

PAPER • OPEN ACCESS

A reliable measure solved the voltage sag problem by comprehensive energy service mode

To cite this article: Zuquan Liang and Zhengxing Yan 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **252** 032085

View the [article online](#) for updates and enhancements.

A reliable measure solved the voltage sag problem by comprehensive energy service mode

Zuquan Liang^a, Zhengxing Yan^b

State Grid Sichuan comprehensive energy service Co., Ltd, Chengdu 610016, China

^aliangzuquan@126.com, ^b1378126450@qq.com

Abstract. With the rapid development of our country's economy and the improvement of residents' living standards, the power users are paying more and more attention to the quality of electric power. As the subsidiary of the State Grid Company, the comprehensive energy company should be actively involved in the solution of it. Based on the analysis of power quality market, the studies on the problems such as advantages of comprehensive energy company to solve the problem, the measures can be adopted and the risk may encounter are analyzed. And it also suggests several modes of the project for Comprehensive Energy Service Company to carry out. It will give a certain theoretical basis to related work.

Keywords: the voltage sag; comprehensive energy service; electric power quality.

1. Introduction

As the renewable energy sources such as wind power, photovoltaic power generation developed rapidly in China [1], a new set of power quality problems [2] also accompanied with the application of electrified railway, the acceleration of urban rail transit construction, the widespread use of new energy car battery pile and the emergence of various kinds of new electronic equipment. These new problems can be viewed as the extension of the past one which had existed in the past long time. At the same time, with the rapid development of our country's economy and the improvement of residents' living standards, the power users are paying more and more attention to the quality of product. On supply side it is necessary that the structural reform of electric power and electric power service requirement has quietly shifted from "quantity" to "quality".

Power quality problems including harmonic pollution, voltage sag, imbalances of three phases and so on. As the voltage sag [3] is difficult to solve, big losses to the enterprise, high admittance of market threshold, wide social influence, it is conducive to a comprehensive energy company to play its own advantages. So this article focuses on the control methods of voltage sag.

2. Market Analysis

The loss caused by voltage sag to the high-end manufacturing enterprise is huge and it has been a biggest pain point of enterprise production which seriously restricted the local government attracting business and investment [4].

It has reported that Shanghai, Nanjing, Wuhan, Fuzhou, Xiamen, some provincial governments and municipal governments noticed the electric power company must solve this difficult problem. While the



electric power companies are trying various ways to deal with and solve it, they are mostly in the stage of scientific research and experiment and do not form a method which is worthy of technology promoting and business modeling.

2.1. Market Scale

According to the "2018 to 2023, China power quality management industry market and investment strategy analysis report"[5] published by China foresight Industry Research Institute, the Market Scale of China power quality management is expected to total 118.7 billion Yuan in 2018 and to maintain a steady growth of ten billion Yuan every year.

At present, the high-tech zone government received complaints and claims of the quality of power supply problems from high-end manufacturing enterprises in all provinces and cities in China which affected both re-investment of the high-end manufacturing enterprises and government attracting business and investment.

2.1.1. Sub heading. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. When receiving the paper, we assume that the corresponding authors grant us the copyright to use.

2.2. Market of the Comprehensive Energy Service Co., Ltd.

The comprehensive energy services is a new type of service to satisfy the diversified energy production and consumption of clients which including energy Resources planning and design, project investment and construction, diversified energy services and investment and financing service operation etc.

According to file "Practice of the comprehensive energy service business in the provincial State Grid Corporation"[6], the comprehensive energy services should be more prominent in 2018 and the goal of SG is: "strengthen and enlarge the comprehensive energy services business, promote company from an electricity supplier to comprehensive energy servicer. In 2020, ensure realized total annual income of 50 billion Yuan, strive to achieve 60 billion Yuan, get a significant boost market share". In order to achieve these goals, the comprehensive energy service company should not only carry out the normal sell electricity, electricity alternative, the energy conservation service business, but also expand comprehensive energy service value-added business scope and implement the specific implementation projects.

3. Advantages of the comprehensive energy service Co., Ltd

There are some advantages when the comprehensive energy company carries out the power quality management project:

3.1. The Power Quality Management is Professional

Voltage sag control is a worldwide problem. It has technical threshold, strong professionalism and the social capital cannot easily intervention. The comprehensive energy company relies on the SG, is a professional company of electric power with the incomparable advantages such as technologies, capital, talents etc.

3.2. Provide Good Support for Province SG Company

It can create excellent quality power supply, improve the quality of power supply, ensure enterprise to the requirement of power quality, and ensure the Quantity of Sold Electricity. It can reduce complaints and improve the social image of SG.

3.3. Gain the Support of Local Government

High-end manufacturing industry needs a high request for power quality. The ensured the power supply reliability, stability and high quality, both in line with the reform of electricity sales, and is beneficial to

the government's investment promotion and capital introduction, service and local economic development, both economic and social benefits.

These customers are sensitive to voltage sag events which included precision machining, chip electronics manufacturing, medical, aerospace and high value-added enterprise data center. At the same time they are high quality customer group of SG.

The comprehensive energy service company should provide complete sets of power quality solution for their power distribution systems which can carry out governance, service application, and solve the prominent problems at present.

Table 1. Three Scheme comparing

Numble	Scheme 1	Scheme 2	Scheme 3
1	456	456	123
2	789	213	644
3	213	654	649

4. Device Comparison

In order to realize the complete governance of power quality problems, the fast-respond device which has the following 2 characters is need:

1. It can detect the voltage sag quickly and immediately put into application;
2. The application process must not cause other problems to power grids, such as high shock, oscillation and so on.

The following devices are adopted mainly to solve voltage sag/temporary rise and voltage interruption problems at home and abroad

4.1. Uninterruptible Power System/Uninterruptible Power Supply (UPS)

It has the AC-DC-AC topology as the following figure. The structure of UPS can isolate the system with load, and guarantees the stability of the output voltage when voltage sag disturbances the power grid. Limited by the Capacity and the voltage level, it is difficult to protect the whole centralized factory or large capacity load.

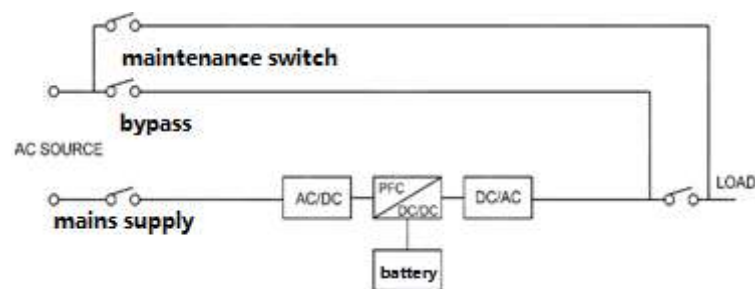


Fig 1. The main topology of UPS.

4.2. Dynamic UPS

Dynamic UPS [7] is related with UPS. The difference of them is that the Dynamic UPS is used the flywheel energy with Diesel generator while the UPS is battery.

Due to the diesel generator is used, the advantages of Dynamic UPS is that the energy storage time is long. On the contrary, the disadvantage is that it has large noise, exhaust gas pollution and it is very expensive.

4.3. Multiple Power Compensator

Multiple Power Compensator (MPC) is a kind of series-parallel type voltage sag control device based on the technology of high-speed switches (HSS). Its topology is showed in following figure.

As the switch speed of HSS is very fast (mechanical switch breaking speed is less in 4ms, power electronic switch breaking speed is less in 1ms), the MPC can supply the load with the energy storage in batteries immediately through the bi-directional inverter.

When the system voltage is recovery, the MPC will adjust the output voltage synchronized with system voltage, and make the load supply by system power by HSS. At same load the MPC is been in charging status.

HSS switch at the same time, the is rapid in operation, the load by the energy storage equipment power.

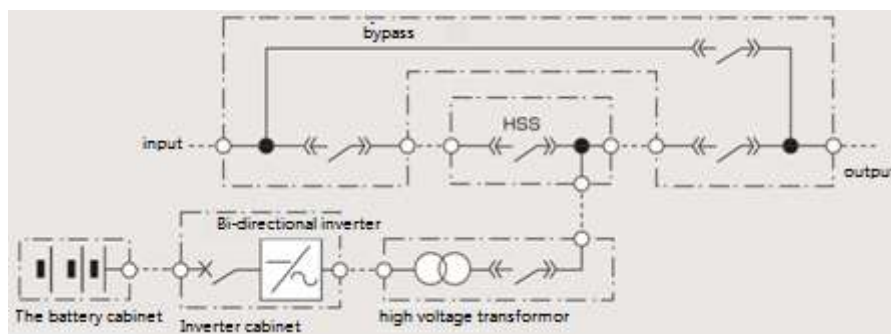


Fig.2 The main topology of MPC

4.4. Dynamic Voltage Restorer (DVR)

Dynamic Voltage Restorer (DVR) is a series kind of device controlled the voltage sag.

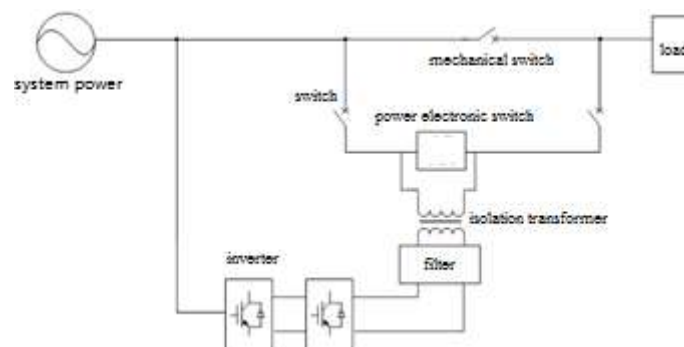


Fig.3 The main topology of DVR

In power grid when voltage sag occurs, the DVR can send a compensated voltage added to the load voltage through inverting side when the voltage sag occurs. It can provide power in short time and if the system voltage is too low such as lower than 70% percent of the rated value, the compensation effect is poor.

4.5. The solid state transfer switch

The solid state transfer switch (SSTS) is a kind of high-speed switching power supply device which can switch two power supply system in 20 ms (only consider switching speed). It is composed of a set of the parallel thyristors with fast parallel mechanical switch.

4.6. DC-Bank

There are some other Devices such as DC-Bank. It is also named uninterruptible power supply, which constructor is converter-dc load and it is a device that can provide stable, continuous and uninterrupted.

4.7. Device Comparison Results

The comparison results of the devices are showed in Table 1.

Table 2. Three Scheme comparing.

Device	UPS	Dynamic UPS	MPC	DVR	DC-Bank	SSTS
Problem can be solved	Sag; interruption	Sag; interruption	sag; interruption	sag	sag; interruption	interruption
The lowest voltage it can work under	0	0	0	>50% - 70%Un	0	0
output voltage precision when power supply is abnormal	±2%	±2%	±2%	±2%	——	——
output voltage precision when power supply is normal	±2%	±2%	±2%	±2%	——	——
The work efficiency	<95%	<95%	>99%	>98.50%	>98.5%	>99.5%
Switch time	0-10ms	0-10ms	≤1ms (Power electronic switch)	≤10ms	≤10ms	≤20ms(Pure impedance load)
compensation time	It is up to the energy storage	It is up to the energy storage	It is up to the energy storage	The duration is inversely proportional to the sag depth	It is up to the energy storage	/
Whether could cooperate with backup power supply or not	yes	yes	yes	no	the inverter working mode need to be redesigned	yes
Energy storage device	battery	The flywheel, diesel generators	battery / Super capacitor	no	battery	no
Protection scope or type	Low voltage wire/ single device	The factory/ Important wire	The factory/Important wire/Low voltage wire/single device	Important wire/Low voltage wire	the inverter	The factory (switch between Double power supplies)

From the Comparison Results of the Table.1, it is proved that the different equipment performance is difference and each of them should work in correct way. For example, the MPC products has more

than 17 years application history and no accident report means it is a useful service to solve the problem of voltage sag and it is possible to settle this “terrible” problem fundamentally in technical level.

5. Business Mode Provided:

There is some business modes recommended:

1. In current under the background of electric power system reform, the objective management results are the high-quality power demands of high-end sensitive customer. Under the market environment, differential customization means difference power rates. In order to meet the national standard of power quality, the power supply company can gain additional revenues by providing customized services which can be named “High Quality and Good Price”.

2. Companies can buyout the control devices

3. According to annual loss of the enterprise's caused by voltage sag, the Equipment Hiring mode can be adopted.

4. According to annual loss of the enterprise's caused by voltage sag, the Energy Performance Contracting (EPC) mode can be adopted.

5. Can cooperate with high-tech zone government, build high quality power supply zone where the PPP mode is adopted.

6. Main Risk and Prevention

There are some main risk and prevention:

1. The potential risk is payment collection. The avoid method is cooperated with good reputation enterprises and a tight business cooperation contract is necessary;

2. The benefits and investment risk. The avoid way is preliminary budget at prophase, strictly control at metaphase, do a good maintenance and management of operations and formulate a set of closed loop management system at anaphase;

3. The risks of control effects. The avoiding method is the plan design should be the most optimal, and approved by the equipment provider, signed a back-to-back memorandum which means both should understand the risk-sharing.

7. Conclusion

As the subdivision plate of power quality, the voltage sag Suppression is difficult in technology. But there are great market demands, the comprehensive energy company takes part in solving it can provide service function, increase the company image, be advantageous to the local investment promotion, and achieve economic and social benefits of double harvest.

Acknowledgments

This work was financially supported by Science and Technology project fund of State Grid Sichuan Electric Power Company.

References

- [1] Shaofeng Xie, Manqi Fang, Guohua Xia, haohua Dai. Influence of PV generation system accessing to traction power supply system on power quality, Electric Power Automation Equipment. Vol.38 (2018) No.10, p. 53-59.
- [2] Weijie Dong, Xiaomin Bai, Ninghui Zhu etc. Discussion on the Power Quality Under Grid-Connection of Intermittent Power Sources, Power System Technology. Vol.37 (2013) No.5, p. 1265-1271.
- [3] Xuezhen Si, Qionglin Li, Jiali Yan etc. Analysis of voltage sag characteristics based on measured data, Electric Power Automation Equipment. Vol.37 (2017) No.12, p. 144-149.
- [4] Chunmin Li, Xianrong Xiao, Yi Zhang and Yuanqian Ma. Fuzzy Comprehensive Evaluation on Loss Risk of Voltage Sag for Industry Plant, Proceedings of the CSU-EPSA. Vol.30 (2018) No.9, p. 50-56.

- [5] Information on “2018 to 2023, China power quality management industry market and investment strategy analysis report”.
- [6] Information on files of the State Grid Company in 2017. “Practice of the comprehensive energy service business in the provincial State Grid Corporation.”
- [7] Xingjian Dai, Zhanfeng Deng, Gang Liu etc. Review on Advanced Flywheel Energy Storage System With Large Scale, Transactions of China Electrotechnical Society. Vol.26 (2011) No.7, p. 133-140.