



Synergies between Renewable Energy and SDG 7: A Comparative Analysis of India and Singapore

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Abstract

The research paper aims to provide a comparative analysis into the synergies between renewable energy (RE) and Sustainable Development Goal 7 (SDG7)- Affordable and Clean Energy. This research paper explores the potential synergies between renewable energy and SDG 7, examining how the deployment of renewables can not only contribute directly to the goal's targets but also generate positive impacts on other interconnected areas of sustainable development. This paper examines the approaches of Singapore and India, two Asian nations with contrasting geographic, economic, and demographic profiles, to explore how they harness the synergies between renewable energy and SDG 7. Through a comparative analysis, we identify current policies, strengths, challenges in their respective transitions to cleaner energy futures. Singapore's technology-driven focus on solar power and regional collaboration complements India's decentralised solutions, cost-effective approach, and large-scale deployment potential. The paper offers policymakers, researchers, and industry stakeholder's useful insights by means of a thorough review of the experiences of Singapore and India. In the final analysis, it hopes to promote global cooperation and provide practical approaches for incorporating renewable energy into sustainable development routes, which will further the goal of reaching SDG7

Keywords: Renewable Energy, Sustainable Development Goals, India, Singapore

I. Introduction

Renewable energy (RE) has gained considerable prominence in international debate due to the quest of sustainable development. Highlighting its pivotal significance in accomplishing Sustainable Development Goal 7 (SDG 7) - access to affordable, reliable, sustainable, and modern energy for all-countries are

progressively broadening their energy assortments to encompass more sustainable sources. This study explores the complex relationship between RE and SDG 7 by comparing the energy production and consumption practices of Singapore and India, two Asian nations that are quite distinct from one another.

Singapore, an island nation with limited resources, has become a rising leader in renewable energy innovation. The city-state has taken a multifaceted approach to achieving its ambitious sustainability goals and resource limitations. It has made significant investments in solar photovoltaic (PV) technology, and is actively involved in regional electricity trading, investigating non-traditional energy sources like biogas and waste-to-energy. As a result, Singapore's RE share has increased significantly, and it now has one of the highest rates of solar PV penetration worldwide and is gradually decreasing its reliance on imported fossil fuels.

India, however, offers a quite different environment. India, a developing country with a rapidly expanding population and high energy needs, must simultaneously provide energy security and make the transition to a sustainable future. The nation is endowed with a wealth of renewable resources, such as hydro, wind, and solar power, but it will take effort to make full use of them. The broad adoption of RE technology is hampered by financial limitations, unclear policies, and infrastructure obstacles. India has launched large-scale initiatives to increase the use of renewable energy despite these obstacles, with the goal of leading the world in the generation of clean energy.

The Renewable Energy Landscape in India

As a developing nation, India has continually struggled with energy production and even today, many areas lack proper access to electricity and other energy resources. By 2040,



rapid consumption of these resources will compel the country to switch its methods of energy generation and supply.

By the end of 2022, the Indian Government set an ambitious target of increasing its renewable energy to 175 GW. This required a \$100 billion investment and another \$50 billion project targeted smaller grids that could provide clean energy to rural areas. The goal there was to give over 18,000 villages access to energy.

India aims to fulfil 50% of its energy requirements through renewable clean resources by 2030. These include solar, wind, and other hybrid sources of energy. Expecting a 30-40 GW increase/year over the next nine years, the country looks forward to having zero-net energy commissions by 2070.

The Importance of Renewable Energy for India

As a rapidly growing economy with a vast population, India produces large amounts of waste and depends heavily on the use of fossil fuels for its production which leads to several challenges related to energy. The shift towards the use of renewable energy for India comes up with several advantages for the nation and its people.

- **Energy security and Independence:** India today is extremely reliant on imported fossil fuels and is the world's third-largest energy consumer. The cost of importing energy sources such as crude oil, etc. is high in this case. To lessen the reliance on foreign energy sources, there is a need to improve capacity to produce renewable energy, such as wind and solar, which are locally available and can drastically lessen reliance on outside sources. India will become less reliant on imported coal and oil because of its ambitious goal of installing 500 GW of renewable energy capacity by 2030, enhancing its energy security.
- **Source of employment:** Many Indians are employed in the energy sector, which is rather significant, in capacities like manufacture, installation, distribution, and maintenance. Increased employment prospects and increased buying power for those in the workforce will undoubtedly result from further growth in the renewable energy sector. The National Solar Mission has helped in creating million job opportunities and similarly in the wind energy sector, it has helped local economies by creating jobs in the rural areas.

- **Environment sustainability:** The non-renewable energy sources contribute significantly to the greenhouse gas emissions which are extremely harmful for the environment. Whereas the renewable sources are clean and emit minimal emissions which helps India fight against the climate change and contribute to a cleaner environment and commit to the international agreements. The installation of solar panels in several houses, limitation of use of coal powered plants are some successful examples conducted by the nation.
- **Better access to energy:** For rural India, where the access to reliable electricity is limited, the development and use of renewables such as the Pradhan Mantri Sahaj Solar Yojna which provides solar power packs to the rural households for electrical needs has empowered the local communities and improved their living conditions.

The International Renewable Energy Agency (IRENA) estimates that renewable energy can supply 25% of India's energy needs. By 2030, the nation may raise its percentage of renewable energy generation to more than one-third. Overall, for India, it is crucial to invest and contribute more to the renewable energy sector for a brighter and more sustainable India.

The Impact of Renewable Energy on SDG 7 in India

India's commitment to the Sustainable Development Goal 7 (SDG 7) is commendable. Through investments in green hydrogen, sustainable energy transitions, and a bioeconomy, it has made modern, inexpensive, and reliable energy accessible to everyone. India has been combating climate change by implementing sustainable economic strategies for developing nations. SDG 7 offers optimism for India's energy industry with its goals of reaching net zero emissions by 2070 and obtaining 50% of its electricity from renewable sources by 2030. As the world's third largest electricity producer, India faces challenges regarding the high amount of carbon emission, the heavy reliance on coal as primary source of energy and import of oil has led to interventions and policies to align with SDG 7 has become necessary.

CURRENT INITIATIVES

- The Indian cabinet approved a national plan in August 2022 to strengthen the country's pledge to cut its GDP's emissions intensity by 45%



which would help in achieving net zero emissions.

- The transportation system is also seeing an upgrade towards green mobility. Around 146 airports are shifting to carbon neutral by 2025 and currently 25 airports are using 100% green energy
- The growth in the sector of bioeconomy has been remarkable and these overall impacts the Indian economy. The launch of National Bioenergy Program by the Ministry of New and Renewable Energy of India (MNRE) in 2022 encourage the usage of biofuels, installation of bio-CNG power plants, use of pellets and briquettes in generating power and overall reduce the reliance on fossil fuels and mitigate environmental damage.
- In February 2022, the framework for the production and export of green hydrogen as the National Green Hydrogen Mission was formulated with the aim to make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives. The nation's efforts to diversify its energy sources are reflected in the focus on green hydrogen. A Haryana based startup known as Hygenco Green Energies has announced to set up India's first 100% green hydrogen plant in Maharashtra which will produce energy without emitting carbon dioxide.
- The Pradhan Mantri Ujjwala Yojana (PMUY) with the target of 80 million deposit free LPG connections to the rural household is another initiative by the government for the sustainable growth abiding by the goals of SDG7

India's work towards using renewable energy to achieve SDG 7 is impressive and transitioning to clean energy has significant impact such as the reduced reliance on fossil fuels, cleaner energy access, economic growth and employment opportunities and overall help in the climate change mitigation. However, there are challenges that need to be addressed and newer technologies need to be explored to help India achieve great heights in its renewable energy adoption.

The Renewable Energy Landscape in Singapore

Singapore is a country with very limited resources to generate energy. The average wind speed lies at 2m/s which is unsustainable for wind turbines and on top of that, there is a scarcity of resources on a geothermal and hydroelectric scale.

In such a setting, solar energy becomes key to the Renewable Energy Landscape in Singapore, and it boasts solar irradiation of about 1600 kWh/m². However, it is important to consider factors like limited available land and high cloud density over urban areas in general.

By 2030, Singapore aims to generate at least 2 GW of solar energy which should be enough to run 350,000 households.

On a micro level, the country has implemented measures like placing solar panels on rooftops of high-rise public house buildings and on the water surfaces at reservoirs. This is how the administration can tackle the limited availability of land and further innovate the solar energy production landscape.

While the solar energy consumption in Singapore is still functional and the nation can supply electricity to most of its residents, there are certain limitations when it comes to implementing new ways of geothermal energy production. Technologies required to harness the energy in the deep underground are still not viable from a commercial and economic point of view, but once solar energy sources are exhausted, the next big step will naturally be to improve the geothermal energy production.

The Importance of Renewable Energy for Singapore

Singapore is a small island country with limited resources and heavy dependence on natural gas for energy, transitioning to cleaner energy sources to meet the climate change concerns as well as energy security and production has become crucial.

- **Limited land and Resources:** Singapore's small size poses difficulties for conventional renewable energy sources like geothermal and wind power, in contrast to nations with large landmasses. However, solar energy holds great potential with the country reaching its target of 350 MWp solar production of the 2020 Green Energy Agenda Goal and further targeting for 2 GW by 2030.
- **Energy Security and Price Volatility:** Due to its reliance on imported natural gas, Singapore is subject to both price volatility and geopolitical interruptions. Almost all of Singapore's energy is generated from natural gas and as of June 2023, 94.3% of fuel mix comes from natural gas. More energy security as well as reduced long-term expenses are provided by renewable energy sources. The



soaring rise of gas prices has put Singapore at risk for its energy security and for a shift to sustainable resources.

- **Innovation and Economic Growth:** By making investments in renewable energy technologies, Singapore may establish itself as a pioneer in this quickly expanding industry, drawing in new capital and generating skilled employment opportunities. TotalEnergies is a petroleum business company with its regional hub in Singapore in the forefront of creating new low-carbon energy sources, electricity, biofuels, liquefied natural gas, renewable energy, and new low-carbon energy sources.
- **Environmental Sustainability and Climate Change:** Singapore is working to lower its greenhouse gas emissions as a signatory to the Paris Agreement. Renewable energy sources help mitigate climate change and provide greener energy generation. As proof, the Singapore Green Plan 2030 has set an aspiration of having net-zero emissions by 2050. Increasing the use of renewable energy is essential to reaching this objective.

The Impact of Renewable Energy on SDG 7 in Singapore

Singapore with its limited geography and lack of natural resources has limited alternative clean energy however it has made relative progress such as transitioning to natural gas from oil for a cleaner future. The Singapore Green Plan 2030 is a major initiative by the government to diversify the energy plan and transition to more renewable sources such as the deployment of solar panels, regional power grids and making use of recently developed low-carbon substitutes like hydrogen and carbon capture, utilisation, and storage (CCUS), all the while maintaining and making investments in natural gas.

CURRENT INITIATIVES

- Singapore's about 95% electricity is produced by natural gas and to enhance this process, there are policies implemented by companies such as "The Energy Efficiency for Power Generation Companies Grant Call" and the "Advanced Combined Cycle Gas Turbine" programmes that push businesses to invest in machinery and technologies that can lower carbon emissions and increase generating efficiency.
- Solar energy is the most viable source for Singapore and has installed 700-megawatt peak (MWp) solar capacity as of 2022. Innovative

methods are used such as setting up solar photovoltaic (PV) systems on water bodies and vacant lands. A 60 MWp floating solar farm which is one the world's largest inland floating solar PV system has been set up in 2021. Energy storage systems (ESS) have also been installed in Singapore to improve grid resilience and manage solar fluctuations. The largest ESS facility in Southeast Asia, with 285 megawatt hours, was put into service in Singapore in December 2022.

- Singapore is actively working with regional actors to develop regional power grids. The Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS PIP) imported up to 100 MW of renewable hydropower from Lao PDR via Thailand and Malaysia to Singapore was set up on 23rd June 2022 making a historical project involving 4 ASEAN members and the first project to import renewable energy in Singapore. In 2022, Memorandums of Understanding (MOUs) with Vietnam, Lao PDR, Cambodia, and Indonesia to expand energy cooperation in areas such as the development and funding for renewable energy initiatives and international electricity trading has been signed.
- Singapore is looking into cutting-edge low-carbon technologies including geothermal, hydrogen, and CCUS to lessen its carbon impact. The government launched the National Hydrogen Strategy in October 2022 with the goal of using hydrogen as a primary decarbonisation pathway. An Expression of Interest process was started in December 2022 to determine whether it would be possible to develop an end-to-end low- or zero-carbon ammonia power generation and storage solution.
- Singapore is actively collaborating with international actors. More than thirty ASEAN participants took part in the Singapore-US Third Country Training Programme on renewable energy in 2022, which was organised in collaboration with the US. Singapore also took active participation in energy discussion in forums such as ASEAN, G20, APEC.
- A Memorandum of Cooperation (MOCs) to enhance collective energy security and work together on long-term initiatives to reduce emissions has been signed with Japan. Additionally, Singapore and Australia signed the first-ever Green Economy Agreement (SAGEA), which will lower trade barriers for renewable energy across national borders.



Despite its limited natural resource availability and infrastructure, Singapore is actively working towards renewable energy advancements with focus on goals of SDG7 of clean and affordable energy for a better and cleaner future for all.

Comparative Analysis between Energy landscape in India and Singapore

The global pressure related to reducing carbon emissions and relying more on renewable sources of energy, both Singapore and India have had to change their energy production methods while taking care of the high population, increasing social welfare demand, and rampant privatisation of the economy.

Singapore is not a major polluter on a global level, but it is the leading Asian nation on the World Economic Forum Energy Transition Index. The Green Plan 2030 aims to improve green technology in buildings and infrastructure that does not lead to direct pollution. By increasing the rail network, there are plans to reduce personal automobile dependence and increase the reliance on public commuting methods.

Despite having access to LNG and other fossil fuels, Singapore pledges to reduce its dependencies on conventional sources and by 2040, all vehicles in the country could be green. Strategies like reduced taxes and import duty have been implemented to encourage the population to purchase EVs and this has been accompanied by rapid installation of charging ports country wide.

On the flip side, India stands at the 67th spot in the World Economic Forum Energy Transition Index as opposed to Singapore's 21st global standing. India is still a nation with a lot of rural land and the reliance on industrialization has naturally affected its ability to produce more and more clean energy sources because the latter requires significant capital.

The leaders of the country acknowledge that if they were to invest heavily on clean sources of energy, it would harm the masses, majorly the poor. The capital required for welfare has urgent uses while energy transition is a long-term goal for the country.

Regardless of their diverse needs and demographics, India and Singapore have an agreement to trade green energy from 2025. Newly built ships will use the green ammonia sent by India and this seems like the right move for both countries considering the increasing demand of green sources of energy worldwide.

India's hydrogen production is plausible and key to its progress towards affordable and clean energy while Singapore's model to harvest solar energy is being studied, scrutinised, and implemented throughout the world.

Barriers in generating affordable and clean energy resources

Indian High Commissioner to Singapore, P Kumaran was able to identify key challenges for sustaining renewable energy generation during an India-Singapore Ministerial Roundtable in 2023. These are as follows:

Digital connectivity, Fintech, renewable energy, green economy, skill development among youth, and security of food are areas that both countries can improve through collaborations.

The High Commissioner emphasised that energy supply needs to be resilient and should be able to survive the changing global landscape. As demands to reduce net-energy emissions increase, both countries can aim to focus on moving ahead from traditional chains that only consider efficiency and cost.

The biggest challenge to generate affordable and clean energy is to develop an understanding between the government and the companies that undertake such projects. Corporations must realise that changing conventional means of energy generation involves risk that they should be aware of through risk assessment tests, contingency plans, and insurance investments.

India can be a top contributor in the affordable and clean energy landscape, but it would require cooperation between large and small firms and at the same time, the governments should monitor the progress through schemes and policy implementation.

For India, its biggest contrast remains the population that is divided into a ton of different demographics and geographical regions. A plan to ensure the continued growth of all diasporas while abiding by the global norms is necessary. On the flip side, Singapore is struggling with the high cost of generating energy in the first place and the country's only hope is to extract/exhaust/discover more of its remaining conventional sources.

The idea that high conventional energy is required to boost the production of new-conventional sources of energy is a paradox that both countries need to analyse and fix for themselves.



Conclusion: Future Directions for India and Singapore in Sustainable Energy Transition

In conclusion, the comparative analysis of India and Singapore's progress towards SDG 7 highlights the unique strategies and challenges faced by each country. Both India and Singapore have made significant efforts to integrate renewable energy into their energy mix and contribute to the achievement of SDG 7. However, there are still challenges and opportunities that need to be addressed to enhance the synergy between renewable energy and SDG 7. This includes improving energy access and distribution infrastructure in India, as well as addressing the environmental consequences of energy development. Additionally, both countries can benefit from continued investment in research and development to drive technological innovation and efficiency in the renewable energy sector. Overall, the comparative analysis suggests that collaboration and knowledge sharing between countries can play a crucial role in advancing renewable energy and achieving sustainable development goals. By learning from each other's experiences and implementing effective policies, both India and Singapore can accelerate the transition towards a sustainable energy future while contributing to the global

effort to address climate change and promote inclusive development. Overall, this comparative analysis highlights the synergies between renewable energy and SDG 7 in both India and Singapore. By leveraging renewable energy sources, both countries can enhance energy access, reduce greenhouse gas emissions, and promote sustainable economic growth. In India, the renewable energy landscape has seen significant growth in recent years. However, there are still challenges to overcome, such as improving energy access in rural areas and ensuring the stability of the power grid. In Singapore, the government has implemented various policies and initiatives to support renewable energy adoption, including feed-in tariffs, tax incentives, and research and development funding. These efforts have resulted in an increase in renewable energy capacity and a decrease in greenhouse gas emissions. While both India and Singapore have made progress in integrating renewable energy into their energy mix, they face unique challenges and opportunities. India, as a developing country with a large population and diverse energy needs, faces challenges in improving energy access and distribution infrastructure. On the other hand, Singapore, as a small city-state with limited land availability, has focused on innovation

and technology adoption to maximize the potential of renewable energy in urban environments. Overall, the comparative analysis highlights that both India and Singapore have made significant strides in integrating renewable energy into their energy systems and are aligned with SDG 7.

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