IMPORTANCE OF RENEWABLE ENERGY SOURCES OF NATURAL ENERGY

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WHAT IS RENEWABLE ENERGY?

Renewable energy uses energy sources that are continually replenished by nature—the sun, the wind, water, the Earth's heat, and plants. Renewable energy technologies turn these fuels into usable forms of energy—most often electricity, but also heat, chemicals, or mechanical power.

WHY WE USE RENEWABLE ENERGY?

Today we primarily use fossil fuels to heat and power our homes and fuel our cars. It's convenient to use coal, oil, and natural gas for meeting our energy needs, but we have a limited supply of these fuels on the Earth. We're using them much more rapidly than they are being created. Eventually, they will run out. And because of safety concerns and waste disposal problems, the United States will retire much of its nuclear capacity by 2020. In the meantime, the nation's energy needs are expected to grow by 33 percent during the next 20 years. Renewable energy can help fill the gap. Even if we had an unlimited supply of fossil fuels, using renewable energy is better for the environment. We often call renewable energy technologies "clean" or "green" because they produce few if any pollutants. Burning fossil fuels, however, sends greenhouse gases into the atmosphere, trapping the sun's heat and contributing to global warming. Climate scientists change agree that the Earth's average temperature has risen in

the past century. If this trend continues, sea levels will rise, and scientists predict that floods, heat waves, droughts, and other extreme weather conditions could occur more often. Other pollutants are released into the air, soil, and water when fossil fuels are burned. These pollutants take a dramatic toll on the environment—and on humans. Air pollution contributes to diseases like asthma. Acid rain from sulfur dioxide and nitrogen oxides harms plants and fish. Nitrogen oxides also contribute to smog.

Renewable energy will also help us develop energy independence and security. The United States imports more than 50 percent of its oil, up from 34 percent in 1973. Replacing some of our petroleum

with fuels made from plant matter, for example, could save money and strengthen our energy security. Renewable energy is plentiful, and the

technologies are improving all the time.There are many ways to use renewable energy. Most of us already use renewable energy in our daily lives.

RENEWABLE ENERGY WE USE IN OUR DAILY LIVES:

- ***BIOENERGY*** :

  Bioenergy is the energy derived from biomass (organic matter), such as plants. If you've ever burned wood in a fireplace or campfire, you've used bioenergy. But we don't get all of our biomass resources directly from trees or other plants. Many industries, such as those involved in construction or the processing of

agricultural products, can create large quantities of unused or residual biomass, which can serve as a bioenergy source.

- ***BIOPOWER:***

  After hydropower, biomass is this country's second-leading resource of renewable energy, accounting for more than 7,000 MW of installed capacity. Some utilities and power generating companies with coal power plants have found that replacing some coal with biomass is a low-cost option to reduce undesirable emissions. As much as 15 percent of the coal may be replaced with biomass. Biomass has less sulfur than coal. Therefore, less sulfur dioxide, which contributes to acid rain, is released into the air. Additionally, using biomass in these boilers reduces nitrous oxide emissions. A process called gasification—the conversion of biomass into gas, which is burned in a gas turbine—is another way to generate electricity. The decay of biomass in landfills also produces gas, mostly methane, which can be burned in a boiler to produce steam for electricity generation or industrial processes. Biomass can also be heated in the absence of oxygen to chemically convert it into a type of fuel oil, called pyrolysis oil. Pyrolysis oil can be used for power generation and as a feed stock for fuels and chemical production.

- ***HYDROPOWER:***

  Hydropower is our most mature and largest source of renewable power, producing about 10 percent of the nation's electricity. Existing hydropower capacity is about 77,000 megawatts (MW). Hydropower plants convert the energy in flowing water into electricity. The most common form of hydropower uses a dam on a river to retain a large reservoir of water. Water is released through turbines to generate power. "Run of the river" systems, however, divert water from the river and direct it through a pipeline to a turbine. Hydropower plants produce no air emissions but can affect water quality and wildlife habitats. Therefore, hydropower plants are now being designed and operated to minimize impacts on the river. Some of them are diverting a portion of the flow around their dams to mimic the natural flow of the river. But while this improves the wildlife's river habitat, it also reduces the power plant's output. In addition, fish ladders and other approaches, such as improved turbines, are being used to assist fish with migration and lower the number of fish killed.

- ***BIOFUELS:***

  Biomass can be converted directly into liquid fuels, called biofuels. Because biofuels are easy to transport and possess high energy density, they are favoured to fuel vehicles and sometimes stationary power generation. The most common biofuel is ethanol, an alcohol made from the fermentation of biomass

high in carbohydrates. The current largest source of ethanol is corn. Some cities use ethanol as a gasoline additive to help meet air quality standards forozone. Flex-fuel vehicles are also vow on the market, which can use mixture of gasoline and ethanol, such as E85—a mixture of 85 percent ethanol and 15 percent gasoline. Another biofuel is biodiesel, which can be made from vegetable and animal fats. Biodiesel can be used to fuel vehicle or as a fuel additive to reduce emissions. Corn ethanol and biodiesel provide about 0.4 percent of the total liquid fuels market. To increase our available supply of biofuels, researchers are testing crop residue such as cornstalks and leaves—woodchips, food waste, grass, and even trash as potential biofuel sources.

➢ *BIO-BASED PRODUCTS:*

Biomass—corn, wheat, soybeans, wood , and residues can also be used to produce chemicals and materials that we normally obtain from petroleum. Industry has already begun to use corn starch to produce commodity plastics, such as shrink wrap, plastic eating utensils, and even car bumpers. Commercial development is underway to make thermoset plastics, like electrical switch plate covers, from wood residues.

➢ *GEO-THERMAL ENERGY:*

The Earth's core, 4,000 miles below the surface, can reach temperatures of 9000° F. This heat—geothermal energy—flows outward from the core, heating the surrounding area, which can form underground reservoirs of hot water and steam. These reservoirs can be tapped for a variety of uses, such as to generate electricity or heat buildings. By using geothermal heat pumps (GHPs), we can even take advantage of the shallow ground's stable temperature for heating and cooling buildings. The geothermal energy potential in the uppermost 6 miles of the Earth's crust amounts to 50,000 times the energy of all oil and gas resources in the world. In the United States, most geothermal reservoirs are located in the western states, Alaska, and Hawaii. GHPs, however, can be used almost anywhere.

➢ *WIND ENERGY:*

For hundreds of years, people have used windmills to harness the wind's energy. Today's wind turbines, which operate differently from windmills, are a much more efficient technology. Wind turbine technology may look simple the wind spins turbine blades around central hub; the hub is connected to a shaft, which powers a generator to make electricity. However, turbines are highly sophisticated power systems that capture the wind's energy by means of new blade designs or air foils. Modern, mechanical drive systems, combined with advanced generators, convert that energy into electricity. Wind turbines that provide electricity to the utility grid range in size from 50 kW to simplicity, it doesn't occur naturally as a

gas on the Earth. Today, industry produces more than 4 trillion cubic feet of hydrogen annually. Most of this hydrogen is produced through a process called reforming, which involves the application of heat to separate hydrogen from carbon. Researchers are developing highly efficient, advanced reformers to produce hydrogen from natural gas for what's called Proton Exchange Membrane fuel cells. You can think of fuel cells as batteries that never lose their charge. Today, hydrogen fuel cells offer tremendous potential to produce electrical power for distributed energy systems and vehicles. In the future, hydrogen could join electricity as an important "energy carrier": storing, moving, and delivering energy in a usable form to consumers. Renewable energy sources, like the sun, can't produce energy all the time. But hydrogen can store the renewable energy produced until it's needed. Eventually, researchers would like to directly produce hydrogen from water using solar, wind, and biomass and biological technologies.

- ***Ocean energy:***

  The ocean can produce two types of energy: thermal energy from the sun's heat, and mechanical energy from the tides and waves. Ocean thermal energy can be used for many applications, including electricity generation. Electricity conversion systems use either the warm surface water or boil the seawater to turn a turbine, which activates a generator. The electricity conversion of both tidal and wave energy usually involves mechanical devices. A dam is typically used to convert tidal energy into electricity by forcing the water through turbines, activating a generator. Meanwhile, wave energy uses mechanical power to directly activate a generator, or to transfer to a working fluid, water, or air, which then drives a turbine/generator. Most of the research and development in ocean energy is happening in Europe.

BENEFITS OF RENEWABLE ENERGY USE:

Wind turbines and solar panels are an increasingly common sight. But why? What are the benefits of renewable energies—and how do they improve our health, environment, and economy?

This page explores the many positive impacts of clean energy, including the benefits of wind, solar, geothermal, hydroelectric, and biomass. For more information on their negative impacts—including effective solutions to avoid, minimize, or mitigate—see our page on The Environmental Impacts of Renewable Energy Technologies.

- ***Less global warming:***

  Human activity is overloading our atmosphere with carbon dioxide and other global warming emissions. These gases act like a blanket, trapping heat. The result is a web of significant and harmful impacts, from stronger, more frequent storms, to drought, sea level rise, and extinction.

  In the United States, about 29 percent of global warming emissions come from our electricity sector. Most of those emissions come from fossil fuels like coal and natural gas .

- ***What is CO2e?***

  Carbon dioxide (CO2) is the most prevalent greenhouse gas, but other air pollutants—such as methane—also cause global warming. Different energy sources produce different amounts of these pollutants. To make comparisons easier, we use a carbon dioxide equivalent, or CO2e—the amount of carbon dioxide required to produce an equivalent amount of warming.

  In contrast, most renewable energy sources produce little to no global warming emissions. Even when including “life cycle” emissions of clean energy (ie, the emissions from each stage of a technology’s life—manufacturing, installation, operation, decommissioning), the global warming emissions associated with renewable energy are minimal .

  The comparison becomes clear when you look at the numbers. Burning natural gas for electricity releases between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour (CO2E/kWh); coal emits between 1.4 and 3.6 pounds of CO2E/kWh. Wind, on the other hand, is responsible for only 0.02 to 0.04 pounds of CO2E/kWh on a life-cycle basis; solar 0.07 to 0.2; geothermal 0.1 to 0.2; and hydroelectric between 0.1 and 0.5.

  Renewable electricity generation from biomass can have a wide range of global warming emissions depending on the resource and whether or not it is sustainably sourced and harvested.
  Increasing the supply of renewable energy would allow us to replace carbon-intensive energy sources and significantly reduce US global warming emissions.

  For example, a 2009 UCS analysis found that a 25 percent by 2025 national renewable electricity standard would lower power plant CO2 emissions 277 million metric tons annually by 2025—the equivalent of the annual output from 70 typical (600 MW) new coal plants .

  In addition, a ground-breaking study by the US Department of Energy's National Renewable Energy Laboratory (NREL) explored the feasibility of generating 80

percent of the country’s electricity from renewable sources by 2050. They found that renewable energy could help reduce the electricity sector’s emissions by approximately 81 percent .

- ***Improved public health:***

The air and water pollution emitted by coal and natural gas plants is linked with breathing problems, neurological damage, heart attacks, cancer, premature death, and a host of other serious problems. The pollution affects everyone: one Harvard University study estimated the life cycle costs and public health effects of coal to be an estimated $74.6 billion every year. That’s equivalent to 4.36 cents per kilowatt-hour of electricity produced—about one-third of the average electricity rate for a typical US home .

Most of these negative health impacts come from air and water pollution that clean energy technologies simply don’t produce. Wind, solar, and hydroelectric systems generate electricity with no associated air pollution emissions. Geothermal and biomass systems emit some air pollutants, though total air emissions are generally much lower than those of coal- and natural gas-fired power plants.

In addition, wind and solar energy require essentially no water to operate and thus do not pollute water resources or strain supplies by competing with agriculture, drinking water, or other important water needs. In contrast, fossil fuels can have a significant impact on water resources: both coal mining and natural gas drilling can pollute sources of drinking water, and all thermal power plants, including those powered by coal, gas, and oil, withdraw and consume water for cooling.

Biomass and geothermal power plants, like coal- and natural gas-fired power plants, may require water for cooling. Hydroelectric power plants can disrupt river ecosystems both upstream and downstream from the dam. However, NREL's 80-percent-by-2050 renewable energy study, which included biomass and geothermal, found that total water consumption and withdrawal would decrease significantly in a future with high renewables .

- ***Inexhaustible energy:***

Strong winds, sunny skies, abundant plant matter, heat from the earth, and fast-moving water can each provide a vast and constantly replenished supply of energy. A relatively small fraction of US electricity currently comes from these sources, but that could change: studies have repeatedly shown that renewable energy can provide a significant share of future electricity needs, even after accounting for potential constraints .

In fact, a major government-sponsored study found that clean energy could contribute somewhere between three and 80 times its 2013 levels, depending on assumptions . And the previously mentioned NREL study found that renewable energy could comfortably provide up to 80 percent of US electricity by 2050.

- ***Other economic benefits:***

Compared with fossil fuel technologies, which are typically mechanized and capital intensive, the renewable energy industry is more labor intensive. Solar panels need humans to install them; wind farms need technicians for maintenance.

This means that, on average, more jobs are created for each unit of electricity generated from renewable sources than from fossil fuels.

Renewable energy already supports thousands of jobs in the United States. In 2016, the wind energy industry directly employed over 100,000 full-time-equivalent employees in a variety of capacities, including manufacturing, project development, construction and turbine installation, operations and maintenance, transportation and logistics, and financial, legal, and consulting services . More than 500 factories in the United States manufacture parts for wind turbines, and wind power project installations in 2016 alone represented $13.0 billion in investments .

Other renewable energy technologies employ even more workers. In 2016, the solar industry employed more than 260,000 people, including jobs in solar installation, manufacturing, and sales, a 25% increase over 2015 . The hydroelectric power industry employed approximately 66,000 people in 2017 ;the geothermal industry employed 5,800 people .

Increased support for renewable energy could create even more jobs. The 2009 Union of Concerned Scientists study of a 25-percent-by-2025 renewable energy standard found that such a policy would create more than three times as many jobs (more than 200,000) as producing an equivalent amount of electricity from fossil fuels .

In contrast, the entire coal industry employed 160,000 people in 2016.

In addition to the jobs directly created in the renewable energy industry, growth in clean energy can create positive economic “ripple” effects. For example, industries in the renewable energy supply chain will benefit, and unrelated local businesses will benefit from increased household and business incomes .

Local governments also benefit from clean energy, most often in the form of property and income taxes and other payments from renewable energy project owners. Owners of the land on which wind projects are built often receive lease payments ranging from $3,000 to $6,000 per megawatt of installed capacity, as well as payments for power line easements and road rights-of-way. They may also earn royalties based on the project's annual revenues. Farmers and rural landowners can generate new sources of supplemental income by producing feed stocks for biomass power facilities.

UCS analysis found that a 25-by-2025 national renewable electricity standard would stimulate $263.4 billion in new capital investment for renewable energy technologies, $13.5 billion in new landowner income from? biomass production and/or wind land lease payments, and $11.5 billion in new property tax revenue for local communities .

- ***Stable energy prices:***

Renewable energy is providing affordable electricity across the country right now, and can help stabilize energy prices in the future.

Although renewable facilities require upfront investments to build, they can then operate at very low cost (for most clean energy technologies, the "fuel" is free). As a result, renewable energy prices can be very stable over time.

Moreover, the costs of renewable energy technologies have declined steadily, and are projected to drop even more. For example, the average price to install solar dropped more than 70 percent between 2010 and 2017 . The cost of generating electricity from wind dropped 66 percent between 2009 and 2016 .Costs will likely decline even further as markets mature and companies increasingly take advantage of economies of scale.

In contrast, fossil fuel prices can vary dramatically and are prone to substantial price swings. For example, there was a rapid increase in US coal prices due to rising global demand before 2008, then a rapid fall after 2008 when global demands declined . Likewise, natural gas prices have fluctuated greatly since 2000 .

Using more renewable energy can lower the prices of and demand for natural gas