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Energy Optimal Scheduling Based on Smart Grid Technology Load Control Thermostat

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In view of the present situation of large-scale centralized development of new energy sources, the necessity of new energy sources developing and the characteristics of the new energy sources are analyzed. The traditional scheduling technology support system has been unable to cope with large-scale new energy grid connected power grid operation to bring challenges. We introduces a based on multi time scale of new energy coordination optimization scheduling method, including years/ monthly new energy power plan, recently and days rolling optimal scheduling based on the ongoing promotion application of smart grid dispatching control system, the platform design and development of new energy scheduling technology support system. Weighted factor queuing algorithm allows users to choose according to their own preferences and needs of the load device response, to ensure that the control effect, but also take into account the user's comfort and fairness.

1. Introduction

The new energy output of wind power and photovoltaic power generation has characteristics of volatility and uncertainty. When the power system is relatively small, the new energy fluctuation can be regarded as error of load forecasting (Liu et al. 2005). But when the proportion of new energy to a certain extent, the output volatility and uncertainty will to power grid brings many challenges: increasing pressure on power grid peak load and frequency regulation; power operation mode arrangement and increase difficulty of the spare capacity allocation; power quality; affecting security and stability of the system (Hu et al. 2013). At this point, the traditional power supply for a long time to determine the mode of scheduling management is no longer applicable (Zhu et al. 2012).

And new energy power generation scheduling has a strong policy (Shariatzadeh et al. 2015). Therefore, it is necessary according to the requirement of the new energy characteristics and operation policy, set up to adapt to the dispatching technical support means, making grid operation can fully adapt to the characteristics of large-scale new energy generation, improving power system new energy utilization rate (Spencer et al. 2004). Firstly, this paper analyzes the characteristics of new energy scheduling, introduces a kind of based on multi time scale of new energy coordination optimization scheduling method, including the formulation of the annual monthly new energy plan, and recently and rolling optimal scheduling method (Sadek et al. 2008). Finally, a detailed description of the smart grid dispatching control system based on the platform of the new energy scheduling technology support system framework design, the function of each sub module, as well as the application of the system (Tarighat et al. 2005).

Through this system, the coordination and optimization of new energy sources can be realized. To further reduce new energy prediction error, to ensure maximum safety of new energy consumption. Distributed power supply contains wind, light and other new energy sources, its power generation is intermittent and uncertain, and it brings some difficulties to the optimal utilization of new energy sources and its operation control. The traditional micro grid operation control strategy is to rely on battery and other energy storage equipment as the main control means, construction and use costs are higher, it is difficult to promote. Therefore, the introduction of the demand side response, propose a queuing algorithm based on improved algorithm of weighted coefficient, can directly control the home environment of common air conditioning and heat pump temperature load for participating in the demand side response, so as to realize the micro control system optimal operation.

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2. New energy coordination and optimization scheduling technology based on multi time scale

2.1 Electric quantity plan making method

In order to optimize the system operation mode, in order to ensure the effective implementation of the annual plan of the conventional power supply based on maximum for new energy power consumptive space and need to develop new energy annual / monthly electricity plan (Stoller et al. 2013). The new energy / monthly plan should be based on the long-term forecast of new energy generation in the year / month, then according to the operation mode of the whole network to optimize the power balance, and ultimately get the power system can be included in the power system operation (Beek et al. 1995).

Through the development of new energy in / monthly plan, in the annual / monthly operation mode set aside reasonable new energy receiving space and ensure the implementation of the annual / monthly plan (Wong et al. 2005). System operation mode optimization and maintenance arrangements and improve the operational efficiency of the conventional unit and for the optimization of the new energy source management, improve power system new energy utilization rate has an important guiding role and the construction of regional power grid and new energy also has guiding significance (Wong et al. 2001).

New energy / monthly electric energy plan making method is generally based on the annual / monthly new energy consumption forecast results are determined, reserved space (Zhu and Raore et al. 2011). However, at present, wind power has become an inevitable fact, the prediction of wind power can not be fully integrated into the balance. Therefore, the simulation method based on time series production is needed to simulate the whole year operation. Considering wind power output characteristics, load characteristics, load characteristics of a unit, transmission capacity and other factors, in order to maximize acceptance of wind power as the optimization objective, the hourly optimization of the whole network with the power balance of the wind power, was built to study the provincial grid annual wind power plan optimization model, used to guide containing wind power annual system operation mode.

2.2 New energy recently optimized scheduling method

A new energy plan should not only consider the load constraints, but also consider the power flow of each section of restrictions. By accepting the capability evaluation can be optimized power curve, for new energy consumptive vacates space, achieve new energy and conventional power coordinated operation, improve the economical operation of the system (Sotgiu et al. 2014).

To meet the principle of priority consumptive new energy, new energy power generation optimization scheduling model of the objective function should be set for system in the new energy of the total power brownouts, namely minimum:

$$\min\left(\sum_{t=1}^{T}\sum_{i=1}^{Nw}P_{W_{ci}}^{t}\right) \tag{1}$$

Type: T is the number of scheduling the total cycle time; N_W access system of new energy station number; Pt_{Wci} for new energy station I at time t power rationing power. The constraints of the model are as follows:

$$\sum_{i=1}^{N_{Tw}^{i}}\left(P_{W_{pi}}^{t}-P_{W_{ci}}^{t}\right)\le P_{T_j}^{\max}\qquad j=1,2,...,N_T \tag{2}$$

$$\sum_{k=1}^{Ng}P_{Gk}^{t}=\sum_{m=1}^{N_L}P_{Lm}^{t}-\sum_{t=1}^{Nw}\left(P_{W_{pi}}^{t}-P_{W_{ci}}^{t}\right) \tag{3}$$

$$P_{Gk}^{\min}\le P_{Gk}^{t}\le P_{Gk}^{\max}\quad k=1,2,...,Ng \tag{4}$$

$$-r_k^dT_x\le P_{Gk}^{t}-P_{Gk}^{t-1}\le -r_k^uT_x\quad k=1,2,...,\mathrm{Ng} \tag{5}$$

$$\sum_{k=1}^{Ng}\left(P_{Gk}^{\max}-P_{Gk}^{t}\right)\ge P_{Ru}^{t\min} \tag{6}$$

$$\sum_{k=1}^{Ng}\left(P_{Gk}^{t}-P_{Gk}^{\min}\right)\geq P_{Ru}^{t\min} \tag{7}$$

T_{Gk} is the conventional unit k t time output project value; N_g is the number of conventional unit; N_T is the number of main transformer system access to new energy station; N_{jTw} is the number of new energy access J main transformer station; main transformer capacity of J P_{maxTj}; P_{tLm} m for bus load at time t predictive value; N_L is the number of bus load; P_{maxGk} and P_{minGk} respectively, the maximum and minimum output technology of conventional units of K; R_{DK} and R_{uk} respectively for conventional unit K maximum climbing ability within the 1min and T_x grade ability; interval; P_{tLinen} line n t time trend value; $P_{limLinen}$ current limit circuit n; N_{line} is the number of lines; P_{minRu} and P_{minRd} were the minimum demand system at time t is spinning reserve and negative spinning reserve.

Due to the large error of the new energy power prediction, scheduling scheduling process, the new energy power generation scheduling program can only be an acceptable range of operation, the scope of the uncertainty in accordance with the forecast uncertainty. Figure 1 shows a wind farm recently planned, the blue area for the wind power scheduling. The lower limit is shown in the plan period to zero power plan period, lower limit is not zero time for power period. Due to a larger range of uncertainty, in order to make the range of uncertainty is reduced, the daily adjustment must be carried out.

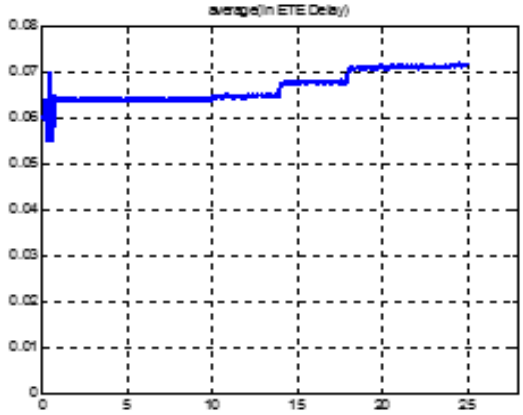

Figure 1: Wind farm planned

2.3 Micro net control structure

The community level micro network mainly consists of photovoltaic power generation system, wind power generation system, energy storage system and micro grid. The load is divided into uncontrollable load and controllable temperature control load. When the permeability of the new energy in the micro network reaches a certain level, the new energy output fluctuation has a great influence on the micro grid, which can not match the new energy output. If the energy storage device can be used to adjust, it can offset the impact of the new energy output fluctuation, but the construction and operation cost is high. If the demand side response technology is introduced, then a part of the temperature control load can be controlled to adjust the fluctuation of the output of the new energy. Due to the temperature control load, such as air conditioning needs to meet the user set temperature limits, compressor start and stop time and other constraints, the use of resources is limited.

In this paper, the control structure of the micro network is shown in Figure 2. User information by the device through the wireless network feedback to the energy management center; energy management center receives signal and is responsible for the measurement of wind and photovoltaic power, to calculate out the goal of load control and according to the control target and the user state, the proposed weighted coefficient queuing algorithm that the user control objectives and storage devices in response, and then the control signal is transmitted to each user of the colorbox equipment and storage equipment, by the colorbox according to the control signal to control the on-off state of the user equipment, in order to achieve demand side response of load control objectives. Application of the demand side response to participate in micro network operation control can significantly reduce the construction and use of energy storage system, the auxiliary energy storage system can make the load control target to get a precise response.

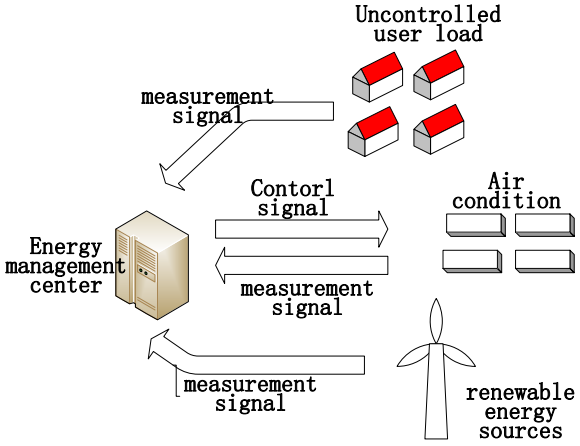

Figure 2: Control structure of micro-grid

3. New energy dispatching technology support system

3.1 Application design of technical support system

As shown in Figure 3, the new energy is divided into two levels: the grid level and station level. Grid level will be new energy station as a whole to carry on the management, and the station level as a whole in grid scheduling of wind turbine the local management of PV inverter and reactive power equipment is carried out in two aspects to support the new energy dispatch.

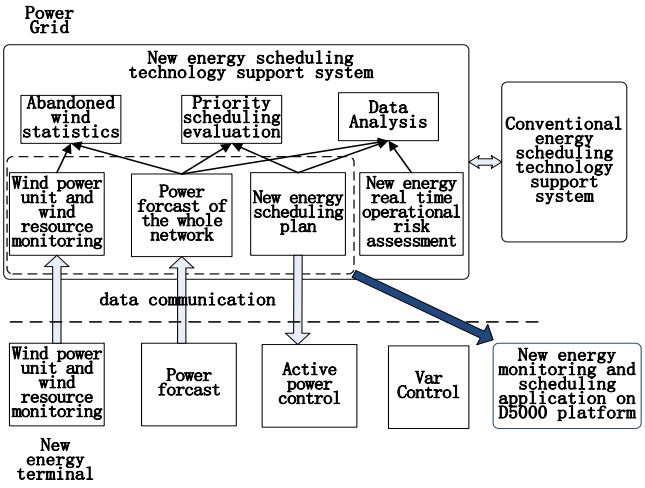

Figure 3: New energy scheduling technology support system framework

Station side through the construction of the intelligent monitor platform to achieve the unified management of all the equipment in the venue, to support the new energy scheduling, its contents mainly include: prediction of wind turbine and wind resource monitoring, power, control of active and reactive power control. Power grid side needs to start from the perspective of the whole network, the establishment of new energy scheduling technology to support the application, and with the conventional energy scheduling technology to support the application of coordination, auxiliary safe and stable operation of the whole network. New energy scheduling techniques support the application content and can be divided into two aspects: on the one hand is the runtime, including wind power units and wind resource monitoring, predictive power of the whole network, scheduled new energy, new energy to run real-time risk assessment; another aspect is the evaluation and analysis of, including abandoned wind statistics, priority scheduling and data analysis.

3.2 Control objectives and constraints

In a parallel operation of micro network exists only for PV and wind power, photovoltaic output for the PS, fan output for PW, uncontrolled state natural air-conditioning consumption load for PAC and other uncontrollable load (such as residents of the home lighting and other home appliances). Under the premise of ignoring the network loss, micro network and external network tie line power pl for the total load minus micro net photovoltaic and wind turbine generating capacity, PI:

$$P_L = \left(P_{AC} + P_R\right) - \left(P_S + P_W\right) \tag{8}$$

Without external control condition, the air conditioning needs to maintain the indoor temperature in the vicinity of the set temperature of air conditioning users, each determined by the outdoor temperature, the thermodynamic parameters of the temperature change of the room. And, due to the existence of color box, PAC and other air conditioning load controllable load PR Home Furnishing uncontrollable is capable of real-time measuring. To maximize the use of renewable energy to follow the principle of the maximum power, renewable energy has been played, t moment of tie line power control objectives can be set to

$$P_L^{target,l} = \left(P_{AC}^l + P_R^l\right)\left(1 - s\%\right) \tag{9}$$

Weighted factor queuing algorithm allows users to choose their own response degree, green represents the most preferred response, yellow represents a second priority response, red represents a non priority response, black represents never respond. In of on line power and control object connection created demand control, priority control user green; when meet the constraints of the controlled equipment used but has not yet reached control goal, yellow user control, followed by analogy. But even if the green yellow red user controllable resources are exhausted, still cannot reach the control target, the user will not respond to black. Different response level of user control of the sequence is shown in Figure 4.

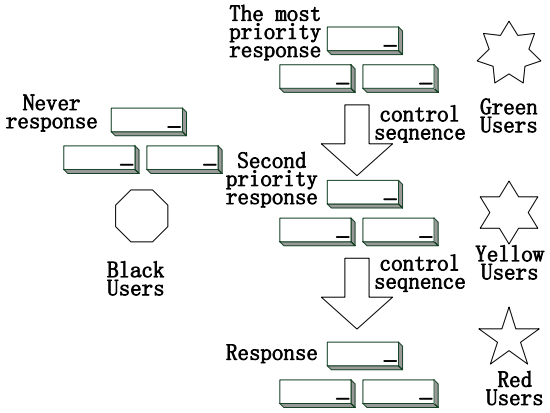

Figure 4: Different response level of user control of the sequence

Weighted factor queuing algorithm allows users to choose their own response. Some users do not want to own device is external control; some users to ensure their comfort degree than equipment response priority is too high; and some users for more and power companies signed the economic compensation agreement provisions of economic compensation, willing to equipment priority in response to the control signal. User response to different levels of choice will affect the number of users to be controlled. The higher the priority level, the more control the number of times. Black user group is controlled for 0 times. As shown in Figure 5, the simulation time is 5 days, the other parameters are the same as above, the different response level of the user group is significantly different between the control frequencies.

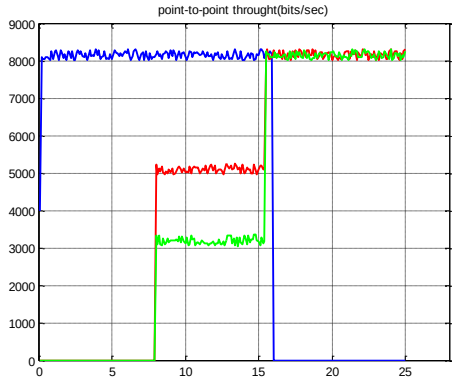

Figure 5: The simulation results

4. Conclusion

In this paper, the necessity of developing new energy sources and the characteristics of new energy sources are analyzed. In view of the present situation, the large-scale centralized development of new energy sources. On this basis, introduces a based on multi time scale of new energy coordination and optimization of scheduling techniques, including years / monthly electricity planning, in the optimal scheduling, in cooperation with multiple time scales, gradually reduce the new energy prediction error influence. With the gradual improvement of the proportion of new energy power generation, the real-time operation risk assessment of new energy sources to ensure the safe and stable operation of power system will be more and more important, but also the focus of future research.

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