Eurasian Academy of Sciences
Eurasian Business & Economics Journal
2023 Volume:33 S: 58- 67
Published Online July 2023 (http://busecon.eurasianacademy.org)
https://doi.org/10.17740/eas.econ.2023-V33-05

SUSTAINABILITY AND ENERGY MANAGEMENT

Acar SEYIS * **Erşan ATLAS ****
*İstek Özel Atanur Oğuz Okulları, Türkiye, acar.seyis2@gmail.com
**İstek Özel Atanur Oğuz Okulları, Türkiye, seanthrowaway17@gmail.com

Received Date:02.05.2023 Accepted Date:09.07.2023

ABSTRACT

Environmental issues have been a cause of concern for more than a century. The environment and ecosystem of Earth are the most fundamental pieces of human life. Nevertheless, due to the rapid growth of the planet's populace and the associated demand for more resources, these irreplaceable parts of humanity's existence are being severely damaged. Global warming and climate change are consistently becoming deadlier day by day, not only for humans but for other living creatures. The soil on which plants grow, the food and water we ingest, the air we breathe, and even the light which lets us see are all being polluted without any signs of stopping. To combat this decline in the welfare of the environment, the concept of "sustainability" was created. Sustainability is the pursuit of alternative measures done for the sake of ecological and environmental preservation. Any endeavour done with the objective aim of helping the environment, be it by reducing/diminishing harm or by bettering the environment, equates to sustainable action. Having said that, not all forms of sustainability possess an exactly synonymous ambition. The purpose of this article is mainly to focus on sustainable development in correspondence to climate change, the cause of climate change through global energy usage and its alternatives, all the while considering different points of view.

Keywords: Environmental Crises, Energy Management, Sustainability, Technological Impact
JEL Clasifications: R11, Q56, Q57

1. INTRODUCTION

As a civilisation, our environment is undoubtedly a predominant issue that we cannot ignore for long. The planet is the result of 3.7 billion years of evolutionary adaptation leading to a canvas of coexisting and codependent galleries of life forms, all-sustaining and adapting while nurturing under the sun. However, over the past 200 years, humanity's rapid growth and capitalisation of the planet has resulted in overpopulation, deforestation, and contamination of soil and water. The aforementioned is a concern to not only animals and plants, but to humankind as well. Our food is dependent on the agricultural industry, clothes on the textile industry, our homes on the material extracted from our very own planet by the construction industry and our houses are heated by the natural gases that we, once again, take from Earth. However, what most have chosen to ignore is that said industries that keep us alive are harming our planet beyond repair. Soon, the same industries that keep humanity afloat will cause damage to the extent of negating their own functionality.

According to the Cambridge Dictionary (2022), technology is defined as "(the study and knowledge of) the practical, especially industrial, use of scientific discoveries". Our age is often regarded as the "age of technology", and not unrightfully so. Since the industrial

revolution, especially with the recent advancements in digital and virtual spaces leading to nearly limitless access to information, technological advances have been accelerating at a rapid pace, which looks only to continue from here. However, technology–or rather, the motivating cause for technology–has severely damaged the planet. The extraction of natural resources done at the scale of our overpopulated collection of civilisations is depleting the Earth of its natural resources, causing mass displacement of non-biodegradable substances, thus resulting in serious harm to our ecosystem. This applies to hundreds of industries: from the extraction of minerals such as cobalt, nickel and lithium to the quarter of the world consumption of helium by MRI scanners to the 7.4 billion tonnes of coal withdrawn from coal mines all around the globe. While many of the resources brought up are essential for the continuation of human life, some have alternatives. Even the most essential resources' consumption can be lessened by a wide margin. Production, consumption and disposal of technology could be carried out more cautiously and responsibly, resulting in a lower amount of used resources.

This is where the concept of sustainable technology, also known as 'green technology' or 'clean technology', comes in. Sustainable technology aims to carry out methods that reduce the harm done or, in some cases, revitalise the environment. Sustainable development strives for the preservation of (or at least abstaining from harm towards) wildlife and environmental resources. A few examples of concepts regarding sustainable development include reducing greenhouse emissions, alternative material use for architectural construction, recycling waste (or even converting waste to energy), and solar power. A leading factor resulting in the idea of sustainability being put in the limelight is the globally recognised threat of climate change. Sustainable development aims for a better world through means of preservation and quality of life advancements through environmental revitalisation. Since its first acknowledgement by The Brundtland Report (1987, p. 16), which defined it as "development that meets the need of the present without compromising the ability of future generations to meet their need", sustainable development concepts have come a long way, yet the end goal has stayed the same: to conserve the environment in the interest of both the planet and humankind. To do so, however, we must analyse and pinpoint the leading cause of environmental harm. Harm such as the usage of fossil fuels, deforestation for supplementation of produce, overpopulation and pollution. However, while each of these causes are directly in correlation to one another, deforestation and overpopulation are local problems, as opposed to pollution and usage of fossil fuels, which are resulting in permanent impairment of the planet. Innovation is overdue, and it comes in the form of mitigation and conversion from fossil fuels into feasible, functioning alternatives. Such procedures are to come into being through the organisation and management of our global energy usage.

2. ENERGY MANAGEMENT

In the modern world, our physical and technical functionality is dependent on the concept of energy and, more preliminarily, energy management. Energy may be defined as a type of power sourced from physical or chemical reactions that can be turned into other types of power-such as heat, light, or mechanic. Humanity is dependent on its energy-supplying industries more than any other industry (excluding basic needs such as the ones provided by the food industry). Energy supplies are pivotal to heating our homes, providing for our electricity and fueling our transportation vehicles. Not only that, but they have also played a key role in history. The four industrial revolutions were all caused by a primary factor, which was the shift from one energy source to a newer, more efficient one (Hasanuzzaman & Rahim, 2019, p. 1). The first Industrial Revolution (1756) transformed the economy from an agriculture-dominated economy to an industry-dominant economy by using coal as an energy source. The second Industrial Revolution (1870) revolved around the discovery of electricity, gas and oil and the

invention of the combustion engine. With the added developments of communication and transportation, a new age started. The third Industrial Revolution was the development of nuclear energy and electrical expansion, which accelerated into the postmodern world. And the fourth Industrial Revolution, the currently labelled, now lived in 'Digital Age' (IED, 2019).

The consumption of energy presents elements of profit and industrial nurturing. Fossil fuel subsidies were globally equated to 5.9 trillion dollars in 2020, or about 6.8 percent of GDP (Vernon et al., 2021, p.2). Fossil fuels take responsibility for being the world's primary energy source; 80 percent of the current global primary energy demand is comprised of them. However, the risk they put the environment in is just as significant as the energy system is the source of close to two-thirds of global CO2 emissions (Foster & Elzinga, 2013:17). Fossil fuels affect the schematics of many industries, such as agriculture and construction. As can be seen, the world is too dependent on fossil fuels while also being at harm because of their unsustainable nature.

Sustainable development plays a vital role in energy management, as the direction, control and governance of usage when it comes to energy sources can be utilised in the most effective form of usage possible. However, to offer alternatives or dictate the usage in alternative ways, one must distinguish between renewable and non-renewable energy.

2.1. Non-renewable Energy

Non-renewable energy is a type of energy produced from resources that are limited in reserve and supply because of the very long time required for them to be replenished in nature (Hasanuzzaman & Rahim, 2019, p. 2). Non-renewable energy sources consist of coal, oil (and the products produced from oil, such as benzene and petroleum), natural gases and nuclear energy.

2.1.1. Coal

At the time of writing this article, approximately 4 trillion BOE (barrels of oil equivalent) of coal are left in the world. The global reserves of coal are just as large as 133.1 times the annual consumption of coal, meaning there is enough coal in the world to last 133 years based on the current consumption of coal (*Coal*, 2022). Coal is only one of many energy sources that possess harmful environmental consequences. According to the EIA (2021), 42 percent of mercury emissions in the United States are caused by coal plants around the country. Not only this, but coal emissions are also responsible for the mass production of sulphur dioxide (SO2), carbon dioxide (CO2) and nitrogen oxide (NO). Many alternatives to coal can be proposed, especially conversion into non-renewable energy. But if the goal is to reduce coal emissions, then the method of ash extraction may be brought up. Ash extraction lowers the emission of coal and the harm it serves to the environment. Extraction of mineral material to produce a higher grade product leading to improvement among actions ash formation, and reduction (or even minimisation) of fouling, ash handling, and disposal should be made (U.S. Department of Energy). In their 1978 article, Tippmer and his co-authors explain a method of removing ash as follows:

"A method of removing ash components from coals, particularly high-ash content coals, comprises grinding the coal into ground particles and suspending the ground coals in an aqueous alkali carbonate solution. The solution is maintained in a reactor for 45 to 120 minutes at a temperature range of from 250 to 280 degrees Celsius and under a pressure of from 50 to 80 atm in order to cause the CO2 to be set free by dissociation. The CO2 is discharged from the reactor by directing an inert gas stream through the reactor and discharging the CO2 with the gas stream. The suspension is stirred and agitated at elevated temperatures and increased

pressures in order to fuse the ashes. The aqueous solution containing the dissolved ash components is then separated from the coal. The removed carbon dioxide is introduced into a solution for reforming the alkali carbonate in order to cause the contents of the solution to become insoluble and separated and the alkali solution to become regenerated. The regenerated solution is then used to continue the operation by forming a further aqueous alkali carbonate solution and ground coal suspension."

2.1.2. Oil

Another industry-dominating source of energy is oil. Oil is the product of organic material buried under high pressure and temperature over millions of years. It can be extracted and refined into petrol, gasoline, diesel oil and other combustible energy-supplying material through fractional distillation (Hasanuzzaman & Rahim, 2019, p. 4). However, as reliable as an energy source it may be, oil also raises many obstacles to achieving a more sustainable world. The carbon footprint for oil is just as staggeringly high as coal, if not more. The pounds of CO2 emitted per Btu (British thermal units) is around 228.6, while diesel alone emits 161.3 Btu, with gasoline close in second, emitting 157.2 Btu (EIA, 2022). Oil accounted for 32.9% of total global energy consumption in 2016 (Hasanuzzaman & Rahim, 2019, p. 5).

2.1.3. Natural Gases

Another non-renewable energy source is the world's reserve of natural gases. Natural gases generally consist of hydrocarbons such as methane and ethane and burn relatively cleanly in comparison to coal and oil's trail of globally noticeable toxic emissions. Despite this, natural gases are still regarded as a harmful energy source towards the environment. A proposed method of sustainable use of natural gases via technology is the application of cow power. Cow power is a term used for the utilisation of energy through the conversion of cow manure. Cow manure can be reconstructed into energy sources such as renewable electricity, renewable vehicle fuel (biomethane) and renewable natural gases that can be injected into pipes for usage, such as temperature management in heating and power plants. (Sustainable Conservation, 2019).

2.1.4. Nuclear energy

Another extraordinarily effective yet non-renewable energy source is nuclear energy, extracted from the heat released from the fission reactions of neutrons and protons. The discovery of fission was made by Enrico Fermi, who created the first self-sustaining nuclear chain reaction (U.S. Department of Energy, 2002). Discoveries of splitting uranium were made in Berlin in 1938. After a letter by Albert Einstein was written to then-president Franklin Roosevelt, concerns rose, leading to the establishment of the Manhattan Project, a project which discussed and subsequently advanced nuclear technology and promoted its usage (AMNH). The first power plant EBR-I became the first power plant to produce electricity on December 20, 1951 (U.S. Department of Energy, 2019). Today the development of nuclear technology has come a long way. And so have the environmental concerns. While exceedingly providing energy, nuclear energy produces nuclear waste such as uranium mill tailings (EIA). An argument is to be made, however, that compared to other non-renewable energy sources, due to the radioactive waste being smaller and disposable if taken care of carefully, nuclear energy poses less of a threat to our world's environment.

Sustainable methods can be implemented onto non-renewable energy sources for better management in favour of the environment when it comes to the sustainability of the planet. One such method is energy efficiency. Energy efficiency is the use of less energy to perform the same task or produce the same results (U.S. Department of Energy). In 2016, the

world would have had 16% more energy had energy been used efficiently (Hasanuzzaman & Rahim, 2019, p. 13). However, sustainable development goals and the planet can only rely on said methods in favour of sustainability as they are more efficiently managed but unchanged procedures of the already established environmentally harmful methods. To abate the distance between the real world and the sustaining vision, reformation and adaptation into renewable energies must be made, despite haltation of profit.

2.2. Renewable Energy

Renewable energy is a vital topic in the sphere of sustainability, particularly due to its nature. Renewable energy is defined as any source of energy that replenishes at a higher rate than it is produced. This type of energy includes solar energy, wind energy, geothermal energy, ocean energy, hydropower, and bioenergy (United Nations). The overarching purpose of renewable energy is to replace the non-renewable energy sources currently dominating the energy market. It aims to do this in regard to the fact that non-renewable energy is ecologically unfriendly and is currently harming the environment in ways that will take multiple decades to mend fully. This purpose and the definition of renewable energy clearly identify it as a part of sustainability. To talk further about this topic, however, a better understanding of the individual components that make up renewable energy is required. As such, the following paragraphs will define each of the six renewable energy sources and then proceed to talk about their place in the current landscape.

2.2.1. Solar Energy

Solar energy is a renewable energy that uses the Sun to create energy. More specifically, it uses sunlight to harness energy in two distinct ways: radiation entrapment and heat conversion. The first method is called photovoltaic (PV) energy, and it captures sunlight, which is a form of electromagnetic radiation, and converts it into electrical energy using semiconducting materials (U.S. Department of Energy). The second method is concentrating solar-thermal power (CSP) which uses mirrors to reflect and concentrate the light, which in turn heats a fluid. At this point, the energy is turned into thermal energy and can be used to power turbines or engines to create electricity. It can also be used as direct heat and has applications in water desalination, enhanced oil recovery, food processing, chemical production, and mineral processing (U.S. Department of Energy).

It should be noted that the solar power that the Earth is subjected to on a daily basis is exponentially higher than the amount actually turned into energy. As such, there is always room for development in the solar energy space. Room for development that, unfortunately, may never see its potential utilised to the fullest extent due to the cost difference between it and fossil fuels. Another thing to consider is that electricity through solar energy may not be produced during the night or in other conditions where the Sun is blocked (such as certain types of weather), as there is not enough sunlight.

2.2.2. Wind Energy

Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea/freshwater (offshore) (United Nations). Wind energy is harnessed through electric turbines and rotors: they use the kinetic energy present in the motion of air to produce electricity. Due to the nature of this particular energy source, the geographical location is of utmost importance. Places with high altitudes that have few buildings around them are the best fit for wind energy production. This makes it so that remote locations without many inhabitants and much advancement are quite open to using wind energy; it not only reduces

electricity costs due to not having to buy it from external sources, but it also gives an economic opportunity in selling made electricity to nearby locations.

2.2.3. Geothermal energy

Geothermal energy is a form of renewable energy that utilises the existent heat/thermal energy reservoirs present within the interior of Earth. Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems. This form of energy, while without the theoretical energy potential of other renewable energy systems, is one of the most reliable and has been operating around the globe for more than 100 years (United Nations).

2.2.4. Ocean energy

Ocean energy refers to the potential energy seawater holds in the form of kinetic and thermal energy. This technology is in its very early development stages, but the overall theoretical power potential that exists within it should easily exceed current energy requirements.

2.2.5. Hydropower

Hydropower uses the kinetic energy present in moving water. Hydropower may be harnessed through artificial reservoirs of water or natural rivers. Often, the hydropower reservoirs have other uses, such as providing drinking water. Currently, hydropower is the leading source of renewable energy in electricity. While it can be affected by conditions such as weather, it is usually stable. This, coupled with the fact that it has additional uses besides solely producing electricity, gives reason to why it is used so often.

2.2.6. Bioenergy

Bioenergy creates electric power from biological materials, such as manure or wood. These materials are called biomass and are used in various ways to create energy. For example, biomass may be burned in the same fashion as coal and create energy in that way. It may also be used as a fuel, as seen in the liquid biofuel made from agricultural crops.

2.2.7. Considerations

It is to be recognised that while renewable energy removes the factor of resource depletion, it is not without flaw. Most machinery made for the harvesting of renewable energy is still commonly made in non-renewable energy-using facilities. Considering the number of solar panels, wind generators or geothermal centres the world will need in the event of a large-scale migration into renewable energy, the emissions and harm caused by the manufacturing of these systems need to be kept in mind. As an even worse offender, bioenergy not only requires an ample amount of preparation and machinery to work (leading to the previously mentioned problem of emissions), but it also emits hazardous material to the environment. So, while it is renewable, it is not very ecologically friendly. The same applies to hydropower. While it does make up most of the renewable energy used, the infrastructure used affects ecosystems in adverse ways.

While a complete and immediate transition from non-renewable energy sources to renewable ones is not currently expected, seeing as approximately 80% of global energy comes from fossil fuels (National Geographic Society, 2022), a slow yet steady switch must happen in the near future, for our environment may not be able to handle the deadly effects caused by the fossil fuel industry.

3. SUSTAINABLE TECHNOLOGY

Sustainable technology can be implemented in the process of energy management and regulation of our footprint on the environment. Innovation is the principal conduit of sustainable technology and development. It should be noted, however, that sustainable technology can vary for the consumer and producer. For example, a civilian may not take up the mantle of managing the schematics of agricultural harvestation, but what they can do is regulate the gas usage in their own homes and vice versa. Sustainable technology narrows down into what can already be done and what may become a possible thing to do with technological advancements in the future. It is notable to reflect and differentiate fictional concepts from the less exciting but more applicable ones. Some notable examples of sustainable technology include carbon capture and storage (CCS), ultraviolet light disinfection, LED light technology, LEED-certified architecture, and irrigation/fleet management in agriculture. CCS can be used for encapsulation of carbon from the atmosphere effectively by 90% (Climate Council, 2021). However, CCS causes emissions of its own and uses hazardous chemicals in its workings. In architecture, the LEED certificate is regarded with admiration for the environment and is treated as a well-known standard of procedure. The LEED certificate is made up of six categories: sustainable sites, water efficiency, energy and the atmosphere, materials and sources, indoor environmental quality, and innovation in design (USGBC). Points are awarded based on the number of sustainable solutions applied to the project. In agriculture, technology is used for irrigation, fleet management, biotechnology and such as a way to reduce the use of energy and increase information on the progress of plant and crop growth (Moore, 2020:1).

Sustainable technology and other variations of environmental preservation, such as green technology, are an effective way to make the planet a more eco-friendly atmosphere, not just for humanity but for all other inhabiting organisms. However, the implementation of sustainable technology to already outdated industry systems of energy, food and construction will not bring about a sustainable era. Deep modification and transformation from the fundamental basis of harvestation is needed to reach the goal of a thriving planet.

4. THE ECONOMIC DILEMMA OF SUSTAINABILITY

While the prioritisation of sustainable development for our planet has taken precedence over most other global concerns, the act of carrying out said measures by corporations' or governments' inaction has not. The corporate business structure is set for the maximisation of profit. In circumstances where moderate government regulation is implemented, corporations will strive for the bare minimum with the intent of making as much profit as possible, resulting in a lack of motive for the betterment of the environment. Corporations do not always actively strive for the possible harm done at the expense of the environment but often find themselves in the competitive market and industrial settings in which taking alternatives could potentially postpone or even break off their field of trade. Some corporations tend to ignore such environmentally assisting requirements due to the sheer effort and time it may potentially take. However, as the issue of climate change becomes more prevalent and environmental awareness reaches higher peaks in applicability to our day-to-day life, expectations and civil awareness are to be obligated. Current modes of development are ecologically not sustainable because the damage to the environment is largely externalised from the marketplace. Economists call these externalities. Externalities are present whenever an individual or a firm can take an action that directly affects others. Also, for which it neither pays nor is paid compensation. The effect of the action is ‘external’ to the individual or the firm. Externalities have a wide range of examples. From a child creating a mess in a home to someone smoking in a restaurant to a factory emitting CO2 into the atmosphere, all create externalities.

Even so, corporations are not the sole actors of environmental harm. Sense of blame must be channelled into governmental actions too. Corporate operations are only regulated if the government allows it, and not enough governments around the world are doing so enough to cause a significant enough change. An example of the many efforts done by assemblies of states is the Kyoto Protocol. The Kyoto Protocol was an assembly of 150 countries with the promise of reducing greenhouse emissions to battle climate change. The list included 192 countries in the agreement to reduce emissions in hopes of sustainable development. However, countries such as the United States and Canada withdrew from the protocol. Not only this, but the Kyoto Protocol did not have a lasting effect on the still-signed countries, as can be seen from the fact that they have not reached their designated goal as of yet. The abandonment of global north countries such as the US and Canada were partially to blame for the lack of faith placed in the effectiveness of protocols such as or similar to the Kyoto Protocol. Another prominently known global effort for thwarting climate change was the Paris Climate Agreement. However, similarly to the Kyoto Protocol, the Paris Climate Agreement did not reach the set-out goal (acknowledging that the Paris climate agreement goal has been practical enough for what it set out to do, but not enough as could have been done for the planet), not only because of lack of regulation but also due to the fact that the carbon emission goals were not ambitious enough in the first place. Another example of a universal effort to achieve sustainability (not exclusive to climate change) was the 70/1 resolution passed by the United Nations on the 25th of September, 2015. “Ending poverty and hunger, in all forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality in a healthy environment.” and “We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.” However, said resolution passed under the General Assembly, which is not legally binded (unlike the security council committee), proving ineffective.

Sustainable development through any means is not prioritised by most governments or corporations unless socially obligated to do so by the people of that state. Most global north countries in power to make a change tend not to do so if it means aiding incapable countries of the global south. Sustainable innovation does not only equate to technological changes but also changes in the fundamental business model. In simpler terms, sustainability is not a priority if it is not profitable. Civilians, too, do not act in the effort of sustainability because they assume that their effort will not have an effect in the long run. If one is to assume that their efforts do not create a difference because of how insubstantial they may be, and if all follow the same collective mindset, then in no way will sustainable goals be fulfilled. Of course, this does not mean that blame or expectations should be put off of governments, states or corporations. As free choosers of our consumption, we can encourage environmentally friendly employee practices. We can protest, and we can vote for politicians who bring such measures into action. We can watch our footprint, and we can research to be aware of corporate agendas, which shine publicity on the wrong means of environmental preservation as to distract the general media understanding of how actual harm is being done. If we are to place more relevance on said topics as a collective, we can instil change.

5. CONCLUSION

Measures need to be taken for sustainable development goals regarding climate change, be it through the reduction of carbon emissions or complete abatement of it. Conversion from non-renewable to renewable energy sources with advancements in solar, wind, ocean and other previously cited examples of energy is required. Not only that but improvement and innovation in harvestation methods of renewable energies through the means of sustainable technology is required.

A change in general and public perceivement of climate issues is needed as more and more people recognise that the issue is not a local one. Acknowledging participation of countries on the matters of sustainable development and environmental issues are to be made, with no short absence of blame on countries which do not follow the standard of expenses and actions which they should take. Sustainable development asks for more strict regulations in the free market, such as trade barriers and price controls, so that corporate operations are tailored to the standards. Examples of said standards include the usage and production of less environmentally harmful material, minimising emissions to the atmosphere and diminishing toxic waste released in the surrounding (or any) terrain.

Sustainability is not exclusive to just wildlife or specific countries, and one must always remember that sustainability is not (or rather should not be) a political issue. It is an environmental issue. Furthermore, disregarding it only results in the destruction of billions of years of accumulated bio-organisms. Said bio-organisms include us, who inhabit this planet and consume and work and communicate, who use transportation and eat processed food and use devices so that they can read about the very discussed topic. Without proper care for our planet, we cannot remain extant. If we allow ourselves to continue displacing the planet's resources, then a tomorrow will not come for us to put the resources to use.

REFERENCES

- American Museum of Natural History (AMNH). (n.d.). *The Manhattan Project*. https://www.amnh.org/exhibitions/einstein/peace-and-war/the-manhattan-project
- Cambridge University. (2022, October 12). Technology. *Cambridge Dictionary*. Cambridge University Press. https://dictionary.cambridge.org/dictionary/english/technology
- Climate Council. (2021, July 20). *What is Carbon Capture and Storage?* Retrieved October 23, 2022, from https://www.climatecouncil.org.au/resources/what-is-carbon-capture-and-storage/
- Foster, S., & Elzinga, D. (2013). The Role of Fossil Fuels in a Sustainable Energy System. *UN Chronicle*, 52(3), 17-19. https://doi.org/10.18356/1007f69a-en
- Hasanuzzaman, MD, & Rahim, A. N. (2019, June 15). *Energy for Sustainable Development: Demand, Supply, Conversion and Management* (1st ed.). Academic Press.
- IED. (2019). *The 4 Industrial Revolutions*. Institute of Entrepreneurship Development. https://ied.eu/project-updates/the-4-industrial-revolutions/
- Moore, M. (2020, March 6). *5 Tools and Technologies That Drive Sustainable Agriculture*. U.S. Farmers & Ranchers in Action. https://usfarmersandranchers.org/stories/sustainable-food-production/5-tools-and-technologies-that-drive-sustainable-agriculture/

- National Geographic Society. (2020, May 20). *Nonrenewable Resources*. Retrieved October 23, 2022, from https://education.nationalgeographic.org/resource/nonrenewable-resources/
- Sustainable Conservation. (2019, June 20). *Cow Power*. https://suscon.org/project/cow-power/
- Tippmer, K., Schmitt, H., Vinke, H., & Abendroth, G. (1978, July 11). *Method of removing ash components from high-ash content coals*. https://www.osti.gov/biblio/6848477
- United Nations. (n.d.). *What is renewable energy?* https://www.un.org/en/climatechange/what-is-renewable-energy
- United Nations-Brundtland Commision. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. Oxford University Press. United Nations General Assembly document A/42/427.
- U.S. Department of Energy. (n.d.-a). *Concentrating Solar-Thermal Power Basics*. https://www.energy.gov/eere/solar/concentrating-solar-thermal-power-basics
- U.S. Department of Energy. (n.d.-b). *Energy Efficiency*. https://www.energy.gov/eere/energy-efficiency
- U.S. Department of Energy. (n.d.-c). *Improving the Competitiveness of Coal*. https://www.energy.gov/fecm/science-innovation/office-clean-coal-and-carbon-management/advanced-energy-systems/improving
- U.S. Department of Energy. (2019, July 18). *9 Notable Facts About the World's First Nuclear Power Plant - EBR-I*. https://www.energy.gov/ne/articles/9-notable-facts-about-worlds-first-nuclear-power-plant-ebr-i
- U.S. Department of Energy (n.d.-d). *Photovoltaics*. https://www.energy.gov/eere/solar/photovoltaics
- U.S. Department of Energy. (2002, January 31). *The History of Nuclear Energy*. https://www.energy.gov/ne/articles/history-nuclear-energy
- U.S. Energy Information Administration. (2021, December 2). *Coal and the environment.* Retrieved October 23, 2022, from https://www.eia.gov/energyexplained/coal/coal-and-the-environment.php
- U.S. Energy Information Administration. (2022, October 5). *Carbon Dioxide Emissions Coefficients*. Retrieved October 23, 2022, from https://www.eia.gov/environment/emissions/co2_vol_mass.php
- U.S. Energy Information Administration. (n.d.). *Nuclear power and the environment*. https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php
- U.S. Green Building Council. (n.d.). *LEED rating system.* https://www.usgbc.org/leed
- Vernon, N., Parry, I., & Black, S. (2021). Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies. *IMF Working Papers*, *2021*(236), 1. https://doi.org/10.5089/9781513595405.001
- *World Coal Statistics - Worldometer*. (2022, October 23). Worldometer. Retrieved October 23, 2022, from https://www.worldometers.info/coal/