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Review

A Review of Rural Household Energy Poverty: Identification, Causes and Governance

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Abstract: Energy poverty is one of the three major crises of the global energy system. It tends to deepen as a result of the imbalance between supply and demand, energy transition and financial factors, especially in rural areas of developing countries. This paper took rural household energy poverty as the subject and collected 27 Chinese papers and 44 English papers from Google Scholar, Sci-hub, CNKI and other academic websites in the academic field on the definition, identification methods, influencing factors and governance countermeasures of energy poverty. It focused on analyzing the influence of income level, geographic location, urban–rural differences, demographic characteristics and other factors on energy poverty, as well as the profound impact of energy poverty on the population's health, the population's economic status, social equity, welfare of the population, the national economic development, etc. It finally landed on the government's countermeasures to govern energy poverty so as to provide references for solving the problem of energy poverty by systematically sorting out the literature.

Keywords: rural household; energy poverty; identification methods; influencing factors; government governance

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1. Introduction

Energy poverty is one of the three major crises facing energy systems around the world, and governments have been committed to energy poverty reduction. The latest report of the IEA, "World Energy Outlook 2022", pointed out that since the outbreak of war between Russia and Ukraine, Europe has been plunged into an energy crisis, and energy prices have risen dramatically, with the price of a barrel of oil rising to USD 250, and the price of a barrel of coal rising to a record high of USD 100. The high energy prices have spilled over into other areas of the economy, resulting in higher inflation in Western economies such as in the United States, the United Kingdom, the Eurozone and Japan. The total household energy costs have increased by between 63% and 113% since February 2022; each household is paying more for fuel, utilities and food and other goods (World Energy Outlook, 2022 [1]). All this may lead to extreme poverty for millions of people around the world.

Reducing the impact of adverse factors such as energy shortages and rising energy prices on global development (Xu and Yang, 2022 [2]; Xu and Huang, 2023 [3]), and breaking through the bottleneck of energy transition, is an important way to achieve the global sustainable development goals. Household energy poverty is a prominent problem in rural areas, so energy use in rural areas is the key to the sustainable development of developing countries. However, due to their vulnerability and special energy use structure, it is more difficult for rural households to withstand the impact of increasing energy use costs. In recent years, there has been an increasing number of studies on energy shortage and its impact on poverty, but they have different focuses and research directions. Therefore, it is necessary to conduct a systematic review of these studies. This paper takes rural energy

poverty as the object of research and identifies it from the point of view of influencing factors and governance countermeasures and other perspectives to systematically sort out the existing literature with a view to providing reference for solving the world problem of rural energy poverty.

2. Materials and Methods

2.1. Search Process

Relying on Google Scholar, Sci-hub, CNKI and other academic websites, relevant academic papers were collected; the English literature basically came from the SCI/SSCI document library, and the Chinese literature came from CNKI.

2.2. Inclusion–Exclusion Criteria and Data Extraction Process

Through the keyword search, a total of 122 papers were retrieved, and 71 papers were retained. Among them, through the keywords "energy poverty", "fuel poverty", "energy poverty alleviation", "household energy" and "energy consumption", 42 articles were found in Chinese, and 27 articles were retained after eliminating 15 articles with low relevance. Using "poverty" and other keywords, we searched 80 articles in English, and retained 44 articles with a high degree of relevance. All this literature was either based on rural areas or focused on rural–urban comparisons.

It should be noted here that some of the 44 English articles were based on Chinese samples. The purpose of this paper is not only to systematically sort out the literature on rural household energy poverty, but also to provide suggestions for China's energy policy. Therefore, in the elaboration of the content, China may be more discussed.

We extracted the following information from the selected papers: author, date, sample, research method and purpose and main conclusions. First, a researcher exported information about the paper to an Excel database and removed duplicates. Second, a cross-check was performed by another researcher to ensure that all data were filtered and vetted. Finally, the two researchers examined and discussed the inconsistent literature and reached agreement.

2.3. Quality Assessment of the Literature

We used the Critical Appraisal Skills Programme (CASP) to evaluate all papers that were selected and selected 4 of the original 10 questions within the CASP Checklist that were suitable for our paper to evaluate the quality of the papers (shown in Table 1).

Table 1. Quality assessment of all studies.

Rank	Author	(1) Did the Paper Address a Clearly Focused Question?	(2) Do You Think All the Important, Relevant Studies Were Included?	(3) Can the Results Be Applied to the Local Population?	(4) Were All Important Outcomes Considered?
1	Liao et al. (2015) [4]	Yes	No	Yes	Yes
2	Lewis (1982) [5]	Yes	No	No	Not sure
3	Boardman (1991) [6]	Yes	No	Yes	Yes
4	Hills (2011) [7]	Yes	No	Yes	Yes
5	Pereira et al. (2011) [8]	Yes	Yes	No	Yes
6	Charlier et al. (2019) [9]	Yes	Yes	Yes	Yes
7	Sovacool (2012) [10]	Yes	Yes	Yes	Not sure
8	Nussbaumer et al. (2013) [11]	Yes	No	Yes	Yes
9	Li (2014) [12]	Yes	Yes	Yes	Yes
10	Day et al. (2016) [13]	Yes	Yes	Yes	Yes

Table 1. *Cont.*

Rank	Author	(1) Did the Paper Address a Clearly Focused Question?	(2) Do You Think All the Important, Relevant Studies Were Included?	(3) Can the Results Be Applied to the Local Population?	(4) Were All Important Outcomes Considered?
11	Okushima (2016) [14]	Yes	Yes	Yes	Not sure
12	Chang et al. (2020) [15]	Yes	No	Yes	Yes
13	Zhang et al. (2020) [16]	Yes	Yes	Yes	Yes
14	Moore (2012) [17]	Yes	Yes	Yes	Yes
15	Besagni and Borgarello (2019) [18]	Yes	Yes	Yes	Not sure
16	Falchetta et al. (2021) [19]	Yes	Yes	Yes	Yes
17	Wei (2014) [20]	Yes	Yes	Yes	Yes
18	Heindl (2015) [21]	Yes	No	Yes	Yes
19	Sánchez et al. (2018) [22]	Yes	Yes	Yes	Not sure
20	Bouzarovski and Tirado (2015) [23]	Yes	Yes	No	No
21	Tirado et al. (2015) [24]	Yes	Yes	Yes	Yes
22	Maxim et al.(2016) [25]	Yes	Yes	Yes	Yes
23	Okushima (2017) [26]	Yes	No	Yes	Not sure
24	Che et al. (2021) [27]	Yes	Yes	No	Not sure
25	Cai (2020) [28]	Yes	Yes	No	Yes
26	Cai et al. (2021) [29]	Yes	No	Not sure	Yes
27	Lin et al. (2016) [30]	Yes	Not sure	Yes	Yes
28	Peng et al. (2008) [31]	Yes	Yes	Yes	Not sure
29	Fu (2012) [32]	Yes	No	Not sure	Yes
30	Liu and Yao (2020) [33]	Yes	Yes	Yes	Yes
31	Gouveia et al. (2019) [34]	Yes	Not sure	Yes	No
32	Halkos et al. (2021) [35]	Yes	Yes	Not sure	Yes
33	Zou et al. (2019) [36]	Yes	No	Yes	No
34	Teschner and Vornicu (2020) [37]	Yes	Yes	Yes	Yes
35	Miah et al. (2010) [38]	No	Yes	Not sure	Not sure
36	Qin et al. (2013) [39]	Yes	Yes	Yes	Yes
37	Clancy et al. (2003) [40]	Yes	Yes	Not sure	No
38	Yang (2016) [41]	Yes	Not sure	Yes	Yes
39	Wang (2015) [42]	Yes	Yes	Not sure	No
40	Pachauri (2004) [43]	Yes	Yes	Yes	No
41	Wang (2008) [44]	Yes	Yes	Not sure	Yes
42	Liang et al. (2012) [45]	No	No	Yes	No
43	Wu et al. (2013) [46]	Yes	No	Yes	Yes
44	Han Phoumina et al. (2019) [47]	Yes	Yes	Not sure	Yes
45	Keith J. Baker (2018) [48]	Yes	Yes	Yes	Yes

Table 1. *Cont.*

Rank	Author	(1) Did the Paper Address a Clearly Focused Question?	(2) Do You Think All the Important, Relevant Studies Were Included?	(3) Can the Results Be Applied to the Local Population?	(4) Were All Important Outcomes Considered?
46	Cooke (1998) [49]	Yes	No	Yes	No
47	Moniruzzaman and Day (2020) [50]	Yes	No	Yes	Yes
48	Benjamin K. Sovacool (2012) [51]	Yes	Yes	Yes	Yes
49	Sadath (2017) [52]	Yes	Yes	Yes	Yes
50	Álvarez et al. (2017) [53]	Yes	Yes	Yes	Yes
51	Biermann (2016) [54]	Yes	Yes	Yes	Not sure
52	Liu and Deng (2019) [55]	Yes	No	Not sure	Yes
53	Liu et al. (2020) [56]	Yes	No	Not sure	Yes
54	Heltberg (2000) [57]	Yes	No	Yes	Not sure
55	Yao (2013) [58]	Yes	Yes	Yes	Yes
56	Ivan Faiella (2021) [59]	Yes	Yes	Yes	Yes
57	Bazilian et al. (2014) [60]	Yes	No	Yes	No
58	Borozan (2018) [61]	Yes	Yes	Yes	Not sure
59	Bouzarovski et al. (2021) [62]	Yes	Yes	No	No
60	Goldthau (2014) [63]	No	Not sure	Yes	No
61	Phoumin (2019) [64]	Yes	No	Yes	Not sure
62	Barnes and Samad (2011) [65]	Yes	Yes	Yes	Yes
63	Wu and Zheng (2022) [66]	Yes	Yes	Yes	Yes
64	Yadav and Abdullah (2018) [67]	Yes	Yes	Yes	Yes
65	Xu and Wei (2021) [68]	Yes	Yes	Yes	Yes
66	Sesan (2012) [69]	Yes	No	Not sure	Yes
67	Papada (2018) [70]	No	Yes	Yes	No
68	Gregory (2019) [71]	Yes	Not sure	Not sure	No
69	Chapman et al. (2019) [72]	Yes	No	Yes	Yes
70	Liu et al. (2017) [73]	Yes	Yes	Not sure	Yes
71	Ashar Awan et al. (2022) [74]	Yes	Yes	Yes	Yes

Notes: for the Critical Appraisal Skills Programme (CASP), please refer to the website https://casp-uk.net/casp-tools-checklists/ (accessed on 12 May 2023).

3. Results

3.1. Identification of Households' Energy Poverty

3.1.1. Conceptual Discrimination

The impacts of energy poverty on health and other socio-economic aspects belong to the realm of cross-disciplinary research and are one of the key areas of sustainable development management and macro policy research (Liao et al., 2015 [4]). The proposal of energy

poverty originated from the British fuel access movement in 1982, when the focus in terms of energy use was on the availability of purchasing energy services. With the development of the economy and society, many scholars have also defined energy poverty in different ways from different perspectives, and, in general, there are three levels (Figure 1).

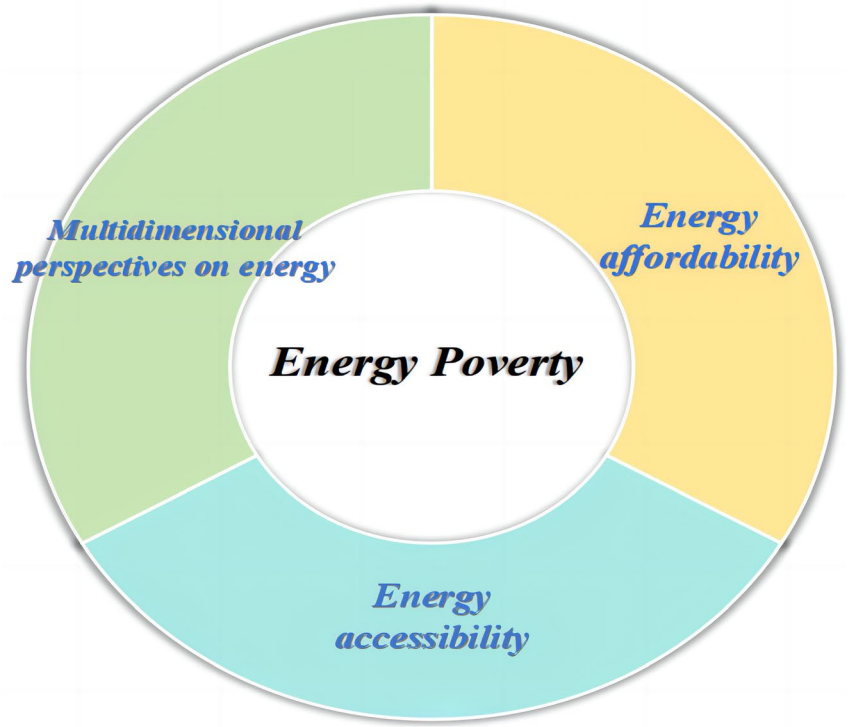

Figure 1. Conceptual discrimination of households' energy poverty.

Firstly, based on energy affordability, Lewis (1982) [5] considered energy poverty as a situation in which a household cannot maintain indoor temperature and cannot afford to pay for domestic energy use. From a quantitative point of view, Boardman (1991) [6] argued that, in terms of fuel use, energy poverty is caused if a household's energy consumption expenditure exceeds 10% of the household's disposable income, and Hills (2011) [7] argued that energy poverty is a combination of high levels of energy consumption and low levels of income, namely: the LIHC (Low Income High Cost) indicator. Both the "10%" indicator and the "LIHC" indicator have been officially used by the UK government.

The second is based on energy accessibility. The International Energy Agency (IEA) defined energy poverty as the phenomenon of not having access to advanced energy sources and having to rely on biomass for cooking, heating, lighting, etc. Some scholars expanded this concept, such as Pereira (2011) [8], Charlier et al. (2019) [9] and Sovacool (2012) [10]; the first two scholars defined energy poverty as a state in which the actual household living energy consumption does not meet the basic needs of life, and the latter included the basic human living energy needs, the energy needs of social production and social service energy needs in the concept of energy poverty.

Thirdly, the multidimensional energy poverty index (MEPI) is used to assess energy poverty by constructing a composite index using a weighting methodology for a multi-dimensional energy poverty evaluation indicator system. Nussbaumer et al. (2013) [11] constructed the first macro-level multidimensional energy poverty index (MEPI) in terms of households' access to modern fuels, access to electricity and ownership of household electricity. Li (2014) [12] designed a three-tier index of the multidimensional energy poverty system based on affordability and availability of energy access and cleanliness and efficiency of domestic energy use. Day et al. (2016) [13] defined multidimensional energy poverty as the inability to access affordable, reliable and secure energy services, which, in turn, fails to fulfill the basic subsistence and developmental functions of the people.

Okushima (2017) [14] defined energy poverty as a phenomenon where households are deprived of all three dimensions of energy costs, income and residential energy efficiency. Chang et al. (2020) [15] and Zhang et al. (2020) [16] introduced a psychological perspective to test the endogeneity of multidimensional energy poverty and residents' psychological conditions, further expanding the research boundaries of the field.

Overall, although the existing literature presents a multidimensional definition of household energy poverty, the most central elements remain energy accessibility and affordability, i.e., whether a household is able to access or afford the modern clean and efficient energy services it needs, such as electricity and liquefied petroleum gas (LPG), or whether it relies on traditional biomass energy sources, such as firewood and straw, which can affect the household's health, education, income and welfare levels.

China's energy poverty alleviation policy has progressed through four stages. The first stage was "guaranteeing energy use", the second was "guaranteeing energy use and improving the level of use", the third was "improving access to energy and optimizing the energy structure", the fourth was "guaranteeing energy use, optimizing the energy structure and improving energy use level". As China has won the battle against poverty and built a moderately prosperous society on schedule, the rural areas covered by large power grids have basically been equipped with power electricity, and energy poverty has been completely eliminated. However, the problems of a poor energy structure, low energy efficiency and a low level of energy use still exist in China. Therefore, in the future, China's key research directions in terms of energy are discovering how to optimize the energy structure, how to use energy efficiently and how to improve the level of energy use, which is actually the research content of multidimensional energy poverty.

Overall, the existing literature provides a comprehensive and detailed description of the definition of household energy poverty, including energy affordability, access and multidimensional perspectives, which contributes to a deeper understanding of the complexity and diversity of energy poverty issues. However, in describing the different definitions, there is a lack of comparison and comprehensive assessment of their corresponding advantages and disadvantages. For example, the availability of biomass energy is often measured by the ease of transition to clean energy, rather than by whether there are actual energy difficulties. Households judged to have poor access may not actually lack energy use. Regional heterogeneity exists in habits and structures of energy use, which creates the potential for miscalculation. Household income will be affected by changes in other factors. If the impact is severe enough, it will lead to the weakening of household energy affordability, and the resulting energy poverty will be out of the scope of the discussion of energy use. Therefore, the detailed comparison of the advantages and disadvantages of various energy definitions and the determination of the scope of application can be carried out on this basis to further understand the definition of energy poverty and provide more references for formulating policies and solutions.

3.1.2. Identification Method

In response to different definitions of energy poverty, energy poverty identification methods have also diversified. Currently, they can be broadly categorized into three types of identification methods: unidimensional indicator methods, independent multidimensional indicator methods and the multidimensional energy poverty index (Table 2).

Table 2. Main approaches to energy poverty identification.

Type of Identification Method	Author	Year	Sample	Identification Indicator or Method
Unidimensional indicator identification method	Boardman [6]	1991	UK	The 10% of total household income principle and the principle that energy expenditure is twice the median share of household income are used to determine household energy poverty status
	Hills [7]	2011	UK	Set thresholds for the income and energy expenditure components of household energy expenditures followed by a state below income and above expenditures to be considered energy poor
	Moore [17]	2012	UK	"Minimum income principle", i.e., ability to pay for basic energy costs after housing and other needs are met
	Chang et al. [15]	2020	2015 CGSS	The rural energy poverty line was calculated to be 600 kgce/a per household
	Falchetta et al. [19]	2021	Kenya	Establishment of a multisectoral geospatial data-processing platform for potential electricity demand, M-LED, to identify energy poverty with electricity consumption profiles
Independent multidimensional identification indicator approach	Wei [20]	2012	China	Five dimensions: accessibility of energy services, cleanliness of energy consumption, completeness of energy management, affordability and efficiency of domestic energy use
	Heindl [21]	2014	German	Calculations and comparisons were made using the 10% indicator, the MIS basic indicator and the LIHC, respectively, for the three measures of energy poverty
	Sánchez et al. [22]	2018	Spain	All households are categorized into six groups using two indicators, the monetary poverty line and the energy poverty line, and policies are applied accordingly
Multidimensional energy poverty index identification method	Tirado et al. [24]	2014	Europe	A composite energy poverty index was calculated using three proxies: "unable to keep their house adequately warm", "in arrears on utility bills" and "living in a home with a leaky roof, or a damp and rotting house"
	Maxim et al. [25]	2016	Europe	A composite energy poverty index (CEPI) was constructed with five indicators at its core: utility arrears, poor dwelling quality, self-assessed inability to keep the home sufficiently warm, related indicators and the proportion of the population with self-assessed summers that are not cool enough and dwellings that are too dark
	Okushima [26]	2017	Japan	A multidimensional energy poverty index (MEPI) was constructed from energy costs, income and house energy efficiency

Table 2. *Cont.*

Type of Identification Method	Author	Year	Sample	Identification Indicator or Method
Multidimensional energy poverty index identification method	Cai [28]	2020	China	Assignment and characterization of indicators for the comprehensive assessment of energy poverty in China using hierarchical analysis
	Che et al. [27]	2021	Global	A multidimensional indicator system for energy poverty is developed in terms of energy availability, energy affordability and energy cleanliness. Secondly, a synthesized approach combining rough sets, large-scale surveys and an improved sequential preference technique based on the similarity of ideal solutions (TOPSIS) is proposed
	Cai [29]	2021	China	The entropy method was used to calculate the energy poverty composite score and to study the changing pattern of energy poverty in each province in China

Firstly, the unidimensional indicator method determines whether the research object is in energy poverty or not by determining the threshold value of a single energy poverty indicator, which can reflect the basic situation of energy poverty in a certain country or region in a more intuitive way. Boardman (1991) [6] takes 10% of the total household income as a measure of energy poverty, and if more than 10% of the total household income is used to pay for the appropriate energy costs, the household falls into household energy poverty. In addition to this, the two-times-median principle (2M) is also considered as one of the indicators for determining energy poverty, i.e., a household is considered to be in household energy poverty if it needs to spend more than twice the median income of all households on energy expenditure. Due to the shortcomings of the 10% principle, Hills (2011) [7] in the UK adopted the "Low Income Higher Expenditure (LIHC)" indicator, i.e., if the income after expenditure on energy costs is below a certain income threshold and the portion of the energy expenditure is above a certain expenditure threshold, which is considered to be "Low Income Higher Expenditure (LIHC)", then the household is considered to be energy poor. Moore (2012) [17] uses the Minimum Income Principle (MIS), which means that a household is considered energy poor if it no longer has enough income to cover its basic energy costs after housing and other needs are met. Besagni and Borgarello (2019) [18] developed a "minimum thermal expenditure" measure that compares the minimum thermal expenditure of different households with their actual annual energy expenditure to determine household energy poverty. In addition to using income or expenditure as indicators, some scholars have also used electricity consumption as a unidimensional indicator to define energy poverty, such as Falchetta et al. (2021) [19], who set up a multi-sectoral potential electricity demand geospatial data-processing platform based on the consumption of residential electricity for the identification of energy-poor communities. Domestic scholars were more inclined to set an energy poverty line to measure the energy poverty status; Chang et al. (2020) [15] used the data of the China General Social Survey (CGSS) in 2015, combined with the per capita household energy consumption of rural residents and the per capita household population of rural households, to calculate the average household living energy consumption of rural households and the per capita household population of rural households. They then introduced the proportion relationship between the national poverty line and the average per capita net income and deduced that China's rural energy poverty line at this stage was about 600 kgce/household.

Secondly, we address a dashboard of individual indicators. The independent multidimensional indicator method refers to the use of multiple independent indicators to

separately analyze the situation of energy poverty in different dimensions. Wei (2014) [20] constructed a comprehensive assessment index system of energy poverty in China, including the five dimensions of energy service availability, energy consumption cleanliness, energy management completeness, affordability and efficiency of domestic energy use, to assess China's energy poverty in the temporal and spatial dimensions. Heindl (2015) [21] analyzed the energy poverty situation in China based on household data in Germany by using the 10% indicator, the basic indicator of the MIS and the LIHC to calculate and compare energy poverty. Sánchez et al. (2018) [22] started from the energy poverty line and used the monetary poverty line and the energy poverty line to classify low-income households in Spain as six kinds, which were: below both the monetary and the energy poverty line, below the monetary poverty line but above the energy poverty line, above the monetary poverty line but below the energy poverty line, economically and energy vulnerable, economically vulnerable and above both the economic and energy poverty lines.

Thirdly, we address the multidimensional energy poverty index (MEPI). The multidimensional energy poverty index (MEPI) is used to assess energy poverty by constructing a comprehensive index using a weighting method for the multidimensional energy poverty evaluation index system. Tirado et al. (2015) [24] calculated a composite energy poverty index using three representative indicators: the proportion of people unable to keep their homes adequately warm, arrears on utility bills and leaky dwellings with damp corruption. Based on Bouzarovski and Tirado's (2015) composite energy poverty index (CEPI) [23], Maxim et al. (2016) [25] added two more indicators, namely, "the proportion of the population living in dwellings that are uncomfortably cool in summer" and "the proportion of the population who consider their dwellings to be too dark". Okushima (2017) [26] similarly constructed a multidimensional energy poverty index using energy cost, income and house energy efficiency and pointed out that the subjective judgment and wealth dimensions in the multidimensional energy poverty index are the future direction of development. Che et al. (2021) [27] constructed an index system from the three dimensions of access to energy services, affordability of energy for living and cleanliness of energy consumption, then used the method of subjective–objective composite empowerment to construct a multidimensional energy poverty index to analyze the energy poverty situation in 125 countries around the world. Cai (2020) [28] selected the hierarchical analysis method to assign weights to the comprehensive assessment indicators of energy poverty in China and constructed the China Energy Poverty Index to assess and characterize regional energy poverty in China. Cai et al. (2021) [29] used the entropy method to calculate the comprehensive score of energy poverty and deeply studied the change pattern of energy poverty among Chinese provinces and its influencing factors.

The identification and measurement of energy poverty are the groundwork for addressing multidimensional energy poverty. The report of the 20th National Congress of the Communist Party of China (CPC) explicitly proposed to "promote the energy revolution in depth" and "accelerate the planning and construction of a new energy system". Only by accurately identifying the current state of the problem and characteristics of energy poverty and exploring the driving forces for improving energy poverty can we provide a scientific basis and empirical evidence for consolidating the results of China's poverty eradication and realizing the goal of common prosperity.

The comprehensive evaluation of energy poverty identification methods is based on different dimensions of the reference definition based on the definition of energy poverty and adopts three kinds of methods, such as one-dimensional index methods, independent multidimensional index methods and the multidimensional energy poverty index. However, as with the definition of energy poverty, much of the literature does not mention the specific scope of the application of various methods, which makes the selection and application of the index highly subjective, so further research lacks specific reference and operational experience for various actual situations in different rural areas. Especially considering the regional heterogeneity, such as the huge differences in energy consumption habits, housing characteristics and climate characteristics, direct identification of energy

poverty is prone to misjudgment. We should first make a preliminary judgment on the overall characteristics of a region and then select appropriate energy poverty index methods and indicators on this basis. Therefore, the identification of energy poverty should include two parts: regional identification and energy poverty identification. In order to achieve a good combination of the two, it is necessary to summarize the specific application scope of the three types of energy poverty identification methods, especially the connection between the identification indicators and the actual situation, so as to further provide a more accurate identification of energy poverty.

3.2. Causes of Rural Households' Energy Poverty

The factors affecting rural energy poverty are complex, and current research focuses on factors such as income levels, infrastructure perfection, geographic location and population characteristics (Figure 2 and Table 3).

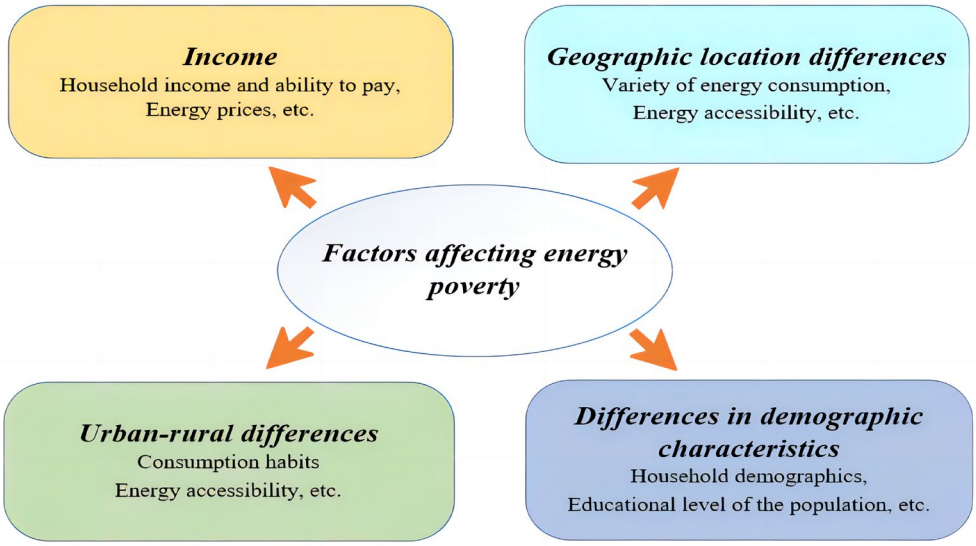

Figure 2. Factors affecting energy poverty.

Table 3. Main factors affecting rural energy poverty.

Category	Author	Year	Sample	Research Methodology	Main Findings
Income	Peng et al. [31]	2008	A total of 401 farmers and 100 enterprises randomly selected in Hubei Province	Applying logistic and Tobit models to study the behavior of rural households in terms of accessing and using electricity and log-linear models to study the behavior of rural industrial enterprises in terms of using electricity	Households and businesses with lower incomes are more likely to face energy poverty
	Fu [32]	2012	Data on the income of urban residents in Beijing and the consumption of various types of domestic energy in beijing	Analyzing residential energy consumption behavior using SPSS 12.0 software	Increased household income will alleviate household energy poverty
	Lin et al. [30]	2016	Indicators of energy consumption of five types of home appliances by urban residents in China	Empirical analysis using appliance diffusion models	Household income is the main cause of structural differences in energy consumption and energy poverty
	Gouveia et al. [34]	2019	Data on energy consumption for heating in all 3092 parishes in Portugal	Using a combination of socio-economic indicators of population (AIAM sub-index) and building characteristics and energy performance (EPG sub-index)	Unemployment affects residents' ability to pay for energy

Table 3. *Cont.*

Category	Author	Year	Sample	Research Methodology	Main Findings
Income	Liu et al. [33]	2020	China Household Energy Consumption Survey (CRECS) data	Analysis using the LA-AIDS model	Large-scale use of clean energy may increase the likelihood of energy poverty
	Halkos et al. [35]	2021	Energy poverty indicators for 28 selected European countries for the period 2004–2019	Consensus methodology and integrated measurements	Energy prices, unemployment and the economically poor are the main drivers of the persistent worsening of energy poverty, and GDP per capita is inversely related to energy poverty
Infrastructure perfection	Zou et al. [36]	2019	Data from 1472 rural households in the 2015 CGSS	Estimating the determinants of energy consumption in rural households using the Tobit model	The survival energy consumption structure in rural areas makes them face a lower possibility of energy poverty
	Teschner et al. [37]	2020	Grid energy data for Roma communities in Romania and Bedouin villages in Israel	ATLAS	In rural areas, housing, infrastructure and other conditions are relatively backward, and the energy supply capacity is insufficient, and the possibility of energy poverty is low
Location	Miah et al. [38]	2010	A survey of 120 households in rural Bangladesh was conducted using a stratified random sampling technique	Use of the Games–Howell multiple comparison test model to compare mean values of different parameters in different regions	Examining the differences in household energy consumption in different regions of Bangladesh from the point of view of different uses
	Wu et al. [46]	2013	Linwei—household domestic energy use data in rural areas	Field questionnaire survey, energy use location quotient, relevant analyses	The type of regional geography can greatly influence the energy choices of rural households for domestic use
	Qin et al. [39]	2013	Data on per capita consumption expenditure of urban and rural households in China	The regression model of household energy consumption was constructed by taking the household energy consumption of China's residents as the dependent variable and choosing the urbanization rate and average years of schooling as independent variables	The characteristics of the population, as the main consumer of energy in households, are factors that cannot be ignored
Demographic characteristics	Clancy et al. [40]	2003	Household income and poverty data for men and women in developed countries in the northern hemisphere	Qualitative analysis	Poverty alleviation programs for energy poverty should be developed in accordance with the gender ratio and demographic structure of households
	Wang [42]	2015	China Family Panel Studies (CFPS) data, 2010	Using non-linear regression (least squares) to estimate household consumption of commodities	There is a positive correlation between household size and total household energy consumption, with larger households more likely to face energy poverty

Table 3. *Cont.*

Category	Author	Year	Sample	Research Methodology	Main Findings
Demographic characteristics	Yang [41]	2016	Survey data from 322 farming households in ethnic minority areas of Gansu and Yunnan Provinces	Factors affecting farmers' fuelwood consumption demand were quantified using the Tobit model	Household members with higher levels of education will be more inclined to choose cleaner energy sources, and their energy costs will be higher, making them more likely to face energy poverty
	Ashar Awan et al. [74]	2022	Eight waves of HIES, 1998–2019, covering 142,537 households in Pakistan	Probit model	Sizeable clean energy programs targeting the poor with low education, families living in rural areas and female-headed households are needed

Firstly, we discuss the impact of income level on rural energy poverty. Lin et al. (2016) [30] pointed out that residents mainly consider economic cost factors when consuming energy, and the results of the existing domestic literature are more consistent; household income is the main cause of differences in energy consumption structure as well as energy poverty. Peng et al. (2008) [31] found that the income level of agricultural households affected the electricity demand of agricultural households, while the income of industrial enterprises also affected the electricity demand of industrial enterprises. The lower the income, the higher the likelihood that households and firms will face energy poverty. Fu (2012) [32] pointed out that the lower the household income of residents, the lower their level of energy consumption, and an increase in income will alleviate household energy poverty. Liu and Yao (2020) [33] found that after traditional energy sources were replaced by modern energy sources, the large-scale use of clean energy sources might increase the likelihood of energy poverty due to the reduced direct availability of energy sources and increased energy costs. Gouveia et al. (2019) [34] hypothesized that unemployed populations possess more economic difficulties and less motivation to implement energy poverty alleviation measures and thus used unemployment as a core indicator for energy poverty assessment. Halkos et al. (2021) [35], in their assessment of the impact of the economic crisis on energy poverty in Europe, noted that energy prices, unemployment and economically deprived populations were the main drivers of the continued worsening of energy poverty, and GDP per capita was found to have an inverse relationship.

Secondly, we discuss the impact of infrastructure perfection on rural energy poverty. Zou and Luo (2019) [36] combined the types of energy consumption and pointed out that rural areas have a relatively low level of infrastructure perfection in aspects such as entertainment, sanitation and transportation, so energy consumption related to the above aspects is relatively small. Energy consumption in rural areas has a typical surviving-type energy consumption structure. Compared with urban areas, which have development-type or pleasure-type energy consumption, rural areas are less likely to face energy poverty. Teschner et al. (2020) [37] pointed out that the housing, infrastructure and other conditions in rural areas are relatively backward, and their energy supply capacity is insufficient, so there are fewer people living in energy poverty, and the possibility of facing energy poverty is low.

Thirdly, we discuss the impact of different geographical locations on rural energy poverty. Miah et al. (2010) [38] started from the different usage to study the difference in household energy consumption in different regions of Bangladesh and pointed out that energy-poor rural areas choose more initial energy sources to reduce the cost of energy consumption and avoid the possibility of households facing energy poverty. Wu et al. (2013) [46] showed that differences in the type of regional geographic environment can greatly affect the choice of energy for domestic use in rural households and then affect the

availability of energy for domestic use in rural households and the governance of energy poverty.

Fourthly, we discuss the impact of population characteristics on rural energy poverty. Qin et al. (2013) [39] pointed out that household energy consumption was related to economic, technological, natural environmental, social and psychological factors, of which the population's own characteristics are factors that cannot be ignored as the main body of household energy consumption. Similarly, Clancy et al. (2003) [40] argued that poverty alleviation programs for energy poverty should be developed based on the household gender ratio and demographic structure. Yang (2016) [41] pointed out that family members with high levels of education and long average years of education were more inclined to choose cleaner energy with higher prices, and the corresponding cost of energy use would increase, making them more likely to face energy poverty. Wang (2015) [42] pointed out that the number of people in a household was positively correlated with the total energy consumption of the household, which meant the larger the population, the more likely the household was to face energy poverty. Ashar Awan et al. (2022) [74] used eight waves of HIES 1998–2019 covering 142,537 households in Pakistan and found that sizeable clean energy programs targeting the poor with low education, families living in rural areas and female-headed households are needed.

In general, this part provides a comprehensive discussion of the factors affecting energy poverty, and the application of numerous data and theoretical models in the literature also provides valuable information for further research and policy formulation. However, despite the above-mentioned four factors, the current literature on the influencing factors of energy poverty still mainly focuses on income level, and the impact of income level on energy poverty under different endowments is different in terms of performance and mechanism; only a few studies have included specific analysis of the performance and mechanism of income impact on energy poverty. In addition, there is a lack of in-depth analysis of other factors in the current literature. For example, in rural areas, population structure, housing scale, cultural cognition, customs and other factors have an impact on energy poverty. If these factors are not further discussed, the evaluation and exploration of influencing factors of energy poverty may be limited. Therefore, the further study of the influencing factors of energy poverty can start from a more detailed perspective, select different factors for analysis and discussion and emphasize the investigation of the influencing mechanism of the influencing factors to further improve the research content on the influencing factors of energy poverty.

3.3. Adverse Consequences of Rural Households' Energy Poverty

As a complex problem, energy poverty has a wide and far-reaching social and economic impact on rural areas, including in relation to five aspects: health of rural residents, economic conditions of rural residents, social equity, welfare of rural residents and regional economic development (Table 4).

Table 4. Socio-economic impacts of energy poverty.

Dimensions	Author(s)	Year	Sample	Findings
Residential health	Wei [20]	2014	Data from 3255 rural households tracked by the China Health and Nutrition Survey Programme from 2000 to 2011	Significantly higher respiratory morbidity among people who use solid fuels for cooking activities over a long period of time.
	Liao et al. [4]	2015	2001–2010 China Statistical Yearbook	Energy-poor people often burn large quantities of traditional biomass in inefficient ways, releasing high levels of respirable particulate matter (RSP) that worsens indoor air quality and endangers the health of energy-poor people.

Table 4. *Cont.*

Dimensions	Author(s)	Year	Sample	Findings
Net income of the population	Keith J. Baker [48]	2018	Data on the population of Scotland	There is a strong correlation between household energy poverty and the poor physical and mental health of household members, both of which have a significant negative impact on personal debt and income.
	Han Phoumina et al. [47]	2019	Cambodia socio-economic survey data, 2015	Energy poverty significantly affects household out-of-pocket spending on illness, especially respiratory illnesses, further exacerbating the net income position of energy-poor households.
Social justice	Cooke [49]	1998	Selected developing countries in Asia	Energy poverty is not conducive to solving the problems of time allocation and the low status of families among the population.
	Benjamin [51]	2012	Population data on energy poverty compiled by the International Energy Agency (IEA), the World Health Organization and United Nations organizations, 2009	Energy poverty affects both gender roles in society and the educational opportunities available to children and adults. In regions with low grid coverage, children are less educated and generally spend less time studying than their peers.
Residential welfare	Biermann [54]	2016	Panel data on life satisfaction for about 40,000 people in Germany from 1994 to 2013	Fuel poverty and subjective well-being have a negative and significant impact. The magnitude of the effect is comparable to that of other significant factors in life satisfaction, and the effect goes beyond that of income poverty alone.
	Álvarez et al. [53]	2017	Data from the Spanish Living Conditions Studies (SLCS), 2013	The relationship between energy poverty and subjective well-being is very strong, and energy poverty (an aspect of general poverty) affects individual well-being in a different and important way. Compensating households with high rates of energy poverty is more effective in terms of increasing well-being.
	Sadath [52]	2017	Household-level data in Indian Human Development Survey-II (IHDS-II), 2011–2012	Energy poverty is widespread in India, and its existence coincides with other forms of deprivation such as income poverty and social backwardness. At the same time, increasing energy accessibility can be effective in improving the welfare of the population.

Table 4. *Cont.*

Dimensions	Author(s)	Year	Sample	Findings
Residential welfare	Liu and Deng [55]	2019	Chinese General Social Survey 2015 (CGSS2015)	Energy poverty significantly reduces the welfare of the population, and the greater the intensity of energy poverty, the lower the welfare of the population. There is regional, urban–rural and income heterogeneity in the effect and magnitude of energy poverty on well-being. The transmission mechanism of the impact of energy poverty on well-being is "energy poverty—health/inequality—well-being".
National economy	Heltberg [57]	2000	Data on villages surrounding protected areas in rural India	The high consumption of fuelwood by rural households has led to serious degradation of local forest resources, with serious negative impacts on the economy and the environment.
	Yao [58]	2013	CGSS	The large amount of greenhouse gases released during solid combustion also contributes to some extent to the adverse effects of global climate change, which, on the one hand, increases the cost of governance for governments and, on the other hand, again negatively affects the health of the population.
	Ivan Faiella [59]	2021	Energy poverty data published by the Italian government	Inadequate warmth and inefficient healthcare caused by energy poverty negatively affect the productivity of the country as a whole, while children who are unable to learn in properly heated or lit environments due to energy poverty may contribute to a reduction in the accumulation of human capital, which, in turn, reduces the overall growth potential of the economy.

Firstly, from the perspective of residents' health, Liao (2015) [4] believes that energy poverty in rural China is mainly reflected in the use of solid fuels such as firewood, wood and coal and further explores the health risks caused by indoor air pollution caused by the use of solid fuels in rural households. Wei et al. (2014) [20] applied data from 3255 rural households tracked by the China Health and Nutrition Survey Project from 2000 to 2011 to analyze solid fuel cooking utilization and its relationship with residents' respiratory diseases and found that, after controlling for other factors, the likelihood of residents suffering from respiratory diseases was greatly increased due to the use of solid fuels for long-term cooking labor.

Secondly, in terms of the economic status of rural households, Han Phoumina (2019) [47] examined energy poverty in Cambodia using data from the Cambodian Socio-Economic Survey (CSES) and found that rural energy-poor households in Cambodia were likely to have higher out-of-pocket costs related to illness, particularly respiratory illness, compared to non-energy-poor groups, and this further reduced the earning power of rural households experiencing energy poverty by about 48%. Keith (2018) [48] pointed out the close relationship between rural household energy poverty and household income and

expenditure. They found that energy poverty leads to poor indoor conditions, resulting in poor physical and mental health of family members, which, on the one hand, makes family members work less efficiently and affects their income, and, on the other hand, may lead to illnesses of family members, which causes an increase in the family's additional medical expenditures, and puts pressure on the family's expenditures or pre-existing debts. In other words, economically disadvantaged groups in the plight of household energy poverty are prone to enter into adverse feedback loops, further increasing the extent of household energy poverty.

Thirdly, from a social equity perspective, the negative impacts of energy poverty on women and children are particularly evident. For example, energy-poor households use solid fuels to meet their daily needs, and heavy solid fuel procurement activities can be time consuming, and these activities are usually performed by women and children of lower household status who have to spend less time on other productive or learning activities, hindering the emancipation of women and children (Cooke, 1998 [49]). Energy poverty affects both gender roles in society and the educational opportunities available to children and adults, and children in regions with low grid coverage are less educated and generally spend less time learning than their peers (Benjamin, 2012 [51]).

Fourthly, in terms of residents' well-being, Sadath (2017) [52] found that energy poverty is widespread in India, especially in rural areas where households rely heavily on traditional biofuels such as firewood, dung cakes and agricultural residues; increasing access to energy can significantly improve the welfare of rural residents. Álvarez et al. (2017) [53] comparatively analyzed the effects of energy poverty and income poverty on residents' subjective well-being and life satisfaction. Biermann (2016) [54] examined energy poverty and its effects on life satisfaction and found that energy poverty adversely affected life satisfaction, and its effect exceeded the effect of income poverty. Liu and Pen (2019) [55] pointed out that the high incidence of energy poverty in China led to the impairment of residents' welfare, and there was regional, urban–rural and income heterogeneity in the effect and extent of the impact on residents' welfare.

Fifthly, from the perspective of national economic development, in most developing countries, rural residents in the state of household energy poverty use firewood as fuel for a long period of time, which undermines the sustainability of forest resources. Heltberg (2000) [57] studied the demand and supply of domestic energy in rural households in India and found that the high consumption of fuelwood by rural households had led to the serious degradation of local forest resources. Yao (2013) [58] pointed out that the large amount of greenhouse gases released during solid combustion exacerbated the adverse effects of global climate change, increasing the government's cost of governance while negatively affecting the health of the population. Ivan Faiella (2021) [59] found that mortality rates in European winters were on the higher side of the scale during the course of a year, further pointing to the lack of adequate warmth resulting from energy poverty and the healthcare inefficiencies. He also noted that, in the long run, children who were unable to learn in properly heated or lighted environments may reduce human capital accumulation, which, in turn, reduces the overall growth potential of the economy.

In summary, there are negative externalities arising from household energy poverty due to lack of access to minimum levels of energy services. Although it is difficult to quantify such negative externalities precisely, it is clear that the impacts are large. In the case of China, there are micro-level and macro-level impacts of energy poverty. At the micro level, energy poverty affects the health, well-being and income of the population, while, at the macro level, energy poverty affects national economic development and social equity.

The empirical results of the relevant literature studies provide a relatively comprehensive assessment of the socio-economic impact of rural energy poverty, and there is also relevant data quantification as support, but most of the analysis stays on the surface, without discussing the deeper socio-economic impact. For example, diseases caused by rural energy poverty will lead to the weakening of farmers' income capacity and form self-payment pressure for disease treatment, which will further aggravate household energy

poverty. The negative social and economic impact caused by household energy poverty often leads to a vicious circle mechanism, and a thorough analysis of it can further solve the dilemma of household energy poverty. Therefore, the social and economic impact of household energy poverty should be analyzed in the circular mechanism so as to further find the weak link in this vicious circle for breakthrough and provide breakthrough reference countermeasures for the problem of household energy poverty.

3.4. Governance Responses to Rural Households' Energy Poverty

Energy poverty is a global problem, and the United Nations proposed the "Sustainable Energy for All" initiative in 2021, which aims to increase the population's access to energy, improve the level of energy services and ameliorate energy poverty. In order to deal with energy poverty, governance can be carried out in three aspects: formulating energy poverty reduction policies, promoting the development of new energy industries and fostering public awareness.

The government should adjust the environmental regulation policy and increase the intensity of environmental regulation so that environmental regulation becomes an important driving force to improve energy poverty and promote inclusive green development. Bouzarovski et al. (2021) [62] stated that the EU should adopt a common general definition of energy poverty and set up a pan-European monitoring center to help determine the extent of energy poverty. Phoumin et al. (2019) [64] pointed out that energy-poor households may have high out-of-pocket expenses, especially for respiratory diseases, so the government should provide energy-poor households with minimum medical health insurance. Similarly, Wu and Zheng (2022) [66] pointed out that the government can formulate differentiated fiscal and energy policies, transferring fiscal funds originally used to improve the energy transition of high-income groups and regions with higher levels of economic development to poorer regions and low-income groups so as to realize the tilting of fiscal funds to low-income groups and backward regions. In addition, Yadav and Abdullah (2018) [67] and Xu and Wen (2021) [68] proposed to improve environmental protection policies, increase penalties for high-pollution, high-energy-consumption and high-emission enterprises and tailor environmental policies to local conditions. Combined with the level of regional energy poverty, a reasonable and effective environmental policy system should be constructed.

The government should strongly support the development of the new energy industry to reduce the level of energy poverty and give full play to the role of energy poverty reduction in boosting inclusive green development. In developing countries, Sesan (2012) [69] found that technological, economic and cultural aspects improve energy poverty, and kitchen equipment upgrades are most effective. Papada et al. (2018) [70] argued that improving energy poverty can be achieved by providing households with renewable energy sources and thus transitioning to a carbon-free environment. Barnes and Samad (2011) [65] stated that rural electrification in Brazil has significantly reduced energy poverty levels, thus improving energy equity. Furthermore, Han Phoumina et al. (2019) [47] suggested that the government could expand the grid and distribution through innovative financing or through rapid reforms in the power sector. Additionally, it can vigorously promote home solar systems to electrify remote areas.

The government should guide the public to form an awareness of environmental protection, reduce inefficient or even unnecessary energy waste and improve the bottom-up environmental supervision and governance system so that the public's supervisory power can help improve energy poverty and become a guarantee for the coordination of the environment and the economy. Chapman et al. (2019) [72] argued that low-income and energy-poor households had a weaker awareness of environmental protection and that the low-carbon transition process needed to focus on this part of the population and help them to improve the efficiency of energy use in order to achieve the purpose of improving energy poverty. Xu and Wen (2021) [68] suggested that government departments should build an effective information disclosure platform to improve the public's right to know

and participation so that the public can accurately grasp the level of energy poverty in China and the current situation of environmental governance. In this way, the public's environmental aspirations can play a role in the government and enterprises to promote green development, and they can further improve the energy utilization rate, or even launch a new type of green energy, which would, in turn, play a counteracting role in the government's efforts to improve energy poverty.

To sum up, the literature on household energy poverty governance mainly gives some constructive suggestions on energy poverty governance with regard to three aspects, policy support and infrastructure construction, new energy industry development and public awareness cultivation, but it is slightly insufficient in some aspects. First, in terms of policy support and infrastructure construction, the literature mentioned that the government should formulate relevant policies to increase investment in the construction of energy infrastructure in rural areas. This kind of policy support is correct. However, for the policy support for rural areas, on the one hand, the design needs to consider the characteristics of the region; on the other hand, the implementation needs to be operable, and the effective combination of the two is the key to the realization of governance countermeasures. Existing studies in the literature provide some specific policy measures and implementation methods, but there is a lack of detailed examination of the operational evaluation of policy implementation and of how to ensure the long-term sustainability of these policies. Secondly, in terms of the development of the new energy industry, many scholars pointed out that the government should vigorously support the development of the new energy industry and reduce the level of energy poverty in rural areas. However, this measure means that the government needs relevant transfer payments and industrial policies to support the development of the new energy industry. The upgrading of the energy structure and the supply of new energy in rural areas is a systemic issue. How to ensure the reliability of the supply of new energy and the feasibility of economic payment are not covered in the current study. Third, in terms of public awareness training, the government should guide farmers and residents to form awareness of environmental protection and reduce energy waste. However, considering the actual situation of different regions and the education status of rural residents, conventional publicity and public awareness training may not be effective, and we should focus on how to design reasonable supporting incentives and constraints with both short- and medium-term energy and environmental awareness training goals. In conclusion, the existing research suggests some specific directions and recommendations that could help address energy poverty. However, it still needs to be further refined to provide more details and specific policy measures to support the implementation of these recommendations, such as a greater focus on realistic integration of short- and medium-term measures and different energy poverty management policies for different regions.

4. Discussion

Rural energy poverty is a complex, multidimensional and multi-level issue which involves household income, infrastructure improvement, geographical location, population characteristics, etc., and has a significant impact on residents' quality of life and health, individual income and welfare and even the development of the whole region and country. This paper systematically combs the literature on rural energy poverty, clarifies the research status and finds the direction for further research so as to provide reference for other scholars.

4.1. Findings

First, the definition of household energy poverty has been expanded from the single-dimensional definition to the multidimensional definition. Recently, the research on the dimensions of subjective psychology has gradually become a hot topic. Although multidimensional energy poverty is difficult to define, the core definition is still the availability and affordability of energy. In other words, the lack of access to energy that can meet the

daily energy needs under the general energy use structure of the region and the payment for the consumption of this type of energy exceeding a certain percentage of household income are considered energy poverty.

Second, the identification of household energy poverty is largely determined by the author's definition of energy poverty, so the indicators selected by these identification methods are often not clear standards and have a certain degree of subjectivity. The early single-dimensional indicator identification method can be very direct and focus on a certain dimension, but it is too narrow. Considering the complexity of the real situation, it is necessary to adopt multidimensional indicators to measure, and independent multidimensional indicator identification can better reflect the depth and breadth of the research. The multidimensional energy poverty index (MEPI) has emerged in order to integrate the one-dimensional indicators and the multidimensional nature of some energy poverty problems, and the MEPI has a stronger explanatory power for the reality.

Third, there are many factors affecting rural household energy poverty, and most of the existing studies focus on income, infrastructure construction, geographical location and population characteristics. With the increase in residents' income, they are more inclined to choose clean energy, which has a high energy cost, and will face a greater risk of energy poverty. With the rapid development of developing countries, the problem of energy transition is becoming more and more urgent. The transition from solid energy to clean energy reduces the direct availability of energy, increases the cost of energy use and makes rural residents more prone to energy poverty. In this process, we should investigate the influencing factors of rural household energy poverty from multiple angles, analyze the influencing mechanism clearly and find a breakthrough for solving rural energy poverty.

Fourth, the impact of rural household energy poverty on social and economic development is quite complex; long-term energy poverty directly affects the respiratory health of rural residents and at the same time makes the economic situation of rural families deteriorate. The unequal distribution of personal time and energy caused by energy poverty further exacerbates social inequality and impedes the emancipation of women and children. It will also make residents' welfare and subjective happiness low for a long time and cause huge resistance to the overall economic development of the country. The negative impacts of these different aspects also feed back to each other, making the negative externalities caused by energy poverty even worse. Although current research has not been able to quantify this negative externality precisely, its scope and extent are obvious. On the one hand, household energy poverty in rural areas should be regarded as a holistic and systematic proposition. At the same time, it should also be recognized that, due to the differences of the countries studied, the negative impacts caused by rural energy poverty will show great heterogeneity and have their own characteristics in formation and transmission mechanisms.

Finally, with regard to the governance countermeasures of rural household energy poverty, scholars generally believe that the government should be relied on to make efforts in policy support, infrastructure, new energy industry development and public guidance. The main idea is to increase the rural residents' access to energy opportunities, improve the level of energy services and reduce the cost of energy payments.

4.2. Comments

First, although the use of energy poverty composite index has become a more popular way, the composite index has a certain degree of personal value judgment in the process of combining different variables and simplifying it into a single measure so it is highly subjective. Especially when the result analysis is too simple or the index is not well constructed, the corresponding multidimensional energy poverty composite index may not have much reference value, so discovering how to objectively and accurately set up this composite index will become the key to identify and measure household energy poverty. Therefore, further research should focus on the multidimensional energy poverty index (MEPI), deeply

combine the characteristics of rural energy poverty areas and strengthen the selection of indicators to enhance the realistic explanatory power of energy poverty indicators.

Second, the impact of household energy poverty on social and economic development involves a wide range of fields, but scholars have not thoroughly studied the impact mechanism in the study of relevant impacts; especially when the impact is interdisciplinary, there are few clear transmission mechanisms to explain the impact caused by energy poverty. At the same time, few scholars have conducted quantitative investigation on this series of negative effects, and most of them stay at the level of qualitative analysis. When discovering how to break the vicious circle formed by household energy poverty in terms of social and economic impact, the focus of research and breakthroughs should be thoroughly analyzing the mechanism of the cycle and, through accurate quantitative research, determining the more serious negative impact of the link.

Third, in terms of rural energy poverty management measures, from the identification of household energy poverty to the lack of effective connection of energy poverty alleviation policies, energy poverty easily causes a vicious circle; that is, the current situation of energy poverty leads to income problems and aggravates household energy poverty. However, most studies tend to propose mid- and long-term governance measures, ignoring direct poverty alleviation policies, which are slightly out of touch with the reality. Therefore, a combination and a distinction should be made in terms of governance measures; they should pay attention to the combination of short-term and medium- and long-term measures and distinguish between energy poverty and general poverty and make recommendations according to their characteristics. At the same time, we should pay more attention to the operability of policies and governance measures, especially the government-led governance of rural energy poverty, involving the details of transfer payments and industrial support, not only to take into account the level of financial payments, but also to do a good job in the creation of relevant incentive and constraint systems.

5. Conclusions

Based on a systematic review of the literature on rural energy poverty, this paper makes a critical analysis of the definition, identification, influencing factors, socio-economic impact and governance countermeasures of rural energy poverty and clarifies the research status. It is found that there are still some problems in the existing research, such as uncertain identification indicators of energy poverty, insufficient quantitative analysis of socio-economic impact, insufficient mechanism analysis, weak pertinence and operability of policy recommendations and insufficient timely update of research data. Based on these problems, the ideas for further research under the theme of rural energy poverty are found. In general, this paper has achieved the expected research purpose.

In the further research, the first aim is to continue to improve the identification indicators of energy poverty and form a more complete multidimensional energy poverty index (MEPI). The second is to conduct an in-depth analysis of the influencing factors of energy poverty and the transmission mechanism of its impact on social economy to find out the aspects that are relatively easy to improve and then sort out the ideas of energy poverty governance with breakthrough points according to the regional characteristics of different rural areas. Third, in the design of specific energy poverty management countermeasures, the operability of policies in various dimensions should be taken as the focus of further research. On the one hand, the economic payment capacity of government-led behavior is considered, and whether the financial payment level can support the relevant transfer payment or industrial policy is examined, and what impact such government-led behavior has on the improvement of rural energy poverty in the short and medium term is further investigated. On the other hand, the investigation of the incentive and constraint system of energy poverty governance shows that the progress of energy transformation in countries around the world is accelerating, and the situation of energy poverty will be repeated in this process. Therefore, improving the efficiency of energy poverty management and

ensuring the smooth progress of energy transformation through an incentive and constraint system are also the topics that need to be further discussed in this field.

While the previous literature has provided a wealth of research on energy poverty, there are still some limitations. For example, the major global impact of the COVID-19 and the dramatic upheaval of the world situation have led to major changes in the world energy landscape, and the original energy data may not be able to support further research on the topic of energy poverty. The data currently used need to be reorganized urgently, and the energy consumption situation, in some regions in particular, needs to be investigated and updated in greater detail.

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