Study on rural electrification policies and demonstration projects in China

Min Li 1, Xuan Zhang 2,5, Guan Zhao 3, Junhua Ma 2, Hao Meng 4, Shuangqing Xu 2, Xing Yan 2, Lei Wang 2 and Wenrui Huang 2

1 State Grid Shandong Electric Power Company, No.150 Zhongjing 2nd Road, Shijiazhuang District, Jinan, Shandong, P.R. China;
2 Energy Internet Research Institute, Tsinghua University, No.77 Shuangqing Road, Haidian District, Beijing, P.R. China;
3 Liaocheng Power Supply Company, Shandong Electric Power Company, No.179 Dongchang Road, Liaocheng, Shandong, P.R. China;
4 Linyi Power Supply Company, Shandong Electric Power Company, NO.97 Jinqueshan Road, Linyi, Shandong, P.R. China

5 Email: zhangxuan02@qq.com (Corresponding author)

Abstract. This study aims to further promote rural electrification, optimize the rural energy structure, eliminate poverty among farmers, improve the rural energy efficiency, and achieve an overall well-off and rural revitalization strategy. Shouguang City of Shandong Province, is one of the largest vegetable distribution centres in China and has good policy conditions. This paper examines four types of rural electrification demonstration projects in Shandong Province. We have extracted the “Shandong Shouguang Model” with standard construction mode, advanced application technology and complete local policies. The “Shandong Shouguang Model” includes “Four Ones”: “One Platform”, “One Model”, “One type of business” and “One set of standards” for rural electrification construction, and provided Cost-price and Investment-tax relief policies for rural electrification development across the country. Replicated experience. Promote the achievement of 100% energy cleanliness and 100% end-energy electrification through the construction of Zero-carbon emission demonstration zones and Net-zero energy consumption.

1. Introduction

From 2011 to the present, rural electricity supply has been basically guaranteed, but there is a relative overcapacity of traditional coal-fired power, and an insufficient supply of clean energy. China's rural energy consumption structure, dominated by traditional biomass and bulk coal, has brought considerable pollution to the rural environment, as there are no mandatory management measures and its pollutant emission levels are very high. In northern China rural areas where coal-fired heating is the norm, the burning of loose coal is an important cause of winter air pollution.

The clean transformation of rural energy in China depends on the introduction, promotion and implementation of China's national energy and environmental policies. In June 2014, General Secretary Xi Jinping put forward the strategic idea of “Four revolutions, one cooperation” at the sixth meeting of the Central Leading Group on Finance and Economics, setting out programmatic goals for China's future energy development. In December 2015, the United Nations Climate Change
Conference reached an agreement in Paris to control global warming, requiring that the global average temperature rise should be limited to 2°C and efforts to limit the temperature increase below 1.5°C[1].

In December 2016, General Secretary Xi Jinping first proposed the “Rural energy revolution”. In October 2017, the report of the 19th National Congress of the Communist Party of China proposed to implement the strategy of rural revitalization. China issued the Opinions on Implementing the Strategy of Rural Revitalization with the 2018 No. 1 document, marking the beginning of speeding up the modernization of China's rural areas. [2] In July 2018, the State Council issued the Strategic Plan for Rural Revitalization (2018-2022), further elucidating the meaning of the rural energy revolution. On 2019, the central government No.1 document demands a clear indication of the full implementation of the rural electrification upgrade project, accelerate the completion of a new rural power grid renovation.

In September 2020, General Secretary Xi Jinping commitment to reach the carbon dioxide emission peak before 2030 and the carbon neutrality will be achieved by 2060. Rural electrification is an important guarantee for improving farmers’ production and living[3], supporting the development of rural industries and promoting the revitalization of the countryside [4]. Therefore, it is particularly important to optimize the structure of rural energy supply, vigorously develop solar energy, shallow geothermal energy and biomass energy, and develop hydropower and wind energy in accordance with local conditions. [5]

2. National and local rural electrification policies
Government policies have a direct impact on rural electrification development [6]. The Government should improve rural energy infrastructure networks, accelerate a new round of rural power grid upgrades, promote the extension of gas supply facilities to rural areas, promote green energy-saving rural buildings and agricultural energy-saving technologies and products, develop “Internet+” smart energy, and explore the construction of demonstration zones for rural energy revolution. The Rural multi-energy systems are shown in Table 1.

Table 1. Rural multi-energy systems.

| Category          | Utility                                           |
|-------------------|--------------------------------------------------|
| Electricity       | • Electricity Grid, wind power, photovoltaic, biomass, etc;  
|                   | • Heat pumps converted to heat and cold sources. |
| Biomass gas       | • The gas boiler convert gas into heat source;  
|                   | • The absorption chiller convert gas into cold source. |
| Greenhouse waste heat | • The greenhouse waste heat can supply heat;  
|                   | • The absorption chiller is converted waste heat into cold source. |
| Energy storage    | • Storage of surplus electrical, cooling and heating energy |
| Energy management system | • Dynamically adjusts the operation of the equipment, to achieve the efficient use and full consumption of clean energy. |

2.1. National rural electrification policy
During the “13th Five-Year” Plan period, the State introduced a series of economic, administrative, land and other macro-control measures to promote the optimization of the industrial structure of rural areas, placing electrical energy first in the energy hierarchy. The National Development and Reform Commission (NDRC) issued the Opinions on the Implementation of a New Round of Grid Renovation and Upgrading Project during the 13th Five-Year Plan, pointing out that by 2020, the vast rural areas of the power grid will be fully covered, so that electricity supply and transmission will be raised to a new level, and efforts will be made to achieve a balance between electricity supply and demand [7]. The overall voltage stability pass rate reached 99.99%, and each household supplied electricity over 2.0 KVA. Currently, The NDRC issued the Opinions on Clean Heating Price Policy in Northern
Regions, encouraging village-level “Coal-to-power” heating tariff policy. However, with China's fixed final sale price and a state-approved feed-in tariff, the higher costs of the rural power grid cannot be passed downstream. The tariff mechanism must be changed to reflect the cost of rural electricity production.

2.2. Beijing rural electrification policy
Since 2013, Beijing has accelerated its efforts to combat air pollution. On the one hand, in equipment subsidies, 2017 Beijing rural areas, village winter clean heating work plan proposed, when the village use air source heat pump or ground source heat pump heating, Beijing city and district governments both subsidies 100 yuan/m². For the use of other clean energy equipment, such as thermal storage electric heating and gas wall-hung boilers, Beijing city and district governments both pay ⅓ of the equipment price subsidies, the subsidy amount up to 12,000 yuan per household. On the other hand, the Beijing Municipal Development and Reform Commission issued the Notice on the city's clean heating electricity and gas price, “Coal to electricity” villages electricity price use 0.3 yuan/ kWh, from 20:00 at night to 8:00 the next day. At the same time, Beijing city and district government finance subsidize each family 0.1 yuan/kWh, and the electricity consumption within 10,000 kWh per household per winter. In the case of high subsidies from the Beijing municipal government, the financial pressure on the low temperature air source heat pump company is reduced by 73%.

2.3. Tianjin rural electrification policy
In November 2017, the Tianjin Development and Reform Commission issued the Notice on Issues Related to the Price of Coal-to-Electricity Heating Electricity. Tianjin “Coal to electricity” household winter heating electricity, used a unified peak and valley hourly electricity price policy. From November 1 to March 31, the electricity for winter heating has peak period from 6:00 to 21:00 every day, the price is 0.49 yuan/kWh, while the valley period from 21:00 to 6:00 the next day, the price is 0.3 yuan/kWh. Rural areas to the village as a unit through the coal to electricity heating or heat pumps and other electric heating, should be separately metered. Rural heating electricity and urban residents “Coal to electricity” heating implementation of the same peak and valley hourly price policy.

2.4. Shandong rural electrification policy
The Shandong provincial government actively carries out rural electrification work such as clean heating and electricity substitution in rural areas to improve the level of rural electrification. In November 2017, the Shandong Provincial Price Bureau issued the Notice on Matters Relating to the Peak and Valley Hourly Electricity Price Policy for Residents. From November 1, 2017 to December 31, 2022, the peak and valley time-sharing electricity pricing policy will be implemented. During the heating period, the peak period will be reduced from 14 hours to 12 hours and the valley period will be increased from 10 hours to 12 hours. In the current ladder electricity price standard, the peak section of electricity price increase of 0.03 yuan/kWh, the valley section of electricity price reduced by 0.17 yuan/kWh. Among them, the heating period valley electricity price by reducing 0.17 yuan/kWh adjusted to reduce 0.2 yuan/kWh. That is, the first peak section price of 0.5769 yuan/kWh, the valley section price of 0.3469 yuan/kWh, the second and third peak, valley price increase standard unchanged.

3. Demonstration projects on rural electrification
Shouguang City in Shandong Province is the “Hometown of vegetables” in China, is the largest vegetable distribution center in China, so its energy supply is particularly important. The study compiled the plan for the demonstration project, summarized the typical experience of the demonstration project in Shouguang, and extracted the standardized construction mode, intelligent service of power supply in rural areas, as shown in Figure 1.
3.1. Agricultural production projects

3.1.1. Electrification of agriculture, livestock and fisheries. For agricultural planting, promote the application of technologies such as electric drainage and irrigation in farming machine wells, electric heat preservation in agricultural greenhouses, electric spraying, and integrated water and fertilizer machine, and promote 24 agricultural planting greenhouse projects to be electrified. Livestock breeding, the promotion of electric hatching, heat pumps and other technologies to promote 15 livestock breeding projects electrification, electrification upgrade to promote modern transformation of the farming industry.

3.1.2. Electrification of agricultural products processing and storage logistics. In the area of agricultural processing, electric drying technology is being promoted in areas concentrated in grain, fruit and vegetable processing, and the electrification of five agricultural processing projects is being promoted. In the area of agricultural product storage and logistics, it is promoting the use of temperature control and digital control technologies for fresh cold chain transportation and insulation, as well as the use of heat pumps, ice storage and other refrigeration technologies for cold storage.

3.2. Rural livelihood projects

3.2.1. Electrification of village heating. Steadily pushing forward the replacement of scattered coal in rural areas, helping to win the battle of the blue sky, doing a good job in “Converting coal to electricity” for clean heating, giving priority to the use of electric storage and centralized electric heating and other technologies, and constructing 19 electric heating projects.

3.2.2. Electrification of rural transport. Promotional activities such as electric vehicle exhibitions, sales and experiences are being held to expand the sales market for electric vehicles and charging facilities in rural areas and to promote the electrification of private passenger vehicles in rural areas. It will build “Optical storage and charging” integrated charging stations, and connect the data to the energy control system, which can serve more than 30 electric vehicles per day.
3.2.3. Electrification of rural family life. Shouguang city area solar resources are very rich, has a large solar energy resources development value. Promote smart homes and other new appliances, make mobile display carts that cover photovoltaic and electrification of rural homes, advocate energy-saving and environmental protection, green and low-carbon lifestyles, and create low-energy, low-cost rural housing samples.

3.3. Rural industry project

3.3.1. Electrification of rural tourism. In terms of rural tourism village construction, Jining Riverside Village Revitalization Demonstration Area was built. In terms of rural all-electric scenic spots, build a new model of “Electrification + tourism” and promote the electrification of seven scenic spots. Improve the electrification level of cooling, heating, production and processing in homestay operations, and realize the upgrading of electrified homestays.

3.3.2. Electrification of rural specialty industries. Promote the application of electrical energy in specialty industries, the construction of four electric fried tea and two electric baking tobacco projects. Actively docking the park energy planning, assistant modern rural agricultural industrial park, science and technology park and business park development, and take the initiative to provide energy efficiency analysis, energy-saving consulting and cooling power supply and heating integration of multiple services, improve the park energy efficiency.

3.4. Rural electric service project

3.4.1. Rural clean energy generation feed-in services. It actively supports the development of clean energy power generation projects such as distributed photovoltaic, comprehensive utilization of straw, and utilization of waste incineration in rural areas, and provides grid-connected services for clean energy generation projects, promoting clean and low-carbon energy transition and ecological environment improvement in rural areas.

3.4.2. Construction of rural electric service system. For power supply station grid services, innovative construction of power supply station digital transformation, promote the power supply station production and living facilities are fully electrified. Enhance the brand value of “Shouguang Model”.

4. Conclusions

Based on the resource endowment of Shandong Shouguang city, we have summarized the typical experience in the construction and operation of Shouguang demonstration projects, and extracted the “Shandong Shouguang Model” with standard construction mode, advanced application technology and complete local policies. The “Shandong Shouguang Model” includes “Four Ones”: “One Platform”, 365 electric housekeeper wisdom energy service, and “One Model”. Summarizing the integrated energy commercialization operation model, “One type of business” has cultivated the whole industry chain of intelligent agriculture, formed “ One set of standards” for rural electrification construction, and provided replicable and sustainable solutions for rural electrification development across the country. Replicated experience. Promote the achievement of 100% energy cleanliness and 100% end-energy electrification through the construction of zero-carbon emission demonstration zones and net-zero energy homes.

4.1. Cost-price policy
The Government is actively promoting electric heating in rural areas and reducing the use of coal. On the one hand, subside the initial investment, and because of the huge investment in rural power grids, it is recommended that Shandong province refer to Beijing's policy of subsidizing 30% grid-supporting projects of 10 kV and below, including grid-supporting investments in transmission and
distribution tariffs, and bearing the land acquisition and demolition costs. To reduce operating costs, use coal to power special tariffs, and further expand the price difference between peak and valley tariffs. The Government, wind power, photovoltaic power generation enterprises, power grid enterprises and villages are encouraged to construct a quadripartite consultation mechanism or market-based bidding for direct trading of electricity for heating, in order to reduce costs.

4.2. Investment-tax relief policy
It is recommended that the state inject the national debt funds as capital into the grid companies. Seek low-interest, interest-free loans from the World Bank, Asian Development Bank. Apply the government subsidized loans and low-interest policy loans from the China Development Bank, relax the lending conditions, extend the loan period and reduce interest rates. Local governments are encouraged to use special funds for air pollution control, and explore new modes such as government guarantee and service sharing [8]. Continuing to reduce or waive fees for low-voltage maintenance of rural power grids, exempting donations of grid assets from income tax, allowing accelerated depreciation charged before tax, increasing the proportion of income tax reductions and exemptions for agricultural electric power enterprises, including all agricultural and electric power enterprises in the scope of the value-added tax transformation pilot project.

4.3. Approval process and technical advice
Power grid companies should strengthen communication with the government on the location and routing of “Coal to electricity” supporting substations, clarify the need for transformation and the scope of implementation, speed up the progress of approval procedures for rural power grid projects, and solve the land use index. According to the specific conditions of the project, make reasonable technical plan to avoid blind investment [9]. We should include the clean energy technologies in the planning of heating and cooling projects, and organize exhibitions to promote new concepts of rural energy consumption, recommend new equipment for power substitution, and popularize environmental protection knowledge.

Acknowledgements
This paper is supported by State Grid Shandong Zaozhuang Power Supply Company 2019 Poverty Village Electrification Application Demonstration Project, code 50610190001.

References
[1] ZHOU X 2015 J. A tentative idea of building new generation of energy system. Shaanxi Electric Power 9 1-4
[2] He Q 2019 J. China Power Enterprise Management 6 23-24
[3] Jahangiri, M., Haghani, A., Heidarian, S., Alidadi Shamsabadi, A. and Pomares, L.M., 2018. Electrification of a tourist village using hybrid renewable energy systems, Sarakhiyeh in Iran. Journal of Solar Energy Research, 3(3) 201-211
[4] Jahangiri, M., Khosravi, A., Raiesi, H.A. and Mostafaeipour, A., 2017. Analysis of standalone PV-based hybrid systems for power generation in Rural area. In International Conference on Fundamental Research in Electrical Engineering 1-2
[5] Jahangiri, M., Haghani, A., Heidarian, S., Mostafaeipour, A., Raiesi, H.A. and Shamsabadi, A.A., 2020. Sensitivity analysis of using solar cells in regional electricity power supply of off-grid power systems in Iran Journal of Engineering, Design and Technology
[6] Javadi F S, Rismanchi B, Sarraf M, et al. 2013 Renewable & Sustainable Energy Reviews 19(1) 402-416
[7] MA Z. 2015 J. Exploring the concept, key technologies and development model of energy internet. Power System Technology 39(11) 3014-3022
[8] Qiao Q 2019 J. China Power Enterprise Management 17 19-20
[9] Cook P. 2011 J. Energy for Sustainable Development 15(3) 304-313