The Comparative Consequences of Energy

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In the heavily politicized world of energy production and their impacts on the economy, the environment, and human health, it can be difficult to truly understand all of the impacts of different energy sources, such as coal, natural gas, nuclear, and solar. Many negative impacts may be buried for financial gain, and many relatively negligible risks may be exaggerated in the eyes of the public. Only by taking an objective look at the impacts and by-products of these energy sources will the world be able to accurately decide what steps must be taken to shape a future built on the safest, most reliable energy possible.

Nuclear energy does not produce any air pollution but requires large amounts of energy in the mining and refining of uranium and the construction of plants, which is oftentimes supplemented by the combustion of fossil fuels. Solar energy does not produce any air pollution but requires large amounts of energy in its construction and maintenance, which, like nuclear energy, is oftentimes supplemented by fossil fuel energy. Burning coal produces the largest amount of air pollution of the four, including carbon dioxide, ozone, sulfur oxides, nitrogen dioxide, and particulate matter. Sulfur oxides and nitrogen dioxide react in the atmosphere under sunlight to form sulfuric and nitric acid respectively, which can irritate the respiratory tract and lead to chronic illness such as asthma. Natural gas leaks methane during transportation and collection and produces large amounts of carbon dioxide when burned. Burning natural gas also releases the same additional air pollutants as coal but at much lower levels than coal.

The carbon footprint of an energy source refers to the amount of carbon dioxide equivalent it will release into the atmosphere per unit power in the lifespan of the energy plant. While nuclear and solar energy do not directly release carbon dioxide, the maintenance, construction, and mining necessary to keep producing energy require a large amount of energy, most of which comes from energy sources that do release carbon dioxide and other pollutants as by-products. This causes the carbon footprint of a nuclear plant to be 4 grams of C02 equivalent per kilowatt-hour (gCO2e/kWh) and the carbon footprint of solar power to be 6

gCO2e/kWh. Relative to nuclear and solar power, there is a large jump in the carbon footprints of coal and natural gas. The carbon footprint of gas power is 78 gCO2e/kWh and the carbon footprint of coal is 109 gCO2e/kWh (Carbon Brief).

This large difference between the carbon footprints of nuclear and solar and the footprints of coal and gas is due to the by-products of natural gas and coal plants. While all four of the energy sources use energy in the necessary mining, transportation, maintenance, and construction to keep the plants going, solar and nuclear energy do not release greenhouse gases while coal and gas produce amounts of carbon-dioxide and other pollutants that make the carbon footprints of nuclear and solar almost negligible in comparison. One of the main reasons for analyzing the carbon footprint of an energy source is to observe its effects on climate change driven by global warming.

Global warming is caused by the accumulation of greenhouse gases in the atmosphere, which trap heat from the sun and gradually increase the temperature of the global climate. The long-term repercussions of climate change will be devastating to the environment, the economy, and to the human condition. Carbon dioxide is the most well known greenhouse gas, but others exist as well, such as methane. Although methane does not remain in the atmosphere for long before converting to carbon dioxide, it is 84 times more potent as a greenhouse gas than carbon dioxide, causing it to be a major problem in the climate crisis (EDF). This poses a problem for natural gas extraction and transportation, which has been shown to leak large amounts of methane into the atmosphere. As mentioned, the carbon footprint of an energy source is a good way to predict its effects on global warming. The larger the carbon footprint of an energy source, the more greenhouse gases it releases and the larger a contributor it is to worsening global warming. The relatively tiny carbon footprints of nuclear and solar power show how useful they will be in combating climate change, and the relatively large carbon footprints of coal and gas power show how necessary it is to shift away from those energy sources as quickly as possible.

On top of having the largest carbon footprint, coal and natural gas also release several additional air pollutants that more directly lead to death and illness. Pollutants such as nitrogen dioxide, sulfur oxides, and ozone can react in the atmosphere to form acid rain and smog. These different forms of these pollutants can aggravate respiratory illnesses and can even lead to death (EPA). The particulate matter released by burning fossil fuels is the most serious immediate danger, however. Breathing in this fine particulate matter can lead to many life-threatening illnesses, such as stroke, heart disease, lung cancer and chronic respiratory diseases (WHO). The particulate matter released by burning fossil fuels such as coal and natural gas was responsible for as many as 8 million deaths in 2018 alone. This is equivalent to 18 percent of all deaths in the world that year. The deaths caused by the separate energy sources can be observed by comparing the expected annual premature deaths that would be caused by producing one terawatt-hour every year, or about the amount of energy used by a town of 27,000 Europeans. If this town were to be powered by coal, about 25 premature deaths could be expected every year. For natural gas, about 3 yearly deaths would be expected. For nuclear power, this number would be about 0.07, meaning one death could be expected every 14 years, which is possibly an overestimate. For solar power, one death could be expected every 53 years (Our World in Data). The deaths caused by nuclear and solar energy consist of accidents and air pollution from the supplemental energy required for maintaining plants, transporting resources, and mining of raw resources.

One of the major perceived drawbacks of nuclear energy is its creation of nuclear waste as a by-product. Nuclear waste is classified into three separate levels: low-level, intermediate-level, and highly-contaminated waste. 90% of nuclear waste is composed of low-level waste, which consists of tools, equipment, and clothing that has been lightly contaminated. Low-level waste is usually just stored in plants and requires no special protective measures. 7% of nuclear waste is intermediate-level waste, which consists of waste such as used filters and steel reactor components which have been exposed to alpha-particle radiation. This waste is solidified in

concrete and stored underground in shallow repositories at the plants. The final 3% of nuclear waste, the highly-contaminated waste, consists of used nuclear fuel and the waste after reprocessing the fuel. This is the waste that most people envision when they think about nuclear waste; however, this waste is not as dangerous as most people believe. Proven-safe methods of storing this waste exist, and the most accepted solution is geological disposal. The excessive concern for radioactive waste is not based in reality, as nuclear waste is not particularly dangerous or difficult to manage when compared to other toxic industrial wastes, like coal ash, a toxic by-product of coal-fired plants (WNA). In fact, the fly ash, a component of coal ash, from coal-fired plants releases 100 times more radiation into the environment than its nuclear counterparts due to less regulation (Scientific American).

After analyzing all of the impacts of these fuel sources, a few points are made clear. For one, fossil fuels are not cutting it. They have astronomically larger carbon footprints than their nuclear and solar counterparts and are responsible for countless more premature deaths on the global scale. Immediate action needs to be taken to phase out of fossil fuels such as coal and natural gas and into cleaner alternatives. Additionally, after cutting through the facade and hysteria around nuclear energy, it begins to appear that it can be one of the world's most useful tools in cutting down on fossil fuels and combating the coming climate crisis. Despite being one of the most controversial forms of energy, it has a very low carbon footprint, manageable waste, and does not lead to the excessive loss of human life caused by fossil fuel energy.

References

Ambient (outdoor) air pollution. (2018, May 2). Retrieved February 28, 2021, from https://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

Evans, S. (2017, August 12). Solar, wind and nuclear have 'amazingly low' carbon Footprints, study finds. Retrieved February 28, 2021, from https://www.carbonbrief.org/solar-wind-nuclear-amazingly-low-carbon-footprints

Hvistendahl, M. (2007, December 13). Coal ash is more radioactive than nuclear waste. Retrieved February 28, 2021, from https://www.scientificamerican.com/article/coal-ash-is-more-radioactive-than-nuclear-waste/

Methane: The other important greenhouse gas. (n.d.). Retrieved February 28, 2021, from https://www.edf.org/climate/methane-other-important-greenhouse-gas

Overview of the human health and environmental effects of power generation: focus on sulfur dioxide (SO2), nitrogen oxides (NOX) and mercury (Hg). (n.d.). Retrieved February 28, 2021, from https://archive.epa.gov/clearskies/web/pdf/overview.pdf

Radioactive waste management. (2020, February). Retrieved February 28, 2021, from https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx

Ritchie, H. (2020, February 10). What are the safest and cleanest sources of energy? Retrieved February 28, 2021, from https://ourworldindata.org/safest-sources-of-energy