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The Impact of Building Clean Energy Consumption on Residents' Subjective Well-Being: Evidence from China

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Abstract: This study used micro data from the Chinese General Social Survey (CGSS) in 2018 to explore the impact of China's residential clean energy consumption on residents' subjective well-being. Our research results show that: the more clean energy consumption is present in housing, the stronger the residents' sense of happiness; furthermore, it can be seen from the results of marginal effects that the increase in residential clean energy consumption increases the probability of residents choosing "relatively happy" and "extremely happy". Moreover, the heterogeneity analysis found that the increase in residential clean energy consumption increased the happiness of people with housing and low education, and also increased the happiness of residents in central China and middle-aged and elderly residents; the intermediary analysis shows that the use of clean energy in housing improves the health of residents, and improves their quality of life while increasing their expenditure. In addition, central heating affects the relationship between residential clean energy consumption and residents' well-being. Further analysis shows that there is no non-linear relationship between the increase in residential clean energy consumption and residents' happiness. This study enriches the research on residential clean energy and provides policy suggestions for improving residents' living standards and welfare.

Keywords: clean energy; subjective well-being; energy consumption; health; China residents

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1. Introduction

Energy is a basic element for human survival and development, and residential energy consumption is an important part of China's energy demand [1]. Demand for energy has increased with the development of the Chinese economy [2]. On the one hand, traditional energy is nonrenewable. With the continuous exploitation and use of human beings, traditional fossil energy will eventually be exhausted [3]. On the other hand, traditional fossil energy produces a large amount of greenhouse gases such as CO_2 during combustion, and when fossil energy is not completely burned, it produces harmful gases such as SO_2 and CO [4]. Under the background of green and sustainable development, clean energy has become an ideal substitute for traditional fossil energy [5]. In addition, the Chinese government promised in the "Paris Climate Summit" to achieve peak carbon emissions by 2030 and carbon neutrality by 2060 [6]. In order to fulfill its commitments, reducing the use of traditional energy and increasing clean energy consumption are important measures taken by the Chinese government to reduce carbon dioxide emissions [7]. As shown in Figure 1, from 2000 to 2019, China's per capita domestic energy consumption increased from 132 kg to 438 kg coal equivalent, an increase of 3.2 times. For Chinese residents, on the one hand, the energy consumption of Chinese residents is still dominated by traditional sources (e.g., coal, firewood). The efficiency of solid fuels is low, heat is insufficient, and many harmful gases are produced during combustion, which is not conducive to the health of residents while polluting the environment [8]. However, the use of low-quality energy aggravates economic poverty [9]. To obtain basic energy consumption, low-income people often need to spend a lot of time collecting straw or wood, which to a certain extent, occupies the working time of residents and the time for children to learn, ultimately leading to a negative feedback cycle between energy shortage and economic poverty [10]. The United Nations Sustainable Development Goal 7 (SDG 7) emphasizes that "everyone has access to affordable, reliable and sustainable modern energy" [11]. The Chinese government has also established the "Energy Consumption Revolution (ECR)" as a basic strategy for China's energy development and formulated specific plans [12]. Furthermore, with the promotion of infrastructure construction in China, China has achieved full coverage of electricity, and energy infrastructure such as natural gas pipelines, are also under construction. China's residential energy consumption mode has gradually changed from traditional to clean energy, and its energy use mode has improved [13]. The use of clean energy differs from traditional energy sources. Can clean energy overcome the limitations of traditional energy in improving residents' happiness and effectively enhancing their well-being? Moreover, owing to obvious regional development differences in China, is there any difference in the impact of clean energy consumption on residents' well-being? As one of the important starting points of the clean energy policy, the current academic community has not yet established a clear answer to this question. This study attempts to answer these two questions and focuses on the impact of clean energy consumption on residents' health.

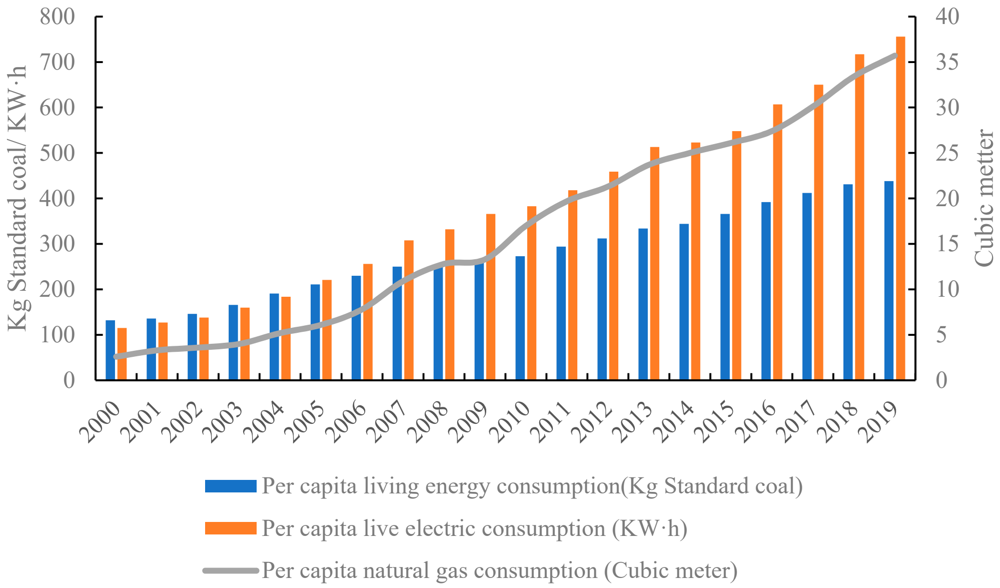

Figure 1. Domestic energy consumption of Chinese residents.

In recent years, discussions on the factors influencing residents' well-being have become widespread among scholars. At present, there are two theories to measure residents' well-being: on the one hand, it is the objectivist welfare theory. Objectivist welfare theory advocates measuring welfare by income, wealth, and commodity ownership [14]. In addition, social environment and behavioral culture are also factors that affect residents' well-being; on the other hand, the utilitarian utility welfare theory takes utility as the index to evaluate welfare. Utility is equivalent to subjective psychological evaluations such as happiness or happiness and satisfaction with life, including sensory enjoyment and pain, as well as spiritual pleasure and torture [15]. Personal happiness is a complex combination of multiple levels and elements. The distribution of happiness is similar to that of human needs, conforming to Maslow's hierarchy of needs theory. Many scholars have characterized residents' welfare by their subjective psychological evaluation and carried out research, age difference [16], gender difference [17], employment status [18] and income inequality [19] affect residents' happiness; Herman et.al. (2013) found that residents' health status significantly affects their life satisfaction. The healthier the residents are, the higher their life satisfaction will be [20]. Based on the above literature, this study uses residents' subjective well-being to represent their welfare.

Currently, research on residential clean energy consumption and residents' subjective well-being is mainly concentrated in developed countries. Binder and Blankenberg's (2017) research on British households found that residents' clean energy consumption was positively correlated with their life satisfaction [21]. Spanish research shows that clean energy has made important contributions to the sustainable development of local society, economy, and environment, and has improved the living standard and happiness of local residents [22]. Welsch and Biermann's survey of European residents showed that an increase in the share of wind energy and solar energy will improve residents' sense of happiness [23]. Moreover, residential clean energy consumption will promote household living standards through lighting, cooking and other behaviors, thus improving residents' life satisfaction [24]. In addition, some scholars' research on 27 countries such as the United States and Germany shows that the use of clean energy is significantly positively correlated with residents' life satisfaction [25]. However, few scholars have studied the impact of China's residential clean energy consumption on residents' subjective well-being. Therefore, improving the consumption of clean energy in residential buildings is not only an important proposition to realize China's energy transformation, but also an objective need to improve residents' living standards and welfare. Therefore, studying the clean energy consumption of buildings in China is of practical significance.

In summary, this study explores the impact of clean energy consumption in China's housing on residents' subjective well-being from the actual situation in China, using micro data from the Chinese General Social Survey (CGSS) in 2018. The marginal contributions of this study are as follows: first, this paper analyzes the impact of residential clean energy consumption on residents' welfare from the theoretical and empirical perspectives, and also effectively identifies the mechanism of the impact of residential clean energy consumption on residents' welfare from the perspective of utility function, which provides a new way for China to implement the "energy consumption revolution" policy to improve residents' welfare; secondly, this paper extends the research perspective from macro energy consumption behavior to micro household energy consumption behavior, and measures the impact of China's residential energy consumption on residents' welfare; thirdly, this study brings the heterogeneity characteristics of residents' age, education background and region into the analysis framework to explore the characteristics of residential clean energy consumption on subjective well-being of different residents. Furthermore, compared with other micro survey data, this paper makes in-depth research and innovative use of the data of CGSS (2018) energy module, filling the lack of research on clean energy in China's housing due to the lack of micro data, in order to better analyze China's residential energy problems.

2. Theoretical Analysis

Based on China's national conditions, this study defines residents' welfare as utility from the perspective of welfare economics, constructs a theoretical model in line with China's actual situation, and analyzes the impact of residential clean energy consumption on residents' well-being. To better analyze the relationship between the two, this study makes the following assumptions: (1) there are two types of consumption, building clean energy consumption (C_g) and other total consumption (C); (2) all the income gained in one's life is used for consumption; (3) the use of residential clean energy can obtain economic benefits, and the higher the use of residential clean energy, the higher the benefits that can be obtained.

The general utility function is considered an increasing function of the utility consumption level, that is, $U = U(y)$. Based on the above assumptions, this study constructs the resident utility function as:

$$U\left(C, C_g\right) = lnC + \beta lnC_g \tag{1}$$

where β represents the weight of clean energy consumption on utility. For individual residents, the constraints are:

$$C \times P_1 + C_g \times P_2 = Y + \Delta C_g \tag{2}$$

P_1 indicates the price level of the total consumption in the market. P_2 indicates the price level of clean energy consumption; Y represents the absolute income level of an individual in his life; ΔC_g represents the economic benefits of using clean energy. Individuals choose the best clean energy consumption (C_g) and other total consumption (C) to maximize the weighted utility function, that is,

$$MaxU(C, C_g) \tag{3}$$

$$s.t.\ \ C \times P_1 + C_g \times P_2 = Y + \Delta C_g \tag{4}$$

$s.t.$ is the constraint condition, using the Lagrangian method:

$$L = lnC + \beta lnC_g + \lambda(C \times P_1 + C_g \times P_2 - Y - \Delta C_g) \tag{5}$$

thus,

$$C = \frac{Y + \Delta C_g}{P_1 + \beta P_1} \tag{6}$$

$$C_g = \frac{\beta(Y + \Delta C_g)}{P_2(1 + \beta)} \tag{7}$$

Therefore, the maximum utility value that individuals can get is:

$$U_{max} = \ln\left(\frac{Y + \Delta C_g}{P_1 + \beta P_1}\right) + \beta \ln\left[\frac{\beta(Y + \Delta C_g)}{P_2(1 + \beta)}\right] \tag{8}$$

Based on this, this study proposes the following hypothesis: there is a positive relationship between building clean energy consumption and residents' well-being.

3. Data and Model Setting

3.1. Data Source and Sample Selection

The data used in this study were obtained from the Chinese General Social Survey (CGSS) conducted in 2018, which was implemented by the China Research and Data Center of Renmin University of China. This data covers 28 provinces, autonomous regions and municipalities in China except Hainan, Tibet, Xinjiang, Hong Kong, Macao and Taiwan. The population surveyed included urban and rural residents aged $\geq$ 18 years. The sample was representative and could be used for reliable statistical analyses. The survey items mainly included basic characteristics of respondents, the social attitude of the interviewees, including self-rating of social status and happiness of life, and energy use of the interviewees, including energy expenditure, heating, etc. Combined with the research theme of this study, the data were collated, and samples lacking basic variables (such as happiness and household expenditure) and invalid samples were deleted. The final valid samples were 3012.

Compared with the samples used in the existing research, the data used in this study have the following advantages in research on building clean energy and residents' well-being in China: (1) CGSS (2018) is one of the most detailed data on energy consumption in China, including electricity, natural gas, gas, central heating and other data; (2) CGSS (2018) carried out a detailed survey on residents' sense of happiness, health, education, and social status, making our later mechanism analysis more reliable.

3.2. Research Design and Variable Processing

In economic research, subjective well-being is often used to measure residents' welfare [26]. This is because we can avoid the shortcomings of using income to represent residents' welfare, because it is not necessarily that residents with higher income have higher welfare. The higher the income, the greater the desire, and utility may be reduced, leading to a reduction in welfare. In addition, measuring welfare using objective indicators such as income or wealth can ultimately be transformed into whether life is happy. When residents' income or wealth meets their desires, they are happy [27]. As a subjective concept, it is difficult to objectify happiness; therefore, the questionnaire was reasonable and feasible [28]. This study's explained variable used residents' happiness to represent their subjective well-being. We used the question from the Chinese General Social Survey (CGSS) data: "in general, do you think your life is happy?" to measure Chinese residents' happiness. $Happiness_i$ takes values from 1 to 5, where 1 means "extreme unhappiness", 2 indicates "relatively unhappiness", 3 means "feel general", 4 indicates "relatively happiness", and 5 means "extreme happiness".

The explanatory variable of this paper is the consumption of clean energy ($Cese_i$). We use Xu and Ge (2022) to define modern clean energy [29], calculate the monthly consumption of electric energy, natural gas and liquefied petroleum gas used by the surveyed residents, add them up and convert them into annual consumption. This study used the natural logarithm of annual consumption as the explanatory variable.

The control variables were divided into two levels: personal and family. Individual characteristics included age, gender, education, marriage, residence account, political affiliation, race; while family characteristics included homeownership, residential area, family size, and family economic status.

The intermediary variables in this study were health and household expenditures. Health represents the health status of the respondents, and household expenditure is the annual household expenditure of the respondents. The data indicators of the regulating variables were obtained from the CGSS questionnaire "do you have central heating in your home?", we set central heating to 1 and no central heating to 0. See Table 1 for variable definitions. Figure 2 shows that there is a positive correlation between clean energy consumption and happiness of Chinese residents.

Table 1. Variable definition.

Variable		Variable Assignment Description
Explained variable	$Happiness_i$	Extremely unhappy = 1, relatively unhappy = 2, acceptable = 3, relatively happy = 4, extremely happy = 5
Explanatory variable	Clean energy consumption ($Cece_i$)	Natural logarithm of annual clean energy consumption
Individual characteristic variables	Age	The specific figures filled in by the respondents in the questionnaire shall prevail
	Gender	Female = 0, Male = 1
	Education degree	Unschooled = 0, elementary school = 6, middle school = 9, high school = 12, junior college = 15, undergraduate = 16, master or doctoral = 19
	Marriage	Unmarried = 0, married = 1
	Residence account	Rural account = 0, city account=1
	Political affiliation	Other = 0, party member of CPC = 1
	Race	Other = 0, Han race = 1
Family characteristic variables	Homeownership	Otherwise = 0, housing owner = 1
	Residential area	Natural logarithm of residential area
	Family size	The specific figures filled in by the respondents in the questionnaire shall prevail
	Family economic status	Far below average level = 1, below average level = 2, average level = 3, above average level = 4, well above average level = 5
Mediating variables	Health	Extremely unhealthy = 1, relatively unhealthy = 2, acceptable = 3, relatively healthy = 4, extremely healthy = 5
	Household expenditures	Natural logarithm of annual household expenditures
Moderator variable	Central heating	No central heating = 0, have central heating = 1

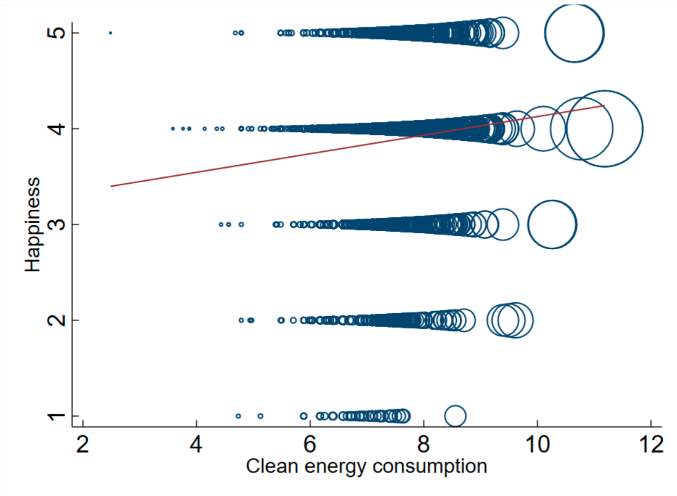

Figure 2. Happiness and clean energy consumption.

3.3. Model Analysis

Considering that the variable $Happiness_i$ is restricted to ordered data, if OLS estimation is adopted, it is biased and inconsistent. Therefore, based on theoretical analysis, we adopt an ordered probit for the estimation. The empirical model used in this study is as follows:

$$Happiness_i = \alpha_0 + \alpha_1 Cese_i + \alpha_2 X_i + \theta_i + \mu_i \tag{9}$$

In Equation (9), $Happiness_i$ represents the happiness of resident i, which is the explained variable; $Cese_i$ is an explanatory variable that represents clean energy consumption; X_i is a series of control variables, including personal and family characteristics; θ_i is the regional fixed effect; ε_i is the random interference term. Assumptions $\mu \sim N(0, 1)$ distribution, the Oprobit model can be expressed as:

$$\begin{aligned}
P(Happiness = 1 \mid x) &= P(Happiness^* \le r_0 \mid x) = \phi(r_0 - \alpha_1 Cese_i - \alpha_2 X_i - \theta_i) \\
P(Happiness = 2 \mid x) &= P(r_0 < Happiness^* \le r_1 \mid x) \\
&= \phi(r_1 - \alpha_1 Cese_i - \alpha_2 X_i - \theta_i) - \phi(r_0 - \alpha_1 Cese_i - \alpha_2 X_i - \theta_i) \\
\ldots \\
P(Happiness = 5 \mid x) &= P(r_3 \le Happiness^* \mid x) = 1 - \phi(r_3 - \alpha_1 Cese_i - \alpha_2 X_i - \theta_i)
\end{aligned} \tag{10}$$

In Equation (10), $r_0 < r_1 < r_2 < r_3$ is the parameter to be estimated; and the value of $Happiness_i$ is 1 to 5. The maximum likelihood method was used to estimate the model parameters by constructing the likelihood function of happiness for each respondent.

3.4. Descriptive Statistics

To obtain a preliminary understanding of the studied samples, we first conducted a descriptive analysis of the relevant variables, and the results are shown in Tables 2 and 3. We found that the mean value of the variable "happiness" was 3.8678, indicating that the happiness of the surveyed residents was between "relatively happiness" and "acceptable", close to "relatively happiness"; secondly, the variable "gender" is 0.4641, which shows that the proportion of men and women interviewed is approximately equal, which is relatively representative; moreover, we have noticed that the education level of residents is 8.3434, indicating that compulsory education is basically universal in China, but the education level of Chinese residents still needs to be improved. Meanwhile, "marriage" represents whether the residents interviewed are married. 78.85% of the respondents in the sample are married. The value of the variable "residence account" is 0.4180, indicating that nearly 42% of the residents interviewed are urban residence account. In addition, 91.27% of the respondents own houses, which indicates that the housing ownership rate of Chinese residents is extremely high, and the policy of "having a place to live" is basically realized.

Furthermore, the variable "family size" is 2.8390, which indicates that Chinese families are basically composed of parents and one child, and the only child has become the mainstream. Finally, the "family economic status" value is 2.5710, which reflects that most respondents believe that their economic status is between the below average level and the average level.

Table 2. Descriptive statistics of binary variables.

Variable	Mean	Std. Dev	Min	Max	0 (%)	1 (%)
Gender	0.4641	0.4988	0	1	53.59%	46.41%
Marriage	0.7885	0.4084	0	1	21.15%	78.85%
Residence account	0.4180	0.4933	0	1	58.20%	41.80%
Political affiliation	0.0966	0.2955	0	1	90.34%	9.66%
Race	0.9240	0.2651	0	1	7.60%	92.40%
Homeownership	0.9127	0.2823	0	1	8.73%	91.27%
Central heating	0.2095	0.3321	0	1	79.05%	20.95%

Table 3. Descriptive statistics of other variables.

Variable	Mean	Std. Dev	Min	P50	P75	Max
Happiness	3.8659	0.8207	1	4	4	5
Clean energy consumption	7.3099	0.8009	2.4849	7.3340	7.7857	11.1845
Age	51.8373	15.9224	18	52	64	93
Education degree	8.3434	4.7950	0	9	12	19
Residential area	4.6292	0.9423	1.9459	4.6001	4.8828	9.2102
Family size	2.8390	1.4216	1	3	4	14
Family economic status	2.5710	0.7119	1	3	3	5
Health	3.5252	1.0869	1	4	4	5
Household expenditures	10.0647	1.1141	1.3863	10.1659	10.7852	14.4307

4. Analysis of Empirical Results

4.1. Benchmark Regression

Table 4 presents the regression results for the Oprobit model. Column (1) only controls for the explanatory variables and regional fixed effects and examines the direct impact of Chinese residents' clean energy consumption on their happiness. The regression results show that there is a positive relationship between residents' clean energy consumption and their well-being, and it is significant at the 1% statistical level. Column (2) adds individual characteristic variables on the basis of Column (1), and the explanatory variables are significant at the 1% level. Column (3) all control variables are included in the model, and the regression results are significant at the 5% level, and are basically consistent with the operation results of the first two models. For each control variable, according to the estimated results in Column (3) of Table 4, we can see from the regression coefficient of age and its square that there is a significant U-shaped relationship between age and happiness. At the same time, there is gender difference in residents' well-being, and the well-being of men is lower than that of women. There is a significant positive correlation between the political identity of party members and residents' happiness. In addition, we found that family size was positively correlated with residents' happiness; the higher the economic status of the family, the better the living conditions of residents, and they will feel happier. In general, the influence direction and significance level of the explanatory variables do not change significantly between the columns, indicating that the model estimation is relatively robust. This further shows that there is a significant positive relationship between residents' clean energy consumption and happiness.

Table 4. Benchmark regression.

Variables	Explained Variable: Happiness		
	(1)	**(2)**	**(3)**
Clean energy consumption	0.125 *** (0.033)	0.120 *** (0.035)	0.071 ** (0.035)
age		−0.049 *** (0.010)	−0.042 *** (0.010)
Square of age		0.501 *** (0.097)	0.442 *** (0.095)
Gender		−0.102 *** (0.046)	−0.089 ** (0.047)
Education degree		0.003 (0.005)	−0.006 (0.005)
Marriage		0.216 *** (0.076)	0.123 (0.077)
Residence account		0.038 (0.061)	−0.002 (0.064)
Political affiliation		0.159 *** (0.055)	0.117 * (0.064)
Race		0.006 (0.119)	0.004 (0.110)
Homeownership			0.132 (0.093)
Residential area			0.030 (0.023)
Family size			0.041 ** (0.020)
Family economic status			0.400 *** (0.041)
Regional fixed effect	Yes	Yes	Yes
/cut1	−1.637 *** (0.244)	−2.545 *** (0.415)	−1.626 *** (0.389)
/cut2	−0.820 *** (0.252)	−1.713 *** (0.441)	−0.744 * (0.413)
/cut3	−0.173 (0.243)	−1.056 ** (0.428)	−0.050 (0.407)
/cut4	1.601 *** (0.250)	0.740 * (0.438)	1.811 *** (0.410)
Observations	3012	3012	3012

Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.2. Marginal Utility

Since the regression coefficient value of the Order probit model has no reference significance, we can only obtain limited information from the regression results, such as the significance level and sign direction. Therefore, this section further calculates the marginal effect of the order probit regression. The calculation method is as follows:

$$\left.\frac{\partial P(y = i \mid x)}{\partial P x_i}\right|_{x = \overline{x}} (i = 1,2,3,4,5) \tag{11}$$

x represents all control variables and regional fixed effects except the explanatory variables in the two−stage regression. Formula (11) indicates that when other variables are at their mean value and remain fixed, the change in x_i per unit will lead to a change in the probability of taking $i = 1,2,3,4,5$ as the explanatory variable.

Because the explanatory variable $\widehat{Cece}$ of the two-stage regression is the fitting value of the one-stage probit regression, $\widehat{Cece}$ can be regarded as a continuous variable. When the probability of $Cece = 1$ changes, the change in the marginal probability of the explanatory variable $i = 1,2,3,4,5$ is taken as:

$$\left.\frac{\partial P(y = i \mid x)}{\partial P(Cece = 1 \mid x)}\right|_{x = \overline{x}} = \left.\frac{\partial P(y = i \mid x)/\partial \widehat{Cece}}{\partial P(Cece = 1 \mid x)/\partial \widehat{Cece}}\right|_{x = \overline{x}} \quad (i = 1,2,3,4,5) \tag{12}$$

Table 5 presents the marginal effects of column (3) of Table 3. From the perspective of the marginal effect of explanatory variables, when all other variables are at the mean value and remain unchanged, the probability of clean energy consumption $P(Cece = 1 \mid x)$ increases every Δ, and the probability of happiness value "extremely unhappy" $P(happiness = 1 \mid x)$ decreases by 0.002150Δ, and so on. The probability $P(happiness = 2 \mid x)$ of value "relatively unhappy" decreases by 0.007405Δ; the probability $P(happiness = 3 \mid x)$ of value "acceptable" decreases 0.009807Δ; the probability $P(happiness = 4 \mid x)$ of the value "relatively happy" increases 0.002444Δ; and the probability $P(happiness = 5 \mid x)$ of the value "extremely happy" increases 0.016918Δ. According to the results of marginal effects, the increase in clean energy consumption increases the probability of residents choosing "relatively happy" and "extremely happy", and reduces the probability of residents choosing "extremely unhappy", "relatively unhappy" and "acceptable".

Table 5. Marginal utility.

Variable Happiness	Explanatory Variable: Clean Energy Consumption				
	dy/dx	**Standard Error**	**Z Statistics**	***p*-Value**	**Significance**
1	−0.002150	0.001090	−1.97	0.049	**
2	−0.007405	0.003738	−1.98	0.048	**
3	−0.009807	0.004772	−2.06	0.040	**
4	0.002444	0.001218	2.01	0.045	**
5	0.016918	0.008263	2.05	0.041	**

Robust standard errors in parentheses, ** $p < 0.05$.

4.3. Robustness Check

To further ensure the reliability of the research conclusions, we conducted a robustness test on the regression model from the perspectives of samples and models. Table 6 presents the results. First, we changed the explained variable, replacing "happiness" with "social stratum". Since there is a strong correlation between social status and happiness [30], we choose to replace happiness with social status as the explained variable. The data indicators are from the CGSS question volume "what do you think of your current social status?"; the variable value ranges from 1 to 10, and all control variables and provincial fixed effects are introduced to conduct an ordered probit regression on the model. The regression results are still significant at the 1% significance level, as shown in Table 6 (1). Second, we replaced the regression model for the robustness test, using the ordered logit model and Tobit model for regression, and the empirical steps were consistent with the benchmark regression. Columns (2) and (3) of Table 6 show the regression results. The explanatory variables are significant at the 5% levels, which is consistent with the above results, indicating that the estimation results are robust.

4.4. Placebo Test

Owing to differences in the economic development of China's provinces, different regions have different characteristics. Although the regional fixed effect is controlled for in the regression equation, it may have different effects on interviewees with different educational backgrounds, genders and other aspects. To test the effectiveness of the above research results, this study uses the method of randomly generating experimental groups to complete the placebo test, to verify the impact of clean energy consumption on the difference in residents' well-being. First, we randomize the core explanatory variable "clean energy consumption", and then put it into the regression model to generate an estimation coefficient $\hat{\beta}$. This process was repeated 1000 times, and finally 1000 $\hat{\beta}$ was obtained; Figure 3 shows $\hat{\beta}$ distribution. The $\hat{\beta}$ distribution is close to the standard normal distribution, and the mean value is close to 0, indicating that the estimation equation passed the placebo test, indicating that the impact of clean energy consumption on residents' well-being is robust, and excluding the interference of other random factors on the results.

Table 6. Robustness check.

Variables	Explained Variable: Social Stratum	Explained Variable: Happiness	
	(1)	(2)	(3)
	Ordered Probit	Ordered Logit	Tobit
Clean energy consumption	0.092 *** (0.030)	0.119 ** (0.060)	0.046 ** (0.022)
Individual characteristic variables	Yes	Yes	Yes
Family characteristic variable	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes
Observations	3012	3012	3012

Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$.

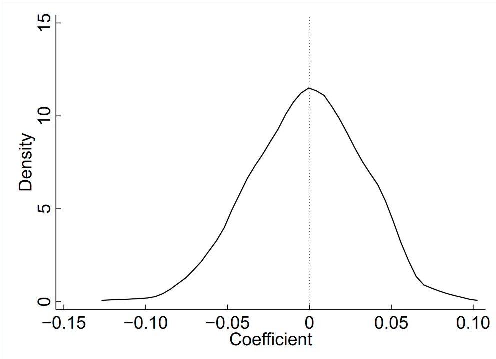

Figure 3. Placebo test.

5. Heterogeneity Analysis

5.1. By Age

The impact of energy consumption on different people is not identical [31]. With increasing age, the age energy consumption curve shows almost linear growth [32]. The results in Table 7 show that for different age groups of the study, there is a heterogeneous effect of clean energy consumption on residents' well-being, and the older the age, the higher the significance of the effect of clean energy consumption on residents' well-being. On the one hand, young people under the age of 35 are more willing to reduce the dependence on their original families and establish their own families. They tend to live in smaller families with a low capacity for energy consumption, which does not reflect that clean energy can improve their quality of life, thus improving their sense of happiness; on the other hand, for middle-aged and elderly people over 35 years old, most of them are married and have children, and perform more energy consuming activities such as cooking and washing, which increases the energy consumption of the middle-aged and elderly groups. Furthermore, these behaviors improve the quality of life of middle-aged and elderly individuals and increase their life satisfaction. Moreover, with increasing age and the gradual degradation of physical functions, middle-aged and elderly people have a slightly higher demand for comfort in their living environment. They pay more attention to products closely related to their own health [33]. The use of clean energy can make them healthier and increase their sense of well-being.

Table 7. Heterogeneity analysis from the perspectives of age.

Variables	Explained Variable: Happiness		
	(1) **18–35**	**(2)** **35–60**	**(3)** **More Than 60**
Clean energy consumption	−0.018 (0.064)	0.102 * (0.058)	0.092 ** (0.042)
Individual characteristic variables	Yes	Yes	Yes
Family characteristic variable	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes
Observations	541	1506	965

Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$.

5.2. By Homeownership and Education Degree

The difference between residents' housing and educational backgrounds may also bring about the heterogeneous impact of clean energy consumption on well-being. This section further discusses whether housing and educational differences exist in the impact of clean energy consumption on residents' well-being. The regression results in columns (1) and (2) of Table 8 show a significant positive relationship between clean energy consumption and the happiness of residents with housing. The relationship between happiness of residents without housing and clean energy consumption was not significant. We believe that for residents without housing, they may consume more in other aspects, are insensitive to energy consumption, and have greater randomness. The way for residents with housing to enjoy clean energy is more convenient. Simultaneously, clean energy can improve the quality of life of residents in housing and make them feel happier. In addition, the results in Columns (3) and (4) of Table 8 indicate that for the low educated group, clean energy consumption can significantly promote happiness, while those with high education are not significant. We refer to people with a college degree or above as people with a high educational background, while people with other educational backgrounds are those with a low educational background. Compared with people with low education background, people with high education background have a higher income level, and their quality of life has greater advantages compared with people with a low education background. The marginal utility of clean energy consumption on the quality of life of highly educated people is relatively small. Generally, the quality of life of the lower education group is probably less than that of the higher education group. Therefore, the marginal utility of consuming clean energy is relatively high for the lower education group, which can increase their life satisfaction.

Table 8. Heterogeneity analysis from the perspectives of homeownership and education degree.

Variables	Explained Variable: Happiness			
	(1) **Homeownership**	**(2)** **Non-Homeownership**	**(3)** **Lower Education**	**(4)** **Higher Education**
Clean energy consumption	0.086 ** (0.037)	−0.107 (0.093)	0.076 ** (0.037)	−0.004 (0.083)
Individual characteristic variables	Yes	Yes	Yes	Yes
Family characteristic variable	Yes	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes	Yes
Observations	2749	263	2578	434

Robust standard errors in parentheses, ** $p < 0.05$.

5.3. By Region

There are differences in the economic development of the eastern, central, and western regions of China, and the demand for energy in each region is different [34], which causes a large gap in the impact of clean energy consumption on the well-being of residents in the eastern, central and western regions of China. Table 9 reports the estimation results grouped into the central, western, and eastern regions. Robust standard errors were used for each estimation equation. For the central region, the regression results show a significant positive correlation between clean energy consumption and residents' well-being, which is significant at the 5% statistical level. This indicates that clean energy in the central region can promote the happiness of residents. Moreover, compared to the basic regression results using the national sample, the coefficient of clean energy consumption in the regression results of the central region is larger, which shows that the happiness enhancement effect of clean energy consumption in the central region is higher than the average level in China. In addition, residents' clean energy consumption was not significant in the eastern and western regions, which indicates that the use of clean energy in these regions did not produce a significant happiness enhancement effect.

Table 9. Heterogeneity analysis from the perspectives of region.

Variables	Explained Variable: Happiness		
	(1) Mid	**(2) West**	**(3) East**
Clean energy consumption	0.103 ** (0.051)	−0.018 (0.061)	0.089 (0.063)
Individual characteristic variables	Yes	Yes	Yes
Family characteristic variable	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes
Observations	1064	767	1181

Robust standard errors in parentheses, ** $p < 0.05$.

We believe that whether clean energy consumption can play a significant role in improving residents' well-being is limited by economic development and income levels. Compared to the central region, economic development in the western region is relatively backward, the income level is low, and people are more urgent to improve their material living conditions. The impact of material factors such as income on happiness is often more prominent than the ecological environment factors. While the economic development level of the eastern region is the highest in China, the income level of residents is also high, and the price sensitivity is low. They may not care about the happiness brought about by clean energy consumption. The income, housing, and GDP per capita of residents in the central region are at a moderate level, and they are able to consume clean energy. At the same time, because the income of residents in the central is not as high as that of residents in the East, they focus on clean energy to improve their quality of life and improve their subjective well-being.

6. Mechanism Inspection and Further Analysis

The above analysis shows that clean energy consumption has a significant positive impact on residents' well-being. What type of path does clean energy use affect residents' welfare? Therefore, this study uses the intermediary and regulatory effect models to identify the mechanism of the impact of clean energy on residents' welfare.

At present, the existing literature has shown that energy consumption will cause a series of health and inequality problems [35], among which residents' health and other factors will affect their subjective well-being [36]. In addition, Middlemis et al. (2015) showed that it would cost more to obtain clean energy if one wanted to obtain a healthy body [37]. In addition, owing to the special geographical location of China, the temperature gap between the north and south is large. Most northern regions have implemented central heating policies, and there are many financial subsidies for central heating in northern cities. Residents have low energy consumption in winter, which may play a regulatory role in the process of improving their happiness. Based on the analytical framework of social psychology mediation and regulatory effects, we built a conceptual model of the clean energy consumption mechanism that affects residents' well-being (Figure 4).

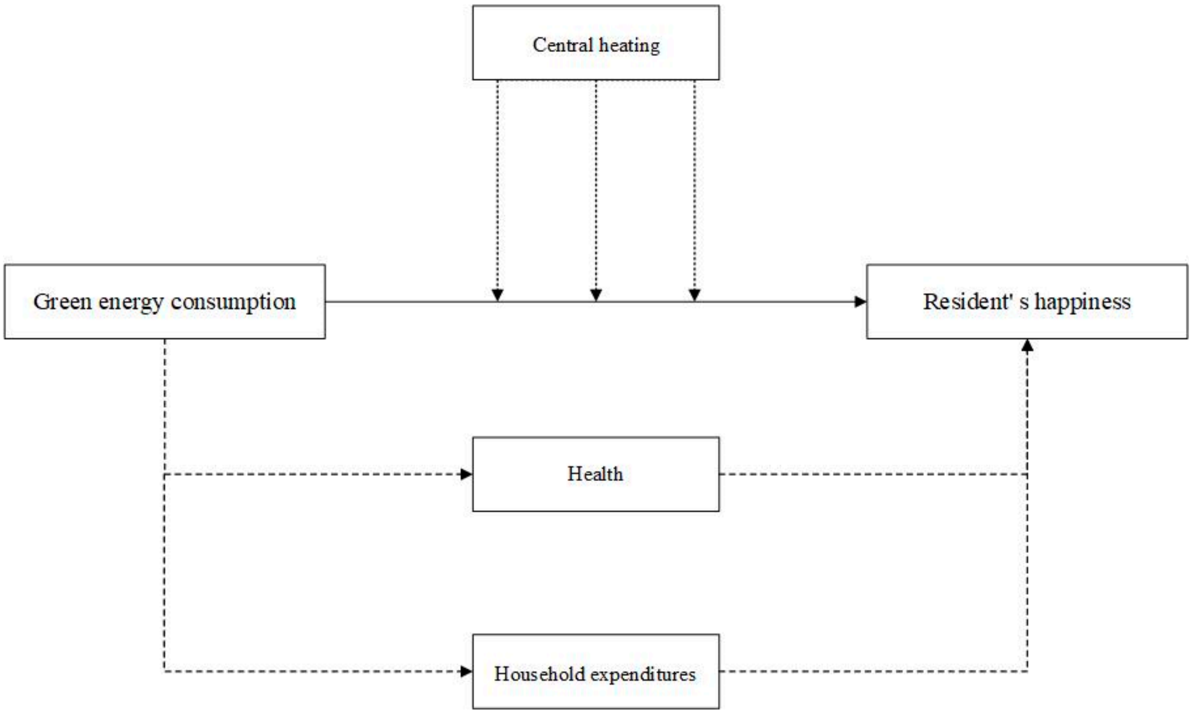

Figure 4. The mechanism of clean energy consumption revolution effect on resident' happiness.

6.1. Intermediary Effect Test

To empirically analyze whether clean energy has an impact on residents' well-being by affecting their health and consumption, we refer to Mehmetoglu's (2018) intermediary effect test procedure [38] to test whether residents' clean energy consumption affects their well-being by affecting their health and household expenditure. The intermediary effect model was set as follows:

$$Happiness_i = \beta_0 + dGese_i + \varepsilon_i \quad (13)$$

$$Mid_i = \beta_0 + aGese_i + \varepsilon_i \quad (14)$$

$$Happiness_i = \beta_0 + bMid_i + d'Gese_i + \varepsilon_i \quad (15)$$

In Formula (13), $Happiness_i$ regresses $Gese_i$ and estimates the coefficient d. d is the total effect of clean energy consumption on the well-being of the ith resident. If the statistics are significant, it means there is a mediation effect; in Formula (14), Mid_i regresses $Gese_i$ and estimates the coefficient a. a is the impact of clean energy consumption on intermediary variables, which must be statistically significant to prove the relationship between explanatory variables and intermediary variables. Mid_i is the intermediate variable. In Formula (15), $Happiness_i$ regresses Mid_i, while controlling $Gese_i$, and the estimation coefficient b must be statistically significant. b and d' represent the direct effects of the intermediary variables and clean energy consumption on the well-being of the ith resident. If d' is not significantly 0, then Mid_i is a partial intermediary effect. By substituting Formula (14) into Formula (15), we can conclude that the intermediary effect of clean energy consumption is $a \times b$. Then, we use Equation (16) to test the mediation effect $a \times b$. If $z > \pm 1.96$, the intermediary effect $a \times b$ at the statistical level of 0.05 is significant [39], that is, the indirect impact of clean energy consumption on residents' well-being through intermediary variables.

$$z = \frac{a \times b}{\sqrt{b^2 s_a^2 + a^2 s_b^2}} \quad (16)$$

In Formula (16), a and s_a^2 (standard error of a) come from Formula (14); b and s_b^2 (standard error of b) come from Formula (15).

Table 10 presents the regression results of the mediation model. First, the paths X → M and M → Y of the variables "health" and "household expenditures" are significant, indicating that the mediation effect exists, and the Z value of the variable and the direct effect X → Y are significant, indicating that the variables "health" and "household expenditures " are part of the mediation, that is, residents' health and household income play a part of the mediation effect between clean energy consumption and happiness. By calculating the intermediary effect value, we find that the intermediary effect of "health" is 0.030, accounting for 31.9% of the total effect. The intermediary effect of "household expenditures" is 0.035, accounting for 36.8% of the total effects. This shows that in the process of clean energy consumption affecting residents' happiness, residents' health and household expenditure play an intermediary role. In general, with an increase in clean energy consumption, residents have become healthier. At the same time, the increase in household expenditures has improved the quality of life of residents and their sense of happiness.

Table 10. Mediation Analysis.

Variables	**X→M**	**M→Y**	**X→Y**	**Indirect Effect**	**Standard Error**	**Z Value**	***p*-Value**	**Significance**	**RIT**
Health	0.143 ***	0.211 ***	0.064 ***	0.030	0.005	6.657	0.000	***	31.9%
Household expenditures	0.355 ***	0.098 ***	0.060 ***	0.035	0.007	4.965	0.000	***	36.8%

Robust standard errors in parentheses, *** $p < 0.01$.

6.2. Regulatory Effect

Column (1) of Table 11 shows whether the presence or absence of the heating interaction item (*Treat*) affected residents' clean energy consumption and happiness. The results show that the interaction coefficient is negative, and significant at the 10% level. This shows that if residents enjoy central heating, the higher their clean energy consumption, the weaker is their sense of well-being. In other words, heating plays a negative role in regulating the impact of clean energy consumption on residents' sense of well-being. Because central heating can reduce residents' energy consumption [40], if residents enjoy central heating while their clean energy consumption increases, this will increase their expenditure, reduce their sense of well-being and reduce their welfare.

Table 11. Moderator and further analysis.

Variables	**Explained Variable: Happiness**			
	(1)	**(2)**	**(3)**	**(4)**
Clean energy consumption	0.085 ** (0.035)	−0.117 (0.335)	−0.112 (0.339)	−0.083 (0.323)
Square of clean energy consumption	-	0.017 (0.023)	0.016 (0.024)	0.011 (0.023)
Treat	−0.074 * (0.045)	-	-	-
Individual characteristic variables	Yes	No	Yes	Yes
Family characteristic variable	Yes	No	No	Yes
Regional fixed effect	Yes	Yes	Yes	Yes
Observations	3012	3012	3012	3012

Robust standard errors in parentheses, ** $p < 0.05$, * $p < 0.1$.

6.3. Further Analysis: Test of Non-Linear Effect

The main effect analysis above shows that, after controlling for a series of other variables, residential clean energy consumption has a significant positive effect on residents' well-being. However, the greater the clean energy consumption, the greater the consumption expenditure of residents, which inhibits residents' happiness. Therefore, this section explores whether there is an inverted U-shaped relationship between residential clean energy consumption and residents' happiness; that is, after residents use residential clean energy to reach a certain extreme value, their happiness declines with the increase in clean energy consumption. Columns (2), (3) and (4) in Table 11 present the regression results. The values of the secondary terms of residential clean energy consumption and residential clean energy consumption are not significant, indicating that there is no nonlinear relationship between residential clean energy consumption and residents' well-being, that is, there is no inverted U-shaped relationship. This demonstrates that residents have not yet felt the negative impact of excessive clean energy consumption, and that the increase in residential clean energy consumption is constantly improving the quality of life of residents. This proves that the Chinese government must vigorously develop clean energy to enhance the happiness of Chinese residents.

7. Conclusions and Policy Implication

7.1. Conclusions

This study used data from the Chinese General Social Survey (CGSS) in 2018 to explore the impact of residential clean energy consumption on residents' well-being. Our research results show the following: there is a significant positive relationship between clean energy consumption and residents' well-being; furthermore, it can be seen from the results of marginal effects that the increase in clean energy consumption increases the probability of residents choosing "relatively happy" and "extremely happy". Moreover, in the heterogeneity analysis, for the groups with housing and low education background, there is a significant positive relationship between residential clean energy consumption and residents' well-being, and the impact on the middle and elderly groups is more significant. The intermediary analysis shows that the use of clean energy in housing improves the health of residents, and improves their quality of life while increasing their expenditure. In addition, central heating affects the relationship between residential clean energy consumption and residents' well-being. Further analysis shows that there is no nonlinear relationship between the increase in residential clean energy consumption and residents' happiness. This study conducted a series of robustness tests on the empirical results, including a placebo test, and the estimated results were robust.

7.2. Policy Implication

The results of this study have several important policy implications. Therefore, this study proposes corresponding policy suggestions from the following aspects. First, the government should actively promote the construction of residential clean energy infrastructure, such as natural gas pipelines, to achieve "household ventilation", so that residents can obtain clean and efficient living energy. In addition, through the relocation policy in combination with the poverty alleviation work, the residents living in remote mountain areas will be relocated to areas with high access to clean energy, reducing the cost of energy infrastructure construction. Secondly, when formulating policies to popularize clean energy for housing, we should adjust measures to local conditions and implement differentiated policies. Furthermore, we should vigorously publicize the advantages of clean energy, actively promote the policies of "replacing coal with electricity", "replacing coal with gas", and "clean heating in winter", and appropriately subsidize residents' use of clean energy in their homes. Third, the government should not only improve residents' ability to obtain clean energy for housing, but also cooperate with several measures to improve residents' welfare. Additionally, we will accelerate the construction of leisure and entertainment facilities to increase residents' leisure activities. Moreover, providing basic health services for residents who cannot use clean energy temporarily, formulating policies to reduce air pollution, ensuring residents' health, and preventing residents from feeling less happy due to health problems.

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References

1. Wu, Y.; Wu, Y.; Zhang, Y.; Wang, X.; Song, Z. The Effect of Building Electricity Consumption on Residents' Subjective Well-Being: Evidence from China. *Buildings* **2022**, *12*, 710. [CrossRef]
2. Huang, H.; Hong, J.; Wang, X.; Chang-Richards, A.; Zhang, J.; Qiao, B. A spatiotemporal analysis of the driving forces behind the energy interactions of the Chinese economy: Evidence from static and dynamic perspectives. *Energy* **2022**, *239*, 122104. [CrossRef]
3. Valero, A.; Valero, A.; Calvo, G. Summary and critical review of the International Energy Agency's special report: The role of critical minerals in clean energy transitions. *Rev. Metal.* **2021**, *57*, 197. [CrossRef]
4. Sohail, M.T.; Ullah, S.; Majeed, M.T.; Usman, A.; Andlib, Z. The shadow economy in South Asia: Dynamic effects on clean energy consumption and environmental pollution. *Environ. Sci. Pollut. Res. Int.* **2021**, *28*, 29265–29275. [CrossRef] [PubMed]
5. Malinowski, M. "Green Energy" and the Standard of Living of the EU Residents. *Energies* **2021**, *14*, 2186. [CrossRef]
6. Wang, X.; Huang, H.; Hong, J.; Ni, D.; He, R. A spatiotemporal investigation of energy-driven factors in China: A region-based structural decomposition analysis. *Energy* **2020**, *207*, 118249. [CrossRef]
7. Ben Mbarek, M.; Saidi, K.; Rahman, M.M. Renewable and non-renewable energy consumption, environmental degradation and economic growth in Tunisia. *Qual. Quant.* **2018**, *52*, 1105–1119. [CrossRef]
8. Zhang, X.; Wu, L.; Zhang, R.; Deng, S.; Zhang, Y.; Wu, J.; Li, Y.; Lin, L.; Li, L.; Wang, Y.; et al. Evaluating the relationships among economic growth, energy consumption, air emissions and air environmental protection investment in China. *Renew. Sustain. Energy Rev.* **2013**, *18*, 259–270. [CrossRef]
9. Zahoor, Z.; Khan, I.; Hou, F. Clean energy investment and financial development as determinants of environment and sustainable economic growth: Evidence from China. *Environ. Sci. Pollut. Res.* **2021**, *29*, 16006–16016. [CrossRef]
10. Liddell, C.; Morris, C. Fuel Poverty and Human Health: A Review of Recent Evidence. *Energy Policy* **2010**, *38*, 2987–2997. [CrossRef]
11. United Nations. *The Sustainable Development Goals Report*; United Nations: New York, NY, USA, 2021; p. 2020.
12. Schwab, K. The fourth industrial revolution: What it means, how to respond. *Econ. Cult. Hist. Jpn. Spotlight Bimon.* **2016**, 3–5. Available online: https://www.jef.or.jp/journal/pdf/208th_Cover_01.pdf (accessed on 8 June 2022).
13. Nie, P.; Li, Q.; Sousa-Poza, A. Energy poverty and subjective well-being in China: New evidence from the China Family Panel Studies. *Energy Econ.* **2021**, *103*, 105548. [CrossRef]
14. Ejrnæs, A.; Greve, B. Your position in society matters for how happy you are. *Int. J. Soc. Welf.* **2017**, *26*, 206–217. [CrossRef]
15. Anand, P.; Hunter, G.A.; Smith, R. Capabilities and Well-Being: Evidence Based on the Sen–Nussbaum Approach to Welfare. *Soc. Indic. Res.* **2004**, *74*, 9–55. [CrossRef]
16. Bittmann, F. Beyond the U-Shape: Mapping the Functional Form Between Age and Life Satisfaction for 81 Countries Utilizing a Cluster Procedure. *J. Happiness Stud.* **2020**, *22*, 2343–2359. [CrossRef]
17. Tesch-Römer, C.; Motel-Klingebiel, A.; Tomasik, M.J. Gender Differences in Subjective Well-Being: Comparing Societies with Respect to Gender Equality. *Soc. Indic. Res.* **2007**, *85*, 329–349. [CrossRef]
18. Binder, M.; Coad, A. Heterogeneity in the Relationship between Unemployment and Subjective Wellbeing: A Quantile Approach. *Economica* **2015**, *82*, 865–891. [CrossRef]
19. Deaton, A. Income, health, and well-being around the world: Evidence from the Gallup World Poll. *J. Econ. Perspect. A J. Am. Econ. Assoc.* **2008**, *22*, 53–72. [CrossRef]
20. Herman, K.M.; Hopman, W.M.; Rosenberg, M.W. Self-rated health and life satisfaction among Canadian adults: Associations of perceived weight status versus BMI. *Qual. Life Res.* **2013**, *22*, 2693–2705. [CrossRef]
21. Binder, M.; Blankenberg, A. Green lifestyles and subjective well-being: More about self-image than actual behavior? *J. Econ. Behav. Organ.* **2017**, *137*, 304–323. [CrossRef]
22. Río, P.; Burguillo, M. An empirical analysis of the impact of renewable energy deployment on local sustainability. *Renew. Sustain. Energy Rev.* **2009**, *13*, 1314–1325.

23. Welsch, H.; Biermann, P. Electricity supply preferences in Europe: Evidence from subjective well-being data. *Resour. Energy Econ.* **2014**, *38*, 38–60. [CrossRef]
24. Welsch, H.; Biermann, P. Energy Affordability and Subjective Well-Being: Evidence for European Countries. *Energy J.* **2017**, *38*, 159–176. [CrossRef]
25. Welsch, H.; Kühling, J. Pro-environmental behavior and rational consumer choice: Evidence from surveys of life satisfaction. *J. Econ. Psychol.* **2010**, *31*, 405–420. [CrossRef]
26. Easterlin, R.A. Explaining happiness. *Proc. Natl. Acad. Sci. USA* **2003**, *100*, 11176–11183, PMCID:PMC196947. [CrossRef] [PubMed]
27. Ferrer-i-Carbonell, A. Income and Well-Being: An Empirical Analysis of the Comparison Income Effect. *J. Public Econ.* **2005**, *89*, 997–1019. [CrossRef]
28. Ferreira, S.; Moro, M. On the use of subjective well-being data for environmental valuation. *Environ. Resour. Econ.* **2010**, *46*, 249–273. [CrossRef]
29. Xu, Z.; Ge, R. The Impact of Energy Consumption Revolution on Farmers' Happiness: An Empirical Analysis from China. *Front. Public Health* **2022**, *10*, 778002, PMCID:PMC8960032. [CrossRef] [PubMed]
30. Argyle, M. Causes and correlates of happiness. In *Well-Being: The Foundations of Hedonic Psychology*; Kahneman, D., Diener, E., Schwarz, N., Eds.; Russell Sae Foundation: New York, NY, USA, 1999.
31. Aristondo, O.; Onaindia, E. Inequality of energy poverty between groups in Spain. *Energy* **2018**, *153*, 431–442. [CrossRef]
32. Estiri, H.; Zagheni, E. Age matters: Ageing and household energy demand in the United States. *Energy Res. Soc. Sci.* **2019**, *55*, 62–70. [CrossRef]
33. Gyberg, P.; Palm, J. Influencing households' energy behaviour—How is this done and on what premises? *Energy Policy* **2009**, *37*, 2807–2813. [CrossRef]
34. Wu, Y.; Huang, H.H.; Hong, J.; Wang, X.; Wu, Y.; Wu, Y. Transfer patterns and driving factors of China's energy use in trade: Evidence from multiregional input–output analysis and structural decomposition analysis. *Energy Rep.* **2022**, *8*, 10963–10975. [CrossRef]
35. Walker, G.; Day, R. Fuel poverty as injustice: Integrating distribution, recognition and procedure in the struggle for affordable warmth. *Energy Policy* **2012**, *49*, 69–75. [CrossRef]
36. Smith, J.; Borchelt, M.; Maier, H.; Jopp, D.S. Health and Well–Being in the Young Old and Oldest Old. *J. Soc. Issues* **2002**, *58*, 715–732. [CrossRef]
37. Middlemiss, L.; Gillard, R. Fuel poverty from the bottom-up: Characterising household energy vulnerability through the lived experience of the fuel poor. *Energy Res. Soc. Sci.* **2015**, *6*, 146–154. [CrossRef]
38. Mehmetoglu, M. medsem: A Stata package for statistical mediation analysis. *Int. J. Comput. Econ. Econom.* **2018**, *8*, 63–78.
39. Iacobucci, D.; Saldanha, N.; Deng, X. A meditation on mediation: Evidence that structural equations models perform better than regressions. *J. Consum. Psychol.* **2007**, *17*, 139–153. [CrossRef]
40. Walker, G. Decentralised systems and fuel poverty: Are there any links or risks? *Energy Policy* **2008**, *36*, 4514–4517. [CrossRef]