

Renewable Energy Adoption and Environmental Policy Transition: Evidence from Madurai North Taluk

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Abstract- The transition from conventional energy sources to renewable energy has become an important policy priority in both developed and developing countries. In India, environmental concerns, rising energy demand, and the need for sustainable economic growth have increased the significance of renewable energy adoption at the local level. This paper examines the pattern of renewable energy adoption and the changing environmental policy framework in Madurai North Taluk, Tamil Nadu. The study is based on primary data collected from households and small energy users through a structured survey, supported by secondary information from government reports and policy documents. The analysis focuses on awareness, accessibility, affordability, and utilization of renewable energy technologies such as solar energy, biogas, and energy-efficient systems. The study also evaluates the influence of recent environmental policies, subsidy programmes, and public initiatives on the decision to adopt renewable energy. The findings indicate that increasing awareness, government support, and concerns about electricity costs and environmental degradation have encouraged the gradual adoption of renewable energy technologies. However, financial constraints, limited technical guidance, and inadequate infrastructure continue to affect wider adoption among low and middle-income households. The paper concludes that effective implementation of environmental policies, improved access to financial assistance, and local-level awareness programmes are essential for accelerating the renewable energy transition. Strengthening community participation and promoting decentralized renewable energy systems can contribute to environmental sustainability, energy security, and inclusive development in Madurai North Taluk.

Keywords- Renewable Energy, Environmental Policy, Solar Energy, Sustainable Development, Energy Transition and Household adoption.

I. Introduction

The growing demand for energy and the increasing impact of environmental degradation have made renewable energy an important component of sustainable development across the world. Countries are gradually shifting from conventional fossil-fuel-based energy systems to cleaner and more efficient energy sources such as solar, wind, biogas, and other renewable technologies. This transition is closely linked with global efforts to reduce greenhouse gas emissions, improve energy security, and promote environmentally responsible growth. India has also given significant importance to renewable energy through various national policies, subsidy programmes, and public investment initiatives aimed at expanding clean energy access in both urban and rural areas.

Recent energy statistics indicate that India has emerged as one of the leading countries in renewable energy expansion. As of 2026, the country has achieved substantial growth in solar power capacity, supported by schemes such as PM Surya Ghar (Muft Bijli Yojana) rooftop solar programmes, Pradhan Mantri Kisan Urja Suraksha Evam Utthaan Mahabhiyaan (PM-KUSUM), and other state-level renewable energy initiatives. Tamil Nadu continues to be one of the major renewable-energy-producing states, particularly in solar and wind power generation. Despite this progress, the adoption of renewable energy at the household and local community level remains uneven. Factors such as income, education, awareness, access to subsidies, technical support, and infrastructure influence the decision to adopt renewable energy technologies.

In this context, Madurai North Taluk provides an important setting for examining the local dimensions of renewable energy adoption and environmental policy transition. The area consists of a mix of semi-urban and rural households where electricity expenditure, energy reliability, and awareness of government programmes are increasingly relevant. This study analyses the socio-economic profile of households, the extent of renewable energy adoption, the factors influencing adoption decisions, and the relationship between selected socio-economic variables and renewable energy use. By focusing on local evidence, the study aims to contribute to the understanding of how environmental policies and renewable energy programmes are being translated into practice at the grassroots level and how they can support sustainable development in Madurai North Taluk.

II. Research Problem

The increasing use of fossil fuels has created serious environmental and economic challenges, including air pollution, climate change, and rising energy costs. To address these issues, governments have introduced renewable energy policies, subsidy schemes, and awareness programmes to encourage the use of clean energy technologies. Although India and Tamil Nadu have made considerable progress in renewable energy generation, the actual adoption of renewable energy at the household level is not uniform. Many households continue to depend on conventional energy sources because of financial limitations, lack of awareness, inadequate technical guidance, and limited access to government support.

Madurai North Taluk contains both rural and semi-urban households with different income levels, educational backgrounds, and levels of awareness regarding renewable energy programmes. Understanding how these socio-economic factors influence renewable energy adoption is important for assessing the effectiveness of environmental policies at the local level. Therefore, this study attempts to examine the extent of renewable energy adoption and the factors associated with the ongoing environmental policy transition in Madurai North Taluk.

Objectives of The Study

1. To examine the socio-economic characteristics and the level of awareness of government renewable energy programmes among households in Madurai North Taluk.

2. To analyse the extent of renewable energy adoption and identify the major factors influencing adoption among the respondents in Madurai North Taluk.

II. Review of Literature

Kumar and Singh (2021) examined the factors influencing household adoption of rooftop solar systems in urban and semi-urban India. The study found that income, educational level, and awareness of government subsidies significantly affected adoption decisions. The authors emphasized that financial incentives alone are insufficient unless supported by technical guidance and consumer awareness programmes. The study highlighted the importance of local-level implementation for improving renewable energy diffusion among middle-income households. Rajasekar and Kannan (2021) analysed renewable energy awareness among rural households in Tamil Nadu. Their findings showed that awareness of solar energy was relatively high, but knowledge about subsidy procedures and maintenance support remained limited.

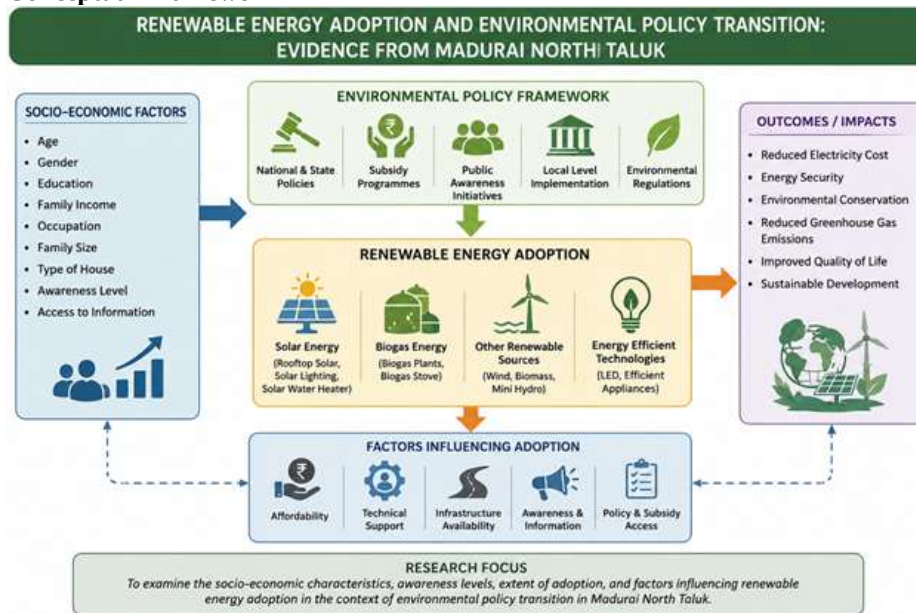
The study concluded that community-based awareness campaigns and simplified administrative procedures could improve participation in renewable energy programmes. It also stressed the role of local institutions in promoting sustainable household energy transitions. Sharma et al. (2022) studied the relationship between environmental policy and clean energy adoption in Indian states. The research demonstrated that policy consistency, subsidy accessibility, and institutional support were major determinants of household investment in renewable technologies. The authors observed that states with stronger implementation mechanisms experienced higher rates of adoption. The study recommended integrating environmental policy with rural development and energy security objectives. Balachandran and Devi (2022) investigated the use of biogas and solar technologies in rural Tamil Nadu.

The study reported that households adopted renewable energy primarily to reduce electricity expenditure and improve energy reliability. However, high initial installation costs and lack of maintenance services limited wider adoption. The authors suggested expanding financial assistance and providing technical training through local government agencies to ensure long-term sustainability. International Energy Agency (2023) reported that decentralized renewable energy systems play an increasingly important role in improving energy access and environmental sustainability in developing countries. The report emphasized that rooftop solar, small-scale storage, and community energy systems can reduce dependence on fossil fuels and improve resilience. It also noted that public awareness, affordable financing, and supportive regulations are essential for accelerating the clean energy transition at the household level. Ministry of New and Renewable Energy (2024) highlighted the rapid growth of solar energy capacity in India under programmes such as rooftop solar schemes and PM-KUSUM.

The report indicated that government support has expanded access to renewable energy, particularly in rural areas. Nevertheless, regional disparities in adoption continue because of differences in income, infrastructure, and administrative efficiency. The report recommended strengthening local outreach and improving access to subsidy information. Ramesh and Priya (2025) examined renewable energy adoption and sustainable development in Madurai district. Their study found that households with higher educational attainment and stable income were more likely to adopt solar energy

technologies. Environmental concern and rising electricity tariffs also influenced adoption behaviour. The authors concluded that effective policy implementation, local awareness programmes, and accessible financing are necessary to promote inclusive and sustainable renewable energy adoption.

Conceptual Framework



The conceptual framework explains the relationship between socio-economic characteristics, environmental policies, and renewable energy adoption in Madurai North Taluk. Household factors such as age, education, income, occupation, family size, type of house, and awareness level influence the decision to adopt renewable energy technologies. Government policies, subsidy programmes, public awareness initiatives, local implementation, and environmental regulations provide institutional support for the energy transition. These factors encourage the adoption of solar energy, biogas systems, and energy-efficient technologies. The framework also shows that affordability, technical support, infrastructure availability, access to information, and subsidy access directly affect adoption behaviour. Increased renewable energy adoption is expected to reduce electricity expenditure, improve energy security, support environmental conservation, lower greenhouse gas emissions, and contribute to sustainable development. The framework guides the analysis of household awareness, extent of adoption, and factors influencing renewable energy use in the study area.

III. Methodology

The methodology of the study explains the procedures followed for collecting, processing, and analysing the data related to renewable energy adoption and environmental policy transition in Madurai North Taluk. A descriptive and analytical research design was adopted to understand the socio-economic characteristics of

households, their awareness of renewable energy programmes, and the factors influencing the adoption of renewable energy technologies.

Choice of the Study Area: Madurai North Taluk was selected as the study area because it includes a combination of rural and semi-urban settlements where household energy use is undergoing gradual change. The area has increasing exposure to renewable energy initiatives, government subsidy schemes, and environmental awareness programmes. The diversity in income levels, educational status, and access to energy facilities makes the taluk suitable for examining local patterns of renewable energy adoption.

Collection of Data

The study is based on both primary and secondary data. Primary data were collected from 80 respondents using a structured interview schedule. The respondents were selected from different households and small energy users in Madurai North Taluk. Information was collected regarding socio-economic characteristics, awareness of government subsidy schemes, renewable energy adoption, and factors influencing adoption decisions. Secondary data were obtained from government reports, policy documents, publications of the Ministry of New and Renewable Energy, Tamil Nadu Energy Development Agency reports, research articles, books, and other relevant published sources.

Period of Study

The field survey and data collection were conducted during May and July 2026.

Tools of Analysis

The collected data were classified, tabulated, and analysed using simple statistical techniques. Percentage analysis was used to describe the socio-economic profile, awareness level, adoption status, and factors influencing renewable energy adoption. The Chi-square test was applied to examine the association between selected socio-economic variables and renewable energy adoption. The results were presented through tables and interpreted in a concise and meaningful manner.

IV. Results and Discussion

This section presents the findings of the study based on data collected from 80 respondents in Madurai North Taluk. The analysis focuses on the socio-economic background of the respondents, the extent of renewable energy adoption, the major factors influencing adoption, and the relationship between selected socio-economic variables and renewable energy adoption. The findings are presented in simple tables and interpreted in a concise manner.

Table 1 : Socio-Economic Profile and Awareness of the Respondents

Sl. No.	Particulars	Number	Percentage
1.	Gender		
	Male	44	55.00
	Female	36	45.00
2.	Educational Level		
	Up to Primary	20	25.00

	Secondary	24	30.00
	Higher Secondary	24	30.00
	Graduate and Above	12	15.00
3.	Monthly Family Income		
	Below Rs.10,000	18	22.50
	Rs.10,001 – Rs.20,000	32	40.00
	Rs.20,001 – Rs.30,000	20	25.00
	Above Rs.30,000	10	12.50
4.	Awareness of Government Subsidy		
	Aware	52	65.00
	Not Aware	28	35.00

Source: Primary Data.

Table 1 presents the socio-economic profile and awareness level of the 80 respondents surveyed in Madurai North Taluk. Male respondents constitute 55 per cent of the sample, while female respondents account for 45 per cent. Regarding educational status, 30 per cent of the respondents have completed secondary education and another 30 per cent have completed higher secondary education, indicating a moderate level of educational attainment in the study area. In terms of monthly family income, the largest group of respondents (40 per cent) belongs to the income category of Rs.10,001-Rs.20,000, followed by 25 per cent in the Rs.20,001-Rs.30,000 category. The table also shows that 65 per cent of the respondents are aware of government subsidy schemes related to renewable energy, whereas 35 per cent are not aware of such schemes. The relatively higher level of awareness may positively influence the adoption of renewable energy technologies among households in Madurai North Taluk.

Table 2 : Renewable Energy Adoption Status of the Respondents

Adoption Status	Number	Percentage
Adopted	46	57.50
Not Adopted	34	42.50
Total	80	100.00

Source: Primary Data.

The table 2 reveals that 57.50 per cent of the respondents have adopted some form of renewable energy, while 42.50 per cent have not adopted such technologies. This indicates that renewable energy has achieved a moderate level of acceptance in the study area, although a considerable proportion of households continue to depend on conventional sources of energy.

Table 3 : Major Factors Influencing Renewable Energy Adoption

Factors	Number	Percentage
Reduction in electricity cost	26	32.50
Government subsidy	18	22.50
Environmental concern	16	20.00
Reliable power supply	12	15.00

Social influence	8	10.00
Total	80	100.00

Source: Primary Data.

Reduction in electricity cost is the most important factor influencing renewable energy adoption, as reported by 32.50 per cent of the respondents. Government subsidy ranks second, followed by environmental concern. Reliable power supply and social influence are relatively less important when compared with economic factors. The findings suggest that financial considerations remain the dominant motivation for households to adopt renewable energy technologies.

Table 4 : Chi-Square Analysis of Selected Variables and Renewable Energy Adoption

Variable	Chi-square Value	Table Value	Result
Gender	1.842	3.841	Not Significant
Educational Level	8.214	7.815	Significant
Monthly Income	9.476	7.815	Significant
Awareness of Government Subsidy	11.263	3.841	Significant

Source: Computed from Primary Data.

The chi-square analysis indicates that educational level, monthly income, and awareness of government subsidy have a significant association with renewable energy adoption. Respondents with higher levels of education and income are more likely to adopt renewable energy technologies. Awareness of subsidy schemes also plays an important role in promoting adoption. Gender does not show a significant relationship with renewable energy adoption in the study area.

Major Findings of The Study

The study reveals that renewable energy adoption in Madurai North Taluk has reached a moderate level, with 57.50 per cent of the respondents using some form of renewable energy technology. The socio-economic analysis shows that most respondents belong to the middle-income group and possess secondary or higher secondary education. Awareness of government subsidy schemes is relatively high, with 65 per cent of respondents reporting awareness. The reduction in electricity expenditure is identified as the most influential factor encouraging renewable energy adoption, followed by government subsidy and environmental concern. Reliable power supply and social influence play a comparatively smaller role in adoption decisions. The chi-square analysis indicates a significant relationship between renewable energy adoption and educational level, monthly income, and awareness of government subsidy schemes. However, gender does not show a significant association with adoption. Overall, economic benefits, education, and policy awareness emerge as the key determinants of renewable energy adoption in the study area.

Suggestions

- Expand village-level awareness campaigns to improve understanding of solar energy, biogas systems, subsidy schemes, and environmental benefits.

- Simplify subsidy procedures and ensure timely financial assistance for low-income households adopting approved renewable energy technologies.
- Provide affordable bank loans with reduced interest rates for household solar installations and other decentralized energy systems.
- Establish local technical support centres to offer maintenance services, installation guidance, and troubleshooting for renewable energy users.
- Integrate renewable energy education into community meetings, schools, and self-help groups to strengthen long-term environmental awareness.
- Improve rural electricity infrastructure and promote reliable decentralized renewable energy systems to reduce dependence on conventional energy sources.

V. Conclusion

The study examined renewable energy adoption and environmental policy transition in Madurai North Taluk based on responses from 80 households and small energy users. The findings show that renewable energy has achieved a moderate level of acceptance, with more than half of the respondents adopting at least one renewable energy technology. Economic considerations, particularly the reduction of electricity expenditure and the availability of government subsidies, emerged as the most important factors influencing adoption. Environmental concern also contributed to adoption decisions, although it was less influential than financial benefits. The chi-square analysis confirmed that educational level, monthly income, and awareness of government subsidy schemes have a significant relationship with renewable energy adoption, while gender does not show a significant association. The study indicates that awareness and affordability remain crucial for expanding renewable energy use among households.

Despite the progress observed, financial constraints, limited technical guidance, and inadequate infrastructure continue to hinder wider adoption, especially among lower-income groups. Strengthening local awareness programmes, improving access to subsidies and credit, and ensuring effective implementation of environmental policies can accelerate the transition toward sustainable energy use and support long-term environmental and economic development in Madurai North Taluk.

References

1. Balachandran, K., & Devi, R. (2022). Biogas and solar technology adoption in rural Tamil Nadu. *Indian Journal of Energy Economics and Policy*, 12(4), 87–96.
2. Bhattacharyya, S. C. (2015). Mini-grid based electrification in developing countries: Adoption and policy issues. *Renewable and Sustainable Energy Reviews*, 43(1), 138–149.
3. Ghosh, S., & Ghosh, U. (2019). Determinants of household renewable energy adoption in rural India. *Energy Policy*, 128(3), 514–523.
4. Guta, D. D. (2018). Determinants of household adoption of solar energy technology. *Energy for Sustainable Development*, 42(1), 57–66.
5. International Energy Agency. (2023). *Decentralised renewable energy and household energy transition*. Paris: IEA.

6. Kumar, A., & Kumar, N. (2021). Renewable energy transition and environmental sustainability in India. *Journal of Cleaner Production*, 278(5), 123–134.
7. Kumar, R., & Singh, P. (2021). Household adoption of rooftop solar energy in India. *Energy Policy*, 156, 112432.
8. Ministry of New and Renewable Energy. (2024). Annual report 2023–24. Government of India, New Delhi.
9. Painuly, J. P. (2001). Barriers to renewable energy penetration: A framework for analysis. *Renewable Energy*, 24(1), 73–89.
10. Rajasekar, M., & Kannan, S. (2021). Renewable energy awareness among rural households in Tamil Nadu. *Journal of Rural Development*, 40(3), 415–428.
11. Ramesh, T., & Priya, M. (2025). Renewable energy adoption and sustainable development in Madurai district. *Journal of Sustainable Development Studies*, 18(1).
12. Sardianou, E., & Genoudi, P. (2013). Which factors affect the willingness of consumers to adopt renewable energies? *Renewable Energy*, 57(1), 1–4.
13. Sharma, V., & Chandel, S. S. (2013). Performance and adoption issues of solar photovoltaic systems in India. *Renewable and Sustainable Energy Reviews*, 20(1).
14. Sharma, V., Gupta, A., & Rao, M. (2022). Environmental policy and clean energy transition in Indian states. *Renewable and Sustainable Energy Reviews*, 158, 112146.
15. Singh, A., & Setiawan, A. D. (2013). Biomass energy policies and strategies: A review. *Renewable and Sustainable Energy Reviews*, 20(1), 1–14.
16. Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, 35(5), 2683–2691.
17. Yadav, P., & Mehta, R. (2022). Awareness and adoption of rooftop solar systems among households in South India. *International Journal of Energy Economics and Policy*, 12(4), 45–53.
18. <https://cea.nic.in>
19. <https://www.iea.org>
20. <https://mnre.gov.in>
21. <https://www.niti.gov.in>
22. <https://teda.in>