Renewable Energy: Alternative Energy Source to Mitigate Climate Change in a Sustainable and Cost-Efficient Way

Yangxiameng Lu

Xi'an Medical University, Xi'an, Shaanxi, China

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Abstract: An increasing growth in extreme weather and natural disasters has led to more concerns on climate crisis than ever. One possible solution to tackle the climate crisis and curb environmental harm brought by existing energy sources is to explore the possibilities of future energy. Renewable energy, which plays an essential role in global future energy sources, has received considerable attention in recent years. However, opponents promote nuclear power as an alternative to be environmentally safe and affordable future energy. Despite the fact that switching from fossil fuels to nuclear energy system is likely to reduce GHG emissions to achieve climate mitigation and meet electricity demand, there is convincing evidence that renewable-dominated energy stystem has a more significant impact on future environmental-friendly and cost-effective energy supply.

1. Introduction

An increasing growth in extreme weather and natural disasters has led to more concerns on climate crisis than ever. For example, ferocious Hurricane Dorian slammed into the islands of the Bahamas in September 2019, which caused catastrophic damage costing over US$7 billion and at least 58 deaths in the country. This kind of natural disaster was affected by climate change because warmer oceans fueled more extreme storms and rising sea levels bolstered storm surges [1]. Greenhouse gas (GHG) emissions from fossil fuel combustion contribute to global warming and climate changes [2]. One possible solution to tackle the climate crisis and curb environmental harm brought by existing energy sources is to explore the possibilities of future energy. Renewable energy, which plays an essential role in global future energy sources, has received considerable attention in recent years. The reasons lie in that renewable energy is not only eco-friendly and cost-competitive but also can increase global Gross Domestic Product (GDP) and employment opportunities. However, opponents promote nuclear power as an alternative to be environmentally safe and affordable future energy [3]. Despite the fact that switching from fossil fuels to nuclear energy system is likely to reduce GHG emissions to achieve climate mitigation and meet electricity demand, there is convincing evidence that renewable-dominated energy stystem has a more significant impact on future environmental-friendly and cost-effective energy supply.

2. Environmental Aspect

2.1 Nuclear Energy

Nuclear energy supporters contend that nuclear power can serve as a viable low carbon energy option for global electricity supply industry. The CO2 emissions are produced only in the testing period of emergency diesel generators and maintenance stage [4]. But fossil-based power plants release substantial carbon dioxide emissions once the carbon-intensive fuels are burnt [5]. For example, in 2018, CO2 emissions produced from generating 2563 TWh of electricity by nuclear plants was 74 million tonnes, whereas coal-fired facilities were responsible for 2276 million tonnes [5]. Moreover, the International Atomic Energy Agency described the contribution of nuclear power in CO2 mitigation avoiding 66 Gt CO2 from 1970 to 2013 compared with renewables' 10 Gt CO2 [6]. In the long run, The Intergovernmental Panel on Climate Change (2014) predicts that nuclear

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power use will only rise to 15% of annual greenhouse gas reductions by 2050 [7].

However, although proponents claim that nuclear energy is favored to be a sustainable electricity generation source, evidence shows that nuclear plants do cause massive GHS emissions. For example, due to the mining and milling of the raw material uranium, CO2 emissions emitted by nuclear stations are up to 28 g CO2equ per kilowatt-hour for a nuclear power plant in Germany [8]. World Nuclear Association estimated that CO2 emissions caused by nuclear power worldwide in 2010 amounted to more than 117,000,000 t CO2equ, which were nearly the same entire CO2 emissions produced by Greece in 2010 [8]. Moreover, another environmental concern related to nuclear power is the radioactivity caused by nuclear fission and nuclear leakage. Radioactive isotopes and radioactive noble gas released by Nuclear plants contaminate the environment. For instance, krypton 85, one of radioactive noble gases produced during nuclear fission, leads to air pollution [8]. In addition, radioactive releases to air, water, and lands from nuclear accidents also result in pollution to the environment. For example, one of the radionuclides in the nuclear fuel, caesium-137, was sent into asmosphere and contaminated land when it landed in the Fukushima Daiichi Accident [9].

2.2 Renewable Energy

In fact, renewable energy, which can minimize environmental damage, is increasingly recommended to develop a climate-friendly environment for the future. One important factor is that the use of renewable energy can provide global energy in a sustainable way with low or approximately zero CO2 emissions. For instance, CO2 emissions in wind power are the lowest emissions with only around 25 g/kWh CO2e. Hydro and photovoltaics power emit less than 100 g/kWh CO2e [10]. Also the data from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety has shown that around 67 million tonnes of CO2 were avoided by wind, biomass, photovoltaics and hydropower generation in 2006 [11]. However, nuclear energy leads to 9–25 times more carbon emissions than wind energy, mainly due to emissions from uranium mining [12]. Taking the future development of renewables into consideration, based on U.S. Deep Decarbonization Pathways report in 2015, renewable energy is likely to cut emissions 80 percent below 1990 levels by 2050 if 2,500 gigawatts of wind and solar generation are put into use [13]. What’s more, renewable technologies do have low impacts on wildlife, water, and land because natural resources from wind, water and sunlight are available and infinite [12]. For instance, most solar power plants are located in habitats where diverse plants and wildlife are protected [14]. Therefore, having access to renewable energy technologies is one recommended way of protecting the environmental.

3. Economic Aspect

3.1 Nuclear Energy

In terms of economics, it has been argued that nuclear power with low cost and good operating performance is cost-competitive compared with fossil-based electricity generation. In the Republic of Korea, for example, when it comes to total generation costs, nuclear plants are much cheaper than coal-fired plants by 17.4% and oil-fired facilities by 28.5% [15]. In addition, fuel costs (mainly including costs of raw materials) give nuclear energy an advantage. This is due to the fact that uranium (the principle fuel material) is a highly concentrated source of energy that can be transported easily and cheaply [16]. For example, total fuel costs of a nuclear power plant in the countries of the Organisation for Economic Co-operation and Development (OECD) are usually around one-third to one-half of those for a coal-fired power plant and between one-quarter and one-fifth of those for a combined-cycle gas plant [17]. The US Nuclear Energy Institute also presents that the cost of fuel for a coal-fired plant occupies 78% in total costs, the figure for a gas-firedplantis 87%, but the cost of uranium for nuclear power is approximately 14% [16].

However, even though nuclear power can be an economic source of electricity generation, it is undeniably true that there is an increasing growth in construction costs, due to after being over

budget and past schedule, which heavily influences nuclear power economics. According to US Energy Information Administration in 2016, the realized overnight cost which belongs to construction costs of a nuclear energy plant built in the USA increased from $1500/kWe in the early 1960s to $4000/kWe in the mid-1970s, and even to $5945/kWe in 2016 [18]. Factors causing this growth classifies into following categories: licensing issues, cost overruns for project delay problems and erroneous estimation of costs [16]. Moreover, it is worth noting that nuclear radioactivity waste can be costly to manage and dispose of. There are three options to conduct nuclear waste storage: onsite storage, long-term storage and reprocessing which all require a substantial cost to build and operate facilities [19]. For example, The Public Accounts Committee stated that the operational costs of a British nuclear waste management facility, Sellafield, had increased from risen from £67.5bn in 2013 to a £70bn in 2014 [20]. Also according to Nuclear Decommissioning Authority, this cost would rise to an additional £115 billion, spread over the next 120 years [21]. Furthermore, governments ask for a levy on taxpayers to pay for establishing nuclear waste storage sites in some countries. For example, the Director of Federal Programs at the Nuclear Energy Institute points out that 97 nuclear plants are operating in the U.S. and the amount of waste will be able to grow. As a result, more than $41billion in funds will be collected from consumers' payment for repositories [22]. Nuclear energy, therefore, is contentious source energy which requires a considerable financial cost.

3.2 Renewable Energy

On the other hand, renewable energy is a more economical source of electricity generation than nuclear energy. For example, in terms of the levelized cost: the minimum cost per-megawatt hour to establish a new nuclear plant is $112, whereas the cost is cheaper for wind, utility-scale solar, and combined cycle gas by $30, $46 and $42, respectively [13]. Furthermore, there has been a sharp decline in the capital cost of renewable energy from the early 2000s. For instance, the average value of PV modules fell from $3.5/watt to $0.72/watt between 2006 and 2016 [23]. According to Bloomberg New Energy Finance, the average price of solar power decreased to US$1.65 million per megawatt in almost 58 emerging-market countries [24]. Moreover, renewable energy plays a significant role in increasing global Gross Domestic Product (GDP). If renewables double its share in the energy mix worldwide by 2030, this will boost global GDP by up to 1.1% or 1.3 trillion dollars [25]. Finally, the creation of employment opportunities in the renewable energy industry also helps achieve economic development. According to IRENA, the renewable energy sector supported eleven million jobs in 2018 [26]. Renewables, consequently, bring many economic benefits by reducing energy bills, creating jobs and raising global GDP.

4. Conclusion

In conclusion, nuclear energy fails to be a clean future energy option for sustainable development because of CO2 emissions and environmental damage caused by radioactivity. Also nuclear power is considered as a costly way of producing electricity since there is a rise in construction cost and high cost on waste management. On the other hand, renewable energy is a far better alternative to fossil fuel than nuclear energy as a result of an environmental-friendly and cost-effective energy source. Therefore, it is suggested that policymakers promote the use of renewable energy as a clean energy according to different countries' requirements and capabilities.

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