

## THE DUAL EFFECT OF THE LEGAL SYSTEM ON THE TECHNICAL STANDARDIZATION OF NEW ENERGY ENTERPRISES

### O DUPLO EFEITO DO SISTEMA JURÍDICO NA PADRONIZAÇÃO TÉCNICA DAS EMPRESAS DE ENERGIA RENOVÁVEL

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#### ABSTRACT

This study examines the influence of the legal environment on technology standardization in new energy enterprises. The purpose is to clarify how existing legal frameworks both promote and constrain standard-setting processes. A combination of theoretical analysis and empirical investigation is employed, including a review of relevant laws, case studies of enterprises, and comparative analysis across industry sectors. The research identifies several critical challenges in the current standardization process: the unclear scope of legal applicability, difficulties in implementing technical standards, and variations in technological development across industries. Empirical findings show that these legal ambiguities directly affect enterprises' ability to develop and adopt standardized technologies, leading to inconsistencies in innovation outcomes and industry competitiveness. To address these issues, the study proposes targeted legal clarifications, enhanced enforcement mechanisms, and cross-industry coordination strategies. The results demonstrate that a well-structured legal system significantly facilitates technological standardization, supports innovation diffusion, and improves operational efficiency in new energy enterprises. These insights offer practical guidance for policymakers and industry stakeholders seeking to optimize legal frameworks and promote standardized technology development.

**Keywords:** Legal environment, Technology standardization, Standard-setting challenges, Regulatory impact, Innovation patterns, Policy guidance.

#### RESUMO

Este estudo examina a influência do ambiente jurídico na padronização tecnológica em empresas de energia renovável. O objetivo é esclarecer como os marcos legais existentes tanto promovem quanto restringem os processos de definição de padrões. Utiliza-se uma combinação de análise teórica e investigação empírica, incluindo revisão de leis relevantes, estudos de caso de empresas e análise comparativa entre setores industriais. A pesquisa identifica diversos desafios críticos no processo atual de padronização: escopo pouco claro da aplicabilidade legal, dificuldades na implementação de normas técnicas e variações no desenvolvimento tecnológico entre indústrias. Os achados empíricos mostram que essas ambiguidades legais afetam diretamente a capacidade das empresas de desenvolver e adotar tecnologias padronizadas, gerando inconsistências nos resultados de inovação e na competitividade do setor. Para enfrentar esses problemas, o estudo propõe esclarecimentos legais específicos, mecanismos de fiscalização aprimorados e estratégias de coordenação intersetorial. Os resultados demonstram que um sistema jurídico bem estruturado facilita significativamente a padronização tecnológica, apoia a difusão da inovação e melhora a eficiência operacional nas empresas de energia renovável. Essas percepções oferecem orientações práticas para formuladores de políticas e partes interessadas da indústria que buscam otimizar os marcos legais e promover o desenvolvimento tecnológico padronizado.

**Palavras-chave:** Ambiente jurídico, Padronização tecnológica, Desafios na definição de padrões, Impacto regulatório, Padrões de inovação, Orientação política.

#### 1 INTRODUCTION

The rapid development of the new energy industry, especially under the global energy transition and rising environmental concerns, has become an important driver

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of modern economic and sustainable development. Technical standardization — the formulation of uniform technical requirements so different producers follow the same specifications for manufacturing, installation and operation — helps ensure product quality, interoperability and market order (Chen, 2024). For new energy enterprises, standardization not only guarantees product safety and quality, but also reduces production uncertainty and facilitates market access; empirical studies show government policy and subsidies significantly affect firms’ R&D and innovation outcomes (Wu et al., 2024; Jiang & Xu, 2023). At the same time, regulatory instruments and environmental regulation shape firms’ strategic choices: market-incentive regulations tend to better stimulate green technological innovation than pure command-and-control measures (Shi & Li, 2022).

Scholarly work has also emphasized that standards themselves influence innovation incentives and coordination — standard-setting procedures, IPR rules and the coordination problem can either stimulate or inhibit innovation depending on institutional design (Llanes, 2024; Blind, 2023). Moreover, recent research specifically examining environmental/energy technologies finds that well-designed technology standards can induce further innovation when coordination problems are addressed, but may reduce incumbent patenting after standard adoption while enabling entry by new inventors (Grégoire-Zawilski & Popp, 2024).

Therefore, the interaction between law/regulation and technical standardization is complex and produces a “double effect”: legal frameworks can both promote standard diffusion and create compliance burdens or rigidity that hinder innovation. Legal-theoretical discussions and policy analyses highlight the governance dilemmas and the need for flexible, foresighted regulatory designs that balance prescriptiveness and innovation space (Brownsword, 2024; Entsaló et al., 2023).

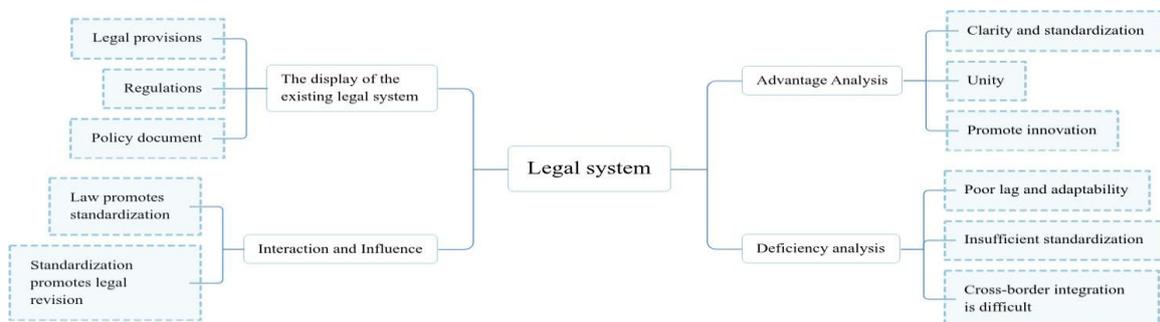


Figure. 1 The legal system in the standardization of new energy technologies

## 2 THEORETICAL RESEARCH BASE

Starting from the impact of the legal system on technical standardization, the

dual effect of standardization under the legal framework is explored. Firstly, it introduces the theoretical basis of the research adopted, including the theory of legal effect, the theory of innovation and the theory of standardization; secondly, it analyses the positive and negative effects of the legal system on the technological standardization of new energy enterprises; and lastly, it proposes how to seek a balance in the legal system, so as to promote the compatibility of the technological standardization and innovation of new energy enterprises.

### 2.1. *Theory of Innovation*

Innovation theory is a theoretical framework that explains technological progress and the innovative behaviour of firms. Innovation refers not only to technological breakthroughs, but also to improvements in products, processes and services. One of the most representative ideas in innovation theory is Schumpeter's "innovation theory". According to Schumpeter, innovation is the core driving force of economic growth, and technological innovation of enterprises can promote industrial upgrading and market structure change. In the new energy industry, technology standardization and innovation are closely related. Standardization often promotes the popularity of technological innovation, while technological innovation can promote the iteration and improvement of standards (Fang et al., 2020).

In the process of technology standardization, new energy enterprises not only need to follow the existing legal provisions, but also promote the formation and optimization of new standards through technological innovation (Su and Yu., 2019). Innovation theory points out that the innovation ability of enterprises is closely related to the external environment, and factors such as government policies, legal frameworks and market demand can all influence the innovation motivation and innovation mode of enterprises (Lamble, 2011). In this process, the legal system can provide a stable innovation environment for enterprises, and at the same time provide institutional guarantee for the updating and improvement of technical standards.

### 2.2. *Theory of standardization*

The theory of standardization examines how products and services can be regulated in a given industry by setting uniform technical standards. The theory of standardization stresses that technical standards not only help to improve product quality and reduce production costs, but also promote market integration and global

competition. Standardization can reduce uncertainty in technology development and improve the universality of technology application, thus accelerating the maturity of the industry. The legal system plays an important role in promoting the technical standardization process of new energy enterprises. On the one hand, the state requires new energy enterprises to comply with certain technical standards through laws and regulations to ensure the quality and safety of products and services; on the other hand, the legal system also provides a legal basis and guarantee for the formulation and implementation of standards to ensure the popularization and implementation of technical standards in the industry.

The concepts of "active standardization" and "passive standardization" in standardization theory are instructive in understanding the impact of law on new energy enterprises. Active standardization refers to the formation and upgrading of technical standards driven by enterprises through independent innovation, while passive standardization is the process by which enterprises follow existing technical standards under the requirements of laws and industry norms. In this process, the legal system not only requires enterprises to comply with standards through mandatory measures, but also motivates enterprises to actively participate in the development and improvement of standards through incentive mechanisms.

### **3 THE DOUBLE EFFECT OF THE LEGAL SYSTEM ON THE TECHNICAL STANDARDIZATION OF NEW ENERGY ENTERPRISES**

The impact of the legal system on the technological standardization of new energy enterprises is twofold. On the one hand, the legal system can promote the development of technological standardization by providing a clear legal framework, standard-setting mechanisms and policy incentives; on the other hand, imperfections in the legal system or overly stringent regulation may become barriers to technological innovation, restricting the innovative vitality and market competitiveness of enterprises.

#### *3.1. Positive effects of the legal system on technical standardization*

The legal system promotes the rapid development of technical standardization for new energy enterprises by providing clear legal norms and standards (Jacobs, 2012). Firstly, through legal means, the government sets industry access standards and compels new energy enterprises to comply with relevant technical standards, thereby ensuring product quality and safety in the market. Secondly, the legal system encourages enterprises to carry out technological innovation on the basis of

compliance with national standards by formulating incentive policies (Wu et al., 2024), such as research and development subsidies, green certification (Shi and Li, 2022), and tax incentives (Li et al., 2023).

In addition, the legal system ensures the fair and just implementation of technical standards by regulating market competition behaviour and preventing vicious competition and unfair means (Marino et al., 2023). For example, the electric vehicle industry, which is part of the new energy industry, has formulated strict technical standards for batteries and environmental emission standards with the support of many governments. These legal provisions have not only improved the technical level of new energy enterprises, but have also prompted them to increase their technological research and development efforts, improve product quality and meet higher market requirements.

### 3.2. *Negative effects of the legal system on technical standardization*

However, imperfect or over-regulated legal systems may also have a negative impact on the standardization of technologies by new energy enterprises. Firstly, overly strict legal regulations may limit the innovation space of enterprises, leading them to consider compliance more than technological breakthroughs in the R&D process. Secondly, inconsistent laws and regulations or frequent policy changes may also increase the legal risks of enterprises, placing them in an uncertain legal environment during the standardization process and affecting the sustainability and stability of their technological innovation (Wang et al., 2023). For example, some countries have over-regulated the technical standards of new energy enterprises, resulting in enterprises having to strictly follow existing standards when developing new technologies, without being able to flexibly respond to changes in market demand or technological development trends. In this case, excessive legal regulation may inhibit the technological innovation capability of enterprises and hinder the long-term development of the industry.

By exploring the dual effects of the legal system on the technical standardization of new energy enterprises, it can be seen that the role of the legal system in the new energy industry is complex and varied. It can not only guide the process of technological standardization through legal norms, but also promote technological innovation through incentives. However, excessive intervention of the legal system or an imperfect legal framework may also constrain the innovation and development of enterprises. Therefore, how to find a balance in the legal system that promotes

technological standardization while safeguarding the room for innovation for enterprises is an important issue in future policymaking and legal reform.

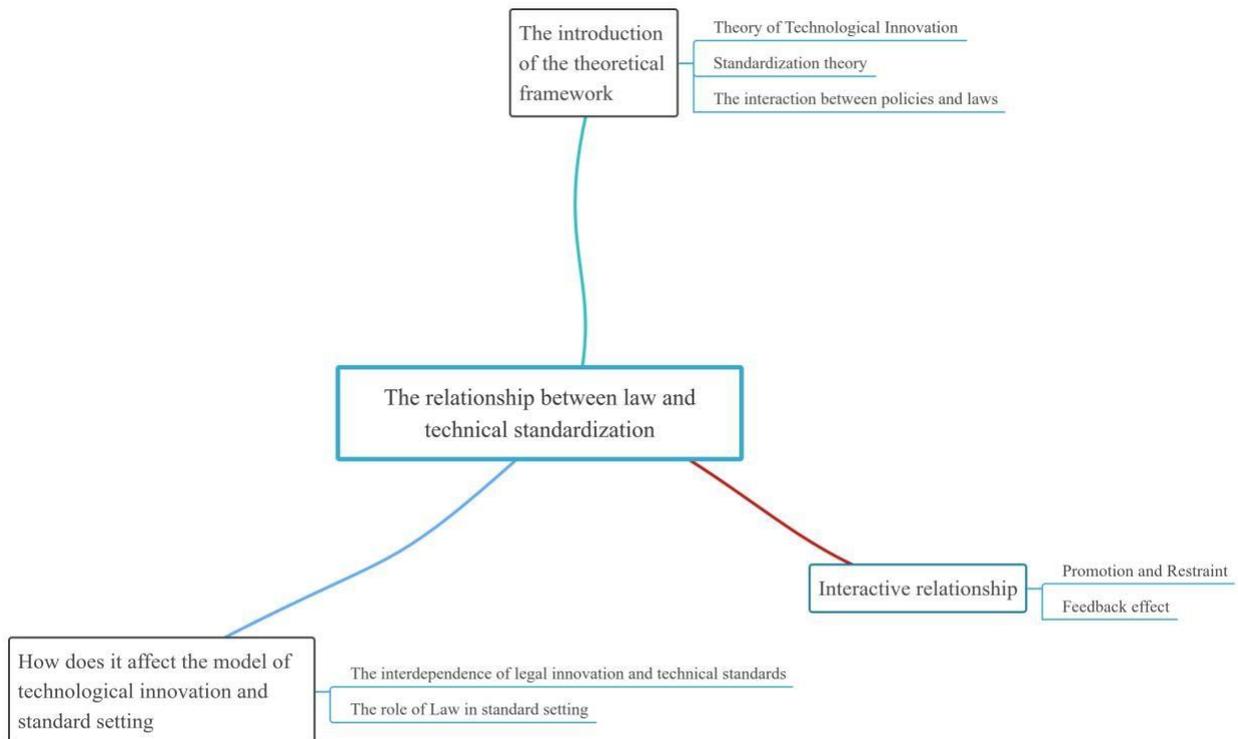


Figure. 2 The interactive relationship between law and technical standardization

## 4 PROBLEMS AND ANALYSIS OF CAUSES

### 4.1. Lack of specificity and flexibility in the legal system

The current legal system often fails to keep pace with the technological development of the industry in terms of technical standardization for new energy enterprises. Due to the rapid changes in new energy technologies, the current legal system lacks specialized technical standards in many areas, which are often developed to meet the actual production needs of enterprises. Technology changes short cycle, the development of new energy technology is fast, the traditional law-making cycle cannot adapt to the rapid changes in technology, resulting in the lag of the law.

Lack of flexibility, once the law is formed, it is more difficult to amend it, resulting in the lack of sufficient flexibility in the refinement and updating of technical standards. Institutional constraints, when formulating relevant laws, priority is often given to stability at the macroeconomic level, ignoring the details and individual needs of technical standardization of new energy enterprises. A survey of the new energy industry can demonstrate the rate of change in new energy technologies over the past five years and the lag in updating the current legal system. For example, statistical

charts are used to show the frequency of updating new energy technology standards and the lag in updating the corresponding laws.

#### 4.2. *Inadequate enforcement of legal standards*

In the process of technical standardization in new energy enterprises, although the law provides for standards, there is a lack of enforcement in the actual implementation process. Many new energy enterprises fail to strictly follow the technical standards when implementing them, resulting in the standardization process being affected. Uneven supervision by local governments. Different regional governments attach different importance to the new energy industry, and the implementation of local government regulatory measures is inconsistent, resulting in the implementation of the law and standards are not in place. Resistance of enterprises.

Some enterprises believe that the technical standards stipulated in the law are cumbersome and increase operating costs, which leads to resistance and avoidance of strict implementation. Incomplete legal regulatory mechanism. The current regulatory system of the new energy industry is not perfect, and the relevant regulatory agencies often lack sufficient resources and power, resulting in the law cannot be effectively enforced. By comparing the relevant legal enforcement theories, it can be pointed out that the implementation of the law does not only depend on the formulation of legal provisions but also requires an effective enforcement mechanism and regulatory power. Inadequate enforcement often stems from the weakness of regulatory institutions and the lack of regulatory resources.

#### 4.3. *Inadequate market orientation of the legal system*

The current legal system does not provide sufficient guidance for the technical standardization of new energy enterprises, particularly with regard to the interface between market demand and technical standards. In complying with the law, enterprises often lack a clear market orientation, resulting in the formulation of technical standards that fail to truly meet market demand. Market demand forecasts are inaccurate, and the current legal system is often formulated on the basis of overly conservative assumptions, ignoring the actual changes in demand in the new energy market.

Insufficient enterprise autonomy. The legal system focuses too much on technical details and ignores the autonomy of enterprises in terms of innovation and

market orientation, resulting in a disconnect between technical standards and market demand. Lack of interaction between the law and industry associations. Technical standards in the industry are usually led by industry associations, but the legal system has insufficient communication with industry associations, resulting in a lack of market perspective in the formulation of technical standards. It is possible to show the extent to which various types of enterprises in the new energy industry are affected by the law in the process of setting technical standards, for example, by showing the different responses of enterprises to market orientation and legal standards (Changala and Foley, 2011).

## 5 RELEVANT REASONS

Against the backdrop of growing global environmental awareness, the new energy industry has become a key force in promoting the development of a green economy. As technology advances and market demand continue to grow, new energy companies are investing significant resources in innovation and technology development.

However, the legal system plays an indispensable role in ensuring that these new technologies can be promoted smoothly and in line with the industry's development needs. The dual effect of the law on the standardization of technology in new energy enterprises is that it has both a facilitating and a restraining effect.

### 5.1. *Over-regulation in the standardization process*

In some cases, overly stringent laws and regulations may lead to greater compliance pressure on new energy enterprises in the process of technology standardization (Laptev and Kovarda, 2025).

Particularly for enterprises in the early stages of technology development, overly stringent regulations may increase their compliance costs and inhibit their incentives for technological innovation. For example, if the standardization process pays too much attention to technical details and ignores the development space of the technology, it may result in some innovative technologies not being applied in a timely manner, hindering the rapid updating and iteration of the technology.

### 5.2. *The problem of regional disparities*

Differences in laws and regulations in different regions may result in new energy companies facing different legal requirements in the standardization process. In a

globalized market environment, multinational corporations need to follow the legal standards of multiple countries and regions, which undoubtedly increases the cost and complexity for enterprises. Failure to harmonize laws and regulations across regions will affect the competitiveness of new energy companies in the global market. In addition, the lack of synchronization of legal systems may also lead to a waste of resources and technological conflicts in the standardization process of new energy enterprises.

### 5.3 Lagging legal system

The rapid development of new energy technologies far exceeds the speed of adaptation of the existing legal system. The failure of existing legal standards to keep pace with technological development may result in new technologies facing regulatory gaps or difficulties in the application of the law. This lag may cause some technological innovations to be eliminated from the market before they can be legally recognized, affecting the rapid application of the technology (Seligman, 2010). For example, some cutting-edge technologies in the new energy industry, such as the use of hydrogen energy, may be hampered in their promotion by the lack of sound regulatory support.

## 6. RECOMMENDATIONS FOR IMPROVEMENT

### 6.1. *Strengthening the foresight and flexibility of laws and regulations*

In order to better promote the formulation of technical standards and technological innovation, it is recommended that laws and regulations be designed to take into account future technological development trends and provide enterprises with greater room for innovation. For example, the government can set up a dynamic assessment mechanism for the new energy industry and adjust relevant laws and regulations in a timely manner according to changes in the market and technology to ensure that the legal system can keep pace with technological progress. In addition, the laws and regulations should have a certain degree of flexibility in the process of implementation, to avoid too rigid regulations to limit the innovation ability of enterprises.

### 6.2. *Promoting international cooperation and harmonization of standards*

With the globalization of new energy technologies, international standardization of technologies should be taken seriously. The legal systems of different countries should strengthen international coordination and cooperation on new energy

technology standards and promote the unification of international standards. This will not only reduce the compliance costs of multinational enterprises, but also ensure the uniform promotion of new energy technologies on a global scale. Especially when it comes to global issues such as environmental protection and energy efficiency, international co-operation can play a greater role in the formation of globally unified technical standards and enhance the overall level of the industry.

### 6.3. *Optimizing intellectual property protection mechanisms for technological innovation*

The technological innovation of new energy enterprises cannot be separated from the support of patent protection mechanisms. The Government should strengthen the protection of intellectual property rights in the new energy sector and encourage innovation through policies.

For example, it can provide more support to enterprises by reducing or waiving patent application fees and accelerating the patent approval process. In addition, for the technological achievements of enterprises, the Government should strengthen international cooperation on intellectual property protection to prevent technology loss and patent disputes.

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### **Conflict of Interest**

The authors declare that there is no conflict of interest, we do not have any possible conflict of interest.

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