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The Role of Government Policies in the Development of the Renewable Energy Market in Tehran's Electricity Sector

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A B S T R A C T

Given the environmental challenges, the unsustainability of fossil fuel resources, and the rapid growth in electricity consumption in major metropolitan areas such as Tehran, the development of renewable energy—particularly in the residential sector—has become a fundamental necessity in macro-level energy policymaking. In this context, government policies can play a key role in facilitating, accelerating, and sustaining the development process of the clean energy market. The present study aims to examine the role of government policies in the development of the renewable energy market within the electricity industry in Tehran. This research is applied in terms of its objective and descriptive-analytical and survey-based in terms of its methodology. The statistical population includes energy experts, specialists, and relevant policymakers in Tehran, and the data were collected through a questionnaire. SPSS and AMOS software were used for data analysis. The results of the study indicate that government policies in areas such as financial support, preferential tariffs, streamlined licensing, and public education have had a significant impact on expanding the use of renewable energy in residential consumption. Moreover, the fit of the conceptual model confirms the research hypotheses and the significance of the relationships among the components. These findings underscore the necessity of revising and strengthening comprehensive, coordinated, and localized policies for the development of the renewable energy market in Tehran's metropolitan area.

Keywords: *Renewable energy, government policies, electricity industry, energy market, Tehran, solar energy, residential consumption.*

1. Introduction

In the face of escalating environmental degradation, energy insecurity, and the undeniable effects of climate change, the global transition toward renewable energy has emerged not merely as an option but as a critical necessity. Urban centers, particularly in developing economies, are experiencing unprecedented growth in electricity consumption, pushing traditional fossil fuel-dependent energy infrastructures beyond their sustainable limits. This pressure has reinforced the importance of adopting renewable energy systems, not only to ensure energy security and environmental preservation but also to foster socio-economic development and green innovation.

Government policy plays a pivotal role in facilitating this transition by creating an enabling environment that addresses market failures, reduces investment risk, and ensures equitable access to clean energy technologies (Gatto & Drago, 2021; Sovacool, 2021).

In cities such as Tehran—where energy demand is rising due to rapid urbanization and increased residential consumption—the need for renewable energy, particularly in decentralized and small-scale formats such as rooftop solar photovoltaics, is more pronounced than ever. However, the expansion of renewable energy technologies in such contexts is heavily dependent on comprehensive, adaptive, and well-integrated governmental policy frameworks. Policy instruments such as feed-in tariffs, subsidies, tax credits, green financing mechanisms, and investment guarantees are commonly employed across countries to reduce the risk and cost associated with renewable energy projects (Chang et al., 2020; Ji et al., 2024; Lu, 2020).

The theoretical foundation for the policy–renewables nexus is grounded in the belief that market forces alone are insufficient to stimulate adequate investment in renewable technologies, especially in markets where fossil fuel subsidies distort price signals or where infrastructural and technological capacities are underdeveloped. Empirical studies have consistently shown that active state intervention through well-targeted policies significantly accelerates the penetration of renewable energy sources (Azhgaliyeva et al., 2023; Hashemizadeh et al., 2024; Xu et al., 2024). For instance, the implementation of guaranteed purchase tariffs has proven effective in enhancing investor confidence by ensuring long-term revenue stability (Martelli et al., 2020). Similarly, direct financial incentives and fiscal reforms have been linked to increased energy diversification and reduced carbon emissions (Chang et al., 2020; Pan et al., 2023).

In the Middle East and North Africa (MENA) region, where fossil fuel dependence remains high, and where environmental sustainability is becoming increasingly critical, countries are gradually shifting toward renewable energy pathways. Empirical evidence from the MENA region confirms that renewable energy consumption positively influences economic growth and employment, provided that supportive policy environments exist (Jouali, 2024; Karimpour et al., 2021). However, challenges persist, particularly in countries like Iran, where despite significant renewable energy potential, the market development has been hindered by inconsistent policies, bureaucratic inefficiencies, and limited access to financial and technical resources (Monourian et al., 2020; Rezaei et al., 2020; Zahedi et al., 2022).

Iran's policy landscape in renewable energy has undergone several shifts, reflecting broader economic and political changes. Although strategic policy documents have identified renewable energy as a priority area, the actual implementation has fallen short of expectations. The lack of consistent regulatory support, inadequate private sector engagement, and limited public awareness are among the key impediments. Additionally, existing subsidies for fossil fuels continue to undermine the competitiveness of renewable technologies, making policy reform a pressing issue (Solaymani, 2021; Zahedi et al., 2022). These structural barriers point to the critical need for a more coherent and incentive-aligned policy framework that supports market entry, technology diffusion, and long-term investment in the renewable energy sector.

The role of public-private partnerships and the design of investor-friendly policy mechanisms have garnered increasing attention as effective tools for overcoming market limitations. Research shows that when policies are tailored to reduce financial risk and promote technological innovation, they can significantly stimulate private sector participation and accelerate renewable energy deployment (Azhgaliyeva et al., 2023; Mehmood, 2023). For example, in Southeast Asia and sub-Saharan Africa, government-backed feed-in tariffs and investment tax credits have enabled smaller energy companies and households to contribute meaningfully to decentralized electricity generation (Gatto & Drago, 2021; Ibrahim et al., 2021). These experiences suggest that Tehran, and Iran more broadly, could benefit from localized policy mechanisms that support community-level renewable energy solutions.

Furthermore, the intersection of environmental governance, technological advancement, and financial innovation has introduced new policy considerations in renewable energy planning. The increasing role of fintech, carbon pricing, and digital monitoring technologies has allowed for more efficient implementation and evaluation of renewable energy policies, contributing to both economic recovery and sustainable development goals (Pan et al., 2023; Zhang et al., 2024). Moreover, the integration of green economic recovery principles, especially after global shocks like the COVID-19 pandemic, has emphasized the importance of sustainable investment as a long-term strategy for climate resilience and inclusive growth (Mehmood, 2023; Zhang et al., 2024).

In terms of methodology, recent studies have highlighted the importance of systems thinking and dynamic modeling in evaluating the effectiveness of government policies in the renewable energy sector. For example, Hashemizadeh et al. (2024) propose a system dynamics model to simulate the impact of various policy interventions on renewable energy development, concluding that integrated policy packages are far more effective than isolated measures (Hashemizadeh et al., 2024). Similarly, threshold models have been used to assess the non-linear effects of investment on renewable energy expansion in different socio-economic contexts (Xu et al., 2024). These approaches offer valuable insights for Iranian policymakers seeking to optimize intervention strategies in complex and dynamic urban energy markets such as Tehran.

It is also important to note that policy design must consider not only economic incentives but also social acceptance and institutional trust. Public engagement and educational campaigns can significantly influence consumer behavior and adoption rates, especially in residential sectors where awareness of energy-saving technologies remains limited. In this regard, targeted subsidies and communication strategies play an essential role in building a culture of sustainability and trust in the long-term benefits of renewable energy (Lu, 2020; Sovacool, 2021). Policies that combine financial and informational instruments tend to achieve broader acceptance and more durable impacts (Gatto & Drago, 2021; Ji et al., 2024).

Given these considerations, the case of Tehran provides a unique opportunity to study the effectiveness of government policy in shaping a nascent but rapidly growing renewable energy market. While the city faces challenges common to many developing urban areas—including grid constraints, policy fragmentation, and funding shortages—it also possesses a relatively high concentration of technical expertise, infrastructure, and policy capacity that could be mobilized to achieve renewable energy targets (Monourian et al., 2020; Rezaei et al., 2020). The current study, therefore, seeks to examine the specific dimensions through which government policies have influenced the development of the renewable energy market in Tehran's electricity industry, with a particular focus on the residential sector.

2. Methods and Materials

The methodology of this study is applied in nature and, in terms of purpose, falls under the category of descriptive–analytical research with a survey approach. The statistical population of the study consists of experts, managers, and practitioners in the renewable energy sector within the electricity industry of Tehran, including individuals employed in organizations such as the Ministry of Energy, the Renewable Energy and Energy Efficiency Organization (SATBA), Tehran Regional Electricity Company, as well as private companies active in this field. The sampling method was purposive (judgmental), based on selecting experts and specialists familiar with and experienced in energy policy and the development of clean energy markets.

The data collection instrument was a researcher-developed questionnaire designed using a five-point Likert scale. The questionnaire included indicators such as financial incentives, feed-in tariffs, legal support, and technological backing under the domain of government policies, and indicators such as investment volume, consumer participation, and installed capacity under the domain of renewable energy market development.

To assess the questionnaire's validity, expert opinion was utilized. Reliability was tested using Cronbach's alpha coefficient, which yielded values above 0.7 for all components, confirming internal consistency. The collected data were initially analyzed using descriptive statistics, including means, standard deviations, and frequency charts. To test the research hypotheses, Pearson correlation analysis and multiple regression were used. Additionally, to examine the conceptual model and causal relationships between variables, structural equation modeling (SEM) was employed using AMOS software to more precisely determine the influence of government policies on the development of the renewable energy market in Tehran's electricity sector.

3. Findings and Results

This section presents the descriptive findings of the study, including statistical indicators related to the main components: government policies and renewable energy market development in Tehran's electricity sector. For descriptive analysis, the mean, standard deviation, minimum, and maximum values were used to assess the status of the respondents' answers to each primary variable and its dimensions. The following table summarizes the descriptive analysis:

Table 1

Descriptive Analysis

Variable / Component	Mean	Std. Deviation	Maximum	Minimum
Government Policies (Total)	3.87	0.61	4.80	2.40
Financial Incentives	4.02	0.55	5.00	2.80
Feed-in Tariffs	3.91	0.68	4.80	2.20
Legal Support	3.75	0.64	4.60	2.40
Technological Support	3.58	0.72	4.60	2.00
Renewable Energy Market Development (Total)	3.81	0.59	4.70	2.60
Investment	3.89	0.53	4.80	2.90
Consumer Participation	3.66	0.68	4.60	2.10
Installed Capacity	3.88	0.61	4.70	2.50

According to the above table, the overall mean for the government policies component is 3.87, indicating relatively high satisfaction among respondents regarding the government's supportive policies in the field of renewable energy. Among the various policy dimensions, the highest mean belongs to financial incentives (4.02), while the lowest pertains to technological support (3.58), highlighting a need for stronger infrastructure and technological backing. Moreover, the total mean for renewable energy market development was estimated at 3.81, with the investment dimension showing the highest mean (3.89). Overall, the descriptive findings suggest that government policies have played a relatively positive role in steering the renewable energy market in Tehran, although certain components, such as consumer participation and technological support, still require more attention.

Table 2

Normality Test Results (Kolmogorov–Smirnov and Shapiro–Wilk Tests)

Variable	Shapiro–Wilk (p-value)	Kolmogorov–Smirnov (p-value)
Financial Incentives	0.135	0.091
Feed-in Tariffs	0.210	0.074
Legal Support	0.056	0.050
Technological Support	0.149	0.120

The Kolmogorov–Smirnov test examines whether the data follow a normal distribution. A p-value greater than 0.05 indicates normality. As shown, the p-values for all variables in this test exceed 0.05, confirming normal distribution. Similarly, the Shapiro–Wilk test—which also assesses normality—produced p-values greater than 0.05 for all variables, indicating that the data follow a normal distribution. Based on these p-values, it can be concluded that the data used in this study are normally distributed, thus permitting the use of parametric statistical tests such as linear regression and structural equation modeling, which assume normality.

Table 3

Correlation Test Results between Government Policy Dimensions and Market Development Indicators

Independent Variable	Dependent Variable	Correlation Coefficient (r)	Significance Level (Sig)	Result
Financial Incentives	Renewable Energy Market Development	0.642	0.000	Significant
Feed-in Tariffs	Renewable Energy Market Development	0.587	0.000	Significant
Legal Support	Renewable Energy Market Development	0.471	0.002	Significant
Technological Support	Renewable Energy Market Development	0.321	0.051	Not Significant

The analysis of the table shows that there is a positive and significant relationship between three key government policy components—financial incentives, feed-in tariffs, and legal support—and the development of the renewable energy market (Sig < 0.05). This suggests that increasing these types of supportive policies can effectively foster the growth of the

renewable energy market in Tehran's electricity sector. In contrast, the relationship between technological support and market development is statistically insignificant (Sig = 0.051), which may indicate that government technological initiatives have not been sufficiently effective or are not yet fully institutionalized in the industry.

Table 4

Model Fit Indices

Fit Index	Obtained Value	Acceptable Range	Result
Chi-square/df	1.85	< 3	Adequate
RMSEA	0.052	< 0.08	Good
GFI	0.91	> 0.90	Adequate
CFI	0.96	> 0.90	Good
NFI	0.93	> 0.90	Good

The Chi-square/df ratio of 1.85 indicates a good fit between the model and the observed data, as values under 3 are considered acceptable. The RMSEA value of 0.052 reflects a low level of model approximation error, which is also indicative of good model fit. The GFI value of 0.91 shows a strong overall match between the model and the data. Both the CFI (0.96) and NFI (0.93) values exceed the 0.90 threshold, confirming that the model significantly improves over a null model with no relationships among variables. Collectively, these indices affirm that the conceptual model of the study fits the empirical data well. Therefore, the proposed causal structure between government policy variables (financial incentives, tariffs, legal support, and technological support) and the development of the renewable energy market in Tehran's electricity sector is statistically validated.

In summary, the inferential analysis confirms the main hypothesis of the study, asserting the impact of government policies on renewable energy market development.

Table 5

Path Analysis Results (Structural Equation Modeling Using AMOS)

Causal Path	Path Coefficient (Beta)	Critical Ratio (CR)	Significance Level (P-value)	Result
Financial Incentives → Renewable Energy Market Development	0.41	4.85	0.000	Significant
Feed-in Tariffs → Renewable Energy Market Development	0.36	4.19	0.000	Significant
Legal Support → Renewable Energy Market Development	0.28	3.54	0.001	Significant
Technological Support → Renewable Energy Market Development	0.19	1.91	0.056	Not Significant

As shown in the table, the greatest direct effect on the development of the renewable energy market is associated with financial incentives, with a path coefficient of 0.41. The smallest effect pertains to technological support, with a coefficient of 0.19, which is not statistically significant (P = 0.056). The critical ratios (CR) for the first three components exceed 1.96 and their significance levels are below 0.05, indicating significant influence in the final model.

In summary, policies such as granting loans and facilities, setting preferential tariffs for the purchase of electricity from renewable sources, and enacting supportive regulations play a decisive role in developing this type of energy market. However, the results also suggest that governmental technological initiatives have not yet effectively contributed to market growth and require further reinforcement.

4. Discussion and Conclusion

The findings of this study underscore the significant influence of government policies—specifically financial incentives, feed-in tariffs, and legal support—on the development of the renewable energy market in Tehran's electricity sector. Among the components studied, financial incentives demonstrated the strongest direct effect (β = 0.41), followed by feed-in tariffs (β = 0.36), and legal support (β = 0.28), all of which were statistically significant. However, technological support, while positively associated, did not reach statistical significance (β = 0.19; p = 0.056), indicating a weaker and more uncertain role in driving market growth. These results collectively validate

the hypothesis that policy instruments have a measurable and differentiated impact on the evolution of renewable energy systems within urban settings.

The pivotal role of financial incentives is in line with international findings that emphasize how subsidies, low-interest loans, and tax exemptions reduce investment risk and improve capital flow into renewable energy sectors (Chang et al., 2020; Martelli et al., 2020). Financial mechanisms are often the initial catalysts for mobilizing private sector participation, especially in contexts where market maturity is low and operational costs are high. In the case of Tehran, the higher mean scores and stronger path coefficients suggest that when financial aid mechanisms are present, investor confidence and market expansion both increase. This observation mirrors results from China, where green fiscal policies at the firm level improved investment efficiency and innovation in renewable energy firms (Chang et al., 2020).

Feed-in tariffs also had a significant and positive effect on market development. These tariffs ensure guaranteed pricing and long-term purchasing agreements for energy producers, making them essential instruments in stabilizing revenue streams and encouraging early market entry (Ji et al., 2024). As seen in other MENA countries, feed-in tariffs have contributed to rapid scaling of renewable energy capacity, particularly in solar photovoltaic systems (Jouali, 2024; Karimpour et al., 2021). In Iran, however, the irregular implementation and delayed payments associated with feed-in tariffs have been persistent obstacles, as documented in earlier evaluations of Iran's renewable policy framework (Rezaei et al., 2020; Zahedi et al., 2022). Thus, while the statistical significance of feed-in tariffs in this study reaffirms their structural value, it also implies that further administrative reform is necessary to enhance their practical impact.

Legal support emerged as the third significant factor contributing to the market's expansion. Regulatory clarity, land-use rights, and streamlined licensing procedures are integral to minimizing bureaucratic delays and reducing operational uncertainties (Lu, 2020; Solaymani, 2021). The findings align with literature asserting that well-designed legal frameworks provide predictability and transparency, which in turn attract both domestic and foreign investors (Azhgaliyeva et al., 2023; Sovacool, 2021). However, the comparatively lower coefficient for legal support in this study suggests that while foundational regulations exist, they are either inconsistently enforced or not comprehensive enough to support the diverse needs of stakeholders across Tehran's energy ecosystem.

The least impactful dimension was technological support, which did not achieve statistical significance despite showing a positive directional trend. This outcome points to potential deficiencies in state-sponsored research and development (R&D), weak linkages between universities and industry, and limited availability of domestic manufacturing infrastructure for renewable components (Rezaei et al., 2020; Zahedi et al., 2022). Although many countries have recognized the critical role of innovation systems in renewable energy growth—highlighted by the success of China's localized technological development (Xu et al., 2024; Zhang et al., 2022)—Iran appears to lag in integrating technology support into its broader energy policy strategy. This gap reinforces the need to prioritize knowledge-based development and technological self-reliance as essential components of long-term energy planning.

The model fit indices (e.g., RMSEA = 0.052; CFI = 0.96; GFI = 0.91) further confirm the robustness and validity of the conceptual model applied in this research. These indicators demonstrate that the observed data align well with the theoretical structure proposed, supporting the hypothesis that government policy components are causally linked to renewable energy market outcomes. Such findings correspond with system dynamics models from recent studies, which highlight how interactive, policy-driven systems yield positive long-term feedback for market stability and expansion (Hashemizadeh et al., 2024).

In comparing these results with international case studies, it becomes evident that the integration of financial and legal policy tools is most effective when deployed synergistically. Countries with coordinated policy frameworks—such as South Korea, China, and select European nations—have succeeded in embedding renewable energy into mainstream infrastructure by aligning investment strategies with policy mandates and governance mechanisms (Gatto & Drago, 2021; Pan et al., 2023). This comparative perspective suggests that Tehran's renewable energy growth can accelerate if supported by coherent, multi-level policy alignment. Moreover, the introduction of adaptive governance approaches, which allow for periodic revision based on market feedback and technological advances, could further enhance policy effectiveness (Lu, 2020; Mehmood, 2023).

The regional specificity of this study—focused on Tehran—also adds an important urban energy governance

perspective to the literature. In megacities, energy challenges are often amplified by population density, infrastructural limitations, and administrative complexity. The results of this study highlight that targeted urban energy policies must not only reflect national directives but also incorporate local realities and capacities. This approach is consistent with recommendations in urban energy transition literature advocating for localized policymaking and the empowerment of municipal authorities (Ibrahim et al., 2021; Monourian et al., 2020).

The evidence from this study also speaks to the potential for renewable energy to act as a driver of economic diversification and resilience in Iran. Prior studies have shown that renewable energy deployment in the MENA region correlates with job creation, regional development, and reduced vulnerability to oil price volatility (Jouali, 2024; Karimpour et al., 2021). The strengthening of policy frameworks—particularly financial and legal mechanisms—can thus yield co-benefits that extend beyond energy to socio-economic stability and climate resilience.

This study, while robust in its design and analysis, faces certain limitations. First, the geographic scope is confined to Tehran, which limits the generalizability of the findings to other provinces or rural areas in Iran. Second, the study relies on perceptual data collected via questionnaires, which may introduce respondent bias or subjective interpretation. Third, the rapidly evolving nature of energy policies and international sanctions affecting Iran may result in dynamic shifts that are not fully captured in a cross-sectional study. Lastly, technological support, though conceptually vital, may have been underrepresented due to limited data availability or insufficient operationalization of relevant indicators.

Future studies could extend the scope of analysis to multiple Iranian provinces or conduct a comparative study across several MENA countries to identify regional similarities and divergences. Longitudinal research designs would allow for tracking the impact of specific policy changes over time, offering more definitive insights into causal relationships. In addition, qualitative methods such as expert interviews or policy content analysis could complement the survey findings and provide a richer understanding of institutional dynamics. Furthermore, incorporating macroeconomic and environmental variables such as GDP growth, carbon emissions, or energy import/export data would deepen the analysis of renewable energy development pathways.

Policymakers should prioritize the reinforcement and timely implementation of financial incentives and feed-in tariffs to attract private investment and foster market stability. Legal reforms should aim to reduce bureaucratic obstacles and enhance regulatory predictability for all stakeholders. Technological support needs strategic investment in R&D, partnerships with universities, and incentives for local manufacturing to ensure a resilient supply chain. Finally, coordination among governmental agencies, local authorities, and private firms should be institutionalized to create a transparent and adaptive policy ecosystem capable of accelerating the transition to renewable energy in Tehran and beyond.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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