Nuclear Energy Research

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Project Details
Research Outline: Nuclear Energy Research

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Key Takeaways

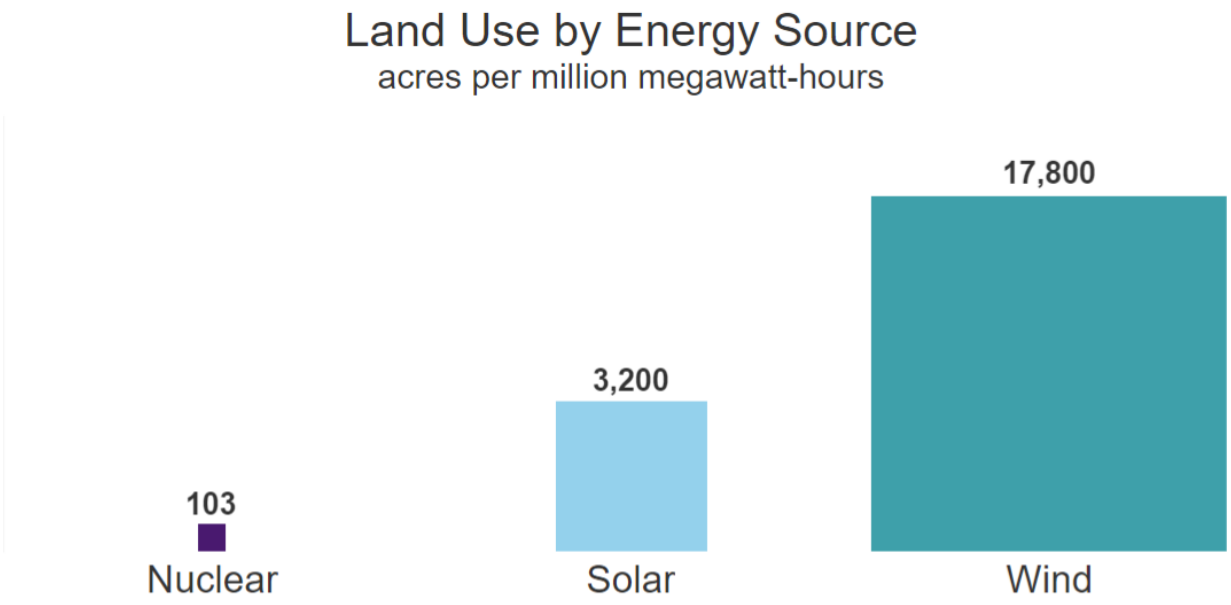
- Compared to other sources of clean air, less land is required for nuclear energy to produce electricity. To generate the same amount of electricity, 75x and 360x more land space is required by solar photovoltaic plants, and wind farms respectively, according to Nuclear Energy Institute (NEI).
- While sources of conventional fossil energy inject huge amounts of carbon dioxide into the atmosphere, causing global climate change, no carbon dioxide, or air contaminant is generated during nuclear energy plants operation, in fact the quality of air is protected by the release of water vapor.
- Sources of geothermal, hydro power, solar, and wind electricity are also emission-free, however, nuclear energy generates more electricity than a combination of all of them. Nuclear energy has zero emissions, low impact, high performance, and can provide power all round-the-clock, unlike other forms of clean air energy.
- Due to the energy density of nuclear fuel, only a small amount is needed to generate huge amounts of electricity, particularly in comparison with other energy sources. Nuclear fuel is approximately 1 million times higher in density than other sources of conventional energy, and correspondingly, the amount of waste produced is little.

Introduction

This report analyzes the competitive advantages that nuclear energy has over fossil fuel energy and solar/wind power. For each of the advantages identified, we have provided a description of the competitive advantage, a contrast between the advantage offered by fossil energy vs solar/wind power, as well as supportive metrics, where available.

Smaller Land Footprint

- Decreasing land footprints is beneficial to the environment, just like decreasing carbon footprint and water footprint are planet friendly. Less land is required for nuclear energy to produce electricity than any other clean-air source. Typically, a little over 1 square mile is required to operate a 1,000-megawatt nuclear facility in the United States.
- According to Nuclear Energy Institute (NEI), to generate the same amount of electricity, 75 times more land space is required by solar photovoltaic plants, and 360 times more is needed by wind farms. I.e., over 3 million solar panels or over 430 wind turbines (excluding capacity factor) are needed to generate the same amount of power as a conventional commercial reactor.
- According to mapping of possible energy pathways to a carbon-free U.S. economy by 2050, carried out by Princeton University's Net-Zero America Project, the most land-intensive plan excludes all nuclear plants. The U.S. energy footprint would have to increase in size by 200% to construct the extent of wind and solar necessary to support the grid — i.e., the equivalent of Arkansas, Kansas, Iowa, Nebraska, Missouri, and Oklahoma would be covered by wind farms.



Source

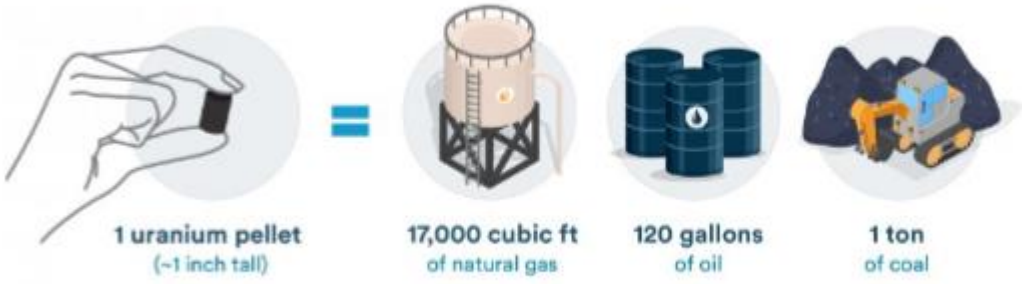
Zero-Emission Clean Energy Source

- Nuclear energy is generated through fission, i.e., a process that involves the splitting of uranium atoms to produce power. The heat produced by fission is utilized in the creation of steam, which drives a turbine to generate electricity devoid of the harmful byproducts emitted by fossil fuels. While huge amounts of carbon dioxide are injected by sources of conventional fossil energy into the atmosphere, causing global climate change, no carbon dioxide, or air contaminant is generated during nuclear energy plants operation.

- Thousands of tons of toxic air pollutants that cause smog, acid rain, cardiovascular disease, and lung cancer annually, are eliminated, with nuclear energy — protecting the quality of air by releasing only water vapor. In 2021, over 476 million metric tons of carbon dioxide emissions were prevented in the United States, according to NEI. This equates to the removal of more than 100 million cars from the highway, and higher than a combination of all other clean energy sources.
- Although geothermal, hydropower, solar, and wind electricity sources are also emission-free, nuclear energy provides more electricity than all of them put together. Nuclear energy has low impact, zero emissions, high performance, and the only form of clean air energy that can provide power anytime of the day or night, around-the-clock.
- According to studies, the fastest way to a reliable, affordable, low-carbon energy future is a substantial share of nuclear energy. Using nuclear energy will help decrease emissions to meet clean air requirements sooner, and with a better return on investment. In 2020, over 46 million metric tons of carbon emissions were prevented by Pennsylvania's nuclear power plants. According to the U.S. government's assessment, the saved social cost of carbon is in excess of $2.4 billion yearly. Canada, France, Saudi Arabia, and South Korea are some of the big nuclear players that have recorded fast decrease in carbon intensity and experienced a clean energy transition by developing nuclear reactors and hydroelectric dams.

Minimal Waste Production

- Same as all industries and energy-generating technologies, using nuclear energy results in some waste products. Nuclear fuel is very energy dense, so only an incredibly small amount is needed to generate huge amounts of electricity, especially in comparison with other energy sources. Compared to other sources of conventional energy, nuclear fuel is about 1 million times greater in density, and correspondingly, the amount of waste produced is little. The amount of used nuclear fuel generated by the commercial nuclear energy industry, since the 1950s, could cover an entire football field at a depth of approximately 10 yards.
- Waste produced can be reused and recycled; nearly 97% of the material in used fuel, the majority being uranium (~94%), can be recycled and used to fuel some innovative reactor designs being built. Belgium, France, Germany, and Japan are some of the countries that have used plutonium recycling to generate electricity, while also lowering the radiological footprint of their waste.



Source

Research Strategy

For this research on Nuclear Energy Research, we leveraged the most reputable sources of information that were available in the public domain, including NEI, U.S. Department of Energy, EnergySage, and World Nuclear Association.
Note that we have referenced a slightly dated source, NEI, because it is an authoritative source of information on the topic and is repeatedly referenced by credible industry sources.

Did this report spark your curiosity?

Start Wondering

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