Critical Factors in Renewable Energy Generation

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The factors influencing the development of renewable energy in the electrical power sector can be grouped into four main clusters: (i) economic factors, (ii) legal and policy factors, (iii) social acceptance factors, and (iv) adverse impacts of renewable energy projects on the ecological environment.

Renewable Energy economic legal and policy social acceptance

1. Introduction

According to a recent report by the International Renewable Energy Agency (IRENA), if one doubles the current share of renewable energy in the global energy mix by 2030, the global gross domestic product (GDP) will rise to USD 13 trillion by 2030 [1]. That is why the world's largest companies and deep-pocketed investors are lining up to fund a trillion-dollar shift away from fossil fuels [2][3]. Investment funds focused on the environment had assets of USD 2 trillion, which have more than tripled in last three years [4]. More than 10 million people currently work in the renewable energy sector and more than 500,000 new jobs were added in 2017 alone [5]. Although the installation of renewable energy systems requires significant upfront investment, they are relatively cheap to operate. For example, China and India have high primary energy consumption and demand growth, and as such the strategies above are crucial to shaping a low-carbon transition that includes natural gas alongside a wider range of fuels and technologies [6][7]. Switching from fossil fuels to renewable energy can help slow climate change and avoid potential economic losses. There are many reasons why the use of renewable energy instead of fossil fuels is advantageous. As a result, many countries have announced and pursued policies widely known to have the potential to transform their demand patterns, and the breadth of their energy mix suggests that the question is not whether oil and gas will be part of the energy transition in China, India, and the rest of East and Southeast Asia, but whether a similar dynamic will apply to larger oil and gas roles, as is the case with natural gas [8][9]. Oil and gas could be included in the energy mix in the foreseeable future, but the picture, which is characterized by a number of markets and geopolitical concerns, is different than that of the past. Progress in implementation has been slow in recent years, but researchers can achieve this goal with continued investment and commitment to smart approaches to renewable energy infrastructure on the ground that address the issues described in this review paper [10][11]. These approaches enable efficient project permits, the responsible use of public land, the development of areas with high energy potential and low non-conflict environmental impacts, and help protect the exceptional deserts, mountains, forests, and rivers for future generations [12]. This review assesses the main economic benefits of renewable energy on land derived from wind, solar, and geothermal resources on public land.

Renewable energy is starting to play an important role even in such oil-abundant countries as Iran, showing its economic feasibility [13]. Recently, Iranian officials have responded enthusiastically to the West's curiosity by cutting red tape in its energy sector, streamlining the permit process, and creating incentives for renewables to compete [14]. Iran's Sixth Development Plan, a government five-year growth policy, includes a provision requiring Iran to install renewable energy. With the removal of major restrictions on domestic and foreign financing, an investment target of USD 10 billion in 2018 and USD 60 billion by 2025 seems feasible, and Iran has unveiled plans to develop non-conventional renewable energy sources in response to growing demand for renewable energy generation [15]. This includes increasing solar and wind capacity in parallel with the integration of the electricity grid, thereby encouraging the development of more conventional renewable energy sources.

2. Legal and Policy Boost Factors for Renewable Energy Project Development

There are many success stories that list the use of legal and policy factors for boosting renewable energy projects that justify continued state involvement in a dynamic energy market [16]. For example, between 2001 and 2017, the cumulative wind capacity worldwide increased by more than 539,000 megawatts (23,900 MW), more than 22-fold [17]. This fast-growing sector has created jobs, made power grids more resilient, expanded access to energy in developing countries, and helped reduce energy costs. The use of renewable energies, in particular solar and wind energy, needs the wide support of the population [18]. However, without government support for the use of wind and solar technologies, their costs will be in the same league as the increased cost of fossil-fuel technologies per kilowatt-hour, and it is more likely that CO_2 emissions will be added to electricity generation by these technologies [19][20]. Wind turbines have developed rapidly in recent decades, and solar photovoltaic technologies are becoming increasingly efficient, improving the prospects of harnessing energy from tides and waves [21]. Solar thermal technologies, in particular heat storage, have great potential in sunny climates. Some people are opposed to wind turbines, but they look to the horizon, where they are solid, and wind energy prices are falling, proving that a valuable resource can be denied [22]. Currently, 29 U.S. states have set standards for renewable energy—policies that require a certain percentage of energy to come from renewable sources—and more than 100 cities have at least 70% renewable energy, whereas others have committed to reaching 100% [23].

In 2020, states, cities, utilities, and businesses started to announce and pursue decarbonization plans after the onset of the global pandemic and recession. Direct incentives for the development of green infrastructure and stimulus measures adopted in response to COVID-19 and the demand for clean energy in the United States have proven resilient, with renewable storage systems recording declining costs and increasing capacity and utilization factors [24][25]. New policy initiatives have revised customs policy and made purchasing and production obligations mandatory. Expressions of interest invited the installation of photovoltaic production capacity and the associated guaranteed purchase of up to 20 GW. Tenders are set for solar, wind, and hybrid systems, and existing projects are invited. Facilitating research and development of renewable energy technologies in national laboratories for policy testing, standardization, and certification has been announced by the authorities [26].

In some countries, there are programs designed to train graduates in the installation, commissioning, operation, and management of solar panels. The International Solar Alliance (ISA) headquarters in Gurgaon, India, is the new beginning of the improvement of solar energy in the country [27]. The new site procedure will create uniform environmental standards and conditions to support and accelerate project development, create new jobs, and combat climate change. In the United States, the first Renewable Energy Site and Site Office (RESO) will consolidate environmental audits for large renewable energy facilities at the U.S. Department of State and provide a single forum to ensure that site decisions are made in a predictable, responsible, and timely manner and that local communities have an opportunity to get involved [28]. To ensure that the development of renewable energy is aimed at maximizing economic development, the Natural Resources Protection Act created the Clean Energy Development Incentive Program. This landmark law provides for responsible, intelligent, and rapid permitting of sites so that customers can be sure that they have the renewable energy they need [29].

In an effort to develop countries' renewable energy resources for the efficient use and production of electricity, the government of Ghana has adopted two key energy policy documents that set renewable energy targets as the government envisions them. This is the first policy instrument to provide details of the government's plans for the use of renewable energy for electricity generation [30]. According to the plan, the government plans to contribute to the development of an efficient energy market that provides reliable, adequate, and efficient energy services for the economic development of the country.

China's National Energy Plan provides policy guidelines for the country and challenges for the energy sector. The National Energy Commission (NEC) is the objective to design China's energy strategy, ensure its energy security, and coordinate cooperation programs [31]. Renewable energy certificates (RECs) with renewable energy credits (also known as "green tags" or "green energy certificates") for the acquisition of renewable energies are tradable certificates for renewable energy that represent the technological and ecological attributes of electricity from renewable resources. When purchasing renewable energy from utilities through green pricing or green marketing programs, the buyers pay a small price in exchange for electricity from renewable sources [32]. Renewable energies ae generated on site by means of an appliance system at the place of electricity use (e.g., panels on government buildings, geothermal heat pumps, biomass cogeneration).

3. Social Acceptance of Renewable Energy Projects and Environmental Issues

One would probably agree with the fact that the complete removal of hydrocarbons from the energy system constitutes a degradation in the industry's social license to operate. The combination of public distrust and contradictions in the name of an industry that has crafted a successful narrative about its value in decarbonizing the system and reclaiming its social license will further complicate pressure on oil and gas companies in the short term [33][34][35]. There is also a considerable debate as to whether nuclear power should be considered sustainable, with the debate centering on the risk of nuclear accidents, the generation of radioactive waste, and the potential of nuclear energy to contribute to the proliferation of nuclear weapons [36]. Public support for nuclear energy is low due to safety concerns, but per unit of energy produced it is safer than fossil fuels and comparable to renewable

sources. Various new forms of nuclear power are being developed to remedy some of the drawbacks of conventional power plants [37][38][39].

In 2012, renewables accounted for 22% of the world's total energy production [40], which would not have been possible a decade earlier. In 2018, almost a quarter of electricity generation came from renewable sources other than biomass, which shows that renewables are one of the fastest-growing energy sources in the world, with an annual growth of 2.5%, but in the eyes of the general public it is not enough to keep pace with the effects of the rapid increase in energy demand [41]. More efforts should be made to enhance the public image of renewable energy and its social acceptance [42][43]. This is particularly important when dealing with the "not-in-my-backyard" approach (known as "NIMBY"), wherein people oppose even the best and most beneficial renewable and clean energy projects when they concern them directly [44][45].

Global investment in renewable energy capacity and fuels has increased significantly over the last several decades. With the advent of the Industrial Revolution based on concentrated energy tied to fossil fuels, attention has turned to renewable sources. This has been exacerbated by the growing use of fossil fuel-based grid electricity and the importance of portable, high-density energy sources for transport in the age of oil. As the electricity demand has increased and supply depended on fossil fuels, hydropower, and nuclear power, concerns have arisen that carbon dioxide emissions could possibly contribute to global warming. The public opinion needs to be shaped and the members of the general public should realize how important climate change might be and how crucial it is to deploy a wide use of renewable energy sources in the electricity sector of the 21st century.

4. Adverse Impact of Renewable Energy Projects on the Environment

With all the positive effects of renewable energy generation, there are unfortunately also adverse or negative impacts [46][47]. Policymakers must understand the relative environmental impacts of alternative energy sources in order to develop sound policies, including the impact of renewable energy technologies on fossil fuels and ways to improve energy efficiency [48][49]. For example, the potential impact of wind energy on wildlife is a potential problem that could delay or block the development of wind energy in high-quality wind resource areas where addressing impacts, location, and licensing issues should be a high priority [50]. Another problem might be cybersecurity, since many renewable energy projects employ advanced ICT solutions and tools and rely heavily upon the Internet. Many serious problems might emerge in this area, too [51][52][53].

In addition to the economic costs of greenhouse gases, sound climate policies must also take into account other sustainability dimensions, as outlined in the 2015 United Nations Sustainable Development Goals (SDGs) adopted. The energy systems of the future are relevant to the SDGs on health, on clean water, on responsible consumption and production, on life in water, and on land. The annual growth in global energy demand and related environmental impacts (EIS) play an important role in the major, sustainable, green global energy transition [54][55].

Increasing global warming prevents adequate access to renewable energy and the improvement of renewable energy technologies. In developing countries, the main focus should be on job creation and financial development, focusing on environmental impacts, shifting consumer attention to renewable energy for society, and improving smart belt systems effectively and efficiently. Renewable energy sources are the best option to minimize pollution, and increase the economy, energy security, employment opportunities, and poverty by reducing the dependence of poor people on natural resources [56][57].

Although fossil fuels such as coal have a significant impact on the environment, renewable energy projects can have little environmental impact on ecosystems and human health. Location, project design, and technology selection are critical for investors and governments. Current findings suggest that researchers need to look for ways to use technologies that minimize damage to ecosystems.

In the energy sector, decarbonization paths bring great environmental benefits, but researchers note that the extent of the benefit–benefit profile and the negative side effects depend on the choice of technology. Mitigation scenarios that focus on wind and solar energy are more effective in reducing impacts on human health than low-level renewables and lead to a less prominent shift away from fossil fuel depletion.

Non-climatic ecosystem damage is less secure and tends to increase due to land requirements for bioenergy. The negative impacts of solar energy are associated with land use, water consumption, habitat loss, and harmful materials used in the production of solar panels. Large areas are required for the construction of solar power plants on a supply scale [58].

In order to provide a clearer picture of the solar CO_2 footprint, hundreds of studies have been carried out in recent decades on the life cycle assessment of solar energy as an emissions profile. These studies cover the upstream, operational, and downstream stages of energy production from diverse fuel sources such as solar energy, solar thermal energy, wind, nuclear power, natural gas, and coal. Everyone assesses the likelihood of economic growth and improved environmental quality in the long term. It is estimated that by 2050 about half of the world's energy supply will be generated from renewable energy sources and that the level of renewable energy sources will be 140 times higher than the annual global energy consumption [59][60]. Although it is widely acknowledged that renewables will not solve the world's energy problems, renewable energy technologies are seen as a significant untapped potential to allow many countries around the world to meet their growing energy needs.

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