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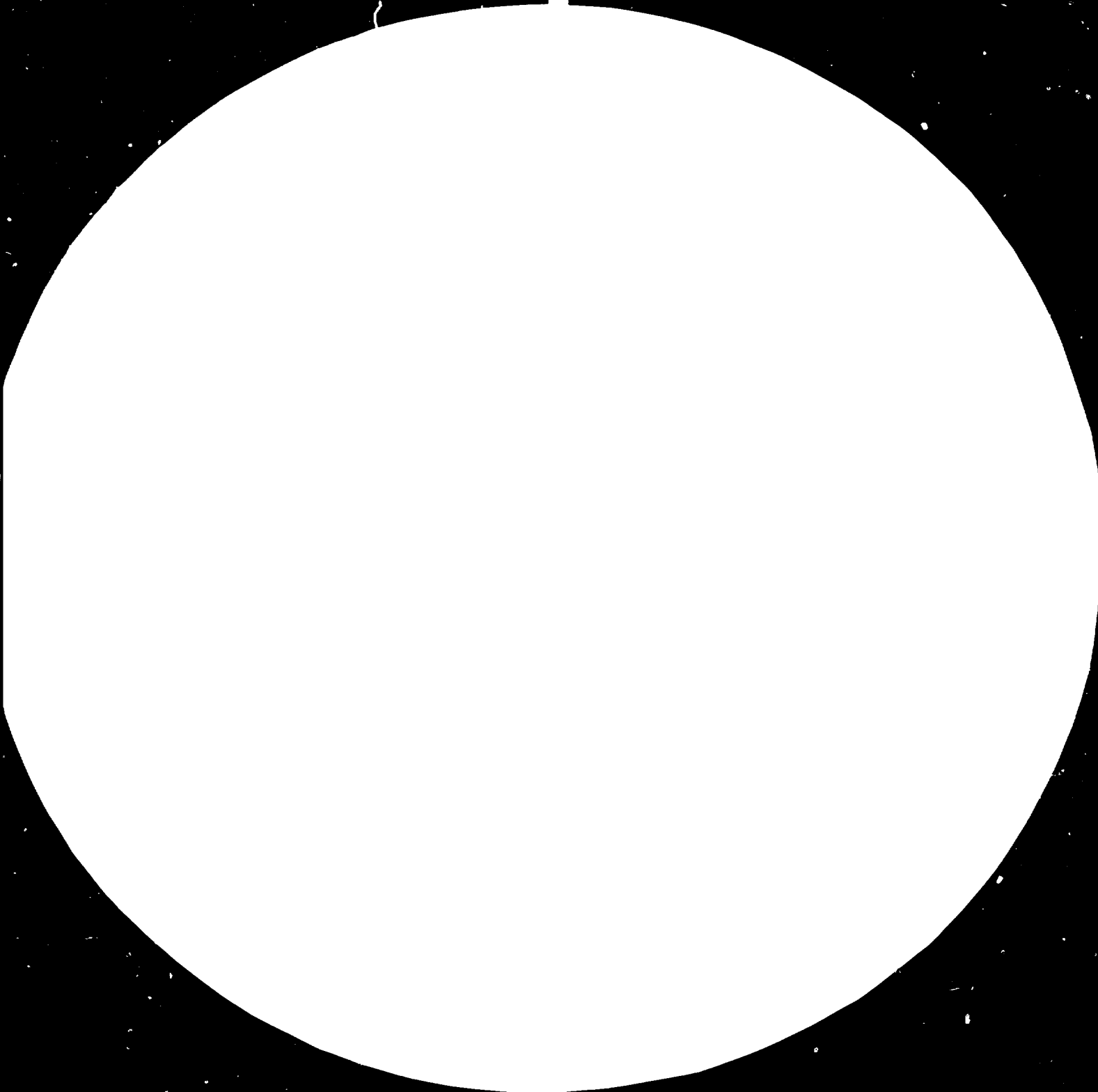

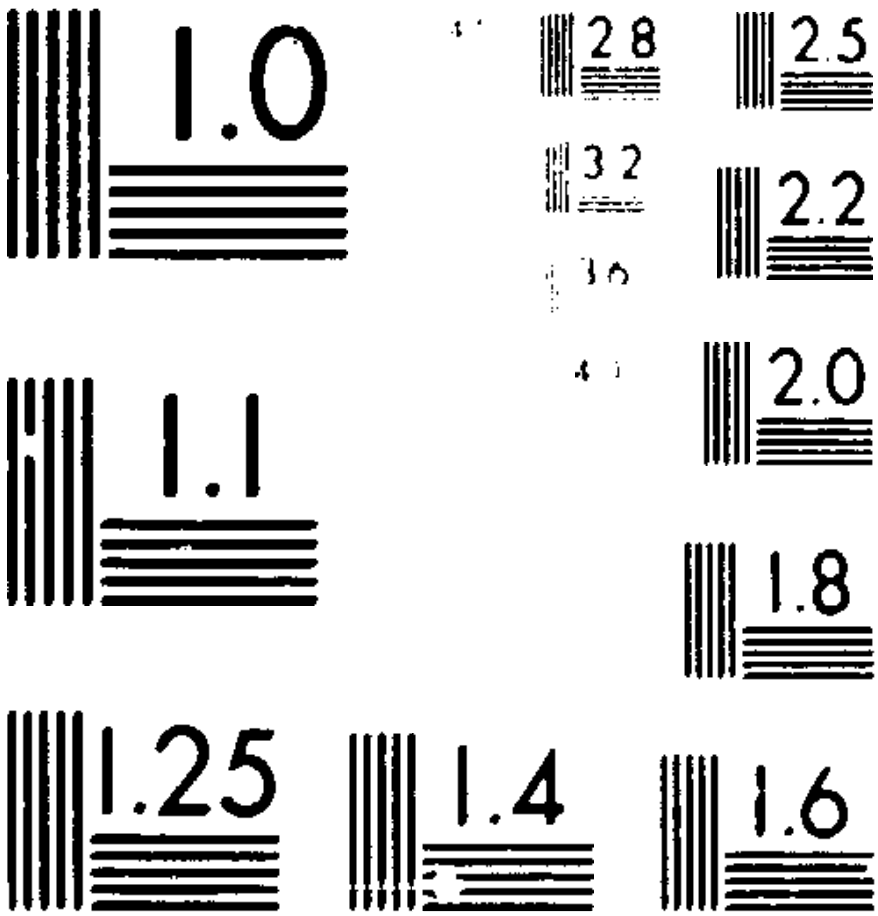

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THE RURAL ELECTRIC POWER NETWORK PLANNING AND OPERATION IN DAYI COUNTY, SICHUAN PROVINCE *

by

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Part 1 Introduction

The development of modern agriculture and improvement of material and cultural life in rural society are pressing the electrification of the countryside.

China's counitryside has a vast territory and is in the process of rapid economic expansion. For this reason, it is obviously unrealistic to count on the state-grid for meeting the power demand by the rural electrization within a short span of time.

Consequently, adequate and rational exploitation of local energy resources, building of power stations and establishing of local power networks are of paramount importance to accelerate the progress of rural electrification.

China's southern provinces have rich hydropower resources. This is favourable to the development of small hydroelectric stations. Building such stations on the spot is now widely accepted because it will require few investment, save time, and produce quick results. What's more, it will enable the builder to mobilize manpower and material resources, as well as local capital. These small hydroelectric stations and the electric networks of county, not only have laid a power foundation for the electrification in the rural areas, but also have contributed power supply to the main network. Adding to the income of and making up power shortage in the country, it is now considered as an effective way of eccelerating electrification in the rural areas.

In this paper the author intends to cite the example of the network of Dayi County, Sichuan Province and make an analysis on rural area electric network planning and operation.

Part 2 An Outline in the Rural Electric Network of Dayi County

Dayi County is located on the west fringe of west Sichuan plain. In this county, hilly areas and mountaineous region account for 77.7% of the total area. Rich in natural resources, it has a hydraulic energy deposit of 40000 kw, stored in seven natural rivers, and a coal deposit of 170 million tons.

In 1952, the first small hydroelectric power station was built in Dayi County. From that time to the end of 1979, fifty such stations have been completed with a total generating capacity of 9921 kw, the largest unit capacity is 2500 kw. Meanwhile, two small thermal power stations with total capacity of 2250 kw, five substa-

tions, two hundred and ten distribution stations, 40 km long of 35 kv trasmission lines, 371 km of 10 kv lines and 1000 km of low voltage distribution lines had also been put into operation. In this fashion, a county-wide network has taken shape. The graphic representation of network connection now in Dayi County is shown in figure I.

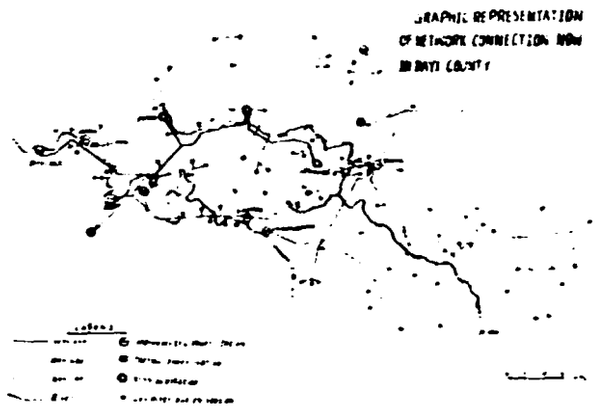

Fig. I

The development of electric power industry spurred effectively the growth of production of industries and farm in the rural areas. From 1976 to 1979, the output of grain production increased by 39%, that of chemical fertilizer by 60%, and the total output value of industrial and agricultural production increased by 79%. A comprehensive local industries, including nitrogen fertilizer, chemical engineering machinery, farm drugs, farm machinery, electric appliance, cement, brick and tile, iron-pot, sugar-refining and foodprocessing, etc., have been set up. Electric equipment for industrial use has a capacity of 18000 kw. In agricultural sector, electricity is consumed in field-threshing, flourmilling, rice-husking, oil-extracting, tea-making, silo-processing, back light lamps and electric irrigation, etc. Electric equipment for agricultural use has a capacity of 6000 kw. Now electric application has been extended to all the 30 communes.

Part 3 The Rural Electric Network Planning and Operation in Dayi County

Hydraulic resources are mainly distributed in the mountainous region of the northeast part of the county, where the most of the key hydro-electric power stations is concentrated. In the county there are many small rivers, streams and artificial irrigation canals. A large number of low-capacity stations are built on them. On the other hand, the county's administrative and commercial centre and local industry are concentrated in the county proper, while the greater part of electricity for agricultural load is consumed in the vicinity of the southeast plain, therefore the Dayi network is characterized by a domination of hydroelectric stations, a tendency of a single-direction of the main network flowing basically from the mountains to the plain, a high density of distribution networks and multiplicity of power sources. In designing such a network, it is imperative to take into con-

sideration its special requirements in time of natural resource exploitation in mountainous region, load distribution, network connection, voltage control, regulation type and the way of its connection with the state-grid.

The development of electric load in China's rural area is originated with agricultural production. In view of its wide dispersal, low capacity, and high seasonality, the network planners should pay special attention to pre-estimate the loads in different periods of the year. On this basis, they should make a point of vigorously exploiting the rich resources in the mountains, utilizing electric energy on the spot, supplying power to neighbouring counties from source terminals, forming power-supply districts with the sources at the center developing agricultural-industrial enterprises, expanding the application of electicity in agricultural technolgy so as to rise the living quality of the rural area and achieve better results in the distribution of network current flows and load characteristics.

Hydraulic resources in the mountainous region have its superiority for the development of small hydrostations. In this respect the Chu River is an outstanding example. The upper reach of this river is in the mountaineous area, where the valleys are rather narrow, and the slopes on both banks are steep, the current swift and the course winding. Only a small area of farmland can be exploitated. The middle and lower reaches, being an alluvial plain, covered with a thick layer of fertile soil, are the major farming area. It is very suitable to made cascade development in the upper reach and thus the contradiction between power generation and irrigation might be solved. At the head of the Chu River, there is fairly large karst-spring called Dafei Shui, which has a potential of 360 metres and an annual flow varies from 2.2-0.6 m^3/sec. A 500-metre long water-conveyance canal, and a backbone hydro-plant with installed capacity 2x2500 kw have been built.

Because the whole network is operated in coordination, those stations possessing good conditions may be equipped with proper additional capacity. This enables them to make full use of the seasonal water resource. As the micro hydro plants built independently by local funds are entitled to choose the installed capacity and number of generators reasonably according to the local load development and irrigation, equipment in complete set and standardization will be strengthened. In operation, it is better to make local balance of power and the surplus power will be delivered to the main network. Generation of reactive power is encouraged in order to raise the benefit of network operation.

Transmission lines go over a long distance to the load terminals. In order to control voltage and load distribution, a 35 kv central substation, namely the Zhilong Temple substation in the county proper, was constructed with a capacity of 2 × 6300 kva. At this point the countywide network is coupled, and power exchange with the state-grid takes place.

Parallel to hydraulic resource exploitation and load build-up, the construction of the network is divided into several stages. At the present stage, a 40 km long 35 kv LGJ-95 transmission line and a 22 km long 35 kv LGJ-120 line, connected to the existing Dafei Shui station and the newly built Shaoba, Zhi River and Ansheng stations respectively for power supply, are erected to connect them with the central substation Nearby the agricultural electrical consumer the Anreng substation was set up with a capacity of 2 × 600 kva and connected by a 14 km long 35 kv LGJ-50 line to the central substation. In short, the local network consists of six power supply districts, three 35 kv lines, seven 35 kv substations and has a total installing capa-

city of 28710 kw. The prospective plan requires that the installed capacity should be nearly doubled reaching 53000 kw.

The recent electric network plan of Dayi county is shown in Figure I, and a prospective plan in table I.

All the hydroelectric stations unexceptionally are run-of-river type without regulation. Subject to natural water flow variation, they can not meet the load demands for the whole year. In the middle reach of the Chu River, the valleys are rathe wide. It is suitable to build a regulation reservoir capable of impounding 100 million cubic metres of water. However, due to considering amounts of money and material required, the technical force involved and the duration of construction, such project must be deferred. It is preferable to build small pithead thermal power station. In the near future, the joint operation of hydro and thermal is adopted to adjust the power generating curve of the hydro units in accordance with the natural flow and then to fully utilize the seasonal regulation ability of the thermal electric generator set and power can be generated at the rated load during dry season. It is considered to build a regulating reservoir when the grid is further developed. Load curve of the joint operation of hydroelectric and thermal power stations is shown in Fig. II.

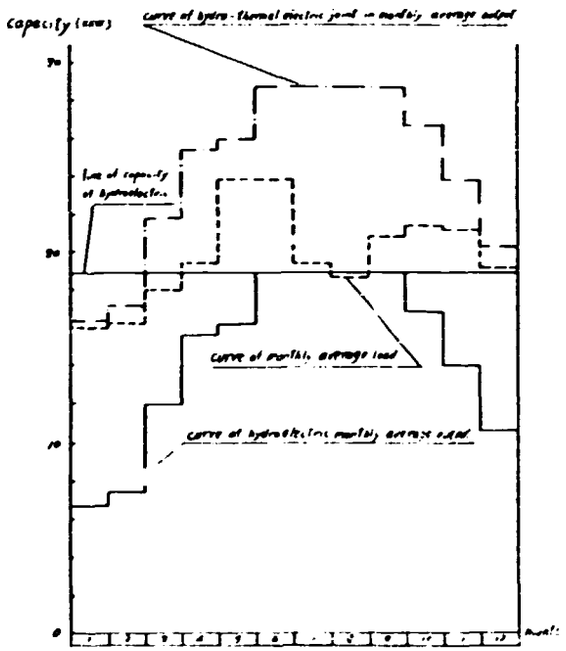

Fig. II

For the sake of quality of electric energy, a frequency regulation station, with larger capacity, better governationbility and higher automation is preferable. Besides, the bus-line of generators of the back-bone stations in multi power supply districts and of the primary substations are designated as voltage supervision point. Those of the rest of the generators should have a rated value, with allowable de-

viation between 15% and -7%. The substations is equipped with shunt compensator.

Many small hydroelectric stations are integrated with the network by means of distribution lines. as a result, the lines are dual-sourced, and fitted with a no voltage monitoring at the load terminals, in order to prevent the accidents of equipments and lives. In addition, small hydroelectric stations must adopt simple overcurrent and no voltage protector, which will guarantee its automatic detachment from the faulted line.

Difference and disersity in ownership of hydroelectric stations in rural areas present a problem that should not be overlooked. For its solution, all the generating and supplying equipments in corporated in the network are placed under the unified dispatching of the local network in accordance with the principle of ensuring security, economy and quality, ecoomic interests of all parties concerned are well looked after in load dispatching. Generating load and electicity quota allocation should be in rational propertion to the monthly contribution within the whole hear and installation percentages.

It is advisable to use radial connection for high voltage distributions network and to extend 10 kv line as far as possible to the consumers. There should be as many distributing point as possible, and low voltage lines should be reduced to the minimum. It is common practice that a capacity of 20-50 kva and a supply radius of 5-15 km should be used. The line should divided into segments. Every two segments are linked by a switch.

High-and low-voltage distribution lines are regarded as the major factor of supply security. In Dayi County the rural electric lines are managed by the department in charge of power industry. In each commune a professional agricultural electricity inspecter is nominated. These above-mentioned measures have played a positive role in ensuring supply security and reliable operation.

The acceleration of rural electrification calls for a still greater amount of capital and material which is to be devoted to building electric network. Rural network are deficent in compensating regulation-effect. The varities of agricultural loads are on the rise. Therefore, more work remains to be done to search a new structure for electric network there. Three phase power supply system has reach maturity through practice and this standardized products are available, while single supply system has strengths in good economy and a high power factor of operation. How to benefit from the superiorities of both, to reduce the costs with different type of loads, to improve the operation of the network and eventually, make a composite form of power distribution supply is of great significance. The researchs on network structure, communication disturbances and single-phase apparatus are under way now in Dayi County. An experimental centre has been designed and constructed.

Part 4 Conclusion

The rural electric networks have their distinguishing features. It is important to carry on national planning and operation of electric networks in order to adapt those characteristics and meet the demands of development of agriculture and industry.

Dayi County utilizing local energy resources, developing energetically small hydroelectric stations, and establishing independent local power network, spurred the growth of industries and farm in rural areas, set a fine example. At present a remarkably massive plan for developing electric networks in rural areas is being carried out and research work in this field has been intensified with a view to realizing modernization of agriculture at an earliest possible date.

Table 1: The prospective developable plan of small hydroelectric and thermal power station in Dayi County.

Power station	1976	1977	1978	1979	1981	Recent	Prospect	Total capacity
1. Hydroelectric								
Daifei Shui	5000							5000
Zhaoping			640	640				1280
Anshuw		500	500					1000
Chujiang					1600			1600
Sanba					3200	5000		8200
Suanghe							2000	2000
Dailong xi							2520	2520
Lujia wan							1500	1500
Hutiao he							2520	2520
Xi aohe zi shang							2000	2000
Xi aohe zi xia							2400	2400
2. Thermal								
Lizi ping	1500					1500		3000
Tang chang		750						750
Zhaoping					3000	3000		6000
GUANKOU							12000	12000
3. Other small hydro-electric						1880		1880
Amount								53850