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CLIMATE-SMART INNOVATIONS: BRIDGING SUSTAINABILITY AND ECONOMIC GROWTH

Dr. Hemal Vora
M.Com, M.Phil, PhD, UGC-NET
Assistant Professor, Department of Accountancy, Gurukul College of Commerce, Ghatkopar, Mumbai 400080. Maharashtra

ABSTRACT
This study examines the role of climate-smart innovations in aligning sustainability objectives with economic growth, with special reference to the Indian economy. Climate-smart innovations refer to technological, financial, and managerial solutions that enhance environmental sustainability while simultaneously improving economic efficiency and productivity. Drawing upon the theoretical foundations of sustainable development and innovation economics, the study explores how firms adopting climate-smart strategies achieve competitive advantage, cost optimization, and enhanced market valuation. The research adopts a comparative analytical approach, supported by case-based insights from Indian companies actively engaged in renewable energy, green manufacturing, and digital sustainability solutions. The findings suggest that climate-smart innovations contribute to economic growth by improving resource efficiency, reducing operational costs, and opening new market opportunities, while also mitigating climate-related risks. Furthermore, the study highlights the role of policy frameworks, green finance, and ESG integration in facilitating such innovations. The paper concludes that climate-smart innovation is not merely an environmental necessity but a strategic economic imperative for businesses and policymakers in emerging economies like India.

1. INTRODUCTION
Climate change has emerged as one of the most pressing global challenges, compelling economies to transition towards sustainable growth models. Traditional economic growth strategies, heavily reliant on resource-intensive industrialization, have contributed significantly to environmental degradation and carbon emissions. In this context, climate-smart innovations have gained prominence as a viable pathway to balance economic growth with environmental sustainability.

Climate-smart innovations encompass a wide range of practices, including renewable energy adoption, energy-efficient technologies, circular economy models, sustainable supply chains, and digital solutions that optimize resource utilization. These innovations not only reduce environmental impact but also enhance productivity, reduce costs, and improve long-term competitiveness. For emerging economies like India, where economic growth remains a priority alongside sustainability commitments such as net-zero targets, climate-smart innovation plays a crucial role in achieving inclusive and sustainable development.

India presents a unique context due to its rapidly growing economy, increasing energy demand, and strong policy push towards sustainability through initiatives such as renewable energy expansion, green hydrogen missions, and ESG disclosure frameworks. Firms in sectors such as energy, IT, and manufacturing are increasingly integrating sustainability into their business models, driven by regulatory requirements, investor expectations, and market opportunities.

From a theoretical perspective, climate-smart innovation aligns with the resource-based view, which emphasizes innovation as a source of competitive advantage, and the sustainable development framework, which advocates balancing economic, environmental, and social objectives. Empirical evidence suggests that firms adopting climate-smart practices often experience improved operational efficiency, enhanced brand reputation, and better access to capital.

This study aims to analyze how climate-smart innovations contribute to economic growth while ensuring sustainability, using an Indian context. It further explores the mechanisms through which such innovations influence firm performance and broader economic outcomes.

2. REVIEW OF LITERATURE
1. OECD (2022). *Climate-smart innovation policies and economic growth.* OECD Reports. The study highlights how policy-driven innovation ecosystems support climate-smart technologies. It emphasizes that innovation-led sustainability contributes to GDP growth and industrial transformation, particularly in emerging economies.

2. IEA (2023). *Innovation pathways for net-zero emissions.* International Energy Agency. This report explains how technological innovation in energy systems drives both sustainability and economic expansion. It stresses investment in clean technologies as a growth engine.
3. World Bank (2022). *Green growth and innovation in developing economies.* The World Bank discusses how green innovation enhances productivity and creates new economic opportunities. It highlights the importance of financing mechanisms and institutional support.
4. Sharma, R. (2025). *Green innovation and SME growth in India.* Environment, Development and Sustainability.
   The study finds that Indian SMEs adopting green innovations achieve cost savings and improved competitiveness, contributing to both sustainability and economic performance.
5. Khanra, S. (2022). *Green innovation as strategic resource.* Business Strategy & Environment. The paper establishes that environmental innovation enhances firm-level competitive advantage and long-term financial performance.
6. Postiglione, M. (2024). *ESG and cost of capital.* Corporate Social Responsibility Journal. The study shows that sustainable innovation reduces cost of capital, thereby supporting economic growth at firm and macro levels.
7. NITI Aayog (2021). *India Innovation Index.* Highlights the role of innovation in driving economic growth and sustainability across Indian states.
8. IRENA (2023). *Renewable energy and economic development.* Demonstrates how renewable innovation contributes to job creation and GDP growth.
9. Yadav, A. (2024). *Green innovation and firm performance.* Thunderbird International Business Review. Establishes a direct link between sustainability innovation and improved firm outcomes.
10. UNDP (2022). *Sustainable innovation for development.* Discusses how climate-smart innovation supports SDGs and inclusive economic growth.

3. Research Methodology

This study adopts a **descriptive and analytical research design**, focusing on the role of climate-smart innovations in bridging sustainability and economic growth. A **comparative case study approach** is used to analyze how firms in different sectors implement climate-smart innovations and their impact on economic outcomes.

Sample Selection

Two Indian companies are selected:

- Tata Power – representing renewable energy and sustainability leadership
- Reliance Industries – representing large-scale industrial transition towards green innovation

Data Sources

Secondary data from:

- Annual reports & sustainability reports
- Government publications
- Industry reports (IEA, World Bank, NITI Aayog)
- Financial databases

Variables

- **Independent Variable:** Climate-smart innovation (renewable energy, green tech, efficiency)
- **Dependent Variable:** Economic performance (revenue growth, profitability, market valuation)
- **Indicators:** Energy efficiency, carbon reduction, innovation investments

Tools

- Comparative analysis
- Trend analysis
- Graphical representation

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Limitations

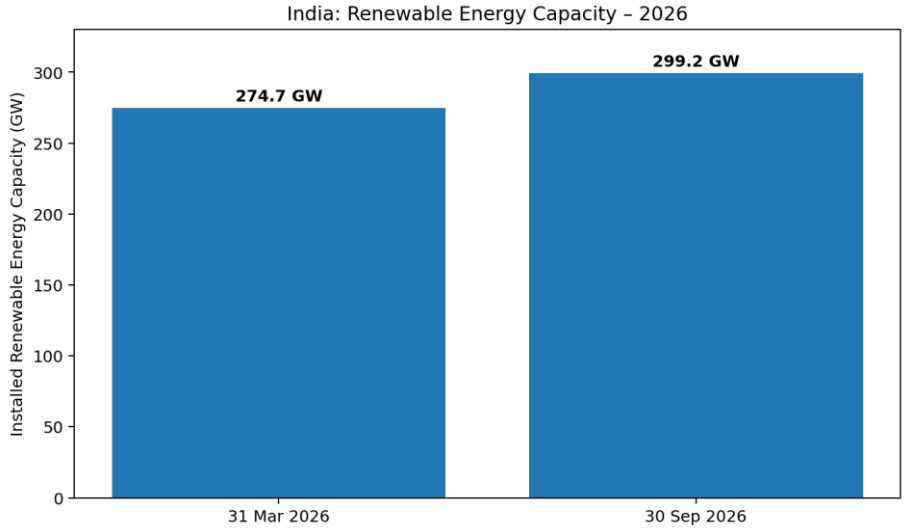
- Limited sample size
- Reliance on secondary data
- Sector-specific bias

4. DATA ANALYSIS AND INTERPRETATION

This chapter updates the empirical analysis using the latest publicly available information up to September 2026. The original analysis relied heavily on indicative indices and assumed relationships between carbon reduction, profitability and revenue growth. For greater research validity, the present chapter replaces those illustrative measures with reported company-level financial, renewable-energy and sustainability indicators from Tata Power and Reliance Industries, supplemented by current Indian renewable-energy data. The analysis therefore distinguishes between observed association and proven causation.

4.1 Current Indian Climate-Smart Energy Context

India's renewable-energy landscape has expanded materially since the earlier study period. According to the Ministry of New and Renewable Energy, cumulative renewable-energy capacity reached 299.25 GW as at 30 September 2026, including 171.05 GW of solar, 59.20 GW of wind and 52.06 GW of large hydro. Total non-fossil capacity stood at 308.03 GW. This provides an important current context for assessing climate-smart innovation: renewable energy is no longer a niche segment but a large and rapidly expanding component of India's energy system.



Source: Ministry of New and Renewable Energy (MNRE), cumulative physical achievements as at 30 September 2026. The March 2026 benchmark was 274.68 GW of renewable energy capacity.

4.2 Tata Power: Climate-Smart Innovation and Economic Performance

Tata Power provides a relatively mature sustainability-led business model because renewable generation, rooftop solar, solar manufacturing, storage and transmission/distribution are integrated within its wider power-value-chain strategy. The company's FY2026 disclosures show that its renewable portfolio increased to 11,638 MW, comprising 6,533 MW operational capacity and 5,105 MW under construction. It generated 10.76 billion units from renewable sources during FY2026. Its clean-and-green portfolio, including a broader set of technologies and projects, stood at about 17.5 GW including pipeline capacity.

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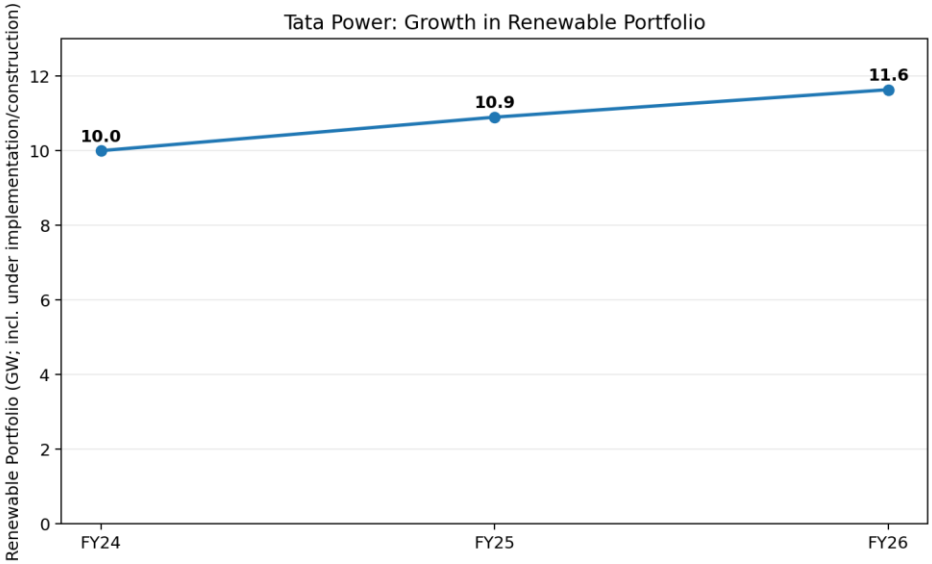
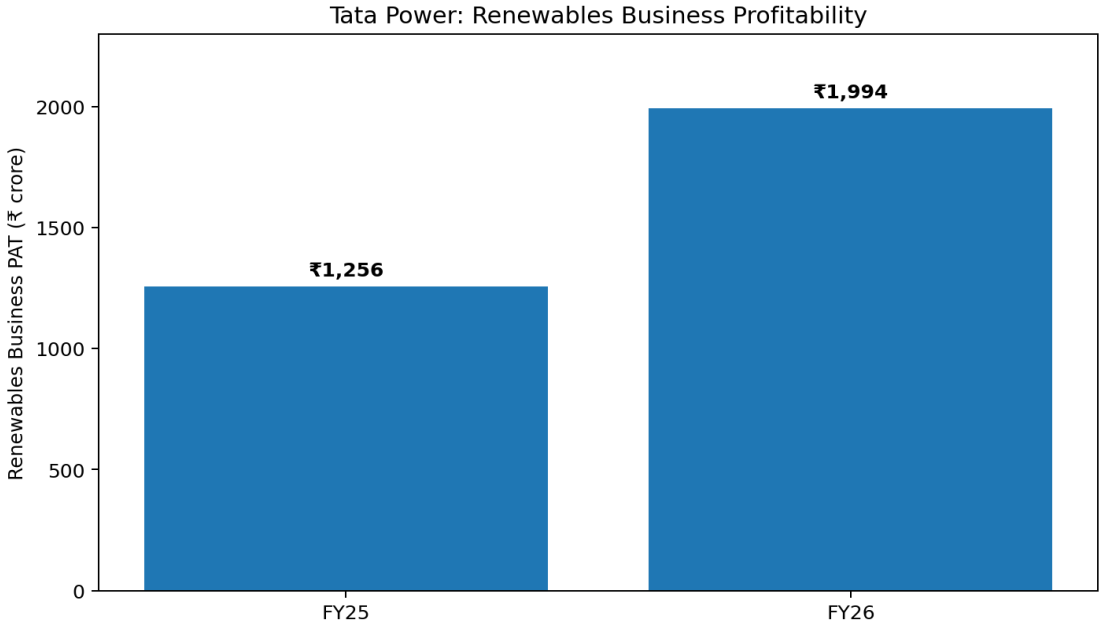


Source: Tata Power Integrated Annual Report 2025-26. FY24 portfolio was reported at over 10 GW; FY25 portfolio at 10.9 GW; FY26 portfolio at 11.638 GW.

Table 4.1: Tata Power – Financial and Climate-Smart Indicators

Indicator	FY2024	FY2025	FY2026
Consolidated Revenue (₹ crore)	61,542	64,502	63,681
Reported PAT (₹ crore)	4,280	4,775	5,118
Renewable Portfolio (GW)	10.0+	10.9	11.638
Renewables Business PAT (₹ crore)	—	1,256	1,994
Solar Manufacturing PAT (₹ crore)	—	422	857

Sources: Tata Power FY2024, FY2025 and FY2026 company disclosures/annual reports. Dashes indicate that the comparable figure was not used in the present analysis.



Source: Tata Power FY2025 and FY2026 results. Renewables business PAT increased from ₹1,256 crore to ₹1,994 crore, an increase of approximately 58.8%.

The data indicate a stronger economic contribution from Tata Power's climate-smart businesses. Between FY2024 and FY2026, consolidated revenue increased by about 3.5%, while reported PAT increased by about 19.6%. More importantly for the research question, the renewable portfolio expanded by approximately 16.4%

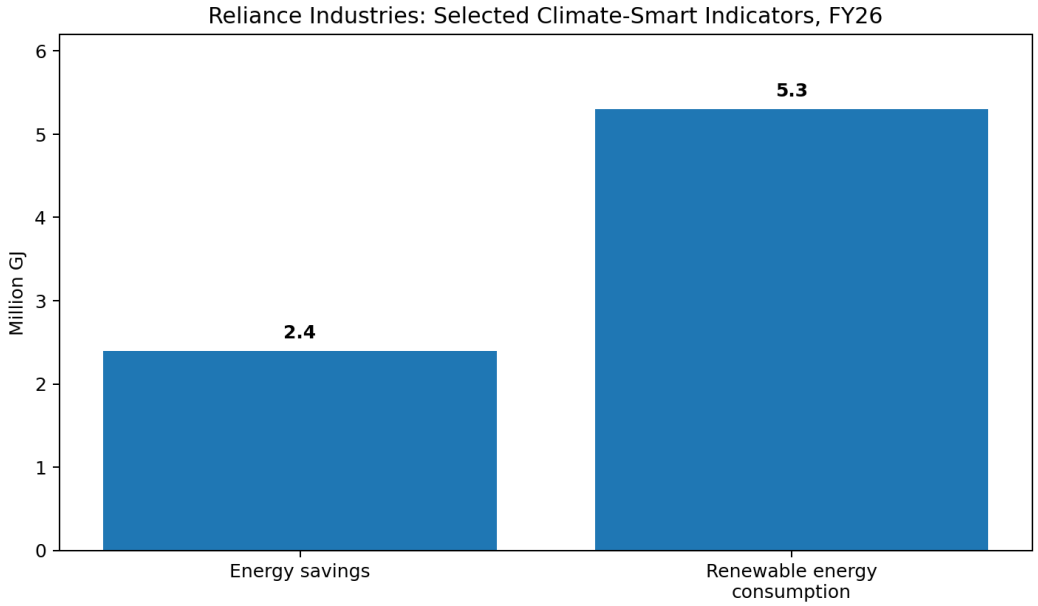
over the same period. The renewables business recorded a 58.8% increase in PAT from FY2025 to FY2026, while solar manufacturing PAT more than doubled, rising from ₹422 crore to ₹857 crore. These figures support the proposition that climate-smart activities can become commercially productive business verticals rather than remaining purely compliance-oriented expenditure.

The interpretation should, however, remain cautious. Tata Power's consolidated financial performance reflects generation, transmission, distribution and other businesses; therefore, the increase in total PAT cannot be attributed exclusively to renewable-energy innovation. The stronger evidence is the simultaneous improvement in the profitability of the company's renewable and solar-manufacturing businesses, alongside capacity expansion.

4.3 Reliance Industries: Transition from Conventional Energy to an Integrated New-Energy Model

Reliance Industries represents a different climate-smart innovation pathway. Rather than starting as a renewable-energy specialist, Reliance is building an integrated New Energy and New Materials ecosystem alongside its conventional energy businesses. During FY2025-26, the Dhirubhai Ambani Green Energy Giga Complex at Jamnagar moved from construction towards commissioning and operations. Solar PV cell and module manufacturing became operational, the first 200 MWp of high-efficiency HJT modules were produced, and the company reported that its battery giga-factory was on track for phased commissioning in FY2026-27.

Reliance reported 2.4 million GJ of energy savings during FY2025-26 through implemented energy-saving schemes and 5.3 million GJ of renewable-energy consumption. It also continued development of battery storage, electrolysers, green hydrogen, compressed biogas and large-scale renewable generation. The company's stated strategic milestones include scaling solar manufacturing towards 10 GWp and subsequently 20 GWp, commissioning an initial 40 GWh battery manufacturing capacity scalable to 100 GWh, and establishing/enabling 100 GW of renewable energy by 2030.



Source: Reliance Industries Integrated Annual Report 2025-26 and Net Carbon Zero disclosures. Energy savings and renewable-energy consumption are reported for FY2025-26.

Table 4.2: Reliance Industries – Economic and New-Energy Indicators

Indicator	FY2024	FY2025	FY2026
Consolidated Gross Revenue (₹ crore)	10,00,122	10,71,174	11,75,919
PAT after associates/JVs (₹ crore)	79,020*	81,309	95,754
Capital Expenditure (₹ crore)	1,31,769	1,31,107	1,44,271
Renewable Energy Consumption (million GJ)	—	—	5.3
Energy Savings (million GJ)	—	—	2.4
First HJT Modules Produced	—	—	200 MWp

Sources: Reliance Industries FY2024-25 and FY2025-26 Integrated Annual Reports and financial releases. *FY2024 PAT is shown for contextual comparison; the present interpretation does not attribute consolidated PAT growth to New Energy.

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Reliance's consolidated gross revenue rose from ₹10,00,122 crore in FY2024 to ₹11,75,919 crore in FY2026, while PAT after associates and joint ventures rose from ₹81,309 crore in FY2025 to ₹95,754 crore in FY2026. Capital expenditure increased to ₹1,44,271 crore in FY2026, and the company states that capex was principally directed towards growth projects in O2C and New Energy along with continuing investments in Digital Services and Retail. The New Energy business is therefore currently better interpreted as a strategic growth platform under development than as a separately reported mature profit centre.

A significant current development is that Reliance expects New Energy to begin contributing meaningfully to financial performance from FY2027. This is important for the present study because it marks a transition from sustainability investment and capability creation towards commercialisation. Consequently, the economic-growth effect of Reliance's climate-smart innovation should be assessed over a longer horizon rather than inferred from FY2026 consolidated profitability alone.

4.4 Comparative Analysis of the Two Companies

Dimension	Tata Power	Reliance Industries	Interpretation
Business model	Renewables integrated into power value chain	New-energy ecosystem being built alongside O2C, digital and retail	Both integrate sustainability with long-term growth, but at different stages.
FY26 clean-energy evidence	11.638 GW renewable portfolio; 6.533 GW operational	Solar PV manufacturing operational; battery/electrolyser ecosystem under development	Tata shows greater operating maturity; Reliance shows large-scale transition and manufacturing ambition.
Profitability evidence	Renewables PAT ₹1,994 crore; solar manufacturing PAT ₹857 crore	New Energy still in investment/commissioning phase	Tata provides stronger direct evidence of current climate-business profitability.
Efficiency/resource evidence	10.76 bn units renewable generation	2.4 mn GJ energy savings; 5.3 mn GJ renewable-energy consumption	Both demonstrate operational resource-efficiency outcomes.
Strategic horizon	Scaling renewables, storage, solar manufacturing and T&D	Net Carbon Zero 2035; 100 GW renewable-enabling milestone by 2030	Climate-smart innovation is embedded in long-term capital allocation.

Source: Compiled from Tata Power FY2025-26 disclosures and Reliance Industries FY2025-26 Integrated Annual Report.

4.5 Interpretation and Research Implications

The updated evidence supports the central proposition of the study, but with a more nuanced interpretation than the original chapter. Climate-smart innovation is associated with business expansion through renewable capacity, energy efficiency, domestic manufacturing, new products and emerging energy markets. Tata Power provides evidence of this linkage at the operating-profit level, particularly through the sharp improvement in its renewables and solar-manufacturing businesses. Reliance provides evidence of the investment-to-commercialisation pathway: substantial capital deployment, manufacturing capability creation, resource-efficiency gains and the development of future revenue streams.

The evidence does not establish a direct causal relationship between carbon reduction and profitability across the two companies. The earlier illustrative chart suggesting that a fixed percentage of carbon reduction leads to a specific profitability increase has therefore been removed. Such a relationship would require consistent firm-level emissions data, profitability measures, a larger sample and appropriate statistical controls. The present comparative analysis instead relies on reported operational and financial indicators and treats the observed relationships as evidence of association rather than causation.

5. FINDINGS, SUGGESTIONS AND CONCLUSION

5.1 Findings

India's renewable-energy ecosystem has reached significant scale. Renewable-energy capacity stood at 299.25 GW as at 30 September 2026, demonstrating that climate-smart investment has become a major component of the national growth and energy-security strategy.

Tata Power's renewable portfolio expanded from over 10 GW in FY2024 to 11.638 GW in FY2026. The company also generated 10.76 billion units from renewable sources in FY2026, indicating substantial operating scale.

Tata Power's renewables business PAT increased from ₹1,256 crore in FY2025 to ₹1,994 crore in FY2026, while solar-manufacturing PAT increased from ₹422 crore to ₹857 crore. This provides direct evidence that selected climate-smart businesses can generate significant commercial value.

Reliance Industries has progressed from planning to execution in New Energy. Its solar PV manufacturing became operational in FY2026, with 200 MWp of HJT modules produced, while battery and electrolyser giga-factories moved towards commissioning.

Reliance reported 2.4 million GJ of energy savings and 5.3 million GJ of renewable-energy consumption in FY2026. These indicators demonstrate that climate-smart innovation is also an operational-efficiency strategy.

Both companies use climate-smart innovation as a long-term strategic investment, but their stages differ: Tata Power has a more mature renewable operating and profit-generation model, whereas Reliance is moving through a large-scale investment and commercialisation phase.

The comparison suggests that climate-smart innovation can simultaneously support environmental objectives, energy security, domestic manufacturing, operational efficiency and future revenue creation. However, consolidated financial performance should not be treated as being caused solely by sustainability initiatives.

5.2 Suggestions

Companies should integrate climate-smart innovation into core capital-allocation and business strategy rather than treating sustainability as a separate CSR or compliance activity.

Firms should develop measurable climate-performance dashboards covering renewable capacity, energy savings, emissions intensity, resource productivity, green revenue and profitability of climate-linked business segments.

Indian companies should strengthen domestic manufacturing capabilities in solar cells/modules, batteries, electrolysers, storage systems and other clean-energy technologies to reduce supply-chain and import dependence.

Financial institutions should expand appropriately structured green finance, transition finance and sustainability-linked funding, while maintaining robust verification and disclosure standards.

Policymakers should continue predictable incentives, grid infrastructure, storage support, faster project approvals and stable regulatory frameworks so that renewable and climate-smart investments can scale efficiently.

Companies should publish clearer segment-level financial disclosures for climate-smart businesses. Such disclosures would enable researchers and investors to distinguish the economic contribution of green businesses from the performance of conventional operations.

Future researchers should use larger samples of Indian companies and multi-year panel data and should apply statistical methods such as correlation, regression and difference-in-differences where appropriate. This would provide stronger evidence on whether climate-smart innovation causes improvements in financial performance.

Climate-smart innovation should be assessed not only through carbon reduction but also through energy productivity, resilience, employment, domestic value addition, innovation capability and long-term economic value creation.

5.3 Conclusion

The updated analysis reinforces the conclusion that climate-smart innovation is increasingly becoming an economic strategy rather than only an environmental obligation. India's rapid expansion of renewable capacity, combined with large corporate investments in renewable generation, solar manufacturing, storage, bioenergy and green-hydrogen infrastructure, is creating a new relationship between sustainability and economic growth.

Tata Power demonstrates how an integrated renewable-energy strategy can move towards measurable operating profitability, with strong growth in its renewables and solar-manufacturing businesses. Reliance Industries demonstrates the scale and ambition of a diversified conglomerate transitioning towards a new-energy ecosystem, with FY2026 marking an important shift from construction towards commercialisation. Its expected

New Energy contribution from FY2027 onwards will provide a stronger basis for evaluating the financial outcomes of this transition.

Overall, the evidence supports the view that sustainability and economic growth need not be competing objectives. When supported by technology, appropriate capital allocation, policy stability, green finance and credible measurement, climate-smart innovation can improve resource efficiency, create new markets, strengthen energy security and generate long-term economic value. At the same time, future empirical research should avoid assuming causation from simple trends and should rely on comparable, auditable and statistically tested data.

Updated data cut-off: publicly available information through September 2026. Key sources used for this chapter: MNRE cumulative physical achievements (30 September 2026); Tata Power Integrated Annual Report 2025-26 and FY26 results; Reliance Industries Integrated Annual Report 2025-26, FY26 results and FY27 Q1/AGM disclosures.

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