



Clean Energy for Sustainable Future

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¹Abstract— Clean energy for a sustainable future (Sustainable Development Goal 7(SDG 7)) emphasizes enduring access to affordable, reliable, sustainable, and modern energy for all. Energy is a crucial driver of economic growth, industrial development, and human well-being, yet the world still faces challenges such as dependence on fossil fuels, rising carbon emission, and unequal energy access. The transition towards renewable energy sources like solar, wind, hydro, and biomass is not only vital for reducing greenhouse gas emission but also poverty and fostering sustainable economic development. It explores the role of renewable energy adoption in achieving SDG 7, with a focus on its environmental, social, and economic impacts. Furthermore, it discusses barriers such as high initial costs, lack of infrastructure, and policy challenges, while suggesting solutions including government incentives, technological innovations and international collaboration. The SDG 7 is not only about providing electricity but about transforming energy systems to be inclusive, sustainable, and climate friendly.

I. INTRODUCTION

Clean energy for a sustainable future is sustainable development goal 7. It focuses on providing affordable and clean energy for all. Clean energy sources like solar, wind, and hydro help reduce pollution and support sustainable growth. Using renewable energy is essential for protecting the environment and building a better future. It is

established by the United Nations in 2015. It has five targets that will be achieved by 2030. The five targets are

- 1) Universal access to modern energy
- 2) Increase global percentage of renewable energy
- 3) Double the improvement in energy efficiency
- 4) Promote access to research, technology and investments in clean energy
- 5) Expand and upgrade energy services for developing countries out of five targets three is achieved and two is not achieved. According to a review report in 2019, some progress towards achieving SDG 7 is being made, but many of the targets of SDG 7 will not be met. SDG 7 and SDG 13 are closely related.

II. LITERATURE SURVEY

Sustainable Development Goal 7 (SDG 7) aims to ensure access to affordable, reliable, sustainable, and modern energy for all. According to studies and reports by the International Energy Agency (IEA), IRENA, and the World Bank, global progress in energy access has improved, with millions gaining electricity through renewable sources like solar, wind, and hydropower. However, the literature also highlights that progress is uneven-many developing countries still face challenges such as lack of finance, poor infrastructure, and limited access to clean cooking fuels. Studies suggest that stronger policies, technological innovation, and international cooperation are needed to close the energy gap. Improving energy efficiency and investing in decentralized renewable systems like mini-grids are key to achieving SDG 7 by 2030.

A. Quick framing

SDG 7 aims to "ensure access to affordable, reliable, sustainable and modern energy for all." Research on SDG 7 clusters around four pillars: energy access, renewable energy deployment, energy efficiency, and clean cooking / household energy - plus cross-cutting issues (finance, policy, equity, technology/ innovation).

B. Key global reports (authoritative, must-read)

Tracking SDG7: The Energy Progress Report (annual; World Bank / IEA / IRENA partners) - central dashboard on access, renewables share, efficiency and clean cooking; warns progress is insufficient to meet 2030 targets.

Research shows that renewable energy plays a vital role in reducing carbon emissions, creating jobs, and promoting sustainable economic growth.

•IRENA - Tracking SDG7 / market updates (2024-2025) - useful for renewable capacity per capita, policy briefings, and country-level deployment

The reports are the backbone for most empirical SDG7 literature because they compile cross-country indicators and up to date data.

C. Major academic themes & representative literature

- 1) Energy access & electrification studies evaluate grid extension, mini-grids, and solar home systems; metrics include households connected, reliability, hours of supply, and socio-economic impacts. Empirical case studies and quasi-experimental evaluations are common.
- 2) Renewable power deployment and grid integration-research on solar, wind, storage, policy instruments (auctions, feed-in tariffs), and system flexibility requirements. Modelling and techno-economic assessments are frequent.
- 3) Clean cooking & household energy transitions - public health and gender dimensions; research shows slow uptake due to affordability, cultural preferences, and supply issues.
- 4) Energy efficiency - sectorial analyses (industry, buildings, transport) and policy evaluations; many studies find efficiency improvements have slowed.
- 5) Finance, policy and equity – analyses of investment flows, international cooperation, and the mismatch between global investment and needs in low-income regions.

D. Common methods / data sources

Quantitative: cross-country indicator analysis (TrackingSDG7 dataset), scenario modelling (IEA / IAMs), cost-benefit / LCOE, GIS for electrification planning.

Qualitative / mixed: case studies, stakeholder interviews, policy analysis, implementation studies for programs (e.g., mini-grids, cook stove projects).

E. Key findings from recent reports

- 1) Progress is real but too slow - Global electricity access improved (2015-2023), renewables grew strongly in power, but current trajectories are insufficient to meet SDG7 by 2030.
- 2) Renewables dominate power growth Renewables are the main driver of electricity generation expansion; solar is the single largest contributor. (IEA WEO and Renewables reports).
- 3) Investment shortfall & geographic mismatch - Much global energy investment does not reach low-income countries where access gaps remain; finance flows need redirection and scaling.
- 4) Installed renewable capacity per capita rose but remains insufficient - IRENA notes installed renewables per capita hit all-time highs but still fall short in many developing regions.
- 5) Recent signals of rapid change (2024-2025) – Some datasets (Ember, IEA adjustments) show renewables generation overtaking coal in parts of 2025 and revisions in forecasts due to policy shifts - highlighting volatility and policy sensitivity.

(These five are the most load-bearing claims to support project work or policy briefs; I cited the main sources.)

III. PROBLEM DESCRIPTION

SDG 7 is tackling the problem of the high number of people globally who live without access to electricity or clean cooking solutions (0.8 billion [4] and 2.4 [5] billion people, respectively, in 2020). Energy is needed for many activities, for example jobs and transport, food security, health and education.^[6] People that are hard to reach with electricity and clean cooking solutions include those who live in remote areas or are internally displaced people, or those who live in urban slums or marginalized communities.^{[3]:32} As well as addressing a range of inequalities in the distribution of resources.

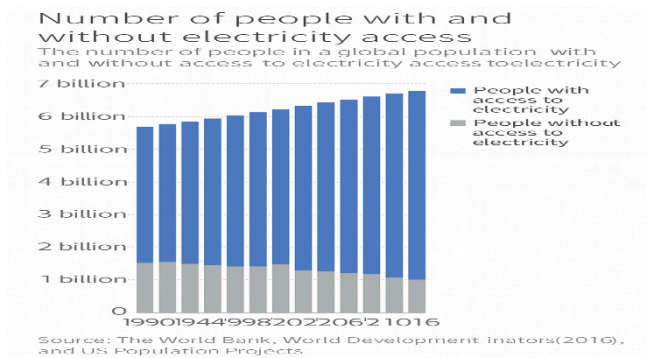


Fig.1 Inequalities in the distribution of Resources

Target 1: Universal access to modern energy

This target aims to ensure that everyone has access to affordable, reliable, and modern energy services. It focuses on providing electricity and clean cooking fuels to all people, especially in rural and developing areas, to improve living standards and support development.^[9] Many countries have made good progress, but millions of people especially in rural and developing regions still lack access to electricity and clean cooking fuels.

A report from 2019 found that India, Bangladesh, and Kenya had made good progress with supplying more of their people with electricity [4]. Globally, there are now 800 million people still without electricity [5], compared with 1.2 billion people in 2010 [4].

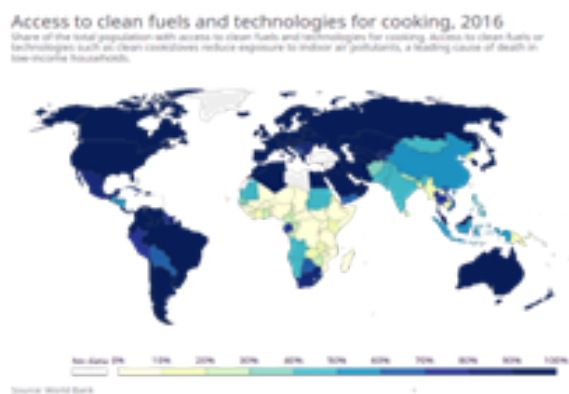


Fig.3 Access to Clean Fuels and Technologies for cooking

There are several options to tackle this problem, for example private sector financing and ensuring that rural areas get access to electricity; this may involve decentralized renewable energy [4]. And by changing the clean cooking solutions indoor air pollution can be avoided [4].

The target is still in progress and aims to be achieved by 2030.

Target 2: Increase global percentage of renewable energy

This target aims to increase the share of renewable energy in the world's total energy mix. It encourages the use of clean sources such as solar, wind, hydro, and bio energy to reduce dependence on fossil fuels. By expanding renewable energy, we can cut greenhouse gas emissions and missions and move toward a sustainable and cleaner future.



Fig.2 Clean sources such as solar

The global share of renewable energy is increasing, but not fast enough to meet the 2030 goal [7]. Many countries are investing in solar and wind projects, yet fossils still supply most of the world's energy needs.

However, challenges such as high initial costs, energy storage issues, limited technology, poor infrastructure, and lack of awareness slow progress. To overcome these problems, governments and organizations can invest in affordable technology, provide incentives and subsidies, improve infrastructure, raise public awareness, and promote international cooperation. These steps can accelerate energy future [11]. Data from 2016 showed that share of renewable energy compared to total energy consumption was 17.5% [3].

Target 3: Double the improvement in energy efficiency

This aims to double the global rate of improvement in energy efficiency by 2030. Energy efficiency means using less energy to perform the same tasks, such as lighting, heating, and industrial production. Improving efficiency reduces energy consumption, lowers costs and decreases greenhouse gas emissions, contribution to a sustainable future [7].

However, progress is slowed by challenges such as outdated equipment, high initial costs, lack of awareness, weak policies, and limited access to technology. These

problems can be addressed by upgrading to energy efficient appliances and machinery, providing government incentives and subsidies, promoting awareness programs, strengthening energy policies, and improving access to modern technologies. By taking these steps, we can achieve more sustainable and energy efficient future [11].

In general, energy efficiency has been going up in recent years, in particular in China [3]. Governments can help with this process for example by providing suitable financial incentives and by helping people access information about energy efficiency [3][10].



Fig.4 Energy Integrity of Economies

Target 4: Promote access to research, technology and investments in clean energy

This target aims to promote access to clean energy resources, modern technology and financial investments especially for developing countries [7].

However, challenges like limited funding, weak infrastructure, and lack of technology can be overcome through increased investment, technology sharing, better policies, and international cooperation. This ensures faster adoption of renewable energy and a sustainable future for everyone [11]

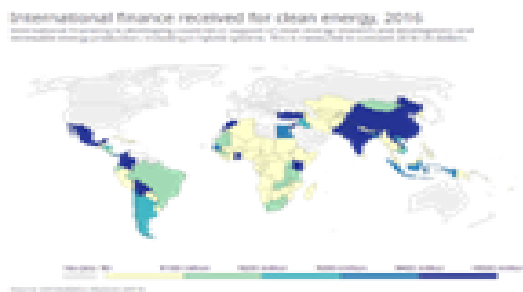


Fig.5 Geographical Adoption of Renewable Energy

There is twice the amount of international financing for renewable energy going to developing countries in 2017 compared to 2010 [8]. In 2017 most of this financing went

to hydropower and nearly 20% to solar power projects [8][10]. More investments are needed for global energy access, namely for electrification and clean cooking: A report in 2021 state that the financing community is failing to deliver on SDG 7 [9].

Target 5: Expand and upgrade energy services for developing countries

This target aims to improve and expand energy services in developing countries, ensuring access to reliable, affordable, and sustainable energy [7].

Many regions face challenges such as limited infrastructure, lack of funding, and dependence on fossil fuels. These problems can be addressed by investing in energy infrastructure, increasing funding and subsidies, promoting clean energy, transferring modern technologies, and solar systems for remote communities. Expanding energy services supports economic growth, education, health and overall development in these countries. As of August 2020, there is no data available for this target [2].

It was reported in 2020 that expanded and upgraded energy service might be removed as it is identical with SDG 12 [10].

IV.CONCLUSION

Clean energy for a sustainable future (SDG 7) focuses on ensuring clean, affordable, and reliable energy for all. Achievements include increased use of renewable energy like solar and wind, better energy efficiency, and wider access to electricity in rural areas. These efforts support sustainable development and climate action, through more work is needed to reach universal energy access by 2030.

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BIBLIOGRAPHY

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Third Author Vishnuvarthan, is currently pursuing studies in the Department of Electronics and Communication Engineering at PSNA College of Engineering and Technology. Alongside my academic journey, I am deeply passionate about tree plantation and sustainable agriculture, reflecting my commitment to environmental stewardship and innovative farming practices. My interests motivate me to explore the integration of technology with agricultural systems and to actively participate in projects that promote ecological balance and resource management. As I advance in my field, I aim to combine my technical expertise with my devotion to sustainable farming to contribute meaningfully both to my profession and to the broader community.