How Clean, Renewable Wind, Water, and Solar (WWS) Energy Reduces Four Types of Energy Insecurities That Fossil Fuels With or Without Carbon Capture and Nuclear Create

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Summary
Three of the most significant problems facing the world today are air pollution, global warming, and energy insecurity. These problems need to be solved together due to the serious nature of all three. None should be solved in isolation. As such, a solution to any one of the problems must be solutions to all three. This is why some proposed solutions that partly address some problems but not others, should not be advanced (Chapter 3). A solution that does address all three problems simultaneously is to transition the world's all-purpose energy to electricity and heat provided by clean, renewable energy and storage. Clean, renewable energy is energy in the wind, the water, and the sun (WWS). The proposed solutions of fossil fuels with carbon capture and nuclear power contribute to all four types of energy insecurity. This section discusses energy insecurity and its solution.

1.3. Energy Insecurity

Energy insecurity is a third major problem that needs to be addressed on a global scale. Several types of energy insecurity are of serious concern.

1.3.1. Energy Insecurity due to Diminishing Availability of Fossil Fuels and Uranium

One type of energy insecurity is the economic, social, and political instability that results from long-term depletion of energy supply. Fossil fuels and uranium are limited resources and will run out at some point. As fossil fuel supplies dwindle, for example, their prices will rise. Such price increases will first hit people who can least afford them – those with little or no income. Such people will suffer by not being able to warm their home as much during the winter, cool their home as much during the summer, or pay for vehicle fuel so easily when they live far from their job and public transit is not an option.

Higher energy prices will also increase the price of food, which uses energy to be produced and transported. Higher energy prices will ultimately lead to economic, social, and political instability. The end result will be chaos and civil war.

A solution to this problem is to transition to an energy system that is sustainable – one in which energy is at less risk of being in long-term short supply. Such a system is one that consists of **clean, renewable energy**, which is energy that is replenished by the wind, the water, and the sun. Solutions that do not solve this problem are fossil fuel power plants, with or without carbon capture, and almost all nuclear power plants, because they rely on fuels that will be depleted over time.

1.3.2. Energy Insecurity due to Reliance on Centralized Power Plants and Oil Refineries

A second type of energy insecurity is the risk of power loss due to the reliance on large, centralized electric power plants and oil refineries. If a city or an island relies on centralized power plants, and one or more plants or the transmission system goes down, power to a large portion of the city or island may be unavailable for an indeterminate amount of time. Such loss can result from severe weather, power plant failure, or terrorism. Similarly, an accidental fire or act of terrorism at an oil refinery or storage facility or gas storage facility can cause a significant disruption to local and regional oil and gas supply.

On September 18, 2017, Hurricane Maria hit Puerto Rico and knocked out its power grid to 1.5 million people for almost 11 months. The hurricane toppled 80 percent of the island's utility poles and transmission lines. With 10 oil-fired power plants, 2 natural gas plants, and 1 coal plant, the island's energy supply was all but wiped out by the loss of transmission. The long delay restoring power to individual homes and businesses occurred because of the need to rebuild most of the transmission system before power could be restored. A more distributed energy system with rooftop solar photovoltaics, distributed onshore and offshore wind turbines, and local battery storage would have allowed hospitals, fire stations, and homes to maintain at least partial power during the entire blackout period and would have reduced the time required to restore power to most customers. In fact, in early 2019, the main utility in Puerto Rico proposed to divide the island into eight connected mini-grids dominated by solar and batteries. If one mini-grid goes down, the other seven will still function.

In another example, a September 14, 2019 terrorist attack on two Saudi Arabia oil processing facilities knocked out 5 percent of the world's and half of Saudi Arabia's daily oil production, 5 million barrels per day. Oil and gas refineries and storage facilities worldwide are continuously at risk of such attacks, and many are targets during conflict. Whereas, risk does not go to zero with decentralized power generation and storage, which is what WWS largely provides, the risk significantly decreases due to the difficulty in taking down hundreds to thousands of units rather than one or two.

Another problem with large, centralized power plants is that they don't serve 1.3 billion people currently without access to electricity, and they poorly serve another 1 billion with unreliable access to electricity (Worldwatch Institute, 2019). Similarly, centralized power plants cannot provide power to remote military bases. Those bases obtain their power from diesel transported and used in diesel generators. For example, in 2009, seven liters of diesel fuel were burned during the transport of each liter of diesel used in a generator to produce electricity in U.S. military bases in Afghanistan (Vavrin, 2010). Many soldiers died during the transport of the fuel.

Because WWS technologies are largely **distributed** (decentralized), it is possible to use them in microgrids to reduce this lack of access to electricity. A **microgrid** is an isolated grid (not connected to a larger transmission network) that provides power to an individual building, hospital complex, community, or military base. A WWS microgrid consists of any combination of solar PV panels, wind turbines, batteries, hydrogen fuel cells for electricity, pumped hydropower storage facilities, or other WWS technology. When used in a microgrid, WWS can bring electricity to many people either without it or who have poor access to it because the fossil fuel and nuclear systems have not been able to supply electricity to them.

In sum, a transition to WWS facilitates the creation of interconnected mini-grids and results in the use of more distributed energy generators. Both factors reduce the chance that severe weather, power plant failure or terrorism will bring a large portion of the grid down. Fossil fuel power plants, with or without carbon capture, and nuclear power plants do not solve this insecurity problem because these power plants, as commercialized today, are large centralized power plants.

1.3.3. Energy Insecurity due to Reliance on Energy From Outside of a Country

A third type of energy security is the risk associated with one country relying on other countries to supply its energy. For example, many countries, particularly island countries, must import coal, oil, and/or natural gas to run their energy system. Importing fuel not only results in higher fuel prices but also creates a reliance of one country on others. This reliance may be tested in times of international conflict when countries that control energy may withhold it or may not be able to supply it anymore.

A clean, renewable energy system that is built within a country and that supplies most, if not all, of the country's all-purpose energy, avoids this type of energy insecurity. This does not mean that countries adjacent to each other should not trade electric power. In fact, such trading is likely to reduce the cost of energy and improve reliability of the overall energy system. It just means that most of a country's power can be home grown. This reduces the risk of energy insecurity due to international conflict. The reduced risk also translates into avoided costs of war and lower costs of energy.

Fossil fuel power plants with or without carbon capture and nuclear power plants do not avoid this problem because they both rely on fuels that must be supplied continuously across country boundaries for most countries of the world. In many cases, especially for island countries, the fuels must be transported long distance.

1.3.4. Energy Insecurity due to Fuels That Have Mining, Pollution, Waste, Meltdown, and/or Weapons Risk

A fourth type of energy insecurity is the risk associated with byproducts of energy use. For example, the continuous mining forever of fossil fuels and uranium causes health damage to miners and major environmental degradation. For example, coal mining results in black lung disease to many miners. Uranium mining results in high cancer rates from the decay products of radon (Section 3.3.2.4). In addition, energy production at fossil fuel plants produces air pollution waste that kills millions of people each year (Section 7.6.2). Nuclear power plants similarly produce radioactive waste that must be stored for hundreds of thousands of years (Section 3.3.2.3). Nuclear plants also run the risk of a reactor core meltdown (Section 3.3.2.2). The spread of nuclear plants to dozens of countries has also contributed to the proliferation of nuclear weapons in several of these countries (Section 3.3.2.1).

A transition to clean, renewable energy avoids these risks to health, environment, and safety. The use of fossil fuels, with or without carbon capture, and nuclear power continues these energy security problems.

References

Vavrin, J. Power and energy considerations at forward operating bases (FOBs). United States Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory, 2010 http://www.dtic.mil/dtic/tr/fulltext/u2/a566876.pdf (accessed February 13, 2019).

Worldwatch Institute, Energy poverty remains a global challenge for the future, 2019, http://www.worldwatch.org/energy-poverty-remains-global-challenge-future (accessed February 13, 2019).