

Rural Electrification in China: History and Institution

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Abstract

China has been highly successful in electrifying rural areas in the past half century. Institutional structure and its reform are important for investment and, therefore, development of rural electrification. Over time, there have been three major institutional changes initiated by the central government; When the People's Republic was founded in 1949, it was short of capital, technology and management professionals to promote rural electrification, so rural electricity had a separate administrative system from the urban areas. From 1949 to 1977, China established a comprehensive vertical system of rural electricity administration under strict central planning. At the end of the 1970s, with the adoption of economic reform policy, the central government handed over the management of the local electricity system to local government. County level has proved the most effective implementation unit for both planning and project implementation of the rural electricity system. From 1998 to 2002, the central government has been separating local electricity supply from local governments to facilitate the commercial operation of the utility market. After 2002, the rural electricity system was merged with the urban system, forming an integrated national electricity administrative system in China.

Key words: history, institutional structure, investment, rural electrification

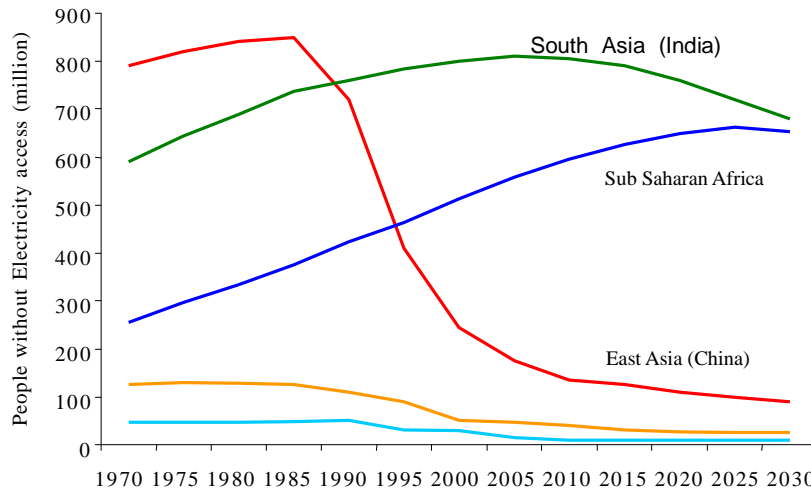
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I. Introduction

Prior to 2002 there was a rural electricity administrative system at the county level and

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Figure 1. Regional Electricity Access: A Comparison



Source: International Energy Agency (2002).

below, which was separated from the urban (or state) electricity system. In 1949 when the People's Republic was founded, there were only 33 small hydropower stations in rural China, with a total installed capacity of 3.63 MW, and total electricity consumption in rural areas was 20 million kWh. Since 1949, rural electrification has made considerable progress and contributed a lot to the sustained and steady development of the agricultural sector, the rural economy and the quality of life of rural households. As a developing country, China has introduced electricity access to over 900 million rural residents in over 50 years (Figure 1) and has achieved an electricity access rate of as high as 98 percent. Considering the high cost of electricity delivery and the low income of rural residents, China has been highly successful in electrifying rural areas in the past half century.

Access to electricity is the key to overall development of the rural region. The historical process of rural electrification in China has seen major institutional changes at the central government level over the last 50 years. In 1949, when the People's Republic was founded, it was short of capital, technology and management professionals to promote rural electrification. From 1949 to 2002, there coexisted two separate electricity systems in China: rural electricity and state electricity, which was responsible for urban areas. The evolution of the rural electricity system can be divided into three stages. From 1949 to 1977, China established a comprehensive vertical system of rural electricity administration under strict central planning. After the introduction of economic reform and the opening-up policy at the end of 1970s, the central government transferred the management of the local electricity system to local governments. From 1998 to 2002, China implemented a policy of "reforming

rural electricity management, renovating rural power grid, and unifying rural and urban electricity tariffs”, and the central government separated local electricity supply from local government to facilitate the commercial operation of the utility market. After 2002, the rural electricity system merged with the urban system to form one uniform and integrated electricity system nationwide.

Rural electrification is a common challenge facing developing countries due to the high cost of electricity delivery and the low income of rural residents, and because private investors have little incentive to invest. Why then has China made steady development and considerable progress in rural electrification? What is the relationship between rural electrification and its institutional reform? The World Bank (1996) proposes that the success of rural electrification in China is a result of the Government’s emphasis on providing electricity. Yang (2003) and Zhang and Heller (2004) also argue that it was the central government’s favorable policy that encouraged the development of rural electrification, but they did not provide an empirical demonstration of their argument. In our opinion, the process of China’s rural electrification has developed with funds from multiple channels, multiple levels and under multiple modes. In terms of fund sources, investment is made not only by central and local governments, but also by rural residents. Therefore, the effect of institutional structure and its reform on different investors would have been overlooked if the rapid progress of rural electrification had been attributed only to governmental investment and its favorable policy.

The hypothesis of the present paper is that institutional structure and its reform is important for investment and, therefore, the development of rural electrification; at the central government level, there are three separate institutional regimes, so we divide the history of rural electrification into three stages reflecting overall institutional changes over time.

The rest of the paper is organized as follows. In Section II, we illustrate the background of rural electrification in China. Types of counties with electricity supply in China, main consumption patterns and sources of rural electricity are discussed. In Section III, IV and V, we discuss the institutional evolution and features of investment in the three stages. Section VI summarizes the study.

Since there is no systemic official data on rural electricity, the data used in this paper comes from different sources and varies greatly. We have made no attempts to harmonize the data from these sources because, in general, statistical information is consistent with the overall trend of rural electrification in China.

II. Background of Rural Electrification in China

Until 2002, there were three types of counties with electricity supply in rural China: direct

Table 1. Types of Counties with Electricity Supply in China

Year	Electricity supply pattern at the county level				
	Direct supply through national grid	Supply through local dispatch	Self-supply counties		
			by small hydropower	by small thermal power	Subtotal
1995	707	996	567	79	646
1996	716	1004	571	81	652
1997	727	1005	580	66	646
1998	775	1065	513	35	548
1999					
2000	854	1131	433	20	453

Source: Ministry of Electricity Industry of China, *China Electricity Yearbook* (1994–2004).

supply through the national grid, supply through local dispatch and self-supply counties. There are two sources of electricity in self-supply counties: generation by small hydropower and by small thermal power. In the last several years, the number of self-supply counties has decreased and the use of the other two sources has increased (see Table 1).

There are three main purposes for rural electricity usage: industry; agriculture, forestry, herding, fishing, water resource and others; and residential living (see Table 2). The former 2 types are both for production purposes.

In 2002, almost 80 percent of rural electricity consumption was from the national power grid, with the rest being generated locally. Small hydro and small coal-fired thermal production accounts for 95 percent of the electricity generated locally.

III. First Stage (1949-1977): Establishing a Comprehensive Management Network Vertically from the National Level

1. Background

By 1949, the year in which the People's Republic of China was founded, electricity consumption in rural areas was 20 million kWh, only 0.58 percent of the national total. Electricity consumption per capita in rural China was 0.05 kWh.

From 1950 to the late 1970s, China was under strict central planning and

Table 2. Main Purposes for Rural Electricity Usage

Year	Purpose for rural electricity usage					
	Industry		Agriculture, forestry, herd, fishing, water resource and others		Residential	
	Amount (billion kWh)	County level and below (%)	Amount (billion kWh)	County level and below (%)	Amount (billion kWh)	County level and below (%)
1993	173.8	59.1	69.0	23.5	51.3	17.4
1994	199.9	59.5	75.4	22.4	60.7	18.1
1995	225.0	59.5	81.8	21.6	71.2	18.9
1996	242.6	59.35	88.5	21.65	77.8	19
1997	253.8	58.22	96.9	22.23	85.2	19.55
1998	268.2	58.32	78.0	16.96	93.8	20.40
1999	292.6	58.73	103.7	28.79	102.0	20.47
2000	347.0	61.21	105.7	18.64	114.2	20.15
2001	386.5	61.76	117.5	28.59	121.8	19.46
2002	465.1	64.49	124.7	17.30	131.4	18.21

Source: Ministry of Electricity Industry of China, *China Electricity Yearbook* (1994–2004).

industrialization took priority over agricultural development; at the same time food shortages were high on the agenda. In particular, China was short of capital, technology and management professionals to promote rural electrification. The rural areas covered by power supply from national grids were mainly suburbs and areas on outskirts of large cities. From 1950 until 2002, rural electricity appeared as a separate system in China.

2. Institutional Structure

During 1949–1957, China's first 5-year plan period, although China imported power technologies from the former USSR and developed many power projects, not much electricity was supplied to rural communities. Rural electrification was mainly managed by provincial and local governments. There was no specific national institution to manage and invest in the rural electricity system.

From 1958, the government started to establish wholesale and retail power institutions at the county level to manage power supply for rural areas. In 1958, the Government set out a plan to promote rural electrification in 100 villages of 5 counties as demonstrative models. In 1961, the central government gave county level institutions the responsibility of managing all small hydrothermal networks and other types of rural-power networks. The government specified that the power management institutions at county level were the basic management units for rural electrification. In 1963, the government made a policy and announced in a National Electric Power Development Meeting: "Rural electricity consumption for irrigation

in grain production bases should be mainly supported by national and provincial power networks. In the meantime, rural networks and rural small-hydropower plants are encouraged to develop.” In the 1970s, the central government established a “self-construction, self-management, and self-consumption” policy to mobilize electricity construction resources. By 1978, under the planning economy mode, China had established a comprehensive management network vertically from the central level, through regions, provinces, prefectures and cities to counties.

3. Investment

From 1958 to 1977, the central government developed a rural electrical irrigation and agricultural production program. In the 1970s, there was a national policy of “revenue from electricity for electricity” in small hydropower construction, and the subsidy from the central government was 20 percent (RMB150 per kW) of construction costs. But this policy was not fully implemented. Since large rural areas were left with no option but to follow the government maxim of “self-construction, self-management, and self-consumption”, many analysts have concluded that rural electrification was entirely ignored by the central government before 1980 (Xu, 2002).

In the 1970s, the central government initiated a few pilot rural electrification projects, but urban power shortages rendered these efforts short-lived and inconsequential. With little support from the central government, county communes and villages slowly developed small, mostly hydro, local power stations during the 1960s and 1970s.

4. Achievement

In nearly 3 decades from 1949 to 1977, the primary driving force for rural hydropower development was to secure stable agricultural production by improving agricultural production facilities, in particular irrigation and drainage. In this period, more than half of China’s counties developed certain hydropower facilities, and for a long time these counties mainly relied on rural hydropower stations for electricity supply. Rural electrification at this stage was slow, small in scale and backward in technology, explaining why rapid development did not happen earlier under exclusive central government control. However, steady progress did occur throughout this stage.

By 1957, when the whole of China consumed 16.4 TWh electricity, rural electricity consumption was 0.108 TWh, only 0.66 percent of the national total. In the 1960s, China developed approximately a 200–300 MW rural power load each year for agricultural production. By 1979, approximately 90 000 small hydropower stations had been built, with a total capacity of 6.33 GW. These facilities averaged only 70.3 KW in capacity, were

unreliable because of seasonality, had no connection to major grids, and suffered inefficiency with line losses as high as 25–30 percent.

Because of slow development of rural electric power and lack of support from the national system, rural power consumption was historically low. In 1978, rural areas, which contained 70 percent of the country's population, consumed only 13.3 percent of national power, or 27.5 TWh. Thirty-seven percent of the rural population, or 245 million people, had no access to electricity in 1979.

IV. Second Stage (1978–1997): Central Government Transferring Management of Local Electricity System to Local Government

1. Background

At the end of 1970s, rural China faced severe energy shortages: two-fifths of rural household had been short of energy for cooking for more than 3 months in 1979, as reported by the national census; 30–40 percent of 250 million tons fuel wood was over-cut. Rural energy shortages, poverty, and ecological degradation were interwoven.

In 1978, the government initiated the economic system reform for rural areas, changing from central planning to a market-oriented mode. Consequently, local autonomy in investment decisions increased sharply during the 1980s. During the 1970s more than 80 percent of the funding for capital construction in rural areas was provided to county governments from higher government levels. By the late 1980s, most funding for investment had been arranged by local governments, and state funds for capital construction investment had reduced to approximately 20 percent.

Township and village enterprises (TVEs), especially in southeast coastal areas, have become the most important business in rural areas for poverty reduction and revenue generation. The development of TVEs increased the demand for electricity. The increase in electricity consumption in rural areas made incessant rural grid expansion necessary.

2. Institutional Structure

After the introduction of economic reform and the opening-up policy, the institutional environment was further improved for rural electrification. In 1983, the State Council issued the No. 190 Document and demanded that in areas with favorable water resources, local government and non-government entities should actively develop rural hydropower through their own initiative with their own capability. Local government authority was strengthened

and the central government handed over the administration of rural electrification to local governments. Power supply bureaus at towns were partially or fully local government institutions.

Development of township and village enterprises increased the demand for electricity, especially from coal and diesel power, which are more reliable than run-off-the-river hydro stations. Since 1985, the central government has adjusted the electricity tariff several times to encourage local governments to build power plants, and to established the policy of “old tariff for old plant, new tariff for new plant.” This greatly mitigated the losses of the power generation industry.¹

In 1993, national tax revenue and local tax revenue were separated, which strengthened the electricity construction capacity of local government. In the same year, the Ministry of Energy was withdrawn and the Ministry of Water Resource and the Ministry of Electricity Industry were set up. From then on, many rural electrification projects were initiated by these two ministries.

3. Investment

There were three main investment projects at this stage: “1, 2, and 3 poverty reduction projects”² through rural small hydropower; poverty reduction through access to electricity; and construction of rural electrified counties.

1, 2, and 3 poverty reduction projects through rural small hydropower

In 1983, rural small hydropower and rural grid construction were in the sixth national 5-year plan. To gain large-scale rural electrification, it was formally decided to select the first batch of 100 pilot counties for preliminary electrification. At the end of 1990, 109 counties met the requirements for rural hydropower preliminary electrification.³ This large-scale rural electrification scheme continued until the turn of the century. By the end of 1995, 209 counties reached relevant standards. In 2000, 335 counties were electrified in accordance with the national standards. In slightly over 16 years, the government managed to electrify 653 counties in remote rural areas, mainly through hydropower development.

¹ Some scholars attribute the loss of electricity and other energy industry to price regulation by the central government (see Zhang, 1998).

² Abbreviations for 100, 200 and 300 pilot counties, respectively.

³ Requirements include (i) 90 percent of the rural households have access to electricity for lighting, broadcasting, TV programs throughout the year and cooking seasonally, and for irrigation, food processing and township and village enterprises; (ii) the guarantee rate of electricity usage is above 85 percent; and (iii) on average, per capita electricity consumption is approximately 200 kWh.

Of the first batch of 100 pilot counties for the preliminary electrification project, the subsidy from the central government was RMB 200 million, 13.8 percent of the total cost, and the rest was funded by local government. The total investment of the third batch of 300 pilot counties for electrification project was RMB 4.07 bn. Of which, the subsidy from the central government was RMB 250 million, 6.1 percent of the total cost; the subsidy from provincial governments was RMB 260 million, 6.4 percent of the total cost; funds collected by county governments were RMB1.55 bn, 38.1 percent of the total cost; bank loans amounted to RMB2.01 bn, 49.4 percent of the total cost.

In the course of rural hydropower preliminary electrification, the government announced a series of policies supporting the development of rural small hydropower, including (i) the strategy of “the one who invests owns and operates” and the principle of “unified construction and operation and unified generation and supply”; (ii) special loans for rural hydropower with low interest rates and long duration; (iii) the policy of “revenue from electricity to be used for development of electricity”; (iv) preferential rate of value-added tax at 6 percent instead of the normal 17 percent; and (v) connection of small local grids to large grids.

Poverty reduction through access to electricity

In May 1994, the National Planning Committee,⁴ National Economic and Trade Committee, and the Ministry of Electricity Industry⁵ jointly presented the “poverty reduction through access to electricity project”, which was listed in the National Plan for Poverty Reduction. RMB720 million was put into the project the same year and a total of RMB2.1 bn was invested until 1996. Of which, the National Electricity Corporation contributed RMB 32 million.

Construction of rural electrified counties

The Ministry of Electricity Industry planned construction for 400 electrified counties by 2000, and had completed construction for 500 counties by the end of 1997. The Ministry of Water Resource planned construction for 400 hydropower electrified counties during the tenth 5-year plan period, and the government subsidy was RMB 400 million per year.

4. Achievement

Rural electrification was developed rapidly and in large scale throughout China during this period. The county was the basic unit of government administration, and the county level

⁴ It was renamed as the National Development and Reform Committee.

⁵ The latter two ministries merged into the Ministry of Commerce in 2003.

Table 3. Rural Electricity Development, 1987–1997

Rural capacity	1987		1994		1997	
	(Mw)	(%)	(Mw)	(%)	(Mw)	(%)
Total	15 930	100.0	32 090	100.0	43 830	100.0
Small hydro	10 660	66.9	15 770	49.1	20 410	46.6
Small thermal	2330	14.6	8180	25.5	14 040	32.0
Diesel	2900	18.2	8060	25.1	9270	21.1
Renewable	40	0.3	80	0.2	120	0.3
Rural generation	(TWh)	(%)	(TWh)	(%)	(TWh)	(%)
Total	39.9	100.0	98.9	100.0	126.9	100.0
Small hydro	27.7	69.4	54.3	54.9	62.0	48.9
Small thermal	10	25.1	38	38.4	56.8	44.8
Diesel	2.1	5.3	6.5	6.6	8	6.3
Renewable	0.1	0.3	0.1	0.1	0.14	0.1

Source: Ministry of Electricity Industry (1996); Ministry of Electricity Industry, *China Electricity Yearbook* (1998).

has proved the most effective unit for both planning and project implementation. With populations generally between 300 000 and 1 million, and with substantial natural resources stock and economic scale, counties are large enough to make programs effective, but small enough to minimize many variations in local conditions. .

By 1996, there were more than 6000 small hydropower stations, and total installed capacity was 19.2 TW. Within the small hydropower grid, there were small thermo power stations, which were supplementary. Available data indicate that both installed capacity and power generation have increased rapidly (see Table 3).

By 1998, total electricity consumption at the county level and below was 495.5 billion kWh, accounting for 40.53 percent of the national total. The total installed capacity of generating units at the county level and below were 44.15 GW and total electricity generation amounted to 132.1 billion kWh, accounting for 26.7 percent of the total electricity consumption at the same level; the rest, 73.3 percent, came from large grid supply.

Rate of access to electricity for townships, villages and rural households was 99.2 percent, 98.1 percent, and 96.87 percent at the end of the 1990s, respectively. Township electricity access rate was 100 percent in 2231 counties. 100 percent village access was realized in 1831 counties. In 1787 counties, all rural households have been provided access to electricity. Only in 50 counties, was the rate of households' access to electricity lower than 50 percent; At the end of this stage, electricity did not reach 8 counties, 364 townships and 14 042 villages. In total, some 8.81 million rural households did not yet have electricity access.

V. Third Stage (1998–2002): Promoting Commercial Operation of the Utility Market

1. Background

There are many barriers that prevent rural electrification from expanding, including institutional and physical/technical factors. There are three types of counties with electricity supply in China: direct supply through national grid; supply through local dispatch; and self-supply counties (see Table 1). After the central government transferred the administration of the rural electricity system to local governments, political issues and the business of power created many problems in rural electrification. For instance, some county governments tried to collect various fees (birth-control fees, forestation fees) by surcharging power tariffs. In those counties, electricity tariffs were generally so high (1–2 yuan/kWh, twice that of urban residents) that not many rural households could afford to use electricity. The technical problems were serious: the rural grids were made of outdated equipment and, in general, not well planned and constructed due to irrational layout, over-long electricity supply radius, poor supply quality, low reliability, high wire losses, and inefficient distribution of electricity. These issues have existed for a long time, but it was not until 1998 that the central government decided to tackle the problem. When the Asian financial crisis took place in 1997, foreign direct investment was reduced and exports decreased in China. To realize an annual 8 percent growth rate, the central government adopted an expansionary fiscal policy and enlarged the input and construction of infrastructure. Furthermore, since 1996, there was an excess capacity of electricity supply in the urban areas. It was necessary to integrate the electricity system to transmit excess electricity to rural areas (Research Institute of Nuclear and New Energy Technology in Tsinghua University, 2004).

2. Institutional Structure

From the second half of 1998, China began to implement a rural grid renovation program. The target of the program was clearly defined as realizing unified electricity tariffs on urban and rural users within the same grid through reforming rural electricity management system and renovating rural grids.

The rural electricity management reform was to separate local electricity supply from local governments to facilitate the commercial operation of the utility market. Electricity operating entities in the form of commercial companies, that is, state electricity companies, provincial electricity companies and county electricity supply enterprises, were to be set up, to replace government affiliated subordinates at respective levels. When multiple electricity supply enterprises were involved, limited liability companies or share-holding

limited companies should be established according to their capital contributions to ensure that there is only one electricity supply company in a county and to integrate county (city) and township electricity management. Direct supply and direct management counties should be gradually transformed into wholly-owned subsidiaries of respective provincial electricity companies. Electricity supply enterprises in self-supply and self-management counties should be reformed according to the requirement for liberalization of the electricity market, to reduce government intervention and to increase market competition.⁶

3. Investment

In 1998, the State Council launched a program “rural network development and upgrade, reform of rural electricity supply institutions, and same tariffs in the same network”. From 1998, the government invested RMB290 bn to renovate rural grids in 5 years. In principle, the provincial electricity companies act as project owners during rural grid renovation and take the responsibility of unified planning, construction, management and operation. The principal repayment and interest payment of the rural grid renovation cost should be included in grid costs and amortized into a national electricity tariff. After renovation, the overall rural wire losses of high-voltage grids decreased to less than 10 percent and the wire losses of low-voltage grids to less than 15 percent.

4. Achievement

Through implementation of the program of “reforming rural electricity management, renovating rural power grid, and unifying rural and urban electricity tariffs”, rural electrification has accomplished a process of consolidation and upgrading. This program also electrified 6 counties and extended electricity to 25 million people that did not have electricity access before. Electricity access rate, electricity consumption and electricity supply quality all saw major improvement. The up-to-national-standard rate of electricity voltage generally reached more than 90 percent, 12 percentage points higher than before the renovation. The reliability rate of electricity supply reached over 95 percent, 8 percentage points higher than before the renovation; and in some regions, this rate reached 99 percent. Rural grid structure witnessed some improvement and the grid losses experienced significant decrease, down by 25–30 percent from the level before the renovation, to approximately 12 percent. In rural areas, the average end-user electricity

⁶ The direction of national electricity industry reform is “separating government administration with enterprise operation, electricity generating plants and grids with transmission and dispatch, and major operations with secondary operations”. The aim is to break monopoly and introduce competition.

Table 4. Rural Electricity Development, 1998–2002

Rural capacity	1998		2000		2002	
	(Mw)	(%)	(Mw)	(%)	(Mw)	(%)
Total	44 140	100.0	46 130	100.0	51 680	100.0
Small hydro	21 080	47.76	23 800	NA	26 760	51.78
Small thermal	14 790	33.51	16 270	NA	18 420	35.64
Diesel	7960	18.03	5740	NA	5980	11.58
Renewable	320	0.72%	NA	NA	510	1
Rural generation	(TWh)	(%)	(TWh)	(%)	(TWh)	(%)
Total	132.1	100.0	154.1	100.0	186.2	100.0
Small hydro	65.3	49.43	77.2	NA	91.8	49.30
Small thermal	59.9	45.34	69.9	NA	83.6	44.89
Diesel	6.5	4.92	7.6	NA	10.1	5.42
Renewable	0.385	0.3	NA	NA	0.789	0.39

Source: Ministry of Electricity Industry, *China Electricity Yearbook*, 1999–2003.

Note: NA, not available.

tariff was reduced by over RMB0.13/kWh. As a result, each year rural households save RMB42.0 bn in electricity cost.

Table 4 displays the rural electricity development from 1998 to 2002. In this short period, both the rural capacity and generation developed very rapidly.

VI. Conclusion

The main driving force of rural electrification in China is a top-down one that relates to national macroeconomic and strategic concerns. At the first stage, the main investment entities were rural communities; at the second stage, the central government, provincial and local governments all played crucial roles; at the third stage, it was the central government that invested. Rural development and electrification are mutually reinforcing. It is not easy to tell which factor plays a leading role, but the need for development drives the process of electrification. Rural electrification has to be driven and supported by a series of social, economic and environmental factors. However, realization of electrification requires a friendly institutional context. Furthermore, the ever-increasing demand by consumers pushes the process in a commercially sustainable manner to enhance both the quantity and quality of electrification. Finally, the liberalization of the electricity market diversifies the sources of investment and consolidates the achievements of rural electrification.

The main targets of rural electrification are to facilitate rural social, economic and cultural development, not just to offer electricity access to rural areas, but to maximize the

function of electricity. Therefore, in the course of rural electrification, the government should synthetically consider policies and strategies for boosting local electricity market, agricultural production, industry, and education development, instead of making electricity access its ultimate target.

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