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# Satisfaction evaluation of a just energy transition policy: evidence from China

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China has declared that it will achieve carbon neutrality by 2060, and energy transition will play a primary role in this process. This transition will encourage leapfrog development in efforts to achieve carbon neutrality. However, energy transition is often accompanied by social risks and injustices, which can be effectively addressed only by incorporating a just energy transition (JET) into the policy process. In this paper, three policy dimensions (material compensation, livelihood maintenance, and social development) associated with 13 policies designed to promote a JET in China are categorized. In addition, the satisfaction of vulnerable groups with these policy approaches is evaluated according to the analytic hierarchy process (AHP) and via second-level fuzzy comprehensive assessment (FCA). The results of a satisfaction evaluation of 1,329 vulnerable people who have been laid off, forced to immigrate, fallen into energy poverty, had their rights and interests violated, etc., indicate that the overall satisfaction rate with a JET is 0.404 (the total values of “very satisfied” and “satisfied”), i.e., less than half. Accordingly, China still faces clear JET challenges and should rely on the collaborative promotion of four multi-responsible actors: the government, enterprises and trade unions, social organizations, and individuals. Only through this process can social resources be widely absorbed and mobilized to foster cross-boundary discussions and ensure that no vulnerable populations are left behind. This study thus enriches policy research on energy transition, providing an opportunity to expand the academic horizon of JET as a research field. Furthermore, this study may also inspire policymakers to pay more attention to JET, offering references for subsequent policy improvement.

## KEYWORDS

just energy transition, energy transition, public policy, justice, satisfaction evaluation, vulnerable groups, collaborative governance, carbon neutrality

## 1 Introduction

The world's second-largest economy and top carbon emitter, China, has declared that it will strive to reach its carbon peak by 2030 and achieve carbon neutrality by 2060 (Jiang et al., 2023). In this context, the Chinese government has identified a series of carbon neutrality policy paths, such as energy transition, industrial upgrade, technological innovation, and eco-sink enhancement. Among these paths, the energy system is the most critical, as it produces the largest amount of carbon emissions (Zhou et al., 2022). Therefore, it presents the main challenge for developing a policy path to achieve carbon neutrality (Research Group on Energy Transition and Energy Security of Chinese Academy of Social Sciences, 2021; Song et al., 2021; Zeng et al., 2021). Some scholars propose that this energy transition

will bring new opportunities for leapfrog development during the progress toward carbon neutrality (De La Peña et al., 2022). However, historical experience indicates that energy transitions are often accompanied by substantial benefits as well as risks. The greater the policy strength of an energy transition is, the greater the social impact it will have, and the greater the socioeconomic injustice and inequality it will likely bring (Jasanoff, 2018; Winkler, 2020). As Sovacool et al. (2019) suggest, a wave of emission reductions in an energy system may “create new injustices and vulnerabilities, while also failing to address preexisting structural drivers of injustice.” In this context, many scholars have gradually demonstrated the importance of a just energy transition (JET), arguing that only the integration of a JET into the energy transition policy process can effectively address the accompanying social risk, inequity, and injustice issues, thus ensuring the smooth development of politics, economy, and society (Snell, 2018). While there are many extant JET findings in academia regarding the latest policy contexts, such as carbon neutrality, JET “merits further exploration in the context of decarbonization and the primacy of the just transition debate” (Garvey et al., 2022). Furthermore, few studies have focused on a JET in China. As the largest fossil energy user worldwide (Abbasi et al., 2022), China’s JET is bound to be challenging (Power Salon, 2020; Ning and Yang, 2022b). Hence, China’s energy transition to achieve carbon neutrality will require strong policies, whereby guaranteeing justice for its vulnerable groups will become highly necessary and urgent (Zhou and Qian, 2022).

Since the beginning of the 21st century, the Chinese government has formulated a series of policies to promote a JET. Nonetheless, whether and to what extent these policies have achieved a just transition remain unclear. More importantly, vulnerable groups’ satisfaction with JET policy approaches is not yet clear. Nevertheless, the subjective perceptions and evaluations of vulnerable groups are highly significant, as the goal of a JET is to prevent injustice and inequality. Unfortunately, thus far, this type of research has not been performed in academia. To address these issues, we construct a satisfaction evaluation indicator system based on the typical policy approaches in promoting a JET in China. That is, we analyze the satisfaction evaluation of JET policy approaches based on the analytic hierarchy process (AHP) and via second-level fuzzy comprehensive assessment (FCA) and to provide specific policy recommendations.

This study, therefore, contributes to the literature in three ways. First, to the best of our knowledge, this is the first study to empirically analyze the satisfaction evaluation of JET policy approaches, partially filling a gap in the literature on JET policy. Second, given that the JET concept is still clearly in an initial development phase, especially in China, this study provides an opportunity to further discuss the JET and expand its horizon and relevance as a field of study. Finally, the results could also be useful for and have an impact on policymakers and governments, who often tend to undervalue JET in the policy process concerning decarbonization.

The rest of this paper is organized as follows: Section 2 provides the research context for JET challenges and the evaluation indicators of policy approaches. Section 3 describes the data and methods. Section 4 presents the results of the satisfaction analysis of China’s JET evaluation indicators. Section 5 discusses the reasons and future

policy recommendations for a JET. Finally, Section 6 concludes the paper with key findings.

## 2 Research context

### 2.1 The challenges of a JET in China

The Chinese government and energy companies must address many challenges in promoting a JET: 1) unemployment caused by the transition from fossil energy sources (e.g., coal industry); 2) clean energy source (e.g., hydropower projects) development, which has caused the massive immigration of people who have lost their homes and means of production; and 3) the energy poverty of vulnerable groups caused by energy prices and mandatory emission reductions. While the Chinese government and energy companies are working to address these three challenges, deeper analysis is needed to provide a more direct and effective reference for subsequent policy approaches. These efforts can improve the satisfaction of vulnerable regions and groups with JET policy instruments.

#### 2.1.1 Unemployment of workers: the straightforward challenge of fossil energy transition

The coal sector in China produces a significant portion of its greenhouse gases. In addition, China is the world’s largest producer and consumer of coal. Therefore, coal transition is essential and urgent, whereby unemployment in the coal sector is also a prominent concern. China has accelerated its rapid coal transition, shifting many coal power projects into early retirement (Cui et al., 2019). Such a rapid transition inevitably brings many social challenges, such as lower tax revenue and coal asset impairment, the most prominent of which is coal worker unemployment. China’s coal transition is ongoing; today, the remaining coal workers are mainly those with lower education levels and limited skills. Once this group is laid off, their ability to access vocational training or future employment will be incredibly difficult. Furthermore, the skills required for the new energy industry differ from those previously needed in the coal industry. Accordingly, the short time frame for this transition is unlikely to provide these coal workers sufficient time to plan for, re-train for, and transition to new, similarly remunerative careers (He et al., 2020).

#### 2.1.2 Large-scale immigration caused by clean energy development and its unjust effects

The green energy transition is not a one-way industrial restructuring in which only the traditional fossil energy industry will be phased out; clean energy development is also crucial. This includes both the development of green energy sources such as wind, water, and solar energy and the use of new energy minerals such as lithium, cobalt, nickel, and copper. The former is the direct source of new energy, and the latter is the basic raw material for new energy storage and utilization facilities, such as lithium batteries. However, regardless of the form it takes, a certain injustice must still be present in clean energy development. For example, hydropower dams have become a remarkable source of clean energy over the past 50 years; however, they have also displaced nearly 30 million individuals and

caused negative externalities throughout the related areas. The unjust impacts of these hydropower dams on affected communities and vulnerable groups include decreased household incomes (Tilt et al., 2009), diminished mental health and wellbeing (Xi and Hwang, 2011), widening interhousehold and intercommunity economic disparities (Wang et al., 2013), and routine and dissonant cultures (Downing and Downing, 2008).

### 2.1.3 Energy supply shortage and energy poverty

At present, the common types of energy undersupply and energy poverty in China mainly include 1) high or fluctuating prices of traditional fossil energy sources, resulting in their unaffordability among low-income groups; 2) the instability of new energy supplies, which prevents the market from better meeting energy consumption needs, especially in fragile areas and among vulnerable groups; and 3) under the “coal to electricity,” “coal to gas,” “clean heating,” and “restrictions on electricity consumption” policies, energy poverty has emerged, e.g., residents in many vulnerable areas (e.g., Hebei Province) are unable to heat their homes and cook meals in the winter (Shi et al., 2021). Likewise, many enterprises are experiencing a kind of “energy poverty” that prohibits them from being productive. Vulnerable groups, such as people with low incomes, people with disabilities, and people who are elderly, suffer the most when the energy supply is challenged. Therefore, energy poverty puts the energy consumption rights of these groups at risk and leads to injustice.

## 2.2 Constructing evaluation indicators: concrete policy approaches for promoting a JET in China

The Chinese government is cognizant of the aforementioned JET challenges; in response, it has introduced a series of relevant policy documents. This paper first systematically outlines the policy system of a JET in China and reviews the literature to clarify specific JET policy approaches or instruments. A relevant satisfaction evaluation indicator system is then established. For example, to better promote a JET, the Chinese government has issued specific policies, such as its *Opinions on the Relocation of Workers in the Process of Dissolving Overcapacity in the Iron and Steel and Coal Industries to Achieve Destructive Development*, which addresses economic compensation, vocational ability training, and reemployment arrangements. Hence, the aim of this article is to identify a rather comprehensive list of typical JET policy approaches in China (similar to the three aforementioned policy approaches), which, in turn, is used as an indicator system for the satisfaction evaluation of vulnerable groups.

Specifically, we have categorized the typical policy approaches to promoting JET in the policy and academic literature. These mainly include the three primary indicators of “material compensation,” “livelihood maintenance,” and “social development” and 13 secondary indicators (Table 1). These evaluation indicators are precisely the specific policy implementation behaviors adopted by the Chinese government to promote a JET. Understanding and evaluating the satisfaction of vulnerable groups with policy approaches will allow optimizing future JET policies and

promoting the rights and interests of disadvantaged areas and vulnerable groups.

### 2.2.1 Material compensation

China’s policies for promoting JET include material compensation, e.g., monetary compensation, economic subsidies, production material compensation, and energy consumption subsidies.

#### (1) Monetary compensation

Monetary compensation for both clean energy development and traditional fossil energy transition is one of the most common policy approaches for promoting a JET. The purpose of monetary compensation is to reduce the damage to vulnerable groups that results from the energy transition. For example, in hydropower energy development, China provides monetary compensation based on the value of expropriated land, housing, and seedlings (Wang, 2009). Coal and other fossil energy companies also provide humane monetary compensation to redundant employees based on their length of service, position, and standard of living. Overall, the purpose of such policy approaches is to promote a more just treatment of vulnerable groups.

#### (2) Economic subsidies

Economic subsidies often refer to additional and flexible cash compensation. For example, China’s largest coal province, Shanxi, has introduced a policy whereby a site rental subsidy or business start-up subsidy of 2,000–5,000 yuan is provided to surplus workers of coal enterprises who leave their jobs to either start their own business or retire early. Job placement subsidies are available for human resource companies to address the reemployment of surplus workers (Shanxi, 2022). Similarly, China’s Ministry of Finance has established a \$100 billion fund specifically for job placement in the steel and coal industries; much of this has also been used to subsidize vulnerable people who endure injustice during the energy transition.

#### (3) Production material compensation

Most vulnerable people are from remote rural areas where productive resources such as land, cash crops, and farm animals represent the most important livelihood capital. Regarding land compensation, for example, many regions (such as Sichuan Province) often use land compensation as an important means of material compensation when developing hydropower energy, thus ensuring that affected rural residents are treated fairly (Peng, 2020). Typically, two types of such compensation predominate. First, the local government will choose a single land compensation method if a surplus of land resources exists. Second, and in contrast, if surplus land or other production materials is unavailable, a combination of production material compensation and one-time financial compensation or yearly monetary compensation is generally offered.

#### (4) Energy consumption subsidies

During energy transitions such as coal restriction or forestry reform, energy poverty is an inevitable result, as many villagers in remote areas still use wood or coal for cooking meals; local resource restrictions are

TABLE 1 Indicator system of JET policy approaches in China.

No.	Primary evaluation indicator	Secondary evaluation indicator	Main references
1	Material Compensation	Monetary compensation $u_{1,1}$	Spash (1994); Wang (2009); Le Billon and Kristoffersen (2020)
	$U_1$		
2		Economic subsidies $u_{1,2}$	Li and Sun (2018); Shanxi (2022)
3		Compensation for production materials $u_{1,3}$	Peng (2020); Chen et al. (2016)
4		Energy consumption subsidies $u_{1,4}$	Lin and Xu (2019); Lo (2021)
5	Livelihood maintenance	Skill training $u_{2,1}$	Huang et al. (2020a); He et al. (2020); Hu and Wen (2021)
	$U_2$		
6		Reemployment arrangement $u_{2,2}$	He et al. (2020); Huang et al. (2020b)
7		Industrial projects $u_{2,3}$	Li et al. (2022); Huang (2022)
8		Sustainability of livelihoods $u_{2,4}$	Li et al. (2015); Liu and Li (2019); Teng et al. (2022)
9	Social development	Infrastructure $u_{3,1}$	Zhaotong (2022); Zhou and Han (2014)
	$U_3$		
10		Compulsory and vocational education $u_{3,2}$	Sichuan (2012); Huang and Zou (2020); Wu and Han (2022)
11		Community culture $u_{3,3}$	Lu (2018); Hu and Wen (2016)
12		Medical security $u_{3,4}$	Huang et al. (2018); Zhang and Gao (2022)
13		Ecological environment $u_{3,5}$	Sun et al. (2016); Zhong and Feng (2018); Dong et al. (2020)

Source: Presented by the author.

thus likely to cause energy poverty (Lo, 2021). In this situation, some local governments or energy companies have provided energy consumption subsidies to promote better JET in related areas.

### 2.2.2 Livelihood maintenance

Livelihood maintenance promotes the ability of vulnerable people who have experienced injustice to maintain their past livelihood level. It mainly includes skill training and reemployment arrangements, focusing on industrial projects and livelihood sustainability (Zhou and Han, 2014).

#### (1) Skill training

The most common injustice in China's fossil energy transition is unemployment. The most vulnerable people in new energy development are farmers in remote areas, whose long-standing livelihoods are often in agriculture, fishing, or forestry (Hu and Wen, 2021). Consequently, these vulnerable people often express the greatest demand for agricultural skill training when they lose their job or livelihood to energy transition. However, for the few people who migrate to more urbanized areas when displaced by hydropower projects, such training is mainly in upgrading of tertiary industry skills, as these urban areas do not support agricultural industries.

#### (2) Reemployment arrangements

The transition of fossil energy enterprises generates many laid-off workers. In the coal industry, for example, the number of people

directly employed by Chinese coal enterprises was 5.3 million in 2013, a number that sharply decreased to 2.6 million in 2020 due to the energy transition (He et al., 2020). Therefore, enterprises and the government need to ensure reemployment of these laid-off workers to achieve a JET. The ongoing related practices of the Chinese government and enterprises include 1) developing medium- and long-term staff resettlement plans, 2) coordinating employment positions with third-party human resource companies in advance, and 3) collaborating with social security departments to ensure unemployment protection for laid-off workers. By implementing these policies, the reemployment of vulnerable people is ensured to the greatest extent possible.

#### (3) Industrial projects

Practically, two forms of industrial projects have been developed in China's energy transition. First, in the novel energy field represented by hydropower energy, the government and energy enterprises tend to support vulnerable groups through the development of industrial projects; these can often effectively restore these groups to their original livelihood level, while achieving sustainable development (Li et al., 2022). Second, in the traditional fossil energy sector represented by coal, the government is encouraging fossil energy companies to actively transition to other industries. On one hand, such transitions can compensate for the gradual decline in fossil energy production. On the other hand, they can also absorb many surplus workers, thus safeguarding their economic income and employment rights (Zhang

and Wang, 2022). The main types of salient industries developed by the Chinese government and energy enterprises are plantation agriculture, animal husbandry, tourism, handicrafts, and servicing.

#### (4) Livelihood sustainability

A one-time compensation approach in the energy transition will likely result in unsustainable livelihood for vulnerable people, especially among those who have lost their former livelihood or whose livelihood is no longer needed by the society. For these groups, long-term livelihood maintenance is crucial; it is also directly related to the medium- and long-term stability and development of vulnerable areas. The government should thus continue to focus on the livelihood capital of vulnerable groups (Li et al., 2015) and adopt more long-term-oriented policy approaches to continuously safeguard their livelihood capacity during the energy transition (Liu and Li, 2019; Teng et al., 2022).

### 2.2.3 Social development

Social development indicates the promotion of a better social environment, e.g., infrastructure, education, culture, healthcare, and ecology, for vulnerable groups, especially immigrants who have been displaced by hydropower energy development. China is one of the largest countries worldwide in terms of hydropower energy (Zhou et al., 2023); hence, many immigrants have been forced to move due to their homes being flooded or lands being designated as hydropower energy project construction areas. In newly resettled areas, social development is crucial for a JET to not only improve the social integration of vulnerable groups but also continuously improve their environmental adaptation capacity.

#### (1) Infrastructure

For large-scale immigration, especially entire villages that have been relocated or resettled, the Chinese government often provides a novel resettlement area, which must have well-developed infrastructure to ensure the smooth transition of these immigrants' production and life. For example, the second-largest hydropower project worldwide, the Baihetan hydropower station (Jia et al., 2019), in Qiaojia County in Yunnan Province, has not only strengthened the salient infrastructure via the construction of roads, farmland, and water conservancy in the resettlement area but also established new one-stop service centers for community party organizations, engaged in follow-up development, and ensured police access. In addition, the government has constructed activity venues for sports, leisure, women, elderly individuals, and children to continuously improve the quality of life of immigrants after their relocation (Zhaotong, 2022).

#### (2) Compulsory and vocational education

Education has long been a key to people's livelihood in many vulnerable areas in China's energy transition. For example, in Sichuan Province, the policy *Opinions on Further Promoting the Economic and Social Development of Large- and Medium-Sized Water Conservancy and Hydropower Project Reservoirs and Migrant Settlement Areas* clearly states that financial support for students in impacted families should be increased and that a

balanced approach to compulsory education should be effectively promoted. This policy also intensively focuses on rural vocational and adult education, strengthens employment skills and practical technology training for disadvantaged groups, and cultivates vulnerable groups into the technically skilled workers needed in modern agriculture and service industries (Zhou and Han, 2014).

#### (3) Community culture

Culture can enrich the spiritual life of disadvantaged communities and vulnerable groups. In many relocated areas, cultural departments and communities typically offer various forms of cultural, sports, and leisure activities to enrich the spiritual and cultural life of their people. Furthermore, a prosperous community culture can help vulnerable groups integrate into new neighborhoods and social networks, which in turn increases their life satisfaction (Lu, 2018).

#### (4) Medical security

Medical coverage is one of the most basic needs of vulnerable groups, whose inherently fragile financial capacity has a substantial impact on their lives when medical care is not guaranteed. In vulnerable areas, the Chinese government has thus vigorously promoted participation in new rural cooperative medical insurance and implemented a preferential payment policy for vulnerable groups while establishing an insurance system that addresses serious diseases (Zhang and Gao, 2022). With these policy approaches, China demonstrates its commitment to building a comprehensive healthcare system that ensures all vulnerable people have basic health protection.

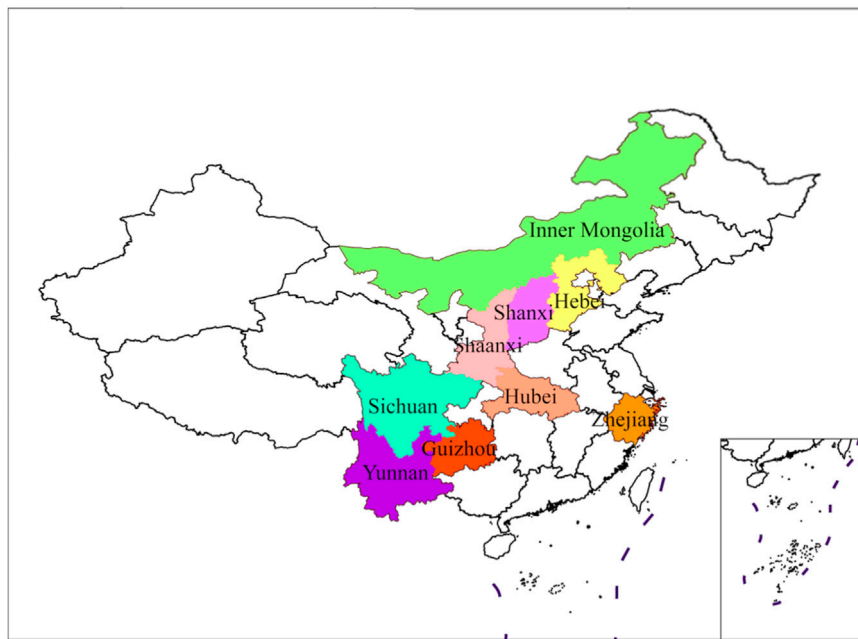
#### (5) Ecological environment

In vulnerable areas, the housing, environmental, and community sectors of the government work together to protect their ecological environment. These sectors often focus on treating sewage and waste from kitchens, latrines, and animal enclosures, as well as on vigorously implementing residential greening and beautification projects to address soil erosion (Zhong and Feng, 2018).

## 3 Data and methods

### 3.1 Data

In this study, we conducted a survey via an online questionnaire in August–September 2022 and collected 1,329 valid questionnaires (a total of 1,450 questionnaires were distributed for an effective rate of 91.66%). The 1,329 respondents mainly included four types of vulnerable people: 1) workers laid off due to the reduction in fossil energy (such as coal) production; 2) immigrants displaced by the development of clean energy (e.g., hydropower energy); 3) residents and business owners who have fallen into energy poverty due to the adjustment of fossil energy prices (Ma and Zhang, 2021); and 4) villagers whose rights and interests regarding energy consumption have been violated by the implementation of clean heating practices



**FIGURE 1**  
Geographical locations of surveyed respondents.

(such as “coal to electricity,” “coal to gas,” “clean heating,” “ban on burning firewood” and “prohibited kang and stove”; Shi et al., 2021; Li and Guan, 2021). Such vulnerable individuals have therefore experienced unfair and unequal treatment in terms of their loss of means of production and livelihood (e.g., land and housing), passive migration, economic loss, and job loss. Moreover, the Chinese government has implemented a series of policy approaches to address the social injustices they have experienced.

The four abovementioned categories are populated by 1,329 surveyed respondents mainly from the key provinces in the energy transition including Shanxi, Inner Mongolia, Shaanxi, Hebei, Yunnan, Guizhou, Sichuan, Hubei, and Zhejiang (Figure 1). These provinces have produced many vulnerable groups who have experienced social injustice as a result of fossil energy abatement and clean energy development (Yao and Wu, 2010; Hu, 2015; Bai et al., 2021; Shi et al., 2021). The participants’ demographic characteristics of gender, age, education level, primary source of income, disposable income, and regional origin are shown in Table 2. To improve the scientific nature of the questionnaire, some of the aforementioned options were selected according to *China’s National Economic and Social Development Statistical Bulletin for 2021* (National Bureau of Statistics, 2021). For example, the *Bulletin* divides the industry into three categories: agriculture, industry and construction, and services. Hence, we adopted these three categories of industry, which represent the main sources of income for vulnerable groups. Regarding the grading of disposable income, we referred to the national median disposable income of RMB 29,975 in 2021 (also accounting for the overall low disposable income of vulnerable groups), dividing disposable income in the questionnaire into four levels (5,000 and below, 5,001–15,000, 15,001–30,000, and 30,001 and above). As shown in Table 2, most of the surveyed respondents were

from the countryside, in line with the actual situation in China. In other words, many countryside vulnerable groups form due to new energy developments, such as hydropower projects. Few traditional fossil energy enterprises or new energy projects can generate such additional unemployment groups or dislocate residents to urban areas.

## 3.2 Methods

### 3.2.1 Determining JET indicator weights based on the AHP

(1) The principles and steps of the AHP

The AHP was first proposed by American operations researcher T.L. Saaty (1986). It is a widely used and effective multi-objective decision-making method that can effectively overcome the subjective preference of a single judgment via quantitative and qualitative analysis (Soam et al., 2023). The AHP has the advantages of applicability and simplicity and consists of three main steps.

First, we construct the judgment matrix. In this paper, we use the nine-scale method to construct the two–two judgment matrix  $P$ :

$$P = \begin{bmatrix} u_{11} & u_{12} & \cdots & u_{1n} \\ u_{21} & u_{22} & \cdots & u_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ u_{m1} & u_{m2} & \cdots & u_{mn} \end{bmatrix}$$

Second, we calculate the weights using the square root method:

① Calculate the product of the elements of each row of the judgment matrix  $M_i$ :  $M_i = \prod_{j=1}^n u_{ij}$ ; ( $i = 1, 2, \dots, n$ ); ② calculate the  $n$ th root of  $M_i$ ,  $\bar{\omega}_i$ :  $\bar{\omega}_i = \sqrt[n]{M_i}$ ; ( $i = 1, 2, \dots, n$ );

**TABLE 2 Characteristics of the survey sample.**

Item	Option	Number of participants	Proportion (%)
Gender	Male	708	53.3
	Female	621	46.7
Age	18 years old and below	0	0.0
	19–35 years old	867	65.2
	36–60 years old	324	24.4
	60 years old and above	138	10.4
Education level	Middle school and below	171	12.8
	High school	285	21.4
	Specialty	369	27.8
	Undergraduate college	393	29.6
	Postgraduate and above	111	8.4
Main source of income	Agriculture	606	45.6
	Industry and construction	417	31.4
	Service	306	23.0
Disposable income	5,000 and below	318	23.9
	5,001–15000	441	33.2
	15,001–30000	351	26.4
	30,001 and above	219	16.5
Area	Countryside	1,092	82.2
	Urban	237	17.8

Source: Presented by the author.

**TABLE 3 1st–11th order judgment matrix values.**

<i>n</i>	1	2	3	4	5	6	7	8	9	10	11
<i>RI</i>	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

③ normalize the vector  $\hat{\omega} = (\hat{\omega}_1, \hat{\omega}_2, \dots, \hat{\omega}_n)$ , that is,  $\omega_i = \frac{\hat{\omega}_i}{\sum_{j=1}^n \hat{\omega}_j}$ ; ( $i = 1, 2, \dots, n$ ); then,  $\omega = (\omega_1, \omega_2, \dots, \omega_n)$  is the requested weight.

Finally, the consistency test is conducted using the weights to ensure the objective reasonableness of weight assignment; the test formula is  $CR = \frac{CI}{RI}$ . In this formula, *CR* is the consistency ratio of the judgment matrix, while *CI* is the consistency index of the judgment matrix, which is calculated by the formula  $CI = \frac{1}{n-1} (\lambda_{max} - n)$ ; then, *RI* is the average random consistency index of the judgment matrix, the 1–11th order judgment matrix value table of which is shown in Table 3. When  $CR < 0.10$ , the judgment matrix is considered to have satisfactory consistency, indicating that the weight assignment is reasonable; otherwise, the judgment matrix needs to be adjusted until it has satisfactory consistency.

(2) The application of the AHP to the JET indicator weights

Following studies based on the AHP (Hoa et al., 2023), we constructed the judgment matrix of indicators and determined the weights of indicators at each level through two rounds of expert consultation (five experts). Among these experts, three were university professors or associate professors studying China’s energy transition and low-carbon development; they have long focused on the protection of the rights and interests of vulnerable groups in the decarbonization process. The fourth expert was from the Three Gorges Corporation, with a wide range of practical experience in safeguarding the rights and interests of vulnerable groups. The last expert was a part of the government and has been involved in many policies on energy transition, with in-depth expertise on the livelihood security of vulnerable people living in China.

In the first round of expert consultation, we independently sent the evaluation indicators to the five experts to determine the importance and rankings of the primary and secondary indicators in the energy transition field (Yontar and Ersöz, 2020).

We then conducted a second round of conference workshops for those indicators with more divergent weights, which the experts discussed to eventually form a consensus opinion. Subsequently, the weights were calculated according to the AHP as  $U = \{0.303, 0.482, 0.215\}$ ;  $U_1 = \{0.281, 0.274, 0.309, 0.136\}$ ;  $U_2 = \{0.204, 0.303, 0.252, 0.241\}$ ; and  $U_3 = \{0.127, 0.251, 0.171, 0.289, 0.162\}$ .

As the aforementioned weighting of the JET evaluation indicators shows, 1) among the four indicators of “material compensation” (monetary compensation, economic subsidies, production material compensation, and energy consumption subsidies), the indicator of “production material compensation” provided the most weight, mainly because there is a strong correlation between livelihood sustainability and production materials. Evidence shows that vulnerable groups tend to have more sustainable livelihood levels when they are compensated for production materials such as land. 2) In the primary indicator of “livelihood maintenance,” the highest weight is provided to “reemployment arrangement.” Undoubtedly, employment is considered the most important means to guarantee the livelihood of vulnerable groups, as it ensures their continuous income. 3) In “social development,” the secondary indicator of improving “medical security” is considered the most important. In fact, in China, the medical cost of some diseases is very high if there is no health insurance. “Poverty caused by illness” and “return to poverty due to illness” still remain; therefore, medical security for vulnerable groups has the highest weight.

Among the three primary indicators, the weights in descending order are “livelihood maintenance,” “material compensation,” and “social development.” “Livelihood maintenance” has the greatest weight because it is relatively more developed and sustainable in relation to vulnerable groups’ practical lives. In other words, having sustainable production and living standards is the most important criterion for vulnerable people.

### 3.2.2 Establishing a satisfaction evaluation set based on FCA

The questions in the questionnaire shown in Table 1 are based directly on the 13 specific policy approaches used by the Chinese government and energy companies to promote a JET. For each question, we use a five-point Likert scale (Bloom et al., 2021); that is, the satisfaction ratings of vulnerable groups for each policy approach are divided into five levels:  $v_1, v_2, v_3, v_4, v_5$ , corresponding to “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied.” Subsequently, we analyzed the final results of respondents’ perceptions of China’s JET policy approaches through a second-level FCA.

In this method, the first-level FCA is performed according to the second-level indicators. First, the first-level indicator  $U_i$  and the second-level indicator  $U_{ij}$  are set. We write the evaluation of  $U_i$  as  $R_{ij} = [r_{ij1}, r_{ij2}, r_{ij3}, r_{ij4}, r_{ij5}]$  and construct the second-level factor

evaluation matrix:  $R_{ii} = \begin{bmatrix} r_{ij1} & \dots & r_{ij5} \\ \vdots & & \vdots \\ r_{im1} & \dots & r_{im5} \end{bmatrix}$ . In the matrix,

$r_{ij1}, r_{ij2}, r_{ij3}, r_{ij4}, r_{ij5}$  are the scores of the second-level factors  $U_{ij}$  on the five levels of “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied,” respectively.  $n_{ij}$  denotes the number of participants among the  $n$  individuals who gave the evaluation level of factor  $U_{ij}$  as  $v_k$ , i.e.,  $r_{ij} = \frac{n_{ij}}{n}$ ,  $k = 1, 2, 3, 4, 5$ , and the evaluation result is calculated as  $B_i = W_i \circ R_i$ . Subsequently, we used the same method to calculate  $B = W \circ R$ . Then, the

satisfaction rating (results) of vulnerable groups is calculated for the JET policy approaches.

## 4 Results

### 4.1 Material compensation

In the primary evaluation indicators of material compensation,  $R_1$  is the satisfaction evaluation of the vulnerable groups based on its four secondary indicators (monetary compensation, economic subsidies, production material compensation, and energy consumption subsidies). Most respondents rated the four indicators of “material compensation” as “neutral,” i.e., they indicated that they are neither satisfied nor dissatisfied with the four indicators. In other words, improving these aspects to protect the rights and interests of vulnerable groups is necessary to improve their satisfaction ratings. Then,  $W_1$  is the weight of the four indicators calculated according to the AHP;  $B_1$  is the FCA’s result of “material compensation.” For the latter, the results of “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied” are 0.173, 0.205, 0.337, 0.146, and 0.139, respectively. That is, the satisfaction rate of “material compensation” among vulnerable groups is  $0.173 + 0.205 = 0.378$ , and the remaining proportions are all “neutral” or “(very) dissatisfied.”

$$R_1 = \begin{bmatrix} 0.14 & 0.23 & 0.42 & 0.09 & 0.12 \\ 0.18 & 0.19 & 0.34 & 0.17 & 0.12 \\ 0.22 & 0.21 & 0.27 & 0.14 & 0.16 \\ 0.12 & 0.17 & 0.31 & 0.23 & 0.17 \end{bmatrix}$$

$$\begin{aligned} B_1 &= W_1 \circ R_1 \\ &= (0.281, 0.274, 0.309, 0.136) \circ \begin{bmatrix} 0.14 & 0.23 & 0.42 & 0.09 & 0.12 \\ 0.18 & 0.19 & 0.34 & 0.17 & 0.12 \\ 0.22 & 0.21 & 0.27 & 0.14 & 0.16 \\ 0.12 & 0.17 & 0.31 & 0.23 & 0.17 \end{bmatrix} \\ &= (0.173, 0.205, 0.337, 0.146, 0.139) \end{aligned}$$

### 4.2 Livelihood maintenance

Similarly,  $R_2$  is the value of satisfaction evaluation on the four indicators of “livelihood maintenance.” Via  $R_2$ , we can observe that the vulnerable groups are most likely to choose “neutral” in all four indicators. Notably, the indicators of “skill training” and “industrial projects” have a relatively high percentage of dissatisfaction, indicating that the vocational skills of vulnerable groups are insufficient. Furthermore, the government and enterprises do not develop more industrial projects specifically for vulnerable groups to maintain their improved livelihoods. In the following equation,  $W_2$  is the weight of the four indicators (skill training, reemployment arrangement, developing industrial projects, and focus on livelihood sustainability).  $B_2$  is the FCA’s result for livelihood maintenance, the values of “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied” of which are 0.181, 0.216, 0.283, 0.189, and 0.131, respectively. The cumulative value of “very satisfied” and “satisfied” is 0.397 ( $0.181 + 0.216$ ), which is slightly higher than the previous primary indicator of “material compensation.”



$$R_2 = \begin{bmatrix} 0.19 & 0.22 & 0.24 & 0.21 & 0.14 \\ 0.21 & 0.23 & 0.26 & 0.14 & 0.16 \\ 0.14 & 0.22 & 0.32 & 0.23 & 0.09 \\ 0.18 & 0.19 & 0.31 & 0.19 & 0.13 \end{bmatrix}$$

$$\begin{aligned} B_2 &= W_2 \circ R_2 \\ &= (0.204, 0.303, 0.252, 0.241) \circ \begin{bmatrix} 0.19 & 0.22 & 0.24 & 0.21 & 0.14 \\ 0.21 & 0.23 & 0.26 & 0.14 & 0.16 \\ 0.14 & 0.22 & 0.32 & 0.23 & 0.09 \\ 0.18 & 0.19 & 0.31 & 0.19 & 0.13 \end{bmatrix} \\ &= (0.181, 0.216, 0.283, 0.189, 0.131) \end{aligned}$$

### 4.3 Social development

Concerning the primary evaluation indicators of social development,  $R_3$  and  $W_3$  denote the weights and satisfaction evaluation values of its five secondary indicators, respectively. Unlike the two primary indicators of “material compensation” and “livelihood maintenance” (which have four secondary indicators each), “social development” has five secondary indicators whose values of satisfaction evaluation also show certain differentiated characteristics.

The first differentiated characteristic is that not all indicators have the highest weight of “neutral.” Two indicators, improving “infrastructure” and improving “medical security,” have the highest value of “satisfied” (rather than “neutral”). Amid the increasing level of modernization in China, the level of improving infrastructure and medical security has become very high all over the country; hence, the vulnerable areas in energy transition are not at a great disadvantage. Furthermore, we find that the later the energy transition occurs, the higher the level of infrastructure, suggesting that the standard of infrastructure construction in China is continuously rising.

The second differentiated characteristic is that the value of “very dissatisfied” for each of the five secondary indicators in “social development” is significantly lower than that of “material compensation” and “livelihood maintenance.” We learned through further interviews that many vulnerable people still focus more on material benefits (“material compensation” and “livelihood maintenance”) than on socially or spiritually oriented interests (i.e., “social development”) at this stage. This finding is very interesting, and we suggest that there are two main reasons for this phenomenon: 1) the Chinese government and energy developers have paid more attention to the social development of vulnerable groups, thus making the satisfaction of these indicators higher; and 2) a gap in material abundance still exists between vulnerable groups and other groups. According to a traditional Chinese proverb, “Inequality rather than want is the cause of trouble”; this fully illustrates the reflections of vulnerable groups. In other words, once vulnerable groups perceive that they are not as rich as others, their dissatisfaction with their level of material and livelihood is triggered. At this point, they are more interested in increasing their level of material abundance and are relatively unconcerned with their social development or psycho-spiritual satisfaction. Precisely because vulnerable groups are not concerned with these indicators (i.e., they have low psychological requirements or expectations for social development), the assigned value of “very dissatisfied” is relatively low.

Finally, the product of  $W_3$  and  $R_3$  is the FCA’s result of “social development” (as shown in  $B_3$ ). The values of “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied” are 0.181, 0.278, 0.303, 0.151, and 0.087, respectively. The cumulative value of “very satisfied” and “satisfied” is 0.459 (0.181 + 0.278), significantly higher than that of the two primary indicators of “material compensation” and “livelihood maintenance.” This result also confirms what was analyzed in the previous paragraph. Therefore, in the future, the policy path toward a JET should be promoted more from “material compensation” and “livelihood maintenance” perspectives, thereby moderately reducing investment in social development.

$$R_3 = \begin{bmatrix} 0.19 & 0.34 & 0.25 & 0.11 & 0.11 \\ 0.14 & 0.29 & 0.34 & 0.14 & 0.09 \\ 0.17 & 0.24 & 0.29 & 0.21 & 0.09 \\ 0.23 & 0.29 & 0.28 & 0.13 & 0.07 \\ 0.16 & 0.23 & 0.34 & 0.18 & 0.19 \end{bmatrix}$$

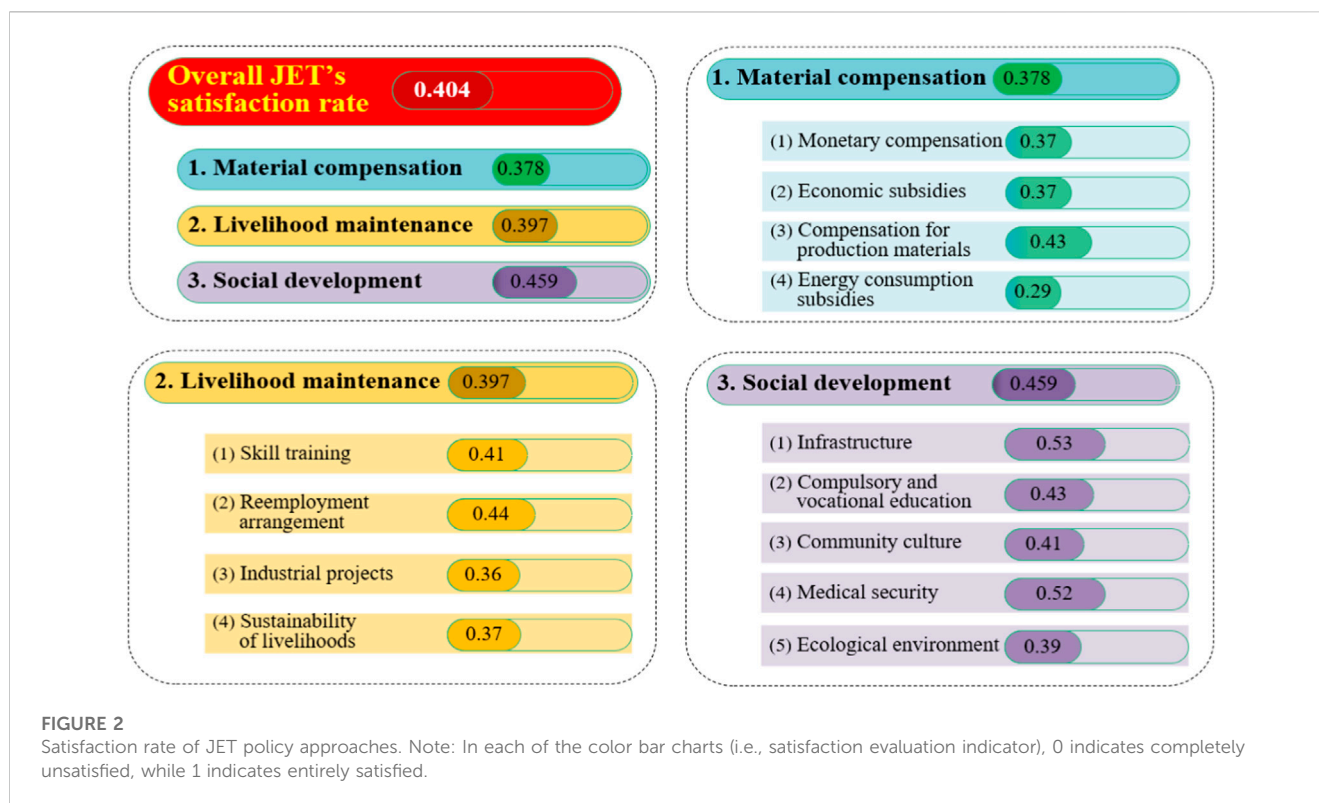
$$\begin{aligned} B_3 &= W_3 \circ R_3 \\ &= (0.127, 0.251, 0.171, 0.289, 0.162) \circ \begin{bmatrix} 0.19 & 0.34 & 0.25 & 0.11 & 0.11 \\ 0.14 & 0.29 & 0.34 & 0.14 & 0.09 \\ 0.17 & 0.24 & 0.29 & 0.21 & 0.09 \\ 0.23 & 0.29 & 0.28 & 0.13 & 0.07 \\ 0.16 & 0.23 & 0.34 & 0.18 & 0.09 \end{bmatrix} \\ &= (0.181, 0.278, 0.303, 0.151, 0.087) \end{aligned}$$

### 4.4 Overall JET satisfaction

Once the FCA results of the three primary indicators (“material compensation,” “livelihood maintenance,” and “social development”) are derived, we run the secondary FCA and calculate the final results based on the principle of maximum affiliation.  $R$  is the satisfaction evaluation values of the vulnerable groups on three primary indicators, while  $W$  is their weight calculated according to the AHP. In the FCA results (as shown in  $B$ ), the values of “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied” are 0.178, 0.226, 0.304, 0.168, and 0.124, respectively. That is, the overall satisfaction rate of the vulnerable groups for a JET is 0.404 (the total values of “very satisfied” and “satisfied,” see Figure 2). The satisfaction rate is still relatively low, less than half. This result suggests that vulnerable groups’ JET satisfaction evaluation in China is not very significant, i.e., JET still faces certain challenges. Fortunately, we can observe that vulnerable groups have the highest percentage of “neutral” among the five satisfaction levels, reaching 0.304. In other words, most members of vulnerable groups are neither satisfied nor dissatisfied with China’s JET policy approaches; they represent a kind of “oscillating group.” As a result, these groups will likely shift to “satisfied” or “very satisfied” if the policy approaches can be further improved. In this way, the satisfaction of vulnerable groups with JET can be significantly increased in the future to ensure that no one is left behind.

$$R = \begin{bmatrix} 0.173 & 0.205 & 0.337 & 0.146 & 0.139 \\ 0.181 & 0.216 & 0.283 & 0.189 & 0.131 \\ 0.181 & 0.278 & 0.303 & 0.151 & 0.087 \end{bmatrix}$$

$$\begin{aligned} B &= W \circ R \\ &= (0.303, 0.482, 0.215) \circ \begin{bmatrix} 0.173 & 0.205 & 0.337 & 0.146 & 0.139 \\ 0.181 & 0.216 & 0.283 & 0.189 & 0.131 \\ 0.181 & 0.278 & 0.303 & 0.151 & 0.087 \end{bmatrix} \\ &= (0.178, 0.226, 0.304, 0.168, 0.124) \end{aligned}$$



## 5 Discussion and policy recommendations

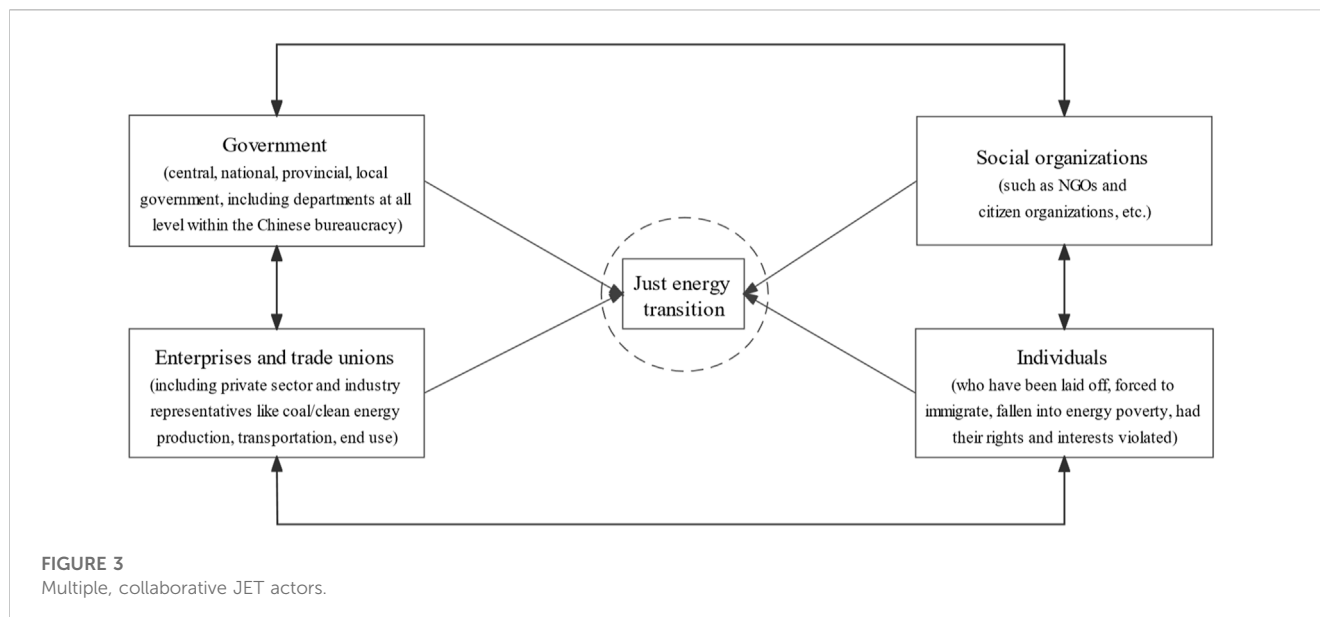
### 5.1 The reasons for the results: insufficient JET policy attention

The results show that the values of “very satisfied, satisfied, neutral, dissatisfied, and very dissatisfied” are 0.178, 0.226, 0.304, 0.168, and 0.124, respectively. The largest proportion of participants chose neutral, i.e., this group has a neutral attitude toward the current JET policy approach; they are neither satisfied nor dissatisfied. However, the overall number of satisfied people is less than half of the sample number. To further analyze the reasons for this result, we conducted further interviews with vulnerable groups and experts, as well as a more in-depth literature review. We found that perhaps the most significant reason for this result is the lack of government policy attention toward the JET. Specifically, most of China’s current JET policy approaches are embedded in its energy transition policy and are, at best, only a part of policy content. The latest policy documents released in 2022, such as the *Opinions on Improving Institutional Mechanisms and Policy Measures for Green and Low-Carbon Energy Transition*, *Implementation Plan on Promoting High-Quality Development of New Energy in the New Era*, and *Guidance on Energy Work in 2022*, are rarely specifically related to JET, and the few references to JET are presented in fragmented statements. For example, one JET-related reference in the aforementioned document is as follows: “to encourage village collectives to participate in the development of new energy projects by using stock ownership and revenue sharing mechanisms.” These policy documents are generally not dedicated to the importance of a JET

and are less than one paragraph in length. This situation may be the primary reason for the low satisfaction of vulnerable groups with current JET policy approaches, especially in terms of “material compensation” and “livelihood maintenance.”

As Zhang Ying, an associate researcher at the Chinese Academy of Social Sciences, states, China has “not established a policy system for a just transition” (Power Salon, 2020). Ning and Yang (2022b) also suggest that the insufficiency of specific JET considerations in China’s energy policies may make “the achievement of energy justice more challenging.” Of course, what they mean is that there is no specialized policy system for ensuring a JET. Indeed, China’s current energy transition policies and decarbonization policies pay more attention to protecting the rights and interests of vulnerable groups now than in the past (Ning and Yang, 2022a). Nevertheless, many current JET considerations in these policies are macrolevel and holistic concerns; detailed information at the micro level is lacking. In other words, China has not yet established a specific linkage or provision to achieving a JET in the implementation of policies concerning energy transition and carbon neutrality, but such a linkage or provision is often the most important element in substantially advancing a JET.

Worldwide, only by incorporating JET into policy process can the values of equity and justice be ensured (Newell and Mulvaney, 2013; Heffron and McCauley, 2018). China is a major consumer of fossil energy. Its strong policies for energy transition have reached a historical high point following its declared goal of achieving carbon neutrality by 2060. Amid deep, systemic changes in society as a whole, further improving the policy satisfaction of vulnerable groups, especially in terms of “material compensation” and “livelihood maintenance,” is not only urgent but also important. Such policies can prevent various kinds of social injustice and risk conflicts from arising.



## 5.2 Future JET policy recommendations

The low satisfaction of vulnerable groups in China with JET policy approaches, particularly concerning “material compensation” and “livelihood maintenance,” indicates the crucial necessity and urgency for policy reforms to guarantee justice and satisfaction. Given the current state of the JET policy in China, its JET policy design should not be regarded as an “add-on” to its energy transition policy but should be integrated into the framework thereof (Galgóczy, 2018) or even embedded in a policy or institutional arrangement that takes precedence over energy governance. In this manner, public satisfaction with the JET can truly be improved. Additionally, in achieving carbon neutrality by 2060, the process of energy transition will be notably accelerated; thus, the realization of JET will be more challenging. The government must realize that it is difficult to achieve a JET on its own, particularly in terms of “material compensation” and “livelihood maintenance.” The practical mechanism of a JET must rely on collaborative promotion by multiple responsible actors, such as governments, enterprises and trade unions, social organizations, and individuals (Figure 3); this allows for widely absorbing and mobilizing social resources (Pesch et al., 2017; Jenkins et al., 2021) while leaving no one behind (Carley and Konisky, 2020; Green and Gambhir, 2020).

The government (central, national, provincial, and local government, including departments at all levels) must play a leading role in a JET, a role determined by the public nature of energy governance. In the energy transition, governments should focus on creating a policy environment for a just transition, giving full play to the core functions of coordination, support, guidance, and integration to ensure that no one is left behind. Specifically, the government’s policy path should include the following: 1) establishing a specialized government agency to facilitate a clear relationship among the responsibilities and rights of different departments, thereby achieving greater policy effectiveness and ensuring the achievement of a JET. International policy has set a precedence for this relationship. For example, Scotland established the independent Just Transition Commission in 2018 to advise its

government on how to deliver energy and industrial transition by examining “how to maximize opportunities for decarbonization in terms of fair work and tackling inequalities while delivering a sustainable and inclusive labor market” (Just Transition Commission, 2019). Germany has also set up the German Coal Commission (GCC), which plays a key role in promoting a just transition to coal (Oei et al., 2020). 2) Promulgating JET legislation: the Illinois *Clean Energy Jobs Act* (Crowe and Li, 2020) has proven that legislation can protect the employment rights of vulnerable groups during energy transition and have a positive impact on JET realization. By adopting similar legislation, China can relieve the tension between energy transition and energy justice and provide strong institutional support for a JET. In the relevant legal provisions, justice should be stipulated as a basic concept of energy transition. Furthermore, in their specific rules, these provisions should provide normative support for JET realization. In this way, legislation can significantly promote energy justice (including procedural justice, distributional justice, recognition justice, and restoration justice) and, in many instances, prevent injustice (Jenkins et al., 2016; Upham et al., 2022). 3) Creating a dedicated public finance fund: China is vast in size, with great differences in energy endowments and development levels across different regions. By studying the European Green Deal’s €100 billion just transition finance fund, China can learn how to support particularly vulnerable sectors and regions. This support can effectively alleviate any unemployment and inequality due to the elimination of fossil energy or new energy development.

Regarding enterprises or trade unions, in contrast to other countries, trade unions in China are often dependent on enterprises and constitute a substantial component thereof. Consequently, many JET responsibilities are performed jointly by enterprises (including the private sector and industry representatives such as coal/clean energy production, transportation, and end use) and trade unions. Two types of enterprises (trade unions) are the most prone to injustice: 1) traditional fossil energy enterprises, as important actors in the carbon neutrality process, will inevitably face strict carbon reduction transformation, production reduction or suspension, and even

permanent withdrawal in response to carbon neutrality governance (Jiang et al., 2022). This transition will inexorably lead to large-scale income reduction and unemployment. 2) New energy development enterprises, especially those in the process of hydropower energy development, tend to generate many involuntary immigrants who experience many injustices, such as loss of their means of production, displacement from where they have been living for generations, and difficulties integrating into their new environment. Therefore, it is the responsibility of fossil energy enterprises, new energy companies, and their respective trade unions to ensure a JET. They should promote JET through the following paths: 1) during energy transition, the concept of just transition should be firmly established as a priority. 2) Special working groups and special funds should be set up to ensure the full realization of JET. 3) Employment and replacement programs are needed for workers impacted by reductions in fossil energy sources, and for immigrants impacted by new energy development. These programs should be formulated in advance to ensure that protecting the rights and interests of vulnerable groups is the highest priority. 4) When resettling workers from fossil energy enterprises, we should proactively explore the development of other industries and strive for internal job diversion and replacement within such enterprises. In general, widely strengthening the “material compensation” and expanding “livelihood maintenance” channels are particularly necessary.

Social organizations (such as NGOs or citizen organizations) are also essential JET actors; they can play the role of “two-way acquisition” (Duan and Li, 2020). Social organizations can embed, interact with, transmit, and draw on administrative government resources (or requirements) in a JET across all levels and the social responses (or demands) of enterprises or people (Ji, 2017). In short, they can play the role of an “intermediary,” a “mediator,” and a “facilitator” among the different actors responsible for a JET, thus promoting the multiple goals of the government, enterprises and trade unions, and individuals in the JET. Social organizations are typically characterized by “dependent autonomy” (Wang and Song, 2013) with regard to other policy actors and can respond to the systemic and complex nature of JET policies, thus enhancing the effectiveness thereof. In addition, from a social science perspective, social organizations, including enterprises and trade unions, communities, and other multi-responsible JET actors, must further and subtly influence the JET policy framework before implementation (Zhang et al., 2022). In this way, a “highly organized and refined structure” of a JET and “top-down” policy synergy can be formed to ensure that a JET safety net can be firmly woven. Therefore, specifically, social organizations can promote JET in the following ways: 1) they can promote the popularization and dissemination of the JET policy as a third-party “intermediary” once the government or enterprises have formulated this policy. 2) Social organizations can track the interests of vulnerable groups and work with the government and enterprises to establish a multidimensional JET protection system. 3) They can also promote procedural justice and help vulnerable groups convey their demands to the government’s decision-making department. 4) They can mitigate any conflicts of interest among the government, enterprises, and vulnerable groups, thereby alleviating social conflicts.

Vulnerable individuals are also responsible for JET. Individual participation can contribute significantly to a JET and the achievement of energy justice. We should thus advocate the active participation of individuals in the whole energy transition framework to

effectively guarantee the realization of energy justice and reduce the risk of social conflict. Moreover, this process will allow energy transition solutions to meet the actual needs and wishes of vulnerable people. As a result, the specific path for individuals to promote JET involves the following actions: 1) ownership of and participation in the social activities related to energy transition should be strengthened, especially in any feasibility study of the energy transition program. Individuals should fully exercise their right to be informed, participate, and vote during the whole process (Zhang et al., 2023). In terms of the listening process and when soliciting others’ opinions, individuals should also offer their opinions and demands objectively to ensure the fairness and justice of the energy transition. 2) Vulnerable groups also need to responsibly exercise democratic oversight. During the planning and implementation of energy transition programs, they should be encouraged to report any violations of justice to minimize the occurrence of such incidents, which harm their interests, and to prevent possible corruption and rent-seeking behavior. 3) Concerning social injustice or the risk of conflict, vulnerable groups should initiate consultation and dialogue through communities, enterprises, or the government and work together to solve social problems.

## 6 Conclusion

This paper constructs a satisfaction evaluation indicator system based on China’s current JET policy approaches. We have analyzed the responses of 1,329 participants according to the AHP and via FCA. The results show that the overall JET satisfaction rate of vulnerable groups is 0.404 (the total values of “very satisfied” and “satisfied”), less than 50%. Accordingly, this study proposes that China’s future JET policy recommendations must be enhanced via the synergy of multiple actors (government, enterprises and trade unions, social organizations, and individuals). Among these actors, the government should play a leading role by establishing specialized agencies, legislation, and funding. Enterprises and trade unions must also play a direct role in a JET, as social organizations should play the role of “intermediary,” and individuals should be actively involved in the whole energy transition. This research thus contributes a Chinese case study of JET and provides references for the subsequent improvement of the JET policy worldwide.

Undoubtedly, certain shortcomings in this study exist. The first is that this paper establishes only a general JET policy approach evaluation indicator system; it does not use discrete evaluation indicators for different groups. Second, the number of participants could be further increased. These two shortcomings open paths for further research.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

## Author contributions

HC wrote and revised the manuscript. MD conducted data collection and data analysis and wrote the manuscript. HC

analyzed the results and revised the manuscript. HC, MD, and CZ conducted the investigation and measurements. HC and CZ supervised the entirety of the research and revised the manuscript. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

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