oil is produced in a factory, steam and other gasses are released. Instead

of releasing all of the pollutants into the environment, they capture some. Then they transport some of it and separate it so they can reuse it in other products. This kind of innovation helps the environment and the production of energy.

Innovations like this often take place when business leaders work close together. In 2001, the Texas Legislature officially declared 2,000 acres in West Houston as the Energy Corridor Management District. The close proximity of energy leaders may explain why Houston has seen improvements to energy production that also keep the environment and economy in mind. Many of the companies located in the Energy Corridor sponsor environmental activities in the city, such as planting trees and protecting local wildlife. The district also attracts people interested in joining the energy field. For example, located near Houston, Texas A&M University's Energy Institute is dedicated to creating the next generation of leaders in energy. They have developed programs where students and professionals can learn to lead and improve the industry.

At the same time that leaders of energy companies try to limit their companies' environmental impacts, Houston government leaders plan for growth with the environment in mind. **Green spaces** like Buffalo Bayou Park have been built all over the city. In these spaces, plants reduce the impacts of pollution. In 2002, the city also began a new green transportation plan where they began to use plug-in hybrid electric vehicles. These were meant to keep the air clean. Hybrid vehicles use less fossil fuels than gas-powered cars but still get their power from electric grids that are often powered by fossil fuels. Even though hybrid vehicles get some of their power from electric grids that are nearly 60% powered by fossil fuel, they use less fossil fuel overall than gas-powered cars. Today, Houston has the third-largest fleet of hybrid city cars in the nation. Hybrid cars and green spaces aren't the

only city-led changes. In 2008, solar panels were installed on many city buildings. While there are impacts from mining materials for solar panels, solar energy does not create the same kind of air pollution as many forms of non-renewable energy. Energy companies work hard to limit their environmental impacts. However, all energy sources use natural resources. Scientists, business leaders, and politicians work to consider ways to use natural resources most efficiently.

Improvements to energy production that involve the environment can have a big impact on the economy. This is because the energy sector in Houston drives the local and state economy. Thousands of Texans are able to find employment in the energy industry. Geologists work to find new oil fields. Engineers design better solar panels. Scientists research cleaner and more efficient ways to produce power. This may lead to new jobs, where people build and then run new equipment. As a result, the process of making and storing energy has less of an impact on the environment. Thus, the environment, the economy, and energy production all benefit.

Houstonians Lead the Way

The city of Houston promotes things that ordinary people can do to help improve the environment. This includes city-wide clean-up days where volunteers come together to pick up the trash left on the city streets. The city even organizes a "Bike to Work Day." On that day, there is less traffic, less pollution, and more exercise!

There is also a "Lights Out Houston" event, where the city dims its lights. This saves power and cost, but there is another reason behind the event: "Lights Out Houston" helps **migrating** birds. They fly at night and use the moon and stars to know where to go. Bright lights at night can confuse them. By dimming the lights, Houston helps keep these birds flying. "Lights Out Houston" began with local leaders in 2017 and

has since expanded statewide!

Houston Makes Strides

Houston has a reputation as a great American city. Nature blooms in and around the city. More and more jobs are coming to Houston as companies expand and the city grows. Power is cheaper and comes from more sources. And other Texas cities have followed Houston's lead. The city of Dallas, for example, is committed to the use of wind energy. As of 2023, the Environmental Protection Agency ranks Dallas just under Houston on a list of top local governments in the nation for use of renewable energy. In fact, five of the top six entries on that list are from Texas!

Glossary

A

abundant, ***adj.*** to exist in a large amount

admiral, ***n.*** a naval officer of high rank

ambitious, ***adj.*** a strong desire to be successful

argumentative, ***adj.*** a genre that demonstrates that a certain claim or idea is correct by supporting it with evidence

atom, ***n.*** the basic unit of a chemical element

B

barges, ***n.*** large, flat-bottomed ships used to transport goods

batteries, ***n.*** devices that change chemical energy into electric energy

biogas, ***n.*** a mixture of gasses, created by the breakdown of organic substances, which can be used as a renewable energy source

bit, ***n.*** the part of a tool that cuts, often used in drills

blunt, ***n.*** dull

boiler, ***n.*** a tank used for heating or holding heated water

buggies, ***n.*** small, often open-top, vehicles pulled by horses

C

carbon, ***n.*** a naturally occurring chemical element found in living things

chemical element, ***n.*** a substance that cannot be broken down into simpler substances

claim, ***n.*** the main idea of an argumentative text, which describes the author's opinion about a topic and is supported by reasons and evidence

compressed, ***v.*** squeezed or pressed together

conclusion, ***n.*** the ending of a piece of writing, which restates the main idea and leaves the reader with a feeling or a call to action

contaminated, ***adj.*** soiled or unfit for use

conveyor belt, ***n.*** a thin surface that moves along a looped track for the purpose of transporting an object

cosmopolitan, ***adj.*** containing people from many places and cultures

D

debris, ***n.*** small pieces of scattered material

defend, ***v.*** to demonstrate that a certain claim or idea is correct by providing evidence

demand, ***n.*** an amount of product or service wanted at a certain time

deposit, ***n.*** an accumulation of material in one place

depressions, ***n.*** spots lower than the surrounding area

derrick, ***n.*** a large wooden frame used to support drilling equipment for the extraction of oil

diverse, *adj.* different (***v.*** **diversify**)

E

energy, ***n.*** the ability to do work or cause change

energy independent, *n.* the state of not needing to rely on other states or countries to provide energy sources to meet energy needs

essay, ***n.*** a short piece of nonfiction writing that gives information or argues a position on a particular topic

evidence, ***n.*** relevant and valid facts, details, or information that supports a claim, inference, or idea

excavations, ***n.*** careful or purposeful digging to uncover something

extract, ***v.*** to pull out or remove

F

fermentation, ***n.*** the chemical breakdown of a substance by microorganisms

film, ***n.*** a very thin layer

flammable, ***n.*** easily set on fire

fractured, ***v.*** broke

fuel, ***n.*** a substance that can be burned as a source of energy

v. to supply power or energy (example: fuel an argument)

fumes, ***n.*** strong-smelling vapor or gas, often emitted from harmful chemicals

G

generate, ***v.*** to produce or make

generator, ***n.*** a machine that changes energy into electricity

goods, ***n.*** products

green spaces, ***n.*** protected areas of natural plants and grass within an urban environment

H

horizontally, ***adv.*** in a side-to-side position

host, ***v.*** to receive guests

hub, ***n.*** center of activity

I

impermeable, ***adj.*** not allowing liquid to pass through

industry, ***n.*** a group of businesses that offer similar goods or services and compete for customers

innovation, ***n.*** a new process, idea, or thing

innovative, ***adj.*** having the quality of something new created for a purpose

innovators, ***n.*** people who develop new ideas or products

intended audience, ***n.*** the group of people meant to receive a message

intermittent, ***adj.*** sporadic; irregular

introduction, ***n.*** the beginning of a piece of writing, which describes the main idea and/or gets the reader interested in the topic

investor, ***n.*** someone who gives money in order to earn more money in the future

M

migrating, ***v.*** moving from one place to another according to the seasons

mining, ***v.*** extracting materials from Earth

modifying, ***v.*** changing for a specific purpose

N

nuclear energy, ***n.*** energy released during nuclear fission or fusion to generate electricity

nuclear fission, ***n.*** when atoms are split apart and release energy

nuclear fusion, ***n.*** when two atomic nuclei join to form a single nucleus and give off energy

nuclear reactor, ***n.*** a device used to generate power through nuclear fission

O

oil, ***n.*** slippery liquid made from petroleum used for fuel that supplies energy for machines

oil well, ***n.*** a shaft drilled into the ground to extract petroleum

P

paragraph, ***n.*** a group of sentences in a piece of writing that share the same key idea

petroleum, ***n.*** liquid found inside the earth that is removed and processed to create different products such as fuels and plastics

photovoltaic cell, ***n.*** a device that changes sunlight into electricity

polluted, ***adj.*** dirty; unclean

port, ***n.*** a city or town where ships load and unload goods for shipping and trade

potential, ***n.*** the existence of a possibility

power plant, ***n.*** a place where electrical power is made and distributed

primary (source), ***n.*** first; information that comes from someone who experienced an event firsthand

R

radiation, ***n.*** the release of energy as electromagnetic waves or particles

radioactive, ***adj.*** material that releases particles smaller than an atom

reliable, ***adj.*** consistent; dependable

renew, ***v.*** to make new

renewable energy, ***n.*** energy source that does not run out

replenished, ***v.*** refilled; reloaded

rotary drill, ***n.*** a tool that works by turning a sharpened bit

S

scams, ***n.*** purposefully deceptive plans or acts

secondary (source), ***n.*** second; a source that is two or more steps removed from the original accounts of an event or experience (e.g., scholarly articles, journalism, reference books such as encyclopedias, history books, textbooks, reviews, or criticisms)

silicon, ***n.*** a chemical element used to make electronic circuits

solar farms, ***n.*** areas with a lot of solar panels to generate electricity

solar panels, ***n.*** devices that absorb the sun's rays for an energy source

space-consuming, *adj.* takes up a lot of space

speculators, ***n.*** investors hoping to make a profit

subsidies, *n.* money, usually from taxes paid by citizens, given by a government to a person or company to provide a good or service for the public

support, ***v.*** to justify a statement by providing evidence of truth

synthetic, ***adj.*** artificial; not made by nature

T

transition, ***n.*** a word or phrase used to link sentences or paragraphs together to make the piece of writing coherent

trenches, ***n.*** long ditches dug in the ground

turbine, ***n.*** a machine with a wheel or rotor that spins to produce power

U

uranium, ***n.*** a radioactive metal

V

valuable, ***adj.*** of high worth

vertically, ***adv.*** in an up-and-down position

visualize, ***v.*** create a mental image

W

wind turbines, ***n.*** devices with blades that turn wind energy into electricity

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