

POTENTIAL OF SOLAR ENERGY IN SOUTH ASIA: CURRENT CHALLENGES AND OPPORTUNITIES

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Abstract

Renewable energy is energy which has been received from earth's natural resources that are not finite or exhaustible, such as wind and sunlight. Renewable energy is an alternative to the traditional energy that relies on fossil fuels, and it tends to be much less harmful to the environment. This study was purely based on the review of the secondary published paper online. The author used journal databases to gather the relevant documents for writing this research paper. This paper aimed to find the potentiality of solar energy in South Asia with respect to the current challenges and opportunities. South Asian countries are located in a region of varieties of climatic conditions such as tropical, humid etc. which supports calm access to a variety of renewable energy sources. The governments of South Asian countries have initiated renewable energy policies to encourage industries and individuals to employ renewable energy powered systems in power applications.

Keywords: Green energy, Nepal, Renewable energy, Solar energy, South Asia

INTRODUCTION

The transition from fossil fuels towards renewable energy sources is motivated by numerous factors such as environmental impacts, limited fossil fuel supplies, cost, and advancements in technology (Timmons et al., 2014). This transition is further supported by international agreements like the Paris Agreement, COP 26, and COP 27, which promote a green economy and combat climate change. Government policies can have a significant impact on the speed and success of this transition to a renewable energy economy. Inevitably, a complete transition to renewable energy is necessary to ensure sustainable economic development and mitigate the adverse effects of climate change.

Renewable energy refers to energy derived from natural sources that are replenished at a higher rate than they are consumed (United Nations). These natural sources include wind, water, and solar power, among others (Jacobson and

Delucchi). Renewable energy sources are not finite or exhaustible and serve as an alternative to traditional energy sources that rely on fossil fuels. Additionally, renewable energy is less harmful to the environment, making it a more sustainable option for economic growth (Just Energy, 2022).

The history of human civilization is marked by various energy transitions. In less developed, subsistence economies, people's primary need for nutrition is met through modest forms of farming, which utilize solar energy for human use. Solar energy stored in firewood or other biomass fuels meet other basic needs for home heating and cooking. Edmond Becquerel discovered the photovoltaic effect in 1839 while working in his father's laboratory, where he found that some materials generate voltage and electric current when exposed to light (Gienergy, 2022). Solar energy is one of the most abundant

energy resources available and can even be harnessed in cloudy weather conditions (United Nations). Solar energy is captured from the sun and can be converted into heat, electricity, or hot water. Photovoltaic (PV) systems, which convert direct sunlight into electricity using solar cells, are a popular technology used to generate solar energy (NG, 2022).

The world's increasing energy needs and the adverse effects of climate change necessitate a transition towards renewable energy sources. This transition is supported by international agreements and is crucial for sustainable economic development. Solar energy, in particular, offers a consistent, renewable source of energy that can be harnessed even in cloudy weather conditions. Therefore, advancements in solar energy technology are essential to facilitate the transition to renewable energy and mitigate the adverse effects of climate change.

The research gap can be identified as the need for a comprehensive understanding of the current state of renewable energy transition in the global economy. Although there has been a growing awareness of the limitations of fossil fuels and the potential of renewable energy sources, there is still much to be explored in terms of the actual transition to a renewable energy economy and the factors that contribute to its success or failure. The primary objective of this study was to investigate the current state of renewable energy transition and the challenges and opportunities involved in this process. By analyzing existing literature, case studies, and policy frameworks, this study aimed to identify the key factors that are driving the transition to renewable energy and the barriers that need to be overcome to ensure a successful transition. The novelty of this study lies in its comprehensive approach to understanding the renewable energy transition process. This study hasn't only explored the technological advancements and economic factors that are driving the transition but also investigate the policy frameworks and political dynamics that are shaping the process.

METHODS

The methodology of this study was based on a review of secondary published papers online. The author utilized journal databases to gather relevant documents for writing this research paper. Search keywords like "Solar energy in South Asia," "Renewable energy in South Asia," "Renewal energy rank," "GDP and Population," "SWOT analysis of solar energy," and "Solar energy" were used to retrieve information from journals, books, and conference papers.

The primary objective of this study was to find the potential of solar energy in South Asia considering the current challenges and opportunities. The study aimed to assess the current status of solar energy in South Asia and identify the key factors that are hindering its growth. Moreover, the research aimed to identify the opportunities available for solar energy in South Asia, which can be capitalized to ensure a smooth transition to renewable energy.

The novelty of this study lies in its approach to assessing the potential of solar energy in South Asia. The study analyzed the SWOT (Strengths, Weaknesses, Opportunities, and Threats) factors of solar energy in South Asia and examined the current scenario of renewable energy in the region. Moreover, this study presents a comprehensive analysis of the potential of solar energy in South Asia, which can be useful for policymakers, investors, and renewable energy enthusiasts. The study also provides insight into the current state of renewable energy development in the region and highlights the need for collective efforts to achieve sustainable development through renewable energy.

RESULTS AND DISCUSSION

Most renewable energy is ultimately solar energy. The sun's energy can be used directly for heat or electricity. Hydropower derives from dwindling water, which occurs because solar energy evaporates water at little raises those later rains on high elevations. The sun also creates wind through variance heating of the earth's surface.

Biomass energy comes from plant matter, produced in photosynthesis which also driven by the sun. Thus biomass, wind, and hydropower are just secondary sources of solar energy. Non-solar renewable energy sources include geothermal energy, which comes from the earth's core, in some combination of energy left from the origin and continued decay of nuclear materials. Tidal energy is another non-solar renewable energy source, being driven by the moon. Though nuclear power from fission is not renewable, there is great debate about whether nuclear power should be part of the post-fossil-fuel energy mix (Timmons et al., 2014).

The main advantage is that it is a renewable, clean source of electricity. Solar energy is also scalable. This means that it can be arranged on an industrial gage, or it can be used to power a sole domiciliary. When it's used on a small scale, further electricity can be stored in a battery or fed back into the electricity grid. In sum, the sun provides off far more energy than we'll ever need. The only restraint is our ability to convert it to electricity in a cost-effective way (Fortum, 2022).

Renewal energy plays a crucial role for carbon neutrality and it can be dominated the world energy economy share from 14% in 2018 to 74% in 2050 reducing greenhouse gas, Carbon emission, natural friendly and sustainable development in the energy protect humans, wildlife, and ecosystems is the major challenges for the globe. As a renewable CO₂-free power source, the environmental impact of solar power is significantly smaller than other power generation methods. The impact is mainly related to the production and supply of the special materials and metals that are required to produce solar panels. The location and the water used to clean the solar panels also affect the environment. We are working hard to find alternative ways to clean our solar panels (Fortum, 2022).

In South Asia, member countries are looking into inexhaustible and repeatable renewable energy sources such as solar, wind, hydro and biomass. Geologically, South Asian countries are located in a region of varieties of climatic conditions such as tropical, humid etc. which

supports calm access to a variety of renewable energy sources. The governments of South Asian countries have initiated renewable energy policies to encourage industries and individuals to employ renewable energy powered systems in power applications (Shukla et al., 2017).

Solar electricity has more importance than other on the basis of geographic location, time of day, season, local landscape, and local weather, which affect the amount of solar energy that can actually be used. And the suitable geology is existed in the region therefore the South Asian region could get more benefit from the Solar energy. Solar electric systems have no fuel costs, low operating and maintenance costs, produce virtually no emissions or waste while functioning, and even raise the value of homes. These systems can be built quickly and in many sizes. This will be well-suited to rural areas, developing countries, and other communities that do not have access to centrally generated electricity. Solar energy is currently cost-effective for meeting remote electrical loads and for providing a distributed source of electricity without the requirement of adding extensive grid infrastructure or putting a burden on the existing grid (Renne et al., 2003).

The main challenge is that the wind does not always blow and the sun does not always shine in a given location. Intermittency problems can be mitigated by a smart balance of sources, such as generating a base supply from steady geothermal or tidal power, relying on wind at night when it is often plentiful, using solar by day and turning to a reliable source such as hydroelectric that can be turned on and off quickly to smooth out supply or meet peak demand (Jacobson & Delucchi, 2009).

Solar water heating is already financially competitive with fossil fuels in many climates. Solar space heating is also possible, but a challenge with solar space heating economics is that monthly demand and supply are almost exactly opposite: the greatest demand is in winter, when there is the least supply of sun, and the most sunshine occurs in summer when demand for heating energy is lowest. In practice this means that solar space heating

systems almost always require some supplemental heat source, since the marginal cost of gathering solar energy in the depths of winter is extremely high. Supplemental heating adds to the cost of solar heating systems. Most renewable energy portfolios will include some sources that are not available on demand, and thus most regions will have to confront energy-source intermittency. Energy diversity is one approach to intermittency. For example, solar energy is strongest in the summer, while in most places wind energy is strongest in the winter. A combination of the two can provide more consistent year-round electricity generation than either one individually. If this diversity of sources would be chosen in a given area anyway, there is no cost to using diversity as a way to correct intermittency. It also is possible to store electricity (Timmons et al., 2014).

Renewable energy technologies can potentially change the comparative advantage of developing nations and solar energy could play more beneficial in rural area where the territory is very difficult to reach the infrastructure single family solar panel system can fulfill the huge amount of electricity in those area. The use of solar energy contributes best of all to inhabitants meeting the energy needs of their own household by an energy supply without sources of energy free of emission (Kuta, Yusuf & Raymond, 2022). Renewable solar and wind energy sources have low operating costs—once generating facilities are built, there is little additional cost for producing energy each year. While this is an operating advantage over fossil fuels, it comes at the cost of higher capital expenditure. Building a renewable energy plant is similar to building a fossil energy plant plus buying all the fuel that the fossil plant will use over its lifetime. Few homeowners would purchase a gas furnace and at the same time purchase all the gas the furnace would use over its life. Yet by their nature, this is what is expected for most renewable energy sources (Timmons et al., 2014).

Impacts of reducing CO₂, NO_X and SO₂ emissions. The emissions from solar electricity generation are negligible as no fossil fuels are combusted to create electricity.

However having the more benefit to the environment, due to the some major barriers to greater use of solar electricity is higher costs than many alternative electricity sources, insufficient transmission, and management of the variable/intermittency electricity output from these sources in many country (Komar, 2009).

The serious disadvantage of the island-like installation is that the storage of surplus energy quantity produced in summer cannot be solved in the long run, whereas in winter solar energy supply systems are often undersized (Lakatos et al., 2011).

Solar electricity also has limitations. It is not available at night and is less available during cloudy days, making it necessary to store the produced electricity. Backup generators can also be used to support these systems. During the manufacturing process of photovoltaic cells, some toxic materials and chemicals are used. Some systems may use hazardous fluids to transfer heat. Adverse impacts can be experienced in areas that are cleared or used for large solar energy generating sites. Large-scale solar electric systems need large amounts of land to collect solar energy. This may cause conflicts if the land is in an environmentally (Guangul & Chala, 2019).

Key challenges faced by the energy sector include increasing energy deficits, single fuel dominance in the energy mix, rising import dependence, and lack of requisite energy infrastructure (Chikaire, Atoma & Ajaero, 2022). Augmenting the energy supply and diversifying the fuel basket requires inter- and intra-regional energy trade. In this regard, apart from existing initiatives on intra-regional energy transfer, a few interregional trade proposals have also been under discussion. South Asia has a good potential for renewable solar energy due to its geographic location, legislative framework, prior experience and well-developed research in academia and personnel training. Support and incentives from government are still attractive and the market has growth potential (Hanook, 2022).

Table 1: Current status of solar energy for different countries

Country	GDP (see world bank rating)(In Millions of US dollars)-21	Population (in Thousand)- 21	Renewable energy rank (in number)	Solar electricity capacity (in million kilowatts)
Nepal	36,289	29,675-49 th rank	93	0.06
India	3,173,398	1,393,409-2 nd rank	4	39.21
Bangladesh	416,265	166,303-8 th rank	111	0.3
Bhutan	2,315	780-163 rd rank	74	0
Pakistan	346,343	225,200-5 th ranking	28	0.74
Sri Lanka	84,519	22,156-57 th rank	73	0.23
Maldives	4,890	544-170 th rank	162	0.02
Afghanistan-20	20,116	39,835-37 th rank	113	0.03

More than 24 percentage of world's populations are situated in South Asia with having only 4.25% share of world's GDP. Fossils fuel is the major dominant energy using in the region and most of the energy is currently being supplied by India. India also imports the fuel from the other nations. Due to higher cost of the non-renewable energy in terms of monetary as well as environmental, as well as various nations recently agreed with reduced the carbon emission and focusing on sustainable energy development, most of the countries are concerning towards the renewable energy. Further most of the South Asian countries are facing huge amount of currency is spending for purchase the fossils fuel therefore they can save the huge amount of capital flight. As per the global economy data India, Pakistan, Sri Lanka, Bhutan, Nepal, Bangladesh, Afghanistan and Maldives place at 4, 28, 73, 74, 93, 111, 113 and 162 rank of renewable energy among the world respectively. India, Pakistan, Bangladesh, Sri Lanka, Nepal, Afghanistan, Maldives and Bhutan have solar energy capacity as of 39.21, 0.74, 0.3, 0.23, 0.06, 0.03, 0.02 and 0 million kilowatts respectively.

The discussion highlights the importance of renewable energy sources and the dominance of solar energy among them. Most renewable energy sources, such as hydropower, wind, and biomass, are derived from solar energy. South Asian countries are situated in regions with climatic conditions suitable for solar, wind, hydro, and biomass energy sources. Solar energy is particularly important due to its geographic location, time of day, season, local landscape, and weather conditions that affect its availability. The discussion also points out the challenges associated with solar energy, including its intermittency problems and the high marginal cost of solar space heating in winter. However, these challenges can be mitigated through a smart balance of energy

sources, energy diversity, and electricity storage. Solar energy is a renewable and clean source of electricity, and its use can contribute to reducing greenhouse gas emissions and promoting sustainable development. Solar energy is also cost-effective for meeting remote electrical loads and providing a distributed source of electricity without putting a burden on the existing grid. Overall, the discussion suggests that renewable energy technologies, particularly solar energy, can potentially change the comparative advantage of developing nations and contribute to meeting energy needs without sources of energy that are not renewable.

Conclusion

In conclusion, renewable energy is an essential component for a sustainable and green future. The world has relied on fossil fuels for far too long, which has resulted in irreversible damage to the environment. The shift towards renewable energy sources is necessary to combat climate change, reduce greenhouse gas emissions, and protect the planet for future generations.

Solar energy is a particularly promising renewable energy source, as it is abundant, clean, and scalable. The sun provides far more energy than we will ever need, and it is our responsibility to convert it to electricity in a cost-effective and environmentally-friendly way. Solar energy can be used to power homes, businesses, and even entire cities, and it has the potential to dominate the world energy economy share from 14% in 2018 to 74% in 2050.

South Asian countries are particularly well-suited for solar energy due to their favorable climatic conditions and geographic location. Governments in the region have already initiated renewable energy policies to encourage the use of solar, wind, hydro, and biomass energy sources. Solar electricity has great potential in rural areas, developing countries, and other communities that do not have access to centrally-generated electricity. Solar water heating is already financially competitive with fossil fuels in many climates, and solar space heating is also possible with supplemental heating sources.

However, there are still challenges that need to be addressed in order to fully realize the potential of solar energy. The intermittency of solar energy and other renewable energy sources can be mitigated by a smart balance of sources, such as generating a base supply from steady geothermal or tidal power, relying on wind at night when it is often plentiful, using solar by day, and turning to a reliable source such as hydroelectric that can be turned

on and off quickly to meet peak demand. Another challenge is the environmental impact of producing and supplying the special materials and metals required to produce solar panels. Efforts are being made to find alternative ways to clean solar panels and reduce the environmental impact of solar energy production.

In summary, solar energy is a crucial component of a sustainable and green future. Governments, industries, and individuals must work together to promote the use of solar energy and other renewable energy sources in order to combat climate change, reduce greenhouse gas emissions, and protect the planet. The potential benefits of solar energy are enormous, including cost-effective electricity, reduced reliance on fossil fuels, and the opportunity for rural areas and developing countries to meet their energy needs. By addressing the challenges associated with solar energy, we can unlock its full potential and create a brighter, cleaner, and more sustainable future for all.

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DECLARATION OF CONFLICT INTEREST

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