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A Comparative Method for Assessment of Sustainable Energy Development across Regions: An Analysis of 30 Provinces in China

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Abstract: Sustainable energy development (SED) has attracted the attention of the whole world. It has a wide range of concepts and rich connotations, which is difficult to be described with a single indicator. Therefore, scholars usually use multiple indicators to evaluate SED in multiple dimensions. Existing studies mostly took countries as the research objects, and there were fewer studies on sub-regions (provincial-level regions). In fact, due to factors such as resource endowment and industrial structure, there would be obvious differences in the energy system of different regions even within a country, such as China. This study took 30 provinces in China from 2010 to 2019 as the research object, and constructed a provincial-level SED evaluation system. Analytical methods of indicator contribution were also proposed to evaluate the improvement of specific indicators and their contribution to SED on both spatial and temporal scales. The findings could help identify where provinces are doing well or poorly in SED, thereby clarifying priorities for future improvements.

Keywords: sustainable energy development; energy indicators; Chinese provinces

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1. Introduction

In the 1980s, the UN put forward the concept of sustainable development in the report, "Our Common Future" [1], which was recognized and valued by governments and public worldwide [2]. Energy systems re closely related to economic development and the ecological environment, and sustainable energy development (SED) is also considered a component of sustainable development [3,4].

As the country with the largest energy consumption in the world, China attaches great importance to SED and is working towards achieving peak carbon dioxide emissions before 2030 and carbon neutrality before 2060 [5]. In addition, every five years, China will release a five-year plan for energy development to make specific arrangements for the energy revolution and development of low-carbon energy [6].

SED is a complex and multidimensional concept [7]. In the research of many scholars, the definition of this emerging concept has gradually become clear [8,9]. Gunnarsdottir et al. [8] divided SED into four interrelated themes: sustainable energy supply, sustainable energy consumption, access to affordable modern energy services, and energy security. Sustainable energy supply emphasizes the transformation of energy production from traditional fossil energy to low-carbon energy. Sustainable energy consumption requires improving energy efficiency and saving energy, and realizing the decoupling of economic growth and energy consumption. In addition, the accessibility of modern energy services and energy security explore the relationship between energy systems and social development.

As SED has a wide scope, many scholars have used energy indicators to quantitatively characterize it [9]. The formulation and evaluation of indicators can help polic makers clearly identify areas for improvement [10,11].

Among the SED indicators, one classic set is the *Energy Indicators for Sustainable Development* (*EISD*), proposed by the International Atomic Energy Agency, which was modified on the basis of *Indicators for Sustainable Energy Development (ISED)* [12,13]. *EISD* includes 4 social, 16 economic, and 10 environmental indicators, and is regarded as a comprehensive and robust set of indicators [9]. Some scholars have used *EISD* to evaluate SED in Africa, Brazil, and the Baltic States [14–16]. However, *EISD* has strict data requirements and does not pay attention to the communication of the indicators and their results, thus it has not been widely adopted [9,17,18].

Other well-known SED indicators are the *Energy Architecture Performance Index (EAPI)*, proposed by the World Economic Forum, and the *Energy Trilemma Index* (*ETI*), proposed by the World Energy Council [19,20]. Unlike *EISD*, both *EAPI* and *ETI* are composite indices, rather than a set of multiple multidimensional indicators [17]. *EAPI* uses 18 indicators to rank 126 countries, and these indicators are divided into economic growth and development, environmental sustainability, energy access, and security [19]. Meanwhile, *ETI* uses 35 indicators that are divided into energy security, energy equity, environmental sustainability, and country context, ranking 125 countries [20]. However, they are considered to be lacking the methodology for indicator selection, and *ETI* is thought to lack transparency regarding indicator applications [9]. In addition, the reasons why *EAPI* and *ETI* index weights are assigned have not been announced, which has also been criticized for a lack of transparency [17].

In addition to the above-mentioned indicators published by official agencies, many scholars also choose specific indicators to evaluate the energy development of different countries or regions. Iddrisu et al. [18] selected 11 indicators to evaluate the SED of 62 developing countries. Elavarasan et al. [21] assessed the energy sustainability of 40 European countries in five dimensions. Mainali et al. [22] selected 13 different indicators to evaluate the rural energy sustainability of six developing countries. Wang et al. [23] selected three indicators to evaluate the SED of China between 2005–2010. Moreover, energy security is considered a component of SED [8], and many studies have specifically evaluated energy security [24–29]. Through a literature review, it was found that the research on SED was mostly concentrated at the national level, while there was little research on regional evaluations and comparative studies across the Chinese provinces [30]. In fact, affected by factors such as resource endowment and industrial structure, there are obvious differences in the energy systems of different regions in China [31,32]. Hou et al. [30] evaluated the energy sustainability of 30 provinces in China in 2016, but could not observe their changes on the time scale, due to the lack of more historical data.

SED methodology could be roughly divided into two categories: one is to present the set value as it is, such as in EISD, to retain multidimensionality [9,13]; the other is to process multiple indicators into a comprehensive index, such as the methods applied in [18–29]. The former method displays the basic data intuitively and has a clear physical meaning but it is difficult to form a final conclusion with the divergent research framework. The latter method, which ranks the aggregation index for analysis, can form clear research conclusions, such as which regions perform best in SED. To make the results intuitive and strengthen the links between the results and various indicators, this study chose the aggregative index method to analyze the SED of 30 Chinese provinces. However, this study does not stop at ranking the SED of various regions, but hopes to further quantitatively describe the differences in the performance of all regions in the specific indicators of SED, especially when all the research subjects are compared together.

The objective of this study was to evaluate SED in different regions of China on both spatial and temporal scales, especially comparing the differences between the specific indicators of 30 provinces from 2010 to 2019. The main contributions of this study are as follows:

(1) A provincial SED evaluation system was constructed from the dimensions of sustainable energy supply (SEsupply), sustainable energy consumption (SEconsum), and sustainable energy social and environment (SEsocial). Then, all indicators were processed normalized by benchmark-best method and aggregated into SED scores for further analysis. Moreover, the analytical methods of indicator contribution were

proposed to evaluate the improvement of specific indicators and their contribution to SED on both spatial and temporal scales (Figure 1).

(2) The regional characteristics of SED in 30 provinces from 2010 to 2019 were sorted out, and the factors affecting the difference of SED in various provinces were analyzed. The findings could help identify where provinces are doing well or poorly in SED, thereby clarifying priorities for future improvements.

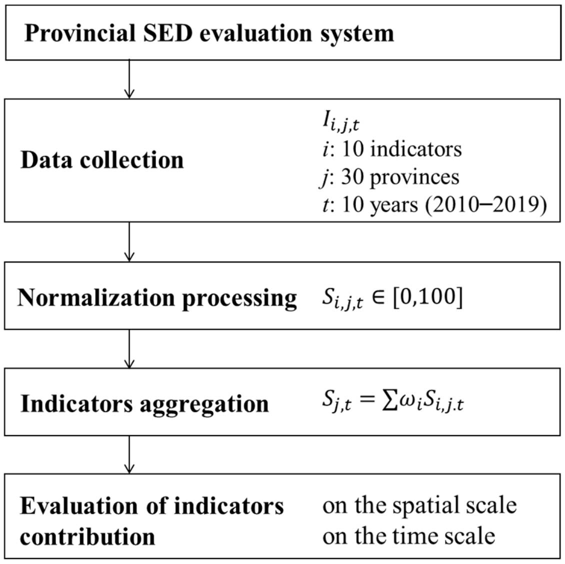


Figure 1. Flowchart overview of this study.

The remainder of the paper is organized as follows: Section 2 presents the provincial SED evaluation system, Section 3 introduces data sources and the methodology for indicator processing and analysis, Section 4 analyzes the results for 30 provinces in China, and Section 5 discusses the improvement suggestions for SED and the uncertainty analysis of indicator processing. Finally, this study summarizes the paper in Section 6.

2. Provincial SED Evaluation System

Although the concept of SED has been widely accepted and studied, it still does not have a unified definition [30]. Moreover, the meaning of SED can vary depending on the context it is applied to and the research objects [8].

After analyzing the history and emerging themes of SED, Gunnarsdóttir et al. [8] divided SED into SEsupply, SEconsum, access to affordable modern energy services, and energy security. However, it was found that in the literature dedicated to evaluating energy security, most of the specific indicators selected can also be classified into three other SED themes. For example, China's energy security index constructed by Song et al. [28] was divided into energy supply, environment, and economic–technical dimensions. However, indicators such as the carbon factor (the ratio of CO_2 to total primary energy supply; TPES) and the share of non-fossil fuel in TPES under the environment classification can be classified under SEsupply, while indicators such as coal consumption for power generation and energy intensity under the economic–technical classification can be classified under SEconsum. There was some overlap between the indicators selected by the studies dedicated to evaluating SED and those dedicated to evaluating energy security because the ultimate goals of both were to build safe, efficient, and sustainable energy systems [9,17,24]. However, it should be emphasized that energy security paid more attention to the self-sufficiency rate of energy [28,32].

Based on the relevant literature and the specific conditions of 30 Chinese provinces, this study divided the provincial SED indicator framework into three dimensions: sustainable energy supply (SEsupply), sustainable energy consumption (SEconsum), and sustainable energy social and environment (SEsocial), which can represent the characteristics of the energy system itself and its relationship with the social and environment. (Figure 2).

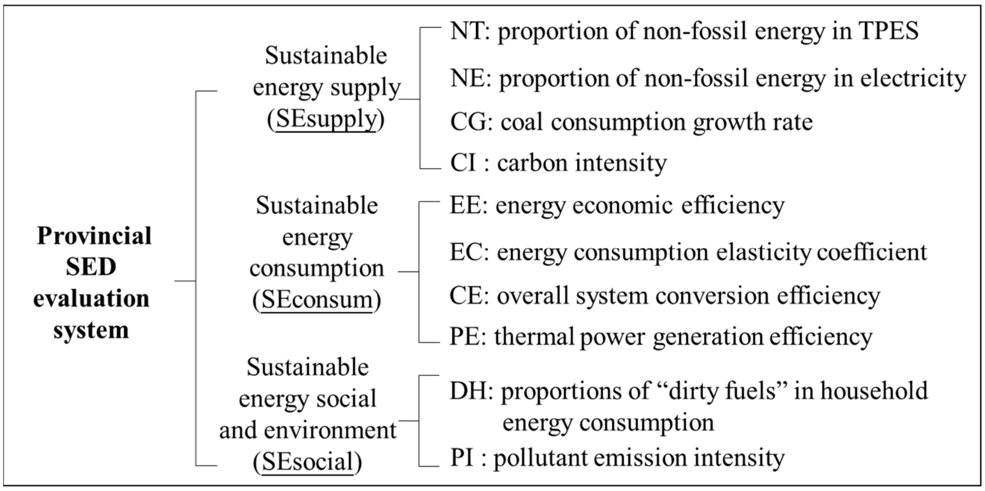


Figure 2. Provincial SED evaluation system and research framework.

SEsupply focuses on the low-carbon development of the energy structure and emphasizes the application of non-fossil energy, thus indicators NT (proportion of non-fossil energy in TPES) and NE (proportion of non-fossil energy in electricity) were selected. In addition, in view of China's coal-based energy structure, controlling coal consumption was a requirement of China's energy transition, and indicator CG (coal consumption growth rate) was selected as an SED evaluation indicator. Furthermore, indicator CI (carbon intensity) was selected, reflecting the impact of the energy structure on carbon emissions. (Table 1).

SEconsum was selected based on the consumption side and it mainly evaluates energy efficiency, which includes economic efficiency and physical efficiency. Economic efficiency was used to evaluate the relationship between economic output and energy consumption. Indicators EE (energy economic efficiency) and EC (energy consumption elasticity coefficient) were selected, and indicator EC reflected the dynamic relationship between energy consumption and economic growth. Meanwhile, physical efficiency referred to the efficiency of the energy conversion process, and indicators CE (overall system conversion efficiency) and PE (thermal power generation efficiency) were also selected (Table 1).

Compared to the other two dimensions, SEsocial pays more attention to the relationship between the energy system, social development, and environment. Therefore, indicators DH (proportions of "dirty fuels" in household final energy consumption) and PI (pollutant emission intensity) were selected in this study. (Table 1).

It should be noted that energy security (mainly the rate of energy self-sufficiency) was not included in this framework because the rate of energy self-sufficiency may not seem appropriate as a provincial SED evaluation indicator. For provinces lacking renewable resources, the most effective measure to reduce fossil energy consumption is to import electricity from areas rich in renewable resources, meanwhile electricity flows freely within China where a unified grid has been established. This would undoubtedly reduce the energy self-sufficiency rate, which confuses the orientation of this indicator.

The details of the SED indicators are shown in Table 1. It needs to be added that the indicators should be oriented and divided into positive and negative indicators to carry out quantitative evaluation. The positive indicators mean that the larger the indicator values are, the better; the negative indicators mean that the smaller the indicator values are, the better.

Table 1. Provincial SED evaluation system.

Dimensions	Indicators	Described Object	Unit	Definition	Attribute	References
Sustainable energy supply (SEsupply)	NT: proportion of non-fossil energy in TPES	Energy structure	%	Consider importing electricity (*IE*) and exporting electricity (*EE*) Regions with electricity imports: $NT = (LNEC + EE \times \lambda_{china})/TPES$, *LNEC* is the local non-fossil fuel energy consumption, λ_{china} is the proportion of non-fossil fuel energy in China's total power structure. Regions with electricity exports: $NT = (LNEC - EE \times \lambda_{china})/TPES$	Positive	[7,18,25,28]
	NE: proportion of non-fossil energy in electricity	Power structure	%	Regions with electricity imports: $NE = (LNE + EE \times \lambda_{china})/LEC$, *LNE* is the local non-fossil electricity generation, *LEC* is local electricity consumption. Regions with electricity exports: $NT = LNE/LEG$, *LEG* is local electricity generation.	Positive	[32]
	CG: coal consumption growth rate	Fossil energy dynamic change: represented by coal	%	Increase in coal consumption divided by coal consumption in previous years.	Negative	[33–35]
	CI: carbon intensity	Relationship between energy structure and carbon emission	tCO_2/tce	Energy-related carbon emissions divided by *TPES*, and the CO_2 emissions of transmitted electricity are included. Regions with electricity imports: $CI = (LNCE + EE \times \varphi_{china})/TPES$, *LNCE* is the carbon emission from local fossil fuel combustion (including local thermal power), φ_{china} is the carbon emission factor of China's electricity Regions with electricity exports: $CI = (LNCE - EE \times \varphi_{china})/TPES$	negative	[28,32,36]
Sustainable energy consumption (Seconsum)	EE: energy economic efficiency	Economic efficiency (current value)	$tce/10^4$ yuan	TPES is divided by GDP, and GDP is calculated at constant 2010 prices.	Negative	[28,30–32]
	EC: energy consumption elasticity coefficient	Decoupling of energy consumption and economic growth (dynamic change)	-	Energy consumption growth rate divided by GDP growth rate.	Negative	[37]
	CE: overall system conversion efficiency	Physical efficiency: overall energy system conversion efficiency	%	Total final consumption (*TFC*) divided by *TPES*. The difference between *TFC* and *TPES* is equal to the value of losses in the energy conversion link (power generation, coking, oil refining, etc.) and the value of losses in transportation (such as electricity transmission losses).	Positive	[18,36]
	PE: thermal power generation efficiency	Physical efficiency: represented by thermal power	gce/kWh	Standard coal consumed per power generation of 1 kWh.	Negative	[27,28,30]

Table 1. *Cont.*

Dimensions	Indicators	Described Object	Unit	Definition	Attribute	References
Sustainable energy social and environment (Sesocial)	DH: proportions of "dirty fuels" in household final energy consumption	Energy and social development: access to modern energy services	%	The share of "dirty fuels" (solid fuels, oil products (such as gasoline), and natural gas) in the household final energy consumption.	Negative	[18]
	PI: pollutant emission intensity	Energy and environment	t/km^2	Annual emissions of major air pollutants (SO_2, NO_x, soot) divided by urban area.	Negative	[38]

3. Materials and Methods

3.1. Data Sources

For the sake of data completeness and accessibility, this study analyzed 30 provinces in China from 2010 to 2019. Data on population, economy, and pollutant emissions are from the "*China Statistical Yearbook*". Energy-related data were obtained from the "*China Energy Statistical Yearbook*" and statistical yearbooks of various provinces. The carbon emission factor refers to the data published by the IPCC and IEA. The coal consumption data for the thermal power supply came from the "*China Electric Power Statistical Yearbook*". The representative values of the indicators are listed in Table 2.

Table 2. The representative value of the indicators.

Indicators	Attributes	Benchmark (China, 2010)	Optimal Level (Province, Year)	
NT	Positive	9%	46% (max)	(Qinghai, 2010)
NE	Positive	21%	92% (max)	(Yunnan, 2017)
CG	Negative	18%	−44% (min)	(Beijing, 2018)
CI	Negative	2.17	0.69 (min)	(Yunnan, 2018)
EE	Negative	0.88	0.27 (min)	(Beijing, 2019)
EC	Negative	0.69	−2.81 (min)	(Jilin, 2018)
CE	Positive	74%	96% (max)	(Hebei, 2018)
PE	Negative	333	206 (min)	(Beijing, 2019)
DH	Negative	46%	14% (min)	(Guangxi, 2019)
PI(SO_2)	Negative	122	0.1 (min)	(Beijing, 2019)
PI(NO_x)	Negative	135	6.0 (min)	(Beijing, 2019)
PI(soot)	Negative	46	1.0 (min)	(Beijing, 2019)

3.2. Indicator Normalization Processing

Because the selected indicators have different units, in order for them to be aggregated and combined into a comprehensive index, it was necessary to convert them into normalized values. The main normalization methods commonly used include min-max, distance to reference, and the standardization method [24]. The min-max method determines the normalized scale by the minimum and maximum values, the distance to reference method measures the deviation of the indicator from a benchmark, and the standardization method uses the mean value to perform z-transformation. To better characterize the differences between provinces, especially the differences between the best performance and national average, this study proposed a benchmark-best method for normalization processing. In this method, the optimal value of the indicator (the maximum value of the positive indicator and the minimum value of the negative indicator) was 100 points, and the corresponding score of China's indicator value in 2010 was set as 60 points (benchmark level), which determined the scoring scale of each specific indicator. That is, a fixed benchmark is established with 2010 as the base year. The remaining indicator values were scored based on equal proportion interpolation, as shown in Equations (1) and (2):

For positive indicator:

$$S_{i,j,t} = 100 - 40 \times \frac{max\left(I_{i,j,t}\right) - I_{i,j,t}}{max\left(I_{i,j,t}\right) - I_{i,benchmark}} \tag{1}$$

For negative indicator:

$$S_{i,j,t} = 100 - 40 \times \frac{I_{i,j,t} - min\left(I_{i,j,t}\right)}{I_{i,benchmark} - min\left(I_{i,j,t}\right)} \tag{2}$$

where $S_{i,j,t}$ represents the percentile scoring result of province j for indicator i in year t, $I_{i,j,t}$ represents the specific value of indicator i of province j in year t, the maximum (for positive indicator) and minimum (for negative indicator) values of $I_{i,j,t}$ for the 30 provinces from

2010 to 2019 (10 years) are listed in Table 2, and $I_{i,benchmark}$ represents the specific value of China's indicator *i* in 2010. For a single indicator, the score interval is 0–100 points; if the result of the equal-proportion interpolation calculation was negative, the result was recorded as 0.

3.3. Weight Assessment

Commonly used weighting methods include the equal weight method, entropy weight method, and analytic hierarchy process [24]. The entropy weight method calculates the weight based on the variation degree of each indicator and its distribution result may not be explanatory, that is, to give a less important indicator an excessively high weight. The analytic hierarchy process is based on expert evaluation, which is highly subjective and may produce sensitive and biased results [39].

The focus of this study was to compare the differences of SED in 30 Chinese provinces. To avoid the influence of subjective factors on the results as much as possible, the equal weight method was adopted [40]. This method was based on the concept of sustainable development and emphasized the equal importance of all relevant factors [39], which was also the most common method [24]. Therefore, for the 10 indicators in this study, their respective weights were all 10%, according to Equation (3). It should be noted that indicator PI had three sub-indices, and they should be aggregated with equal weights first.

$$S_{j,t} = \sum\nolimits_i \omega_i S_{i,j,t} \tag{3}$$

where ω_i represents the weight of indicator i, which is 10% in this study.

3.4. Evaluation of Indicators Contribution

After aggregating the SED indicators, evaluation methods for the SED indicator contribution on the spatial and temporal scales were proposed. On the spatial scale, differences between the 30 provinces' SED indicators were compared; while on the temporal scale, the improvement in the SED indicators of a specific province from 2010 to 2019 was analyzed.

On the spatial scale, $\rho_{i,j,t}$ represented the score of indicator *i* in province *j* that exceeded the benchmark level in year *t*, which was comparable between different provinces, as shown in Equation (4). Then, $\rho_{i,j,t}$ was divided by $|S_{j,t}-60|$ (the absolute value of the difference between the SED of province j and the benchmark value) to get the contribution of indicator *i* to the SED of province *j* in year *t*, which was $\alpha_{i,j,t}$, according to Equation (5).

$$\rho_{i,j,t} = \omega_i (S_{i,j,t} - 60) \tag{4}$$

$$\alpha_{i,j,t} = \frac{\rho_{i,j,t}}{|S_{j,t} - 60|} \tag{5}$$

Note: When the SED of province j exceeds the benchmark level (60 points), there is $\sum_i \alpha_{i,j,t}$ = 100%; otherwise, $\sum_i \alpha_{i,j,t}$ = −100%.

On the temporal scale, the study focused on the contribution of the specific indicator to the improvement of a specific province's SED from 2010 to 2019, attempting to answer which indicators improved during this period and to quantitatively evaluate their contributions, which was $\beta_{i,j,t}$, as shown in Equation (6).

$$\beta_{i,j,t} = \frac{S_{i,j,t} - S_{i,j,2010}}{|S_{j,t} - S_{j,2010}|} \tag{6}$$

Note: When the SED of province *j* in year *t* improved compared to 2010, there is $\sum_i \beta_{i,j,t}$ = 100%; otherwise, $\sum_i \beta_{i,j,t}$ = −100%.

4. Results

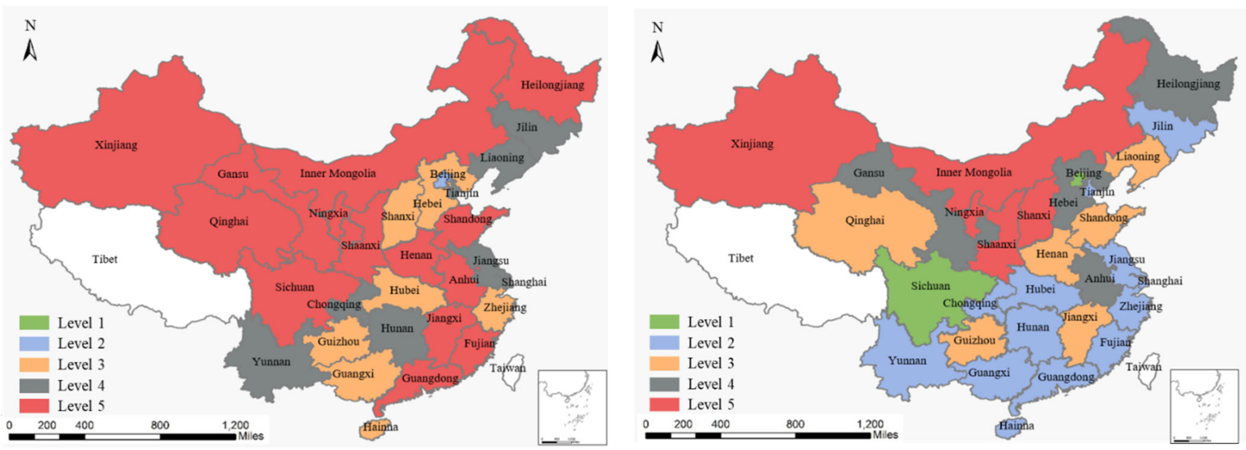
4.1. Sustainable Energy Development Evaluation Results

The final SED evaluation results of 30 provinces in China from 2010 to 2019 are shown in Table A1. To facilitate analysis, the SED scores of the 30 analyzed provinces were classified (Table 3).

Table 3. Division and connotation of SED evaluation levels.

Level	Connotation
Level 1	$S_{j,t} \geq 75$ SED was at a leading level and was significantly better than other provinces on certain indicators.
Level 2	$75 > S_{j,t} \geq 70$ SED outperformed most regions and some indicators were better than the national benchmark level.
Level 3	$70 > S_{j,t} \geq 65$ SED performed relatively well.
Level 4	$65 > S_{j,t} \geq 60$ SED performance was average and there was room for further improvement.
Level 5	$60 > S_{j,t}$ SED was lower than the national benchmark level and was considerably lower than other provinces on some indicators.

The classification results for 2010 and 2019 were presented in Figure 3 and the differences in SED among 30 provinces were observed. In terms of geographical distribution, the southern provinces generally scored better than the northern provinces (more details in Section 4.2). Meanwhile, by comparing SED in 2010 and 2019, the number of provinces at Level 5 decreased remarkably, and at Level 2, that increased. This reflected a significant improvement in the SED of most provinces (more details in Section 4.3).



(**a**) (**b**)

Figure 3. SED evaluation results in 30 provinces: (**a**) in 2010; (**b**) in 2019.

To clarify the differences in the SED of different regions and the specific changes from 2010 to 2019, this study evaluated the contribution of different indicators to the SED of research subjects on both spatial and temporal scales.

4.2. Comparison on the Spatial Scale

4.2.1. Analysis of $\rho_{i,j,2019}$

The $\rho_{i,j,2019}$ of 30 provinces in 2019 were calculated in Table 4, which were used to describe the extent to which the specific indicator exceeded or lagged behind the benchmark.

Table 4. $\rho_{i,j,2019}$ of 30 provinces in 2019.

Dimensions		SEsupply				SEconsum				SEsocial	
Indicators		ρ_{NT}	ρ_{NE}	ρ_{CG}	ρ_{CI}	ρ_{EE}	ρ_{EC}	ρ_{CE}	ρ_{PE}	ρ_{PI}	ρ_{DH}
Level 1	Beijing	0.2	−0.1	3.4	1.0	4.0	0.6	2.4	4.0	4.0	0.1
	Sichuan	2.9	3.7	1.0	3.2	2.6	0.1	2.8	0.3	2.1	−0.1
Level 2	Yunnan	3.7	3.9	1.1	3.9	1.1	0.1	2.7	0.0	−2.6	0.5
	Guangxi	2.1	1.4	0.6	0.8	2.1	0.0	1.3	0.7	1.3	4.0
	Hainan	1.1	1.0	1.3	0.8	2.2	−0.1	0.7	1.0	3.2	2.2
	Shanghai	−0.3	−0.3	1.4	1.0	3.4	0.4	2.5	1.3	3.8	0.1
	Zhejiang	1.2	0.5	1.4	0.5	3.1	0.2	0.6	1.1	3.1	1.5
	Hubei	1.3	1.7	0.8	1.2	2.6	0.2	2.0	1.0	2.3	0.0
	Fujian	1.8	1.4	1.0	0.9	3.1	0.1	0.7	0.9	−0.5	3.4
	Guangdong	1.1	0.6	1.3	0.6	3.4	0.3	0.7	1.1	2.5	0.6
	Chongqing	0.4	0.6	1.3	1.0	2.8	0.1	1.9	0.5	3.1	0.3
	Hunan	1.0	1.0	1.3	0.6	2.8	0.3	2.5	0.7	0.0	1.0
	Jilin	0.4	0.1	1.0	−0.4	2.9	0.1	1.2	1.3	2.5	2.2
	Tianjin	−0.4	−0.6	1.3	0.2	3.2	0.0	1.9	1.7	3.2	0.7
	Jiangsu	0.1	−0.3	1.3	0.0	3.4	0.3	0.6	1.3	2.5	1.6
Level 3	Qinghai	3.9	3.8	1.6	3.4	−3.7	1.3	3.2	0.4	−2.0	−2.3
	Shandong	−0.2	−0.5	1.0	−0.1	2.4	0.4	−0.1	0.8	3.0	2.8
	Henan	0.0	−0.3	1.8	0.0	2.8	1.0	0.1	0.9	1.7	0.9
	Guizhou	0.9	1.0	1.1	0.7	0.0	0.3	−0.7	0.3	1.2	1.3
	Jiangxi	0.3	0.0	1.1	−0.2	2.9	0.2	1.6	1.0	−2.2	0.9
	Liaoning	0.0	0.5	0.9	−0.5	0.7	−0.5	0.6	0.9	1.5	1.3
Level 4	Hebei	−0.2	−0.2	1.4	−0.6	0.4	0.6	3.0	0.8	−0.3	−0.7
	Anhui	−0.4	−0.8	1.2	−0.5	2.6	0.1	−0.9	1.1	0.3	0.5
	Heilongjiang	0.1	−0.2	0.8	−0.4	1.8	0.4	−1.2	0.6	−4.0	2.9
	Gansu	1.8	1.7	1.2	0.9	−0.3	0.8	−0.3	0.3	−5.4	−0.3
Level 5	Shaanxi	−0.2	−0.3	0.4	0.6	1.9	−0.1	−2.2	−1.6	−1.6	0.6
	Shanxi	−0.5	−0.5	0.8	−0.1	−2.3	0.2	−2.5	0.3	−2.2	1.3
	Inner Mongolia	−0.2	−0.3	0.4	−0.5	−1.4	−1.4	−1.5	0.2	−3.4	2.2
	Xinjiang	0.2	0.1	0.6	−0.1	−4.6	0.0	−1.7	0.2	−5.5	0.5
	Ningxia	0.2	−0.2	0.6	0.1	−6.0	−0.6	−3.5	0.2	−5.1	1.1
Range (max–min)		4.4	4.7	2.9	4.5	10.0	2.7	6.7	5.6	9.5	6.3
Median		0.3	0.1	1.1	0.5	2.4	0.2	0.7	0.8	1.3	0.9

It could be found that the ranges of the indicators varied. The larger the range, the greater the gap between the best and worst provinces under this indicator, such as indicator EE (range is 10.0). This indicator represented the ratio between economic output and energy consumption, and the best- and worst-performing provinces were Beijing ($\rho_{EE,\text{Beijing}}$ is 4.0) and Ningxia ($\rho_{EE,\text{Ningxia}}$ is −6.0), respectively. This was mainly affected by the industrial structure. The service industry with low energy consumption intensity developed rapidly in Beijing, making its indicator EE decrease year by year [41]. On the other hand, Ningxia, which performed worse, was highly dependent on resource development and heavy industry occupied a dominant position in the industrial structure.

In addition, the medians for all indicators were greater than 0, indicating that more than half of the provinces outperformed the benchmark on the corresponding indicators. In addition, the larger the median value of an indicator, the more provinces were better than the benchmark level, such as indicators EE and PI.

For specific indicators, Sichuan, Yunnan, and Qinghai had advantages in the SEsupply dimension, especially for indicators NT ($\rho_{NT,\text{Sichuan}}$, $\rho_{NT,\text{Yunnan}}$, and $\rho_{NT,\text{Qinghai}}$ were 2.9, 3.9, and 3.9, respectively) and NE ($\rho_{NE,\text{Sichuan}}$, $\rho_{NE,\text{Yunnan}}$, and $\rho_{NE,\text{Qinghai}}$ were 3.7, 3.9, and 3.8, respectively) due to their abundant renewable resources. Hydropower accounted for

85%, 82%, and 63% of their power supply structure, respectively. Furthermore, the high proportion of non-fossil energy made their ρ_{CI} significantly greater than other provinces, and $\rho_{CI,\text{Sichuan}}$, $\rho_{CI,\text{Yunnan}}$, and $\rho_{CI,\text{Qinghai}}$ were 3.2, 3.9, and 3.4, respectively. Moreover, Beijing had an advantage for indicator CG ($\rho_{CG,\text{Beijing}}$ is 3.4), which reflected Beijing's efforts to reduce coal consumption [42].

Additionally, in the SEconsum dimension, Beijing, Shanghai, Guangdong, and other eastern provinces had an advantage for indicator EE, and $\rho_{EE,\text{Beijing}}$, $\rho_{EE,\text{Shanghai}}$, and $\rho_{EE,\text{Guangdong}}$ were 4.0, 3.4, and 3.4, respectively, which indicated higher economic output efficiency. In terms of indicator EC, which reflected the dynamic relationship between energy consumption and economic output, Qinghai ($\rho_{EC,\text{Qinghai}}$ was 0.3) performed well; in fact, its energy consumption showed a decreasing trend. Indicator CE reflected the conversion efficiency of the energy system and Qinghai performed the best with $\rho_{CE,\text{Qinghai}}$ being 3.2. Beijing had the best performance for indicator PE, an indicator of power generation efficiency ($\rho_{PE,\text{Beijing}}$ was 4.0) because Beijing's power source was mainly gas-fired power plants with higher efficiency.

The provinces with the greatest ρ_{PI} and ρ_{DH} are Beijing ($\rho_{PI,\text{Beijing}}$ was 4.0) and Guangxi ($\rho_{DH,\text{Guangxi}}$ was 4.0), respectively, reflecting Beijing's emphasis on environmental governance and the degree of people's access to modern clean energy in Guangxi.

4.2.2. Analysis of $\alpha_{i,j,2019}$

Different provinces had advantages in different indicators. For quantitative exploration, we analyzed the indicator contribution $\alpha_{i,j,2019}$, which described the contribution of indicator *i* to the SED of province *j* that exceeded the benchmark value.

For province *j*, the indicator with greater $\alpha_{i,j,2019}$ outperformed other indicators, which was its advantage. The $\alpha_{i,j,2019}$ of 30 provinces were calculated in Table A2, and the indicators with the greatest $\alpha_{i,j,2019}$ in 30 provinces were presented in Figure 4. Interestingly, the dominant indicator of most provinces was indicator EE or PI, which contributed the most to their SED scores. Further analysis combined with $\beta_{i,j,2019}$ is presented in Section 4.3.

An analysis of the provinces that were at SED Level 1 showed that the indicators with the greatest $\alpha_{i,j}$ of Beijing were indicators EE ($\alpha_{EE,\text{Beijing}}$ was 20%), PE ($\alpha_{PE,\text{Beijing}}$ was 20%) and PI ($\alpha_{PI,\text{Beijing}}$ was 20%) in 2019, while that with Sichuan was indicator NE ($\alpha_{NE,\text{Sichuan}}$ was 20%). This reflected Sichuan's achievements in developing renewable energy and Beijing's strengths in improving energy efficiency and promoting energy transition.

In fact, as an indicator to describe the contribution of an indicator to SED, $\alpha_{i,j,t}$ could help researchers discover the shortcomings of province *j* in the SED evaluation system, especially for the provinces at SED Level 5. According to the definition in Section 4.1, the SED scores of provinces at Level 5 were lower than 60, which indicated that they had the property $\sum_i \alpha_{i,j,t} = -100\%$. Further analysis found that Shaanxi, Shanxi, Inner Mongolia, Xinjiangm and Ningxia performed the worst for indicators CE, CE, PI, PI, and EE, respectively, reflecting that they ignored the development of energy conservation while pursuing economic development, where they need to improve in the future.

4.3. Comparison on the Temporal Scale

On the temporal scale, $\beta_{i,j,2019}$ for 30 provinces during 2010–2019 were calculated to analyze the contribution of different indicators to the degree of SED improvement over 10 years in Table A3.

Primarily, SED in 30 provinces improved from 2000 to 2019 (Table A1 and Figure 3). Guizhou made the greatest improvement in SED, from 47 to 66 scores, and the improvement for indicators EE ($\beta_{EE,\text{Guizhou}}$ was 32%) and PI ($\beta_{PI,\text{Guizhou}}$ was 38%) were obvious. On the contrary, Xinjiang had the weakest SED improvement (from 49 to 50 scores), and even the performances of indicators CE ($\beta_{CE,\text{Xinjiang}}$ was −326%) and DH ($\beta_{DH,\text{Xinjiang}}$ was −126%) in 2019 were not as good as in 2010.

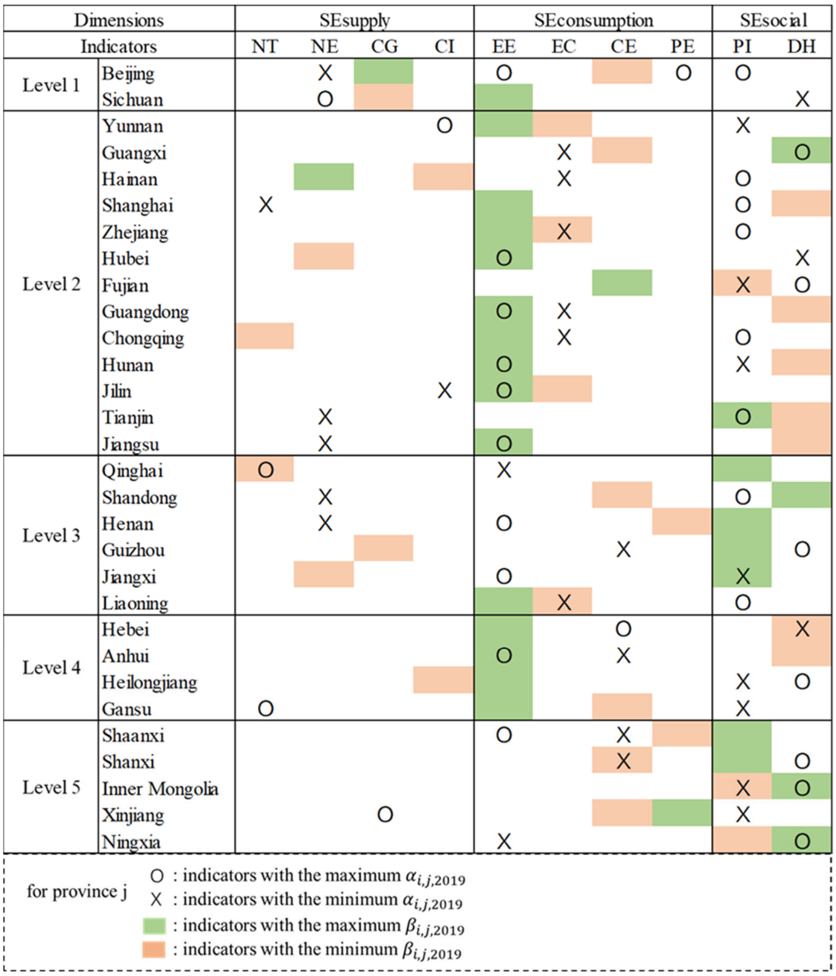


Figure 4. Indicators with the maximum or minimum value of $\alpha_{i,j,2019}$ and $\beta_{i,j,2019}$.

To observe more intuitively, the indicators with the maximum and minimum values of $\alpha_{i,j,2019}$ and $\beta_{i,j,2019}$ in 30 provinces were presented in Figure 4.

For some provinces, the indicator with the maximum $\alpha_{i,j,2019}$ and the indicator with the maximum $\beta_{i,j,2019}$ overlapped, indicating that this indicator had made the greatest progress from 2010 to 2019 and made the greatest contribution to SED in 2019, such as indicator DH in Guangxi. Meanwhile, the indicator with the minimum $\alpha_{i,j,2019}$ and the indicator with the minimum $\beta_{i,j,2019}$ overlapped in some provinces, showing that these provinces had made the least progress for such an indicator (even regressed), and that was also the main indicator that dragged down SED in 2019, which need to be paid attention to and improved, such as indicator PI in Inner Mongolia.

It is noted that, for most provinces, it is more difficult to improve the indicators of the SEsupply dimension compared to those of other dimensions. This was mainly affected by resource endowment, which means that it is difficult to completely change the energy supply structure of a region in a short period of time. In contrast, the improvement on indicators EE and PI were more obvious, and they were the indicators with maximum $\beta_{i,j,2019}$ in most provinces. To some extent, these two dimensions were weakly affected by objective factors such as resource endowment, and subjective factors could play a greater role. For example, regions could improve indicator EE by developing high-tech manufacturing and service industries, like Beijing has [43].

5. Discussion

5.1. Improvement Suggestions for SED

Figure 4 listed the worst-performing indicators for the 30 provinces, which are the focus for future improvement. The relevant improvement suggestions are listed in Table 5.

Table 5. Improvement suggestions for SED indicators.

Dimensions	Indicators	Provinces in Need of Improvement/Improvement Suggestions
SEsupply	NT	Shanghai has high energy demand, but lack of renewable resources. It could actively introduce clean power to replace local thermal power.
	NE	For coastal provinces, such as Tianjin, Jiangsu, and Shandong, offshore wind power or nuclear power could be developed. Henan is rich in agricultural and forestry resources and could develop biomass power. Solar energy also needs to be vigorously promoted.
	CG	Gradually promote the substitution of natural gas and biomass for coal in the industry, and promote the substitution of electricity for coal in the building.
	CI	For Jilin, the proportion of coal in the energy structure could be reduced by virtue of its advantage in wind energy resources.
SEconsum	EE	For Ningxia, it is necessary to improve the production efficiency of energy-intensive industries and reduce energy consumption as much as possible while achieving the same economic output.
	EC	One the one hand, for Guangxi, Hainan, Zhejiang, Guangdong, Chongqing, and Liaoning, they need to promote industrial transformation and improve the proportion of high-tech manufacturing and service industries in the economic structure. On the other hand, they should advocate a green and low-carbon lifestyle to reduce the residential energy consumption.
	CE	For Guizhou, Anhui, Shaanxi, and Shanxi, the efficiency of energy conversion should be improved and waste energy recovery should be promoted, especially the use of waste energy in power generation and steel industry.
	PE	Improve thermal power generation efficiency and eliminate inefficient small thermal power.
SEsocial	PI	For Inner Mongolia, Xinjiang, Heilongjiang, Gansu, Jiangxi, Hunan, Fujian, and Yunnan, the control of air pollution emissions, especially those from industrial boilers, should be strengthened.
	DH	For Sichuan, Hubei, and Hebei, electrification of buildings and electric vehicles should be promoted to reduce the proportion of "dirty fuels" in domestic energy consumption.

5.2. Uncertainty Analysis of Indicator Processing

The aggregation of SED indicators and subsequent analysis were based on the normalization processing. Different processing methods may have different impacts on the results. In this section, it is demonstrated that the study adopted the min-max method to analyze the uncertainty of the research results and the calculation method is shown in Equations (7) and (8).

For positive indicator:

$$S^*_{i,j,t} = 100 \times \frac{I_{i,j,t} - min(I_{i,j,t})}{max(I_{i,j,t}) - min(I_{i,j,t})} \tag{7}$$

For negative indicator:

$$S^*_{i,j,t} = 100 \times \frac{I_{i,j,t} - max(I_{i,j,t})}{min(I_{i,j,t}) - max(I_{i,j,t})} \tag{8}$$

The SED results of the two normalization methods are presented in Figure 5. The overall ranking trend of the 30 provinces' SED in 2019 remained unchanged under the two methods. In other words, the evaluation rankings of SED in most provinces would not change due to the change of the indicator processing method. There were some exceptions, especially Qinghai, which ranked 16th under the benchmark-best method, but 3rd under the min-max method in 2019. This was because the min-max method amplified Qinghai's advantages in the SEsupply dimension, especially for indicators NT, NE, and CI. Further explanation could refer to Figure 6, which showed the distribution of all indicators' processing results under the two methods. For the min-max method, the distribution of S_i depended on its raw data relative to the distance between the best and worst levels. Compared to the benchmark-best method, the medians of indicators NT, NE, CI, and PE under the min-max method were significantly lower. This was because the best-performing level (determining the upper bound) for these indicators were well above the national average level; in other words, most provinces' performance was closer to the lower bound level. However, under the benchmark-best method, this study took the national average level in 2010 as the benchmark, which was set to 60 points in the indicator processing. Therefore, the two methods had an impact on the results: if the median of the indicator was close to the lower bound, such as indicator NT or NE, the min-max method would widen the SED score gap between the better performing provinces and the majority of provinces; if the median of the indicator was close to the upper bound, such as indicator EE or PI, the min-max method would reduce the advantage; that is, the SED score gap between the better performing provinces and the majority of the provinces would narrow. This also explained why Qinghai and Gansu, which performed better in the SEsupply dimension, but poorly for indicators EE and PI, were ranked better under the min-max method. It could also be explained that Shanghai, which performed well for indicator EE, ranked lower under the min-max method.

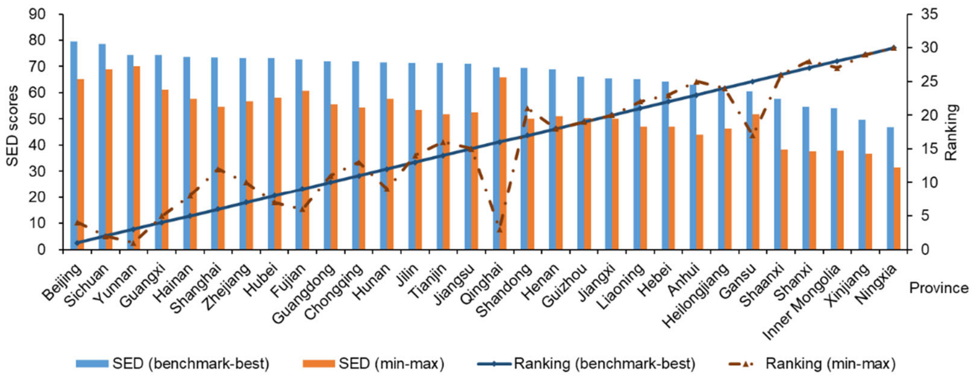


Figure 5. SED and ranking for both methods (2019).

On the other hand, the SED scores processed by the min-max method were generally lower than those processed by the benchmark-best method. Since the benchmark-best method set the benchmark value, it improved the scores of most indicators after normalization to some extent. However, the analysis of the absolute score of SED was of little significance, because the purpose of this study was to analyze the differences of SED in different regions.

In general, different indicator processing methods would produce deviations in the ranking results of individual provinces, but the evaluation results of most provinces were consistent. At the same time, setting China's overall level as the benchmark value also provided a basis for quantitative assessment of the contribution of specific indicators on the spatial and temporal dimensions, which was another focus of this study.

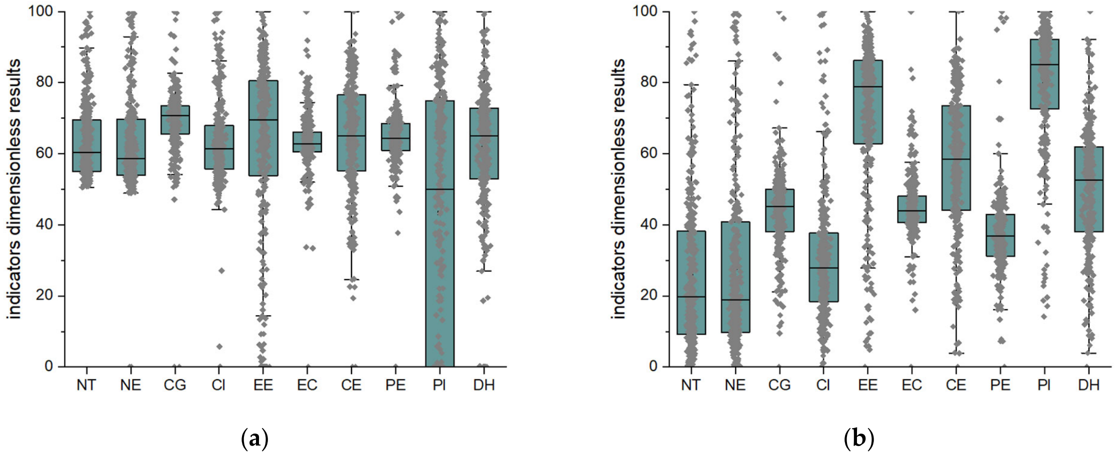


Figure 6. The distribution of indicator processing results under the two methods: (**a**) benchmark-best method; (**b**) min-max method.

6. Conclusions

The sustainable development of energy systems is an important component of the sustainable development of society. This study selected 10 indicators from the three dimensions of SEsupply, SEconsum, and SEsocial to construct a provincial SED evaluation system. Analytical methods of indicator contribution were also proposed to evaluate the improvement of specific indicators and their contribution to SED on spatial and temporal scales. Then, the SED of 30 provinces were evaluated and analyzed for the period from 2010 to 2019. The main conclusions of this study were as follows:

Analysis of the SED evaluation results showed that the SED evaluation results of southern provinces outperformed the northern provinces, with Beijing ranked first in the 2019 SED evaluation, and Ningxia ranked last. From 2010 to 2019, Guizhou had the greatest improvement in SED, and Xinjiang had the weakest improvement.

There was the greatest gap between the best and worst performance under the EE indicator, which was mainly affected by the industrial structure. Southwestern provinces, such as Sichuan and Yunnan, which are rich in renewable resources, had advantages in the SEsupply dimension, while economically developed provinces, such as Beijing, had an advantage in the SEconsum dimension, especially in indicator EE.

$\alpha_{i,j,t}$ and $\beta_{i,j,t}$ can help researchers identify the inadequacies and indicators of least improvement in the SED evaluation system, especially for provinces with poor SED ratings. For example, Ningxia need to make efforts to improve under indicator EE in the future.

As the country with the largest energy consumption in the world, China's sustainable energy development has reference significance for other countries. Through the literature review, it was found that the research on SED was mostly concentrated at the national level, while the research on regional evaluations and comparative studies across the Chinese provinces was low. This study took the SED of 30 provinces in China from 2010 to 2019 as the research object, expanding the boundaries of related research. On the other hand, the comparison method proposed in this study can intuitively show the indicators of the best or worst performance and the greatest or least progress in a certain region in SED, thus laying a foundation for energy development policy formulation.

Author Contributions: J.C.: Methodology, data curation, writing—original draft; Y.K.: methodology, investigation, data curation; S.Y.: investigation, data curation; J.X.: conceptualization, methodology, supervision, project administration, funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Abbreviations

SED, sustainable energy development; SEsupply, sustainable energy supply; SEconsum, sustainable energy consumption; SEsocial, sustainable energy social and environment; EISD, energy indicators for sustainable development; ISED, indicators for sustainable energy development; EAPI, energy architecture performance index; ETI, energy trilemma index; TPES, total primary energy supply; TFC, total final consumption; IE, imported electricity; EE, exported electricity; LNEC, local non-fossil fuel energy source consumption; tce, ton of standard coal equivalent; kgce, kilogram of standard coal equivalent.

Appendix A

Table A1. SED evaluation results of 30 provinces from 2010 to 2019.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
China	60	60	62	63	64	65	67	67	68	69
Beijing	71	72	72	74	74	77	77	79	80	80
Tianjin	62	62	63	66	66	68	70	72	71	71
Hebei	52	49	52	54	55	55	59	61	62	64
Shanxi	41	41	43	44	45	48	49	48	52	55
Inner Mongolia	50	49	49	56	54	54	55	56	53	54
Liaoning	60	60	62	66	65	66	66	66	65	65
Jilin	62	59	62	65	64	66	69	68	76	71
Heilongjiang	50	50	51	57	56	57	57	58	63	61
Shanghai	65	66	68	68	70	69	71	71	73	73
Jiangsu	64	62	64	66	66	67	67	69	70	71
Zhejiang	65	65	68	68	69	69	71	71	72	73
Anhui	59	59	59	59	59	60	60	62	63	63
Fujian	66	64	69	70	69	73	74	74	72	73
Jiangxi	55	55	59	59	60	61	62	62	63	65
Shandong	59	59	61	65	62	62	64	66	66	69
Henan	52	52	54	57	57	58	64	66	66	69
Hubei	67	67	70	73	71	72	73	74	76	73
Hunan	65	64	68	69	68	67	68	68	72	71
Guangdong	66	66	68	69	69	71	70	70	71	72
Guangxi	66	67	69	71	73	75	74	76	75	74
Hainan	66	65	67	68	69	67	74	72	73	74
Chongqing	63	62	65	69	69	70	72	72	75	72
Sichuan	65	68	69	73	72	77	76	79	81	79
Guizhou	47	47	49	52	55	58	58	60	65	66
Yunnan	60	59	60	68	70	74	71	74	74	74
Shaanxi	48	51	51	54	54	55	55	59	61	58
Gansu	49	49	52	54	55	57	58	57	58	61
Qinghai	58	53	55	55	57	57	57	62	65	70
Ningxia	46	42	47	47	49	49	52	49	52	47
Xinjiang	49	47	45	46	47	50	50	50	52	50

Table A2. $\alpha_{i,j,2018}$ of 30 provinces in 2019.

Dimensions		SEsupply				SEconsum				SEsocial	
Indicators		α_{NT}	α_{NE}	α_{CG}	α_{CI}	α_{EE}	α_{EC}	α_{CE}	α_{PE}	α_{PI}	α_{PI}
Level 1	Beijing	1%	0%	17%	5%	20%	3%	12%	20%	20%	1%
	Sichuan	16%	20%	5%	17%	14%	1%	15%	2%	11%	−1%
Level 2	Yunnan	25%	27%	7%	27%	8%	1%	19%	0%	−18%	4%
	Guangxi	15%	9%	4%	6%	15%	0%	9%	5%	9%	28%
	Hainan	8%	7%	10%	6%	16%	−1%	5%	7%	24%	16%
	Shanghai	−2%	−2%	11%	8%	26%	3%	19%	9%	28%	1%
	Zhejiang	9%	4%	11%	4%	23%	2%	4%	9%	24%	11%
	Hubei	10%	13%	6%	9%	20%	2%	15%	7%	18%	0%
	Fujian	14%	11%	8%	7%	24%	1%	5%	7%	−4%	27%
	Guangdong	9%	5%	10%	5%	28%	3%	5%	9%	21%	5%
	Chongqing	3%	5%	11%	8%	24%	1%	16%	4%	26%	2%
	Hunan	9%	9%	11%	5%	25%	3%	22%	6%	0%	9%
	Jilin	4%	1%	9%	−3%	26%	1%	11%	11%	22%	19%
	Tianjin	−3%	−6%	11%	2%	28%	0%	17%	16%	29%	6%
	Jiangsu	1%	−2%	12%	0%	31%	2%	6%	12%	23%	15%
Level 3	Qinghai	40%	39%	16%	36%	−38%	14%	33%	4%	−20%	−24%
	Shandong	−2%	−5%	11%	−1%	25%	4%	−1%	8%	32%	29%
	Henan	0%	−4%	20%	0%	32%	12%	1%	10%	20%	10%
	Guizhou	15%	17%	18%	11%	1%	4%	−11%	4%	20%	21%
	Jiangxi	5%	0%	20%	−5%	53%	4%	29%	19%	−40%	16%
	Liaoning	0%	9%	17%	−10%	13%	−10%	12%	18%	29%	25%
Level 4	Hebei	−6%	−4%	33%	−14%	10%	14%	72%	19%	−8%	−16%
	Anhui	−13%	−24%	37%	−17%	81%	4%	−29%	36%	10%	15%
	Heilongjiang	16%	−21%	98%	−49%	222%	45%	−154%	80%	−497%	360%
	Gansu	345%	337%	229%	178%	−64%	155%	−52%	66%	−1042%	−52%
Level 5	Shaanxi	−7%	−14%	19%	24%	79%	−3%	−91%	−68%	−65%	27%
	Shanxi	−10%	−9%	16%	−1%	−41%	3%	−46%	6%	−41%	24%
	Inner Mongolia	−3%	−5%	8%	−8%	−25%	−24%	−26%	4%	−59%	37%
	Xinjiang	2%	1%	6%	−1%	−45%	0%	−16%	2%	−53%	5%
	Ningxia	1%	−1%	5%	1%	−46%	−4%	−27%	2%	−39%	8%

Table A3. $\beta_{i,j,2019}$ of 30 provinces in 2019.

Dimensions		SEsupply				SEconsum				SEsocial	
Indicators		β_{NT}	β_{NE}	β_{CG}	β_{CI}	β_{EE}	β_{EC}	β_{CE}	β_{PE}	β_{PI}	β_{PI}
Level 1	Beijing	7%	3%	25%	10%	16%	5%	−6%	20%	3%	17%
	Sichuan	12%	8%	−4%	15%	28%	−1%	5%	3%	23%	11%
Level 2	Yunnan	14%	12%	2%	20%	23%	0%	17%	1%	9%	3%
	Guangxi	8%	−2%	8%	3%	22%	2%	−5%	6%	16%	41%
	Hainan	18%	21%	20%	−2%	10%	−2%	−1%	5%	13%	17%
	Shanghai	6%	6%	12%	12%	22%	6%	12%	4%	18%	3%
	Zhejiang	14%	7%	7%	10%	17%	3%	13%	3%	15%	12%
	Hubei	4%	−12%	16%	9%	50%	4%	−6%	9%	7%	20%
	Fujian	31%	9%	−3%	8%	24%	2%	32%	0%	−21%	18%
	Guangdong	16%	8%	20%	7%	23%	6%	3%	10%	5%	1%
	Chongqing	−2%	0%	9%	7%	38%	1%	3%	12%	24%	9%
	Hunan	−5%	0%	8%	4%	48%	7%	12%	9%	30%	−13%
	Jilin	10%	0%	7%	8%	39%	−1%	1%	11%	11%	15%
	Tianjin	5%	2%	13%	5%	23%	3%	8%	15%	30%	−2%
	Jiangsu	10%	7%	11%	8%	23%	3%	7%	9%	20%	2%
Level 3	Qinghai	−1%	4%	2%	6%	20%	11%	13%	10%	34%	2%
	Shandong	7%	6%	3%	9%	24%	3%	−2%	7%	13%	30%
	Henan	3%	3%	6%	5%	18%	6%	4%	2%	45%	7%
	Guizhou	4%	3%	−1%	3%	32%	1%	4%	2%	38%	14%
	Jiangxi	5%	2%	10%	3%	15%	2%	16%	5%	37%	5%
	Liaoning	14%	22%	1%	0%	49%	−12%	1%	15%	19%	−10%

Table A3. *Cont.*

Dimensions		SEsupply					SEconsum			SEsocial	
Indicators		β_{NT}	β_{NE}	β_{CG}	β_{CI}	β_{EE}	β_{EC}	β_{CE}	β_{PE}	β_{PI}	β_{PI}
Level 4	Hebei	4%	5%	4%	4%	30%	5%	15%	6%	23%	3%
	Anhui	11%	7%	8%	5%	42%	1%	1%	11%	18%	−4%
	Heilongjiang	6%	6%	3%	−1%	28%	2%	6%	9%	17%	23%
	Gansu	11%	8%	12%	7%	33%	7%	−4%	3%	6%	16%
Level 5	Shaanxi	7%	5%	8%	16%	21%	0%	−12%	−18%	48%	26%
	Shanxi	3%	4%	1%	5%	28%	0%	−1%	4%	28%	26%
	Inner Mongolia	15%	7%	2%	5%	52%	−32%	7%	9%	−39%	73%
	Xinjiang	120%	41%	6%	27%	−43%	48%	−326%	261%	92%	−126%
	Ningxia	118%	91%	108%	119%	0%	−81%	−125%	19%	−368%	219%

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