Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(10):500-507

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Analysis on influence factors of Beijing rural energy consumption

Suo Chenxia[1], Zhang Zhihui[1], Zhang Yi[1] and Yang Yong[2]

[1]Beijing Institute of Petrochemical Technology, China
[2]Zhejiang Gongshang Universities, China

ABSTRACT

In recent years, with the rapid development of Beijing economy, the energy consumption quantity gradually increases. Of which, the problem of Beijing rural energy consumption has become an important issue which restricts Beijing economic development. On the basis of data of China Energy Statistical Yearbook, China Rural Energy Yearbook and the official website of State Statistics Bureau, combined correlation analysis, factor analysis, grey relational analysis and other methods, this paper conducts research to find out major factors which affect Beijing rural energy consumption, and puts forward the suggestion to improve rural energy consumption structure according to specific circumstance and guides the peasant household to rationally utilize energy to promote the sustainable and sound development of Beijing rural energy consumption and drive the rational utilization of nationwide energy

Key words: Rural; Energy consumption; Factor

INTRODUCTION

China is a developing country and an agricultural country, and the quantity of rural population accounts for a large proportion in the whole national population. With a relatively backward economy, the consumption level of rural per capita commercial energy is restricted by the population quantity and economic development level, and the energy mainly consumed in household is non-commercial energy, in which, the biomass fuel accounts for a large proportion. In turn, the rural energy consumption level and structure change also plays an important role to the economic development of rural areas. It is not only one part which cannot be ignored in our energy consumption, but also an important foundation for establishing national energy plan. Therefore, the analysis on the status of rural energy consumption is increasingly concerned by the scholars at home and abroad.

Through research, JIN Ling [1] considers that the household income, resource availability, educational status and other household characteristics greatly affect the level and structure change of our country energy consumption. With the income increase, we should gradually increase the use of commercial energy and decrease the use of biomass energy. Simultaneously, the peasant household whose educational level is high tends to choose commercial energy, and the household's non-agricultural employment population quantity also affects the energy consumption. Vibol San[2] et al consider by research that most rural residents in less developed economy consume various unconventional energy, including traditional biomass energy (timber, straw, etc), even coal oil and liquefied petroleum gas. This indirectly indicates that the economic income level directly affects the use of energy. ZHAO Chun-sheng[3] et al analyze the influence of population quantity and income on energy use with SPIRPAT model, and the result shows that the difference of per capita energy consumption among regions is tiny. The dominant energy of rural household is biomass energy and fossil fuel. SHI Huading, QI Yongqing and LIU Yun[4] consider that the production and lifestyle changes with the rapid development of rural economy after reform and opening-up. China rural energy consumption exhibits that the total energy consumption rapidly increases, the proportion of production energy and household energy alternatively rises, significant change takes place in the structure of rural

energy consumption, and the proportion of commercial energy consumption increases, which indicates that the economic income level has an important influence on the energy consumption structure. Davis[5] concluded by research that the income level of rural area is the decisive factor of affecting energy consumption. LI Yanyan, ZHAO Xianglian, and LU Min[6] concluded by research that the rural household incomings and outgoings is affected by capital, labor force, energy consumption, energy price level and carbon tax rate. In view of this conclusion, it is put forward that an individual pricing measure should be implemented to rural energy. Alejandro Menéndez[7] et al consider that the development level and energy consumption quantity is low in the area with agriculture as basis. Every household uses timber to cook and illuminate, therefore the economic development degree and income level are the decisive factors of affecting energy consumption. XU Xiaogang[8] considers that the technology progress improves energy utilization efficiency to strengthen the consumption demand to high-quality energy, beneficial to promoting the improvement of energy consumption structure; furthermore, the improvement of per capita income level, energy supply price, energy availability and environmental awareness promote the optimization and upgrading of energy structure. Sanjay K. Nepal [9] thinks that the influence factors of rural energy consumption cover energy price, technology, national policy, etc. Md. Danesh Miah [10] et al thinks that the household energy consumption varies with income group, household size, residence type, and land ownership and education level. The main factors are high initial cost, unavailability and household income. In addition, education and infrastructure should be also reinforced. Lina [11] performed tentative exploration to Beijing rural energy consumption structure and divided the rural energy consumption into 5 kinds of forms, and conducted regression analysis to it. The result shows that the effect of fuel wood and biogas on total energy consumption is not significant, based on which a relevant energy conservation suggestion is put forward. ZHANG Xiao, GAO Haiqing[12] concluded by experiment that the influence of net income level of peasant household on rural per capita biogas consumption is non-linear, and put forward that we should take appropriate measures according to the peasant households with different income levels to promote the sound progress of ecological agriculture. Through the research on Tibet rural energy consumption and environmental influence, CAI Guotian[13] concluded that under the basic condition of Tibet backward rural economy and big urban-rural gap, the proportion of rural energy consumption in modern energy is low, and put forward some improvement measures. WANG Jingjing[14] concluded by analysis that the main factor which affects Beijing rural energy consumption is per capita net income. CHENG Sheng [15] concluded by research that the problem of rural energy consumption is a chaotic system which contains multiple causal feedbacks, nonlinear mechanism actions. WANG Fang[16] thinks that the external factors which affect residential energy mainly cover policy factors, economic factors and locational conditions, and the internal factors cover household characteristic factors and psychological factors. ZHANG Lixiao[17] et al consider that the regional economic development level and the improvement degree of infrastructure also affect rural energy consumption on certain extent. JIN Yanhai[18] thinks that the factors affecting rural energy consumption include economic factors and regional resource factors. Of which, the economic factors include local economic development, peasant household's income, energy consumption cost; in addition, the difficulty level to obtain resource also affects the consumption structure of rural energy. LIU Jing and ZHU Lizhi[19] consider that household per capita wealth, energy price, resource availability and the householder's educational degree are the main factors which affect rural energy consumption. LIANG Yutian, FAN Jie[20] et al concluded by research that the topographic feature significantly affects the rural energy consumption structure of southwest region, and the non-commercial energy is affected by resource endowment, while the commercial energy is more affected by market distance; there is a certain positive correlation between household income level and household educational degree and the use of commercial energy. YANG Zhen [21] considers that the size of rural population is a significant factor affecting rural energy consumption. FAN Yawen and XU Caihua[22] think that the rural household energy consumption is mainly determined by resource availability and peasant household's income level. PENG Ke[23] et al concluded by research that the rural economic growth, agriculture population, mechanization level and consumption custom positively relate to agricultural production energy consumption, and the energy price negatively relates to agriculture production energy consumption. The influence of agriculture fixed-asset investment on agriculture production energy consumption is limit in the short term.

From the above, we can see that there are many factors which affect rural energy consumption, including rural population size, consumption custom, peasant household's income level, resource availability, household educational degree, topography, energy consumption cost, etc, all these directly or indirectly affect rural household energy consumption level and energy consumption structure. Based on the references, this paper analyzes relevant data, determines the influence factors of rural energy consumption, and conducts analysis from the aspects such as gross rural population, rural resident per capita net income, energy consumption efficiency to obtain the main factors affecting Beijing rural energy consumption, and find out the factor to improve energy consumption structure to facilitate the improvement of Beijing rural energy consumption structure..

BEIJING RURAL ENERGY CONSUMPTION STATUS

Rural energy plays an important role in rural economic development. Agricultural production can be conducted

smoothly only when the effective supply of rural energy can be ensured and the energy consumption structure is rationally improved to guarantee rural life, effectively improve farmer's living environment, and promote the construction of new socialist countryside. Beijing rural energy consumption researched in this paper consists of rural production energy consumption (only the energy of primary industry is discussed here) and rural household energy consumption (referred to the energy consumed in daily life such as lighting, heating, etc). From the analysis on the data from 2006 to 2012, we can see that Beijing rural energy consumption in 2006- 2012 is on the rise as a whole, during which there is also fluctuation, as shown in Table 1

.

Table 1 Total energy consumed of Beijing (unit:10kt standard coal)

Year	Total	Primary industry	Coal	Electricity	Biogas	Solar energy	Wind energy
2006	386.63	92.3	194.04	51.18	0.35	48.76	0
2007	406.06	96.4	202	50.54	0.93	56.19	0
2008	402.68	96.9	174.62	52.52	1.5	67.14	10
2009	434.78	99	204.7	53.97	1.04	66.07	10
2010	438.43	100.3	206.3	54.54	0.92	66.37	10
2011	443.22	100.3	210	55.8	0.89	66.23	10
2012	458.61	100.8	210	58.15	0.83	78.83	10

Data source: China Rural Energy Yearbook, Official Website of National Bureau of Statistics of China

From Table 1 we can see that the overall trend of total energy consumed of Beijing during 2006-2012 is as shown in Fig. 1.

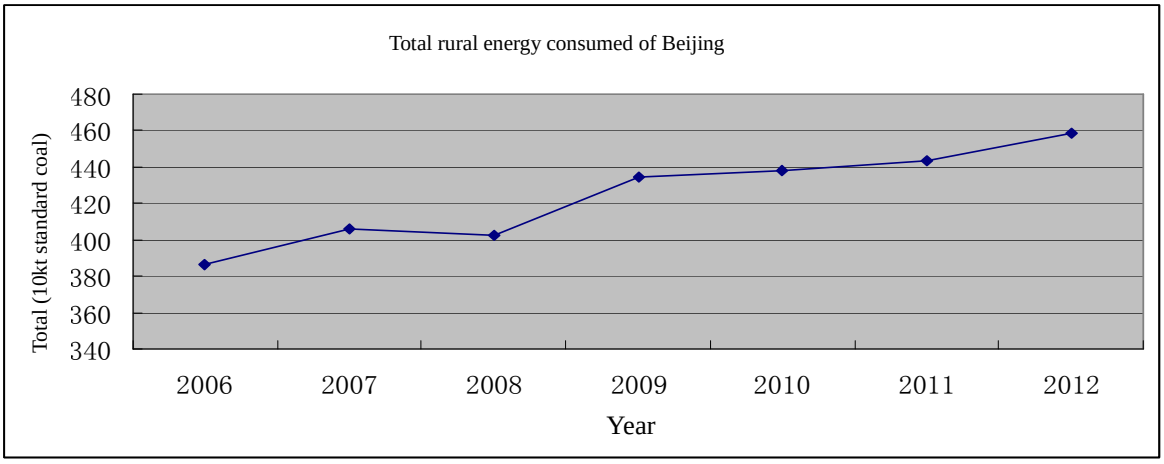

Fig.1 Variation trend of total energy consumed of Beijing

From Fig. 1 we can see that the overall trend of total energy consumed of Beijing during 2006-2012 is on the rise, and it zooms up during 2006~2007. But in the subsequent 2008, it declines, and the main cause for this phenomenon is that the price of coal rapidly rose up around May, 2008, which causes that the consumption of household of coal declines. Since 2008, the amount of increase of total energy consumption is large, indicating that the rural living standard continuously improves. Now we will analyze the consumption situation of all kinds of energy as follows.

For the consumption situation of Beijing rural coal, electricity, biogas, the specific data analysis is as shown in Fig. 2.

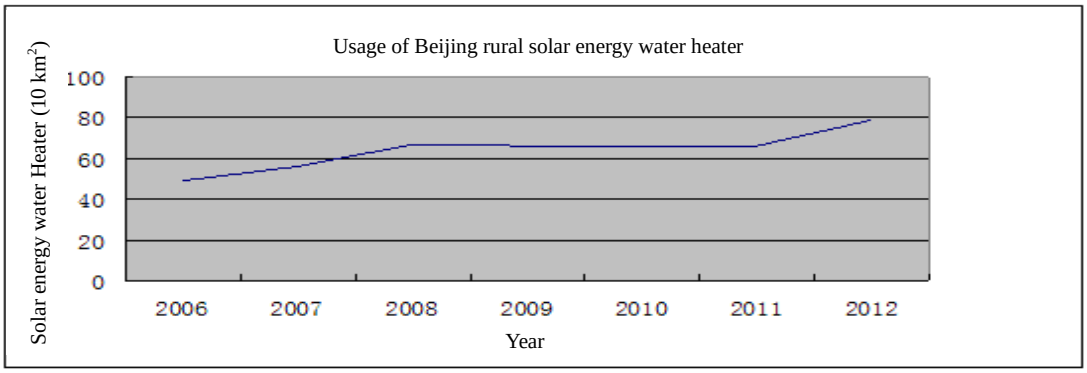

Fig.2. Consumption quantity of Beijing rural coal, electricity, biogas

From Fig.2 we can see that Beijing rural coal consumption is steady as a whole, but in 2008, it declines to 1.7462 million tons. There are two reasons for this: first, the development and utilization of all kinds of new energy makes the proportion of traditional energy decline; secondly, the coal price rise sharply. But on the whole, the coal accounts for 47% of all energy consumption, and always occupies an important position in Beijing rural area. The electricity consumption of Beijing during 2006~2012 goes up steadily to 581,500 ton in 2012 from 511,800 ton in 2006. But the total quantity is not much, which is tied to that our country implements the policy of energy conservation and emission reduction, and also greatly relates to the rising of clean energy and renewable energy. In 2006~2012, the usage amount of Beijing rural biogas is on the rise as a whole. But after a few years, the usage amount of biogas tends to decline. The reasons for this may cover the lack of skill to correctly use biogas, the lack of fermentation raw material, and the imperfect technical service, etc. For this, we should extensively propagandize the technology of using biogas and improve the use of biogas used by peasant household[9]. For the usage of Beijing rural solar energy in 2006~2012, see Fig. 3.

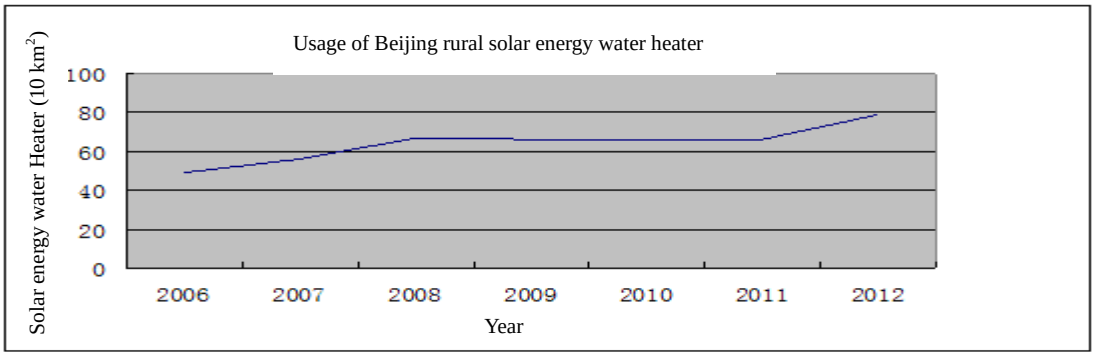

Fig. 3 Usage amount of Beijing rural solar energy

As shown in Fig.3, we can see that the usage amount of Beijing rural solar water heater in recent 7 years is soaring as a whole, but the growth rate is low. The reasons for this may be the price problem[27], the application condition and the influence on house appearance, etc; in addition, it may be that the support of government policy is low.
The usage amount of Beijing rural wind energy in 2006-2012 is as shown in Fig. 4.

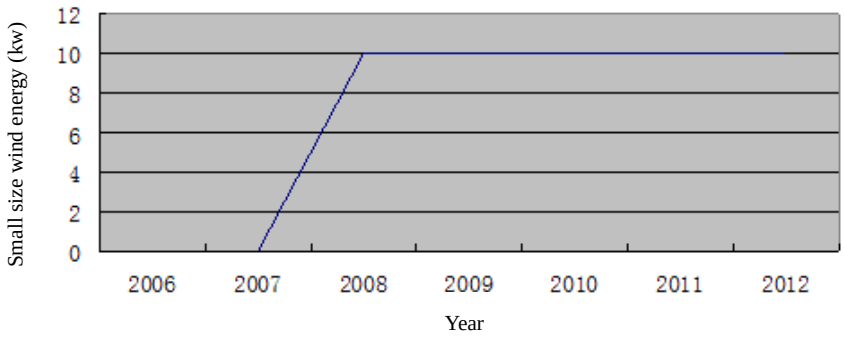

Fig.4 Usage amount of Beijing rural wind energy

From Fig. 4 we can see that the usage amount of Beijing rural wind energy rapidly increases from 2007 to 2008. But in the subsequent 5 years, it remains unchanged basically. The reason for this problem may be the incongruity between wind energy planning and grid planning, as well as that the market which promotes the wind energy consumption and the coordinated operation mechanism of various energy supply are still unsound. It is hoped that our country can lay down relevant policy to guide the wind energy to soundly develop.

EMPIRICAL ANALYSIS OF THE INFLUENCE FACTORS OF BEIJING RURAL ENERGY CONSUMPTION

1. Index data of each influence factor of Beijing rural energy consumption

With the data of China Energy Statistical Yearbook (2006~2012), China Rural Energy Yearbook (2000~2008, 2009~2013) and the official website of National Energy Statistical Bureau, as well as careful screening, we confirmed population X_1, income level X_2, energy utilization efficiency X_3, consumption price change level X_4, consumption level X_5 and various indexes of rural resident employment X_6. Each data is as shown in Table 2.

Table2 Data of influence factors of Beijing rural energy consumption in 2006~2012

Year	X_1/ten thousand person	X_2/Yuan	X_3/(standard coal)/t	X_4/hundred million Yuan	X_5 /Yuan	X6/Yuan
2006	248	8275.47	0.76	112.9	7655	60.3
2007	253	9439.63	0.714	112.5	9063	60.9
2008	256	10661.92	0.662	109.5	10043	63
2009	263	11668.59	0.606	112.1	11483	62.2
2010	275	13262.29	0.582	108.6	12886	61.4
2011	279	14735.68	0.459	102	13659	59.1
2012	286	16475.74	0.436	106.7	14664	57.3

Note: data source: China Energy Statistical Yearbook, China Rural Energy Yearbook

Now we will analyze the above influence factors to determine the main factors of affecting Beijing rural energy consumption, and provide basis for Beijing energy strategy.

2. Correlation analysis of Beijing rural energy consumption factors

2.1 Bivariate correlation analysis between coal and each variable

Bivariate correlation analysis is a statistical method to research the closeness between two variables. Through calculation, we obtain that the Person correlation coefficients between income level, population quantity, consumption level and coal consumption are respectively 0.587, 0.651, 0.608, which indicates that the increase or improvement of the three factors will increase the coal consumption; while the Person correlation coefficients between energy utilization efficiency, consumption price change level, rural resident employment and coal consumption are respectively -0.591, -0.375, -0.648, which indicates that the coal consumption will decrease with the increase of the three variables.

2.2 Bivariate correlation analysis between electricity and each variable

It is concluded by bivariate correlation analysis that the Person correlation coefficients between income level, population quantity and consumption level and electricity consumption are respectively 0.975, 0.959, 0.953, presenting a positive correlation, namely that the electricity consumption will increase with the improvement of income level, population quantity and consumption level; while the r values between consumption price change level, rural resident employment, energy utilization efficiency and electricity consumption are respectively -0.737, -0.641, -0.961, indicating that the electricity consumption will decrease with the improvement of consumption price change level, rural resident employment and energy utilization efficiency.

2.3 Bivariate correlation analysis between solar energy and each variable

Correlation coefficients between income level, consumption level, population and solar energy are respectively 0.886, 0.883, 0.836, presenting a positive correlation, which indicates that the use of solar energy will increase with the improvement of income level, consumption level and population quantity; the correlation coefficients between rural resident employment, energy utilization efficiency, consumption price change level are respectively -0.341, -0.853, -0.585, indicating that the use of solar energy will decrease with the improvement of the three factors. For example, if the unemployment rate of rural resident is high, the income will decrease, so the consumption expenditures on solar energy will decrease, therefore the use of solar energy will be reduced.

3. Factor analysis of Beijing rural energy consumption factors

Factor analysis method is a multivariate statistical analysis to research how to express many variables with several factors, and guarantee that the information loss is the minimum, and there is no significant correlation among factors. Below, we will express the method with mathematical mode.

Set m original variables, $X_1,X_2,\ldots X_m$, assume that these variables have been standardized (the mean value is 0, and the standard deviation is 1) and m variables can be expressed as linear combination with k factors, F_1, F_2, $F_3\ldots F_k$, as follows:

$$X_1=a_{11}F_1+a_{12}F_2+\ldots a_{1k}F_k+\varepsilon_1$$

$$X_2=a_{21}F_1+a_{22}F_2+\ldots a_{2k}F_k+\varepsilon_2$$

$$\ldots$$

$$X_m=a_{m1}F_1+a_{m2}F_2+\ldots a_{mk}F_k+\varepsilon_m$$

The above mathematical model can be expressed as $X=AF+\varepsilon$ with matrix form.

Based on the practical significance of variable, the variables are classified into household factor F_1 (rural resident employment, population quantity), social factor F_2 (energy utilization efficiency, consumption price change level),

economic factor F_3 (consumption level, income level), now we will analyze it as follows:

Table 3 Descriptive statistics

	Mean value	Standard deviation
Population	265.7143	14.442
Energy utilization efficiency	.6027	.12215
Consumption level	11350.4286	2558.73353
Rural resident employment status	60.6000	1.927
Consumption price change level	109.1857	3.90573
Income level	12074.1886	2926.85699

Table 4 Test value

Test of KMO and Bartlett		
Kaiser-Meyer-Olkin measurement.		.538
Bartlett sphericity test	Approximate Chi-Square	54.289
	df	15
	Sig.	.000

Through Bartlett sphericity test, we figure out that the value of KMP is 0.538, larger than 0.50, and the value of Bartlett sphericity test is 54.289 and the value of P is close to 0, indicating that the test data can be used to conduct factor analysis.

Table 5 Total Variance Explained

Total Variance Explained						
Component	Initial eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.091	84.846	84.846	5.091	84.846	84.846
2	0.586	9.771	94.617			
3	0.293	4.887	99.504			
4	0.025	0.416	99.919			
5	0.004	0.074	99.994			
6	0	0.006	100			

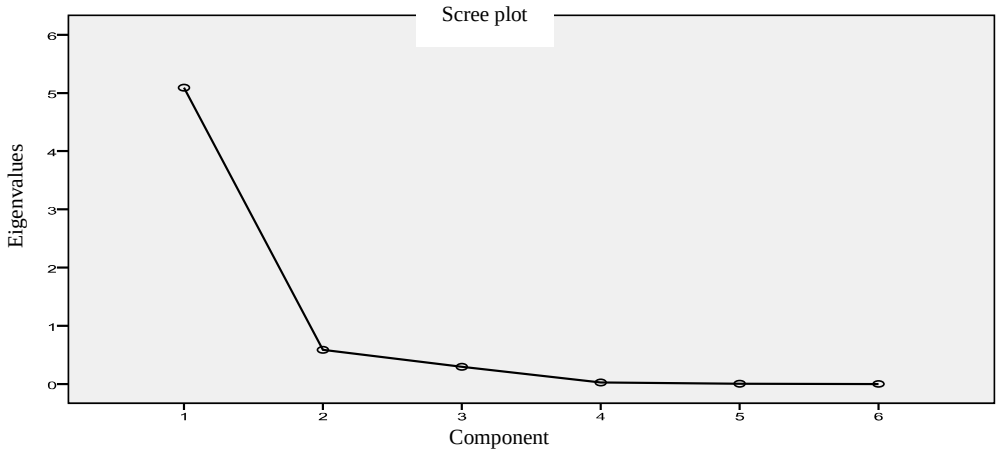

Fig. 5 Scree plot

The extracted cumulative variance contribution rate of first principal component reaches to 84.864% and the equation of factor score is shown as follows:

$$F_M=0.340X_1+0.330X_6$$
$$F_N=0.520X_3+0.380X_4$$
$$F_P=0.360X_5+0.765X_6$$

Of which, F_M is the score of household factor, F_N is the score of social factor, and F_P is the score of economic factor. Calculate the score through factor analysis, and conduct analysis with gray relational analysis method according to

the factor score and relevant coefficient of compositional variable.

4. Grey correlation analysis of Beijing rural energy consumption factors
We can conclude by the above data and grey system analysis method that:
(1) The grey correlation degrees r_m between coal consumption and consumption level and rural resident employment are respectively 0.618, 0.312, from which we can see that the biggest impact on Beijing rural energy consumption is the consumption level, followed by rural resident employment;

(2) The grey correlation degrees r_n between electricity consumption and energy utilization efficiency and consumption price change level are respectively 0.518, 0.556, from which we can see that the biggest impact on Beijing rural energy consumption is the consumption price change level, followed by energy utilization efficiency;

(3) The grey correlation degrees r_p between solar energy consumption quantity and income level and consumption level are respectively 0.688, 0.310. From the degree of correlation we can see that the biggest impact on Beijing rural energy consumption is the income level.

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions
It is concluded by correlation analysis, factor analysis and grey correlation analysis that the main factors of affecting Beijing rural energy consumption cover income level, population, energy utilization efficiency, followed by consumption price change level, consumption level. Of which, the correlation between income level, population and consumption level and energy consumption quantity is positive. With the improvement of the three factors, the energy consumption quantity will increase. For example, when the peasant household's income level is improved, the consumption expenditure will increase, so the commercial energy consumption quantity increases. The correlation between energy utilization efficiency, consumption price change level and energy consumption quantity is negative, namely that the energy consumption quantity will decrease with the improvement of the two factors.

2. Recommendations
Through developing Beijing rural economy and improving the peasant household's income level, the government can strive to reinforce the vocational training, improve the peasant household's employment ability, facilitate the peasant household employment, increase the peasant household's income, and increase the consumption of clean renewable energy and promote the rational utilization of rural energy; enhance the rural infrastructure construction, increase the quantity of biogas digesters, and facilitate the use of renewable energy; reinforce the scientific research input, generalize the clean energy, for example, deeply develop the use of solar energy, not only limited to solar water heater, etc, more widely increase the development of solar energy, wind energy and tidal energy, etc to reduce the use of traditional energy and promote the energy conservation and environmental improvement
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Acknowledgements
This paper was funded by these projects: Beijing philosophy and social science Planning project(10BeJG338); Development research centre of Beijing new modern industrial area（PXM2013-014222-000051）)

REFERENCES

[1] JIN Ling, The Research on Rural Household Energy Consumption and Influence Factors, **2010**-12, master's thesis of Nanjing Agricultural University [D].
[2] Vibol San, *Energy* 48 (**2012**) 484e491.
[3] ZHAO Chun-sheng, NIU Shu-wen, ZHANG Xin, *Energy Procedia* 14 (**2012**) 805 – 811.
[4] SHI Huading, QI Yongqing, LIU Yun, The Research on the Environmental Effect of Rural Energy Consumption [J], The Population of China - Resource and Environment, **2010**, Volume 20, Issue 8.
[5] Mark Davis，*Energy Policy*[J], Vol. 26, No. 3, pp. 207-217, **1998**.
[6] LI Yanyan, The Analysis on the Influence of Carbon Tax and Energy Subsidy on China Rural Energy Consumption [J], **2013** (8), Issues in Agriculture Economy (monthly magazine).
[7] Alejandro Menéndez, María Dolores Curt， *Energy for Sustainable Development*，17 (**2013**) 201–209.
[8] XU Xiaogang, The Analysis on China Rural Household Energy Consumption [D], **2008** (6).
[9] Sanjay K. Nepal, *Tourism Management* 29 **(2008**) 89–100.
[10] Md. Danesh Miah, *Energy Policy* 38 (**2010)** 997–1003.
[11] LI Na, LIN Cheng, Regression Analysis and Energy Conservation Recommendations on Beijing Rural Household Energy Consumption [J], *China Electric Power Education*, special issue of **2009** Management Jungle and Technical Research.

[12] ZHANG Xiao, GAO Haiqing, The Analysis on the Influence of the Peasant Household’s Income Level of the Western China on Rural Energy Consumption, 2007 Shaanxi Soft Science Research Project, (**2007**KR97); Shaanxi Social Sciences Fund Project (07D014S).
[13] CAI Guotian, *Resource Development & Market*, **2006** 22(3).
[14] WANG Jingjing, The Statistic Analysis on Beijing Rural Energy Consumption Status [D], master's thesis of Economics of Hebei University, **2010** (5).
[15] CHENG Sheng, The Research on China Rural Energy Consumption and Energy Policy [D], doctoral dissertation of Huazhong Agricultural University, **2009** (5).
[16] WANG Fang, The Research on Changsha Urban and Rural Household Energy Consumption Behavior and Influence Factors, [D], **2012**-06, master's thesis of Sichuan Agricultural University.
[17] 2011-01.ZHANG Lixiao, HU Qiuhong, WANG Changbo, Rural Energy in China: Pattern and Policy [N], Transactions of the CSAE, Volume 27, Issue 1, **2011**-01.
[18] JIN Yanhai, The Research on Problems and Countermeasures of Rural Energy Consumption – with Jilin province as example [D], **2012**-05, master's thesis of Northeast Normal University.
[19] LIU Jing, ZHU Lizhi, *Journal of Agritechnical Economics*, Issue 2, **2011**.
[20] **2012**-02.LIANG Yutian, *Journal of Geographical Science*, Volume 67, Issue 2.
[21] YANG Zhen, The Analysis on Environmental Effect and Influence Factors of Rural Household Energy Consumption [N]，**2011**-01, Transactions of the CSAE.
[22] FAN Yawen, XU Caihua, Relevant Factor Analysis and Area Research on China Rural Household Energy Consumption [C], Modern Industrial Engineering and Management Seminar (MIEM’06) collected papers.
[23] PENG Ke, AN Yufa, Empirical Analysis on the Influence Factors of China Agricultural Production Energy Consumption [N], based on fixed effect model, Vol.31,No.8,**2012**(1), Technical Economy.
[24] LIU Zhiru, Life Analysis and Policy Research on Beijing Rural Household Energy [D], **2012**-04, master's thesis of Southwest University.
[25] China Energy Statistics Yearbook (2006-2012), China Rural Energy Yearbook (**2000-2008**) (**2009-2013**）
[26] LI Jianshan, the Causes and Countermeasures for the Decrease of Utilization Rate of Rural Biogas Digesters [J], Yunnan Agricultural Science and Technology, Issue 6, **2007**.
[27] http://blog.sina.com.cn/s/blog_58fc81430100ksbb.html。
[28] FU Qiang, The Research on the Relation between Rural Fixed Investment and New Rural Construction – with Gansu province as example, Hunan Agricultural Science, **2010**, (15): 173-176.
[29] YANG Dan, SPSS Valuable Book (Edition 3), Electronic Industry Press, **2013**-10