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Research Article

Illuminating the Path to Sustainability Analysing Global Electricity Access for Achieving SDG 7

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Abstract

Using World Bank data on electricity trends at regional and global levels, this paper seeks to unpack the Universal Electricity Access Challenge, one of the cornerstones of Sustainable Development Goal (SDG) 7. It explores disparities in access and considers how technology, policy, and partnerships can transform these issues, showcasing case studies such as India's Saubhagya scheme and Rwanda's Energy Access Rollout Program. This study applies quantitative methods, Correlation and Growth Analysis, which underscore the crucial role of electricity in socio-economic development and its association with poverty alleviation, education, and income growth. The results highlight a need for scalable solutions that combine renewable energy, geospatial mapping, and new financing mechanisms to break down barriers. As such, these insights give both policymakers and stakeholders concrete strategies on how to make universal electricity access a reality by 2030. Income inequality has taken a backseat to the moral justification for inclusive growth, giving way to an emphasis on access to electricity, not just as an end in itself but as a prerequisite for equitable development and environmental sustainability.

Keywords

Electricity Access, Sustainable Development, Regional Disparities, SDG 7, Policy Impact Analysis, Energy Equity, Renewable Energy Solutions

1. Introduction

Electricity access is a prerequisite step for modern development and a strategic enabler of economic growth, healthcare improvement, and improved quality of life. As stated in Sustainable Development Goal 7 (SDG 7), "Energy is the golden thread that connects economic growth, increased social equity, and an environment that will fuel our planet and communities." Although the world has made progress, major disparities remain, especially in low-income countries and rural areas, which presents a serious challenge to fair development.

This paper uses World Bank data to examine global and regional trends in electricity access and provides insights into the progress achieved and gaps that remain. Although centred on SDG 7, the paper also very briefly analyses the interlinkages of electricity access with other Sustainable Development Goals, e.g., poverty alleviation (SDG 1), sustainable urban development (SDG 11), and climate action (SDG 13). By using quantitative analyses and visualisations, the study aims to identify patterns and regional differences and the impact of innovative technologies on universal access to electricity.

In this paper, I aim to add to the body of knowledge about sustainable energy solutions and their socio-economic impact

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by providing a detailed analysis of the data and identifying key opportunities for improvement. These results are likely to provide insights for policymakers, researchers, and stakeholders, enabling them to identify effective strategies to bridge the electricity access gap and ensure a sustainable energy future that is integrated with global goals.

1.1. Background and Context of the Research Problem

No sustainable development can take place without access to electricity since energy access determines economic growth, education, healthcare and quality of life. According to the International Energy Agency, approximately 733 million people worldwide are still without access to electricity, of which the majority of the electricity access deficit is located in Sub-Saharan Africa and South Asia [6]. Energy poverty is a major hindrance to balanced development, as seen from the data provided by the World Bank [16]. The access to electricity directly impacts the socio-economic condition of regions.

To cope with this problem, the United Nations proposed Sustainable Development Goal 7 (SDG 7), which is to ensure universal access to affordable, reliable, and sustainable energy for all by 2030 [15]. But, progress toward this goal is uneven. Although there has been a notable improvement in East Asia and Latin America [16], Sub-Saharan Africa is still behind, with an electrification rate of just 48% in 2020 [6]. In particular, the need for energy access remains a continuous challenge in rural areas, owing to technological and financial barriers that prevent the development of infrastructure [14].

Another key issue is moving to sustainable energy sources. The use of fossil fuel-based power generation in developing economies raises substantial environmental issues, resulting in Greenhouse Gas (GHG) emissions and climate change [5]. In addition, in energy-poor areas where population growth is rapid, the pace of growth in electricity access often lags behind population growth, posing tremendous challenges to the effort to close the energy gap [16]. The dynamics to meet such demand espouses a desperate need for innovative solutions to meet it sustainably, for example, decentralised renewable energy systems.

This research draws from the World Bank's electricity access data to examine progress towards SDG 7. The analysis compares different regions and provides a close-up view of dissected trends and the underlying economic and policy drivers contributing to this inequity. Understandable case studies of successful initiatives, including India's Saubhagya Scheme [8] and Kenya's Last-Mile Connectivity Project [7], are useful for addressing strategies that have been successful in increasing electricity access.

This study comprehensively analyses the interconnectedness between electricity access and other development goals, namely poverty reduction (SDG 1), sustainable cities and communities (SDG 11), and climate action (SDG 13), in order to also provide a holistic analysis of the issue. This research highlights that solving the energy divide requires multi-stakeholder collaboration, innovative management approaches, and data-driven policies that can improve long-term sustainability by placing electricity access within the context of broader sustainable development. The findings provide both a contribution to the global dialogue on sustainable energy as well as concrete recommendations towards achieving universal access to electricity by 2030.

1.2. Research Question

This paper aims to answer the following research question.

How can global and regional disparities in electricity access be addressed through sustainable, innovative, and data-driven strategies to achieve universal access by 2030, in alignment with Sustainable Development Goal 7 (SDG 7), while also contributing to other interconnected Sustainable Development Goals?

Disparities in electricity access are not only a technical or economic problem but a complex challenge influenced by regional contexts, policy measures, and socio-economic conditions. From rural inaccessibility and a lack of infrastructure to financial and political obstacles, Sub-Saharan Africa and South Asia encounter unique challenges. To bridge this energy divide, a more sophisticated understanding of how these factors interact and how new solutions can transcend these divides is needed.

This research aims to understand the interventions required to bridge these gaps, emphasising the importance of context-specific, actionable interventions that can build on the existing infrastructure in the targeted regions. Decentralised renewable energy solutions like solar mini-grids have been effective for rural electrification, allowing them to bypass the need for expensive grid infrastructure [6]. New financing models, such as pay-as-you-go systems, have made energy access affordable for low-income households [16].

SDG 7 aims for universal access to energy, but it is deeply intertwined with ending poverty (SDG 1), gender equality (SDG 5), and climate action (SDG 13). In addition, increasing access to electricity can support and promote micro-enterprises, increase the number of women participating in economic activities, and reduce dependency on biomass for cooking, which helps address health and environmental issues [14, 15]. Those connections are essential to understanding how to develop comprehensive and impactful solutions.

Lastly, the research question highlights the necessity of data-driven decision-making for implementing solutions that address energy inequities. Geospatial mapping and predictive modelling techniques, among other advanced analytics, have emerged as strong mechanisms for mapping out underserved areas, prioritising interventions, and assessing impact. Integrating these insights with lessons from existing successful initiatives like the Saubhagya Scheme in India [8] and the Last-Mile Connectivity Project in Kenya [7] makes them

globally actionable and repeatable at scale.

By answering this research question, the study seeks to create a valid framework for universal electricity access by 2030. It aims to present findings that engage policymakers and practitioners and nurture a wider discussion around sustainable energy transitions and their importance in equitable development.

1.3. Importance or Significance of the Research

Electricity access isn't just a technical problem — it's a foundational engine of socioeconomic transformation and environmental sustainability. This research is important because it is aligned with Sustainable Development Goal 7 (SDG 7): Ensure access to affordable, reliable, sustainable and modern energy for all by 2030. Advancements in electrification have been made globally. However, millions are still left behind, mainly in Sub-Saharan Africa and South Asia, where energy poverty continues to perpetuate inequality and hinder progress across other areas of development [6]. Bridging this energy gap is vital for inclusive growth and enhancing quality of life.

This work is important because it allows us to identify and analyse electricity access disparities from a data-oriented perspective. Using the World Bank's comprehensive database on electricity access, the study illuminates how far behind or ahead different regions are and the patterns that help or hurt progress. By understanding the dynamics of some of the most vulnerable communities in society, the study is crucial in shaping interventions and responses where and when they are needed most to help ensure no one is left behind. Furthermore, the study derives lessons from successful initiatives such as India's Saubhagya Scheme and Kenya's Last-Mile Connectivity Project, providing scalable solutions adaptable to varied socio-economic circumstances [7, 8].

The importance of having access to electricity is further amplified by its interrelationship with other Sustainable Development Goals. For example, reliable electricity can drive economic growth and poverty alleviation (SDG 1) through increased small businesses, better agricultural productivity, and job creation [14]. It powers infrastructure, transportation and housing systems while reducing emissions through cleaner energy alternatives — SDG 11: Sustainable Cities and Communities [16]. Moreover, the shift towards green energies concurs with climate action (SDG 13), contributing to lowering greenhouse gas emissions and building resilience to climate change [5].

The results are, therefore, of interest to policymakers. The findings can inform the practical work that technology developers, donors/investors, or NGOs do in the field of energy access. Innovative technologies are key to the development of decentralised renewable energy systems, and advanced analytics, including geospatial mapping and predictive modelling, inform the effort. They allow better planning and implementation of electrification and monitoring of its impacts.

This research is important as it addresses this disparity and provides a holistic roadmap to universal electricity access by 2030 while accounting for the socioeconomic facets of sustainability and equity. It serves as a check for the gap between policy and actual practice and brings the different stakeholders together, simultaneously aiding the global forum on sustainable development. This research is an essential building block for crafting inclusive and resilient energy systems globally, promoting implementation pathways and linking them to greater sustainability.

1.4. Overview of the Paper's Structure

In this paper, we systematically outline the challenges and opportunities of universal electricity access in the context of Sustainable Development Goal 7 (SDG 7) to provide a roadmap for further development of the ideas. It starts with an Introduction that frames the central importance of electricity access in facilitating socio-economic development and environmental sustainability. In this introduction, we outline the purposes of this paper, its scope, and its alignment with global sustainability goals.

The Background and Context of the research offer a detailed examination of the indicators of electricity access disparities, with a particular focus on the regional inequities and the socio-economic and environmental impacts of energy poverty. This part prepares the ground for the research question by putting the issue in context and showing its urgency.

Focusing on the concept of Data Sharing, the research Question specifies how inequities in the availability of electricity can be addressed at different geographical scopes via sustainable, innovative and data-based approaches. The research problem also highlights the intrepidity of SDG 7 with other Sustainable Development Goals (SDGs), including poverty reduction, gender equality, and climate action.

The Literature Review includes two main sections: (i) Current Landscape, which summarises existing studies on electricity access, and (ii) Research Gap, which pinpoints topics that still need to be explored more deeply. The literature review highlights some of the state-of-the-art solutions (e.g. decentralised renewable energy systems, innovative financing models) but also notes the absence of well-documented, scalable interventions targeting this problem or sector.

The Methodology describes the mixed-methods approach used in this research. It adds details about the approaches, both quantitative and qualitative, used to assess trends in electricity access, review case studies of successful initiatives, and leverage advanced technologies such as geospatial mapping, artificial intelligence, and blockchain. The methodology also describes the strategy for building recommendations and ensuring the reliability of the findings.

Analysis, Results, and Recommendations describe the study's main findings. Based on the above, this section highlights trends, regional divergences, and correlations with socio-economic variables through Python-based data pro-

cessing and visualisation techniques. The findings of this analysis evidence a set of actionable recommendations for policymakers, investors, and technology developers to consider in light of the policy, technological, and financial barriers that need to be overcome to achieve universal electricity access.

Finally, I add a Discussion and Conclusion that synthesises the main findings in light of the implications for wider SDG 7 attainment, as well as future research and implementation directions. The systematic flow not only guarantees that the study presents a comprehensive and practical guide for closing the electricity access gap but also for contributing to wider plans for sustainable development.

2. Literature Review

2.1. Current Landscape

With respect to electricity access, the public literature offers an integrated perspective on the progress, challenges, and opportunities associated with achieving Sustainable Development Goal 7 (SDG 7). However, access is far from universal, and multiple studies emphasise the disparities in access to energy across the world; for example, the International Energy Agency [6] found that almost 733 million people worldwide still don't have access to electricity, primarily in Sub-Saharan Africa and South Asia. Systematic limitations such as infrastructure, financial, and policy inefficiencies are another challenge faced by these regions to electrification [16].

Underserved areas were studied in order to find cost-effective and scalable options. In this context, decentralised renewable energy systems such as solar mini-grids have been widely examined globally. Bhattacharyya says that decentralised systems eliminate the necessity for expensive grid expansion, which serves as a sustainable solution for rural areas [2]. According to Sovacool and Drupady, small, locally-owned renewable energy facilities can also promote energy independence and resilience [13]. This corresponds with the UNDP report, which reflects the speed with which off-grid solutions can achieve access in areas where centrally grid-locked solutions are not feasible [14]. World Bank's Innovative financing models, like pay-as-you-go systems, have also democratised energy access by enabling renewables to low-income households [16].

The literature is also right to highlight the environmental and social consequences of switching to renewable energy. Fossil fuel-based electricity generation in developing economies has been a major contributor to emissions [5]. This compound challenge — access as well as environmental minimisation — has driven the research of Pachauri & Spreng, who highlight both goals and an ironclad relationship between renewable electricity and both objectives in this frame [9]. Recent studies also reaffirm the importance of international frameworks, including the Paris Agreement, because they help shift countries toward clean energy transitions [15].

Case studies of successful initiatives help us to learn how to scale up against the barriers to electricity access and have been very useful. Examples of successful programs include India's Saubhagya Scheme, which has been touted for its rapid household electrification, with over 26 million households connected in a few years [8]. In a similar vein, Kenya's Last-Mile Connectivity Project has shown the potential gains from converging both on and off-grid solutions to contribute to higher rural electrification rates [7]. As mentioned by Sovacool, these examples show how the local context, governance, and financial innovation can scale solutions [12].

Another key area of emphasis is these interlinkages between electricity access and broader development goals. This has shown that reliable access to electricity contributes directly to poverty alleviation (SDG 1), supporting economic activities and agricultural productivity and fostering entrepreneurship [14]. Access to electricity further facilitates healthcare delivery, educational outcomes, and quality of life, key enablers of sustainable urbanisation (SDG 11) and gender equality (SDG 5) [16].

Nevertheless, large gaps will persist in universal electricity access by 2030. The existing literature suggests the need for more resilient policy frameworks, emerging technologies, and transnational partnerships to address these challenges. Bhattacharyya and Sovacool describe geospatial mapping and predictive modelling as key analytical approaches that can help locate underserved areas, assess where resources are concentrated, and examine their effectiveness [2, 12]. The tools and techniques mentioned above show the changing paradigm of research and work in the area of energy access.

2.2. Research Gap

Though there is a substantial body of literature on electricity access and its importance for achieving Sustainable Development Goal 7 (SDG 7), important gaps remain that undermine progress towards universal access to affordable and reliable energy. Although there have been analyses of general global trends and regional differences, there has been little specific research: studying the particular socio-economic, technological and policy factors applicable to under-researched and underserved areas. Such generalised electrification strategies, however, are often incapable of accurately reflecting the complex dynamics of rural energy poverty across the Sub-Saharan African and South Asian regions [1].

One research gap is the under-exploration of the overlap between electricity access and larger development objectives. Although both electricity access and gender equality are important for alleviating poverty (SDG 1) and gender equality (SDG 5), the potential pathways for operationalising those synergies are underdeveloped. While electricity access can economically empower women, it is recommended that culturally and socio-economically relevant interventions be

made [4].

Technological development is another totally uncharted territory. Although decentralised renewable energy systems, including solar mini-grids, have been extensively researched, little investigation has been conducted into whether emerging technologies such as blockchain for energy trading or artificial intelligence for optimising grid performance may be integrated [10]. The benefits of such technologies in terms of improving energy access and sustainability are currently theoretical and require empirical validation.

There is a need to focus proactively on innovative financing mechanisms. Models like pay-as-you-go systems to assist low-income households have shown that they can make technology more accessible. Still, little research exists about their potential for scaling up and transferring to diverse economic and cultural settings [11]. Finally, the potential for impact investments and blended financing to crowd in debt to finance electrification projects in high-risk areas has not been adequately explored.

Finally, although case studies of successful initiatives (including India's Saubhagya Scheme and Kenya's Last-Mile Connectivity Project) can offer valuable insights, they lack frameworks for adapting such models to regional contexts. According to Burke and Stephens, the transferability of best practices can only be understood by considering local governance structures, available resources, and community engagement [3].

This research aims to fill these knowledge gaps through an in-depth analysis of electricity access trends at global and regional levels that incorporates lessons learned from innovative financing mechanisms, new technologies at different scales and applications, and current practices that are considered good practices. The new initiative seeks to re-frame electricity access in the context of sustainable development, offering a comprehensive and actionable framework for achieving universal energy access by 2030.

3. Methodology

Using a mixed-methods approach, this study assesses global and regional trends in electricity access, draws insights, and offers concrete recommendations consistent with Sustainable Development Goal 7 (SDG 7). This methodology applies quantitative data analysis, qualitative case study evaluations, and advanced analytical tools to thoroughly explore disparities in electricity access and options for obtaining greater access.

3.1. Data Collection

The key dataset being used for the current research is the electricity access data from the World Bank's data repository, which contains data on global, regional, and national electricity access rate statistics over time. Socio-economic indicators, renewable energy adoption, and policy framework data were sourced from the International Energy Agency (IEA), UNDP, and other databases.

3.2. Quantitative Analysis

The study uses statistical and analytical methods to explore patterns and trends in electricity access, specifically:

1. *Global and Regional Trends:* Time trends analysis to study progress for the past 2 decades.
2. *Disparities:* Comparative analysis across income groups, urban and rural settings, and geographical regions.
3. *Correlation Analysis:* Examining the relationship of electricity access with other development indicators like GDP per capita, poverty rates and renewable energy adoption.

3.3. Visualisations

To facilitate understanding and interpretation, the study employs data visualisation techniques, including:

1. Heatmaps to depict regional disparities.
2. Line graphs to illustrate temporal trends.
3. Scatter plots to analyse correlations between electricity access and socio-economic indicators.

3.4. Case Study Evaluations

This research includes an in-depth analysis of successful electrification initiatives, such as:

1. *India's Saubhagya Scheme:* Rapid household electrification through grid and off-grid solutions.
2. *Kenya's Last-Mile Connectivity Project:* Combining decentralised and centralised approaches to expand rural electrification.

These case studies are analysed to identify transferable best practices, key success factors, and challenges.

3.5. Incorporating Advanced Technologies

The study explores the role of emerging technologies in enhancing electricity access:

1. *Geospatial Mapping:* Identifying underserved regions and optimising resource allocation.
2. *Artificial Intelligence (AI):* Predictive modelling for planning and maintenance.
3. *Blockchain:* Enabling decentralised energy trading and enhancing transparency.

3.6. Policy and Economic Analysis

A review of policy frameworks and financing mechanisms is conducted to:

1. Evaluate the effectiveness of existing policies in achieving universal electricity access.
2. Analyse innovative financing models, such as pay-as-you-go systems and blended financing, for their

scalability and adaptability.

3.7. Recommendations

Based on the insights from quantitative and qualitative analyses, the study formulates actionable recommendations for:

1. Policymakers to design inclusive and sustainable electrification strategies.
2. Investors to support innovative financing mechanisms.
3. Technology developers to integrate emerging tools for efficient and scalable solutions.

3.8. Validation

To ensure the reliability of the findings:

1. Historical data trends are validated using secondary sources from reputable organisations.
2. Insights from case studies are corroborated through cross-referencing with published research and policy reports.

This methodological framework enables the study to provide a comprehensive and actionable roadmap for bridging the electricity access gap, achieving SDG 7, and contributing to broader sustainability goals.

4. Analysis, Results, and Recommendations

This section goes into the key results from the analysis and high-level electricity access trends based on World Bank data and other data sources. The analysis shows inequities, geographic trends and relationships with socio-economic variables using Python for data processing, visualisations and statistical exploration. These outputs are merged to derive findings on barriers to and progress toward universal electricity access. Drawing on this evidence, this section makes data-driven policy recommendations to overcome the electricity divide and to accelerate the achievement of Sustainable Development Goal 7 (SDG 7), given the gaps in policy, technology and financing.

4.1. Global Electricity Access Trends

Electricity is one of the key indicators of development and affects economic growth, education, healthcare, and quality of life. Based on an analysis of electricity access, this section tracks global electricity access trends and progress over time and across regions from 1980 to today. It examines both gradual global progress and the challenges of achieving access levels that fall below the 90% threshold for countries.

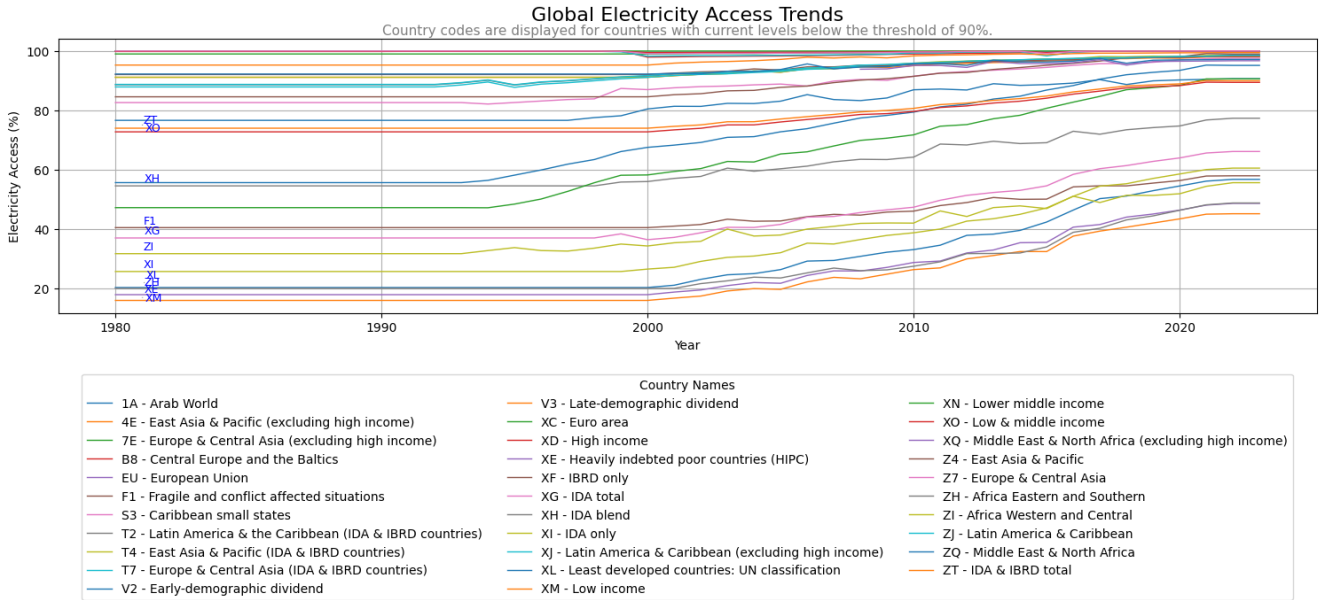

Figure 1. *Global Electricity Access Trends (Link to the code: https://drive.google.com/file/d/1TvhvgnykIyVrID1Llarg5yphPHPD78CZ/view?usp=sharing).*

Figure 1 illustrates the progress in global access to electricity over the last four decades. There is a clear upward trajectory. By 2020, most countries and regions have approached universal coverage. This gradual progress highlights the sound policies and investment efforts of governments, international organisations, and private actors to accelerate electrification. However, the chart also shows stark disparities. Various regions, such as Sub-Saharan Africa, are still on the lower end of the spectrum, with some countries continuing to battle over supplying electricity to a large percentage of their populace. The areas marked as countries with less than 90% access, indicated by their country codes on the chart, indicate

where firm interventions and policy-sustained focus are required.

A closer examination of the trends shows a great deal of regional variation in how fast and how far electrification has occurred. High-income regions, including Europe and North America, experienced near-universal access to electricity in the early stages, with trend lines indicating high marks and little variability thereafter. Other regions, such as Africa and parts of South Asia, began the period with low access (below 30%) to make meaningful progress. These have improved over some decades with the steep upward slopes in recent decades as the results of infrastructure investments, international aid and policy reforms. These are important gains, but the gap in performance between high-income regions and developing countries remains large.

The chart also shows the advancement of individual countries with consistently low access. Annotations of country codes (marked at the starting points of the trend lines) mark regions that started from a position of weakness. However, these annotations do not just call out countries, such as Zambia (ZM) and IDA Total (XG); they show the need for continued focus on low and middle-income countries. Incorporating a 90% threshold deepens the analysis of countries and regions that have lagged and underscores the significance of this threshold in the global electrification process.

This figure reflects progress around the world and reminds us of the work that still needs to be done. Though many countries are approaching universal coverage, major gaps remain, especially in low-income and rural areas. The subsequent sub-section explains India's experience in this regard, explaining how it achieved near-universal electricity access and the methods that led to its success.

Figure 2 shows steady and remarkable progress in India's electricity access from 1980 to 2020. Having begun the decade of the 1980s with about 50% access, the country experienced some limited expansion in the next decade. A window of opportunity for the country towards a period of rapid growth followed, but one which had yet to get visible traction given the prevailing infrastructural and policy conditions. Yet it was the late 1990s that led to a drastic upward uptake in electricity access with mass electrification initiatives that India undertook to bridge its rural-urban divide and keep pace with the ever-increasing energy demands.

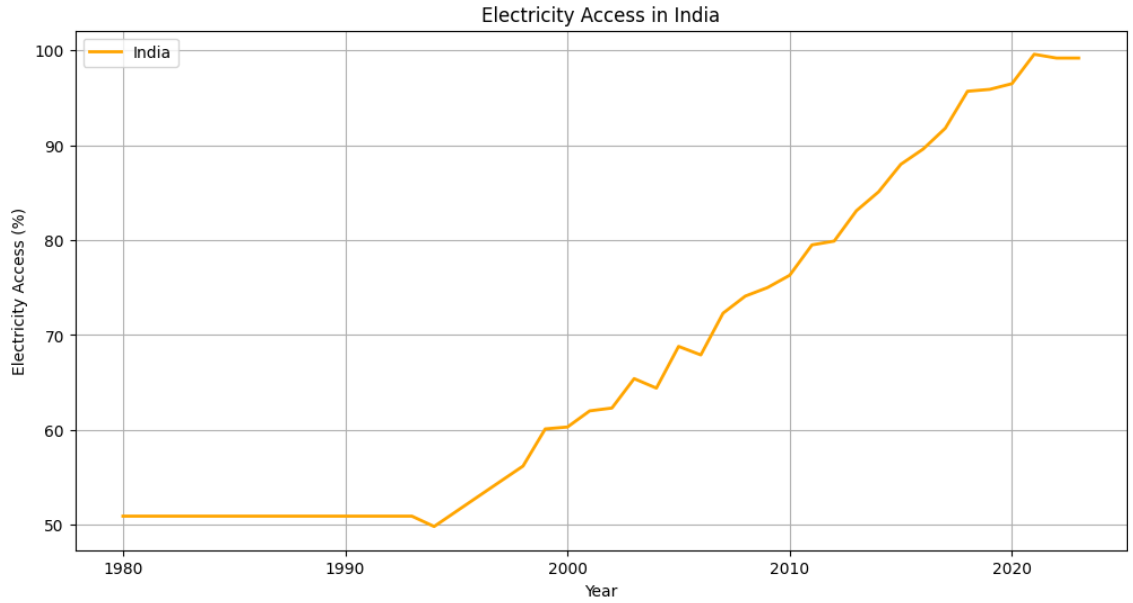

Figure 2. *The trend of Electricity Access in India (Link to the code: https://drive.google.com/file/d/1TvhvgnykIyVrID1Llarg5yphPHPD78CZ/view?usp=sharing).*

As evidenced by the gradual trend-line increase in Figure 2, from 2000 to 2010, the first phase of India's electrification efforts pole vaulted incrementally. This timeframe was concurrent with the introduction of nationwide schemes like the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), which aspired to light up rural regions and give electricity to below-poverty-line households. The observable increased speed of access post-2010 indicates the effect of these programs and related policy interventions. Many initiatives were started, including the Saubhagya scheme in 2017 to provide infrastructure for last-mile connectivity, ensuring that the farthest of places were included in the electricity grid.

The steep upward slope of the graph after 2010 indicates a period of transformation, during which electricity access jumped from about 70% to above 95% in a single decade. These years are underlined by India's focus on infrastructure expansion, distribution network modernisation and renewable energy utilisation. With multiple dynamic growth drivers,

further momentum was provided through public-private partnerships and greater funding. In 2022, over 99% of households in India had access to electricity, making India one of the most electrified countries in the world. It recognises the impact of targeted programs, strong policy frameworks, and collaborative governance with stakeholders to remove systemic barriers.

The chart also represents India's success in bridging regional disparities in electricity. In historical accounts, rural areas fell far behind because of contours, mountains, and other difficulties in reaching them. However, rural electrification was prioritised to allocate resources faster for villages. Thanks to its focus on inclusivity, India achieved this in the last decade. In addition, India's electrification efforts became more effective and sustainable with the advent of new technologies, such as the integration of solar and other renewable energy into the grid.

Overall, the chart represents India's electrification achievements and testifies to the impact of well-planned strategies and dedicated hard work. India's experience shows that near-universal electricity access can be achieved even in a large and diverse country if enough commitment is made to progress toward inclusive growth and development. This accomplishment provides a model for other developing countries striving to bridge the electricity access gap.

The Compound Annual Growth Rate (CAGR) gives a deeper understanding of how quickly electricity access is improving and trends over the years. It provides a standardised metric with which to compare growth between regions and countries and builds on the exponential nature of development. The CAGR for global electricity access is estimated at 2.10%, given global efforts to strengthen electrification in most parts of the world in the last few decades. The growth can be attributed to investments in energy infrastructure on a super-scale, technology improvements, and cross-border collaboration to bring universal electricity access.

India's CAGR, on the other hand, is at 1.56%, marginally below the global average. Though this may seem modest, it is essential to set this number in the context of India's peculiar challenges. In fact, the slower CAGR only serves to reflect the enormity and complexity of going electric in a country with 1.4 billion people with different needs. India, back in 1980, had relatively higher electricity access than several low-income countries, making it a more difficult baseline to draw from compared to countries which began from a lower baseline.

The difference between India's CAGR and the global CAGR also demonstrates that the pace of electrification is accelerating elsewhere, particularly in Sub-Saharan Africa and South Asia, where access levels were initially low. This can lead to higher annual growth rates in recent years. India's electrification experience, however, embodies gradual, continuous progress, not a steep, periodic jump; it is a long-term, strategic response to the electricity divide.

These CAGR numbers are a reminder that innovation and optimisation have to continue. India's next phase rests on ensuring equitable outreach (near-universal access is a big achievement in itself) but coupling this objective with a focus on cost reduction and efficiency. Implementing this all using advanced such as Blockchain and Data sciences provides India with the unique opportunity to climb the affordability and sustainability curve and also be a role model for the world for not just Universal Electricity Access but Equitable, Affordable Access to Electricity for all.

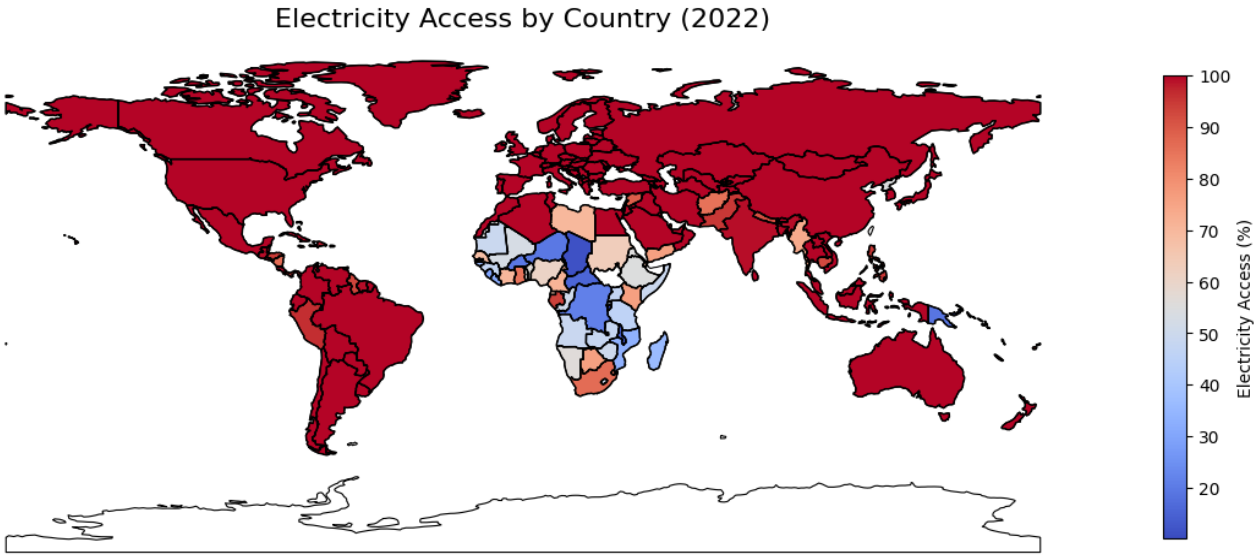

Figure 3. *Electricity Access by Country as of 2022 (reliable and complete data from the World Bank was available till 2022) (Link to the code: https://drive.google.com/file/d/1wX2flSPviAmpjwWggTvxkh0aCzRfW_GY/view?usp=sharing).*

4.2. Regional Disparities

Electricity access is still the basic engine of economic development and quality of life. An enormous gap exists between regions and countries. In this section, regional variations in access to electricity across the world are studied visually. These visualisations expose the disparity of electricity access, pinpointing which areas and countries face the biggest hurdles. This section goes beyond crunching numbers by examining how India's model of electrification is relevant for three electricity-starved countries, highlighting gaps in infrastructure, policy architecture, and socio-economic conditions. By adopting effective strategies, these countries can fast-track the journey to universal electricity access.

The map of the world's electricity accessibility as of 2022 shows how different electrification is worldwide. Countries with electricity coverage of 90% or more are shaded in dark red. This includes most of Europe, North and South America, Eastern Asia, and Australia. Sustainable infrastructure, dynamic economies, and political stability have long insulated these regions. In contrast, Sub-Saharan Africa and parts of South Asia are painted in lighter shades of blue and orange, depicting the lack of electricity access.

The most significant discrepancies are in Sub-Saharan Africa, where rates of access to electricity fall below 50% in nations like Chad, South Sudan, and the Democratic Republic of Congo. Even with external aid, the absence of dependable energy stifles economic expansion, education, medical care, and overall living conditions. This geographic divide demonstrates the convergence of the historical, economic, and political challenges that constrained these regions' ability to construct and maintain critical infrastructure.

India's unprecedented success in achieving almost universal electricity access, increasing from about 50% in the 1980s to more than 99% today, provides a strong model for closing those gaps. Learning from the factors that facilitated India's achievement—political will, targeted strategies, public-private partnerships, and innovative use of renewables—such strategies can be adapted and implemented in countries facing similar challenges.

Chad, one of the world's sunniest countries, has the potential to capitalise on solar power and would thus profit from adopting a model similar to that of India. Chad could harness solar power to electrify rural and underserved populations. In recent years, political stability in Chad has led to several large-scale initiatives, similar to India's Saubhagya scheme, to connect the last mile of electricity distribution.

Rwanda is yet another promising candidate for the Indian model. Although the country does not have extensive access to electricity, it has shown great signs of political stability, an attractive & improving business environment, and a commitment to development goals. Owing to its relatively small size and centralised governance structure, rural electrification schemes similar to India's Rajiv Gandhi Grameen Vidyutikaran Yojana could potentially be deployed rapidly across the country.

Nepal does not belong to Sub-Saharan Africa. However, it has disparities in access to electricity, especially in mountainous and rural regions. Nepal shares cultural and geographical similarities with India and can learn from India's grid of integrating renewable energy and mini/micro-hydropower. The Indian and Japanese governments already have established political and economic links with Nepal, which provide ground for the transfer of knowledge and collaboration.

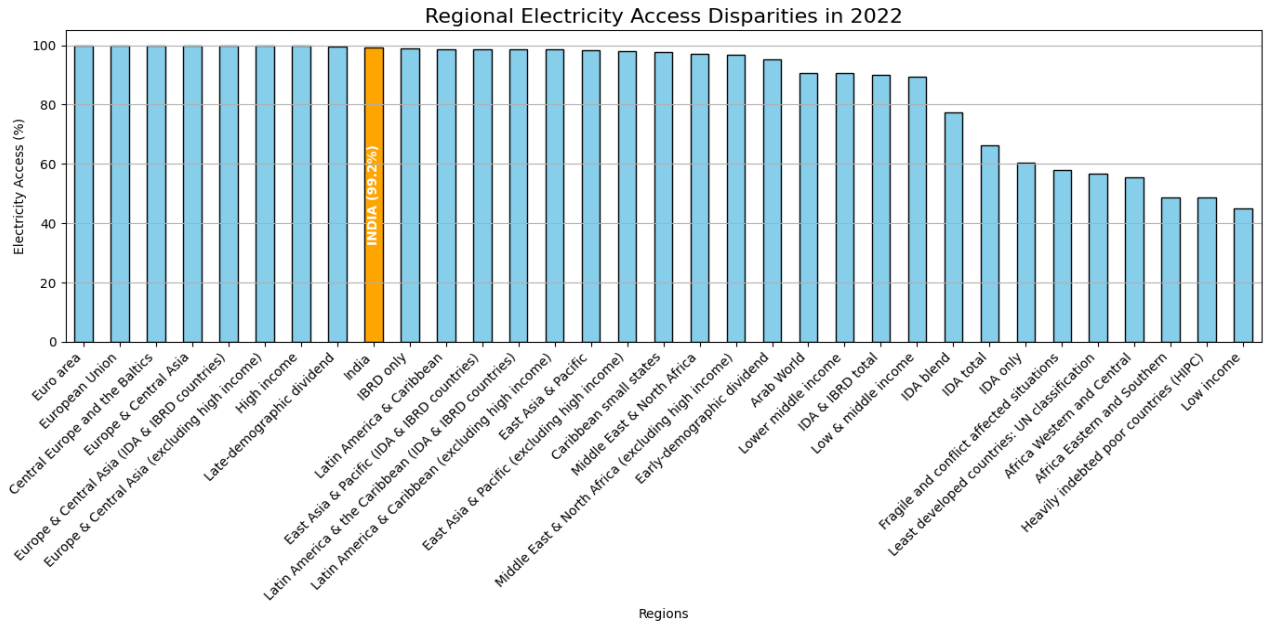

Figure 4. *Electricity Access by Regions as of 2022 (reliable and complete data from the World Bank was available till 2022) (Link to the code: https://drive.google.com/file/d/1wX2flSPviAmpjwWggTvxkh0aCzRfW_GY/view?usp=sharing).*

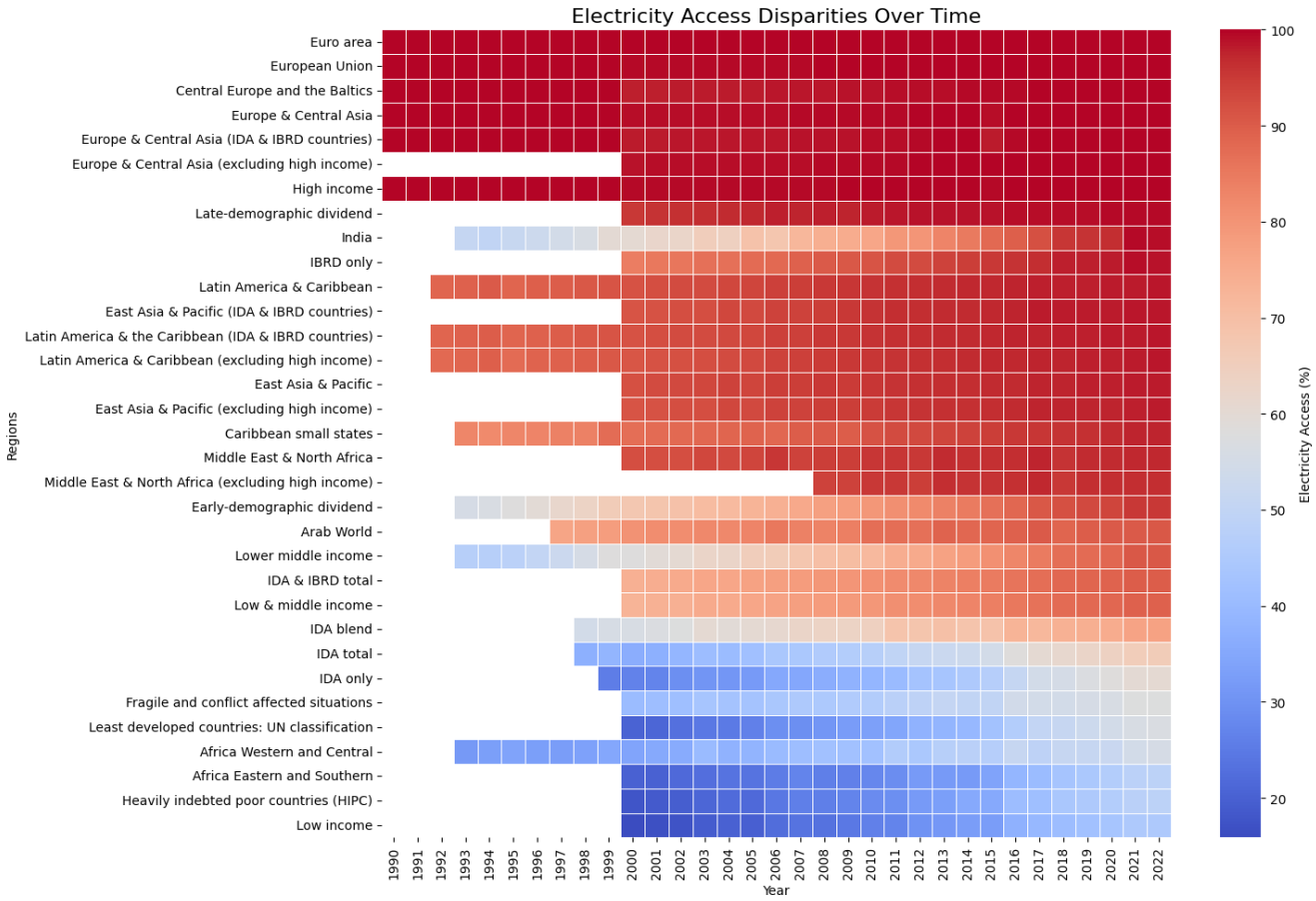

Figure 5. *Heat map of Regional Electricity Access Disparity over time. The regions are arranged in descending order of the total electricity access as of 2022 (Link to the code: https://drive.google.com/file/d/1wX2flSPviAmpjwWggTvxkh0aCzRfW_GY/view?usp=sharing).*

These three countries—Chad, Rwanda, and Nepal—present different but promising contexts for adapting India's electrification strategies to local conditions. This would mean better access to electricity and, in turn, wider socio-economic progress in these countries.

This bar chart illustrates the regional differences in electricity access in 2022, with regions ordered by their level of electrification. Virtually all regions (e.g., Euro Area, North America, East Asia) have nearly universal access (as in bars that approach 100%). These areas enjoy a history of infrastructure investment, strong economies, and political stability that have guaranteed a reliable flow of electricity.

However, Sub-Saharan Africa and fragile and conflict-affected areas have much lower levels of access, with electrification rates below 50%. This divide highlights the ingrained issues of infrastructure, economy, and governance that have plagued these regions. The limitations indicate that Low-income countries remain in deep trouble with funding, inefficient policies, and a socio-political context that opposes progress, adding to the problem and forming a larger gap.

India's extraordinary performance, indicated by the bar in the middle of the chart, is a significant example for the rest of the world. Its path to near-universal electricity connects the dots between focused policy-making, technological innovation, and public-private partnerships, leading to transformational change. With India's unique status as a high-performing region, this demonstrates the possibility of adaptable models to address electrification in underserved communities.

Looking at regions in the middle range of electrification, like parts of Latin America and South Asia, also offers some insights. These areas have made significant progress but continue to need targeted actions to fill the remaining gaps. This highlights the need for collective global action, targeted approaches, and learning from each other to close the gaps in the provision of electricity.

This heatmap dynamically represents electricity access across geographies over time, highlighting inequalities and successes. Areas shown in the dark red spectrum (Euro Area, North America, etc.) are consistently dark red, in some cases for the entirety of the timeline, owing to almost universal electricity access being a historical advantage. Their steady march underscores stable governance, strong economies, and early investments in infrastructure.

In contrast, Sub-Saharan Africa and low-income or fragile countries are slowly moving, but certainly not uniformly, from blue to red tones, indicating persistent access disparities. This difference mirrors systemic challenges such as political instability, economic limits, and weak infrastructures.

Meanwhile, 2021 saw significant (but incomplete) progress in regions such as South Asia and Latin America, with electrification efforts gaining momentum over the last two decades.

The chart showcases India's radical evolution, darkening from lighter shades in the 1980s to almost complete electrification by 2022. This shift is indicative of the effects of focused governance programmes such as Saubhagya aimed at rural connectivity and renewable energy integration. India's rise shows that when guidance is precise and scaled up, even difficult solutions can lead to pronounced access even in non-ideal socio-economic conditions.

Gradual improvement among clusters, like in the Middle East and parts of East Asia, emphasises the transformative role of regional and international collaborations in spurring electrification. However, the gap remains in fragile states and Sub-Saharan Africa, underscoring the call for scalable models, like India's, to be adapted to local contexts. To sum up, this heatmap highlights the clear disparity in global access to electricity and points towards the need for inclusive strategies to solve this issue.

4.3. Electricity Access Gap Analysis

This section gives a visual and data-driven overview of the biggest challenges through an analysis of access levels and gaps from country to country. It explains the dramatic divide between countries with high levels of electrification and those that can't even provide basic needs. The analysis lays the groundwork for detecting areas of priority, highlighting the need to fill these gaps through policy interventions, technological innovation, and multilateral collaboration. By means of targeted visualisations, I hope to motivate actionable insights towards universal electricity access.

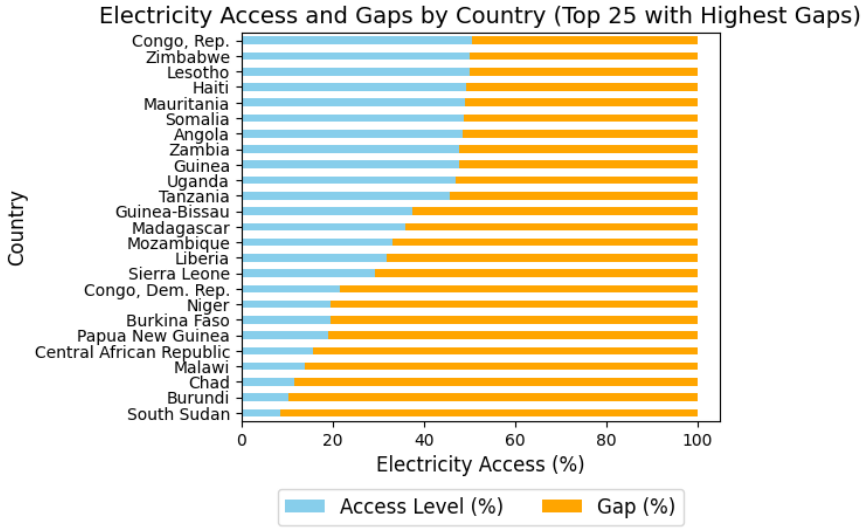

Figure 6. *Countries with the highest gap in Electricity Access (Link to the code: https://drive.google.com/file/d/1dEbBNO6Ag7Af5dXxeoDx_rlk_uFlIqTE/view?usp=sharing).*

This chart illustrates electricity access levels and gaps in the top 25 countries that need to bridge the largest disparity in electricity availability. The countries are arranged in order of the gap percentage from the lowest to the highest. South Sudan had the highest gap percentage at above 90 per cent. This highlights the overwhelming obstacles that some countries face in realising electricity for all.

The blue bars show the percentage of the population with access, while the orange bars show how much work remains to achieve universal access. The map highlights major differences, with some countries, such as South Sudan, Chad, and Burundi, registering less than 10 per cent of electricity access, meaning more than 90 per cent of their populations are left without reliable electricity. Similar examples illustrate the scale of the electrification task in areas like Sub-Saharan Africa.

The governments of mid-tier countries like Liberia, Madagascar, and Mozambique are on track, with electricity access at 20 to 30 per cent. However, the 70 per cent and 52 per cent data gaps in these nations highlight that much work remains to be done to bridge these divides.

At the upper end are countries like Zimbabwe and Lesotho, which show relatively better availability at less than a 50 per cent gap. This suggests that some countries might be closer to achieving universal access than other challenges further down the list.

The graph tells a grim story of inequality in electricity access, driven by poor infrastructure, low investment, and political turbulence. It highlights the importance of focused strategies, global partnerships, and investment in sustainable energy solutions to accelerate progress in these under-electrified areas. Innovative strategies designed based on each country's unique challenges in achieving energy access, as envisaged under SDG 7, can bridge these gaps.

4.4. Progress Toward SDG 7

This section assesses countries' readiness to achieve universal access to electricity by 2030, an important target included in Sustainable Development Goal 7 (SDG 7). The analysis benchmarks against historical growth rates and extrapolates the required annual progress to identify gaps between what is currently being done and the rate of electrification that is necessary. This extracts quantification of both how much growth has been achieved and how much more needs to be achieved, compared to how close or far countries are from the target.

The analysis reveals countries making steady progress and those that urgently need to accelerate their electrification efforts. The bar chart shows which nations are on track, which are lagging, and which are structurally challenged in meeting the goal. This section seeks to identify practical recommendations for prioritising investments, designing and calibrating policies, and addressing the gaps that remain in the global journey towards universal electricity access by 2030.

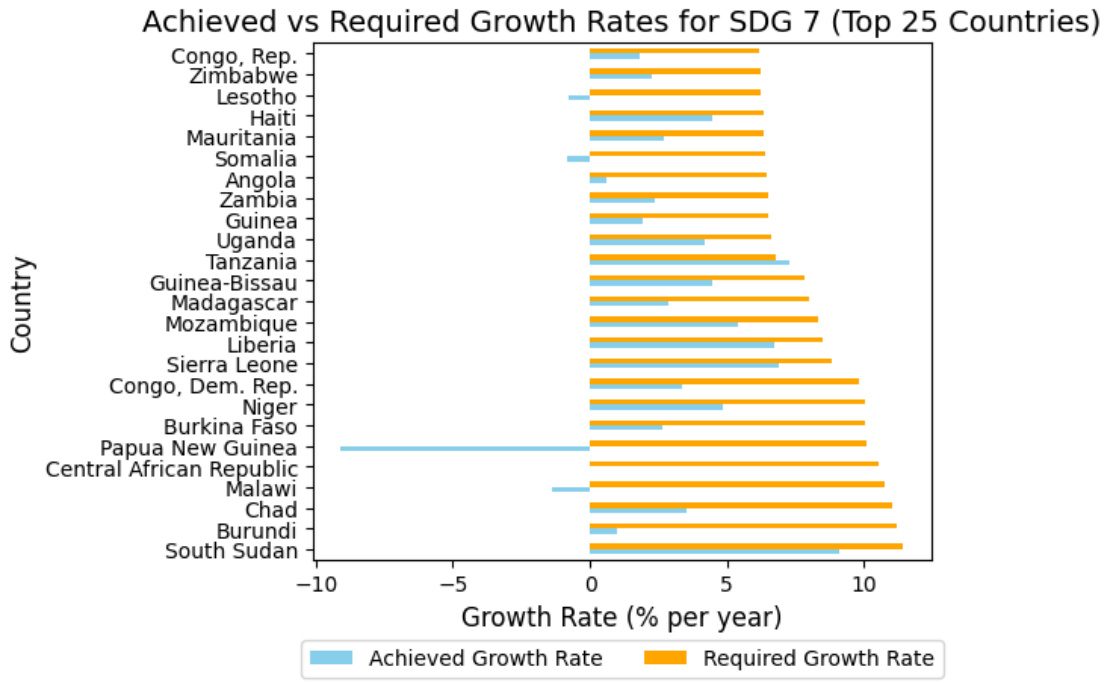

Figure 7. *The rate of electrification required in the countries with a maximum gap towards universal electricity access implementation (Link to the code: https://drive.google.com/file/d/11-JNegcuSIoah1QyzniMFBm1av2xSzi9/view?usp=sharing).*

The chart depicts the actual growth rates versus needed growth rates for electricity access for the top 25 countries with a gap to universal electricity access in 2030. The visual difference between the blue (achieved growth rates) and orange bars (required growth rates) clearly illustrates the struggle these countries face to meet the SDG 7 target. The achieved growth rates are usually far lower than the required growth rates, indicating that immediate and faster electrification is required.

Countries like South Sudan, Chad, and Burundi need growth rates much higher than 10% per year. Their actual growth rates are zero or negative, which indicates resource deficits, political volatility, and less investment in the energy sector. Other nations, including Papua New Guinea and Malawi, are having similar problems. They are also lagging behind their targets for both adoption and growth rate and will need to double down on efforts to catch up.

The chart highlights an important point: the electrification efforts of these countries are not on track to achieve the 2030 goal. A multifaceted approach is critical. Electrification must be a priority on the agenda of governments, supported by strong policy development and financial incentives that engage the private sector. Utilisation of renewable energy sources like solar and wind is an economical and sustainable method to minimise the reliance on grid supply, especially in rural/remote areas. Moreover, the region and the world must collaborate and exchange technical knowledge and funding to overcome some of these challenges and systemic barriers.

Countries with near zero or negative growth rates will need significant targeted strategies to turn the tide. That means good governance, eliminating bureaucratic structures and ensuring political support to create an environment for sustainable infrastructure that is long-term focused. Additionally, funding from international organisations and development banks should also flow into these countries to expand viable projects that can yield immediate results.

While the chart shows the enormity of the challenge, it also indicates the need to move quickly. Through strategic in-

vestments, innovative solutions, and a commitment to inclusive electrification, we can accelerate progress and move closer to universal electricity access by 2030. The SDG 7 window is fast closing, and now is the time to act.

4.5. Regional Policy Impact Analysis

This section explores how successful the policies and programs introduced to improve electricity access in different areas have been. It combines analysis of changes in electricity access before and after policy implementation to present evidence-based insights into what has worked and why it has worked. India's electrification story is one of the case studies illustrating how government-led strategic initiatives can create constructive synergistic effects. The section also looks beyond India to places like Rwanda and Chad to showcase different contexts and the flexibility of successfully applied strategies. It also hopes the findings will encourage more replication of these approaches around the world to accelerate progress towards universal access to electricity.

The table below studies the actual impacts of regional policies on electricity accessibility through both pre- and post-policy implementation. The analysis uses a t-test to determine whether the mean percentage change in electricity access across India, Rwanda and Chad is statistically significant. Within such programs, India's electrification initiatives have shown exceptional progress of over 20%, while Rwanda and Chad have shown substantial improvement from much lower starting positions. The findings underscore the absolute importance of tailored policies in closing access gaps while also signalling the broader adaptability of successful models to achieve similar success across different regional contexts. These findings inform future policy interventions around the world.

Table 1. *Link to the code: https://drive.google.com/file/d/1S-yRbIjoqE_sQBB59A5ZkE9_54KoMUBR/view?usp=sharing.*

Country	Pre-Policy Mean (%)	Post-Policy Mean (%)	Mean Change (%)	T-Statistic	P-Value
India	67.25	87.40	20.15	-7.29	6.54e-07
Rwanda	8.36	26.28	17.92	-4.13	0.0006
Chad	4.55	8.81	4.26	-7.64	3.30e-07

This data illustrates the transformational effect of targeted policies on electricity access in India, Rwanda, and Chad. India is notably ahead, with a mean increase of 20.15% in access to electricity, jumping from 67.25% to 87.40% after passing the policy. These dramatic improvements show the resiliency of India's extensive electrification programs, like its government-led Saubhagya effort, which used political will, public-private partnerships, and renewable energy solutions to iron out gaps.

Rwanda has a particularly high growth percentage, starting at 8.36%, with a mean change of 17.92% to 26.28% at a low baseline. These advances underscore Rwanda's priorities of political stability and rural electrification strategies. Programs like the Energy Access Rollout Program (EARP) have targeted underserved populations and are a testament to the country's commitment to sustainable development.

In Chad, which had the lowest initial rate of 4.55%, this increased to 8.81% (mean change of 4.26%). Though the absolute gain may seem small relative to India or Rwanda, the jump relative to Chad's previously abysmal rating shows that clear policies could help tap Chad's abundant solar resources. Political stability and continued investment in infrastructure are still key catalysts for speeding growth.

The table also shows the t-statistics and p-values that demonstrate the statistical significance across the three cases. India's t-statistic (-7.29) and p-value (6.54e-07) suggest testifies to a strong effect of policy interventions. Likewise, Rwanda's and Chad's results (t-statistics of -4.13 and -7.64 and p-values of 0.0006 and 3.30e-07, respectively) highlight that the detected changes are not by chance but rather a chain response from purposefully designed activities.

These findings underscore that well-designed and ably implemented policies can be effective even in difficult contexts. India's example shows how the combination of innovation, funding, and political commitment can bring about near-universal access. Likewise, Rwanda and Chad emphasise the need to adapt strategies to different circumstances while pursuing long-term sustainability. This analysis highlights the opportunity for policy-driven solutions to bridge the global electricity access divide.

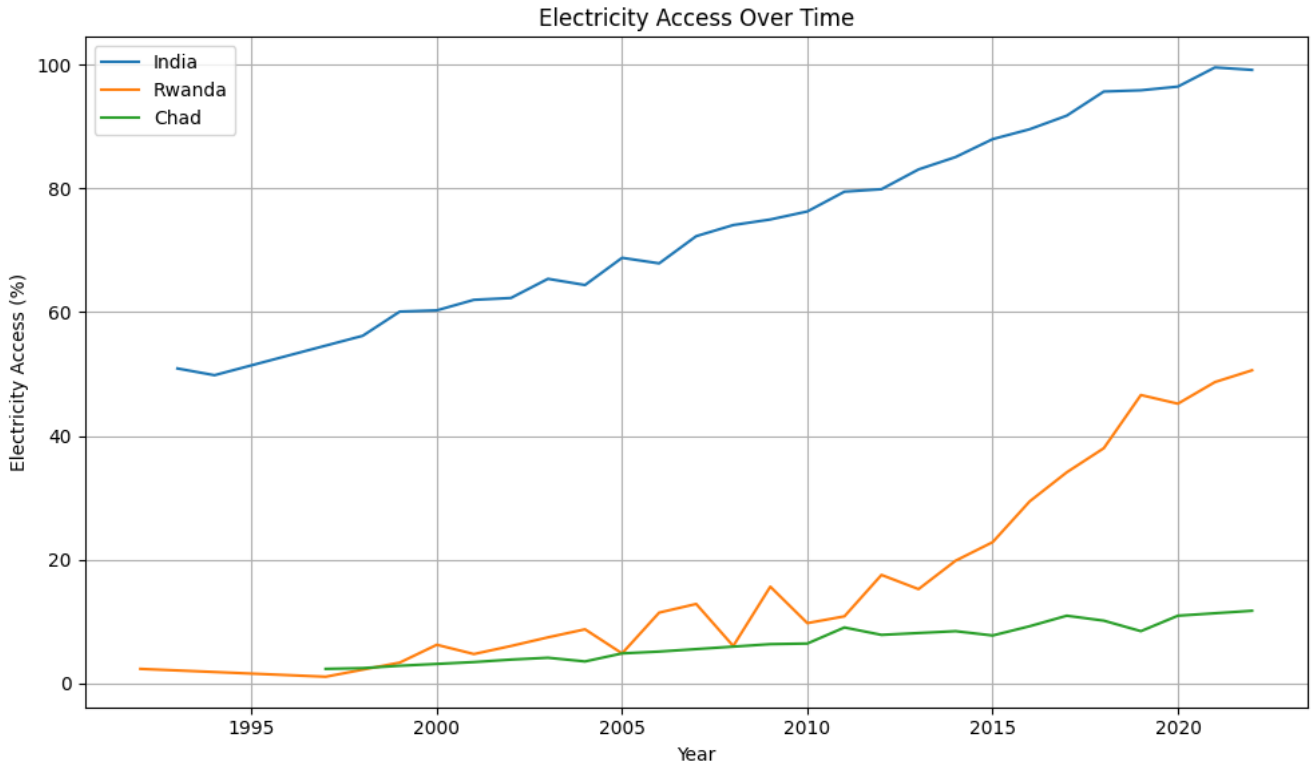

Figure 8. *Progress towards universal electricity access in India, Rwanda, and Chad (Link to the code: https://drive.google.com/file/d/1S-yRbIjoqE_sQBB59A5ZkE9_54KoMUBR/view?usp=sharing).*

4.6. Correlation with Development Indicators

This section shows the fundamental link between access to electricity and socio-economic indicators, providing a data-driven perspective on global development trends. As a critical infrastructure component, access to electricity is related to many aspects of human development, including, but not limited to, its relationship with economic growth, poverty reduction, and education. Two key visualisations explore these dynamics in depth in this section.

The first visualisation—a pair plot—demonstrates the relationships among global electricity access, GDP per capita, poverty rate, and literacy rate, providing a broad lens through which to view the congruities and discrepancies between such metrics. The second visualisation drills into India's performance, using a scatter plot within that country's context to show the positive correlation between GDP per capita and access to electricity. This wealth of analysis provides not just for trends at a macro level but also unique pathways countries like India have followed, providing insights for replication in other contexts.

This pair plot visualises the relations between four important socio-economic indicators: electricity access, GDP per capita, poverty rate, and literacy rate. Each subplot considers a pairwise relationship among these variables, providing key insights into global development trends.

The first row and column, which are related to access to electricity, show very strong correlations with literacy rate and poverty rate. From this, we know that there is a positive relationship between access to electricity and literacy rate. Hence, areas with more access to electricity usually have higher literacy rates. This correlation highlights the importance of electricity in supporting education infrastructure, including lighting, digital tools, and information access. In contrast, electricity access exhibits a robust negative correlation with the poverty rate, underscoring its role in creating economic opportunities, facilitating a better quality of life, and alleviating poverty (due to electrification).

An interesting relationship exists between GDP per capita and access to electricity. Although a clear upward trend can be seen, its impact on low and middle-income countries is less clear, as GDP growth is not always matched by human development. High-income countries tend to cluster at the right end of the spectrum (representing near-universal electrification), while other, mostly lower-income countries are spread out at lower electricity access levels. This indicates that GDP growth alone does not guarantee universal electrification and highlights the importance of more targeted policy interactions.

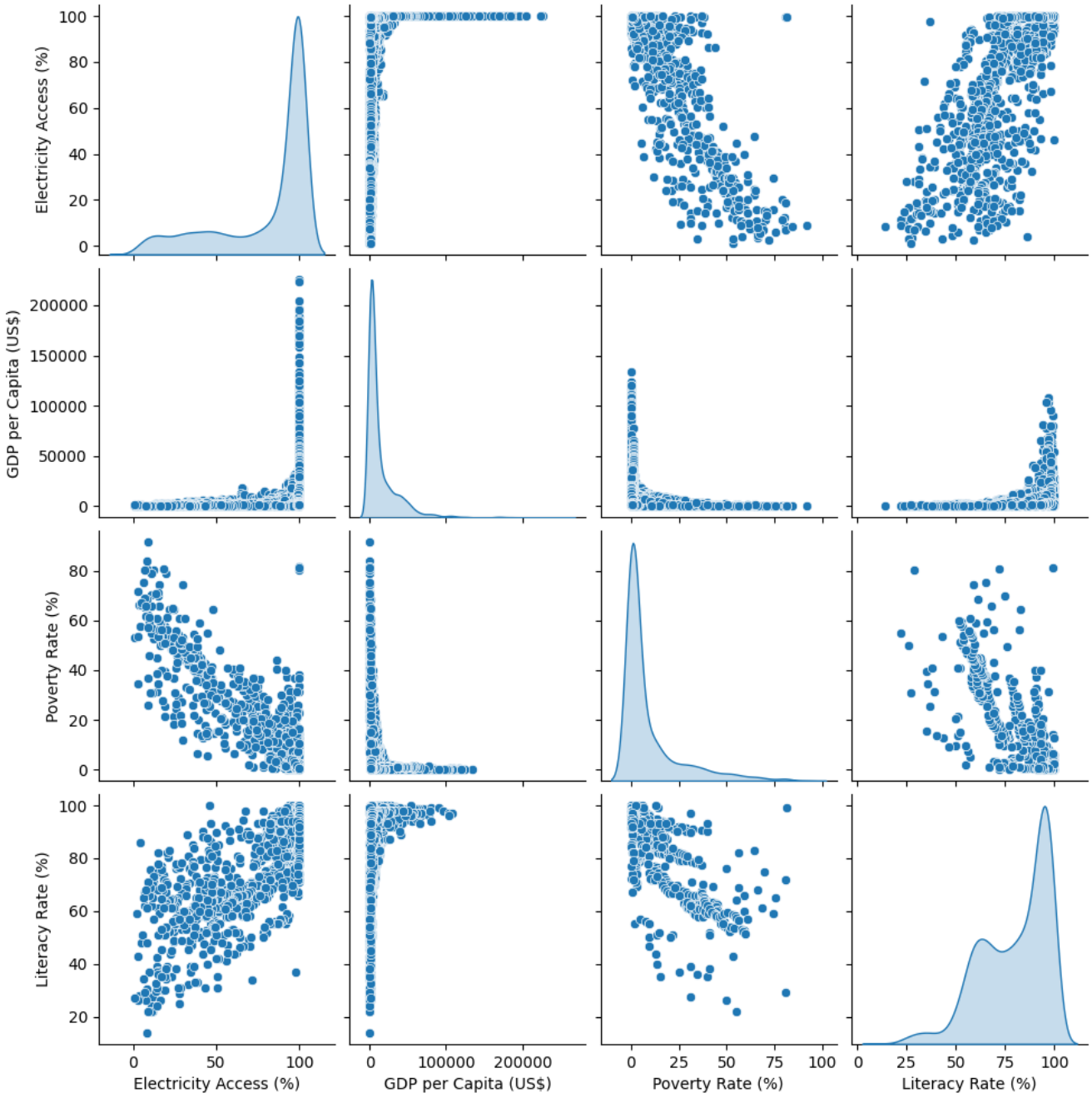

Figure 9. *Pairwise correlation between global electricity access, GDP per capita, poverty rate, and literacy rate (Link to the code: https://drive.google.com/file/d/1lYUqJsm85ICzASAuKdpEqYY58C9MrBha/view?usp=sharing).*

The diagonals show the distribution of each indicator. The distributions of access to electricity and literacy rate, for example, are weighted towards the high end, indicating that many countries have high levels of the indicator. By contrast, poverty shows a much larger dispersion, with a substantial share of countries experiencing high levels of poverty. GDP per capita shows the widest range, illustrating the high levels of income inequality between countries.

The relationships involving the poverty rate are especially revealing. This strong negative association between the literacy rate and electricity access further supports the theory that enhancing them could greatly reduce poverty. The scatterplots show groupings of countries where low literacy and limited electricity access maintain a hold on poverty and those that have managed to break out of this trap through continued socio-economic development.

Overall, this pair plot reveals the relationship between electricity access, economic performance, education, and poverty reduction. It illustrates how access to electricity serves as a key enabler of wider socio-economic development and reveals persistent inequalities between countries. The plots also reflect the importance of an integrated development model, where electrification initiatives are coupled with education and poverty-reduction policies to ensure that growth

is inclusive and sustainable.

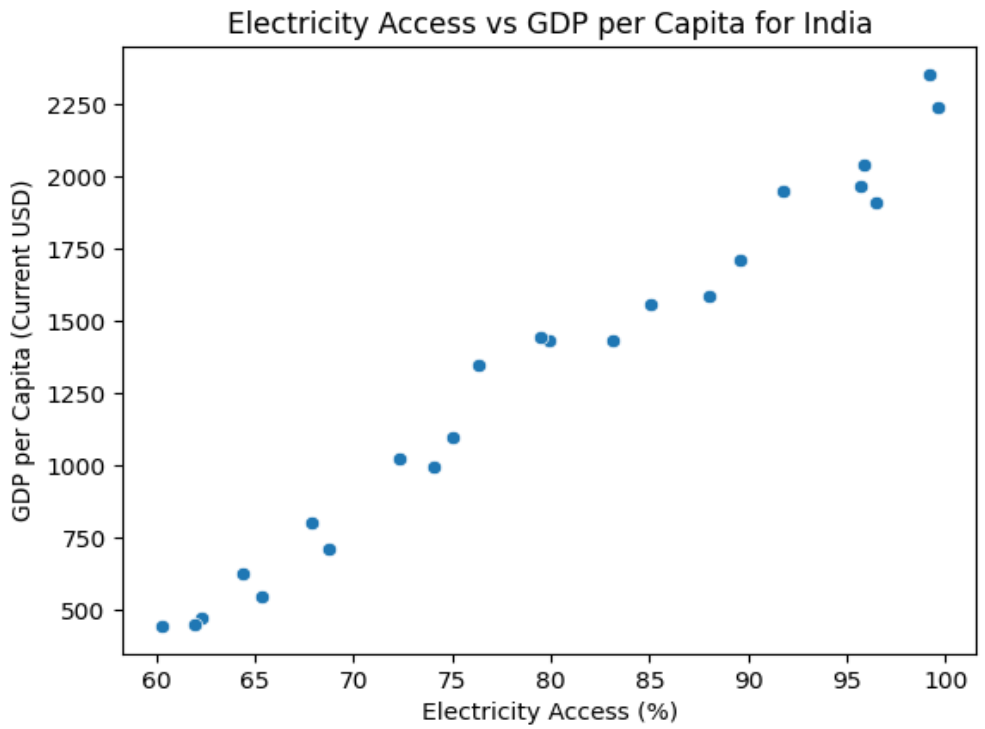

Figure 10. *Correlation between Indian GDP and Electricity Access (Link to the code: https://drive.google.com/file/d/1lYUqJsm85ICzASAuKdpEqYY58C9MrBha/view?usp=sharing)*

This scatterplot shows how electricity access and GDP per capita are related over time in India's case. The data show a high positive correlation, reflecting the fact that growing access to electricity corresponds to a rise in GDP per capita. The positive slope indicates that electrification has been one of the main catalysts behind India's economic progress.

In the earlier plot, when electricity access was 60% to 80%, GDP per capita was low and below 1,000 USD. This was the period when India was progressively electrifying the country. However, access was only available in urban centres and industrial corridors. This transitional period brought economic advantages to these regions in many ways. However, access to electricity was not evenly shared, which limited the scope of benefits for rural and smaller enterprises.

Once more than 80% of homes had access to electricity, it reflected in higher GDP per capita. This era coincided with massive state interventions such as rural electrification programs, energy diversification, and special measures to enhance power supply reliability. The near-universal electrification (over 95% access) we have seen in recent years corresponds with a rapid growth in GDP per capita to over 2,000 USD. This shows how regular and cheap electricity has driven industrial progress, agricultural productivity, and general socioeconomic transformation.

This plot illustrates the role of policy and infrastructure in leveraging electricity access for economic growth. India's capacity to absorb renewables, minimise transmission losses, and achieve last-mile connectivity has boosted the economics of electrification. Additionally, the steady growth in GDP per capita demonstrates the cascading advantages of electricity accessibility, which facilitates education, healthcare, and small business development.

The chart above shows energy access as a key cornerstone of economic development. India's experience illustrates the transformative potential of electrification, especially when combined with sound policies and investments in infrastructure. It serves as a template for other developing countries to establish an energy partnership for economic prosperity.

5. Discussion

The analysis shows the capability of targeted solutions in electrification, specifically through regional policy impact. Data clearly highlights the success of India's electrification policies, which realised a commendable mean degree of change of 20.15% in terms of access to electricity. This incredible progress underscores the transformative impact of India's Saubhagya scheme and its underlying market-enabling initiatives that successfully harnessed a trilateral synergy of public-private partnerships, renewable energy integration and sturdy regulatory frameworks. The statistical significance relative to the t-statistic and p-value indicates that

the improvements were not coincidental but were likely the result of deliberate and well-implemented policies.

With a mean 17.92% change from a low baseline of 8.36%, Rwanda illustrates that targeted rural electrification approaches can be impactful. Rwanda's commitment to sustainable development, as demonstrated through initiatives such as the Energy Access Rollout Program (EARP), underscores the need to facilitate underserved populations systematically. However, Chad presents a different story, with a lower mean change of 4.26%. The gains are slight, but in a landscape riddled with infrastructural and socio-political impediments, they merit being described as progress. The t-statistic for Chad repeats the encouraging message that even in such adverse conditions, targeted policy can create effective change.

The statistical analysis highlights that meaningful policy interventions can result in significant progress in electricity access, even in relatively difficult settings. However, the data also reveals differences in the scale and speed of progress by region. Although India's model may be a road map for success, the different contexts of Rwanda and Chad show that a public model must match local conditions, resources, and governance structures to work.

These findings indicate that countries seeking to replicate India's success must adapt to their unique socio- and infrastructural realities. Expanding existing interventions with more funding and tech support could definitely speed up progress in Rwanda. In Chad, harnessing its plentiful solar potential and encouraging political stability could create much deeper advances.

The analysis confirms that well-conceived and adequately implemented policies remain key in closing the electricity access gap. Other countries can learn from the experiences of India, Rwanda, and Chad to devise approaches that meet their specific barriers and expedite their journey toward universal access to electricity. The lessons learnt illustrate the potential for regional policy impact analysis as a driver of sustainable and equitable development on a global stage.

6. Conclusion

In concluding this paper, let us distil key findings, analysis, and recommendations articulated throughout. These highlight the multidimensional importance of electricity access as a cornerstone of sustainable development. The study highlights the need for rapid universal electricity access in line with Sustainable Development Goal (SDG) 7, but regional disparities and inclusivity temper this.

Drawing on global data for electricity access, the study shows what has been achieved and what remains to be done, especially in places such as Sub-Saharan Africa and South Asia. The results show that significant gaps persist amid global progress, which stifles equality of opportunities and fuels socio-economic disparity. Data from India, Rwanda and Chad illustrate how targeted policy interventions and innovative efforts can change the trajectory. The near-universality of electrification in India through the Saubhagya scheme is a testament to the power of focused political will, public-private partnerships, and the integration of renewable energy. In a similar vein, Rwanda and Chad exemplify the power of region-specific strategies tailored to local contexts and resources.

The correlation analysis also strengthens the evidence that electricity access is a key enabler of higher socio-economic outcomes correlated with poverty reduction, education attainment, and economic growth. However, the differences in progress between countries and regions necessitate a coordinated global approach to technology transfer, investments in renewables, and capacity-building so that no one lags.

Adopting forward-thinking technologies such as geospatial mapping and blockchain, implementing scalable financing mechanisms, and enabling transnational collaborations may address structural challenges. Governments, international organisations, and private stakeholders must work together to create and enforce inclusive, sustainable, and flexible policies that reflect the realities of different regions.

Universal access to electricity by 2030 is a challenge beyond that of the provisions of the infrastructure: it is a question of morality and compliance with the ethical principles of creating a fairer, more cohesive and sustainable planet. This research is a call to action for all those involved in bridging the electricity access gap—policymakers, researchers and practitioners—to speed up progress, ensuring that access to electricity is an accelerant for wider development objectives and a pillar of overall sustainability. The findings highlight the importance of urgent, targeted, collaborative efforts to illuminate the path to a more inclusive, resilient future.

Abbreviations

AI	Artificial Intelligence
CAGR	Compound Annual Growth Rate
EARP	Energy Access Rollout Program
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
NGO	Non-Government Organisation
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
SDG	Sustainable Development Goal
UN	United Nations
UNDP	United Nations Development Programme
USD	United States Dollar
WB	World Bank

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Author Contributions

Partha Majumdar is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflict of interest.

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