Combination of Antecedent Conditions Affecting the Development of Chinese New Energy Market Based on Fuzzy Sets

Abstract: This study discusses the combination of elements that affect the development of a new energy market under the framework of TOE theory. Through the fuzzy set qualitative comparative analysis method, several paths that contribute to the development of a new energy market are analyzed. This study serves as an important reference for effective investment and sustainable development of the new energy market. The results of the study emphasize that the lack of financial markets can cause the regional new energy market to continue to be hindered. Through different grouping paths, we find that blind policy incentives or large financial investments without meeting the necessary market demand, economic fundamentals, and other preconditions will face the risk of failure.

Keywords: New Energy Market; fsQCA; Antecedent Configuration

1. Introduction

Policymakers worldwide are increasingly acknowledging the complex task of tackling climate change and ensuring energy security (Zhao et al., 2024). Concurrently, over 80% of the global energy supply depends on exhaustible fossil fuels, and the distribution of these resources across different regions is disparate, posing notable energy security obstacles (Khan et al., 2023). As such, the emergence and rivalry within the new energy sector will serve as a crucial battleground in the forthcoming wave of technological and industrial competition. The escalating global electricity demand and the imperative to mitigate environmental pollution underscore the compelling nature of new energy as a solution for the Chinese energy market (Wang et al., 2024). As a burgeoning market for renewable energy, China has adopted a transformative paradigm toward sustainable development (Xu et al., 2018). In this context, it is of great significance to explore the influencing factors that drive the development of Chinese new energy market and to study the sustainable development model of the new energy market on this basis, to promote the world's energy transition.

Through energy portfolio diversification and reduced reliance on non-renewable resources, China can effectively leverage the capabilities of new energy technologies to meet its ever-increasing energy demands while concurrently addressing environmental concerns (Chai et al., 2022). The acknowledged environmental bane induced by non-renewable energy has surged investment in the renewable industry, reaching a record of $2.6 trillion in 2019（Bloomberg NEF, 2019）. Projections show that clean energy utilization will increase fivefold in two decades, meeting 14 percent of global primary energy demand (Economics, 2018). However, the emergence of Covid 19 has impacted the global economic situation and influenced the worldwide energy transition, and it is particularly important that new energy sources can be developed with high quality in this context (Ofori et al., 2023).

Following the World Health Organization's declaration of the virus as a global pandemic, the US stock market experienced a rapid decline, entering bear territory with a 20% drop from its recent peak within a few weeks, marking the fastest decline since the Global Financial Crisis. Similarly, stock markets in the UK and Japan witnessed declines of 10% and 20%, respectively, reflecting a similar trend worldwide. Data, however, showed China was among the worse impacted countries; statistics showed they faced a 6.8% economic contraction in Q1 2020, impacting clean energy investment and the energy market, with a record-low PMI of 35.7 and a 6.6% decline in exports (National Bureau of Statistics of China, 2021). Post covid –there are calls to recess the new energy market to ascertain its trajectory to inform policy. As such, this study underscores the pivotal role of the new energy market as a catalyst in propelling China towards a greener and more sustainable future, exemplifying the country's unwavering commitment to combatting climate change through the widespread adoption of clean energy solutions (Chai et al., 2022a).

Chinese impressive ascent as a dominant force in new energy investment has been extensively documented in scholarly literature. Zhang et al. (2016) highlighted Chinese surpassing of the EU and the US in terms of new energy investments, while Chen et al. (2020) emphasized Chinese role as the largest contributor to global renewable capacity growth. However, despite these accomplishments, some barriers stand as a critical bottleneck that hinders the Chinese energy revolution. Notably, scholars such as Nurmakhanova et al. (2023), Bouteska et al. (2023), and Yadav et al. (2023) have examined the intricate relationship between general financial development and its influence on the financing challenges encountered in Chinese renewable energy sector.

Thus, developing renewable energies in China entails confronting numerous distinctive challenges. Within the electric utility industry, these challenges encompass barriers to inadequate power grid infrastructure (Chai et al., 2022), technical complexities related to peak shaving during winter in certain regions (Wei et al., 2023), and fluctuations in power demand (Ding et al., 2018). Moreover, institutional factors further contribute to these challenges (Ofori et al., 2023). Chinese carbon-neutral commitment highlights the need for a transition from traditional fossil energy sources to new ones. However, there is a huge gap in the literature regarding a comprehensive definition of how to effectively achieve this ambitious goal. While previous studies have examined the influence of individual factors such as organization policy (Hu et al., 2022), market dynamics (Chen et al., 2023), technology diffusion (Chen et al., 2023), society imperative (Du et al., 2022), and environment consciousness (Bouteska et al., 2024) on the development of the new energy market, a holistic understanding of their combined impact remains elusive. As such, the novelty of this paper encapsulates doing that and adding a few pointers.

Thus, this scholarly paper utilizes -fuzzy sets to examine the driving factors and design pathways contributing to the high-quality development of new energy. The fsQCA technique gathers pertinent information from intensive case studies, effectively resolving the common "multiple coincidences point" causality problem prevalent in comparative theory. Also, in comparison to existing literature, this paper makes notable advancements in several key areas. Firstly, it focuses on scrutinizing the micro-level development of new energy in China, meticulously investigating the modes and pathways of development while considering crucial antecedents such as market dynamics, technological advancements, and societal perspectives. Consequently, this research enriches the existing qualitative and quantitative studies of new energy development.

Secondly, regarding the measurement of the level of new energy development, this paper surpasses the limitations posed by single evaluation indices by introducing a comprehensive multidimensional evaluation system. By adopting this approach, more thorough coverage of new energy dimensions is achieved. Thirdly, based on the well-established Technology-

Organization-Environment (TOE) theory, this study describes how the three dimensions affect the new energy market and empirically tests this hypothesized relationship to determine which dimension is more important for the development of the new energy market. Lastly, this paper exhibits a creative utilization of fuzzy set qualitative comparative analysis to explore the trajectory toward enhancing the level of new energy development in China.

By employing diverse methodologies and considering critical factors, this paper makes significant technical contributions to understanding new energy development. Consequently, it offers valuable insights for future research and practical implementation in this specialized domain. The research findings of this study are expected to yield substantial theoretical and practical implications for the planning and implementation of new energy initiatives. This assessment aids in maximizing potential benefits while minimizing potential risks, enabling enterprises to adopt a proactive strategy rather than a reactive approach toward emerging challenges. Given the significant number of enterprises worldwide that have yet to venture into the energy sector, the availability of a quantifiable assessment tool holds considerable utility. It is worth noting that the scarcity of empirical research in this specific domain underscores its underexplored nature, thereby positioning this study to fill a substantial research gap. Furthermore, the outcomes of this research align directly with the Sustainable Development Goals (SDGs) 7 and 13, contributing to the global pursuit of sustainable and environmentally conscious energy solutions.

2. Literature review and Theoretical Framework

Before 2005, the Chinese new energy sector had been growing at a moderate pace. The enactment of national laws on renewable energy in China since 2006 has contributed to the development of the new energy market. Overall, every part of the nation is dedicated to fostering the growth of new energy high-tech businesses, with the help of the Chinese government. New energy is therefore growing quickly as an emerging sector. According to the life cycle hypothesis, from a qualitative standpoint, the market is growing quickly in the early stages, demand is rising, and technical development is happening quickly. The firm in this sector is primarily focused on securing market share, but the technology is insecure and there is little knowledge of the market dynamics, the level of competition, or the user base. The entrance barrier is low; during the expansion stage, the market's expansion rate and the rate of demand expansion both increases, and the technology becomes more developed. Chinese new energy industry is at this stage of rapid expansion. During this phase, the Chinese government recognized the urgent need to rectify the harmful environmental impacts of the current economic development model, and this led to the development of a series of central and local policy, most notably the vigorous promotion of the new energy market (Chai et al., 2022b). On this basis, various new energy sources are being rapidly utilized and developed. This new market is volatile and requires holistic understanding to further understand which pathways would lead to the most efficient and effective new energy development market.

However, the existing research has predominantly focused on exploring the isolated effects of specific factors on the new energy sector. However, the intricate interplay and synergistic effects between these (market dynamics, technological advancements, and societal perspectives) elements have not been adequately examined. Understanding how these factors interact and shape the trajectory of new energy development in China is crucial for formulating effective strategies and policies that facilitate the transition to a sustainable energy landscape.

2.1 Drivers of New Energy Market Development

The development of new energy is influenced by numerous factors. This paper compiles and analyzes the factors impacting new energy development, encompassing aspects such as the economy, environment, resource endowment, and technology, as illustrated in Table 1. The factors influencing new energy development are diverse, with a notable focus on technology, organization, and environmental factors extensively examined by scholars in the field.

Table 1. Literature on the influencing factors of new energy

Factor of interest	index	Supporting Literature
Technology	Grid integration system	Guo et al. (2017)
	Green technology	Devine and McCollum (2019)
	Energy conversion & Storage	Shao et al. (2022)
	Battery technology	Yu et al. (2022)
	Solar panels	M. Li et al. (2022)
	Power generation efficiency	Chai et al. (2023)
Organization	ISO 14001	Ullah et al. (2022)
	Environmental Management System	Wang et al. (2023)
	Green Economy	Chai et al. (2023)
	Investment	Dhifaoui et al. (2023)

	Energy prices and competitiveness	Ren et al. (2023)
	Risk-taking	Chen et al. (2023)
Environment	Air pollution	Zhang et al. (2022)
	Kyoto Protocol	(Xu & Zhang, 2022)
	Double carbon	(Wang et al., 2023a)
	Rural or urban area population	(Yan & Huang, 2022)
	Governance Intervention	(Lv et al., 2022)
	Resource curse	(Wu & Bai, 2022)

Due to the phenomenon of global warming and the increasing ecological footprint, there is a significant possibility that green energy resources will emerge as a prominent energy source (Fan et al., 2022). Many nations are actively seeking strategies to harness the potential of green sources, particularly wind energy, which boasts advantages such as high storage capacity, lack of pollution, and mature implementation (Xu et al., 2022). The International Atomic Energy Agency acknowledges the tremendous developmental prospects associated with nuclear power. However, it is important to note that political and energy security concerns are intertwined with its utilization (Gong et al., 2022). Consequently, it is crucial to closely examine the trajectory of new energy development, as it holds substantial promise (Ofori & Appiah-Opoku, 2023).

Existing literature unequivocally demonstrates that technological innovation plays a pivotal role in enhancing the efficiency of new energy utilization (Tabrizian, 2019). Thus Countries that recognize the significance of fortifying their technological infrastructures are poised to gain a competitive edge in the global marketplace. He et al. (2019) conducted a comprehensive analysis of the potential technological requirements for new energy development, employing a subject-action-object framework. They argued that solar power has advanced to the stage of technology application, with corresponding products and production equipment available.

From the organizational level, both the support from the central government and the entry of private capital have contributed to the development of the new energy industry. Policy support plays an important role in the development of the PV industry (Liu et al., 2022). Price subsidies for new energy vehicles stimulate market demand and ultimately promote the development of the new energy vehicle industry (Liu et al., 2021). Kang et al. (2020) explored the important role of capital markets from an industrial economics perspective using genetic neural networks and fuzzy algorithms.

The other leg is market dynamism's influence on new energy development. Works like Zou et al (2017) demonstrated the importance of government-led market reforms to foster the development of new energy sources. Their research highlighted the need for targeted interventions, such as the introduction of subsidies, to incentivize increased investment in this sector. By implementing these reforms, governments can create a more favorable environment for the growth and advancement of new energy technologies.

Existing studies on Chinese use of industrial policies in the energy industry primarily focus on local analysis, specific regions, or specific forms of energy. They examine the selected aspects but neglect the screening process (Liu et al., 2023). Overall energy policy analysis is limited, with few comprehensive studies. For instance, Wei et al. (2023) provide a comprehensive analysis of Chinese energy strategy since the country's founding, but it lacks a detailed examination of policy implementation and the classification of policy tools. Therefore, it does not align well with the current industrial policy analysis framework.

2.2 TOE Theory and Framework Design

Based on the TAM model and innovation diffusion theory, Tomatzky and Fleischer formally proposed the TOE theoretical framework in 1990 (Uzay et al., 2021). This is a comprehensive analysis framework based on the technology application context, which mainly includes the contents of technology(T), organization(O), and environment(E). Among them, the technological level mainly includes the basic technological conditions, such as technological infrastructure, technological capability, innovation capability, etc.; the organizational level mainly includes the organization's structural model, organizational scope, and attitudes of the organization's personnel, etc.; and the environmental level mainly includes the specific environment in which the organization is situated, such as involving the economy, society, culture, and many other aspects.

In the pursuit of the double carbon goal, China faces the challenge and opportunity of incorporating new energy sources into its economic landscape. This transition requires both enterprises, aiming to achieve their business goals while fulfilling social responsibilities, and a government committed to environmental prudence. To effectively navigate this complex landscape, organizations must assess their readiness for the new energy market, while the government must evaluate how opening this market can contribute to reducing environmental risks associated with conventional energy sources. Drawing upon the Technology-Organization-Environment (TOE) framework, this scholarly study aims to develop a measurement instrument and research framework to investigate the readiness of the new energy market in China. The assessment will be conducted from the perspective of technology, organization, and environment, providing valuable insights to guide stakeholders toward informed decision-making. As depicted in Figure 1 (see Figure 1), the proposed model comprehensively identifies and examines the various aspects and components related to new energy development. The model postulates that each aspect plays a significant role in influencing the outcomes associated with the adoption of new energy sources.

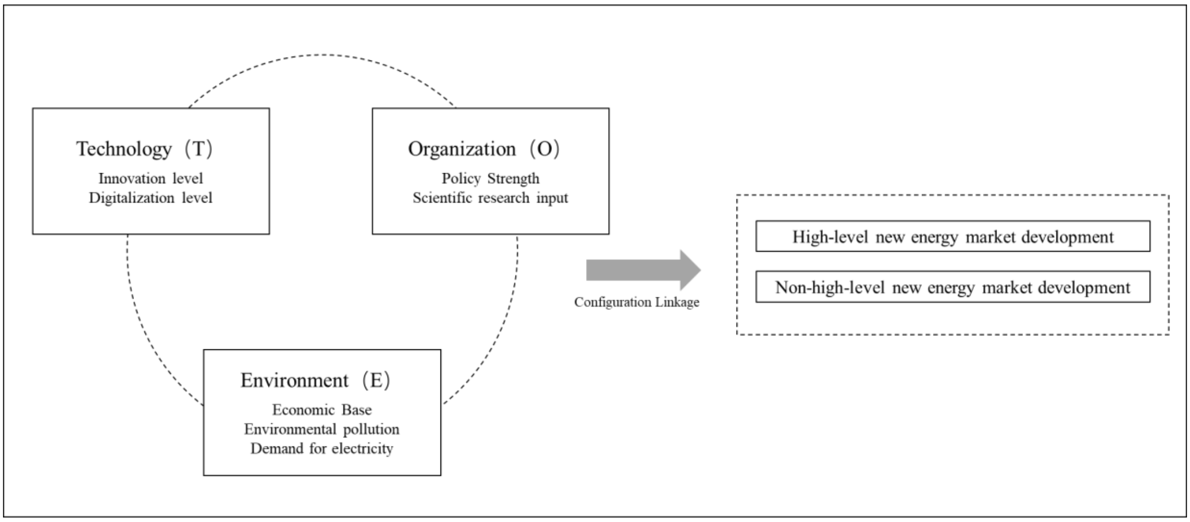

Figure1. TOE model of the antecedents of new energy market development

3. Data and Methods

3.1 Qualitative Comparative Analysis

Qualitative Comparative Analysis (QCA) is a method for exploring the combination of antecedent conditions that lead to an outcome in a complex situation through cross-case comparisons. The method focuses on the combination of conditions that affect the outcome with a holistic perspective and groupthink, which can help researchers understand the essential characteristics of things more comprehensively. This study chooses fsQCA to study the combination of factors affecting the new energy market for the following main reasons: firstly, the market development does not happen overnight, but is the result of a combination of factors that promote together; secondly, there are a large number of scholars who have empirically analyzed the impact of the new energy market in terms of policy support, technology support, resource endowment, etc., which provides the basis for this study, but from the realistic level, even if some provinces receive policy subsidies, their new energy market development prospects are not optimistic. The qualitative comparative analysis method can test the causal asymmetry in the logical hypothesis; finally, the qualitative comparative analysis method is suitable for the comparative analysis of small and medium-sized case samples, so that we can see which provinces are suitable for which development paths from different cases, which makes the analysis more typical and systematic.

3.2 Variable selection and measurement

In this study, 31 provinces in China are selected to study the impact of factors at the technological, organizational, and environmental levels on the development of the new energy industry under the TOE framework. Considering the impact of the epidemic and the variability of economic and social development in recent years, this study, to overcome the influence of individual years on the overall results, refers to the Time-Series Qualitative Comparative Analysis (TSQCA) method proposed by Hino et al. (2009), and put this study's data are analyzed by choosing the mean data of the period of quality improvement and upgrading of Chinese new energy market development (2016-2021) to solve the problem of data heterogeneity. The data were mainly obtained from the China Statistical Yearbook (2017-2022), China Energy Statistical Yearbook (2017-2022), National Renewable Energy Center, China Electricity Council, and LegalStar.com.

3.2.1 Result Variables

This study uses new energy market size as the outcome variable. Specifically, the ratio of new energy power generation in each region to the overall regional power generation is chosen, and this ratio is used to measure the new energy market size in different regions. The larger the ratio, the higher the level of development of the new energy market in the region.

3.2.2 Conditional Variables

① Technological Context

Innovation level. The development and utilization of new energy require technological support, and the depth and breadth of technological utilization depend on the degree of innovation. An increase in the level of innovation can significantly affect the development of new energy sources (Zeng et al., 2023). In this study, the number of domestic patent applications received in each province is chosen as a characterization of innovation capacity.

Digitization level. On the one hand, increased digitization can improve enterprise productivity through data management and forecasting; on the other hand, information collected based on big data will effectively calculate enterprise performance and reduce enterprise costs (Ren et al., 2022). In this study, the digital development index is used to measure the level of digitization in each region, and specifically, the index measures four dimensions, including new factor inputs, digital infrastructure, digital economic development, and digital social construction.

② Organizational Context

Government Support. The development and utilization of new energy sources require large investments in capital and infrastructure in the early stages of the market, so their development depends on government support, and the government's supportive attitude towards new energy sources promotes the development of new energy sources (Lu et al., 2022). In this paper, we refer to the measurement methods of previous scholars to quantify the new energy industrial policies of each province. Firstly, on the Legal Star website will be "new energy" and "policy," "outline," "planning," "program," "regulations," "opinions," "notice" and other words arranged combinations of searches, the use of octopus software to set up a crawling program, access to relevant information totaling 1364. Secondly, screening the data since 2016 and manually cleaning invalid information as well as duplicated information, etc., and finally identifying 524 valid policy information, with data fields including policy type, time of issuance, province, policy name, etc. Finally, the policies were scored according to the type of policy as well as the issuing organization, and the scoring criteria are shown in Table 2.

Table 2 Policy Strength Scoring Criteria

Type of policy				publishing organization	
Policy	Programs, plans, outlines	comment	notifications	Central institutions	Local institutions
4	3	2	1	2	1

Based on the scoring criteria in Table 2, policy strength is calculated according to equation

(1):

$$G = \sum_{i=1}^{n}(GT_i + GI_i) \quad (1)$$

Where G demos the policy strength score GT_i is the issuing unit score of the polycyclic GI_i is the policy type score of the ith policy; and n is the number of policies. The final calculation based on equation (1) yields the policy strength of 31 provinces from 2016 to the present.

Financial Support. Financial support for new energy development includes tax concessions, price incentives, and so on, and its implementation combines the government, enterprises, financial institutions, and social organizations such as the power grid sector. Financial support can help improve enterprise performance and stimulate new energy development (Zhang et al., 2023). In this paper, the level of government support for science and technology is selected as a measure of government financial investment, characterized by the ratio of science and technology expenditures to fiscal expenditures in each province.

③ Environmental Context

Economic Base. The economic base is used to measure the level of economic development of each province, and the economic base provides external environmental support for the development of new energy (Yang et al., 2013). In this paper, the gross domestic product (GDP) per capita is chosen to describe the economic base.

Environmental Pollution. Potential environmental conditions stimulate the determination of regions to develop new energy sources, and poor environmental pollution stimulates local development of new energy sources (Liu, 2023). In this paper, the carbon dioxide emissions of each province are selected to measure the environmental pollution of each province.

Electricity Demand. Social electricity demand reflects the market capacity for new energy development to a certain extent, and as local electricity demand increases, the influence of environmental regulations will stimulate the local community to increase the proportion of new energy on the power generation side (Ma, 2011). In this paper, electricity consumption is chosen as the characterization of social electricity demand. Specific variable descriptions are shown in Table 3:

Table 3 Variable descriptions

Type	Variable	Symbols	Indicators

Result Variables		New Energy Market Development	Ne	Renewable energy generation (excluding hydropower)/total generation
Conditional Variables	Technical Context	Innovation level	Inn	Number of patent applications received
		Digitalization level	Dig	Digital Development Index
	Organizational Context	Government Support	Gov	Policy Release Strength
		Financial Support	Fin	Financial science and technology expenditure / local financial general budget expenditure
	Environmental Context	Economic Base	Eco	GDP per capita
		Environmental pollution	Pol	Carbon dioxide emissions
		Electricity Demand	Dem	Society-wide electricity demand

3.3 Data Calibration

Fuzzy set qualitative comparative analysis is an exploration of multifactor pooled relationships and therefore requires calibration of the variables and their transformation into pooled dimensions on this basis. For the selection of data calibration anchor points, this study refers to Fiss (2011). The quartile method was used as the fuzzy calibration points for the condition and outcome variables, with 75%, 50%, and 25% as the fully affiliated, crossover, and fully unaffiliated thresholds, so that the variable data were between 0 and 1. Variables descriptive and data calibration are shown in Table 4.

Table 4 Results of descriptive analysis of variables and data calibration

Variables	Fuzzy calibration points			Descriptive analysis		
	Fully affiliated	Intersections	Completely unaffiliated	Average value	Maximum value	Minimum value
Ne	0.176	0.098	0.046	11.53%	29.31%	1.43%
Inn	157223.875	88438.417	29650.250	139520.34	780476.33	5017.50
Dig	0.433	0.320	0.228	0.36	0.80	0.18
Gov	68.000	43.500	31.750	53.50	159.00	5.00
Fin	0.035	0.018	0.011	2.33%	5.87%	0.64%
Eco	7.458	5.415	4.747	6.66	15.40	3.34
Pol	59947.764	31938.925	23173.347	44601.95	148587.50	6149.68
Dem	1126.369	1787.670	2953.932	2350.62	6563.58	340.34

4. Results and Discussion

4.1 Necessary Conditions Analysis

Before analyzing the data, it should be checked whether a condition is necessary to constitute the result. The condition is usually considered necessary to exist when the consistency is higher than 0.9. This paper uses the calibrated data to carry out the necessity test of the conditional variables for the outcome variables, and the test results (as shown in Table 5) indicate that the necessity of the single antecedent conditions affecting the development of high-level new energy market or the development of non-high-level new energy market is less than 0.9, which indicates that the independent explanatory power of each single condition for the outcome is weak. Therefore, further configuration analysis of these conditions is required.

Table 5 Analysis of Necessary Conditions

Variables	Ne		~Ne	
	Consistency	Coverage	Consistency	Coverage
Inn	0.377	0.381	0.668	0.702
~Inn	0.705	0.671	0.411	0.408
Dig	0.365	0.389	0.619	0.687
~Dig	0.707	0.640	0.450	0.425
Gov	0.402	0.412	0.624	0.666
~Gov	0.674	0.632	0.449	0.439
Fin	0.359	0.376	0.647	0.705
~Fin	0.717	0.661	0.427	0.410
Eco	0.445	0.440	0.617	0.636
~Eco	0.632	0.613	0.457	0.461
Pol	0.549	0.557	0.486	0.513
~Pol	0.519	0.492	0.580	0.573
Dem	0.591	0.563	0.540	0.536
~Dem	0.513	0.517	0.560	0.588

4.2 Analysis of the adequacy of the conditional configuration

The fsQCA software was further used to construct the truth table and set the case frequency threshold to 1 and the PRI consistency threshold to 0.8 based on the higher default criteria, and then the criterion analysis was performed to derive the complex solution, the analytical solution, and the intermediate solution. The obtained condition configurations are shown in Table 6.

Table 6 Antecedents of new energy market development

Antecedent conditions	Ne		~Ne				
	1	2	1a	2b	3c	2	3
Inn	⊗	⊗	⊗	●	●	●	⊗
Dig	⊗	⊗	●	●	●	●	⊗
Gov	⊗	⊗	●	●	●		●
Fin	⊗	⊗	⊗	⊗	⊗	●	●
Eco	⊗	●	●	●	⊗	●	⊗
Pol	⊗	●	⊗	●	●	⊗	⊗
Dem	⊗	●	⊗	⊗	●	⊗	⊗
raw coverage	0.125	0.280	0.084	0.057	0.112	0.270	0.102
unique coverage	0.097	0.252	0.027	0.018	0.066	0.201	0.047
consistency	0.825	0.819	0.895	0.822	1.000	0.950	0.897
solution coverage	0.377		0.447				
solution consistency	0.855		0.947				

Note: ●Indicates the presence of core variables in the configuration path, •indicates the presence of an edge variable in the configuration path, ⊗ indicates that core variables are missing from the configuration path, ⊗ indicates that an edge variable is missing from the configuration path, blank space indicates that the variable may or may not be present in the configuration path.

4.2.1 Influencing factors of high-level new energy market configuration

Table 6 shows that there are two types of grouping results that generate high levels of new energy market development. According to their grouping characteristics, they can be categorized as self-motivated and environmentally led.

①Self-motivated(~Inn*~Dig*~Gov*~Fin*~Eco*~Pol*~Dem). It is worth noting that in this grouping, all the influencing factors that boost the development of the new energy market are shown to be missing. Among them, government support, financial support, and environmental pollution are missing as core conditions, and the remaining factors are missing as marginal conditions. This suggests that the influencing factors we usually consider for the development of new energy markets are regionally heterogeneous and that in regions such as Qinghai, Jilin, and Gansu in China, these factors do not play a role in the development of new energy markets. To further investigate the reasons for this situation, we examine the characteristics of these provinces in detail and find that the common feature is an unusually rich endowment of new energy resources. That is to say, in resource-rich areas, as long as they have the basic economic foundation, market demand, will attract new energy investment and business influx.

②Environmentally led (~Inn*~Dig*~Gov*~Fin*Eco*Pol*Dem). This grouping reflects the role of environmental level factors in the TOE framework for the overall organization. In the development of the new energy market, the economic base exists as a core condition, environmental pollution and electricity demand exist as marginal conditions, the level of digitization is missing as a core condition, and the level of innovation, government support, and financial support are missing as core conditions. The representative province is Inner Mongolia, China. The region is still very richly endowed with resources. Due to its high level of industrialization, the local economy has a good foundation, and its new energy market has been developed on a large scale with the pressure brought by environmental pollution and elevated power demand.

By comparing these two configurations, we can consider the environment-leading type as the 2.0 version of the pioneering type. As the economic situation of regions rich in new energy resource endowment improves, the pressure of environmental pollution and electricity demand will prompt the development of their new energy market. However, such a finding is far from enough, to further confirm the interaction of these influencing factors, this study makes a counterfactual analysis, which makes the study more rigorous and objective.

4.2.2 Influencing factors of non-high-level new energy market configuration

Table 6 shows that there are three groupings of non-high-level new energy market development, categorized into five paths. The three groupings are lack of financial support, technical support-lack of demand, and organizational support-lack of demand.

①Lack of financial support (Dig*~Fin). This grouping is characterized by the absence of financial support as a core condition, accompanied by the absence of peripheral conditions at the environmental level, which prevents the local new energy market from developing at a high level. This grouping is divided into three paths, 1a (~Inn*Dig*Gov*~Fin*Eco*~Pol*~Dem), 1b (Inn*Dig*Gov*~Fin*Eco*Pol*~Dem), and 1c (Inn*Dig*Gov*~Fin*~Eco*Pol*Dem). 1a reflects the absence of financial support as a core condition, while environmental pollution and electricity demand are not marginalized. core conditions are missing, while environmental pollution and electricity demand do not put pressure on the development of a new energy market, and the level of innovation is not high, even if the local economy has a certain foundation and obtains the support of the government, in this case, the new energy market cannot be developed. 2a reflects the lack of financial support as the core condition, while the demand for electricity as the marginal condition is missing, even if the other elements are present, but due to the absence of the market space for new energy development, the local energy market cannot be developed. 3a reflects that in the absence of financial support as the core condition, the new energy market cannot be developed due to the lack of a local economic base. These paths on the one hand indicate that the financial market occupies a particularly important position in the process of new energy development, and on the other hand indicate that environmental factors are indispensable, and policy support needs to be tailored to local conditions. Representative regions include Shaanxi and Sichuan in China.

②Technical support-lack of demand (Inn*Dig*Fin*Eco*~Pol*~Dem). In this path, the economic base exists as a core condition, the level of innovation, digitalization, and financial support exists as marginal conditions, while electricity demand is missing as a core condition and environmental pollution is missing as a marginal condition. This path reflects that although some of the influencing factors in the TOE framework are satisfied, the development of the new energy market needs to take into account the combined pressure of market demand and environmental pollution. Representative regions are Beijing and Shanghai in China.

③Organizational support-lack of demand(~Inn*~Dig*Gov*Fin*~Eco*~Pol*~Dem). The absence of technological and environmental factors plays an important role in this path, with demand for electricity missing as a core condition, and the level of innovation, digitalization, economic fundamentals, and environmental pollution missing as marginal conditions. Under such a combination of factors, even if policy support and financial support exist as core conditions, they are not effective for the development of the local new energy market. In other words, investment in the new energy market needs to take more account of technical and environmental factors. Representative regions include Jiangxi and Guizhou in China.

5. Conclusion

This study tries to study the combination of driving factors for the development of a new energy market based on the TOE theoretical framework with a qualitative comparative analysis method. It is different from previous scholars' single-factor quantitative research or declarative qualitative analysis. By combining qualitative and quantitative approaches, we find that a single influencing factor does not make the new energy market develop and that these factors interact with each other. In addition, these driving factors have different effects in different regions and different effects at different stages of urban development.

Through the fuzzy set qualitative comparative analysis, we identify two high-level new energy market development influences, self-motivated and environmentally led, among different regions in China. The common feature of these regions is the good endowment of new energy resources, which suggests that there are certain opportunities to invest in new energy markets in resource-rich regions. In addition, the study confirms that the continued expansion of the new energy market needs to be supported by economic fundamentals (Zeng et al., 2024), as well as the pressure of environmental pollution and market demand. At the same time, this study demonstrates the strong dependence of new energy markets on environmental dimensions within the framework of the TOE theory. This has some implications for countries with rich new energy resources, such as Latin America and Africa, where the development of new energy resources requires first upgrading the local economic base and awakening the public's awareness of environmental protection.

To further test the results of the empirical analysis and to verify in more depth the important role that environmental factors play in generating new energy markets. This study analyzes the combination of factors that contribute to the development of non-high-level new energy markets from a counterfactual perspective. The results show that there are a total of three groupings of outcomes that contribute to the development of non-high-level new energy markets: lack of financial support, technical support-lack of demand, and organizational support-lack of demand. This analysis reveals the importance of financial support in the development of new energy markets. Since new energy requires a large amount of capital cost at the initial stage of development (Wang et al., 2024), the effective operation of the financial market is indispensable for the sustainable development of new energy. In addition, the other two grouping results of the counterfactual analysis reflect the importance of market demand. The new energy market should not be developed blindly, and the failure of new energy investments can occur if policy support measures and large amounts of capital are blindly introduced without considering market demand.

At the same time, the results of this study also provide some insights for different stakeholders, such as policymakers, market investors, and energy companies. First, when a region has a new energy resource endowment, the government should carefully consider whether the region has the market demand and necessary economic base, if not, blind policy support or incentives cannot achieve good results; Second, under the guidance of the TOE theoretical framework, the market investors need to pay more attention to the role of environmental influencing factors on the new energy market, these factors include the economic base, environmental pollution, and market demand; again, energy companies actively carry out the energy transition at the same time, need to work closely with the financial market to ensure the effective operation of funds, in addition to these energy companies to actively carry out technological development to help its sustainable development.

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