Chapter

Nuclear Power Plant or Solar Power Plant

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Abstract

Both solar energy and nuclear energy face significant economic challenges. Sustainable energy costs have traditionally been greater than any of those associated with the growth of fossil fuel power generation, although the costs of renewable energy technologies (especially photovoltaic) have dropped. Furthermore, capital costs remain a big challenge in the nuclear generation. In many nations, the cost of building small nuclear power plants is quite large due to time, technology, and environmental and safety challenges for consumers. Such problems might not be as big for state-owned corporations or controlled industries for which utilities have quick access to cheap resources, and this partially explains why the interest for nuclear reactors in Asia is far greater than in the United States or Europe. Learning could help decrease costs for both types of technologies, but the track record for learning-by-doing in the nuclear sector is not good.

Keywords: solar energy, nuclear energy, renewable, power plants, technology

1. Introduction

The sun is a nuclear fusion reactor that contains gravity. It produces unimaginable quantities of energy. Solar energy is a very perfect source of power. It can be captured passively by solar panels or other collectors. When the collectors have been produced, there will be no carbon emissions or waste products [1]. There are no moving parts to hurt wildlife. There is no dependence on foreign entities. The energy is produced and delivered for free by the sun [2]. The uranium division begins progressing with the absorption of the smooth-moving neutron from the non-strong U-235 isotope. The obtained U-236 is split into Ba-139 and Kr-94 as well as three unfastened neutrons. The mass deficiency of approximately 20% of atomic mass units has also been converted into 210 MeV energy units [3, 4]. There were 447 nuclear fission power stations in service globally, 55 in construction and 111 in the design processes [5].

In the United States in 2018, 19.3% of the electricity supply was produced by 97 nuclear power plants. This amounts from zero percent to the other countries, for example, in New Zealand, and 71.7% in the European Union; the total global energy demand in 2018 was 10.3% [6].

With 11 new reactors under development, China has the most quickly expanding nuclear power program. Pakistan aims to construct three to four nuclear power stations by 2030 [7].

Several countries had nuclear installations in the past, but they still do not have nuclear plants in operation. Italy closed all the nuclear power stations between them by 1990, and, as a consequence of the referendums established by the Italians in 1987, nuclear power already has stopped [8]. A number of nations currently run nuclear power stations but are considering the process of nuclear technology. These countries are Belgium, Germany, Switzerland, and Spain [3]. Also according to the U.S. Energy Information Administration (EIA), solar power increased by 39% in the United States from 2014 to 2017 [4]. Starting at 10 GW and ending at 27, this growth trend for the field is very encouraging. In addition, carbon dioxide emissions have decreased by a few percent, the lowest since 1991 [5]. If it continues down this path, more study is likely to be carried out as a result of the growth in the market for efficient, cheap solar energy, in order to attempt to develop even more carbon-free or low-carbon fuels such as wind and nuclear power [6]. There are two big issues relating to nuclear plants: waste disposal and potential failure. Nuclear power plants produce dangerous wastes; for example, a 1-GW nuclear power plant can produce 300 kg of nuclear waste, with a half-life of almost 24,000 years, and cause environmental issues. The current methods for disposing of these kinds of waste are inadequate. The complete reprocessing of all radioactive waste and the chemical transformation of long fission products will be an ideal option. However, trends in this area have not progressed extensively [7]. The first and most critical problem is its disparity; the amount of solar energy that can be harvested depends widely on the time, location, season, weather, and several other factors. In order to improve this topic, engineers are exploring the development of new storage methods for large quantities of energy generated [5]. One of these storage techniques suitable for mountainous areas is pumped hydroelectric storage (PHES) that also uses excess energy generated during nonpeak hours of the day to pump water from a reservoir in a much high elevation. PHES is just one of the several potential storage methods used by many people, and it is so essential because it provides a clean, efficient use of solar energy when normally none is generated by replacing it with hydroelectricity [8]. Because of the good use and storage of solar energy, it becomes more difficult to determine whether to use solar energy or some other form of renewable energy for power companies and individuals. Despite the obvious cost of installing solar power, this is a higher investment opposed to the use of fossil fuels due to much lower maintenance and occasional overproduction of energy.

Solar energy is a key player in the sustainable power plan. In sunny places, many residents built panels on their roofs to support air-conditioning, heating, and other household needs and the panels were set up by themselves. Study in the collection and storage of solar energy should be a major effort worldwide [9]. But in less sunny areas, there are a few expensive homes which run 100% on solar power, using large battery banks to power them through the nights.

Solar energy has the capacity to boost everything we need; however our ability to turn the energy of the sun into electrical power and also to store energy is simply not fully developed. Energy storage in particular has proven to be challenging, as solar panels have a very irregular energy intake because it depends on season, climate conditions, time of day, and so on. The inability to use all solar power harvested efficiently is an issue that is likely to force even more development in the field to come soon after it has been resolved. The industry is full of possible innovations that have yet to be made and which can be recognized if time is taken to develop the innovative technology. Therefore, when looking at potential ways of storing the energy produced, PHES may not be the most cost-effective, but it is proven to be safe and can be added to some existing infrastructure at the same time as analysis seeks to make it more efficient.

2. Solar energy

Solar technology, i.e., renewable wind, offers a reliable and stable supply of solar energy during the year. As our natural resources are likely to decline in the years

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to come, it is necessary for the entire world to shift toward sustainable sources. Solar power is a reactive electromagnetic sunlight energy that can be used for a wide range of still-evolving applications, such as solar heating, photovoltaics, solar electricity, solar thermal processing, artificial molten, salt power plants, and photosynthesis.

Solar energy is a significant source of green energy, and its techniques are generally characterized as either passive solar energy or active solar energy based on whether solar energy is absorbed and transmitted or transformed into solar energy. Strong solar technologies involve the use of photovoltaic devices, concentrating solar power and solar water heaters to harvest electricity. Passive methods include the alignment of a system or building to the sun, the use of products with desirable light properties or thermal mass, and the construction of spaces that automatically disperse air.

2.1 Advantages of solar energy

The biggest advantage of solar energy is that it can be quickly installed by both home and business consumers, because it does not involve any major construction, such as in the case of wind and geothermal power stations. Solar energy not only benefits individual owners but also benefits the environment. **Figure 1** shows a simple model of a solar thermal system.

1. **No pollution**: Solar energy is a safe, nonpolluting, efficient, and green energy resource. This does not pollute the environment by producing poisonous pollutants, such as carbon dioxide, nitrogen oxide, and sulfur oxide. Solar energy does not need power and thus prevents the problems of shipping power or handling radioactive materials.

2. **Long-lasting solar cells**: Solar cells have two special features: first the lack of drive systems and second the minimal maintenance requirements. Then they have already got a longer life and they're more noticeable.

3. **Renewable source**: Solar energy is a sustainable energy source that can continue to generate power as long as there is light. While solar energy cannot be generated during the night and rainy days, it can be used again and again throughout the day. Solar energy from the sun is a steady and continuous source of electricity which can be used to harvest strength in remote areas.

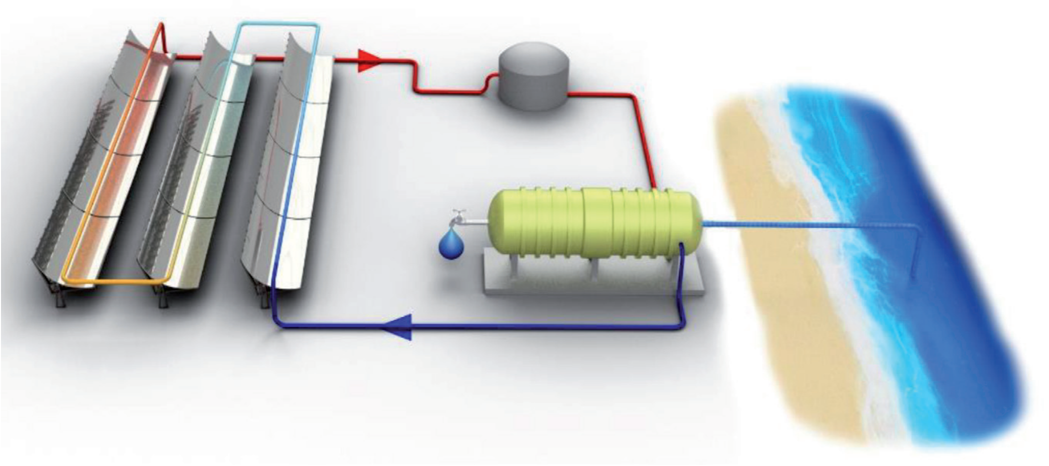

Figure 1.
Solar thermal system [10].

4. **Low maintenance**: Generally, solar cells do not need upkeep and operate for a long time. More solar panels can be installed from time to time if desired. While solar panels have an initial expense, there are no recurrent costs. The initial expense, which is paid once, may be recovered in the long run. Apart from this, solar panels do not create any noise and do not emit an unpleasant scent.

5. **Easy installation**: There is no need to install equipment such as cables, power supply, pipes, etc.; solar panels make solar tracking simpler. Unlike wind and geothermal energy harvesting systems that need land drilling equipment, solar panels do not need them and can be easily mounted on rooftops to insure that no additional infrastructure is needed, so residential home users can easily use this technology to supply electricity. In addition, they can be installed in a dispersed manner, meaning that no large-scale installations are required.

The technology of solar cells is developing, and as our nonrenewable supply decreases, it is necessary for the world to transition into renewable energy sources. There are, though, a range of issues that prohibit solar energy from being used more widely. Solar energy drawbacks are likely to be resolved as technology advances, and their use grows as people continue to realize the benefits of solar energy.

2.2 Disadvantages of solar energy

Solar energy can either be thermal or photovoltaic. The photovoltaic type is one of the most stable types of converting radiant energy into electrical energy. It really is suitable in many countries with adequate sunlight, such as Iran, and countries close to the equator, in terms of the quantity and availability of this technology. The energy source does not relate to someone and requires permission to use it. This feature has given rise to solar energy becoming special among renewable energy sources. Solar energy from ancient times is used by people using a magnifying glass to light the fire. Throughout this way, the sunlight was concentrated on dark wooden surfaces, and the fire became ignited. Also, solar photovoltaic (SPV) cells convert solar energy directly into DC electricity. This power source may be used to power solar clocks, calculators, or signals. These are also found in areas which are not linked to the power grid. **Figure 2** shows a concentrated solar power (CSP) plant. Solar heat energy (SHE) can be used to heat water or air, which requires ventilation of the room inside the house.

Solar energy can be broadly categorized as active or passive solar energy depending on how they are captured and utilized. For active solar power, specific solar heating equipment is used to transform solar power into thermal energy, but there is no specialized equipment for passive solar power [11]. Active solar requires the use of mechanical devices such as photovoltaic panels, solar trap fans, and solar thermal collectors or reservoirs. Passive solar solutions transform solar energy into thermal energy without the usage of active mechanical devices. It is primarily a method to use curtains, doors, plants, positioning of buildings, and other basic methods to catch or block the sun for usage. Passive solar heating is a smart way to save electricity and optimize its consumption. An example of passive solar heating is what happens to your car on a hot summer day.

2.3 Environmental impacts of solar power systems

Although solar energy is recognized to be one of the cleanest and most renewable sources of energy today, it also has several environmental impacts.

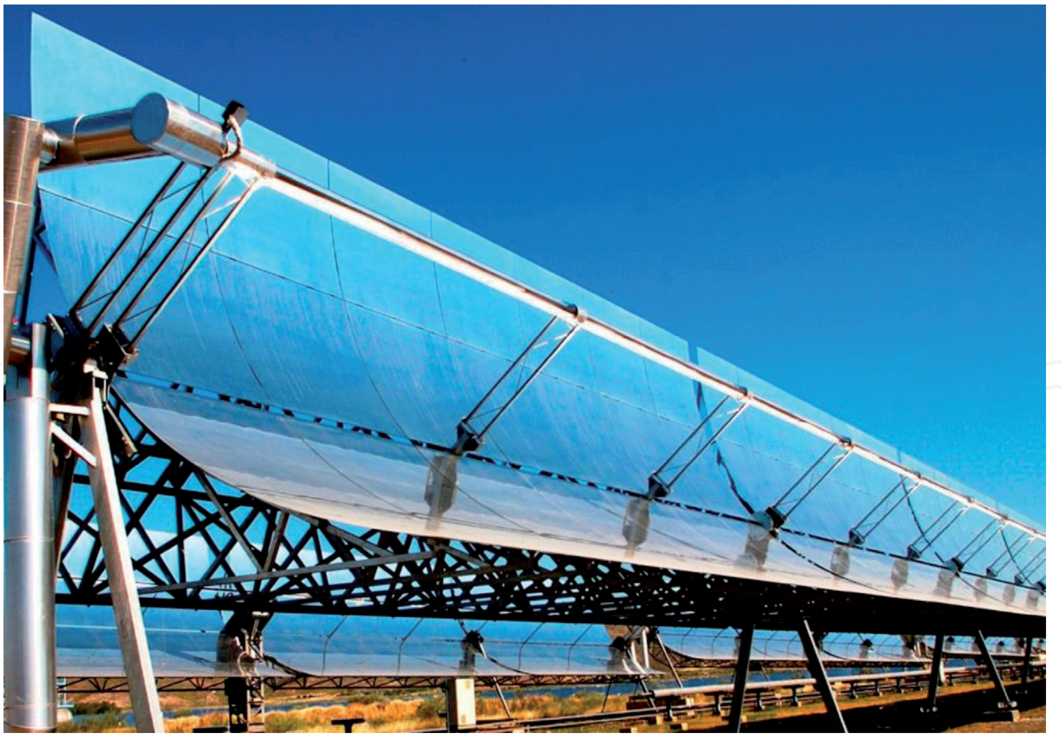

Figure 2.
Concentrated solar power (CSP) plant [10].

Solar energy uses photovoltaic panels to generate solar electricity. Nevertheless, the processing of photovoltaic cells to generate the energy includes silicon and to produce other waste products. Inappropriate handling of such materials can result in hazardous exposure to humans and the environment [12]. Installing solar power plants will entail a significant portion of land that may have an effect on established habitats. Solar energy does not pollute the air when converted to electricity by solar panels. It is found in abundance and does not help in global warming.

2.4 Solar energy's potential

Solar power is now expected to play a greater position in the future due to recent developments that will result in lower costs and better efficiency. In fact, the solar photovoltaic industry is preparing to supply half of all future US power generation by 2025. More and more architects understand the importance of active and passive solar power and know how to successfully integrate it into building designs. Solar hot water systems can compete economically with conventional systems in some areas. Shell has predicted that by 2040, 50% of the world's electricity supply would come from sustainable resources. Over recent years, the rate of generating photovoltaic cells has declined by 3% per year while policy subsidies have increased. While certain other information about solar energy is meaningless, this renders solar energy an even more efficient source of electricity. Solar energy is projected to be used by millions of households across the world in the next several years, as seen by developments in the United States and Japan. Aggressive financial incentives in Germany and Japan and China have made these countries global leaders in solar deployment for years [13].

A renewable resource that can be used to generate power is solar. The sun itself is a source of radiant, daylight, and other energy sources on Earth. Steam engines are a perfect illustration of radiant energy, by having sunrays magnified by mirrors guided to the turbine to heat water and produce steam, which in effect drives the turbine and causes steam to escape, and this pushes the piston. Calculators often work on solar power by storing light rays and transmitting energy to enable the calculator to function even though no light is present. Trevor Smith[1] notes that "solar rays can be used to fuel or cool houses, supply hot water and produce steam for turbines generating energy. Sunlight can be converted directly into energy by photovoltaics, a fast-growing branch of solar technology." This allows people to generate energy from renewable resources. James Bow notes that in 1977, 1 W of solar power costs $76.67. In 2014, the cost dropped to around $0.60. This suggests that modern solar power projects are far more economical, which means that renewable energy has come a long way and will continue to grow. One of the greatest declines in solar power is that, first, the sun is still growing and dropping, ensuring that the energy provided and processed is confined to the location of solar panels. Second, the batteries used to store electricity generated by the sun are expensive and produce a large amount of emissions. Third, in order to allow the best of the light, wide quantities of solar panels or mirrors need to be installed, which could be a function of restricted resources. The energy generated by the solar is a type of renewable energy used by today's society.

3. Nuclear energy

Nuclear power is the energy of an atom. Atoms are very tiny objects which make up a single body in the universe. There is enormous power in the links that connect the nucleus unchanged. Power is generated when the ties are disbanded. Nuclear energy may be used to create electricity, but it must be produced first. Nuclear power can be produced by both nuclear fusion and nuclear fission. In nuclear fission, atoms are separated into smaller atoms, which generate steam. Nuclear power stations have been used for electricity generation. Another method of generating nuclear energy is through nuclear fusion. The combination of atoms to each other and the creation of heavier atoms are established. When atoms are coupled, a lot of energy is released. These reactions occur together in the sun to generate thermal energy to radiation. Numerous studies are currently underway, although this technique has not yet been commercialized and it is not known if it is possible to generate electricity from this method. Uranium (U-235) is the most commonly produced nonrenewable material for nuclear fission. Plants use a particular type of U-235, as the atoms are readily isolated. During nuclear fission, the neutron hits and splits the uranium atom, releasing a large sum of energy in the form of heat and radiation. More neutrons are also released as the uranium atom is separated. Some neutrons proceed to hit other uranium atoms, and the process begins over and over again. It's a chain reaction, too. Although uranium is around 100 times more common than silver, U-235 is extremely scarce. Most of the US uranium is extracted in the western United States, but only 17 percent of the plutonium reactors is generated abroad. Uranium provided to US reactors in 2013 arrived from a number of nations, including Russia, Australia, and several other African countries. **Figure 3** displays the map of uranium mines in the world [14].

There are 648 nuclear power stations in the world. There are 61 nuclear power stations and 99 research facilities in the United States. Nuclear plants are found in 30 states, and 46 are situated east of the Mississippi River. After 1990, nuclear power has supplied around one-fifth of US electricity annually. Nuclear power provides as much electricity as all the fuel consumed in California, New York, and Texas together. Nuclear energy plants supply more than 20% of US energy. **Figure 4** shows the map of nuclear power stations in the world.

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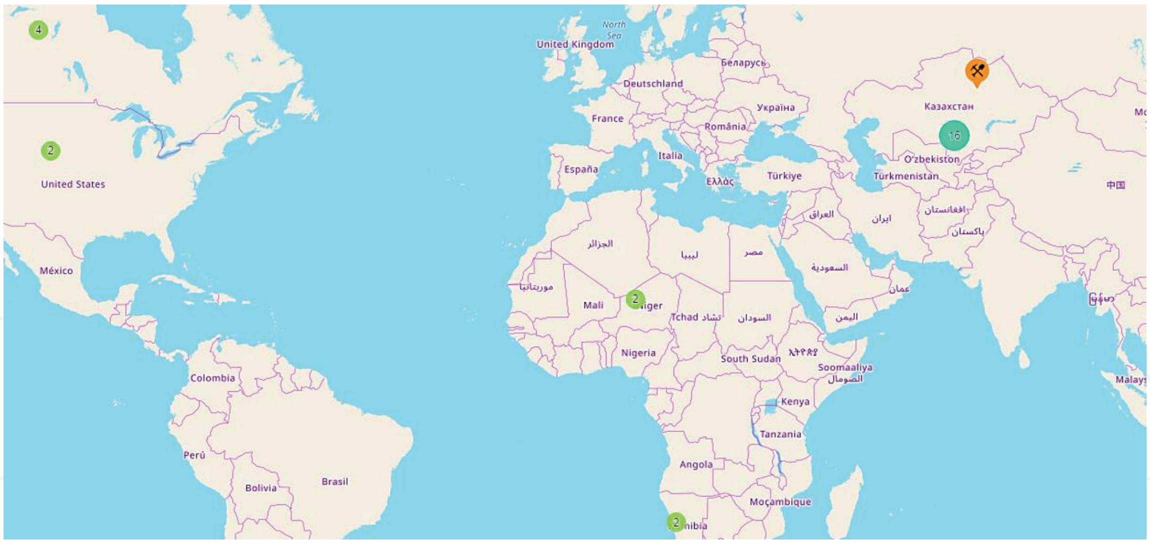

Figure 3.
Map of uranium mines in the world.

Figure 4.
Map of nuclear power stations in the world.

3.1 Nuclear power is the result of nuclear fission

Uranium fission occurs with the capture of the slow neutron by the non-isotope U-235. The resultant U-236 generates three free neutrons and separates into Kr-94 and Ba-139. The mass defect of roughly 0.2 atomic mass units is converted into 210 MeV energy units. $U = 1.66 \times 10^{-27}$ gk for the atomic mass unit, and eV equals 1.60×10^{-27}J, the radioactive energy unit.

Many power stations, like nuclear power plants, use heat to produce electricity. Power plants rely on steam from hot water to drive massive turbines, which then produce electricity. Because of using fossil fuels to produce electricity, nuclear power plants employ nuclear fission energy. The fission occurs in the nuclear power plant reactors. Nuclear reactors are devices which contain and regulate nuclear chain reactions while releasing heat at a regulated rate. The nucleus of the device, which includes nuclear fuel, is at the top of the plant. The uranium fuel is constructed of ceramic pellets. Each ceramic pellet contains at about the same amount of energy as 150 gallons of gasoline. Such energy-rich pellets are packaged in 12 foot wire fuel pipes. The array of fuel rods, sometimes hundreds of them, is called a burn unit.

The heat generated during the fission at the center of the reactor is used to boil water to steam, which turns the turbine blades. The energy can be generated while the rotor blades rotate. Afterwards, the steam is pumped back into the atmosphere in a different power plant system called a cooling tower. The product will be collected.

Nuclear power plants do not emit carbon dioxide emissions during operation compared to fossil fuel-fired power stations. Methods for the extraction and refining of uranium oxide and the processing of nuclear fuel, however, require a large amount of power. Nuclear power stations supply large quantities of metal and concrete which also require a substantial amount of energy to be produced. When fossil fuels are used for the production and refining of uranium oxide or for the installation of a nuclear power plant, the emissions generated by the burning of these fuels may be associated with the energy emitted by nuclear power plants. The main environmental concerns linked to nuclear power include the processing of toxic waste such as uranium mine tailings, expended reactor fuel, and other nuclear waste. These materials can stay radioactive and dangerous to human health for thousands of years. Animals are subject to strict laws governing their care, delivery, preservation, and treatment for the protection of human health and the environment. The US Nuclear Regulatory Commission (NRC) regulates the operations of nuclear power plants. Nuclear waste is classified as small and large rates of emissions. Radioactivity of these materials may range from just over natural background rates, including in mill tailings, to much higher amounts, such as spent nuclear fuel or sections of a nuclear plant. Radioactivity of toxic waste is decreased as time passes by a process called nuclear decay. The period of time taken to reduce the radioactivity of hazardous material to half of the original level is considered the contaminated half-life of the substance. Short-lived radioactive waste is also treated permanently prior to disposal in order to mitigate the future danger of contamination to staff handling and carrying waste, as well as to the amount of pollution at production sites.

Nuclear waste stored in tanks is very dangerous. These vessels are kept under special conditions in the water with safety shields until their half-life exceeds the standard of security. Various countries have specific laws on the processing of nuclear waste. The United States has set out strict rules on the storage and management of radioactive fuel and waste. Some nuclear power plant fuels can be stored in dry storage tanks. In this way, nuclear fuel tanks are stored in separate rooms with cement or steel air-conditioning devices.

Typically, once a nuclear reactor stops, it shifts. It involves the controlled extraction of the reactor and other devices that have been damaged from operation and the elimination of radioactivity to a degree that permits other uses of the site. The United States Nuclear Regulatory Commission (NRC) has stringent regulations regulating the decommissioning of nuclear power facilities, including the washing up of radioactively polluted reactor processes and equipment, including the disposal of atomic waste.

Uncontrolled nuclear reactions in a nuclear reactor will potentially contribute to extensive pollution of air and water. The probability of this occurring at nuclear power plants in the United States is known to be very low due to the complex and robust safeguards and multiple protection measures in effect at nuclear power plants, the preparation and expertise of reactor workers, the monitoring and service operations, and the legislative standards and oversight of the United States. A wide-field near nuclear power plant is controlled and supervised by trained security forces. Some of the reactors have containment vessels that are designed to withstand extreme weather events and earthquakes.

3.2 Advantages of nuclear energy

According to the laws of physics, energy is neither produced nor destroyed, but it can be converted from one kind to another, including the transfer of electrical energy into mechanical energy of electric motors. From the structure of the atom, much of its mass exists in a part called the core, and this mass contains protons with a positive electric field and neutrons with an ineffective or neutral electric field. Studies and experiments have indicated that neutrons weigh a lot more than protons. Nuclear energy is the energy generated by a nuclear explosion or a nuclear fusion under the specific conditions of the nucleus of an atom. A lot of energy can be released as nuclear fission or nuclear fusion happens. Once the heavy element, uranium, was exploded with neutrons, it was found that something special occurred instead of causing radioactivity as other materials. This cycle has been called fission. When nuclear fusion or nuclear fission happens as a product of neutron impacts, not only are two lighter elements produced and many radiations released, but more neutrons are generated, as can be seen in **Figure 5**. It is therefore obvious that concurrently released neutrons can start a chain reaction by acting on released light atoms, increasing the intensity of the reaction. This reaction may spread throughout uranium.

A lot of energy would be produced through the fission of the uranium-235 nucleus (see **Figure 5**). To consider the amount of this energy, it's enough to remember that this amount is around 60,000,000 times greater than when a carbon atom burns. During a nuclear fission reaction, the atom decomposes and releases a lot of kinetic energy into the environment. Obviously, kinetic energy is directly related to the generation of heat. The first reactors to generate a functional volume of electricity were installed in the Calder Hall in England. Atomic bombs may be produced of mere fissionable material. Of the two bombs dropped on Japan to end the World War 2, one contained plutonium and the other very highly enriched uranium-235.

3.3 Advantages of nuclear energy

1. ***Lower greenhouse gas emissions***: As recorded in 1998, the production of greenhouse gasses has been projected to have declined by almost half owing to the success of the usage of nuclear power. Nuclear processing has by far the lowest environmental impacts, because it does not release greenhouse gasses such as carbon dioxide, a fuel that is largely responsible for the greenhouse effect. Thanks to its application, there is no harmful impact on water, soil, or other environment, although certain greenhouse gasses are emitted when shipping fuel or harvesting uranium oil.

2. ***Powerful and efficient***: The other major benefit of having nuclear technology is that it is more effective and efficient than other potential forms of electricity. Technology advances have rendered it more competitive than most. That is one of the reasons that many nations are spending extensively in nuclear power. At least, a tiny part of the world's energy is flowing into it.

3. ***Reliable***: In comparison to conventional energy sources such as solar and wind, which involve sun or wind to generate electricity, nuclear energy may be generated from nuclear power plants even under extreme weather conditions. They also can provide 24/7 power and need to be shut down for maintenance purposes only.

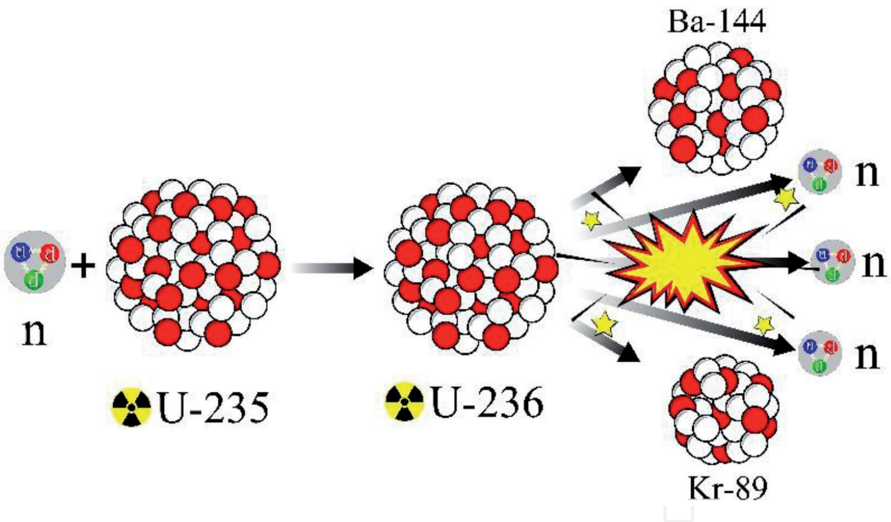

Figure 5.
Uranium-235 radioactive fission.

4. ***Cheap electricity***: Similar to traditional energy sources such as sun and wind, which require solar or wind power production, nuclear electricity may be produced from nuclear power plants even under severe weather conditions.

5. ***Low fuel cost***: The key factor behind the low cost of fuel is that it takes a limited amount of uranium to generate oil. When a nuclear reaction happens, it produces millions of times more hydrogen than normal energy sources.

6. ***Supply***: There are other economic benefits of building up nuclear power stations and utilizing renewable electricity instead of traditional oil. It's one of the nation's biggest producers of energy. The greatest part of it is that this electricity has a constant availability. This is readily accessible, has large supplies, and is projected to last about 100 years, whereas electricity, oil, and natural gas are small and are likely to disappear early.

7. ***Easy transportation***: Electrical power generation requires much fewer raw contents. This implies that just 28 g of U-235 produces as much energy as 100 metric tons of coal. As it is needed in limited amounts, the transport of fuel is much simpler than that of fossil fuels. Optimal use of natural resources in energy production is a rather careful approach for every country. This not only strengthens the socioeconomic climate but provides a precedent for other countries as well.

There is no question that nuclear technology has found its way into the future; however, like most electricity forms, it still suffers from certain significant disadvantages.

3.4 Disadvantages of nuclear energy

1. ***Radioactive waste***: Waste generated by nuclear reactors must be disposed of in a secure location because it is highly dangerous and may leak radiation if it is not properly treated. Any kind of pollution releases radiation from tens to hundreds of years. Collection of toxic waste has become a significant obstacle in the growth of nuclear programs. Nuclear waste includes radioisotopes with

lengthy half-lives. This ensures that the radioisotopes exist in one shape or another in the atmosphere. Such aggressive radicals pollute the sand or the sea. It's classified as mixed waste. Mixed waste induces toxic chemical reactions, which create harmful problems. Radioactive waste is normally covered beneath sand and is classified as proof, although the material is going to be used to produce atomic weapons or chemical bombs.

2. ***Nuclear accidents***: While too many modern measures have been placed in motion to insure that such a tragedy will not arise again as Chernobyl or, more recently, Fukushima, the danger associated with it remains fairly high. Just slight radiation exposure may have disastrous consequences. There are some symptoms that induce fatigue, vomiting, diarrhea, and exhaustion. Many operating in nuclear power plants that live in these areas are at risk of obtaining the toxic radiation on what they are consuming.

3. ***Nuclear radiation***: There are power reactors that are called breeders. They're making plutonium. It is an element that is not present in nature but is a fissionable product. It is a by-product of a chain reaction which, once added in nature, is very toxic. It is mainly used for the development of nuclear weapons. Very definitely, it's considered a dirty gun.

4. ***High cost***: Another realistic drawback to utilizing nuclear technology is that a lot of money is required to put up a nuclear power plant. This is not often feasible for developed nations to support such an expensive renewable energy source. Nuclear power plants usually take 5–10 years to build, because there are a variety of legal formalities to be done, so they are often protested by those residing nearby.

5. ***National risk***: Nuclear technology has provided humanity the ability to create more bombs than to generate anything that will render the planet a safer community to stay in. They ought to be more cautious and diligent when utilizing nuclear technology to prevent any big incidents of any sort. They are soft sites for terrorists and extremist groups. Health is a big concern here. A little weak protection will prove to be deadly and barbaric to humans and even to this world.

6. ***Impact on aquatic life***: Eutrophication is another consequence of nuclear waste. There are several workshops and conferences that take place every year to find a common answer. As of yet, there is no result. Studies claim the nuclear waste requires nearly 10,000 years to return to its original state.

7. ***Big impacts on health and medicine***: We still remember the horror that unfolded during the World War 2, after the atom bombs dropped on Nagasaki and Hiroshima. Still after five decades of mishap, children were born with defects. This is partly due to the nuclear influence. Will we have some treatments for that? The response is no.

8. ***Availability of fuel***: Given the abundance of fossil fuels in most countries around the planet, uranium deposits are so hazardous that they are only available in a few countries, as the map of accessibility to uranium resources depicts in **Figure 3**. Permissions from a variety of foreign bodies are needed before anyone would even conceive about constructing a nuclear power plant.

9. ***Nonrenewable***: Nuclear technology requires plutonium, which is a limited resource that has not been produced in many nations. Most countries depend on other countries for the continuous supply of this gasoline. It's extracted and shipped like any other tool. Supply should be secure as long as demand is accessible. Once all the nuclear reactors have been dismantled, they would not be of much benefit. Due to its dangerous effects and restricted availability, it cannot be identified as renewable.

Various nuclear energy projects are ongoing in both developed and emerging countries, such as India. Not to note, the benefits of nuclear technology are well ahead of the drawbacks of fossil fuels. That's why energy generation technology has been the most preferred technology.

4. Conclusions

By concatenating uranium extraction from seawater, manifestly safe breeding reactor technology, and borehole disposal of nuclear waste, a viable, planetary-scale nuclear energy network can be developed, i.e., another that is capable of supplying such an enormous quantity of energy at such a high degree of intensity that it can be relied on to sustain much—and possibly much—of the human society in virtually much possible scenarios of significant concern. For that way, nuclear technology is qualitatively distinct from other consumable technology options and must be assumed to be completely renewable in other respects. Throughout the immediate future, it is possible that the opportunity to build and demonstrate manifest protection for the latest generation of modern nuclear plants would be necessary to establish the basis for a prosperous future focused on nuclear technology.

Human civilization needs fossil energy because of its current facilities and its basic needs. This need and the high use of fossil fuels in the industrial, commercial, and residential sectors have contributed to major rapid climate change. The challenge of global warming is one of the massive problems confronting governments around the world. Earth heating may change the ecosystems and create many long-term problems. Greenhouse gasses like carbon dioxide are rising water levels in the oceans. Some droughts are in risk of extinction. These concerns are so significant that crisis analysts have described the modern century as a fuel for sustainability and protection of the planet.

Many countries have adopted official targets for the share of renewable energy in their grids, and others are considering them (**Figure 6**). Now that the governments of the world have a common issue, human beings will take collaborative action. Global organizations have been set up to manage this issue. The usage of renewable resources is one of the proposals created by global organizations to manage this crisis. Those alternative sources of energy include renewable energy and nuclear power. Countries must make decisions based on the long-term future to determine and improve the energy structures of the nation and calculate the various costs. At present, taking into account the cost factor, it is not possible to fulfill all energy demand from clean energy sources. But the good news is that this is possible with the cooperation of nuclear and renewable energy. Several countries have, in their perspective, made the energy demand share dependent on renewable and nuclear energy. Specific planners engage in predicting future projects and their costs. **Figure 6** constitutes some of the OECD-calculated costs. The key competition today is between solar and nuclear energy. The cost of using solar energy over active nuclear energy continues to be substantial and significant. They are also ideal for all levels of challenging electricity. Costs for involvement in the energy

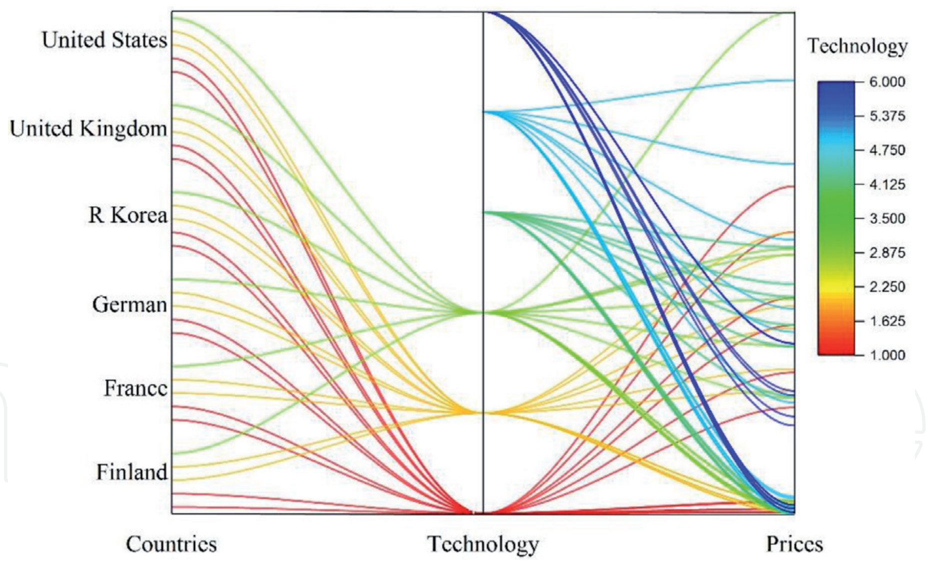

Figure 6.
Costs of combining nuclear technology with renewable energy.

market are assessed by the OECD per year. In **Figure 6**, the authors made the data comprehensible. Six countries pioneered the use of nuclear energy and renewable energy sources. **Figure 6** shows that the United States has been able to keep the cost of participating energy resources low, with the highest level of technology.

If the nuclear energy program is properly and sustainable way installed and the cost limit is eliminated, supplying electricity from nuclear energy resources will be reasonable and resolve these critical challenges for decades to come. It therefore seems necessary that we, as founders and citizens of a global society, begin to lay down the technological and structural foundations that will enable a viable, full-scale nuclear energy network to become operational in the immediate future while at the same time doing the same with regard to other realistic types of renewable energy supply on a scale [14].

One of the problems for nuclear power plants, as discussed earlier, is the difficulty of supplying 100 percent of electricity through these power plants. If we allow the setup and control share to be 10 percent and that share is given by solar energy, then the problem will be solved. However, if their share is assumed to be relatively large, then the cost of the system will increase, presenting another challenge.

These are rather heroic calculations given the paucity of sources, but they do indicate plausible effects. Increasing the penetration of renewable has small effect on backup costs since they tend to increase in direct proportion to the renewable capacity (MW) that needs backup and the increased capacity adds proportional MWh. However, balancing costs increase because more spinning reserve capacity is required at lower load factors. Since research is lowering the price of the solar-connected grid, the next problem is network costs. When renewable sources of energy such as photovoltaic systems manage to meet a district or village's full demands, then there will be a crisis. Power plants continue to use energy for spending networks indefinitely, and it is not clear how cost-effective these networks are. In this case, it would be illogical to establish and to develop a network [15]. (As a side note, backup and balancing are less costly in the United States because the dispatchable power is typically gas fired, which is less costly there.)

Another inference can be drawn from these results: the marginal cost of the system will generally increase with increased penetration of renewables, essentially due to their intermittentness and tendency toward remote locations. In addition to marginal system cost per MWH, there is another critical metric: marginal cost per ton of CO2 emissions reduced by increased deployment of renewables. After all, that is a primary policy driver for renewable targets.

The United States has set ambitious targets for renewable penetration: 33% by 2020, not including hydro. Further consideration (up to 51% in the legislative proposal) has been given for the future. The 33% level is thought to result in an implicit cost of $50/ton carbon reduction. Some energy companies have carried out important research on target utilization of 50% nuclear power and 50% solar energy. This research includes researching this topic in both scientific and economic terms. It was represented in **Figures 6** and 7. If the target is 50%, the lowest cost is $403, and the lowest cost is $340 for 40%. When energy storage technologies, such as nighttime high-altitude storage, are planned for solar energy, then the scenario will be more complex. This scenario shows that the size of large power plants can be utilized with good systems. For plants larger than 5000 mW, $636 per ton saves economic power [16]. **Figure 7** shows the costs involved with combining nuclear and renewable energy.

The next challenge is solar and nuclear energy competition. Although solar power plants will fall in price each day, in most countries the price of renewable energy is still higher than in nuclear power plants. The cost of integrating and merging systems is also important. Currently, the value of building nuclear power plants in many countries is very high due to the companies concerns of moment, technology, sanctions, security, and safety hazards. It is possible to eliminate those limitations in solar energy. The same problems may not be as wide for state-owned companies or regulated markets that services have ready access to cheap capital, and that partly explains why Asia's enthusiasm for nuclear reactors is far stronger than it is in the United States or Europe. Researchers are working to reduce the costs of technology, but the nuclear industry is not strong, although that could improve small modular reactors if they can be developed in the process. According to **Figure 7**, given the right facilities, the United States has to pay the lowest costs for involvement in nuclear and solar energy. South Korea also has the right structure to take this scenario forward.

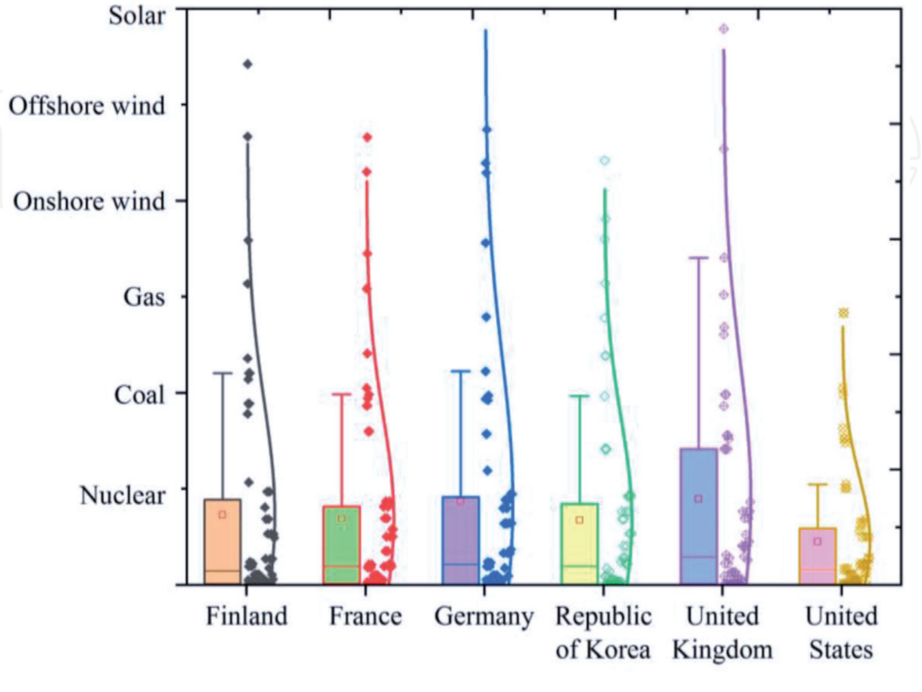

Figure 7.
The cost of getting a combination of nuclear energy and renewable energy paid by different countries.

Nuclear and renewable energies qualify for subsidies that vary from country to region. Some subsidies are direct, such as feed-in imports for renewable energy sources, while others shift the risks from utilities to customers.

The final guidelines would help to better compensate for nuclear and renewable costs and could help to reduce the costs of both:

1. Comparisons of nuclear and renewables costs should account for systems integration and differences in capacity factors.

2. In order to estimate nuclear costs, more attention should be given to the choice sensitivity of discount rate, as the discount rate drastically impacts the relative economic attractiveness of a nuclear project.

3. Findings on problems that may restrict the use of a nuclear reactor in "load-following" phase are important and should be given high priority.

Priority should be given to new reactor technologies like SMRs and regulatory reform in order to reduce nuclear capital costs. The final results of this section will include the following explanation. These explanations will help in choosing and policy making in the field of solar and nuclear energy. The outlook for these results is for the next 10 years. This outlook may change by changing conditions and creating critical conditions such as dramatically lower fossil fuel prices.

Nuclear power is dirty, dangerous, expensive, and not carbon-free and encourages nuclear proliferation. The nuclear power plant itself does not release toxic gasses such as CO2. Nevertheless, nuclear power leads to climate change; for any phase in the fuel chain used to produce electricity at the end of the day, a lot more energy is required, such as uranium extraction and uranium enrichment, which are highly energy-intensive methods. The life study of the whole fuel chain clearly indicates the relation to nuclear electricity to climate change. In a pioneering study [17], more than 100 studies have identified important but simple results, analyzing the life cycle of greenhouse gas emissions equivalent to greenhouse gasses produced at nuclear power plants around the world. The results show that if the life expectancy of a plant is equal to the greenhouse gas emission equivalent to that energy production, then the emission equals 1.4 g of carbon dioxide per kilowatt hour (gCO_2e/kWh) up to 288 gCO_2e/kWh is variable. The mean greenhouse gas emissions equate to 66 gCO_2e/kWh.

As a first conclusion, the extensive use of solar energy services for at least the next decade may be out of the issue. Photovoltaic and solar thermal systems, especially large thermal, wind, and biomass systems, will enter and expand energy networks quickly. Other renewable energy systems will be developed and priced to reduce consumption, such as biogas (wastewater, landfills, and livestock), geothermal, and possibly wave and tidal energy. This growth will be high in the next 10 years, but market with conventional systems will still take time [18]. Nuclear power is also an option when contemplating a transition from the dirtiest of fossil fuels, and thus nuclear power should be debated together with renewables. Nuclear time for building, risk, waste, and, in particular, costs must be tracked, because nuclear costs are increasing when solar energy costs are dropping. Small- and large-scale renewable energy projects and emerging storage systems are being increasingly developed by communities and nations. Also China, probably the most ambitious nation in terms of nuclear power, is introducing more wind and solar power relative to nuclear power—and not just nameplate capacity—which is actually produced. Last year alone, China installed 20.72 GW of wind (4.8 GW of production while its power factor is just 23%) and 28 GW of renewable energy

(10.6 GW of production), with about 90% of its solar installations coming from utilities. In the same year, more than five nuclear plants (5.7 GW output) were added to the existing wind and solar power. China is only one example of how wind and solar power can be installed quickly while producing more electricity. At the period (and if) China finishes its 28 nuclear power plants (many are still behind schedule), with an estimated potential of 34 GW, further wind and solar power would be installed around the same timeframe—again, taking into account efficiency factors [19].

For the coming 10 years, here in the United States, the five US nuclear power facilities are 2 years behind track and have a budget of billions of dollars. Once live, they will produce 5.1 GW while renewables would produce a rather modest 131 GW.

The other two factors are systems for the energy, safety and security systems. In a nuclear power plant, when things go awry, it can be really bad because of accidents, threats, or critical situations that happen. It should be noted that the smallest incident in a nuclear power plant can often incapacitate or destroy a city or a country. Is it likely? Who knows for sure? Could you foresee the next earthquake in Southern California or somewhere else in the United States or Japan or the rest of the world? What about the next wave washing down a coastline? How about the next cyber threat or the Middle East militant organization? Compare a tragedy for a nuclear power plant against a solar power plant. When you ask me why I'm against constructing new reactors, it's about economy, health and protection, and the reality that we can expand on current hydro and nuclear power facilities with all the renewables—and we can do it quicker.

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