A System Analysis of the Emerging Concept of “Inter-regional Justice of Energy Transition” in China

Zheng Li [1,2], Ruoyao Tang [1,2], and Linwei Ma [1,2,*]

[1] State Key Laboratory of Power Systems, Department of Energy and Power Engineering, Tsinghua-BP Clean Energy Research and Education Centre, Tsinghua University, Beijing 100084, China; lz-dte@tsinghua.edu.cn (Z.L.); try21@mails.tsinghua.edu.cn (R.T.); malinwei@tsinghua.edu.cn (L.M.)

[2] Tsinghua-Rio Tinto Joint Research Centre for Resources, Energy and Sustainable Development, International Joint Laboratory on Low Carbon Clean Energy Innovation, Laboratory for Low Carbon Energy, Tsinghua University, Beijing 100084, China

*Corresponding author e-mail: malinwei@tsinghua.edu.cn.

Abstract. During the low-carbon development of China, the different capacity and impact of energy transition among regions has raised an issue of inter-regional justice. However, there are few studies on it, and even basic concepts are lacking. This study proposed the definition of the concept “inter-regional justice of energy transition” (IRJET) based on a system approach. First, the connotations and cross-fields of three basic concepts of “justice transition”, “energy transition”, and “coordinated regional development” are analysed and compared based on China’s background. Second, we take Shanxi Province as a typical case to identify the barriers of IRJET. Third, action suggestions are proposed, combined the policy mechanism of China’s carbon peak policy and the EU’s just transition mechanism. The results indicated that “IRJET” means during the low-carbon energy transition, some regions with concentrated traditional and high-emission industries must be protected to avoid serious losses for current generation’s need satisfaction, while the whole country can be prosperous and carbon reduction targets can be realized. The main barriers include lacking of a clear positioning of each region for multi-regional cooperation in the low-carbon energy transition, lacking of a policy mechanism to balance benefits and costs among regions, lacking of a multi-regional energy and carbon market mechanism that can fully considers the needs of each region，inefficient talent and fund guarantee mechanism. To end this up, national governments should clarify the significance and requirements of IRJET. Cross regional enterprises should layout high-quality industries in disadvantage regions. Local governments should actively participate in energy transition and actively reduce the impact of transition.

Keywords: energy transition; just transition; regional coordination; conceptual model; system analysis.

1. Introduction

China's energy transition is an inevitable choice in response to climate change and the formation of a sustainable development model. Energy transition involves controlling energy consumption, restructuring energy production, and controlling carbon emissions. Previous studies have suggested that there are significant differences in resource endowment, economic development, and industrial structure across different regions in China[1]. Therefore, during the process of low-carbon energy transition, there are significant differences in the transition capabilities and impacts among regions in China. For example, regions where fossil fuel production is an important economic pillar will face significant challenges and higher costs in reducing fossil fuel consumption. It will further exacerbate regional imbalances and hinder the enthusiasm for transition in disadvantaged regions, thus impeding the coordinated promotion of energy transition nationwide. In fact, the IPCC has already proposed the "Just Transition" initiative in its sixth annual report, urging countries to pay attention to the disadvantaged regions that are negatively affected by climate change[2]. However, there are few studies on just transition in China, and even basic concepts are lacking. Therefore, this

article proposes the concept of "Inter-regional Justice of Energy Transition" in China (IRJET), analyzes its connotations from a systematic perspective, and answers the question of what is IRJET.

Based on a system analysis approach, we have developed a method for analyzing soft problems that intersect across disciplines. Using this approach, we defined and explored the concept and implications of IRJET. We then used Shanxi province as a case to examine the barriers between the actual situation and the ideal concept. Finally, we provide feasible action suggestions for key stakeholders at the national and local levels.

The structure of this article is as follows: Section 2 introduces the method of conceptual analysis used in this study. Section 3 shows the analysis results of IRJET. Section 4 discusses the conclusion.

2. Methodology for Concept Analysis

Given that the concept and practice of China's IRJET involve a wide range of social factors and belong to the realm of soft science, a soft system methodology proposed by Chekland[3] is more appropriate. The basic analytical steps of this methodology include: 1) investigating problem scenarios; 2) describing problem scenarios; 3) the root definition of relevant systems; 4) constructing conceptual models; 5) comparing conceptual models with reality; 6) feasible and desirable changes; 7) actions to improve problem scenarios. Its research features are mainly to organize the collective learning and discussion of relevant stakeholders. Considering the large number of stakeholders involved in China's IRJET, it is difficult to carry out collective learning and discussion, so this paper attempts to simplify the seven steps into three steps through literature review and case studies: concept analysis, barrier analysis, and action suggestion analysis. This set of methods can be used to analyze the interdisciplinary intersection of soft concept research.

In the concept analysis step, based on logic, we believe that a concept consists of both intension and extension. Intension can be understood as being general and abstract, while extension refers to the objective things reflected in the concept. In this step, we first propose the logical mechanism of generating the IRJET concept: the intersection of regional coordination, just transition, and energy transition. Based on this, we first define the basic noun meanings and then discuss the extension of the concepts of regional coordination, just transition, and energy transition, and then summarize the intension of these three concepts, which is the fundamental meaning of the concept after stripping away the specific context. Based on this, we summarize the intersection of the intension of these three concepts to derive the intension of IRJET. Then, we combine the national conditions of China as the extension with the intension of IRJET to obtain the concept of IRJET.

After deriving the concept, this paper carries out barrier analysis. We chose Shanxi Province, an important region for coal production, as a case study to analyse the differences between the actual situation and the ideal situation proposed by the concept of IRJET. Finally, we propose action suggestions from the perspective of stakeholders.

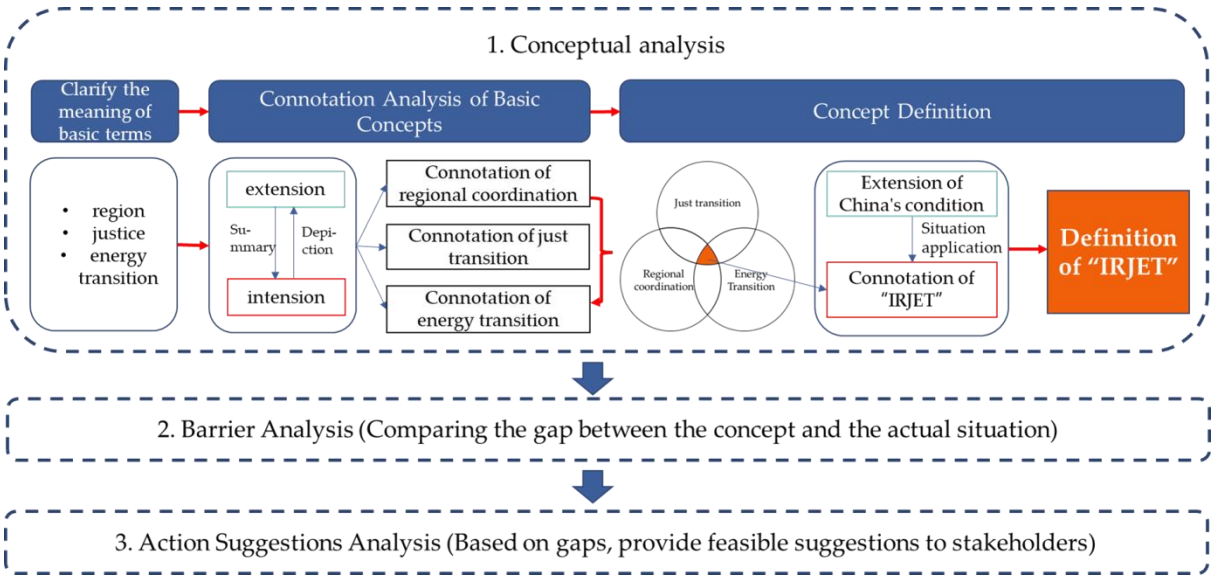


Figure 1. Conceptual Analysis Methodology Framework

3. Conceptual Analysis Results of IRJET

3.1 Conceptual analysis

The concept of IRJET has both practical background and requires rigorous theoretical deduction logic. The mature experience that can be used for reference is the just transition mechanism in the EU's Green Deal[4], which is aim at guaranteeing the equal development rights of different regions and groups, and using technology, funds, and knowledge to help regions that are more negatively affected in the low-carbon transition. According to this mechanism, we believe that the three areas involved in IRJET are regional coordination, just transition, and energy transition. The connotations of the three concepts are nested together, which can reasonably summarize the connotation of IRJET.

This article first clarified the meanings of basic nouns. "Region" refers to the demarcation of land, specifically referring to China's provincial-level administrative regions. "Just" refers to fairness and compliance with people's moral values. Energy transition refers to the transition of energy systems from one mode to another.

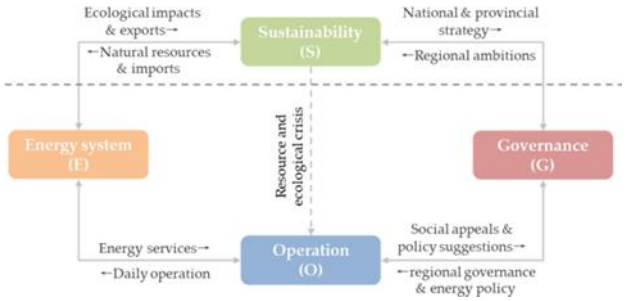
3.1.1 Connotation Analysis of Basic Concepts

Regional coordinated development has clear policy content. At different stages, the Chinese government has promoted the development of the western region, revitalized the old industrial bases in the northeastern region, promoted the rise of the central region, encouraged the eastern region to take the lead in development, and leveraged the advantages and enthusiasm of various regions. By improving market mechanisms, cooperation mechanisms, mutual aid mechanisms, and support mechanisms, it gradually reverses the trend of widening regional development gaps and forms a new pattern of mutual promotion, complementary advantages, and common development in the east, central and western regions. The connotation of regional coordination is: based on the carrying capacity, development foundation, and potential of resources and environment in each region, according to the requirements of giving full play to comparative advantages, strengthening weak links, and enjoying basic public services with equalization, gradually forming a regional coordinated development pattern with clear functional positioning, good interaction among the east, central and western regions, and narrowing the gap in public services and people's living standards.

The term "just transition" was first proposed by American labor unions in 1970 to protect the rights of coal miners. Since then, due to the development of climate change response and

low-carbon transition into all aspects of society, just transition has become an important topic at various world climate change conferences, gradually shifting from focusing on workers' employment to the overall fairness of regional or urban economic transition. The European Union's just transition mechanism under the Green New Deal is the most mature practice of just transition, which mainly helps industries and workers in regions that are heavily affected by energy transition through financial support. As the EU has a high level of economic development and good infrastructure, the main unfairness it faces during the transition is the difficulty of employment for workers in shrinking industries. The essence of just transition reflected in this mechanism is to ensure the fairness of people's development rights and interests during the low-carbon transition. However, in China, the problem that needs to be addressed is not only employment but also the imbalance of regional economic development, inadequate infrastructure construction in underdeveloped areas, low industrial added value, and a series of other problems ultimately stemming from the overall underdevelopment of some regions. Therefore, we believe that in China, the essence of just transition is to use China's institutional advantages to strengthen policy support for regions with low development levels that are heavily affected by energy transition, while steadily promoting energy transition and improving the economic development and people's living standards in these regions.

The term "energy transition" originated from the book "Energy Transition: Growth and Prosperity Without Oil and Uranium", proposing that the dominant energy should shift from oil and nuclear to renewable energy. Studies have already explored the concept of energy transition from perspectives such as the application of new technologies, the transition of energy structure, and energy system reform. This article summarizes existing research and believes that the essence of energy transition is the transition of the energy system resulting from the shift of the dominant energy. The energy system refers to the system that converts natural energy resources into specific energy service forms (effective energy) required for human production and living. The energy system is one of the specific social functional systems that exist in a country or region's economic and social development, including not only energy resources, physical facilities, technology, and knowledge systems related to energy production, storage, transportation, and consumption, but also organizational networks and related social elements such as government departments, enterprises, consumers, relevant laws, regulations, and rules. These elements can be classified into four aspects: Energy, Sustainability, Government, and Operation (ESGO). Therefore, specifically speaking, we believe that the essence of energy transition is to achieve the goal of sustainable development, where the ESGO aspects undergo systematic changes, leading to a shift towards clean energy, improved energy efficiency, and reduced carbon emissions.



3.1.2 Conceptual Analysis of IRJET

The intersection of the concepts of regional coordination, just transition, and energy transition is to achieve coordinated development of regions, energy, and economy, promote sustainable development, improve people's living standards, and achieve a just transition through reasonable planning, institutional innovation, policy support, and other means in the context of economic development and environmental protection. We believe this is the essence of IRJET.

China's special national conditions in the energy transition process mainly include: coal as the main energy consumption structure, and the relatively concentrated supply sources of coal are in Shanxi, Shaanxi, Inner Mongolia, and other regions; high energy demand and great pressure on energy supply security; different economic development stages in various regions, with the eastern regions more developed and per capita energy consumption higher, and the central and western regions relatively lagging behind and per capita energy consumption relatively lower; strong policy support and guidance from the central government for the development of provinces and cities.

Combining the essence of IRJET and China's national conditions, we propose the definition of IRJET: "IRJET" means during the low-carbon energy transition, some regions with concentrated traditional and high-emission industries must be protected to avoid serious losses for the current generation's need satisfaction, while the whole country can be prosperous and carbon reduction targets can be realized.

This concept includes at least the following implications:

At the national level, the low-carbon energy transition should be firmly promoted. Specifically, all elements should be synergistically transformed within the framework of the Energy System with Green and Open Governance (ESGO).

In the process of low-carbon energy transition, regional differences should be emphasized, and each region's comparative advantages should be leveraged to promote rational division of labor and optimized development. In particular, some regions that heavily rely on fossil energy and high-carbon emission industries should be protected, and systematic policies should be scientifically designed to help and guide them within the various elements of ESGO.

In promoting the national energy transition, a just transition should always be an important criterion, specifically ensuring that the energy transition process is fair, supervision is fair, and information disclosure is fair.

3.2 Barrier analysis

Shanxi Province is an important coal production region in China, and the coal industry is also the most important industry in the region. In the process of energy transition, reducing coal production and consumption is inevitable. Therefore, Shanxi's impact in China's low-carbon transition process is evident, and it is a typical case of the IRJET concept.

Coal produced in Shanxi Province has been supplied to 28 regions across China, and exported to 23 countries and regions around the world. In 2021, the amount of coal transferred to other provinces was 760 million tons, and the proportion of it to production reached 63.14%. In 2021, the coal mining and dressing industry accounted for 34% of the total revenue of industrial enterprises in the province, 66% of tax revenue, 44% of employment, and 52% of assets. In some major coal-producing counties in Shanxi Province, the coal-related industries account for nearly 80% of the county's total economic output. The number of employees in the coal industry in Shanxi Province ranked the first in the country, accounting for 33.29% of the national share of the same industry in 2022, an increase of 7.05% over 2017[5]. Shanxi has issued “the Implementation of the Rules of Employment and Resettlement of Workers”, “Implementation Opinions on Effectively Resolving the Placement of Surplus Employees in the Coal, Steel and Iron Industries” and other policies. By various measures such as internal job placement, external job transfer, job retraining, innovation and entrepreneurship, self-employment, vocational training for job transition, internal retirement, and public welfare job placement, the job placement of employees was properly carried

out. The placement rates for laid-off workers due to overcapacity were 99.6% and 88.6% in 2016 and 2017.

However, compared to other regions, Shanxi's energy transition poses greater challenges. First, Shanxi province has the largest number of employees in the coal industry in China, which creates a great pressure for local job placement. The employees in Shanxi's coal industry is 2.56 times that of the total in Inner Mongolia and Shaanxi, leading to a lower larbor productivity. Along with the promotion of intelligence and " Double Carbon" policy, labor productivity improvement and coal reduction will bring a large number of coal industry staff reduction. Second, Coal industry employees face inadequate ability for transitioning to new employment opportunities. Coal industry employees of Shanxi Province show the characteristics of older, men dominant, low education, relatively single skills, low motivation to transition, leading to big challenges in job placement for future. Female jobs are highly substitutable, with a higher risk of unemployment in the future. Third, Strategic new industries in Shanxi Province are still in the cultivation stage, with limited support capacity. Shanxi Province is still dominated by high carbon industries and energy structure. Strategic new industries are small in scale, with limited contribution to the local economy and employment absorption. Fourth, The conflict between coal industry and tourism service industry development. Tourism service industry is an important channel for absorbing coal employment, though it has been squeezed out by the coal industry and developed slowly. Fifth, the governance system for a just transition is not yet complete. The policy framework, employment security measures, funding sources, and stakeholder cooperation mechanisms related to fair and just transition are still being explored[6].

These challenges reflect that, compared to the IRJET concept, the main obstacles in the low-carbon energy transition are the lack of clear multi-regional cooperation positioning among various regions, the lack of policy mechanisms that balance the interests and costs of different regions, the lack of multi-regional energy and carbon market mechanisms that fully consider the needs of different regions, and the inefficiency of talent and funding support mechanisms.

3.3 Action suggestion analysis

China's IRJET involves various stakeholders, including the Chinese government, energy companies, consumers, environmental organizations, international organizations, academia and research institutions, and local communities[7].

To promote IRJET, these stakeholders can take the following actions:

The Chinese government can establish policies and regulations that encourage the adoption of clean energy technologies, promote the use of renewable energy, and incentivize the reduction of carbon emissions. The government can also provide funding and technical support to facilitate the development of clean energy projects.

Energy companies can invest in renewable energy projects, develop new technologies, and implement energy-efficient practices. They can also collaborate with other stakeholders to promote the adoption of clean energy technologies.

Consumers can reduce their energy consumption by adopting energy-efficient practices, such as using energy-efficient appliances and reducing unnecessary energy usage. They can also choose to purchase clean energy products, such as solar panels or electric vehicles.

Environmental organizations can raise public awareness of environmental issues, promote clean energy adoption, and advocate for policy changes that support interregional equitable energy transition.

International organizations can provide funding, technical assistance, and expertise to support interregional equitable energy transition in China. They can also collaborate with local stakeholders to develop and implement clean energy projects.

Academia and research institutions can conduct research on clean energy technologies, provide insights and recommendations to policymakers, and train the next generation of energy professionals [8].

Local communities can participate in the development and implementation of clean energy projects, provide feedback to policymakers and energy companies, and advocate for equitable access to clean energy resources.

4. Conclusion

Based on the actual situation of China's energy transition and the international issue of "just transition," this paper proposes the concept of "inter-regional justice energy transition" and puts forward a set of systematic analysis methods for studying such interdisciplinary soft science concepts. By applying this method, we have systematically analysed the conceptual content of IRJET, development obstacles, and action recommendations for stakeholders.

The main findings of this paper are as follows:

IRJET is the intersection of three concepts: energy transition, regional coordination, and just transition. Considering the actual situation of China's energy transition, we believe that IRJET means during the low-carbon energy transition, some regions with concentrated traditional and high-emission industries must be protected to avoid serious losses for current generation's need satisfaction, while the whole country can be prosperous, and carbon reduction targets can be realized.

At present, the main obstacles to a just transition in China's fossil fuel-rich regions are the lack of clear multi-regional cooperation positioning in the low-carbon energy transition, policy mechanisms that balance the interests and costs of various regions, and multi-regional energy and carbon market mechanisms that fully consider the needs of various regions. Additionally, there are inefficient talent and funding security mechanisms.

The main actions for stakeholders should be for the government to accelerate the improvement of institutional construction based on IRJET goals, for companies to actively deploy sustainable and high-quality industries tailored to local conditions in various regions, and for local regions to actively carry out energy transition and build sustainable energy and industrial structures.

Since IRJET is a new concept, this paper only conducts a preliminary systematic analysis of its content. The main research methods of this paper are literature review and policy research, and there is a lack of quantitative case analysis. In the future, we will further conduct quantitative analysis on the issue of inter-regional just energy transition in China.

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