The Major Outage in South Vietnam in 2013: The Nature of Blackout, Security Measures and Strategy of National Power System Modernization

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***Abstract* - Small commentaries about major outages in the World are presented. The cause of blackout in South Vietnam is analysed. The security measures to protect power systems are considered. Modernized development of national power system of Vietnam based on Smart Grid ideology is discussed.**

***Index Terms* - Power System of Vietnam, Blackout, Security Measures, Power System Modernization, Smart Grid Ideology**

I. ANALYSES OF MAJOR OUTAGES IN THE WORLD

Let us remember the largest outages because of different nature which have occurred in the World. They are called "blackouts" when outages are affecting hundreds of thousand or millions of people.

USA, 1965. The Northeastern United States and South of Canadian Ontario Province with 30 million of people were lost power. The reason was that 230 kV line was lost, then the serial lines were switched of and finally many units of power plants shutdown [1].

USA, 1977. New York City was in darkness, 6 GW of power plant capacity were lost. It is caused by storm and lightning. Electricity supply was restored 15 hours later [2].

France, 1978. Crash of the entire grid connection led to loss of power supply for Eastern Paris. 400 kV line Nancy-Troyes overloading was as the reason because of peak hours and could weather. Disconnections of many power lines were after that. It was the biggest outage occurred in France [3].

Former USSR, 1986. The Chernobyl disaster was a catastrophic nuclear accident that occurred at nuclear power plant in Ukraine. An explosion and fire released large quantities of radioactive particles into the atmosphere, which spread over the Western USSR and Europe. The Chernobyl disaster was the worst nuclear power plant accident in terms of cost and casualties [4].

France, 1987. The first 3 units of power plant Cordemais switched off, after that 9 thermal and nuclear units were lost. The power loss was 9,000 MW. Rapid voltage collapse occurred in Western France. The outage of transformer was as initial reason [3, 5, 6].

Japan, 1987. 3 million people in Tokyo lost power. The reason was that it was too hot and the excessive use of air conditioning leads to network instability and voltage collapse. The generators of three big plants were stopped [6].

Canada, 1989. 6 million people lost of power in Quebec Province. The influence of the Earth's magnetic field related to strong solar wind was as the reason [3].

Canada and the USA, 1998. The most affected area was Quebec Province. The snow storm was as the reason. A lot of towers and poles were broke down [7].

Brazil, 1999. Lightning at a power plant in the State of Sao Paulo has made 97 million people without electricity for 5 hours [8].

USA, 2003. This service outage is the worst in the USA history. The line problems in the Midwest of the country on August 14 made 50 million people in eight USA States and Canada Provinces without electricity for more than 1 day [3, 6].

Denmark and Sweden, 2003. 5 million people were switched off from electricity [3, 6].

Italy and Switzerland, 2003. 56 million power customers were switched off. The reason caused by green tree which touched 400 kV line between Switzerland and Italy [3, 5, 6].

Moscow, Russia, 2005. The reason of blackout was in overloading many lines of Moscow supply system and voltage collapse after that. Many customers of Moscow, as well as Moscow, Tula, Kaluga and Ryazan provinces were without electricity [3].

Switzerland, 2005. 1,500 trains were paralyzed and 100,000 passengers had the problems. The reasons were in short circuit on the line, loss of power plants and unpredictable cascading development of emergency [6, 9].

Europe, 2006. The outage had big impact on European power grid. 15 million people lost electricity. The reason was in two 400 kV lines disconnection because of cruise ship on the river Ems in Germany [3, 6].

USA, 2008. 3 million people were without electricity in Florida during 4 hours. Te reason was in technical problems on substation near Miami. 2 nuclear units were lost [10].

Japan, 2011. 4 million people in Tokyo were without electricity caused by earthquake and tsunami. That led to disaster of Fukushima nuclear power plant [11].

India, 2012. 670 million people lost electricity. Power grid was saturated and weakened because of electricity consumption growth was too fast [12-14].

Philippines, 2013. The Capital Manille and 40 % of Luzon Island were lost power. 14 power plants were stopped [15, 16].

Thailand, 2013. 8 million people in 14 provinces were paralyzed caused by lightning [17].

II. POWER SUPPLY SYSTEM IN SOUTH VIETNAM

Power supply for the South Vietnam depends on 500 kV transmission line from the North, which sometimes supply up to 40 % of power consumption of South provinces. Southern Power System consists of 15 power plants with 43 units, 4,000 km of 110 kV lines, 153 substations 110 kV, more than 57,500 km of medium voltage lines, about 125,000 distributed power plants with 7,300 MW total capacity. Local power plants supply about 60-70 % of consumption in South Vietnam.

III. THE CAUSE OF BLACKOUT IN SOUTH VIETNAM

The outage occurred on May 25, 2013 at 14:20, when the green tree was touched by 500 kV line Di Linh – Tan Dinh [18-20] (see Fig. 1). This outage led to disintegration of transmission and distribution networks in South Vietnam. 43 generator units were lost with 9,400 MW of total capacity. 8 million customers (households, companies, administrative, etc.) including 1.8 million people in Ho Chi Minh City lost power during the period from 1 to 8 hours. Power systems of Vietnam does not have such a big problem two last decades.

Fig.1. Green tree fall on the 500 kV line.

After the disconnection of 500 kV line from North Vietnam big deficit of power appeared in power system of South Vietnam. This disbalance destroyed Southern power system. The automatic devices had to switch of many consumers for balancing production and consumption of power. But deficit was too much, the frequency in separated power system of South Vietnam decreased rapidly, and about all power plants were switched off automatically.

This incident shows main problem of power system of Vietnam, which deals with too long the North-South 500 kV transmission line. A total length of line is 1,487 km from the Hoa Binh to the Ho Chi Minh City. It is difficult to keep security of power system.

IV. THE PHENOMENA WHICH LEAD TO THE COLLAPSE OF THE GRIDS

During the collapse the physical phenomena of concern usually are:

- Overloading the lines,
- Increase or decrease of frequency,
- Voltage collapse,
- Loss of synchronism between generators,
- Low-frequency oscillation (case of large power systems).

The combination or succession of above mentioned phenomena are possible. This phenomena are following additional events like control system effective operation or outages, correct actions or errors of personnel, unique natural events.

There are different requirement to keep power system security in different countries. *N*-1 rule is the most used security criterion. Sometimes, for example in France, more strong *N*-2 criteria is used. Power system planners and operators have to consider these criteria during expansion planning and operation of power systems.

V. THE SECURITY MAESURES TO PROTECT POWER SYSTEMS

The classic preventive measures include:

– Construction of two lines or two-circuit line except one-circuit line. It is good for security but not always economically.

– Construction of underground cable line except outdoor line to exclude influence of extreme natural disasters (storm, lightning storm, frost, snow and ice). But it needs to take into account, that cable lines are very expensive, especially high voltage cables.

- Keeping capacity of power plants after outage.
- Increasing stability of power system by connection with neighbouring regions and countries.
- Automatic separation of power system after loss of synchronism.
- Automatic load shedding in the case of decreased frequency.
- Use of tap-changer of transformers.
- Automatic islanding of generator groups to keep auxiliary machine.

Now it needs to use additional measures like FACTS devices, measures for compensation of unpredictable output of renewable sources, modern smart technologies and tools, etc.

In general it needs to use three areas of measures – equipment, personnel and organization, and three stage of realization: preventive, during event and post-emergency measures.

Preventive measures include maintaining reserves of active and reactive power, transfer capability margins of transmission lines. Monitoring to detect the deviation of physical variables (voltage, frequency) is important on this stage. Main target of preventive measures is to prevent angle instability, voltage collapse and high risk of blackout.

The second stage of measures during outage deals with activity of emergency control system by automatic devices or, sometimes, personnel. The aim of this stage is to keep the stability of power system and to prevent unacceptable development of emergency conditions.

Post-emergency measures include balancing generation and consumption of power in separated subsystems, enhancement of acceptable levels of voltage of the nodes and line loading and frequencies of sub-systems.

All measures have to be calculated during expansion planning of power system and realized for use during operation control of the system. All measures have to consider actual standards and requirements to enhance power system security.

VI. MODERNIZED DEVELOPMENT OF NATIONAL POWER SYSTEM OF VIETNAM

The incident of power system disintegration is the most dangerous type of incidents and often has serious consequences for the society, both in terms of economy and energy security. Therefore modernized development of National Power System of Vietnam to prevent blackouts with heavy consequences is very important problem.

Taking into account the intensive development of power consumption in Vietnam, it needs to consider the construction of not only traditional power plants, which use hydro, gas and coal, but also distributed generation on the base of small hydro resources, wind, solar, biomass, and geothermal energy.

In Vietnam's nuclear program the construction of 14 nuclear reactors is expected with 1,000 MW capacity of first 10 reactors, the others with 1,300-1,500 MW. These nuclear power plants will be localized in 5 central provinces of country, i.e. 3 in Ninh Thuan, 2 in Quang Ngai, 1 in Phu Yen, 1 in Binh Dinh, 1 in Ha Tinh.

First nuclear reactor on the base Russian technology is planed in Ninh Thuan province in 2020. Full capacity of this nuclear power plant will have 8,000 MW. It will be the main source of power supply to the South of country. But many problems of South power system operation can be after the outage of unit of this nuclear power plant. Such possible problems have to be investigated. The similar problems can be met in the future concerning outages on the others nuclear power units.

Above mentioned big power plants have to be connected to 500 kV network. Therefore 500 kV network needs to develop. That can lead to the problem of big fault current what has to be studied carefully.

VII. VIETNAM AND SMART GRID IDEOLOGY

Future Vietnam's power system has many specifies what leads to important operation problems. These specifies and problems include:

- Longitudinal structure of electrical network from North to South of country and the necessity to maintain the stability of the grid;
- Big capacity of units on nuclear power plants what leads to the problems of power supply of consumers after the outage of unit, keeping frequency and power system security;
- Rapid development of renewable energy sources leads to the problems of connection and joint operation of this distributed generation with main power system;
- Big growth of electricity consumption and new technologies of many consumers need to increase the efficiency and reliability of power supply and quality of electricity.

All above mentioned specifics and problems need to use new innovative technologies and tools for application in different parts of power system. Rapid development of information technologies, computer industry, communication tools, control systems and equipment and new requirements of efficiency, reliability and quality of power supply led to use of smart grid ideology and technologies. The investigations of many countries show that smart grid ideology is the innovative technological platform of the future power systems. Vietnam has to use smart grid ideology for solving its own problem of developed power grid for improving efficiency of all subsystems. Let us present some examples of new possibilities.

- It is necessary to use modern FACTS devices like Static Var Compensator, Thyristor-Controlled Series Compensator, etc. for improving controllability of both high voltage and distribution electric networks;
- Dispersed power production structure based on renewable energy sources and strong requirements to controllability of power system need to develop communication network which has to connect generation power plants and consumers each other;
- New information technologies and modern communication network allow to increase activity of consumers in the possibilities of demand response and to take a part in joint operating control of power system and active consumers.

In generally, Smart Metering, Smart Consumers, Smart Homes, Smart Cities, etc. are important targets for developing power system of Vietnam.

VIII. CONCLUSION

Taking into account above mentioned incident of disintegration of South part of power grid, the Government of Vietnam should make quick changes in energy strategy of the country. The Government should demonstrate a political ambitions in growth of renewable energy, energy efficiency and energy saving. Smart grid can be as modern technological platform for development of power system of Vietnam.

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