CHAPTER 20

Assessing the Impact of Energy Projects in Meeting the Sustainable Development Goal 7 (SDG 7)

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ABSTRACT

Achieving the Sustainable Development Goal 7 (SDG 7) universal access to affordable, reliable, sustainable and modern energy remains a challenge with implications on the global economic growth, social equity and environmental sustainability. This study explores how renewable energy projects contribute to sustainable development with an emphasis on the Indian context. The research examines the energy landscape in India, the progress towards SDG 7, and the barriers to the acquisition of clean energy. The paper utilizes the mixed method research technique by combining secondary literature reviews, policy analysis, and case studies with primary research using semi-structured interviews with industry experts from Thermax and Thyssenkrupp. The data is evaluated by comparing and analyzing and identifies patterns and challenges that are important in India's transition to energy. The findings indicate that while India has made significant strides in expanding its renewable energy capacity by undertaking solar, wind, and green hydrogen initiatives, there are still several challenges that continue to impede the large-scale adoption of renewable energy. These challenges include policy gaps, financial constraints, technological limitations, and energy storage inefficiencies. The case study research underscores the importance of public-private partnerships, decentralized energy solutions, and policy incentives in expediting the transition to renewable energy. By comparing Indian and global case studies, this research identifies best practices that can be adapted to strengthen India's renewable energy framework. The paper shows an evidence-based analysis of the progress India has made in clean energies. It identifies the major challenges and provides several policy recommendations on how to improve the accessibility, efficiency, and sustainability of energy.

Keywords: Clean energy transition; Sustainable Development Goal 7 (SDG 7); Renewable energy adoption; Energy efficiency; Green hydrogen; Decentralized energy systems; Climate policy and regulation; Public-private partnerships.

1.0 Introduction

Background: Energy is one of the most important drivers of economic growth, social development and environmental sustainability.

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It regulates the consumption of resources and is associated with all spheres of human life, from industrial production to housekeeping. It is one of the most crucial factors contributing to the development of the nation. To conclude, an increase in the demand for energy resources and the growth of concern about climate change, resource depletion and environmental degradation are the main reasons why a transition to renewable energy is happening (IEA, 2023). Energy is one of the most important drivers of economic growth, social development and environmental sustainability. It regulates the consumption of resources and is associated with all spheres of human life, from industrial production to housekeeping. It is one of the most crucial factors contributing to the development of the nation.

To conclude, an increase in the demand for energy resources and the growth of concern about climate change, resource depletion and environmental degradation are the main reasons why a transition to renewable energy is happening (IEA, 2023). The United Nations Sustainable Development Goals (SDGs) highlight energy as a transformative factor in development, especially in SDG 7. The goal of SDG 7 is to ensure access to affordable, reliable, and sustainable energy for all by the year 2030 (United Nations, 2022). Clean energy access is associated with SCG 13 (Climate Action) and SCG 9 (Industry, Innovation, and Infrastructure). Thus, this goal helps in enhancing economic resilience and decarbonization. However, even though there has been global progress, many developing countries are currently grappling with the issue of achieving SDG 7. In India, for example, demand for energy is on the increase (World Bank, 2023).

1.1 Aim and objectives

This study evaluates energy projects' business models, socio-economic outcomes, and environmental sustainability to determine their influence on SDG 7 and associated SDGs. It identifies obstacles, opportunities, and solutions to promote clean energy adoption in India for a sustainable and equitable energy transition.

Objectives:

- How do energy projects in India shape their business models to align with specific Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy)?
- What challenges do energy projects in India face in delivering sustainable solutions without compromising the achievement of SDGs, and what strategies are employed to address these challenges?

1.2 Scope

The study here deals with renewable energy projects and the contribution towards Sustainable Development Goal 7 (SDG 7) by studying major sources like solar, wind, bioenergy, and new renewable technologies for India. The study incorporates major components of SDG 7, such as energy access, adoption of renewable energy, and efficiency. It also assesses

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the policy frameworks, financial mechanisms, and socio-economic impacts of clean energy programs. The research is limited to actual case studies in real life, policy measures, and investment patterns in India's renewable energy market, giving an exhaustive insight into the country's transition to clean energy.

2.0 Methodology

Energy projects and SDGs are assessed in four phases in this study. Renewable energy adoption and business model literature, case studies, and policies are examined in secondary research. Researchers interview and survey stakeholders for primary research. Comparative examination reveals large-scale, decentralised, and hybrid energy project patterns, successes, and obstacles. Synthesis and suggestions offer policy insights and roadmaps for clean energy adoption and sustainability.

Table 1: Methodology Chart

Step	Objective	Key Activities	Deliverables
Secondary Research	Build foundational knowledge	Data collection from academic papers, reports, and case studies	Database of sources, preliminary analysis
Primary Research	Gather first-hand stakeholder insights	Semi-structured interviews and surveys	Qualitative insights on projects and business models
Comparative Analysis	Identify themes and differences	Compare case studies, stakeholder data, and SDG 7 metrics	Comparative matrix summarizing outcomes and strategies
Synthesis & Conclusion	Integrate findings and propose solutions	SWOT analysis, policy gap identification, recommendations	Detailed conclusion with best practices and policy insights

Source: Compiled by authors

This study utilizes a mixed-method research methodology, combining secondary research (literature review, case study analysis, and policy evaluation) with primary research (stakeholder interviews and surveys). The technique employs a systematic, multi-phase approach, guaranteeing a comprehensive understanding of sustainable energy initiatives in India and their correspondence with Sustainable Development Goal 7 (SDG 7). The study is to examine diverse business models, evaluate policy efficacy, and measure socio-economic effects pertaining to energy access, efficiency, and sustainability. methods.

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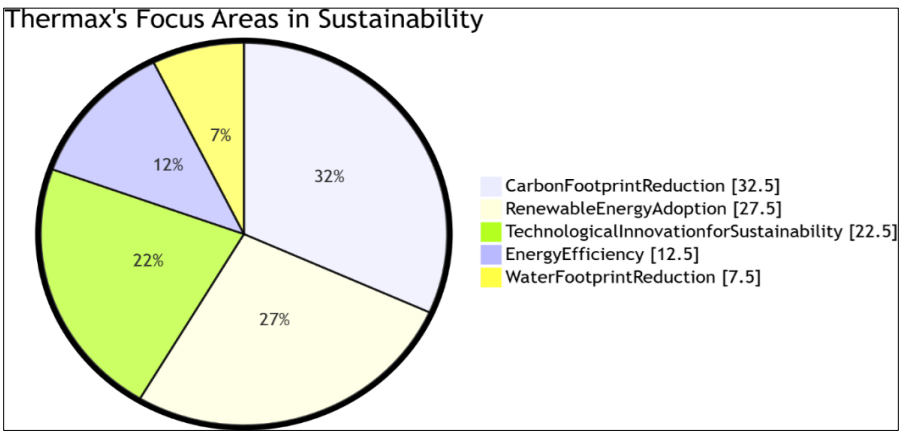
3.0 Data Analysis and Results

3.1 Stakeholder interview analysis

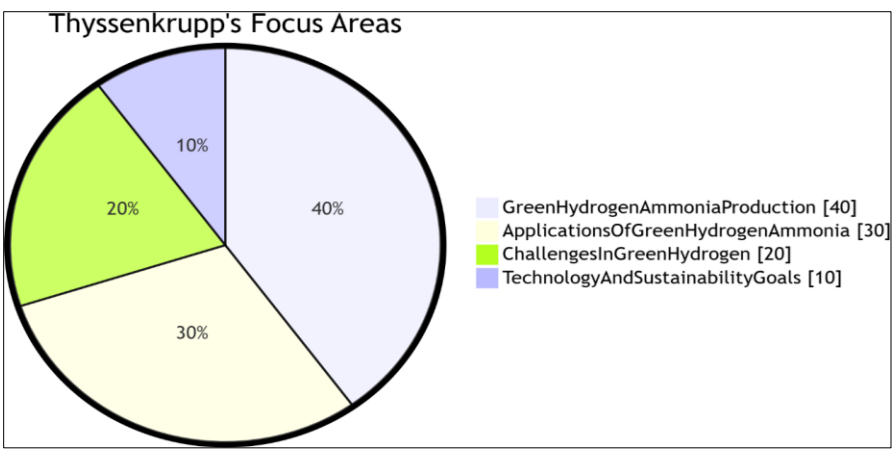
Figure 1 presents the main sustainability focus areas for Thermax, as indicated by the interview data. The size of each slice shows the relative proportion of attention given to each area during the interview. Thus, the focus areas for Thermax in terms of sustainability are Carbon Footprint Reduction and Renewable Energy Adoption since the slices representing these aspects are the largest on the diagram.

Figure 1: Thermax's Focus Areas in Sustainability



Source: Compiled by authors

Figure 2: Thyssenkrupp's Focus Areas



Source: Compiled by authors

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This allows inferring that Thermax is actively engaged in reducing its carbon emissions and increasing the share of renewable energy sources in its operations. In a similar manner, it can be inferred that Technological Innovation for Sustainability is also a key focus area for Thermax since the corresponding slice is large. This implies that the company uses artificial intelligence (AI) and other technologies to improve its efficiency and other sustainability-related aspects. While Energy Efficiency is also a focus area for the company, it is discussed in terms of specific initiatives. In contrast, Water Footprint Reduction is only discussed in terms of the Net Zero water plant, which is why the respective slice is relatively small. Overall, the figure is based on the qualitative data from the interview and is intended to provide a visual representation of the sustainability priorities of Thermax.

Table 2: Comparative Analysis of the Interviews

Feature	Thermax	Thyssenkrupp
Core Focus	Reducing operational electricity consumption and carbon footprint.	Providing green hydrogen/ammonia technologies for industry.
Energy Saving	Implement LED lighting, motion sensors, timers.	Enables energy transition in other industries.
Carbon Footprint	Focuses on Scope 1, 2 (electricity), and 3 emissions.	Reduces CO_2 by enabling green alternatives to carbon-heavy processes.
Renewable Energy	Uses solar power (rooftop, Open Access).	Uses renewables (solar, wind, hydro) for green hydrogen.
Key Projects	Solar project at Shirwal plant.	Green hydrogen plant; Saudi green ammonia project.
Technology	AI for boiler design, machine monitoring, remote performance.	Digital twins, AI tools.
Challenge	Regulatory delays and complex approval processes hinder green energy project implementation.	High green hydrogen cost.
Goal	Zero carbon by 2030; Net Zero water.	Net Zero emissions by 2045.
Application	NA	Steel, refineries, ammonia, power.

Source: Compiled by authors

In Figure 2, the primary areas of focus for Thyssenkrupp are outlined based on the interview data. The size of each slice shows how much relative emphasis the interviewee placed on each area of focus. Green Hydrogen/Ammonia Production is the largest focus area in the interview data, which relates to the company's focus on developing green hydrogen and ammonia technologies. Applications of Green Hydrogen/Ammonia are the next largest focus area, which suggests that the company is interested in other industries or areas that could use green hydrogen and ammonia. Challenges in Green Hydrogen is the next area of focus, as there are economic challenges to using green hydrogen. Technology and Sustainability Goals are of less focus in the interview data. The focus on each area is qualitatively determined from the interview and is shown for illustration purposes.

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3.2 Case study analysis

Table 3: Summary of Indian Case Studies and their Alignment with Research Questions

Case Study	Business Model & Alignment with SDG 7	Challenges in Sustainable Implementation	Strategies for Overcoming Challenges
Kasai Village Biomass Project, Madhya Pradesh	Community-managed with government capital investment; SDG 7 achieved through biomass energy for off-grid areas.	Reliance on traditional biomass for cooking, potential indoor air pollution; need for biogas integration.	Integrating biogas for cooking, enhancing community awareness of clean energy benefits.
Gosaba Biomass Power Plant, West Bengal	Rural Energy Cooperative manages the plant, ensuring financial and operational sustainability; SDG 7 supported through biomass electrification.	Ensuring continuous biomass fuel supply, requiring dedicated energy plantations.	Developing dedicated agroforestry for sustained biomass supply.
Gramme Vikas Renewable Energy Projects, Odisha	Community-financed renewable energy solutions integrating solar, biodiesel, and water supply; aligns with SDG 7 and SDG 6.	Sustaining financial contributions from communities and addressing technical maintenance issues.	Expanding technical training programs and financial incentives for long-term community participation.
Ladakh Micro-Hydro and Solar PV Initiative	Community-operated micro- hydro plant, supplemented with solar PV for energy reliability; aligns with SDG 7 and SDG 9.	Seasonal variability in hydro energy output; need for energy storage solutions to improve reliability.	Hybrid energy model with solar PV as a backup; investment in battery storage solutions.
BERI Biomass Energy Project, Karnataka	Self-help groups involved in biomass fuel supply, ensuring sustainable energy access; aligns with SDG 7, SDG 13, and SDG 8.	Sustainable forestry practices needed to prevent biomass depletion and ensure long-term viability.	Implementing community-led reforestation programs and monitoring biomass usage.

Source: Compiled by authors

3.3 Summary of key findings and challenges in India's energy transition

This section synthesizes stakeholder interview insights, Indian and international case studies, and additional research to assess whether India's clean energy projects conform to SDG 7 while identifying major impediments to its clean energy transformation. Stakeholder interviews indicate that although Thermax's emphasis on energy efficiency and Open Access procurement of solar energy has resulted in substantial savings of electricity, bureaucratic delays and acquisition of land obstruct progress (MNRE, 2023).

Likewise, Thyssenkrupp's investment in green hydrogen and ammonia manufacturing is major steps towards industrial decarbonization, although economic feasibility issues, scarce hydrogen infrastructure, and expensive capital costs are principal challenges (MNRE, 2023). Both companies recognize the promise of AI and IoT technologies to maximize energy

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efficiency but are hindered by fragmented policy frameworks and weak financial incentives for their wider use (IRENA, 2023).

Table 4: Summary of Global Case Studies and their Alignment with Research Questions

Country	Project Type	Key Features	Alignment with SDGs	Challenges
Germany	Wind Energy (Onshore & Offshore)	Feed-in Tariffs, Community Wind Ownership, Grid Integration	SDG 7, SDG 9, SDG 13	Grid congestion, Land acquisition opposition
Denmark	100% Renewable Transition	Offshore Wind, Community-Owned Projects, Energy Trading	SDG 7, SDG 12, SDG 17	Energy intermittency, Grid balancing
China	Large-Scale	Government-Supported Solar Farms, Storage	SDG 7, SDG	Grid integration, Remote location
	Solar Power	Investments	9, SDG 13	challenges
Bangladesh	Solar Home Systems	PAYG Financing, Microfinance Support, Rural Electrification	SDG 7, SDG 1, SDG 10	Maintenance costs, Donor dependence
Kenya	Solar Mini- Grids	Mobile-Based Payments, Off-Grid Energy Access, SME Support	SDG 7, SDG 8, SDG 11	Financing constraints, Regulatory challenges

Source: Compiled by authors

Indian case studies demonstrate that community-led renewable projects like biomass-based rural electrification and solar microgrids have successfully enhanced energy access and socio-economic conditions; however, these projects are plagued by financial sustainability concerns, maintenance issues, and resource constraints (World Bank, 2023). Government-backed initiatives, although enjoying state subsidies and funding mechanisms, are plagued by bureaucratic inefficiencies, policy lags, and uneven state-level policies that hinder their effectiveness (MNRE, 2023). International experiences in Germany, Denmark, China, Bangladesh, and Kenya highlight the need for sustained policy support, strong financing, and new models like state-led solar expansion, PAYG finance, and mobile-powered mini-grids, which may provide important lessons for India (German Federal Ministry for Economic Affairs and Energy, 2023; IEA, 2023; IRENA, 2021). In all, some of the key problems identified are regulatory gridlocks, significant initial capital expenditures on clean energy technologies, and infrastructural bottlenecks such as limited energy storage facilities and ageing grid infrastructure, all of which need to be redressed to stimulate India's clean energy revolution (World Bank, 2023; IEA, 2023).

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4.0 Conclusion and Recommendations

4.1 Conclusion

This study evaluated the role of energy projects in helping achieve SDG 7 by examining business models, sustainability strategies, and challenges of implementation. Findings from stakeholder interviews with Thermax and Thyssenkrupp indicated that Thermax emphasizes energy efficiency and AI-driven solutions but are hindered by regulatory and infrastructure issues. Thyssenkrupp, a pioneer in green hydrogen and ammonia technologies, is limited by high costs and the lack of a robust hydrogen economy. Both firms placed a strong stress on the need for policy stability and funding to propel clean energy objectives (Stakeholder Interviews, 2023). Indian examples like the Kasai Village and Gosaba Biomass schemes highlighted the socio-economic advantages of decentralized renewable energy but indicated problems on issues of fuel sustainability and economic viability (IRENA, 2021). International case studies from Germany, Denmark, and China showed how long-term policy support, technological development, and financial assistance have facilitated the widespread implementation of renewable energy (IEA, 2023). Such cases offer replicable models that India can emulate.

The study identified that the convergence of energy projects with SDG 7 entails a mix of adoption of clean energy, energy efficiency, and policy-based financial incentives. But the major barriers persist, such as policy gridlock, finance, delays in land acquisition, and poor community engagement—highlighting the need for regulatory reforms and streamlined investment processes (World Bank, 2023). In summary, even with significant advancements, India needs to ramp up renewable energy projects, embrace new technologies such as AI, and attract sustained investment to achieve long-term success in its energy transition (UNDP, 2023).

4.2 Stakeholder impact

This study presents valuable lessons for a broad range of stakeholders to undertake the clean energy transition. Policymakers can use the findings to identify regulatory roadblocks and prioritize reforms that ease investment and implementation processes (MNRE, 2023; World Bank, 2023). The emphasis on policy stability and economic incentives highlights the need for balanced, long-term policy frameworks to attract private sector participation (IEA, 2023).

Energy operators and industrial actors can benefit from insights into the best practices in sustainability—like Thermax and Thyssenkrupp's—like the integration of AI, green hydrogen, and energy efficiency (Stakeholder Interviews, 2023; UNDP, 2023). Investors and renewable project developers can ascertain the scalability and feasibility of decentralized renewable projects, like the Kasai Village and Gosaba case studies, to guide future investment (IRENA, 2021; World Bank, 2023). Local communities and civil society organizations cultivate understanding of the socio-economic impacts of renewable energy initiatives and the way such initiatives can drive grassroots engagement as well as fuel sustainability (IRENA, 2023; UNDP,

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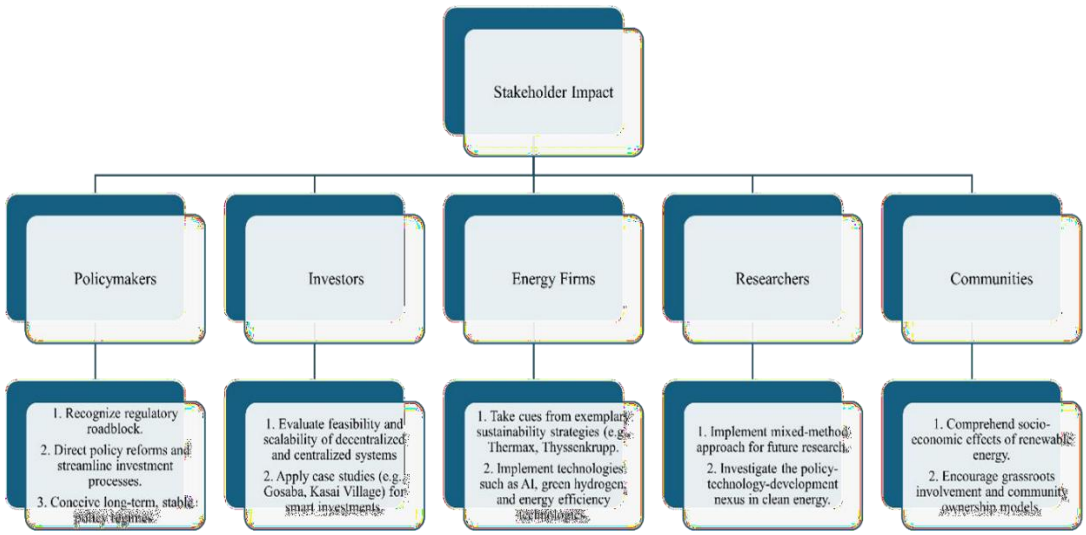
2022). Scholars and academicians, finally, can capitalize on the analysis framework of the study in the sense of deeper exploration of relationship between sustainable development outcomes, policy paradigms, as well as technological innovation (IEA, 2023; UNDP, 2023).

Figure 3: Stakeholder Impact Map



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