Application of Dual-Loop Control Algorithm Simulation Technology in Power Regulation of New Energy Grid

Chaoshan Xin[1(✉)], Jin Yu[1], Jiayu Bian[1], Guokang Yu[1], and Xiaowei Li[2]

[1] State Grid Xinjiang Electric Power Co., Ltd. Economic and Technical Research Institute, Urumqi, Xinjiang, China
ppso210706@126.com

[2] Beijing Jinghang Tianli Technology Co., Ltd., Beijing, China

Abstract. With the development of economy and society, the utilization rate of energy is getting higher and higher, and the energy problem is becoming more and more serious. Therefore, new energy has received extensive attention from all walks of life. New energy occupies a relatively high proportion of the power grid, which brings new challenges to the operation of the power grid, especially the power generation power system connected to the power grid by the inverter to regulate the power of the power grid. Under these conditions, this paper proposes to apply the dual-loop control algorithm simulation technology to the power regulation of the new energy grid, aiming to realize the rapid regulation of the power of the new energy grid. This article conducted a questionnaire survey on the impact of new energy grid output power on residential electricity consumption. The survey results showed that: Residents in the community have the highest annual electricity consumption in August, at 24880 KW/h, and less electricity consumption in a suitable weather month, at about 9100 KW/h; among the household appliances investigated, the air conditioner has the highest power, with an average use time of 4-8h/day, and the average use time of the hair dryer with the lowest power is 0.6 h/day; among the 300 users, 59% have higher requirements for the stability of the input electric energy, and only 0.5% have no requirements for the stability of the input electric energy.

Keywords: Dual-loop control algorithm · Simulation technology · New energy · Grid power regulation

1 Introduction

With the rapid development of economy and society, people's quality of life is getting higher and higher, and the increasing quality of life is inseparable from electric energy [1]. Because of the scarcity of fossil energy sources such as oil, natural gas, and coal, our country has gradually developed from a traditional fossil energy power generation model to a new energy power generation model. Therefore, all walks of life believe that the new energy grid has great value [2]. In order to maximize the power utilization of the new

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energy grid, the dual-loop control algorithm simulation technology is used to explore the main operating rules of the new energy microgrid; at the same time, the inverter is used to connect to the power system of the new energy grid to achieve the power of the new energy grid [3, 4]. Based on this, the economic applicability and stability of the new energy grid can be improved, laying the foundation for the in-depth study of the new energy microgrid [5].

Research shows that the traditional PID algorithm is widely used in inverters, but the accuracy of its current and voltage adjustment needs to be further improved [6]. Based on this, the dual-loop control algorithm simulation technology is applied to the inverter, and the dual-loop control parameters of current and voltage can be designed to obtain a dual-loop control structure and construct a dual-loop control inverter for the new energy grid. The dual-loop control algorithm is used to simulate and prove this algorithm can effectively regulate the power of the new energy grid [7, 8]. New energy grids use dual-loop control algorithm simulation technology for power regulation, which can increase the output rate of power and improve the quality of output power [9]. The traditional single current or voltage control structure algorithm has a long cycle and has certain errors. The dual-loop control algorithm simulation technology can synchronize the control and the voltage input cycle. It is a new type of PFC control algorithm based on a digital model [10, 11]. For the utilization of electric energy, it is necessary to consider the coordinated control of the grid storage system while considering the consumption rate of new energy, so as to reduce energy costs while ensuring the dispatch of the new energy grid [12].

This paper studies the application of dual-loop control algorithm simulation technology in new energy grid power regulation, discusses the impact of dual-loop control algorithm simulation technology on the current and voltage in the new energy grid system, and discussed how it can adjust the power of the new energy grid by constructing a digital algorithm simulation model. This article will elaborate on the following points: First, understand the basic principles of new energy and dual-loop control algorithms; second, study the power adjustment strategy of the new energy grid during the operation; third, study the interference suppression during the operation of the dual-loop control algorithm simulation technology; fourth, aiming at the new energy grid's output power for residents in a community in Hubei Province A questionnaire survey was conducted on the electricity situation.

2 Introduction to Dual-Loop Control Algorithm Simulation Technology and New Energy Grid Power Regulation

2.1 Dual-Loop Control Algorithm Simulation Technology and Basic Principles of New Energy

New energy is a renewable energy that is being developed by researchers but has not yet been promoted. Traditional power generation uses fossil fuels, which not only wastes resources but also pollutes the environment; the use of new energy power generation reduces the production cost of electric energy and saves a lot of energy. Therefore, new energy power grids have attracted social attention. The dual-loop control system includes

two parts: a current loop and a voltage loop. The current and voltage dual-loop control is mainly used in the inverters of the new energy grid. The new digital algorithm simulation technology utilizes the power state information of the system, which can not only improve the dynamic performance but also Can improve accuracy. The digital system of the dual-loop control algorithm simulation technology is realized by computer programming. Its algorithm is relatively simple, and no error table is needed, which greatly saves memory and cost. Applying the dual-loop control algorithm simulation technology to the power adjustment process of the new energy grid can avoid the error of using a single current or voltage closed-loop algorithm, resist the disturbance of the dynamic process of electrical energy output, and quickly adjust the power of the new energy grid.

2.2 New Energy Grid Operation and Power Regulation Strategy

The operating characteristics of the new energy grid are different from the traditional grid, and its inverter is the key to controlling the stable output of electrical energy. This paper mainly uses dual-loop control algorithm simulation technology to study new energy grid operation and power regulation strategies. According to the loadability and power quality of the new energy grid, it is necessary to expand the inverter system and adopt the form of an external inverter to adjust the output power, voltage value and frequency of the new energy grid in time. Ensure that the new energy grid can automatically adjust the voltage value and frequency stability without the grid reference value; at the same time, the output power of the new energy grid is adjusted according to the capacitance of the new energy grid, and the load is reasonably distributed to ensure uninterrupted power supply for residents and various enterprises. According to the actual operation of the new energy grid, in addition to using the dual-loop control algorithm simulation technology to ensure the stable output of the system, the constant power control technology (PQ) and the constant voltage and constant frequency control technology (V/f) can also be used at the same time.

2.3 Interference Suppression in the Operation of Dual-Loop Control Algorithm Simulation Technology

Under different load conditions, the inverter's voltage output presents periodicity and regularity, accompanied by periodic disturbances. The dual-loop control algorithm simulation technology is used to control the inverter of the new energy grid. It can be divided into two components: the voltage control module of the outer loop and the current control module of the inner loop. The current includes the capacitive current and the load current. In an emergency, the inner loop control module's suppression of the current will affect the current output. If you want to enhance the stability of the inverter dual-loop control in the new energy grid, it is necessary to effectively control the current, voltage and various interference factors in the electric energy output process. Among them, interference factors include natural interference factors and man-made interference factors. The larger interference amplitude is spikes with higher noise frequency. The mathematical model of spikes is shown in formula (1), and the complex number expression of spectral functions is shown in formula (2); PI is used to control position

closed-loop system, which is simplified as formula (3); PID formula is shown below:

$$f(t) = \{^{tg\theta \cdot t, 0 \leq t \prec T/2}_{tg\theta \cdot (T-t), T/2 \leq t \prec T} \tag{1}$$

$$G(j\omega) = \int_{-\infty}^{\infty} f(t) e^{j\omega t} dt \tag{2}$$

$$P\text{wm} = Kp * e(k) + Ki * \sum e(k) \tag{3}$$

$$P\text{wm} = Kp * e(k) + Ki * \sum e(k) + Kd[e(k) - \text{e(k} - 1) \tag{4}$$

Among them, T represents the duration of the spike pulse; t is the correlation time; tgθ is the hypothetical condition, the hypothesis tg$\theta = U_{max}$; $j\omega$ is the frequency spectrum function;E (k) represents the current deviation, e(k − 1) represents the last deviation, and Pwm represents the output.The main way to eliminate the impact of noise on the inversion of the new energy grid is to eliminate noise. An instrument with voltage stabilization and filtering functions can be installed in the system to reduce the impact of noise on electrical energy output.

3 Questionnaire Survey on the Impact of New Energy Grid Output Electric Energy on Residential Electricity Consumption

3.1 Purpose and Target of Investigation

The purpose of this questionnaire is to study the impact of the dual-loop control algorithm on the power regulation of the new energy grid, aiming at the output power of the new energy grid, and discuss the power consumption of the residents by the different output power of the new energy grid when the voltage is unstable. The subject of this questionnaire is for residents aged 18–55 in a community in Hubei Province. Under the condition of ensuring a balanced ratio of men and women, 200 community residents of different occupations were randomly selected to fill in the questionnaire.

3.2 Investigation Method

This questionnaire on the impact of the electric energy output from the new energy grid on the electricity consumption of residents in a community in Hubei Province is based on the unstable performance of the electric energy output from the new energy grid under the premise of clarifying the purpose and objects of the survey. This questionnaire survey is completed by offline questionnaires. The investigators will print out the questionnaires and distribute them to residents aged 18–55 in a community in Hubei Province. The time for the questionnaire is selected at 6–8 pm In between, after they completed the questionnaire survey, the investigators took it back.

3.3 Survey Results

In this article, the questionnaire survey report on the impact of new energy grid output on residential electricity consumption will be retrieved by the investigators. The investigators will conduct detailed data analysis on the results of the questionnaire survey. The analysis results will be systematically analyzed and discussed in the fourth part of this article, this part does not analyze the results.

4 Analysis of the Results of the Questionnaire Survey on the Impact of the Electric Energy Output from the New Energy Grid on Residential Electricity Consumption

4.1 Survey on Electricity Consumption of Residents in a Community in Hubei

According to the questionnaire, the statistics of the electricity consumption of residents in a certain community in Hubei in 2020 are obtained. Among them, the electricity consumption of residents is mainly in winter and summer. In winter, they use air conditioners, heaters and other heating equipment to resist the cold. In summer, they need to use air conditioners and electric fans to cool down. The power of these household appliances is generally large, which will increase the electricity demand of residents in the community. The electricity consumption statistics are shown in the Fig. 1, it can be seen from the figure: The electricity consumption in August is 24880 KW/h, which is the month with the highest electricity consumption of the year; the electricity consumption is basically the same in January, February, July, September and December, all around 18000 KW/h; in April, the electricity consumption in May, October, and November is basically the same, and the annual electricity consumption in these four months is all around 9100KW/h. It shows that people's requirements for the quality of life are getting higher and higher. With the improvement of people's living standards, the more household appliances people buy, the greater the demand for electricity usage, which affects the amount of electricity consumption of residents in the community; in summer, it is a common phenomenon to use air conditioners and electric fans to reduce the indoor temperature to prevent heatstroke. It is also a common phenomenon to use electric heaters, electric heaters and other heating equipment in winter, both of which will increase residents' electricity consumption.

According to the questionnaire, the load parameters and use time of household appliances commonly used by residents in the community are obtained, as shown in Table 1, from the table we can see: The power of the air conditioner in household appliances is the largest, and its nominal power is 2200 W; the household appliance with the longest average use time is also the air conditioner, and its average power consumption time is 4–8 h/day; the household appliance with the smallest power is a hair dryer, and the nominal power is 1500 W, and its average use time is also the shortest, and its average power use time is 0.6 h/day. It shows that the higher the power of large household appliances, the greater the electric energy it needs, so the increase in the frequency of using these household appliances will lead to an increase in the electricity consumption of residents.

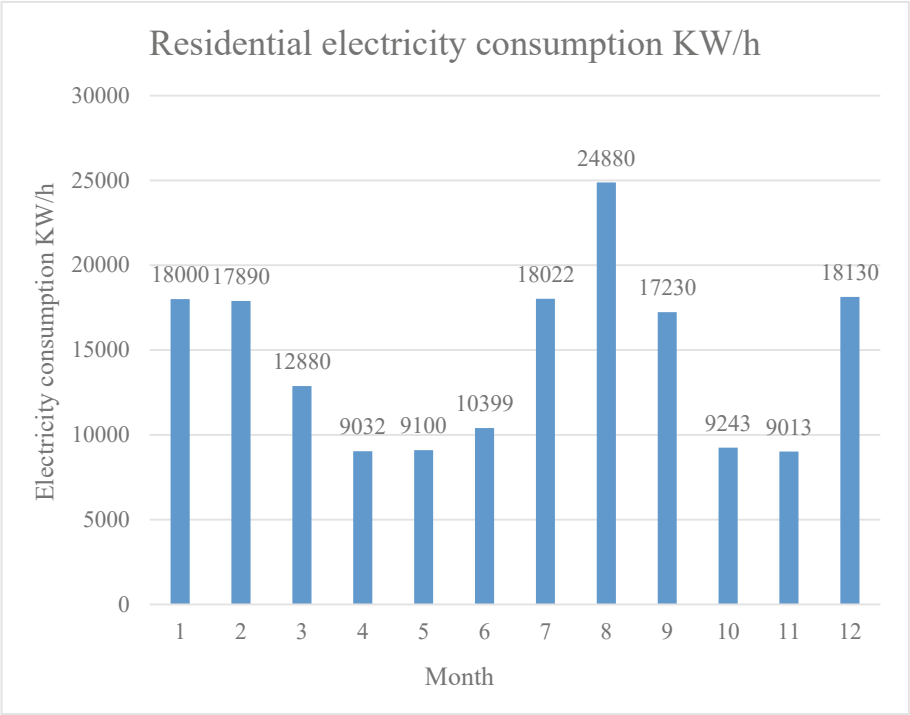

Fig. 1. Statistics of electricity consumption of residents in 2020

Table 1. Household appliance parameters and use time

Household appliances	Specifications/v	Nominal power/W	Average duration h/day
The TV	220	2000	3–5
Air conditioner	220	2200	4–8
Electric grill	220	1700	1.1
A hair dryer	220	1500	0.6
Electric heaters	220	1800	3–5

In order to have a more intuitive view of the service time of common household appliances, we calculate the average service time of each appliance, as shown in Fig. 2. It can be seen intuitively that air conditioning has the longest service time every day, with an average service time of 6 h every day. TV and heater daily use time is the same, other electric appliances use less.

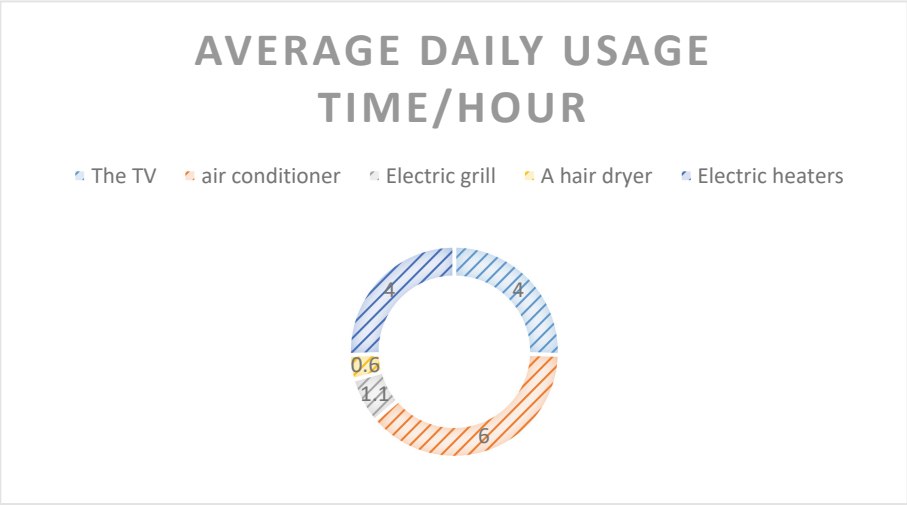

Fig. 2. Household appliance parameters and average daily usage time

4.2 Investigation of User's Requirements for Input Power Stability

The stability of the input power will affect the service life of household appliances, it will also affect the user's sense of use, and it will also affect the working efficiency of household appliances. Therefore, the results of the user's requirements for the stability of the input electric energy are analyzed. Residents in the community can be divided into four levels: higher requirements, general requirements, lower requirements, and no requirements the corresponding survey results are shown in Fig. 2 and Table 2. From Fig. 2 and Table 2, we can get that: 118 users have higher requirements for the stability of the input power, which is the largest number of users, accounting for 59% of the total;68 people have general requirements for the stability of the input power, accounting for 34% of the total; 13 people have low requirements for the stability of the input power, accounting for 6.5% of the total; only one user in the survey has no requirements for the stability of the input power, accounting for 0.5% of the total. It shows that most users have high requirements for the stability of the input electric energy, and few people have no requirements for the stability of the input electric energy (Fig. 3).

Table 2. The proportion of input power stability required by different users

Requirements for input power stability	Proportion of the total population
High requirements	59%
General requirements	34%
Low requirements	6.5%
No request	0.5%

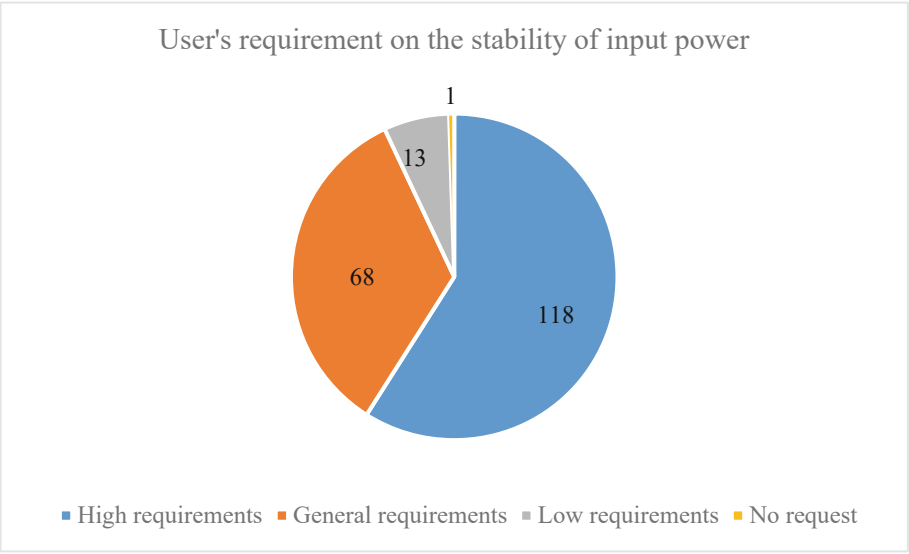

Fig. 3. User's requirement on the stability of input power

5 Conclusions

The rapid development of economy and society has promoted people's living standards. The consumption of fossil energy has made the energy problem more and more serious. The development of new energy sources to alleviate energy pressure has become the focus of social attention. Connect the inverter to the new energy grid, use dual-loop control algorithm simulation technology to adjust the power of the new energy grid, realize the rapid increase/decrease of the power of the new energy grid, and ensure the stable output of electric energy. The use of dual-loop control algorithm simulation technology can reduce errors and reduce production costs, maximize power utilization, and can also increase power output rate and improve the quality of output power. Through the analysis of the results of the questionnaire survey on the impact of the electric energy output from the new energy grid on residential electricity consumption, it can be concluded that the electricity consumption in August in the 2020 electricity consumption survey is 24880 KW/h, which is the month with the highest electricity consumption of the year; the electricity consumption in November is the least in the whole year, which is 9013 KW/h, indicating that climate issues will affect the usage of household appliances. The greater the usage of household appliances, the greater the consumption of electricity by residents. The power of the air conditioner in household appliances is the largest. Its nominal power is 2200 W, and the average power consumption time is 4–8 h/day, which is the electrical appliance with the longest average use time; the home appliance with the smallest power is the hair dryer, which has the shortest average usage time, with an average electricity usage time of 0.6 h/day. In the result analysis of the residents' requirements for the stability of the input electric energy, we can get: There are 118 users who have high requirements for the stability of the input power, accounting for

59% of the total number of users. Only one person has no requirement for the stability of the input power, which only accounts for 0.5% of the total number of users, it shows that most users have higher requirements for the stability of the input electric energy, and very few people have no requirements for the stability of the input electric energy.

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