CZECH TECHNICAL UNIVERSITY IN PRAGUE
FACULTY OF BIOMEDICAL ENGINEERING

Blackouts as a threat for healthcare facilities

Extensive power failure
BLACKOUT

- An extensive power outage represents a serious situation for the country, it creates many situations that endanger the lives and health of the populace.
- The main task of the state is to ensure a functioning critical infrastructure.
- The health sector is the main instrument for preserving the protection of the lives and health of the populace.

Extensive power failure
BLACKOUT

- In the event of a large power outage, the risk of emergencies, which directly and indirectly follow up on the outage, arise.
- These extraordinary events require increased activity of the Integrated Rescue System, namely the Fire Rescue Service, the Police and the Medical Emergency Services.
- The problem of a power failure, however, affects everything in the area, including health facilities, namely hospitals. It is therefore necessary that these units be able to operate even with limited power.

Healthcare and Critical Infrastructure

- Critical infrastructure (from the definition) is tied to the preservation of the basic functions of the state in crisis situations. For these reasons, 10 areas (sectors) were identified as belonging into this sphere .
- energy, water, food and agriculture, **health care**, transport, communication and information systems, banking and financial sector, emergency services, public administration, waste management.

Healthcare and Critical Infrastructure

- Healthcare is one of the most important areas, the disruption of which would have serious consequences for the populace - their health and their lives. Ministries and other central administrative authorities propose sectoral criteria and submit them to the Ministry of the Interior.
- The coordinator for healthcare is the Ministry of Health, which has established sectoral criteria in its area of competence based on the risk analysis of the necessary services assessed.
- The basic parts of the (CI) in healthcare are the following sub-sectors: outpatient and bed care facilities, pharmacies, outpatient emergency medical services and medical surgical centers.

Healthcare and Critical Infrastructure

- Health facilities are relatively equally distributed throughout the Czech Republic. If there is a failure or disruption of one HF, then it will be replaced by the closest possible facilities of a similar type. For this reason, a sectoral criterion was chosen for 2,500 acute beds in a bedside facility.
- From a factual point of view, no HF meets this sectoral criterion, not even the largest university hospital in the Czech Republic - Motol University Hospital.
- According to these criteria, the Czech Republic has no element of critical infrastructure in healthcare.

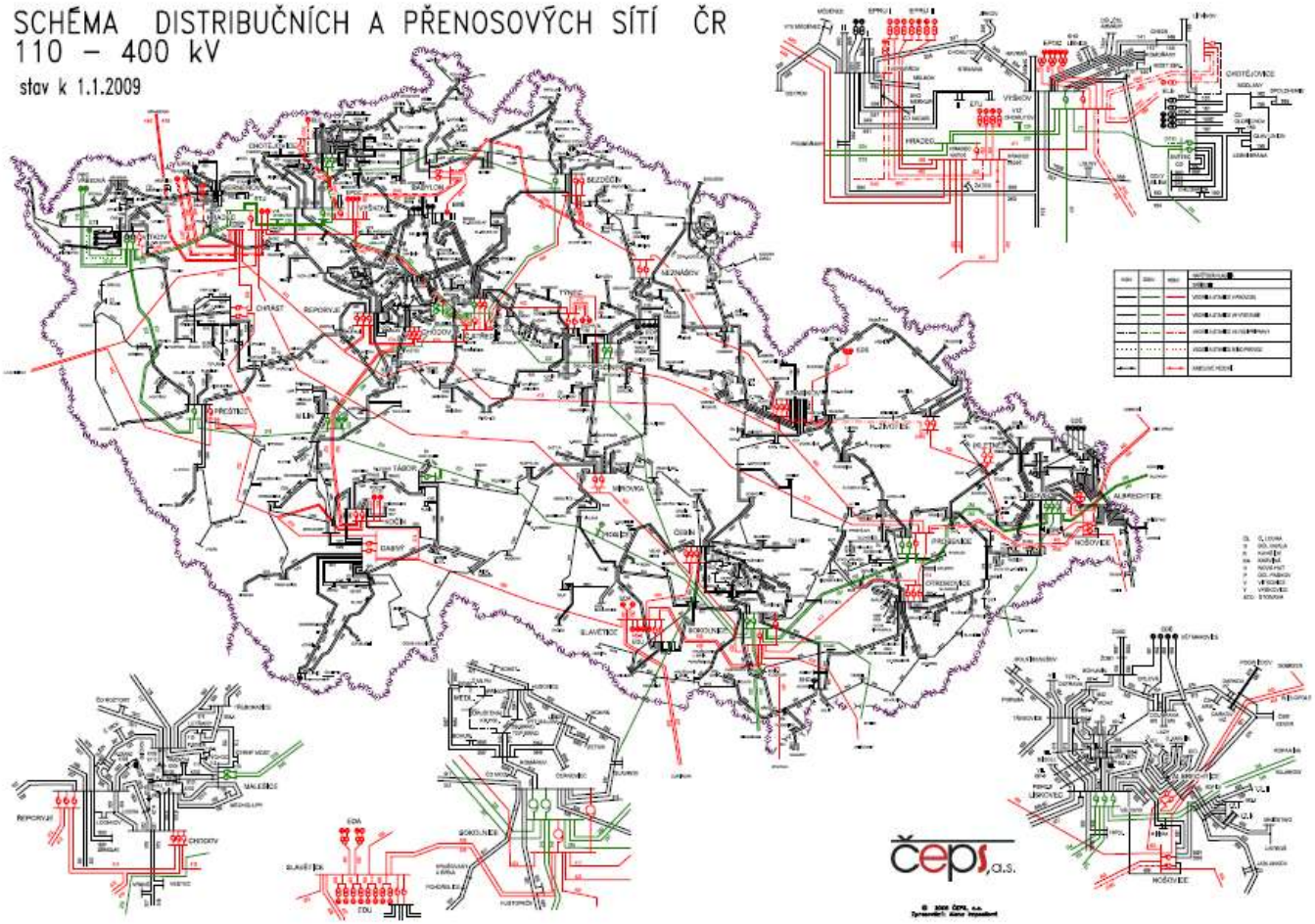
Sub-areas of critical health infrastructure

- **preventive medical care segment** : pre-hospital emergency care infrastructure (medical rescue service including medical ambulance service's necessary transportation capacity of wounded transport), hospital emergency care
- **hospitals segment**: trauma centers, centers for burnout, centers for specialized care for irradiated persons and other centers), as well as infrastructure for psychosocial intervention.
- **logistics segment**: Infrastructure of production, storage and distribution of pharmaceuticals and medical devices, including departmental deposits and deposits of the state administration of mobilization reserves.
- **public health protection segment**: Infrastructure of Institutions and Public Health Facilities.
- **health management segment**: crisis management bodies of healthcare management at different levels.

Obligations of health care providers

- To prepare a traumatology plan which adjusts a set of measures that are applied in mass disasters, and to update it at least once every two years;
- To discuss a traumatological plan draft and the proposal for its updating with the relevant administrative institution, if it is a faculty hospital, with the Ministry;
- To provide the patient with medication and medical devices for 3 days or in justified cases for the rest of the necessary time;

Transmission and distribution system



Transmission system

- ČEPS Transmission system is a subsystem of the Czech Electricity System, which connects all important entities in the system and secures a decisive share of foreign cooperation. The ČEPS transmission system consists of 2,979 km of 400 kV lines, and 1,371 km of 220 kV lines that connect 38 substations.
- ČEPS (as a TSO) provides transmission of electricity, operation, maintenance and development of the transmission system, dispatching control of the Czech Republic's electricity system in real time.
- ČEPS further processes and tests the transmission system defense plan against failure propagation and the recovery plan for the power system after extensive system failures. It technologically controls system services such as power and frequency regulation, voltage regulation and reactive power, and controls the required power reserves.

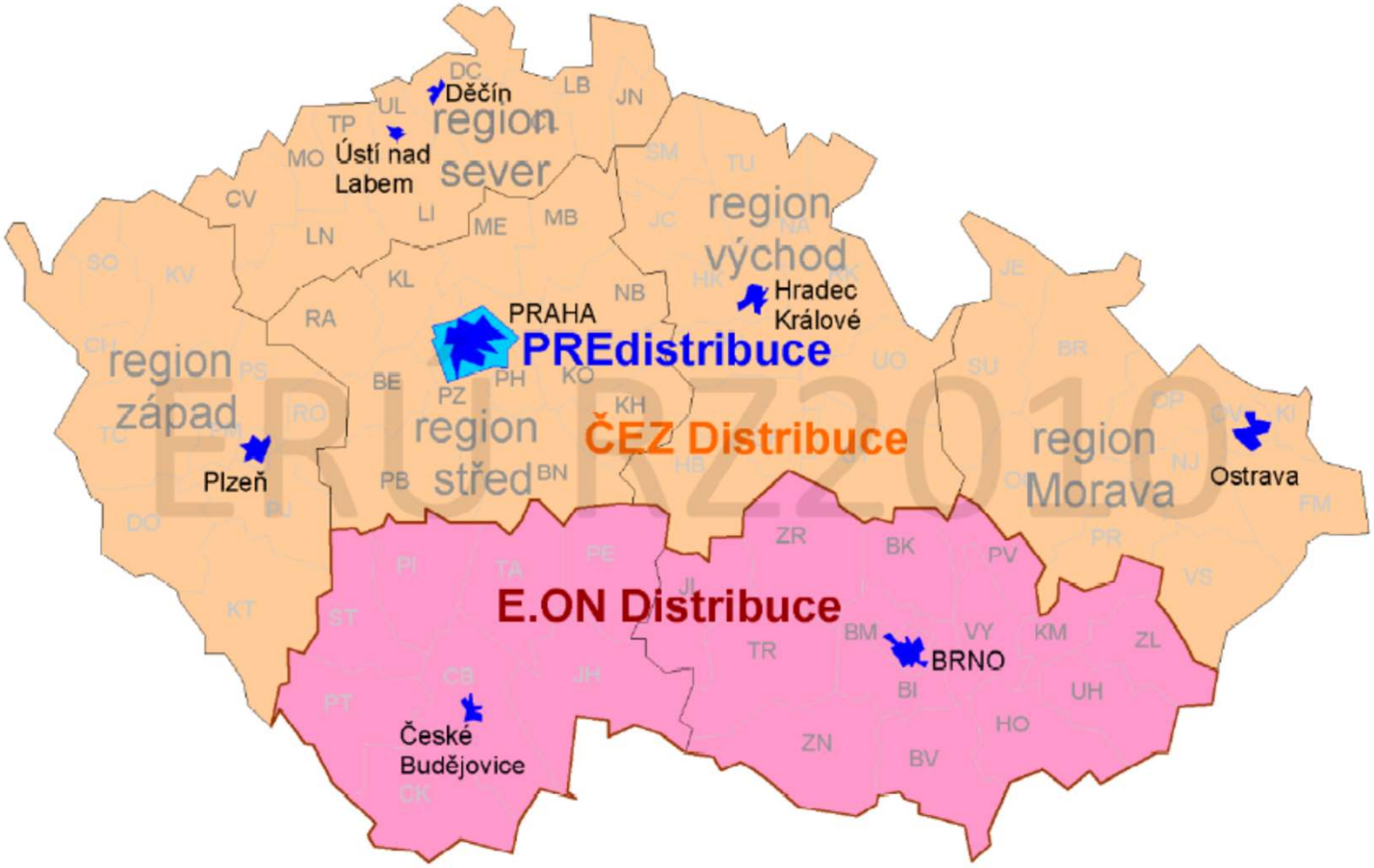
ČEPS- joint-stock company

ČEPS as an owner and operator (TSO) of the transmission system in the Czech Republic (providing dispatching service (DS))

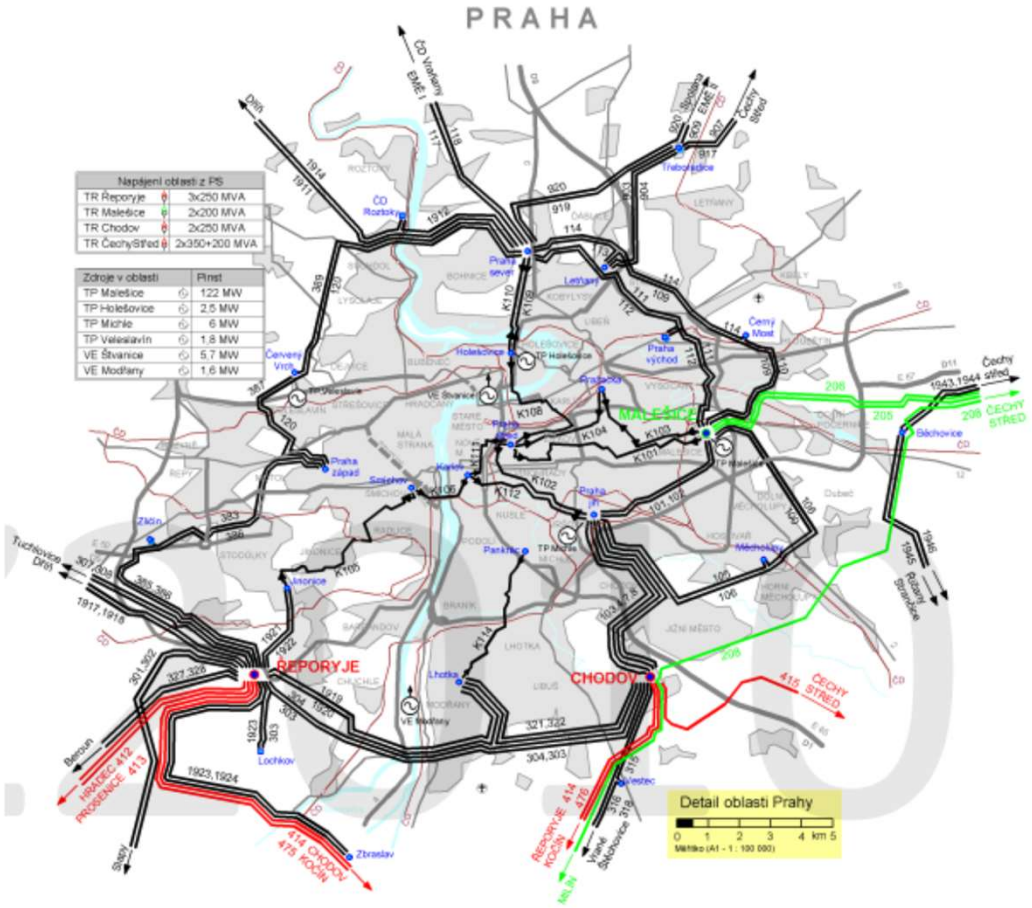
DS is responsible for:

- Ensuring an immediate balance between generation and consumption of electricity in the CR of the Czech Republic while respecting agreed electricity exchange plans with neighboring EC operators
- Flow management in the EC in cooperation with DSO, manufacturers and foreign TSO
- Optimization of voltage ratios in TS
- Implementation of planned shutdown of TS components
- Remote control at TS stations
- Solving emergency situations in TS
- Dispatching the control system
- System preparation operation (future)
- Operational Management System - SCADA / EMS (real time system)
- Evaluation system (past)

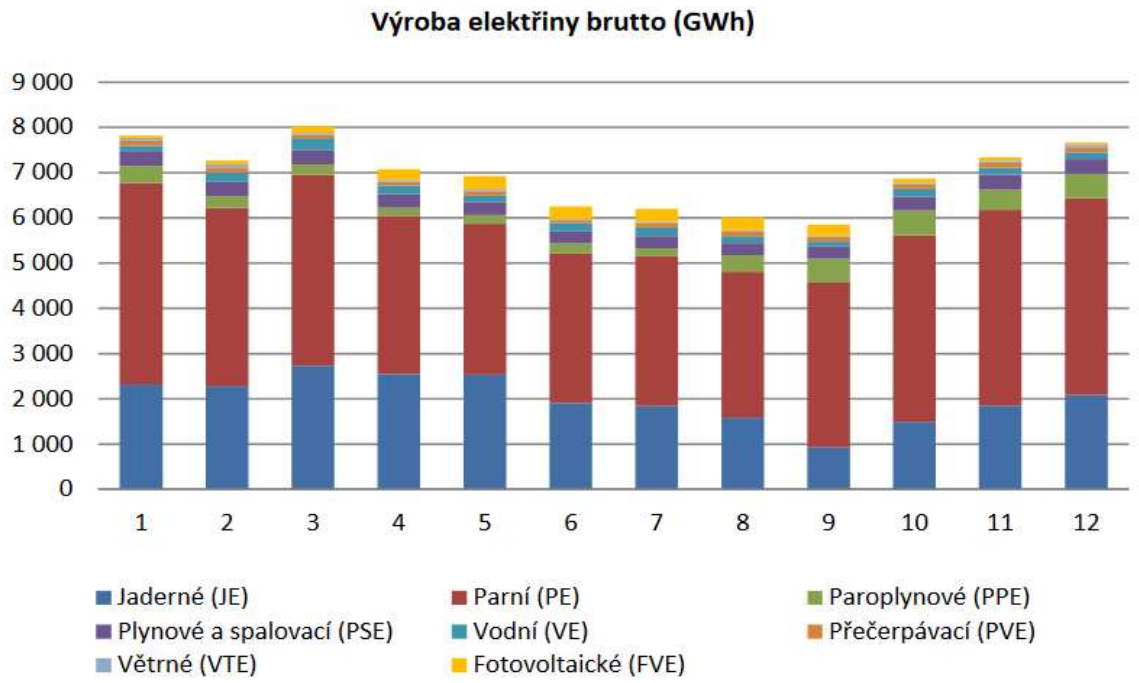
Distribution companies



Distribution company PRE

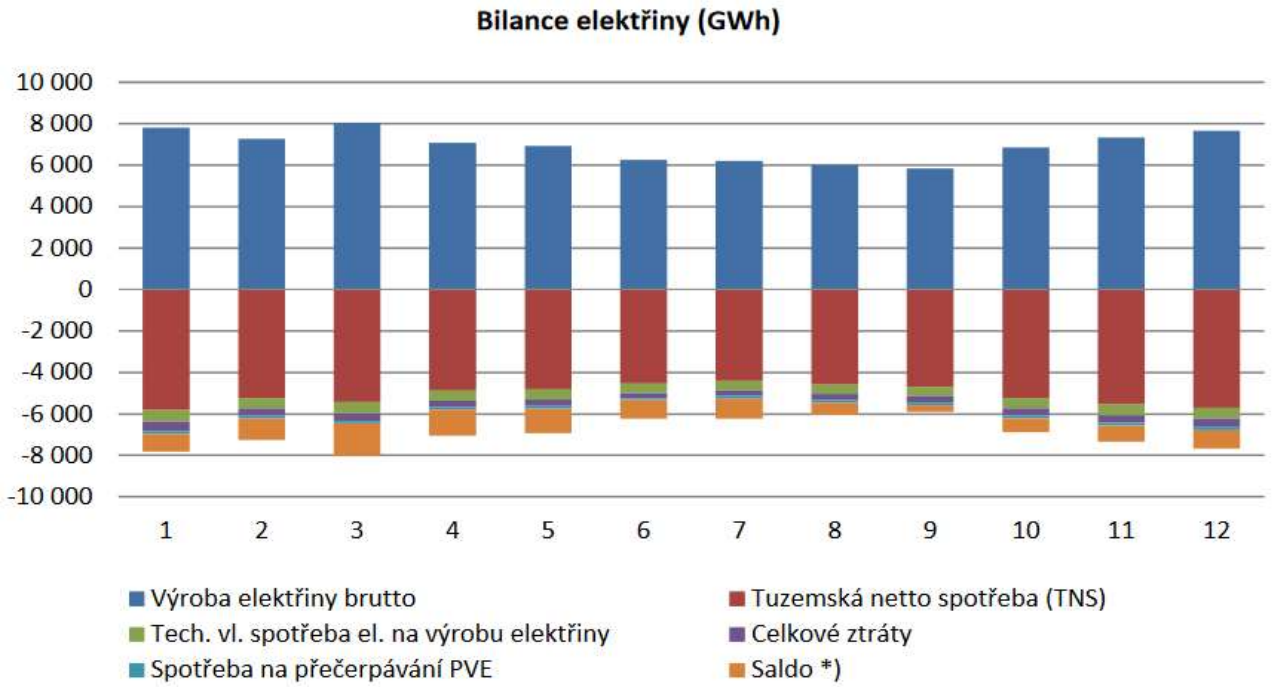


Power sources in the Czech Republic



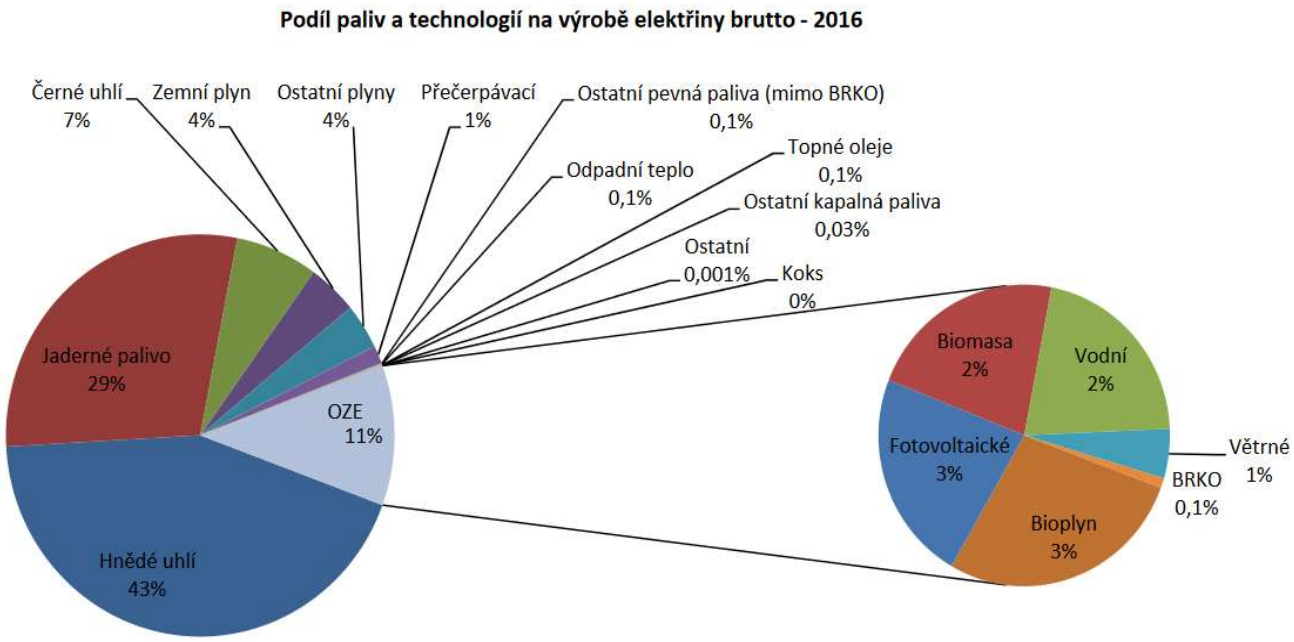
Total production per year 83,3 TWh
Net production per year 77,4 TWh

Electricity balance in the Czech Republic

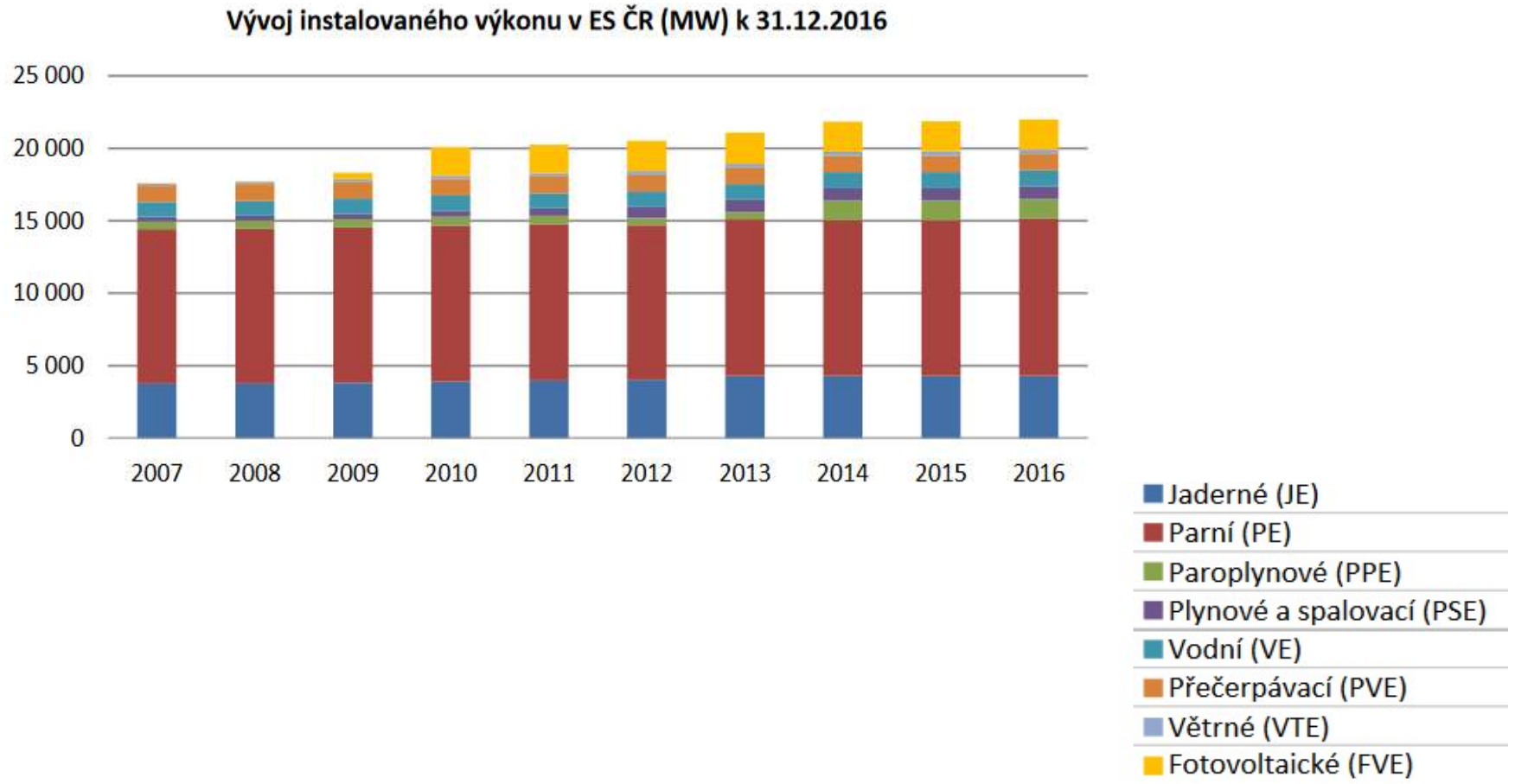


Saldo per year 10,9 TWh
Losses in the system per year 4 TWh
Consumption in the Czech Republic 59.7 TWh

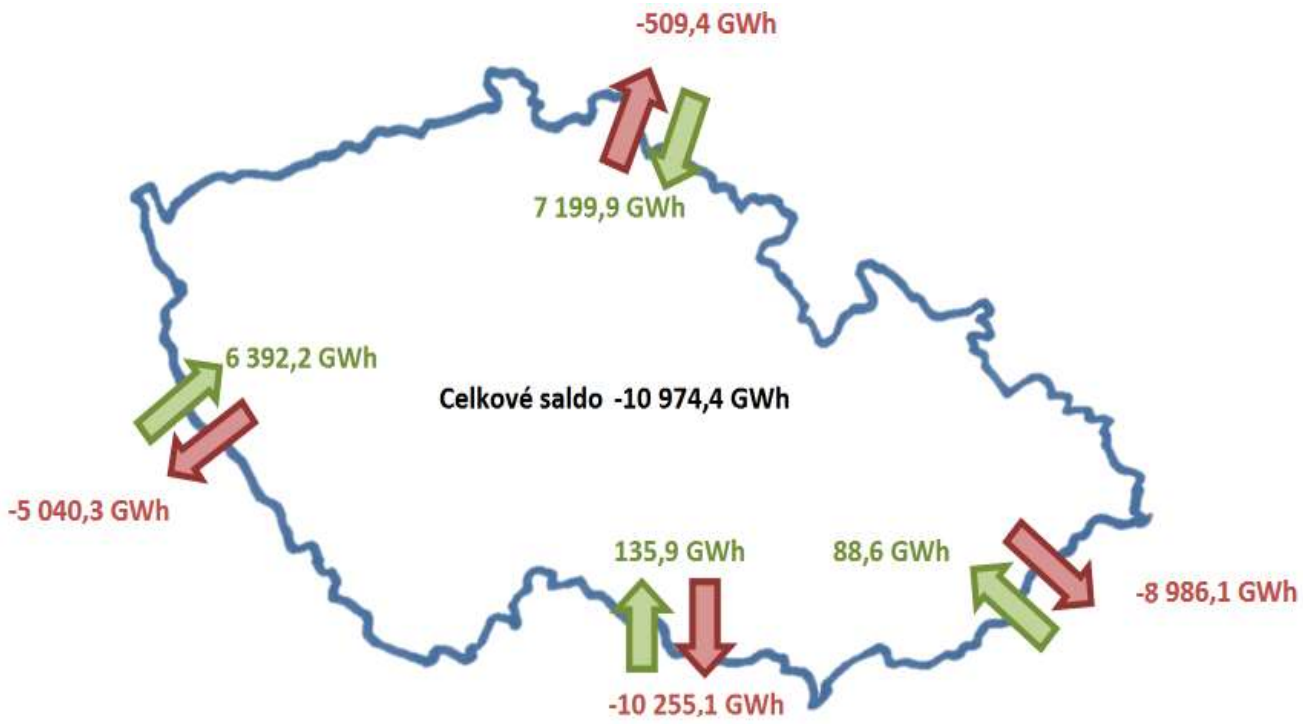
Types of electricity sources in the Czech Republic



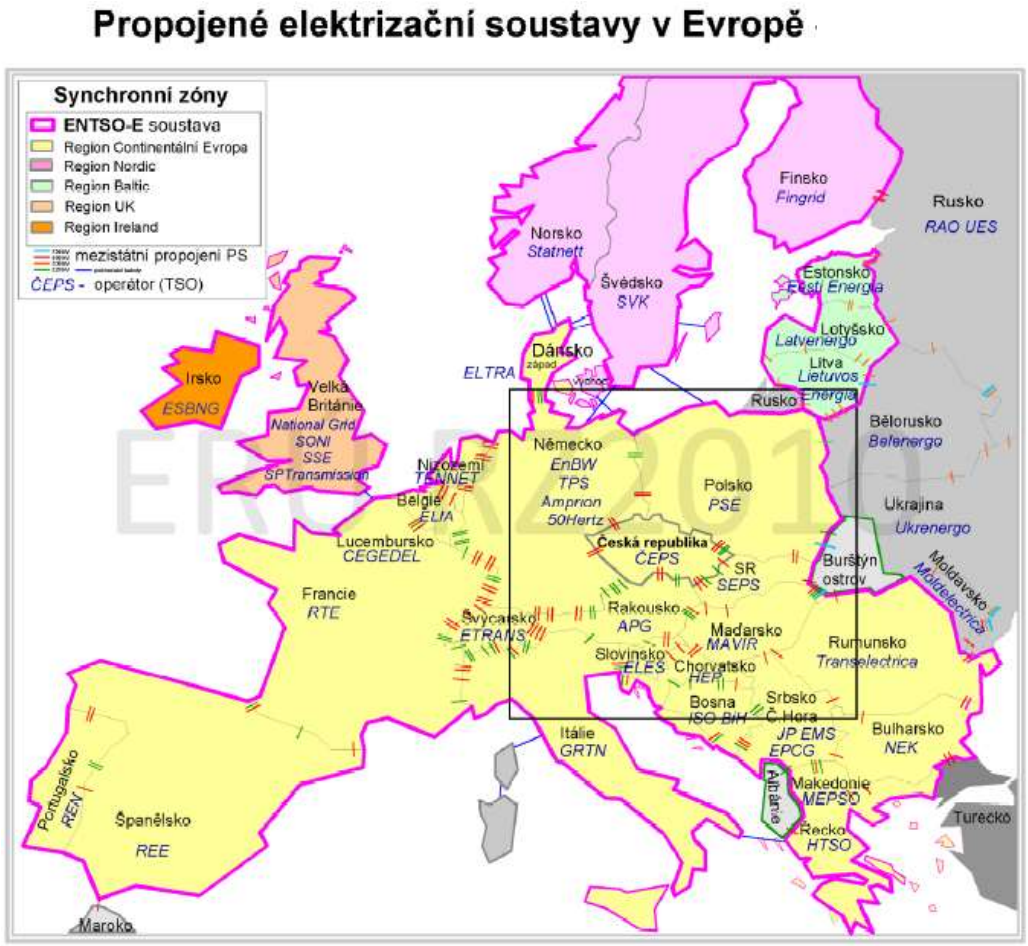
Installed power of resources in the Czech Republic



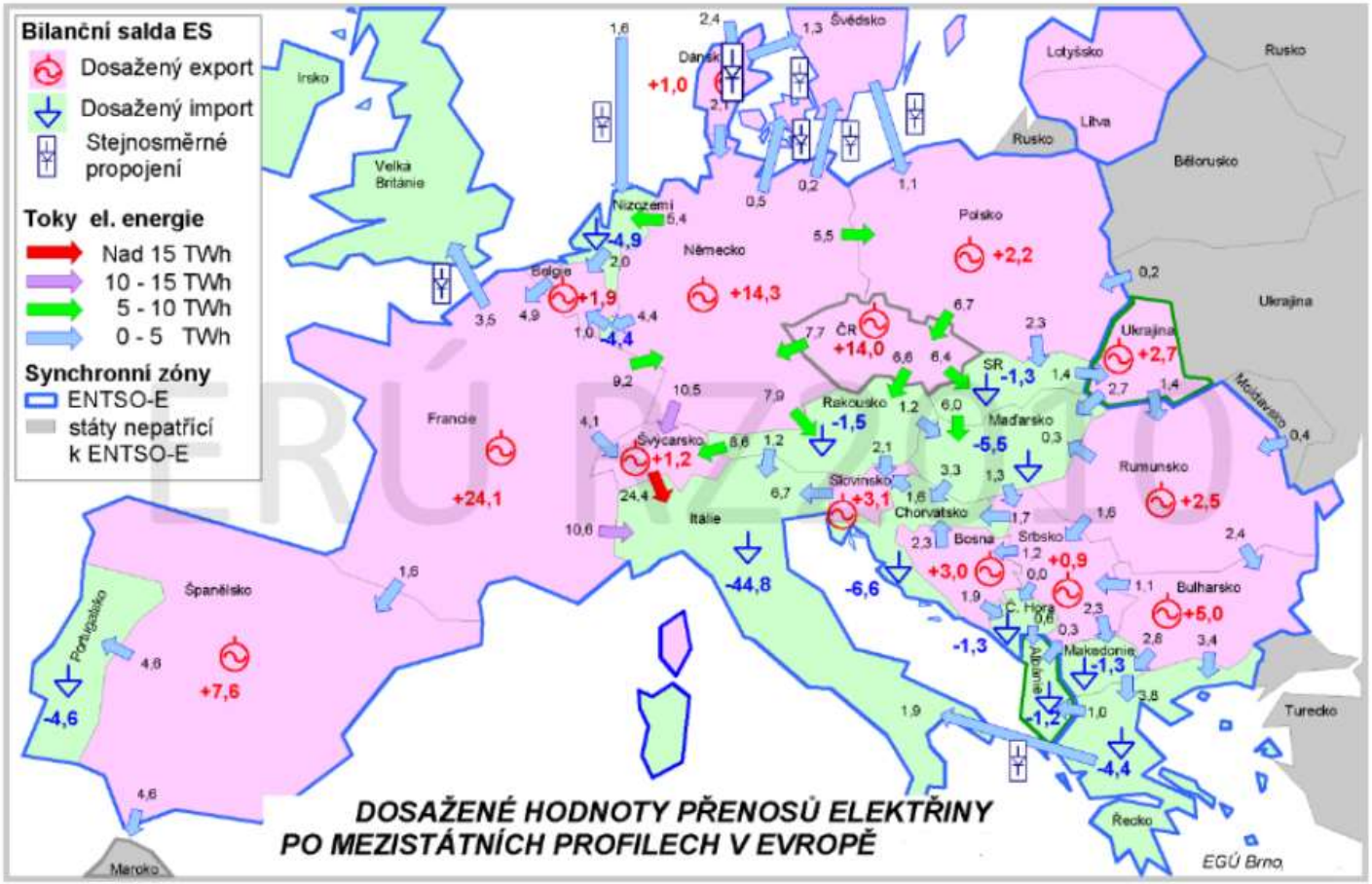
Export- import energy in the Czech Republic



Interconnected electricity systems



Interconnected electricity systems

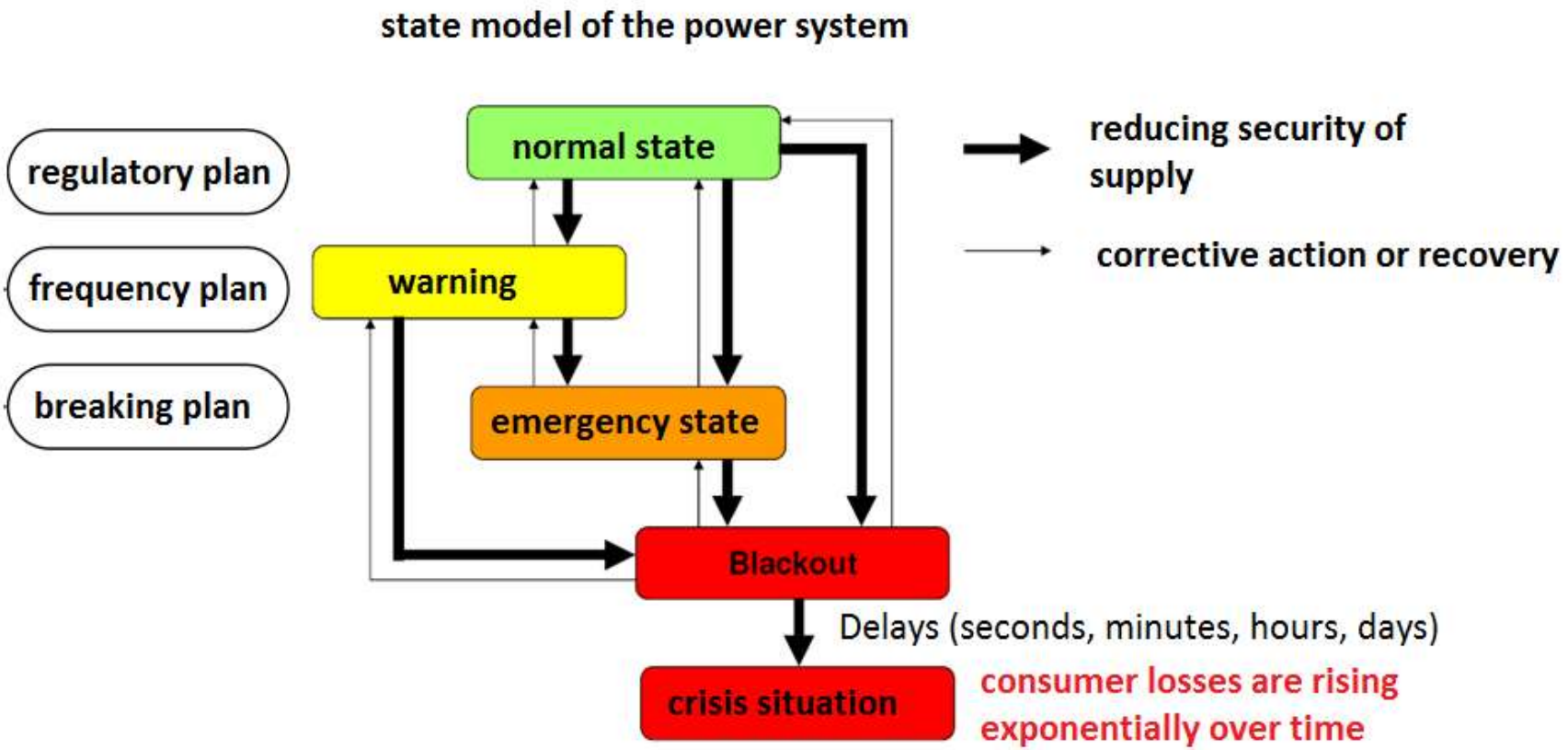


ENTSO-E

European Network of Transmission System Operators for Electricity

- 41 transmission system operators (TSOs)
- 34 European Countries
- 380 TWh of electricity exchange between member TSOs
- 532 million customers served by the represented power systems
- 880GW net generation capacity
- 3,200 TWh electricity consumption
- 305,000 km of transmission lines managed by the TSOs
  = UCTE + NORDEL + BALTSO + ATSOI + UKTSOA + ETSO

Extraordinary states of the power system



Causes of blackouts

transmission of large amount of power at the load limit

overloading transmission lines

unstable renewable sources

operator errors

technical state of the power grid, - targeted attack

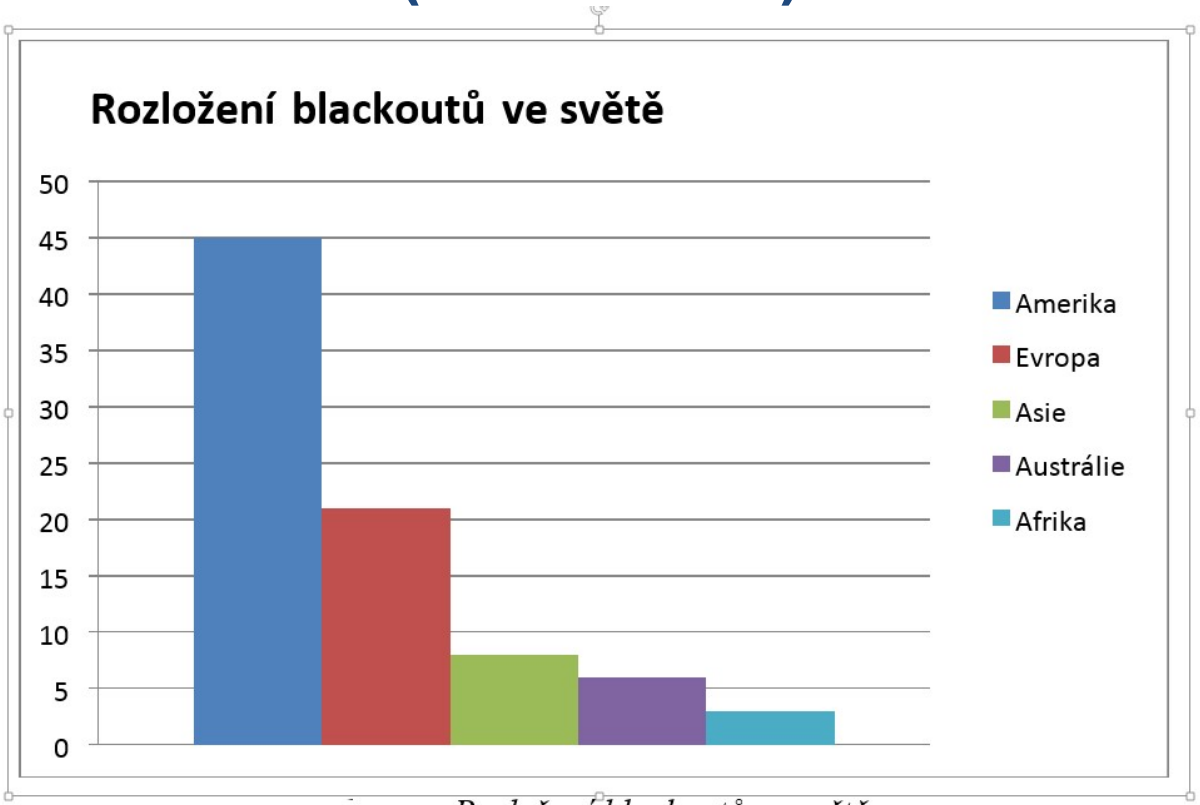
Blackout problems

Railway transport: Electrified lines have no supply. No signaling on the system.
Road transport: Traffic lights do not work, causing traffic jams and further accidents. Complaints during refueling. Urban public transport is paralyzed.
Industry: It is fully electrified and predominantly controlled by computer systems, and would therefore be malfunctioning severely.
Infrastructure: All computer systems would not work, fixed telephone lines, mobile phones, banking services, card payments, cash registers, cameras, radars, photocells, etc.
Food and commodity supply: Families have inventories for a couple of days, but a large part would be devalued because of non-functioning refrigerators.
Waterworks: Their operation is limited to gravity and supplies

Some blackouts in the world

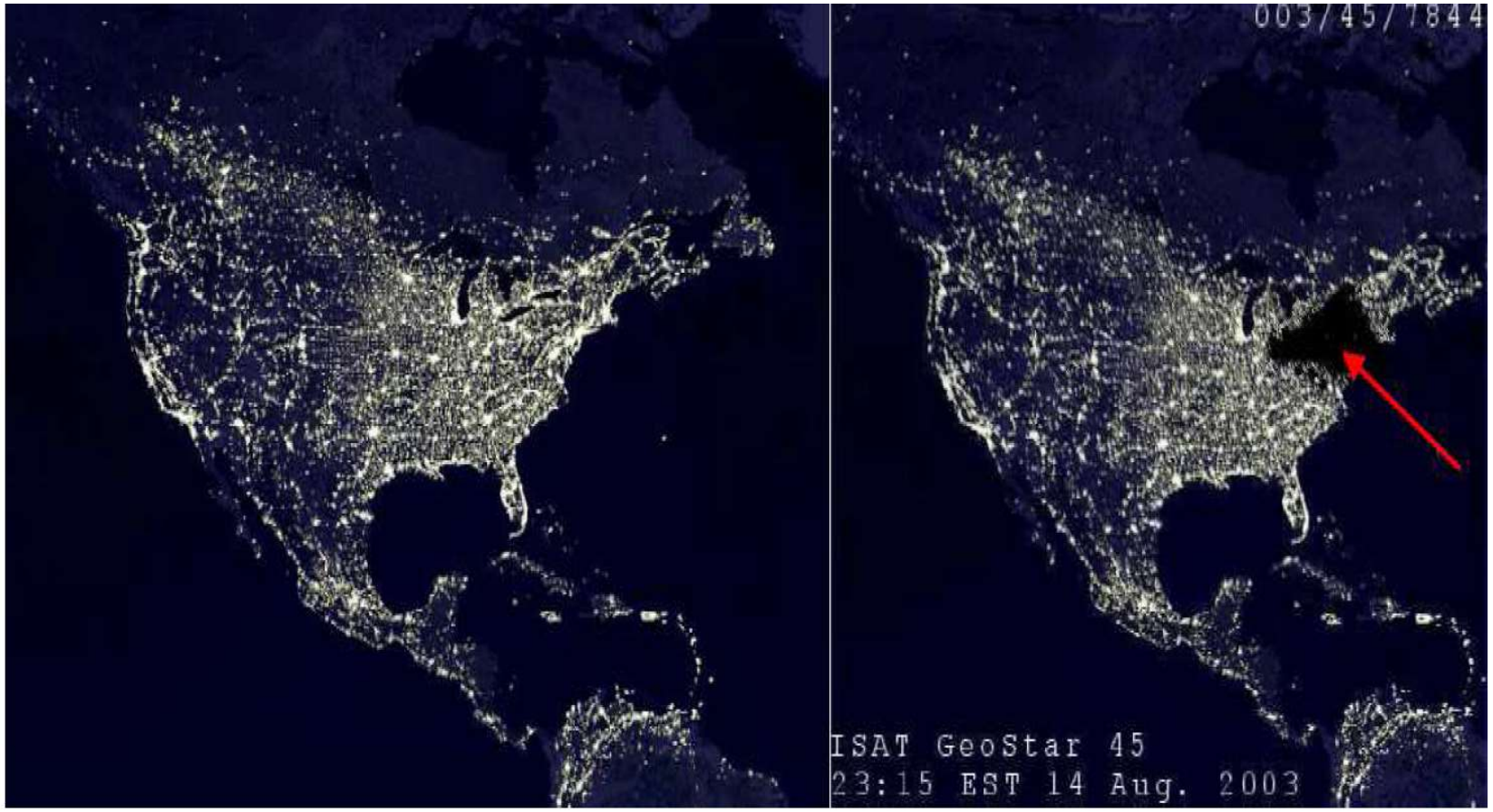
• USA-Kanada 1965	13 hours	30 mil populations
• USA New York 1977	25 hours	9 mil populations
• USA 2003	42 hours	50 mil populations
• Itálie 2003	16 hours	57 mil populations
• Rusko 2005	24 hours	10 mil populations
• Barcelona 2007	78 hours	3 mil populations
• Turecko 2012	20 hours	20 mil populations
• Indie 2012	48 hours	600 mil populations
• CZ emergency2006	9 hours	industry restrictions

The distribution of blackouts in the world (1965-2012)



Rozložení blackoutů ve světě

Blackout USA, Kanada 2003

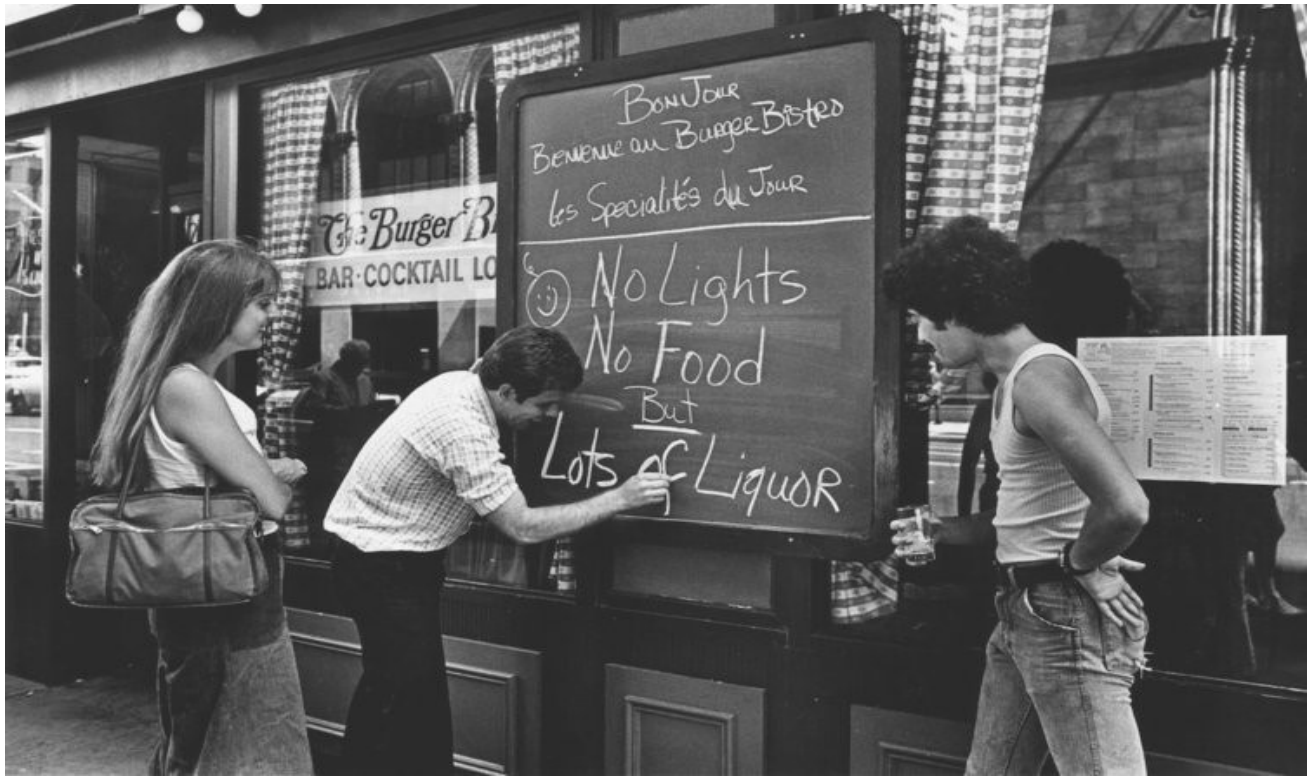


Blackout USA, 1977, 25 hours, damages 300 mil USD

New Yorkers that had been out were forced to walk home through empty streets.

Blackout USA, 1977

But others opted to take advantage of the situation.



Blackout USA, 1977

When the sun finally rose 12 hours into the outage, streets were littered with people and debris.

Blackout USA, 1977

Firefighters battle a blaze above a row of looted stores in Brooklyn.

Blackout- possible consequences of emergencies in hospitals

- Nowadays the long-term power failure has fatal consequences for the quality of care provided in advanced and mechanically and electronically advanced medicine.

- According to patients' needs, we can analyze:

  Outpatient tract
  Standard department
  Intensive care units, operating theaters etc.

Blackout- possible consequences of emergencies in hospitals

- Outpatient tract

- The biggest problem is rather in the administrative part of the treatment.
- The frequency of life-threatening conditions in these workplaces is low.
- An experienced physician will usually be able to investigate and then treat the patient (in a state that is not directly life-threatening) without electrical energy by means of physical examination or mechanical aids.
- In more complex cases, the patient is transported according to the priority of his condition to another workplace.

Blackout- possible consequences of emergencies in hospitals

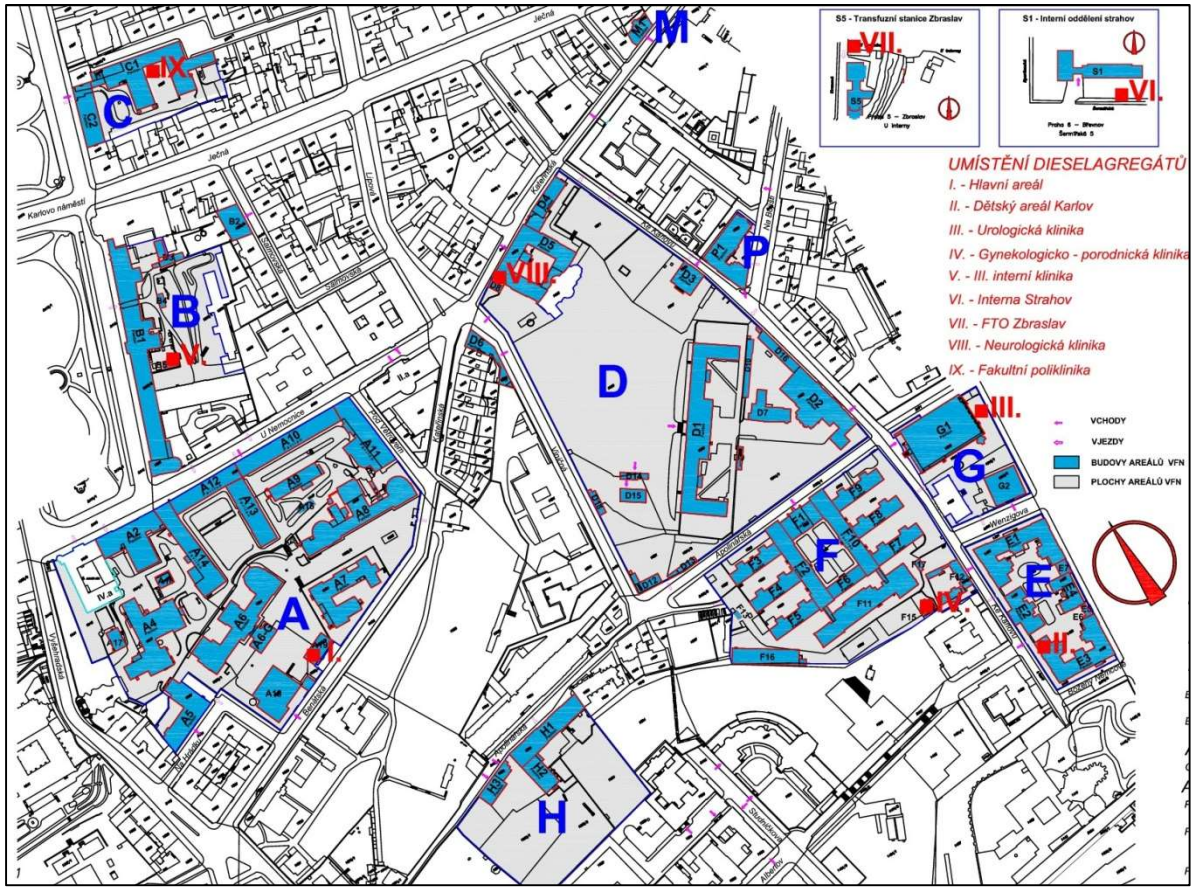
- Standard department

- Ensuring the basic needs of patients, such as cleanliness, warmth, etc.
- Patients in these units are in a stabilized condition and treatment generally does not take place via an electronic device.
- Many devices have built-in batteries that can be used for several hours.
- Of course, it depends on the equipment of each department, because in certain departments electrical devices are still used without a backup power source.

Blackout- possible consequences of emergencies in hospitals

- Intensive care units, operating theaters etc.
  - ➢ The biggest impact of power failure
- ➢ There are patients who are in a direct life-threatening condition and need constant monitoring of essential life functions; their treatment in most cases uses a number of drugs that are automatically administered by electronic devices. However, these devices have embedded backup resources that are capable of working for several hours even without electricity.
- ➢ Replacement power supply needs to be found quickly

Blackout - elimination of emergencies in hospitals by backup resources



Types of electrical networks in the hospital

- **MDO** – LIC

Less important circuits, this network is not backed up. In the event of a power failure, this network is completely out of power. For hospital staff, the socket outlets in the rooms are color-coded according to the standard.

These sockets are white.

Types of electrical networks in the hospital

- **DO**– IC

Important circuits. This is a partially backed up network where a power failure occurs in the event of a power outage.
The duration of this short-term outage is dependent on the time until the diesel generator starts. These sockets are marked in green.
These circuits provide the connection of medical devices that are not important to the vital functions of the connected patients.
Important circuits further ensure safety and protect against damage.

Types of electrical networks in the hospital

- **ZIS** – MIS

Medical isolated system. This network type is associated with a partial backup. This network is supplied again by a diesel generator, and is also characteristically separated from the system by a safety isolation transformer. These circuits are used to connect medical devices that are important to patients' life functions and for connection to medical devices. These sockets are marked in yellow.

Types of electrical networks in the hospital

- **VDO** – VIC

Very important circuits, which are identical to the previous MIS system in terms of safety, but are also supplied with an uninterrupted voltage source - UPS.
These sockets are marked in orange.

Backup electricity in hospitals

Stable Diesel Aggregates - Fuel Requirement
Mobile power generators
UPS, full functionality of battery systems
Cogeneration units (heat, electricity), fuel?, gas risk
Renewable sources (photovoltaics) need to have a supplementary battery system
Separate battery systems - second life of batteries
Microgrids, cooperation with the local distribution area

The impact of blackouts on other systems

Lack of water, total loss of water

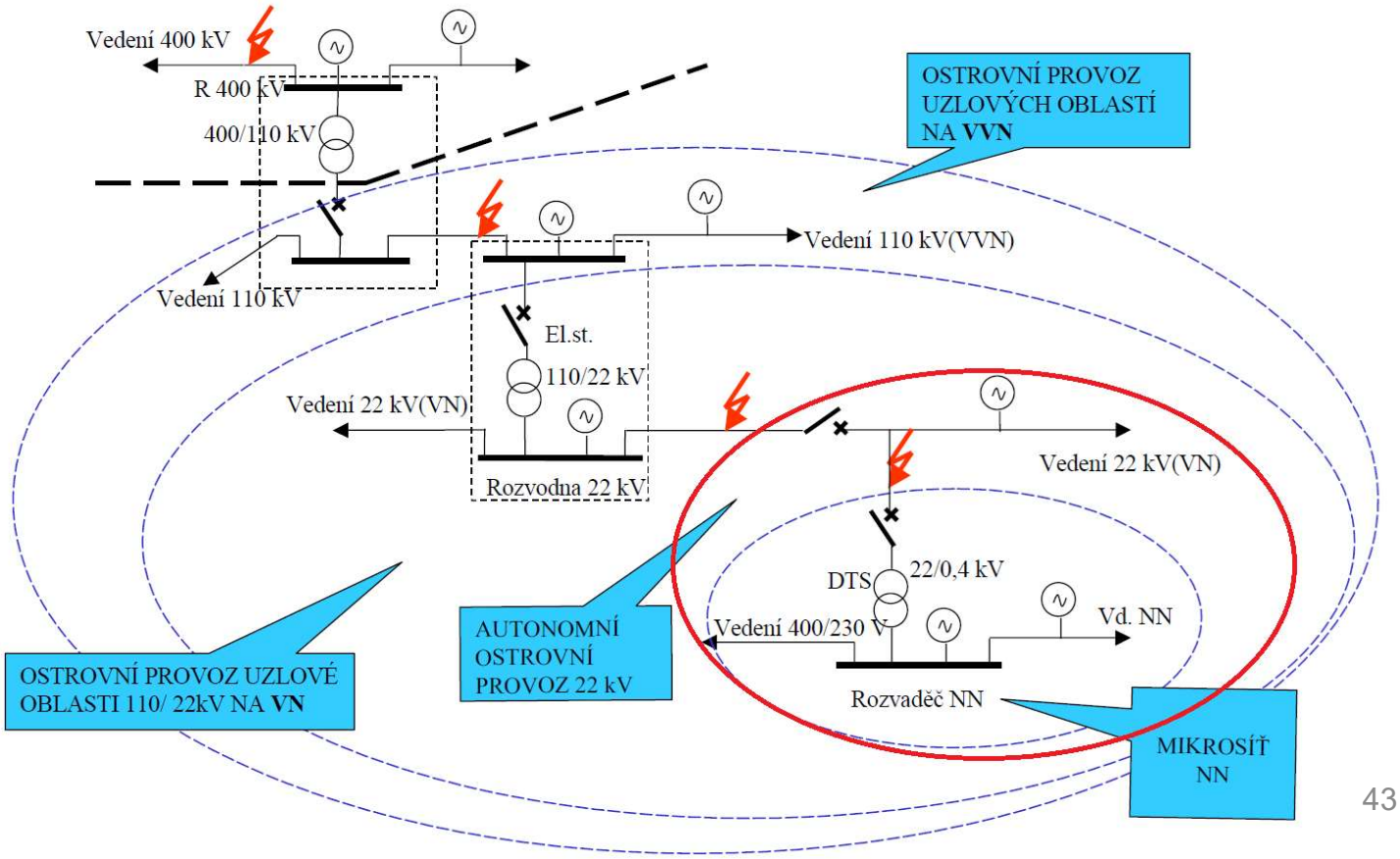
Malfunction of sewerage, sewage

Insufficient service systems

Lack of fuel for replacement sources
(necessary to cooperate with police and fire brigade etc.)

Loss of heat supply

New Challenges in Defense Plans - SMART GRIDS creating an island distribution area



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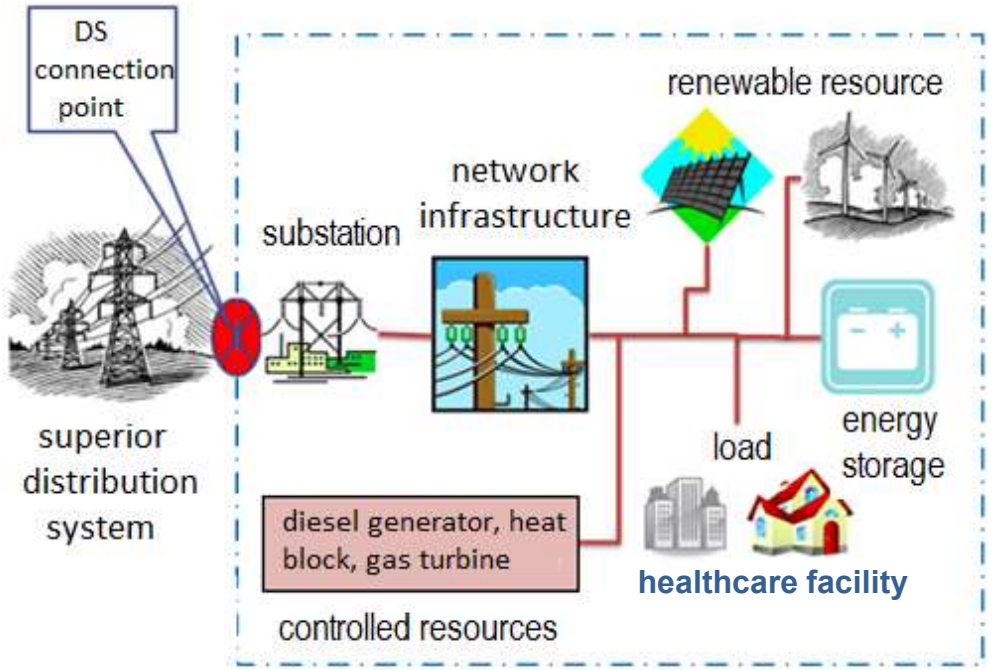


Selection of Critical Infrastructure Objects

Distribution to priority groups

I. Key (existential) - objects that provide indispensable activities to ensure basic needs (physiological needs, security, communication.

II. Supporting - These include CI objects that do not provide key processes, but are necessary in the long run for secondary activities.

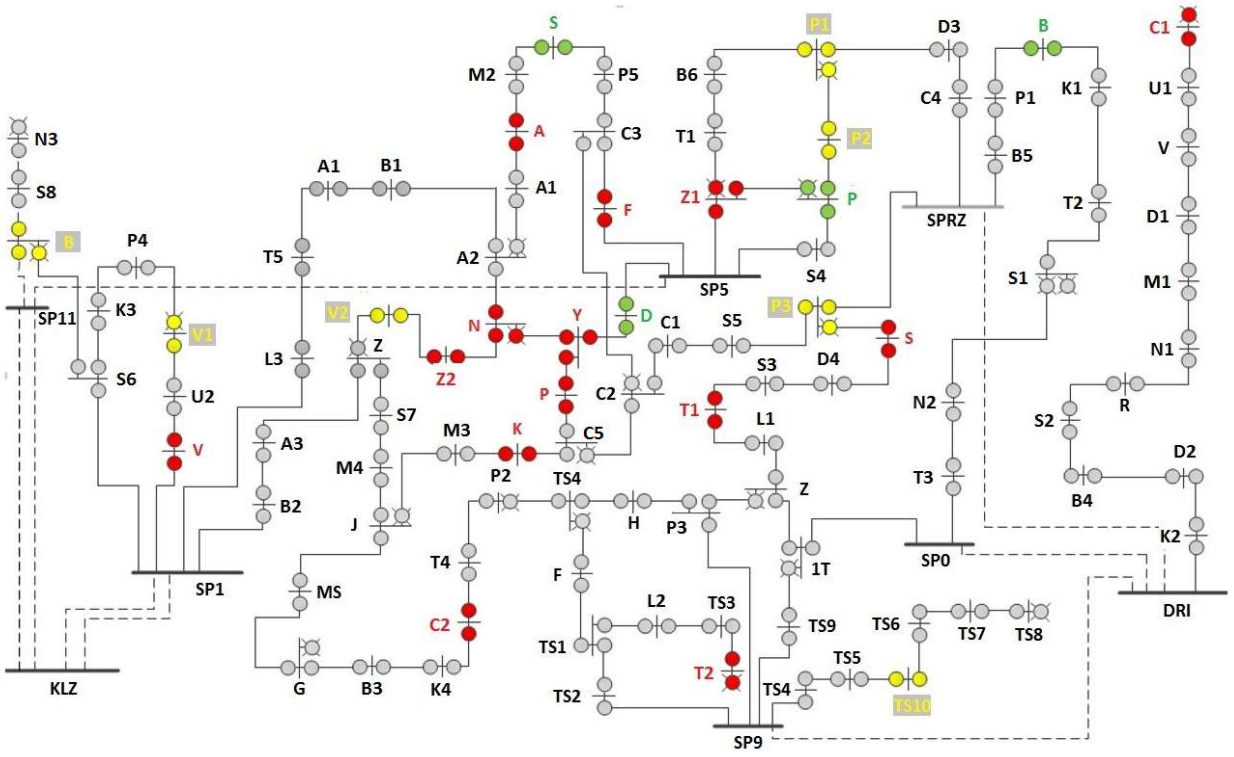
III. Additional - third degree of importance of CI objects. In the short term, their unavailability does not pose a threat to the basic needs or safety of the population.

Power plant feeding an island distribution area

- 2x135 MWe (K4, K5) + 161 MWe (block K7)
- Heating block 34,3 MWe (K3)
- Gas turbine 66,9 MWe (K6)

- Gas turbineTG8 43,2 MW
- diesel generator 750 kW
- the ability to start from the dark

An island distribution area feeding the critical infrastructure objects only



Thank you for your attention

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