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Classification of States of Power Systems

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CLASSIFICATION OF STATES OF POWER SYSTEMS

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I. INTRODUCTION

To describe the state of the power system of the country (territory, region, locality) is formed the list of indicators (indicators), the values of which allow to describe from different direction of its current state. However, the interpretation of the same value of the indicator will depend on what tasks currently are solved for the power system, or in other words, in what mode it operates. In this paper, we tried to identify possible modes of operation of the power system and their relationship with the state of country economic complex. The power system includes the following major components:

1. The electricity sector;
2. Gas pipeline complex (natural gas);
3. Liquid gas complex (LPG);
4. Providing liquid fuels (gasoline, diesel fuel, fuel oil, etc.);
5. Providing solid fuels (coal, wood, etc.).

Obviously, these components are working, at first glance independently of each other, but in fact, they are interacting with each other and form a single energy complex. Energy complex provides operation of economic complex, in particular:

- Enterprises;
- Institutions;
- Transport;
- Infrastructure (eg, housing, water supply, sewerage, heating, communications), etc.

To describe the state of the power systems is used the indicative analysis method [1]. For each indicator is formed its own scale of points, which permits to pass from the named values of the indicators to their dimensionless evaluation, which is expressed in points of scale. Let us try to apply this approach to the entire energy system entirely with some modifications.

II. THE BASIC MODES OF OPERATION OF THE POWER SYSTEM

Consider the possible modes of the operation of the power system (Table 1). As a first approximation, by analogy with [1] it is distinguished three basic modes of operation, shown in the first column of Table 1:

- Normal;
- The pre-crisis;
- Crisis.

Table 1: Modes of operation of the power system

Modes of operation of the power system		Points
Basic	Detailed	
Normal	Normal 1	1
The pre-crisis	The initial precrisis	2
	The developing pre-crisis	3
	The critical pre-crisis	4
The crisis	The unstable crisis	5
	The threatening crisis	6
	The critical crisis	7
	Extraordinary crisis	8

Consider these three basic modes of operation of the power system more detailed

Normal mode of operation: The power system provides the uninterrupted supply energy of all types of the consumers in any time of the day, in any day of the week, in any time of year.

The pre-crisis mode of operation of power system: Power system mainly provides the supply the customers with all kinds of energy, except:

- The number of cases of periodic failures in securing energy resources in some time intervals (time of the day, certain days of the week, few times of the year), that has a significant, but not critical impact on the work of the national economic complex and infrastructure;
- It is fixed the lack of a number of types of energy resources; for minimizing the damage it is formed a coordinated work schedules of different users, including segments of the national economy, transport; execution of the basic functions of the national economic complex, infrastructure it is provided with energy resources.

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III. DETAILED MODES OF OPERATION OF POWER SYSTEM

As more detailed inspection, by analogy with [1], can be separated 8 modes of operation of the power system:

- Normal;
- The Initial precrisis;
- The developing precrisis;
- The critical precrisis;
- The unstable crisis;
- The threatening crisis;
- The critical crisis;
- Extraordinary crisis.

To describe the state of the power system we can use a scale of points, that is given in the last column of Table 1.

Let us examine those modes of power system more detailed.

Normal mode: power system provides an uninterrupted supply of all types of energy consumers at any time of the day, any day of the week, and any time of the year. Crashes, that occur, satisfy the accepted norms.

The initial precrisis: Energy system basically ensures uninterrupted supply to customers of all kinds of energy, except:

- A number of cases of failure of providing energy at some time intervals (some time of the day, some days of the week, few times a year), the duration of them do not significantly interfere with the operation of an economic complex, infrastructure of the region;
- The lack of a number of individual types of energy resources, but the lack of them does not have a significant impact on the work of the national economic complex, infrastructure;
- Operation of economic complex, infrastructure, mainly, is provided by energy.

The developing precrisis: Energy system basically ensures uninterrupted supply to customers all kinds of energy, except:

- A number of cases of failure in supplying of energy at some time intervals (some time of the day, some days of the week, a few times a year), the duration of them is taken into account in the formation of an agreed schedule of institutions, organizations, but has no significant effect on the operation of an economic complex, infrastructure;
- The lack of a number of some types of energy resources, for them compensation is necessary to do corrections in the work schedule of the equipment, vehicles, infrastructure component;
- Operation of the economic complex, infrastructure basically ensured with energy resources.

The critical precrisis: Power system, mainly, provides the supply to customers all kinds of energy, except:

- A number of cases of failure to provide energy at some time intervals (some time of day, some days of the week, a few times a year), the duration of them is taken into account in the formation of the work schedule, institutions and organizations, which limits the operation of the national economic complex, infrastructure and hinders their development;
- The lack of a number of some types of energy, to compensate them, it need to make adjustments in the list (or schedule) of work of the equipment, vehicles, infrastructure;
- Operation of a number of segments of the economy, transport, infrastructure is under the strict administrative regulation;
- Operation of economic complex, infrastructure basically ensured by energy resources, but in clearly marked limits.

The unstable crisis: Power system provides an uninterrupted supply of all types of energy consumers by all types of energy resources, except for:

- A number of cases of failure in providing of energy resources at some intervals of the time (some time of the day, some days of the week, a few times a year). Their duration is taken into account in the formation of the schedule of work of the institutions, organizations, companies, which limits the operation of the national economic complex, infrastructure and hinders their development;
- Are possible unexpected failures in the operation of the energy complex, which leads to a halt of the work organizations, enterprises, transport, components of infrastructure, but their total duration does not pass over of the critical values;
- There is shortage of some types of energy resources to compensate them is necessary to correct the timetable or list of the work of the equipment, vehicles, infrastructure component, some number of them are stopped or are rarely used;
- Operation of economic complex, infrastructure are ensured with energy resources, but into clearly defined limits, there are unexpected disruptions in energy supply.

The threatening crisis: Power system provides supply to the consumers the main types of energy resources, however:

- Providing with energy resources taking place only in some intervals of time (some time of the day, some days of the week, a few times a year). Their duration is taken into account in the formation of the schedule of work, institutions, organizations, enterprises and leads to a substantial restriction of

- functioning of some segments of the economy, transport and infrastructure;
- There are unexpected failures in work of the energy sector, that leads to a halt the work of organizations, enterprises, transport components of infrastructure and have a significant impact on the efficiency of their operation;
 - It is fixed shortages of some types of energy resources, for their compensation it is stopped the work of some enterprises, transport segments, infrastructure, that results to the significant adjustments to the list of works or work schedule of the equipment, vehicles, infrastructure components;
 - Basically, energy resources are ensured the functioning of energy economic complex, infrastructure, but its performance falls.

The critical crisis: Power system is not able to ensure the supply of energy consumers with all kinds energy resources, thus:

- There are periodic disruptions in supply the energy resources in some intervals of time (some time of the day, some days of the week, a few times a year). Their duration is taken into account in the formation of the schedule of work, institutions, organizations, enterprises and leads to a substantial restriction of functioning of some segments of the economy, transport, infrastructure, the closure of some companies, the cessation of the operation of a number of transport and infrastructure segments;
- There are periodic disruptions in supply of the energy resources in some intervals of time (some time of the day, some days of the week, a few times a year). Their duration of is taken into account in the formation of the schedule of work, institutions, organizations, enterprises and leads to a substantial restriction of functioning of some segments of the economy, transport, infrastructure, the closure of some companies, the cessation of the operation of a number of transport and infrastructure segments;
- The development of all spheres of economic complex, transport, infrastructure is impossible.

Extraordinary crisis: Power system provides the main types of energy resources only critical segments of the national economic complex, infrastructure:

- It is fixed the significant interruptions in energy supply, which leads only to the work of limited number of critical institutions, organizations, enterprises, functioning only partially a number of segments of transport, infrastructure;
- It is fixed an acute shortage of certain types of energy resources, which leads to a significant restriction in work of enterprises, transport segments, infrastructure;
- It operates a small part of the national economic complex, infrastructure, which have critical important value.

IV. CLASSIFICATION OF STATES OF THE POWER ENERGY SYSTEM, EXAMPLES

Example 1: The Blackout in the Crimea, November 22, 2015 Electricity supplies to the Crimea from Ukraine completely are stopped. Power grids of Peninsula operate in standalone mode. Own generation of electrical energy, about 350 megawatts - a CHP mobile gas turbine power plants, solar sources and wind generators. However, this is less than half of the required power. Crimean power grid needs about 800 megawatts to work without constraints. Only the big cities of the peninsula supplied with electricity. Rolling blackouts are carried out every four hours. The uninterrupted supply with electricity is available only for hospitals and critical infrastructure - bakeries, treatment facilities, etc. The kindergartens and schools are not completely provided with electricity. As a results, some schools have short mode of working, kindergartens are temporarily closed. The commercial office of State Electricity Company makes electricity supplies the consumers in the alternate mode: two hours the electrical energy is switched on and six hours is switched off.

After shutting down the electrical supply, mainly part of constructions are frozen. Deliveries of natural and liquefied gas, fuel oil remain in the previous volumes. Communication and public transport, covering the needs of the population and enterprises are worked. [2]. in our opinion, the grid of the Crimea state can be classified as 6 points.

Example 2: In 2000, in Pridnestrovie there was a severe accident with falling poles, breakage of wires and large power outages. It started in the night of 26 to 27 November as a result of intensive icing HVL 330 kV and below. Damage occurred due to the fact, that the values of ice load were many times higher, than permissible values by the project. As a result of massive outages have been completely de-energized Rybnitsa and Kamenka regions, as well as partially Dubossary and Grigoriopol districts. The fall of supports are continued until 6 December 2000. Without electricity have remained 88 settlements, most of the industrial enterprises and farms. The water supply was stopped and, as a result, the normal work of the hospitals, schools, kindergartens, etc. in Rybnitsa and Kamenka. All transit HVL which could provide electricity the region from Ukraine and Moldova through substations Rybnitsa and Kamenka were damaged. On our opinion, the state of the grid Rybnitsa and Kamenka regions can be classified as 7 points.

V. CONCLUSION

In the present article is described the classification of the possible grid conditions. Each state is assigned a certain number of points. This

classification can be used when considering the country's power grid, region, city, etc.

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