The Blackout in North America and Canada

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Abstract: Power system stability is the ability of a power system under given operating conditions to revert back to operational equilibrium after being disturbed. The stability of the grid is very important for a country. Because of certain reasons, a blackout was happened in North America and Canada. We studied the incident and learned how to make the grid work reliably.

Keywords: Blackout; Power system operation

1. Introduction

Today in the 21st century, China's power development has entered a new stage of large power grids, large units, high parameters, ultra-high voltage, Automation, andinformatization. Power has become an indispensable means of production and life for economic development and people's lives. Information to ensure a safe and reliable power supply is essential. Disintegration of power grids and large-scale power outages will not only cause huge economic losses, affect people's normal lives, but also endanger public safety and cause serious social impacts. The US-Canada "8·14" power outage caused us to think deeply about the security of the power grid.

2. Background

At 16:11 on August 14th, a large-scale power outage occurred in the northeastern United States and Canada's United Power Grid. In the first 3 minutes of the accident, 21 power plants, including 9 nuclear power plants, stopped operating. More than 100 power plants in the United States and Canada were subsequently tripped, including 22 nuclear power plants. The total load loss is 61.80GW, and the power outage range is more than 9,300 square miles. It involves 8 states including Michigan, Ohio, New York, New Jersey, Massachusetts, Connecticut, Ontario and Quebec in Canada. The affected population is about 50 million. By 21:30 on the evening of August 15, New York City fully restored power supply after 29 hours of power outage [1]

3. Discussion

The direct cause of the accident was that a 345 kV transmission line tripped and its transmitted power was transferred to the adjacent 345 kV line which made the lineoverheat and sag for a long time, then it contacted the under-line trees. The line was tripped due to a short circuit fault, causing the system voltage dropped. Since then, a series of chain reactions have occurred, including multiple return transmission lines, large tidal current shifts, system sway and oscillation, local system voltages further reduced, causing generator sets tripped, resulting in increased system power shortages and further voltage collapse. At the same time, more generators and transmission lines were tripped, causing large-scale power outages [2]

However, there are many macro reasons which caused the blackout.

The power grid lacks a scientific and unified plan and does not form a reasonable grid structure. The North American power grid is gradually formed by multiple power grids. Since there is no unified planning, it has formed a situation in which the power grid has many voltage levels, the network structure is complex, the electromagnetic loop network is staggered, and it is difficult to implement effective control and disaggregation measures in the event of an accident.

The construction of the power grid is lagging behind, and the network transmission capacity is insufficient. The United States has placed too much emphasis on the role of market mechanisms, especially the policy of controlling sales price and liberalizing on-grid tariffs, which has reduced the profit level of the grid and reduced the rate of return on investment. Investors have lost interest in power grid construction, which has affected the development of the grid. According to the American Electric Power Research Association, US electricity demand has increased by 30% in the past 10 years, while power transmission capacity has only increased by 15%. Due to the lag of power grid construction, the line load during the peak load period in summer is too heavy. Once an abnormal situation occurs, it is easy to cause a chain reaction, resulting in a large-scale power outage.

Power grid management lacks an effective coordination mechanism, and it is difficult to unify scheduling and

unified command. The transmission, supply and use of electricity are instantaneously completed at the same time, and the production and consumption of electricity must maintain an instantaneous balance. The large power grid must implement unified dispatching, coordinated control, and unified command during accidents. This is determined by the objective law of power production, which is difficult to achieve in the United States due to the constraints of the power grid management system and operational mechanism. The US power grid adopts a decentralized management model. Each power grid is relatively independent in management. There is no unified scheduling during operation, and there is no unified command in the event of an accident. In the electricity market, there are many market players (more than 100 power transmission companies responsible for power transmission), and each entity is easy to ignore the power grid security for the local economic benefits and ignore the objective laws of power production. Since 1965, the United States power grid has repeatedly experienced large-scale power outages, and the problems in the power grid management system and mechanism cannot be said to be an important reason. In addition, the accident occurred locally. After more than one hour, it failed to be processed in time, and the power grid collapsed. It took about 29 hours to recover which indicating that the emergency response mechanism during the US grid accident was not perfect. The United States has been aware of these problems and has taken improvement measures, such as the establishment of the North American Electric Reliability Association after the November 1965 accident, but it is only an industry organization. Due to the lack of mandatory management tools, the function is not obvious.

The coordination between the grid relay protection and the safety automatic device is poor, which fails to prevent the accident from expanding. Since the grid cannot be uniformly dispatched and managed, the secondary system of the US power grid cannot be uniformly configured and set. Therefore, in this accident, the failure effect was not effectively and timely eliminated according to the accident situation, resulting in a series of chain reactions and developing into blackout accident. This indicates that the configuration and coordination of the secondary system of the North American power grid has obvious defects and functions are not perfect.

In order to reduce costs, each power grid company did not perform normal maintenance on high-voltage transmission lines. The US power grid had an accident caused by the failure to clean up the trees in the transmission line. This problem was exposed in the 1996 Western Blackout, and that year it has once again become the fuse of the accident.

4. Conclusion

The accident reflected the shortcomings and loopholes in the US power system. This is terrible for power system reliability. We should avoid this kind of thing happening. Ample power generation, transmission, distribution, reasonable power market structure, operational rules, effective supervision and regulation are the basis for ensuring the safe and stable operation of the power system and power market. The destruction of the stability of the power system will cause a large number of users to interrupt the power supply, and even lead to the collapse of the entire system, the consequences are extremely serious. Therefore, maintaining the stability of the operation of the power system is of great significance for the safe and reliable operation of the power system.

5. Recommendations

This accident is very terrible and brought many problems to the country and the people. Therefore, we need to prevent this kind of accident from happening. We can learn a lot from the blackout in North America and Canada which make China's power grid run better.

Do a good job in the unified planning of the power system. The large-scale power outage accident occurred in the US power grid several times. The main internal reason is the lack of unified planning. The grid structure has not achieved reasonable stratification and partitioning, and the anti-interference ability is poor. In the case of peak load, the line load is heavy, and when the "N1" fault occurs, the adjacent lines are easily overloaded and successively tripped. It is also difficult to take appropriate disaggregation measures when the fault expands. In addition, the reduction of investment in power grids in recent years and the lag in power grid development have made this situation even more serious. China should learn from the lessons of the United States and do a good job in the unified planning and construction of power and power grids. The main points are: adhere to the principle of decentralized access to the receiving end system; strengthen the main support of the intermediate support and receiving end systems of the transmission channel; achieve reasonable hierarchical partitioning and clear structure [3]

Adhere to the principle of unified dispatch. There is no unified power dispatching center in the United States that can coordinate the operation of power grids in various regions. There is no unified and effective management mechanism for grid dispatching and operation. China should adhere to the principle of unified dispatch, and achieve coordinated operation and control of large power grids, including unified arrangements for operation modes, unified arrangements for power plant maintenance, coordinated deployment of relay protection and safety automatic devices, and unified command of accident handling toensure the safe and stable operation of the entire power system.

The grid operation must have sufficient spare capacity. In the United States, the accident was the same as some of the previous accidents. Most of the accidents occurred during the heavy load operation of the power grid. Once the grid fails, the large power supply will exit, and a chain reaction will occur due to insufficient power supply, which will expand the accident. At present, the power supply situation in some parts of China is tense, and the operation of the power grid is in a state of insufficient standby or no standby. Therefore, it is necessary to pay great attention to rationally arrange the operation mode and take various effective measures to provide reliable guarantee for the safe and stable operation of the power grid.

Strengthen the optimization of relay protection and safety and stability automatic devices. The expansion of the accidents in the US power grid is related to the configuration of relay protection and safety devices. China's power grid structure is weak, and the requirements for secondary relay protection and safety automatic devices are higher. It is necessary to develop advanced and reliable relay protection devices and stable control technologies, and build three lines of defense to prevent accidents from expanding and avoid large-scale blackout accident.

Strengthen the power system calculation analysis and simulation test work. Adhere to the calculation analysis and simulation test of the power system. Through the accident prediction analysis, find out the weak links in the system and make a good plan for possible accidents, which is very important to prevent the occurrence of large-scale blackouts.

References

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