Research on the Precise Identification Method for Poverty Alleviation based on the Characteristics of Electricity Load

Dexiang Jia[1], Suwei Liu[1], Pengjiang Ge[2]，Xiang Shi[3]

[1]State Grid Energy Research Institute CO., LTD., Beijing, PRC 102209
[2]State Grid Ningxia Electric Power Co., LTD., Yinchuan, PRC 750001
[3]State Grid Qingdao Power Supply Company，Qingdao, PRC 266002
jiadexiang71@163.com, jiadexiang@sgeri.sgcc.com.cn

Keywords: Targeted poverty alleviation, Electricity demand prediction, Digital characteristics of the load curve, Electricity consumption structure

Abstract: To identify the poor is an important step to implement the targeted poverty alleviation policy. The current researches are short of multidimensional identification method for poverty alleviation users. A precise identification method for poverty alleviation is proposed to identify the poor and calculate the distribution of the poverty population in the region, based on electricity demand prediction of the poor, analysis of the digital characteristics of the load curve, prediction of electricity consumption structure. Research shows that family workshops has a great significance for poverty alleviation. The research results can provide decision-making references for relevant government departments to deploy poverty alleviation work.

1. Introduction

Power poverty alleviation is one of the key tasks for power grid companies to implement the national poverty alleviation policy and enhance the social image of enterprises. The confirmation of current poverty alleviation targets mainly relies on the verification of user's bank accounts and its income and expenditure information. However, the lack of electronic consumption channels in poor areas makes it difficult to help the poor who real needs supports. With the popularization of smart meters and the authorization of the government, users' electricity consumption information can be used to identify the types and usage habits of their electric appliances, thus providing an effective method for accurately identifying poverty alleviation objects, which is of great significance for improving the effectiveness of poverty alleviation and promoting the harmonious development of society.

In view of economic benefits, paper 1 designs the calculation of total annual power generation of PV poverty alleviation projects, then designs the annual sub-components of total poverty alleviation income, obtains the annual total poverty alleviation calculation method under different models and different objects, analyzes its ecological benefits from two aspects[1]. Based on the background of "targeted poverty alleviation", paper 2 establishes a feasibility index system from the perspective of implementation basis, construction conditions and current conditions of poor area[2]. Based on the theory of limited government, paper 3 analyzes local governments improper behaviors in the work of poverty alleviation in Anhui province, such as offside,omission and dislocation and operational suggestions are put forward aimed at these problems[3]. Paper 4 analyzes the necessity and feasibility of constructing the "photovoltaic cloud network" intelligent service system and puts forward the demand of "photovoltaic cloud network". From the two aspects of operational service architecture and service content, the business structure of the intelligent service system of "photovoltaic cloud network" is analysed[4]. Based on the business structure, the "photovoltaic cloud network" intelligent service is discussed. The poverty alleviation application of "photovoltaic cloud network" is introduced, and the national photovoltaic poverty alleviation information management system—the photovoltaic institute is established. Paper 5 analyzes Shanxi Province innovative working mechanism in the development of photovoltaic poverty alleviation projects[5].

  DOI: 10.25236/icicta.2019.014

The current researches are short of multidimensional identification method for poverty alleviation users.

Based on electricity demand prediction of the poor, analysis of the digital characteristics of the load curve, prediction of electricity consumption structure, a precise identification method for poverty alleviation is proposed to identify the poor and calculate the distribution of the poverty population in the region in chapter 2. The case study is given to show the rationality of the proposed method in chapter 3. Conclusion is given in chapter 4.

2. Methodology

This paper proposes a precise identification method for poverty alleviation based on the characteristics of electricity load, which include:

1) electricity demand prediction of the poor: according to the historical data of economic development level e_c, energy consumption habits e_h, total electricity consumption e_n and average reactive power r_p, air temperature t, and the population p, electricity consumption e_{np} and average reactive power r_{pp} of typical poor families, a fitting method (f_n, f_p) is used to construct the forecast model of poor population's electricity consumption E_n and average reactive power demand R_p. The accuracy of power consumption and average reactive power demand forecasting model is tested by extracting historical data such as electricity consumption of the poor in other area.

$$E_n = f_n(e_c, e_h, e_n, r_p, t, p, e_{np}, r_{pp}) \quad (1)$$

$$R_p = f_p(e_c, e_h, e_n, r_p, t, p, e_{np}, r_{pp}) \quad (2)$$

2) analysis of the digital characteristics of the load curve of the poor: the daily active power and reactive power curve of the poor are extracted, and the moving median method is used to remove the disturbance. The active power curve e_i and reactive power curve r_i are normalized respectively as e_{iu} and r_{iu}, according to the daily maximum active power and reactive power. The statistical characteristics of daily load curve are calculated, such as mean, standard deviation, wave rate, skewness, kurtosis, etc.

$$e_{iu} = e_i / max(e_1, e_2, \dots, e_i, \dots) \quad (3)$$

$$r_{iu} = r_i / max(r_1, r_2, \dots, r_i, \dots) \quad (4)$$

3) prediction of electricity consumption structure for the poor: According to the typical load characteristics of conventional household appliances such as lighting, refrigerator, color TV, electric Kitchenware and washing machine, including active power, reactive power and typical working period, the load curve of the poor is decomposed into the combination of conventional household appliances e_{ic}、continuous motor load e_{im} and impact load e_{il} by using least square method. Calculate the electricity consumption and proportion of various electrical appliances a_{ic}, a_{im}, a_{il}. The accuracy of the forecasting model of electricity consumption structure is tested by extracting the historical data of electricity consumption of other poverty-stricken people and combining with on-site investigation.

$$e_{iu} = a_{ic} \cdot e_{ic} + a_{im} \cdot e_{im} + a_{il} \cdot e_{il} \quad (5)$$

4) identify the poor: the discrimination criteria d are set. According to electricity demand forecast of the poor e_{if}, the digital characteristics of load curve, the electricity consumption structure which are given in the first three steps, with the factors such as the vacant houses are eliminated, the poor population is selected. Through comparative analysis of several actual case data and field investigation, the rationality of the above-mentioned methods is verified.

$$|e_{if} - e_i| < d \quad (6)$$

5) calculating the distribution of the poverty population in the region: By comparing the power consumption of the suspected poverty population, as well as the digital characteristics of the typical daily load curve and the power consumption structure which is based on the level of economic development and the identification criteria of the poverty population in different regions, a statistical index system is designed to rank the suspected poverty population by weight. According to the pro-

vincial government's poverty alleviation work plan, the target of poverty alleviation is selected, and then the distribution of poverty-stricken population in all regions of the province can be given.

3. Case study

Taking Jiangsu province as an example, Jiangsu Province is located in the east of China, ranking first in China in terms of comprehensive economic competitiveness. It is one of the most active provinces in China with a total area of 107.2 thousand square kilometers, governing 13 prefecture level cities, 96 county-level divisions and 1259 township level divisions. By the end of 2018, Jiangsu Province had a permanent population of 80.507 million, realizing a GDP of 9259.54 billion yuan, a per capita GDP of 115 thousand yuan, a total social power consumption of 612.8 billion kWh and a per capita power consumption of 7632.4 kWh, far lower than that of the United States. Even so, a small number of people in Jiangsu Province still live below the poverty line.

The results show that according to the current criteria for identifying the poor, there are still about 400 thousand poor people in Jiangsu province in 2020. They are mainly distributed in the northern part of Jiangsu province. The electricity consumption of the poor people in Jiangsu province is mainly used for lighting, followed by television, and the electricity consumption of other household appliances is very low. Their power consumption time in summer is mainly from 7:30 to 11:00 p.m., and in winter is mainly from 5:30 to 10:30 p.m., with the monthly power consumption mostly lower than 10 kWh. Among the population out of poverty, there are a considerable number of households with continuous motor loads, which shows that family workshops has a great significance for poverty alleviation. Their power consumption during the day accounts for more than 80% of the total power consumption, and the monthly power consumption is mostly higher than 150 kWh. The research results can provide decision-making references for relevant government departments to deploy poverty alleviation work.

Table 1. Calculation of Jiangsu province’s poverty alleviation in 2020

Poor People	Distribution	Electricity Consumption	Consumption Time
400000	mainly in the northern part of Jiangsu province	7:30 to 23:00 in summer, 5:30 to 22:30 in winter	mostly lower than 10 kWh each month

4. Conclusion

It is difficult to identify the poor, which hinders the effective implementation of the targeted poverty alleviation policy. Residential electricity consumption and its characteristics have provided an effective method for the identification of the poor. Based on electricity demand prediction of the poor, analysis of the digital characteristics of the load curve, prediction of electricity consumption structure, a precise identification method for poverty alleviation has been proposed to identify the poor and calculate the distribution of the poverty population in the region. Research has shown that family workshops has had a great significance for poverty alleviation. The case study has shown the rationality of the proposed method.

Acknowledgments

This work was partially supported by State Grid Corporation of China CO., LTD. [grant project: Research on intelligent diagnosis analysis and comprehensive decision technology of power grid development based on data drive].

References

[1] Tong Guangyi, Ni Qi, Pan Yuelong, etal. Photovoltaic poverty alleviation model and benefit promotion mechanism under background of agricultural informatization[J]. Transactions of the Chinese Society of Agricultural Engineering, 2019, 35(10): 131-139.

[2] LIU Yuan. Feasibility evaluation of the photovoltaic power generation's construction from the perspective of targeted poverty alleviation[J]. Journal of Beijing Institute of Technology(Social Sciences Edition), 2017, 19(5): 37-43.

[3] WANG Nian-yi, WANG Lei. Poverty alleviation efficiency problem of PV industry in Anhui province based on the perspective of limited government[J]. Journal of Bengbu University, 2017, 6(4): 108-111.

[4] LI Yang. Research and Application of "Photovoltaic Cloud Network" Intelligent Service[J]. Distribution & Utilization, 2018, (9): 42-46+73.

[5] Li Shumin. Research on the mechanism of innovative photovoltaics poverty alleviation in Shanxi Province[J]. Agricultural Technology & Equipment, 2019, 354(6): 32-33.