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# Study of Local Consumption Measures to Yunnan Small Hydropower

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**Abstract:** Focus on the phenomenon of increasing surplus electricity of small and Medium-sized Hydropower stations in Yunnan Province, After introducing the distribution, capacity, quantity, Production and operation status of YunNan small hydropower and so on. This paper Researched and Analysed the power market、 structure of load and energy consumption characteristics to YunNan power system. According to the realities of power source characteristics、 structure of load and power market of YunNan power system, the methods that “combination of tobacco with hydropower”、 developing electricity consumption for rural residents、 market transaction and energy substitution are proposed to promote the local absorption of YunNan small and medium sized hydropower. According to the existing industrial policies and industry data of Yunnan, these measures can effectively promote the local absorption of small hydropower in Yunnan.

**Keywords:** YunNan Small Sized Hydropower, Power Market, Structure of Load, Absorption,  
Combination of Tobacco with Hydropower, Electricity Market in Rural Residents Living, Energy Substitution

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## 1. Introduction

In recent years, with a number of large units on the main stream of the three rivers coming into operation or the power station being put into operation earlier than originally planned, coupled with the fact that new energy sources, such as wind power, have also entered the peak period of concentrated production, the installation scale in Yunnan Power Grid has risen rapidly, and the power generation capacity has been greatly enhanced. Its increment greatly exceeds the demand increment of electricity, and the power supply changes from seasonal surplus and shortage to full year surplus. Yunnan is beginning to face the problem of energy consumption, especially the contradiction of surplus electricity consumption of small hydropower plants. The small hydropower station in Yunnan is basically a runoff type power station, which has no regulating capacity, most of them are "generation in high water season and stop in low water blackout". the contradiction of the surplus electricity consumption is mainly in the high water season, and it is

located in the remote mountainous area, and the pressure of sending the electricity out through the power grid is great. Therefore, it is necessary to study the measures of local absorption of small hydropower, so as to alleviate the contradiction of surplus electricity consumption of small hydropower.

Small hydropower resources in Yunnan are mostly distributed in the first and secondary tributaries of the six major water systems of the Irrawaddy, Nujiang, Lancangjiang, Jinshajiang, Yuanjiang and Nanpanjiang rivers, covering more than 90% remote and impoverished minority areas. Its development and construction have the characteristics of short period, less investment, quick effect and so on, which make up the deficiency of large power station, and make small hydropower become the hope of speeding up the development of local economy. At present, it is affected by slow economic development and insufficient demand for electricity, the power of various regions is difficult to balance, there is more surplus electricity in flood season.

By the end of 2015, the adjusted balance installed capacity

of Yunnan Province was 6587.105 ten thousand kilowatts, in which hydropower installed capacity is 4 515.4 ten thousand kilowatts, achieving 70.07% to the provincial balance installed capacity, the installed capacity of small hydropower is 520.6 ten thousand kilowatts in the adjusted balance installed capacity of Yunnan Province, it is 8% to the total adjusted balance installed capacity of Yunnan Province, 11.53% to the hydropower adjusted balance installed capacity of Yunnan Province. Small hydropower has small installed capacity, large quantity and wide distribution, and a large amount of electricity is produced in a wide range of interests and contradictions are prominent.

## 2. Yunnan Electric Power Market and Load Structure

### 2.1. General Situation of Yunnan Electric Power Market

The electricity market in Yunnan is divided into two markets: one is within the province and the other is outside the province. The market in the province mainly consists of electricity consumption in the second industry and the daily life of urban and rural residents. The outside market of the

province is mainly the transmission from west to east, and part of the transmission to Vietnam, Myanmar and Laos. From 2006 to 2015, electricity consumption in the province increased rapidly, from 425.48 billion kWh to 1068.0 billion kWh, it's growing 151.01%; outgoing power supply is growing rapidly too, from 114.88 billion kWh to 750.0 billion kWh, it's growing 552.86%. In recent years, with the development of the outgoing power market, the proportion of outgoing power supply has been increasing, showing a steady growth trend.

### 2.2. Load Structure Analysis of Yunnan Power Grid

From the point of viewing of the growth rate of electricity consumption in various industries, electricity consumption in all industries except the first industry has increased substantially. Decade 2006-2015, the whole society's electricity consumption has increased 122.83%, all various industries electricity consumption has increased 114.66%. In various industries electricity consumption, the first industry has a negative growth, it was -2.41%, the second industry has grown 105.59%, The third industry was 290.52%. The power consumption of Yunnan power grid in 2006 to 2015 as Figure 1.

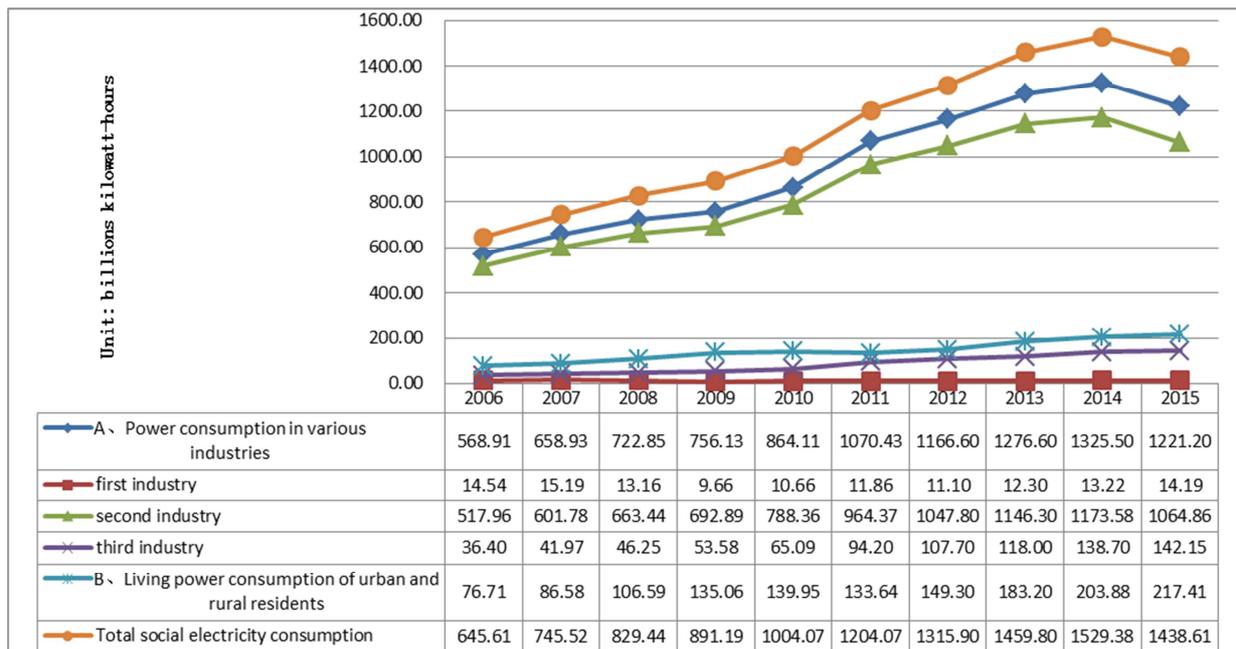


Figure 1. The power consumption of Yunnan power grid in 2006 to 2015.

From the view of the proportion of electricity consumption of various industries and of urban and rural residents to the electricity consumption of the whole society, the electricity consumption of the second industry is the main power consumption in Yunnan. Decade 2006-2015, the average share of various industry consumption in the whole society is 87.11%, the average value of electricity consumption in the first, second and third industry in the whole society was 1.25%, 78.62%, 7.24%, the average proportion of living electricity consumption in urban and rural areas to the the whole society was 12.89%. It can be seen that Yunnan electric power

consumption is mainly in the second industry, although Yunnan is a big agricultural province, but the first industry mainly agricultural electricity consumption is very little.

## 3. Characteristics of Energy Consumption in Yunnan

### 3.1. Yunnan Energy Consumption Is Dominated by Coal

At present, Yunnan's energy consumption mainly includes

coal, oil, gas, electricity, and a small proportion of new energy sources, such as solar, wind and bioenergy, showing as Table 1. From the five-year data available for 2008-2012, Yunnan's energy consumption is dominated by coal. In recent years, under the guidance of national policies such as energy conservation, environmental protection and industrial structure adjustment, the proportion of coal consumption has

decreased, but still accounts for about 70% of Yunnan's energy consumption. Although Yunnan is a large hydropower province, the proportion of electricity consumption is far lower than that of coal, oil and natural gas, in recent years, the proportion of electricity consumption has increased, but the average proportion is only 10.5%.

*Table 1. The energy consumption and energy consumption of Yunnan Province in 2008 to 2012.*

time	total energy consumed(Ten thousand ton standard coal)	Share of total energy consumption (%)				
		coal	oil	gas	Primary electricity	other
2008	6 534.34	72.98	14.72	14.72	9.33	1.89
2009	7 222.76	73.94	14.16	14.16	8.08	2.98
2010	7 655.6	68.48	17.12	17.12	9.67	4.1
2011	8 121.85	68.92	17.48	17.48	11.92	1.05
2012	8 730.66	66.31	17.85	17.85	13.41	1.83

Notes: data from "Yunnan Energy Statistics Yearbook", Based on equivalent calorific value.

### 3.2. Energy Consumption Is Dominated by Energy-Consuming Industries and Concentrated in a Small Number of Enterprises

Energy consumption is dominated by six major energy-consuming industries, And the consumption growth is fast, the proportion is going up. According to the data promulgated by the government in 2013, The power consumption of industrial enterprises above the scale was 951.33 billion kilowatt-hours, an increase of 11.5% over the previous year. The major industries of electric power consumption are: nonferrous metal smelting and calender processing industry consuming 258.09 billion kilowatt-hours, accounting for 27.1%; ferrous metal smelting and pressing processing industry consuming 186.39 billion kilowatt-hours, accounting for 19.6 %; the manufacturing of chemical raw materials and chemical products consumed 171.71 billion kilowatt-hours, accounting for 18.1%, the electricity, thermal production and supply consumed 110.49 billion kilowatt-hours, accounting for 11.6%; Non-metallic mineral products industry consumed 92.05 billion kilowatt-hours, accounting for 9.7%.

Energy consumption concentrated in a small number of key enterprises. Energy consumption is mainly concentrated in a few key energy consuming enterprises, according to the data promulgated by the government in 2013, the top 100 enterprises in the province consume 4118.49 million tons of energy standard coal, the proportion of energy consumption above the scale reached 61.0 %, up 2.6% from the same period last year. Among them, there are 20 key enterprises with energy consumption above 50 ten thousand tons of standard coal, consuming 2367.7 ten thousand tons of standard coal, accounting for 35.1% of industry above scale energy consumption. there are 38 key enterprises with energy consumption ranging from 20 to 50 ten thousand tons of standard coal, and consuming 527.79 ten thousand tons of standard coal, accounting for 7.8% of industry above scale energy consumption.

### 3.3. The Gap of Energy Consumption Between States (Cities) Is Obvious

Showing as Table 2, Kunming, Qujing, Yuxi and Honghe four key states (cities) account for more than 70% of industrial energy consumption in 16 states (cities) across the province.

*Table 2. The energy consumption of Yunnan all city unit.: Million tons of standard coal %.*

Area	Kunming	Qujing	Yuxi	Honghe	Baoshan	Zhaotong	Lijiang	Pu'er
consumption	1 634.46	1 486.09	858.39	916.56	165.13	267.0	158.38	105.81
proportion	24.2	22.0	12.7	13.6	2.5	4.0	2.4	1.6
area	Lincang	Chuxiong	Wenshan	Bannan	Dali	Dehong	Nujiang	Diqing
consumption	108.37	207.25	303.69	25.15	295.96	142.07	51.26	26.72
proportion	1.6	3.1	4.5	0.4	4.4	2.1	0.8	0.4

Notes: data from "Yunnan Energy Statistics Yearbook 2013".

## 4. Local Absorption Measures for Small and Medium Hydropower Stations

### 4.1. Combination of Smoke and Electricity to Promote Local Absorption of Small and Medium-Sized Hydropower Stations

In the process of flue-cured tobacco production, the initial

baking process is mainly completed in the farmers homes, and the time is usually July to October. At present, the fuel is mainly coal burning and fuelwood, and the electrification degree is very low. The flue-cured tobacco production is highly overlapped with the distribution of small hydropower in the region and is located in the remote rural areas, and the time is just in the high water period in which the small hydropower has the condition of full development. The combination of the two has the right time and favorable

conditions.

In the paper "Development and Test of YN100 Electric Baking Room", the author studied the baking time and electricity consumption of each part of the electric baking room, and obtained the average power consumption of 4.39 kWh per kilogram of smoke. Based on the comparative analysis of tobacco production and surplus electricity in some parts of Yunnan Province in 2013, if all flue-cured tobacco

were toasted with electricity, the electricity consumption per kilogram of tobacco was calculated as 4.39 kWh in Table 3. In Dali, Zhaotong and Lijiang areas, the surplus electricity will be completely absorbed during the high water period. Dehong and Diqing areas will have large surplus electricity, small flue-cured tobacco production, and some surplus electricity will be absorbed.

**Table 3.** The contrast of Excess capacity and power consumption of flue-cured tobacco in some area unit: Million kwh ton.

	Dehong	Diqing	Dali	Zhaotong	Lijiang
Surplus electricity	4.133 5	1.935 3	0.889 6	0.071 9	0.874 9
tobacco quantity	30 500	1 774.45	88 620	50 700	34 546
Theoretical power consumption of flue-cured tobacco	1.34	0.08	3.89	2.23	1.52

As far as the province is concerned, the production of flue-cured tobacco in Yunnan in 2013 was 1.0461 million tons, keeping the output unchanged, at 4.39 kilowatt-hours per kilogram of tobacco power consumption. If all flue-cured tobacco were toasted with electricity, it would consume 4.404 billion kilowatt-hours of electricity. Account for more than 80% of the province abandoned hydropower capacity in 2014 and 2015, predicted in the "12th Five-Year Plan of Yunnan Power Grid".

Hydropower and tobacco are the pillar industries in Yunnan, on the one hand, the combination of smoke and electricity can promote the local absorption of small and medium-sized hydropower in Yunnan, realize the positive interaction between pillar industries, and achieve mutual benefit and win-win; on the other hand, it has reduced the burning of coal and firewood and trees cut down, directly reducing air pollution, protecting the ecological environment, and protecting the green mountains and rivers of Yunnan. It has also brought inestimable benefits to the other two pillar industries of Yunnan, biological resources and tourism.

#### **4.2. Development of Electricity Market for Rural Residents in Production and Daily Use**

From the analysis of load structure in Section 2, it can be seen that during the decade from 2006 to 2015, the electricity consumption of the first industry decreased rather than increased. Although Yunnan is a big agricultural province, the consumption of electricity in the first industry, represented by agriculture, is very low, agricultural production should have some developing space for electricity consumption.

In terms of rural household electricity consumption in nationwide, from 2008 to 2012, the National Bureau of Statistics released that Yunnan rural residents per capita average power consumption is 165.91 kilowatt-hours, the country ranked 26th. Shanghai and Guangdong consume 6237.07 kilowatt-hours and 1554.60 kilowatt-hours respectively, 37 times and 9 times as much as Yunnan. Yunnan is a large hydropower province with a large number of small hydropower. However, compared with other provinces, rural residents produce and consume very little electricity.

From the above analysis, it can be concluded that there is a certain space for the development of rural residents production and living electricity market. Therefore, it can be combined with the macropolicy as follows: "12th Five-Year Plan" of Yunnan Province to upgrade the rural power network, electric power construction planning in the area without electricity in the "12th Five-Year Plan" of Yunnan Province, Measures of Yunnan Province for the Management of small Hydropower instead of fuel, Urban and Rural residents in Yunnan Province to implement electricity instead of electricity Price Scheme, Guidance on the Promotion of Electric Power substitution," Household Appliances are popularized in the country" and so on. Strengthen propaganda in rural areas, formulate and implement the scheme of "substituting electricity for firewood" and "substituting electricity for coal" in order to guide urban and rural residents to use more electricity in production and daily life, increasing the proportion of electricity consumption in rural energy consumption market and promoting local absorption of small hydropower.

#### **4.3. Seizing the Opportunity of Electricity Market Reform and Promoting the Absorption of Small Hydropower**

In 2015, the CPC Central Committee and the State Council officially issued "opinions on further deepening the Reform of the Electric Power system" (Zhongfa (2015) No. 9), bringing Yunnan, Anhui, Hubei and Ningxia provinces and regions into the pilot scope of the advance transmission and distribution tariff reform. In April 2016, the Yunnan Provincial Party Committee and the people Government of Yunnan Province issued the Circular on further deepening the pilot Plan for the Reform of the Electric Power system in Yunnan Province (Yunfa [2016] 10), which clarified the overall thinking and basic principles of the reform of Yunnan electric power system. Key tasks and Plan for the Establishment of Yunnan Electric Power Trading institutions, at present, the "3134" Yunnan electric power market-oriented trading model has been established as "three main bodies, one center, three markets and four modes". Small hydropower should seize the opportunity, actively participate in market transactions, promote electricity consumption and reduce surplus electricity.

#### 4.4. Developing Energy Substitution and Increasing the Proportion of Electric Power in Energy Consumption

From the 3.1 analysis, we can see that Yunnan is a big hydropower province, but the energy consumption is mainly coal. With the fundamental changes in the energy structure, the total surplus of electricity, the continuous reduction of coal resources and the increasing pressure on environmental protection, it is suggested that the government issue relevant policies to develop energy alternatives in areas and industries where possible, and replace coal with electric power, increasing the proportion of electricity in the terminal energy consumption, reducing the consumption of coal resources and promoting the consumption of hydropower.

## 5. Conclusion

Yunnan is a big hydropower province, but the energy consumption is mainly coal. Given the fundamental changes in the energy structure, the total surplus of electricity, the continuous reduction of coal resources and the increasing pressure on environmental protection, it is suggested that relevant policies be issued to develop energy alternatives in areas and industries where they can be used to replace coal with electric power. Increasing the proportion of electricity in the terminal energy consumption, reducing the consumption of coal resources and promoting the consumption of hydropower.

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