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The Rural Electrification in China and The Impact of Renewable Energies

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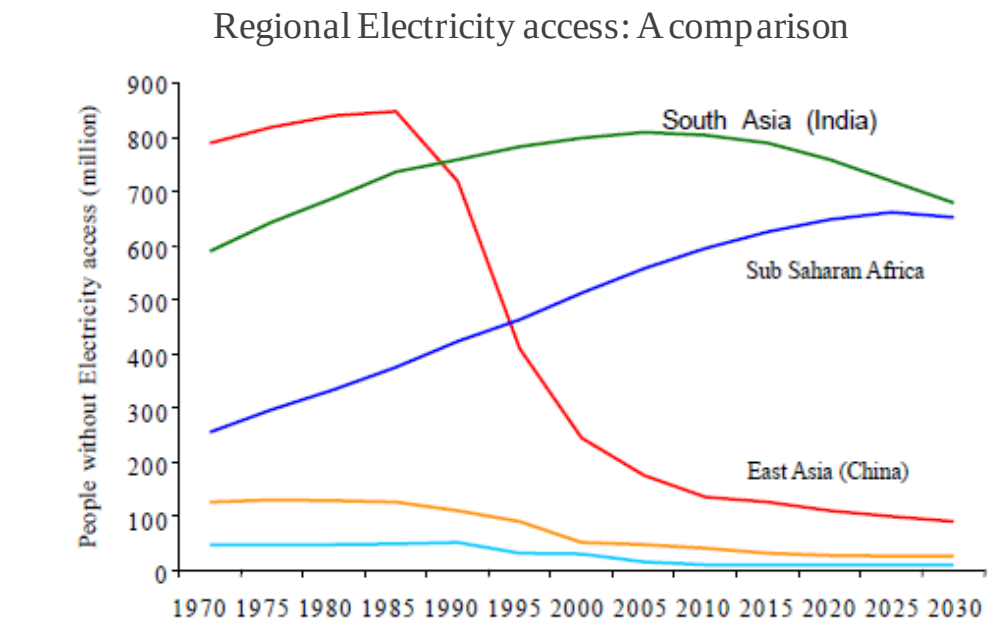
Introduction to Rural electrification in China

Electricity alone is not enough to improve economic growth but it generates substantial benefits, including the promotion of production, better health and education. However, some factors such as low population density, difficult terrain and low consumption, amongst others, make rural electrification substantially more costly to develop than urban schemes. Historically, this has been the reason for low electrification rates in rural areas of most developing countries.

In 2008 over 1.5 billion people, 85% of them living in rural areas in developing countries, had no access to electricity. This represented around 22% of the world´s population. The situation has improved since the beginning of the new century and the population with access to electricity has increased by over 160 million, despite the population has also grown worldwide by approximately half a billion. Nevertheless, the developments are unequal across regions. On the one hand, South Asian and Sub-Saharan African countries have been unable to expand their electrification rate, even with the population of these nations remaining unchanged. On the other hand, conditions are far more favorable in regions such as Latin

America and East Asia.



Source: International Energy Agency (2002).

Within East Asia, China represents a particularly successful electrification story. Despite the obvious difficulties coming from being the world´s third largest country by geographical extent (9.6 million square kilometers), the country have been able to boost the electrification rate over the last 60 years up to 99.4% in 2009, with rural areas achieving 99% and urban areas 100% rates.

Some factors have been argued to be key in the success of the Chinese electrification program. Firstly, the emphasis of the Central government on providing electricity and its determination and ability to reform institutional structures at local level to achieve its goal. Secondly, government´s favorable policies, including subsidies and low-interest loans. Finally, the cheap domestic production of any kind of electrical machines and appliances.

In order to reach the current situation, the electrification process has gone through different stages.

Rural electrification stages in China

First stage: 1949-1957

When the People´s Republic of China was founded, in 1949, over 90% of Chinese rural household were estimated to be unconnected to the national grid. Despite this figure, the Central government focused its efforts on avoiding food shortages and the industrialization of urban areas which were considered a top priority.

Rural electrification was not considered preferential and the investments and the management of this area were led by rural communities and local and provincial institutions. Unfortunately, these institutions lacked the resources to face the issue appropriately and the development was very limited.

Second stage: 1958-1978

From 1958, rural electrification became a relevant issue on the Central government agenda. First of all, national institutions in the sector, inexistent until that moment, were established in order to manage power supply to rural areas and 100 villages from five different counties were planned to be electrified as part of a pilot project. Three years later, the Central government transferred some limited responsibilities of managing rural networks to specific county level institutions.

Small hydro plants locally manufactured or imported from the former Soviet Union become the main source of energy. However, it is argued that the development of the rural electrification significantly slowed down during the 60s as the increase of power shortages in urban areas attracted the government´s full attention.

It is important to highlight that, despite all the difficulties, the rural electrification rate of China at the end of this period (61%), doubled the average rate of the Sub-Saharan African countries nowadays and was roughly the same as the average of the South Asian countries today.

Third Stage: 1979-1997

The Central government started a new economic system at the beginning of this period, substituting the existing central planning for a market-oriented model. Consequently, local institutions had a higher independency on investments in rural electrifications, previously on hands of the national institutions created ad-hoc. The funding, initially provided by the Central government mainly, slowly turned to be arranged by local institutions.

The main method to give access to electricity in rural areas was the extension of the grid. This extension was very active and necessary given the higher needs of energy triggered by the economic expansion of non-urban areas. Nevertheless, this massive extension was not always planned and developed properly which caused a quick deterioration of the grid and supply discharges.

Additionally, Small hydro power plants continued to be built but especially on those remote areas where the extension of the grid was difficult and expensive and water was available.

The result of these policies, mainly based on grid extension, was that in 1997 the percentage of rural population with access to electricity was around 97%.

Fourth stage: 1998-present

Once the electrification rate was closed to 100%, the Central government decided to focus its effort on tackling the energy supply issues caused by the structural problems created by quick and large grid extensions. As a result, the government launched a program, in 1998, to upgrade and repair existing grids in order to improve supply reliability and reduce wire losses, amongst others. This effort took around seven years and required around USD 50 billion in expenditures but, on the positive side, reduced significantly electricity costs.

In addition, the central government also decided to unify the rural and urban grids and facilitate the commercial operation within the utility market. As a result, electricity companies were established to facilitate the liberalization of the market and competition.

The latest data regarding rural electrification indicates that it reaches 99% of the Chinese rural population.

Challenges in the rural electrification process

As mentioned before, the rural electrification process in China has been successful, especially when compared to other developing countries, not only in the Asian region but worldwide. However, it is facing many challenges and, in order to achieve the standards of most of the developing countries, several issues need to be tackled.

First of all, the number of people still lacking access to electricity in 2009 was around eight million. Despite the proximity to full electrification rate, the massive size of the country in terms of population means that still a large number of individuals, equal to the total population of countries like Sweden or Austria, have no electricity yet.

Additionally and despite the large investments deployed over the last decades, further efforts need to be done on the modernization of the network and service and quality improvements which are particularly difficult given the massive investments required to maintain such an extensive grid.

Finally, the rural electrification process needs to incorporate new technologies that may represent the solution to provide electricity to those areas, especially in the Western regions, where the grid extension is not feasible and off-grid applications are required. This is the sector where the new renewable energies such as wind and solar are expected to play a key role by becoming the most appropriate solution in order to achieve the Central government´s goal of a full rural electrification before 2020.

Renewable energy technologies in rural electrification

Grid extension in rural areas is not always cost effective given their geographic location and usually limited energy consumption. As a result, the use of applications of off-grid renewable energy technologies represent a more efficient and effective alternative way in order to give access to electricity. Each renewable technology has its pros and its cons regarding off-grid applications.

Solar photovoltaic technology

Pros	Cons
• Reliable and especially attractive when the load of electricity required is not large • Systems prices are decreasing due to an improvement in the technology applied and further declines are expected • Cost declines will be potentially steeper in solar photovoltaic than in thermo solar • Modular structure: can easily be attached to existing power systems	• Other systems might be more appropriate for large load electricity demand • Only provide electricity during the day • Efficiency varies depending on solar irradiation

Thermo Solar technology

Pros	Cons
• Reliable and especially attractive when the load of electricity required is not large • Applicable to create energy and/or heat water • Systems prices are decreasing due to an improvement in the technology applied and further declines are expected • Energy/heat generated mainly due to solar heat but also high temperatures so may provide electricity at night as well	• Other systems might be more appropriate for large load electricity demand • Needs a great volume of water so not particularly appropriate where water is a scarce asset • Energy generated depends on temperature/ irradiation

Wind technology

Pros	Cons
• Currently, cheaper option than solar technologies • Can provide a significant amount of power • Might generate electricity both during day and night	• Requires wind so cannot be feasible for all rural areas • Installation require more previous analysis/ studies

• Prices continue declining but a slower pace than before	of meteorological conditions than solar

Mini-hydro and biomass technologies

Pros	Cons
• Very efficient when a large power load is required • Reliability. Some of this technologies, especially mini-hydro, have been used for a long time e.g. China has great experience with mini-hydro • Can generate energy either during day or night	• Not useful/applicable for household-scale applications • Mini-hydro can only work when water is close and under certain circumstances

Renewable energy technologies in the rural electrification in China

The main experience of China with renewable energies to promote rural electrification is related to the construction of mini-hydro power plants especially until the late 1970s, when the grid extension became mainstream.

The main reason for this is that Chinese Central government has always considered the extension of the grid as the backbone of its plan to take electricity to rural areas. Mini-hydro was only a preliminary measure before the extension was completed. Furthermore, Chinese population also considered these technologies as non-reliable and inferior so, basically, supported the government´s view that network extension was the most satisfactory way to achieve electrification rate goals.

Nowadays, the perception of both has substantially changed. The Central government is considering that, in order to achieve full electrification rate in rural areas and provide with energy to rural areas in the far west of the country where around eight million people still does not have access to electricity, extending the grid might not be

economically competitive when compared to off-grid applications based on renewable energies. Since the 1990s, some projects have been launched based on solar and wind power to provide a cost-effective alternative to grid extension to these areas and have been the focus of Chinese rural electrification initiatives in recent years. As a result, China is currently one of the world leaders in both the production and installation of renewable energy technologies. Companies such as Trina Solar or Yingli are some of the leaders in the solar panels manufacturing sector and the government is promoting the installation of wind and solar across the whole country e.g. agreement signed with First Solar (US solar panel manufacturer) to install 2 GW of solar photovoltaic energy in the City of Ordos. This support from the government is also making the population to gain trust in these new technologies.

The Central government is expected to favor the construction of small-hydro plants where water is available, as it has been done historically. However, in some remote areas where this is not an option, solar, wind and a combination of both technologies are expected to be the solution to achieve a full electrification rate.

Recent rural electrification initiatives based on renewable energies

Brightness Programme

The Brightness Programme represented the first initiative driven by the Chinese government to use off-grid renewable energy applications, other than small hydro power plants, to provide electricity in remote rural areas.

The plan was released in 1996 and it relied on solar and wind applications to provide electricity to 23 million people located in Gansu, Qinghai, Inner Mongolia, Tibet and Xinjiang provinces by 2010. The target was to provide, eventually, 100 watts of capacity per person. The program finally started in 1999.

a) First stage (1999-2002)

This stage consisted on a pilot phase that brought electricity from single photovoltaic solar home systems and from photovoltaic/ battery systems of village supply to 50,000 people located in Inner Mongolia, Tibet and Gansu.

b) Second stage (2002-2005): *Township electrification Program*

Integrated within the Brightness program, the Township electrification program was, at that moment, one of the largest renewable energy-based rural electrification programs in the world.

With a total investment of USD 700 million supplied by both the central and local governments special funds, this program electrified over 1,000 townships in less than 20 months. Those townships were located in western provinces: Xinjiang, Qinghai, Gansu, Inner Mongolia, Shaanxi, Sichuan, Hunan, Yunnan and Tibet.

Almost one million people got access to electricity thanks to this program.

c) Third Stage (2006-2010): *Village Electrification Program*

Also integrated within the Brightness Program, the Village electrification program was the most challenging phase and the goal was to bring electricity to around 20,000 villages, all of the located in off-grid western regions of the country as well.

In order to reach this objective, several international, national and local agencies, led by the National Development and Reform Commission, needed to work together to develop and implement a training program for national and local-level engineers and technicians.

Final results from this program are expected to be released shortly.

China Renewable Energy Scale-up Program (CRESP)

CRESP was launched in 2005 in parallel with the Brightness Program. However, this program is not only funded with Chinese funds but developed along with the World Bank and Global Environment Facility.

The goal of the program goes beyond rural electrification and is aimed to demonstrate the feasibility of scale-up renewable technologies and their economic and environmental advantages over coal-fired energy generation. To reach this objective, CRESP promotes the implementation of a renewable energy policy development. Actually, the Renewable Energy Law emerged from this program. Additionally, it supports a wide range of investments in renewable energies.

Despite rural electrification is not CRESP´s main purpose, its initial phase financed both on-grid and off-grid renewable energy systems across the country such as Huitengxile wind farm, a 100 MW development in Inner Mongolia.

County Hydropower Construction of National Rural Electrification

This programs aims to build 400 high-standard rural hydropower electrification systems in 400 counties. This will bring electricity to nearly 900,000 people with no electricity access and almost 4.9 million people with very limited electricity provision.

Apart from electrification, local water authorities are responsible for the construction of small hydro power plants to substitute conventional and energy sources for cooking and heating. This part of the program is expected to reach 1.7 million rural households which represent around 6.8 million people.

Golden Sun Program

Recently launched, the Golden Sun consists of a subsidy program to support the installation of solar photovoltaic applications. Despite the program is designed to subsidize the total cost of both on-grid and off-grid applications, the focus on the later is clear with the offer of 70% upfront subsidies for these systems in rural areas.

The length of the program will be two years (2009-2011) and it establishes a cap of 20 MW per province.

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