THE APPLICATION OF ANALYTIC HIERARCHY PROCESS SETTING UP NEW USING ENERGY STRUCTURAL SORT IN RURAL

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ABSTRACT

Employing the AHP in systems analysis, this paper is an analysis on the optimum pattern of energy utilization in the rural areas of Qinghai Province. Even if we have merely unsufficient statistical data, this paper helps to solve problems that caused some disputes before and it also provides these areas with scientific support so that a rational strategy of developing energy sources is made possible.

Analytic Hierarchy Process (AHP) invented by T.L. Saaty, a well-known expert of operations research and professor of Pittsburg University is a simple and convenient approach to the quantitative analysis that is otherwise impossible means to elaborate objectively one's subjective judgement. In recent years, China has seen a big stride forward both in theoretical research and in applications in this respect. Tianjin University is taking lead in this field. AHP has been extensively made use of in such aspects as working out plans for economical and educational development, predetermining demands of energy supply, evaluating achievements in scientific and technological research, and analysing general economic decisions. The following is an application of this approach to restructuring the pattern of energy consumption in the rural areas fo Qinghai Province.

1. BACKGROUND

In late 70's, the regional scheme of comprehensive utilization of energy was worked out in the countryside of China. In 1986, the State Planning Commission made further efforts to have regional programs mapped out for rural energy resources at levels of the state, province, and country respectively. These programs are of great significance in designing energy construction, developing economy in pastoral areas, and raising living standards of the farmers and herdsmen in the vast countryside. The research work on comprehensive programs of this kind calls for a large amount of statistical data. In our country, however, data of this sort are in great shortage All the more so in Qinghai Province which is located namely on the Qinghai-Xizang(tibetan) Plateau. Previously, our work was done in terms of qualitative analysis which frustrated the programming of rural energy resources and restructuring of the energy consumption system.

Qinghai Province has an area of over 720,000 square kilometres and a population of more than four million; It is characterized by unfavorable natural conditions, such as high altitude(averagely over 3,000 m above the sea) and cold weathers; and consequently, it has a sparse population and hostile ecological environment. Energy has been mostly used for daily life, cooking meals and keeping one's house warm, for instance. Ninety percent of energy consumption is for this purpose. Biomaterials

of little quantity of heat are still being used, such as animal excrement, straw and stalks, dried grass and peat. As a result, this ill-concieved way of using energy resouces has bruoght about a shortage of fuel, fertilizer and fodder, therefore, it is crucial for us to find out the optimum way of spending energy in rural areas.

Three so far suggestions have been made by specialists concerned in Qinghai, regarding this problem.

The first is resources-oriented, dealing with solar, wind, and small-scaled hydroelectric power. It aims at increasing resources so as to form a new pattern of energy utilization.

The second is pragmatic-oriented, recommending on the one hand that the existing way of using energy has been formed by a long-term natural selection; and on the other, that new energy resources should be explored on the basis of the original pattern of energy utilization.

The third is ecological-oriented, admitting that, though the Qinghai-Xizang Plateau has a fragile ecological structure, it has abundant geological resources, It is, therefore, advisable to grow trees of various kinds so that the countryside would provide itself with enough firewood.

The three groups of advocators all hold their ground and none of them seems willing to yield. Hence, it is just impossible for us to adopt merely one of the three opinions, rather, to make asysatematic analysis not only to study the status quo, but also look into the future, Only by so doing can we provide scientific evidences for the energy policies for the rural areas of the province.

2. SELECTION OF HIERARCHICAL FACTORS: AHP HAS ADVANTAGES AS FOLLOWS

1.The logical thought-patterns involved in AHP can clarify the points in question easily;

2. AHP takes into account at the same time a great number of interrelated factors, such as ones in the natural, social, economical and political aspects;

3. This is a process of determining and analysing a pattern in a simple, convenient and efficient way;

4.AHP enables us to contain in one pattern both reference data and intuitive judgement of the specialists concerned. Judgement matrix can be set up, and thus, relevantly desirable results can be obtained because comparisons are made both in hierarchical structure and in pairs.

There are many ways to improve the rural energy construction, but we are mainly concerned with reducing consumption and increasing resources.

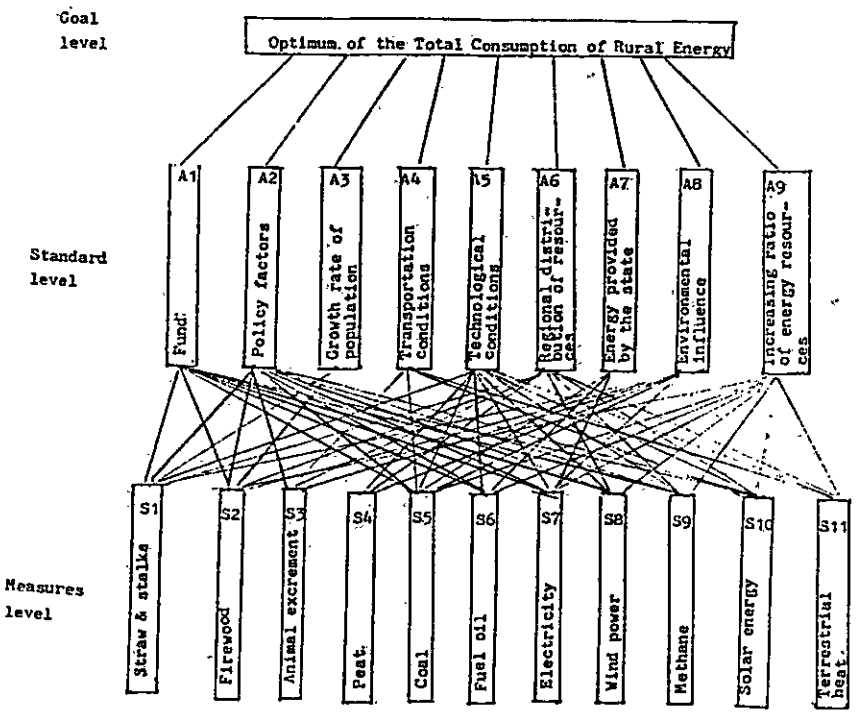
As to the former, it is necessary for us to reform the old facilities of energy transformation into highly efficient and low-consumptive apparatuses, such as cookers, kang(a heatable brick bed), heating and cooking range. vehicles on the farms are also potentially improvable for the same purpose. With these gaols clear in mind, specialists concerned can easily come to an agreement and we do not have to rely on AHP merely for a decision.

For the latter, however, there seem to be so many ways of increasing energy resources in the countryside that disputes often come up as to what pattern we should lay stress on.

To optimize the rural pattern of energy utilization, a number of factors have to be carefully dealt with. Such factors as natural, technological, economical, political, as well as habitual (regarding to differences between nationalities) ones, should be sorted out according to varied importance. We have adopted the Delphi process in this work; moreover, we invited 20 specialests from different units of the province and consulted experts of the Chinese Agricultural Engineering Institute, the Institute of China's Energy Resources and China's Academy of Social Science. We then summed up, collated and classified their opinions, and wrote anonymous reports to them asking for further suggestions, and then did the same all over again. From17 restricting factors, we selected 9 at the standard level; out of a great number of suggestions for increasing energy resources, we sorted out 11 items at the measures level. We did all this to avoid preference and prejudice of our own and compensate the possible deviation in intuitive judgement.

3. ESTABLISHMENT AND CALCULATION OF THE PATTERN

We decomposed the energy problem in the rural areas into a hierarchical structure, set up a matrix to make comparisons in pairs and calculated the root of features, priority and the coincidence tested in the judgement matrix. The model of hierarchical structure, judgement matrix and results are as follows: (Fig. 1)



1. Judgement matrix of the goal level to the standard level

U	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	w
A_1	1	1	2	2	2	1/3	2	1/2	2	0.137
A_2	1	1	1	1	2	1	2	2	1	0.138
A_3	1/2	1	1	1/2	1/2	1	1/2	1/2	2	0.077
A_4	1/2	1	2	1	1	1	1	1/2	1/2	0.089
A_5	1/2	1/2	2	1	1	2	1/2	2	1/2	0.089
A_6	3	1	1	1	1/2	1	1/2	1/3	2	0.125
A_7	1/2	1/2	2	1	2	2	1	2	3	0.112
A_8	2	1/2	2	2	1/2	3	1/2	1	1/2	0.118
A_9	1/2	1	1/2	2	2	1/2	1/3	2	1	0.109

λ_{max}=9.74 CI=0.092

RI=1.45 CR=0.06<0.1

A_5	S_1	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	w
S_1	1	1	1/2	1/2	1/3	1/2	1/2	1	1	0.068
S_4	1	1	1/2	1/2	1/3	1	1	1	1	0.080
S_5	2	2	1	1	1/2	2	2	3	2	0.119
S_6	2	2	1	1	1/2	2	2	2	2	0.115
S_7	3	3	2	2	1	3	3	3	3	0.123
S_8	2	1	1/2	1/2	1/3	1	1	1	1	0.130
S_9	2	1	1/2	1/2	1/3	1	1	1	1	0.127
S_{10}	1	1	1/3	1/3	1/3	1	1	1	1	0.120
S_{11}	1	1	1/2	1/2	1/3	1	1	1	1	0.114

λ_{max}=9.85 CI=0.106

RI=1.45 CR=0.07<0.1

2.Judgement matrix of the standard level to the measure level

Other judgement matrixes are omitted.

3. Results of the hierarchical ranging order

A / S	A1	A2	A3	A4	A5	A6	A7	A8	A9	priority in the combination
	0.137	0.138	0.077	0.089	0.089	0.125	0.112	0.118	0.109	
S1	0.12	0.04	0.25	0	0.06	0.23	0	0.09	0	0.088
S2	0.17	0.04	0.75	0	0	0.18	0	0.11	0.28	0.157
S3	0	0.06	0	0.33	0	0.1	0	0.16	0	0.071
S4	0	0	0	0	0.08	0.1	0	0.17	0	0.041
S5	0.16	0.1	0	0.28	0.11	0	0.19	0.21	0.22	0.145
S6	0.13	0.11	0	0	0.11	0	0.31	0	0.12	0.094
S7	0.13	0.12	0	0	0.12	0	0.49	0.23	0.09	0.141
S8	0.09	0.15	0	0	0.13	0.1	0	0	0.06	0.068
S9	0.08	0.16	0	0	0.12	0.07	0	0	0.07	0.063
S10	0.09	0.17	0	0.2	0.12	0.08	0	0	0.05	0.084
S11	0	0	0	0.16	0.11	0.1	0	0	0.05	0.048

4. CONCLUSION

According to the priority in the combination, we rebuilt the energy utilization in the rural areas in Qinghai Province into a new pattern (firewood-coal-electricity-fuel oil-straw & stalks-solar energy), which is entirely different from the old one (animal excrement-straw & stalks-dried grass-coal-peat-firewood). This new chain of energy structure was soon accepted by those who held different opinions. They even agreed readily that this structure was characterized by a steady growth in the use of commercial and productive energy, though energy used for daily life and for biomaterial remained a big proportion. This also reveals that people in this province have fully realized the importance of utilizing natural resources and developing commercial economy in the countryside to raise living standard.

We have framed the structrue of energy consumption and the strategy of developing rural energy in Qinghai Privonce in the light of AHP, and there upon the structure of consuming energy in the agricultural, pastoral, sandy and forest areas.

In agricultural areas, the bulk of energy consumption is designed as firewood-coal-straw & stalks-electricity-solar energy. Here, attention is focused on developing new sources of energy. The mutual-compensating system consists of the use of both biomaterial and commercial energy. Meanwhile, the agricultural energy system is subdivided into three regional divisions:Chuanshui(river valleys), Qianshan(low mountainous areas) and Naoshan (deep mountainous areas), according to their differences in natural, technological and economical conditions.

The pastoral areas, inhabited by about 500,000 herdsmen, make up 90 percent of the total area of Qinghai Province. The energy pattern is changed here from animal excrement-firewood into one of animal excrement-electricity (and wind power)- solar energy-liquefied petroleum gas. Attention is focused here on increasing new sources; while features of different altitudes (eminently high; high; high and cold) have especially

been taken into account.

In sandy areas (referring to the oasis and sandified areas), the turning from the original pattern (dried vegetation-straw and stalks-animal excrement) into one of firewood-coal-solar energy-wind power is, again, a seeking for new sources.

In forest areas, energy consumption used to be in the pattern of firewood-animal excrement. It has now, however, been developed into a mixed type of firewood-animal excrement-small-scaled hydroelectric power (including wind power), which is aimed both at new sources of energy and thrift in its consumption.

It has been proved that AHP is a scientific approach at once simple and useful. Especially so when used without sufficient qualitative data, and when one's subjective judgement plays an important role. It is of much help, indeed, in reducing faults often made by the decision-makers.

REFERENCES

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