REPUBLIC OF SLOVENIA
MINISTRY OF INFRASTRUCTURE

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Risk-preparedness plan,

pursuant to Art. 10 Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC

(December 2021)

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ABBREVIATIONS

ACE	Area Control Error. The ACE represents the individual remaining imbalance the load-frequency-control (LFC) area is responsible for.
aFRR	Automatic frequency restoration reserve
DSO	Distribution system operator
EBGL	Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing
ENTSO-E	European Network of Transmission System Operators for Electricity
ICT	Information and communication technology
ID-RT	Intra Day-Real time
ITA	Inter TSO agreement
mFRR	Manual frequency restoration reserve
MZI/MOI	Ministry of infrastructure
NCER	Commission Regulation (EU) 2017/2196 of 24 November 2017 establishing a network code on electricity emergency and restoration
RA	Remedial action
RG CE	Synchronous area of Continental Europe
RPR	Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC
RSC	Regional security coordinator
SAFA	Synchronous Area Framework Agreement for Regional Group
SGU	Significant grid user
SI-CERT	Slovenia computer emergency response team
SOGL	Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation - System Operation Guideline
TSO	Transmission system operator

Introduction

The aim of this document is to meet the requirements of articles 10, 11 and 12 of the Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC (abbr. RPR). On the basis of the regional and national electricity crisis scenarios identified pursuant to Articles 6 and 7 of RPR, the competent authority of each Member State shall establish a risk-preparedness plan [1.].

Through the process described in the RPR, ENTSO-E in cooperation with Member States and ECG identified and analysed 31 electricity crisis scenarios. Among the scenarios, we consider 13 of them relevant for Slovenia in the aspect of possible national and regional energy crisis. For this purpose, the Ministry of infrastructure of Slovenia as a designated national authority, in cooperation with ELES (Slovenian TSO) and after consulting distribution system operators, Energy Agency, producers, consumer association, and Slovenian Power Market Operator (Borzen d.o.o.), established the Risk preparedness plan, fully compliant with RPR, in order to prevent, prepare for and manage electricity crises.

Keywords: Critical infrastructure, electricity crisis scenarios, risk preparedness plan

1. General information

Ministry of infrastructure (abb. MOI/MZI) is the designated national governmental authority of Slovenia, responsible for carrying out tasks of REGULATION (EU) 2019/941.

1.1 General information about the Ministry of infrastructure

Full name:
Ministry of infrastructure

Headquarters:
Langusova ulica 4, 1535 Ljubljana, Slovenia

Minister:
Jernej Vrtovec

ELES, d.o.o. is a transmission system operator fully owned by the Republic of Slovenia. ELES is a full member of the European Network of Transmission System Operators for Electricity ENTSO-E.

1.2 General information about ELES, d.o.o.

Company full name:
ELES, d.o.o., Transmission system operator

Company headquarters:
Hajdrihova ulica 2, 1000, Ljubljana, Slovenia

Registration number:
5427223000

Company CEO:
Aleksander Mervar, MSc

1.3 Member states in the region

Slovenia participates in two capacity calculation regions Core and Italy North. Our regional/bilateral measures and procedures are coordinated with:

- Austria,
- Croatia,
- Italy
- and Hungary

as Slovenia's neighbouring countries and in addition to all the members of the above-mentioned regions.

2. Summary of the electricity crisis scenarios

The electricity crisis scenarios, identified at the regional and national level in accordance with the procedure laid down in Articles 6 and 7 of RPR are briefly described hereunder. Summarised scenario descriptions are based on detailed information from "RISK-PREPAREDNESS REGULATION – IDENTIFICATION OF REGIONAL ELECTRICITY CRISIS SCENARIOS" from 7 September 2021, which was prepared by ENTSO-E WG Risk preparedness.

2.1 Cyberattack on entities connected to electrical grid

This crisis scenario considers the cyber attack on business critical ICT infrastructure of entities which are physically connected to the power grid like TSOs, DSOs, power plants and major (industrial) loads.

Assumptions applied are that attackers might gain access to one or more critical ICT systems of TSO, DSO, power plant, or major load, and gather information of the systems from SCADA/EMS to the primary and secondary systems/equipment in the field. The attacker might be able to control the system meaning that it may switch off lines, transformers, manipulate schedules from TSOs towards market partners or other TSOs. The attack may cause unintended outages of lines, transformers, power plants etc. with possible overloading on remaining lines and transformers and/or direct loss of supply. Switching of lines close to border or cross-border lines may cause problems in other grids. Market partners may possibly not be able to follow schedules or to identify manipulated schedules.

There would be a risk of a forced blackout for the whole country, with a possibility of the blackout spreading to adjacent grids or the entire synchronous area.

2.2 Cyberattack on entities not connected to electrical grid

Cyber attack on business critical ICT infrastructure of market participants (not physically linked to the power grid) is taken into account.

Assumptions applied are that attacker is able to enter one or more critical ICT systems of market participants. Attacker may manipulate market conditions, offers and bids on energy exchange platforms and power plant's control systems. Manipulated schedules may cause power plant outages and have an impact on system frequency and security of supply. The attacker may be creating and sending manipulated schedules to other partners. He may stop energy market functions. Power plants might follow wrong schedules and frequency/system balance could be in danger. Market operators or power exchange might lose their control of whole process and have to follow back-up procedures. Security of supply could possibly be in danger if the TSOs are no longer able to balance the system with available reserve power.

2.3 Physical attack on critical assets

In this scenario, any forms of physical attacks including sabotage, acts of terrorism, war or any other intentional destroying of technical equipment, which is the part of TSO or DSO grid or power plants are considered.

The impacts are that N-1 criterion might be violated. Destroyed assets and possible longer time needed for repairing them can cause loss of supply in different areas.
Unplanned usage of redispatch capabilities or reserve energy may be needed. Additionally, load shedding could be applied. The attack could directly cut load from the grid. Destroyed assets may no longer be available for energy transport and distribution. Loss of grid elements may cause overloads on other lines. Market partners are possibly not able to follow schedules or have to reschedule energy trades due to missing connections to other countries or regions. Normal market activities could be stopped due to missing grid elements.

2.4 Physical attack on control centres

This scenario predicts the physical attack on control centres (TSOs, DSOs or major power plants) including acts of terrorism or war, possible hostage situations, insider attacks or any other intentional attack on control centres.

The attacker may attempt to destroy or damage the main and back-up control centre of a TSO or DSOs or major power plant operation centres. The impacts considered are that TSO/DSOs may no longer be able to monitor and operate the system. Power plants may be stopped by the attacker. Missing reaction on events or missing preparation for foreseen grid situation could lead to overloads, violations of N-1 criterion, possible multiple outages/local or total blackouts. The power plant operators may no longer be able to monitor or steer the power plants, consequently balancing and ancillary services might be impacted. Operational staff may have to be sent to substations, area control centres or parts of the power plants to provide information via telephone. Market partners may possibly not be able to follow schedules due to missing power plants. TSOs/power plants may not be able to interact with market partners. In worst case, market may be suspended and replaced by other decision making mechanisms.

2.5 Winter incidents

In this scenario, we consider similar consequences on transmission system operation, thus we are describing them together. Multiple failures caused by extreme winter conditions are taken into the account.

The impact of the scenarios may be several high and low voltage power line cuts because of extra weight caused by ice forming on conductors, fallen trees or extreme wind. The same goes for power line towers and other grid infrastructure.

Sensitive losses of transmission or distribution infrastructure may lead into load shedding or local blackouts. Multiple outages of power lines might cause violation of the N-1 criterion and in case some power plants are out we might face an adequacy issue. Market might also be impacted. Fault repair duration might be prolonged due to blocked roads and dangerous environment.

2.6 Heatwave and dry period

In this scenario, we consider the following preconditions: high temperatures for a longer time, associated with water shortages, reduced hydropower generation, reduced nuclear power generation because of limited cooling capabilities, some power lines operating close to their thermal limits due to high temperatures and high demand.

Assumptions applied are that power generation might be unable to meet the demand as 30 % of Slovenia's annual energy production comes from hydro power plants and 40 % from nuclear power plant Krško. Our neighbouring countries might also experience power shortages due to water shortages, no wind and reduced power plants production capabilities due to reduced cooling efficiency.

The impacts might be: load reduction and/or load shedding, generation reserves might be exhausted/very limited, lack of generation capacity together with lack of import capabilities and high demand might lead to scarcity situation, non-fulfilment of N-1 criterion, high voltage/voltage collapses on some parts of the network, possible multiple outages due to overloads depending also on the number of planned outages on that time, local blackouts.

2.7 Cold spell

In this scenario, we consider the following preconditions: winter with cold temperatures around 10 - 20°C below seasonal average for a longer period.

Impact of cold weather may be that water would freeze in rivers and reservoirs of pump storages. Demand may be increased due to extra heating requirements. Generation outputs of power plants might be decreased due to limited capacity to cool thermal and nuclear power plants (due to frozen rivers). Hydro power plants output may also be reduced. Due to the climate conditions some network elements may be exposed to increased stress (icing, sagging). N-1 criterion might be violated. All of the above might be causing adequacy issues, load shedding may be required and energy prices might increase significantly. This way, the market might also be impacted.

Cold weather can cause breakdowns in power plants. Power generating units in reserve could be out of service due to ice preventing their start. These conditions may cause blackouts and a lot of financial damage.

2.8 Forest fire

This scenario considers a forest fire that starts and spreads because of the wind and dry summer. Several high and low voltage power lines might cut because of burning trees falling on the power grid infrastructure. Other power lines might be disconnected due to firefighters work and some power generating modules might be out of operation. N-1 criterion is expected to be in violation. Uncontrolled wildfires may initiate unavailability or inoperability of some generation units or transmission/distribution infrastructure and cause potential cascading effect. Other possible impacts are local blackouts, load reductions and financial damage. There are difficulties in restoring system operation on affected area due to working conditions (roads might be blocked, terrain might be inaccessible, fire needs to be extinguished first).

2.9 Earthquake

In this scenario, we consider an earthquake of greater magnitude that might damage transmission infrastructure and power plants.

Depending on the magnitude and location of the epicentre, control centres of power plants or other grid infrastructure might be out of operation for a prolonged period of time. If operational control centres are impacted system control could be difficult.

Damage to road infrastructure could impact repair times also due to access restrictions. There is a possible need for balancing and ancillary services and on the other hand we might be unable to provide cross border energy support. N-1 criterion might be violated and there is a potential risk of local blackouts.

2.10 Fossil fuel shortage

In this scenario, we consider potential gas or coal supply disruption. The initiating event occurs in the period of the year when the domestic fuel/coal demand is high and stock is low. The initiating event is one (or more) prolonged disruption of fossil fuel supply system. Prolonged supply limitation leads to shutdown of power generation from at least some of the power plants affected, possibly causing limited energy shortages, most likely in peak demand time. The same supply problem may impact many countries at the same time. All of the above could be leading to adequacy issues and load shedding. There is imminent risk of blackout in at least limited area. Energy market might also be impacted as affected power plants have limited or no ability to offer energy and services, electricity prices could increase significantly. Related impacts might be limited central heating and some critical infrastructure affected (hospitals).

2.11 Pandemic

The spreading of a pandemic disease might cause understaffing across energy sectors. Furthermore, the containment measures of governments might follow restrictions for operation directly (by directives) or indirectly (e.g. by affected other critical infrastructures). Curtailed operational staff of TSO for field work might result in failure of repair in the field. Stressed or curtailed personnel resources of control centres and their processing facilities might jeopardise the performance of system control.

Demand might be low during lockdown possibly causing some high voltage effects. There is a possible increased risk of human error (planning, operations, maintenance...).

2.12 Simultaneous multiple failures of power system primary elements and power system control mechanism complexity

In this scenario, we consider the possible multiple failures at substations or transmission lines which might cause large-scale interruptions in the supply of electricity to consumers and possible technical failures on IT system, communication system or protection components.

N-1 criterion is expected to be in violation. The possible impacts of multiple failures is a cascade of disconnections due to the activation of protection components. In case of a severe

scenario, we might be facing a loss of critical grid elements, power system might become unstable and there is an imminent risk of blackout in at least a limited area.

There is a possible need for system services and, on the other hand, we might be unable to provide cross border energy support. There is also a risk of local blackouts if cascade disconnections are not stopped.

2.13 Local technical failure with regional importance

In this scenario, we consider mainly a malfunction of phase shifting transformer (PST) Divača and further development of critical grid situation due to the inability to control high flows.

Possible impacts of failure are additional damages to other critical grid elements, cascading effects, the system might become unstable, N-1 criterion might be violated, risk of a blackout in at least a limited area and the inability to provide energy support to other countries (Italy).

3. Roles and responsibilities of the competent authority

Pursuant to 138. Article of Electricity Supply Act (Official Gazette of the Republic of Slovenia, No. 172/21), the Ministry of infrastructure is the competent authority of Slovenia, responsible for carrying out tasks provided for in Regulation (EU) 2019/941. When confronted with an electricity crisis, Ministry of Infrastructure shall, after consulting the transmission system operator concerned, declare an electricity crisis and inform the competent authorities of the Member States within the same region and, where they are not in the same region, the competent authorities of directly connected Member States as well as the Commission, without undue delay. In addition, the Ministry of Infrastructure is responsible for performing and coordinating electricity crisis training simulations, drafting policies regulation and rules of legislation on Risk preparedness in the electricity sector.

Pursuant to the second paragraph of Article 70 of the Defence Act (Official Gazette of the Republic of Slovenia, No. 103/04 - official consolidated text, 95/15 and 139/20) and the Decree on Defence Planning (Official Gazette of the Republic of Slovenia, No. 51/13), the Ministry of Infrastructure issued a decree on determining transmission system operator for coordinator in the preparation, definition and implementation of tasks for the operation of the defence system in a state of emergency, war or crisis, and in the event of major natural and other disasters in the field of electricity [2.]. ELES is thus the designated crisis coordinator responsible for carrying out the tasks in REGULATION (EU) 2019/941.

DSOs' role is to limit the loads and consumption in accordance with adopted plans and lists of electricity users protected against limitation. Their responsibility is to carry out coordinated measures in accordance with Risk preparedness plan and subplans in order to prevent and mitigate electricity crises.

SGUs role is to actively participate in frequency deviation management procedures, voltage deviation management procedures, redispatch etc. Their responsibility is to carry out coordinated measures in accordance with Risk preparedness plan and subplans in order to prevent and mitigate electricity crisis.

4. Procedures and measures in the electricity crisis

The procedures and measures which are mentioned under this chapter are prepared, coordinated, implemented, activated and tested according to the legislative basis, which derives from European and national law.

4.1 National procedures and measures

4.1.1 National procedures in cases of an electricity crisis

In addition to the European legislation, in the Republic of Slovenia, the “Electricity Supply Act” (Official Gazette of the Republic of Slovenia, no. 172/21) and “Network code for the electricity transmission system” defines the basic rules for the preparation, coordination, implementation and activation of the national procedures of TSO and other relevant parties. These procedures contain specific measures which are appropriately activated in different conditions and scenarios in the electrical transmission system. For some of the procedures, the individual legislative documentation applies.

List of national legislation relevant for national procedures:

- Energy Act (Energetski zakon EZ-1) [3.];
- Electricity Supply Act [10.]
- Network code for the electricity transmission system (Sistemska obratovalna navodila za prenosni sistem električne energije Republike Slovenije - SONPO) [4.];
- Decree on limiting loads and consumption of electricity in the electricity system (Uredba o omejevanju obtežb in porabe električne energije v elektroenergetskem sistemu) [5.];
- Information Security Act (Zakon o informacijski varnosti) [6.];
- National Cyber Incident Response Plan [7.];
- Decree determining essential services and the detailed methodology for determining essential service operators (Uredba o določitvi bistvenih storitev in podrobnejši metodologiji za določitev izvajalcev bistvenih storitev) [8.];
- Critical Infrastructure Act (Zakon o kritični infrastrukturi - ZKI) [9.];
- Electricity supply act (Zakon o oskrbi z električno energijo - ZOEE) [10.];
- Defence Act (Zakon o obrambi - ZObr) [11.];
- Decree on Defence Planning (Uredba o obrambnnem načrtovanju – Uradni list RS, št 51/13) [12.];
- Decree on the content and elaboration of protection and rescue plan (Uredba o vsebini in izdelavi načrtov zaščite in reševanja - Uradni list RS, št. 24/12, 78/16 in 26/19) [13.];
- Protection against Natural and Other Disasters Act (Zakon o varstvu pred naravnimi in drugimi nesrečami - ZVNDN - Uradni list RS, št. 51/06 – uradno prečiščeno besedilo, 97/10 in 21/18 – ZNOrg) [14.];
- Decree on obligatory setting-up of security service (Uredba o obveznem organiziranju varovanja (Uradni list RS, št. 80/12)) [15.].

Based on this legislative background, the internal procedures and rules for operation in crisis scenarios are designed. This approach applies for all the relevant parties – TSO, DSO, significant grid users (SGU) etc.

Based on the requirements of Commission Regulation (EU) 2017/2196 (abb. NCER) [16.] and applicable national legislation the System Defence Plan [17.], System Restoration Plan [18.], and The Rules for Suspension and Restoration of Market Activities [19.] were designed by ELES. The content of these documents was harmonised between all the stakeholders and is hereafter briefly described.

System Defence Plan

System Defence Plan contains the procedures which are activated when the transmission system is in an emergency state according to the Commission Regulation (EU) 2017/1485 (System operation guideline – abb. SOGL)[1] [20.].

System Defence Plan contains the following national procedures:

- Frequency deviation management procedure,
- Voltage deviation management procedure,
- Power flow management procedure,
- Assistance for active power procedure,
- Manual demand disconnection procedure.

System Restoration Plan

System Restoration Plan contains the procedures which are activated when the transmission system is in emergency[2] or blackout state according to the SOGL.

System Restoration Plan contains the following national procedures:

- Re-energisation procedure,
- Frequency management procedure,
- Resynchronisation procedure.

Based on the provisions of the System Restoration Plan, the national procedure of a “bottom-up” strategy is designed. It is implemented in the internal operational rules for island operation.

The Rules for Suspension and Restoration of Market Activities

The rules for suspension and restoration of market activities are a part of Terms and conditions for balancing service providers (article 18 of EBGL [21.]), prepared by ELES in compliance with articles 36 and 39 of NCER [16.]. The aim of these rules is to define the rights and

[1] System Defence plan might also be activated based on the results of operational security analysis when the transmission system is not yet in the emergency state.

[2] System Restoration Plan may be activated when the transmission system is in the emergency state, which is caused by system frequency deviation, and there are no other measures available to restore the transmission system to the normal state.

obligations of market participants in the event of market suspension or market restoration and to determine the financial settlement for following the enforced procedures.
This document defines the conditions in which the transmission system operator can suspend market activities. The basic procedure for suspension and restoration of market activities is defined.

Protection and Rescue Plan activation

The Protection and Rescue Plan is a detailed idea of the implementation of protection, rescue and assistance in the event of natural and other disasters. Protection and rescue plans, planning authorities, content, criteria for the preparation and manner of preparation of protection and rescue plans for people, animals, property, cultural heritage and the environment in the event of natural and other disasters are regulated by the Decree on the content and preparation of protection and rescue plans [13.]. The plan specifies:

- the disaster for which the plan is drawn up;
- scope of planning;
- the idea of implementing protection, rescue and disaster relief for which a plan has been drawn up;
- the necessary forces and means for protection, rescue and assistance to implement the ideas for protection, rescue and assistance in the event of an accident and the available resources;
- organisation and implementation of observation, information and alerting;
- activation of forces and means for protection, rescue and assistance;
- management and leadership;
- protection measures and protection, rescue and assistance tasks;
- personal and mutual protection.

There are for different levels of this plan:

- national protection and rescue plans → plans are prepared by the Administration of the Republic of Slovenia for Protection and Rescue in cooperation with ministries and other state bodies and relevant professional organisations;
- regional (Slovenia is divided in 12 regions) protection and rescue plans → plans are prepared by branches of the Administration of the Republic of Slovenia for Protection and Rescue;
- municipal protection and rescue plans → plans are prepared by municipalities;
- protection and rescue plans for organisations → plans are prepared by companies, institutes and other organisations.

Which plan is used in the event of crisis depends on the type and scale of the crisis. Among other disasters that could affect most of the country or cause far-reaching consequences, national rescue and protections plans are separately designed for [22.]:

- earthquakes;
- floods;
- large fires in the natural environments;
- nuclear and radiological accidents;

- an epidemic/pandemic of a contagious disease in humans;
- the use of weapons or means of mass destruction for terrorist purposes or a terrorist attack by conventional means.

For natural and other disasters that can cause damage to the electricity transmission network and electricity facilities, and thus indirectly pose a threat to human life and health, Protection and Rescue Plans for organisations were designed by ELES and DSOs. These plans specify the necessary protection measures, coordination and tasks for ELES/DSOs and its members in Civil protection units in the event of crises [23.],[24.],[24.],[25.],[26.],[27.].

Administration of the RS for civil protection and disaster relief

In the event of a major crisis of a national or larger scale the Administration of the Republic of Slovenia for civil protection and disaster relief, which acts under the patronage of Ministry of defence, coordinates tasks among various protection and public informing services such as National and Regional information centres, Civil protection units, Protection, rescue and relief forces, fire brigades and other rescue services [28.].

Slovenian Computer Emergency Response team (SI-CERT) and sectoral security operations centre

SI-CERT is the designated national computer security incident response team (CSIRT) that operates within the framework of the ARNES (Academic and Research Network of Slovenia) public institute. SI-CERT monitors incidents at a national level, provides early warning, alerts, announcements and dissemination of information to relevant stakeholders about risks and incidents, responds to incidents and provides risk and incident analysis and situational awareness. SI-CERT performs risk and incident handling in accordance with Article 28 of the Information Security Act [6.].

SI-CERT is a member of the CSIRTs network, established in accordance with Article 12 of the NIS Directive, the member of the world Forum of Incident Response and Security Teams (FIRST), the group of national response centres at CERT/CC and the European response centre working group (TF-CSIRT) and is accredited by the Trusted Introducer programme [29.].

Sectoral security operations centres respond to cyber incidents. Sectoral security operations centres were established in accordance with Article 24 of Information security act [6.] in order to support and help SI-CERT and Operators of essential services, determined in the Decree determining essential services and the detailed methodology for determining essential service operators [8.].

Information Flow

Figure 1 provides a general frame of information flow in crisis scenarios. The information flow follows information security act requirements and is in accordance with organisational regulations of Information security incident management [30.]. The aim of the latter is to ensure timely and effective response to information security incidents and stakeholder informing. The information exchange takes place on several levels. On the first level, information is exchanged between TSO, DSOs, SGUs, Governmental bodies, Administration of the RS for Civil

protection and disaster relief, Market participants and other parties. On the second level, government bodies exchange information with other government bodies in the region and TSO with other TSOs in the region. The third level of information exchange is public informing.

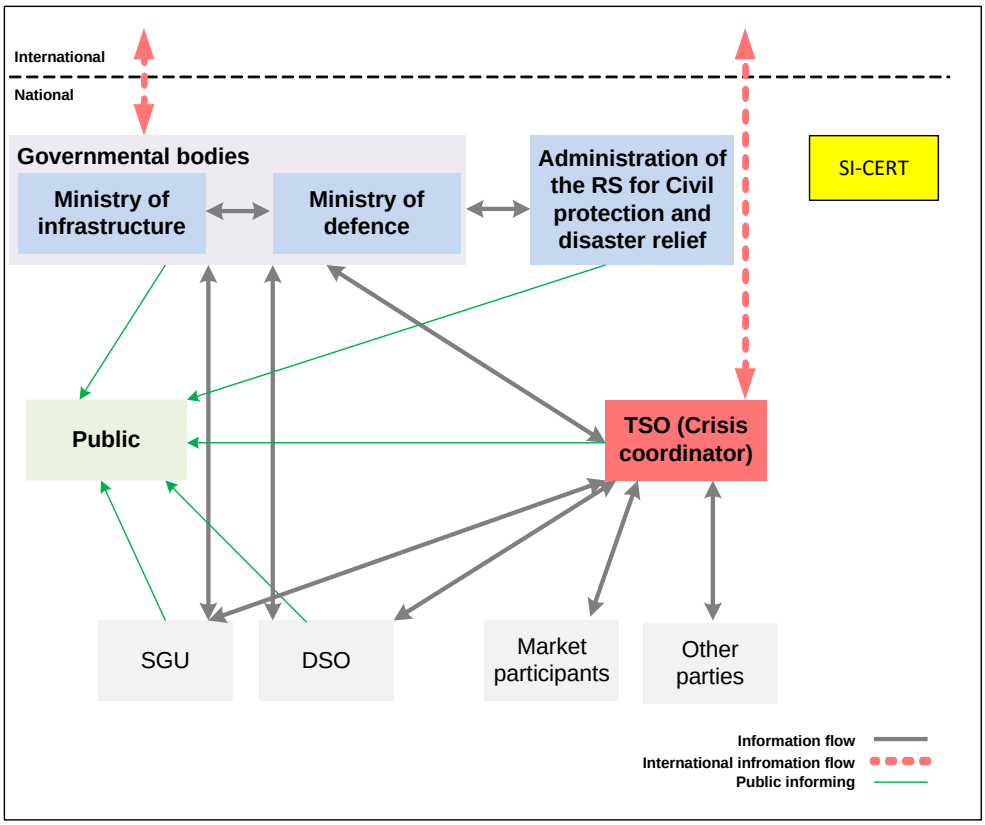

Figure 1: Information flows in crisis scenarios

4.1.2 Preventive and preparatory measures

In preparation for emergencies, TSO and DSOs pay special attention to the operation of critical infrastructure. Critical infrastructure is determined in accordance with Critical infrastructure act and decision on determining the criteria for determining the critical infrastructure of the Republic of Slovenia and their limit values and the priorities for the operation of the critical infrastructure sectors [31.]. For this purpose and following some other European legislative TSO has prepared a document Risk assessment and Critical infrastructure protection measures [32.]. For this purpose, TSO has implemented various preventive and preparatory measures:

Measures for substations classified as critical infrastructure:

- integrated technical system for the protection of critical infrastructure facilities;
- entrance control and video surveillance;
- redundancy of key equipment in substations;
- adjusted dynamics and intensity of electric power device maintenance;
- selective and highly reliable protection system;

- installation of own reactive power sources;
- available montage pylons that enable the quick repair of broken connections;
- training of operators with procedures related to ensuring the operation of critical infrastructure.

Measures for power lines classified as critical infrastructure:

- adjusted dynamics and intensity of maintenance;
- dynamic thermal rating system, which prevents overloading;
- available montage pylons that enable fast repair of power lines;
- training of operators with procedures related to ensuring the operation of critical infrastructure.

Measures for national and regional control centres and their backups:

- strict entry rules;
- physical and technical protection;
- redundancy of key equipment in control centres;
- assurance of the continued availability of a sufficient team of operational staff
- optimisation of the organisation of control centres, planned introduction of a third operator;
- highly reliable state of the art control system, introduction of support tools in the field of smart grids as power control tools;
- regular training of operational staff to deal with emergencies;
- regular intrusion testing and elimination of identified vulnerabilities in order to improve cyber security;
- monitoring the state of the art and technology in the field of cyber security:
- introduction of a system for detecting deviations in the SCADA system (SCADA anomaly detection);
- establishment of a system for the encryption of traffic on communication links between stations and control centres and among control centres.

Measures for company information communication technology safety enhancement:

- evaluation of the change management process, monitoring of changes in services and configurations;
- duplicated connections at the physical level;
- duplicated hardware;
- renting reservations for alternative connections to ensure high availability;
- IPS/IDS (Network Intrusion Detection and Prevention System);
- SIEM (Security information and event management);
- firewall;
- restricting gate traffic;
- establishment of technical mechanisms and tools for appropriate response in the event of security threats and attacks;

- introduction of artificial intelligence for detecting and recognising threats and attacks (predictive analytics and machine learning).

To manage the risks associated with critical infrastructure, TSO adopted a comprehensive set of measures, which are divided into permanent and additional. Permanent measures are implemented in all situations, and in the event of an increased threat to critical infrastructure, an emergency or crisis, their implementation may escalate. Additional measures shall be implemented in the event of an increased threat to critical infrastructure, an emergency or a crisis if constant measures, even if their implementation is escalating, are not sufficient. Risk management measures for individual critical infrastructure facilities are listed below and defined in more detail in the organisational regulations and document Risk assessment and Critical infrastructure protection measures [32.]

Under normal operating conditions, the operation of the transmission system is subject to strict quality standards, which define the permissible deviations of frequency and voltage, the number and duration of power outages of transmission network users and the assurance of n-1 criterion. The requirements and rules of operation of the system in this state are defined in legislative acts (SOGL [20.], EBGL [21.], SONPO [4.], etc.) in a number of internal and joint operating instructions, operating agreements, etc.

Despite constant monitoring of risks and meeting the n-1 safety criterion, TSO is always ready for various operating conditions.

Normal operating state is a state in which system variables, such as frequency, voltages and loads on electricity elements, are within the permitted limits, the n-1 criterion is met, the required scope of balancing services is available and all system users have access to the transmission network. The operator has the following measures at his disposal:

- buying or selling electricity on the balancing market;
- activating the aFRR reserve to compensate for deviations;
- activating the mFRR to compensate for deviations;
- activating agreed international assistance;
- if the system operator cannot compensate the deviations with the measures referred to in the previous paragraph of this Article, it may:
    - require a change in the consumption or production of balance responsible parties that cause deviations, or
    - in the event of surpluses or shortages of electricity, request a reduction / increase in production from operating generating units and, if necessary, their shutdown;
- in the event that the measures referred to in the previous two paragraphs do not eliminate the deviations, TSO may take measures in accordance with the procedures for relieving the transmission system;
- topology change (TR taps, PST taps, elements off/on, busbar separation);
- use of compensating devices;
- engagement of reactive energy under contracts (at power plants, compensation devices) and
- request DSOs to regulate compensation devices.

Measures for return to normal operating state take precedence over the individual interests of the SGUs, DSOs or balance responsible parties and all of the above are obliged to carry them out as soon as possible after the TSO's request.

4.1.3 National measures to mitigate electricity crises

In general, all measures which are activated in crisis scenarios are prepared in internal operational procedures.

Decree on limiting loads and consumption of electricity in the electricity system [5.] provides a legal frame and measures for limiting consumption in the event of:

- prevention of power system degradation (article 3);
- outage of major power plants or reduced electricity production due to ecological reasons (article 4);
- electricity scarcity (article 5).

Network code for the electricity transmission system [4.] provides a basic frame for disturbed operation. Disturbed operation is considered to be an alert state, an emergency state, a blackout state and a restoration state. Article 95 nominates TSO to be responsible and authorised to take appropriate measures to prevent the spread of disturbances and to restore normal operating conditions in the shortest possible time upon the occurrence of disturbed operation. For this purpose, TSO, DSOs and SGUs prepared a plan of measures in the event of a malfunction and ensure an adequate number of production units for the purposes of island operation and production units with the ability to start the unit without an external power source.

Measures for return to normal operating state take precedence over the individual interests of the SGUs, DSOs or balance responsible parties and all of the above are obliged to carry them out as soon as possible after the TSO's request.

Article 97 of Network code for the electricity transmission system provides a frame for measures in the alert state of operation. TSO actions are:

- within the capabilities of leased balancing services;
- restricting new access to cross-border transmission capacity;
- buying or selling electricity to compensate for deviations from the schedule;
- changing the topology of the transmission system;
- relieving the system by redispatch;
- limiting the consumption or production of SGUs, DSO or balance responsible parties bound with the appropriate contracts;
- freezing the secondary frequency control if it deviates more than ± 200 mHz from the nominal frequency for more than one minute and activating the available power reserves in order to establish the nominal frequency value.

TSO may postpone the planned switching of EEN and shutdowns/starts of production units until normal operating condition is established.

In the event of an emergency state, TSO may take the following measures to prevent the spread of disturbances and to restore to normal operating state:

- suspension of work on the power grid elements and their activation as soon as possible;
- change of active power of production units outside the agreed/required scope for participation in primary, secondary or tertiary frequency regulation;
- reduction of desired values of voltage regulators, blocking of voltage regulators on transmission and distribution network transformers, deactivation of U / Q optimisation;
- start of a production unit that is in operational readiness and has not been leased by the system operator as part of system services;
- cancellation of granted access to cross border transmission capacity in accordance with the auction rules;
- deactivation of the transfer point, which endangers the stable operation of the power system;
- relief the transmission system.

According to article 99 TSO prevents the occurrence of a voltage collapse with the following possible measures:

- by increasing the production of reactive power of production units;
- by redispatch or active power flow redistribution;
- by calling on the neighbouring TSOs to normalise voltage conditions;
- by lowering the desired value of the voltage regulator in the distribution transformer stations;
- by calling on the DSO to activate compensation devices, to increase the reactive power production at the production units connected to the distribution network and to reduce the voltage in the distribution network;
- by blocking the operation of voltage regulators or the installation of devices for automatic blocking of voltage regulators on transformers with taps;
- by relieving the transmission system.

System Defence Plan

Following article 11 of NCER TSO has designed a System Defence Plan [17.]. The plan includes the following technical and organisational measures in accordance with articles from 15 to 22 of NC ER [16.]:

- System protection schemes:
  - Automatic under frequency control scheme;
  - Automatic over frequency control scheme;
  - Automatic scheme against voltage collapse;
- System Defence Plan procedures:
  - Frequency deviation management procedure;
  - Voltage deviation management procedure;
  - Power flow management procedure;
  - Assistance for active power procedure;
  - Manual demand disconnection procedure.

Automatic under frequency control scheme is a mechanism used for preventing power system degradation in the event of major disturbances such as outages of major power plants, or a significant part of interconnected system, etc. Article 12 of System Defence Plan specifies measures for power generating modules in order to maintain frequency. These measures are turbine regulator settings and the settings of the limited frequency sensitive mode (underfrequency). Article 13 of System Defence Plan specifies a scheme for automatic low frequency demand disconnection and the rules DSOs and SGUs shall follow.

Automatic over frequency control scheme is a mechanism used for preventing power system degradation in the event of major disturbances such as outages of major loads, transmission lines, transformers or substations. Similar as for under frequency, Article 16 of System Defence Plan specifies turbine regulator settings and the settings of limited frequency sensitive mode (overfrequency).

Automatic scheme against voltage collapse is a mechanism used for identifying insufficient extent of reactive power in the system, that could lead to voltage collapse. Articles 19 and 20 of the System Defence Plan specifies blocking scheme for on load tap changer that TSO, DSOs, cDSOs and demand facilities shall follow and the thresholds that shall trigger these measures.

Frequency deviation management procedure is used when the frequency in TSO's control area meets the conditions for emergency state. Its main aim is to change injections of active power in the control area. Articles 23, 24 and 25 of System Defence Plan specifies measures that TSO has at its disposal. In this event, TSO holds the right to determine desired active power settings for SGUs and balancing service providers or to disconnect them. Other measures used in this procedure are switching energy storage units from load mode to generation mode and manual disconnection of the energy storage unit.

Voltage deviation management procedure is used when voltage meets conditions for emergency state. Its main aim is to change the injections of reactive power in the control area. In this event, as described in article 28 of System Defence Plan, ELES holds the right to determine desired reactive power settings for DSOs and SGUs.

Power flow management procedure is used when power flows meet conditions for emergency state. Its main aim is to change injections of active power in the control area. As stated in articles 31 and 32 of System Defence Plan TSO holds the right to determine desired active power settings for SGUs and balancing service providers or to disconnect them.

Assistance for active power flow procedure is a procedure that ensures adequacy in TSO's control area for day ahead and intraday timeframe. As stated in article 34 of System Defence Plan, in the event that all available bids for balancing energy are activated, TSO holds the right to demand the rest of active power from power generating modules and balancing service providers to be offered on the local energy market.

Manual demand disconnection procedure is used, when all other procedures aren't sufficient to restore the system from emergency to normal state. The procedure is described in articles 37 and 13 of System Defence Plan.

System Restoration Plan

Following article 23 of NCER TSO has designed a System Restoration Plan [18.]. The plan includes the following technical and organisational measures in accordance with articles from 15 to 22 of NCER [16.]:

- Re-energisation procedure
- Frequency management procedure
- Re-synchronisation procedure

Re-energisation procedure in the System Restoration Plan contains the set of measures for top-down and bottom-up strategies, which are activated when the transmission system is in the blackout state according to article 18 of SOGL. The main priorities of the re-energisation procedure are the quick resupply of high priority SGUs and restoration of 400/220 transmission system, which in case of bottom-up strategy enables the Resynchronisation with the neighbouring TSOs.
Top-down re-energisation strategy is based on the request of TSO in blackout state to the neighbouring TSO who shall provide the assistance for active power, unless it would lead their system to the emergency or blackout states.

In general the following measures are activated during bottom-up re-energisation strategy:

- switching of the power generating modules to house load operation and operation in island operating mode;
- operation of DSO and SGUs according to the instructions of TSO in real-time;
- resynchronisation of power generating models to the existing transmission system.

Bottom-up re-energisation strategy is based on island operation of pre-determined transmission system parts, which is initiated with black start of power generating modules. For each pre-determined island, the individual operational rules apply which contain the set of measures for:

- frequency and voltage management,
- monitoring and management of island operation,
- resynchronisation of islands.

In general the following measures are activated during bottom-up re-energisation strategy:

- black start of power generating modules and reconnection to non-voltage transmission system;
- switching of the power generating modules to house load operation and operation in island operating mode.
- operation of DSO and SGUs according to the instructions of TSO in real-time.
- resynchronisation of islands until the whole transmission system is connected.

Frequency management procedure contains the set of measures with the aim to restore system frequency back to nominal frequency. It is activated under the following conditions:

- synchronous area of Continental Europe (RG CE) is split on two or more islands,

    - Measures are defined in the internal procedure which contains the set of measures that are activated according to the different system frequency deviations.
- in case of higher frequency deviation,
    - Measures are defined in the same procedure which is mentioned under the first point.
- in case of activation of bottom-up strategy
    - Measures are defined in the internal operational rules for island operation.

In general, the following measures are activated during the frequency management procedure:

- Switching of load frequency controller to proper operating mode.
- Appointment of frequency leader (in case of split RG CE or higher frequency deviation).
- Operation of SGUs according to the instructions of TSO in real time.

Resynchronisation procedure contains the following set of measures:

- Appointment of resynchronisation leader - in case the RG CE is split.
- Operation of the TSO, DSOs and SGUs according to the instructions of resynchronisation leader – in case the RG CE is split.
- Operation of DSOs and SGUs according to the instructions of TSO in real time – in case of local island operation.

The rules for suspension and restoration of market activities

The rules for the suspension and restoration of market activities are a part of Terms and conditions for balancing service providers (article 18 of EBGL [21.]), prepared by ELES in compliance with articles 36 and 39 of NCER [16.]. The aim of these rules is to define the rights and obligations of market participants in the event of market suspension or market restoration and to determine the financial settlement for following the enforced procedures.

A measure of market suspension may be used in the event of at least one of the following situations:

- if the TSO's transmission system is in the blackout state;
- the TSO has exhausted all the options provided by the market and the continuation of market activities under the emergency state would deteriorate one or more of the conditions referred to in Article 18(3) of SOGL [20.];
- the continuation of market activities would decrease significantly the effectiveness of the restoration process to the normal or alert state;
- tools and communication means necessary for the TSOs to facilitate market activities are not available.

More detailed conditions for the activation of market suspension are specified in articles 6 and 7 of Market suspension rules, where thresholds of load and generation disconnections are defined. Additionally article 9 specifies the conditions for market suspension activation regarding inability of significant share of market participants to participate in the market.

In the event of one or more of the above conditions, the TSO may temporarily suspend one or more of the following activities:

- allocation of long-term NTCs;
- day-ahead NTC allocation and all forms of day-ahead electricity trading;
- intra-day NTC allocation and all forms of intra-day electricity trading;
- activation of the ELES balancing market determined by the Terms and conditions for balancing service providers;
- NTC calculation process.

Market suspension activities shall be carried out in accordance with rules specified in articles 11 and 12 of The rules for suspension and restoration of market activities.

The rules and procedure for market restoration are specified in articles 13 and 14 of The rules for suspension and restoration of market activities.

Other available measures

Some other measures we have at our disposal in the event of crisis situations are:

- Possibility of powering consumers via 110 kV and middle voltage connections. If some major power lines are cut TSO can thus supply their users via alternate connections.
- System overloading mitigation with the use of redispatch. This way, we can prevent some cascade outage events, and supply our users from alternate source.
- Demand side response. With this measure, we can temporarily reduce electricity consumption of the consumers during periods of peak demand.
- Suspension of work on electricity grid. In the event of crisis we can use this measure to reenable connections, mitigate system overloading and resupply consumers.

Cost coverage and financial settlement

Measures for return to normal operating state take precedence over the individual interests of the SGUs, DSOs or balance responsible parties and all of the above are obliged to carry them out as soon as possible after the TSO’s request.

Reimbursement of costs related to measures for implementation of aFRR and mFRR are determined by contracts with producers. Reimbursement of the costs related to measures to ensure the regulation of voltage and reactive power are determined by contracts with producers.

In the event of market activity suspension, the Rules for suspension and restoration of market activities also directly provide for a cost allocation mechanism, to be used by the market operator (delegated operator) instead of the normal procedure, defined by the Electricity market rules.

Reimbursement of costs related to measures in crisis situation are determined in Network code for the electricity transmission system (SONPO) and Electricity Supply Act (ZOEE).

4.1.4 National framework for load shedding and users entitled to special protection against disconnection

The frame for manual load shedding is defined in article 3 of the Decree on limiting loads and consumption of electricity in the electricity system and also in articles 36, 37 and 13 of System Defence Plan. This procedure is used when all other procedures don't suffice to restore the system from emergency state to normal state. Articles 4 and 5 of Decree on limiting loads and consumption of electricity in the electricity system further depict which loads are to be shed and at which rate [5.].

Additionally, article 14 of System Defence Plan provides measures regarding switching energy storage units from load mode to generator mode. These measures are prescribed for ELES and DSOs for decreasing consumption.

Decree on limiting loads and consumption of electricity in the electricity system in its article 7 provides a frame for DSOs regarding which electricity users with regard to public safety and personal security are entitled to receive special protection against disconnection. Additionally, annex 1 of System Defence Plan provides a list of SGUs playing a key role in System Defence Plan, and annex 2 a list of high priority significant grid users and the terms and conditions for their disconnection and reenergisation.

Priority supply of electricity is carried out on the basis of a list owned by the distribution system operator. Activated measures from this plan must ensure that electricity in a state of emergency, war or crisis and in the event of major natural and other disasters is primarily provided to the Slovenian Armed Forces, defence planning bodies, services of the National Assembly, Prime Minister and President of Slovenia, critical infrastructure of national importance, emergency numbers and other bodies, local communities, companies, institutes and other organisations entrusted by the government or competent state bodies to fulfil tasks in a state of emergency, war or crises for defence purposes and major natural and other disasters.

Reimbursement of costs related to demand disconnection procedures are partly determined in contracts with demand facilities (Talum) and partly with Network code for the electricity transmission system (SONPO), Electricity Supply Act (ZOEE).

4.1.5 Mechanisms to inform public about electricity crisis

In the event of crisis situations, all parties act in accordance with their internal Rules of Procedure on the management of Company and Corporate communicating according to the following principles:

- centralisation of all communication activities,
- only the CEO of the company or a person authorised by the director communicates with the external public,

- individuals on the field are not allowed to make statements,
- timely and high-quality information to all target publics on the course of eliminating the causes,
- non-conflicting communication,
- protection of individuals who solve the causes of the crisis from additional burdens in communication processes.

Figure 2 provides a public informing scheme. In the event of electricity crisis situation TSO communicates with governmental authorities about activating measures from Risk preparedness plan via secured telephone line and email. TSO also communicates via telephone lines and email with DSOs, SGUs, Market participants and other contracting parties. All participating parties have their own internal protocols for corporate crisis communications among leadership, supervisory boards, crisis staff and public relations departments. Electricity companies may inform public regarding electricity crisis via Official web pages, Facebook, Twitter etc. Governmental authorities have their own protocols for internal communication. For the purpose of public informing they use national media. Governmental authorities also communicate with army and police forces in case their support is needed. Another governmental institution, which deals with all kind of crisis situations is the Administration of the RS for civil protection and disaster relief. Depending on the scale of crisis, they communicate with national and regional information centres. These centres can activate Protection, rescue and relief forces and when those don't suffice they can organise civil protection units. They also coordinate fire brigades and other rescue services and play an important role in public informing. For this purpose, they use local and national media, radio, etc.

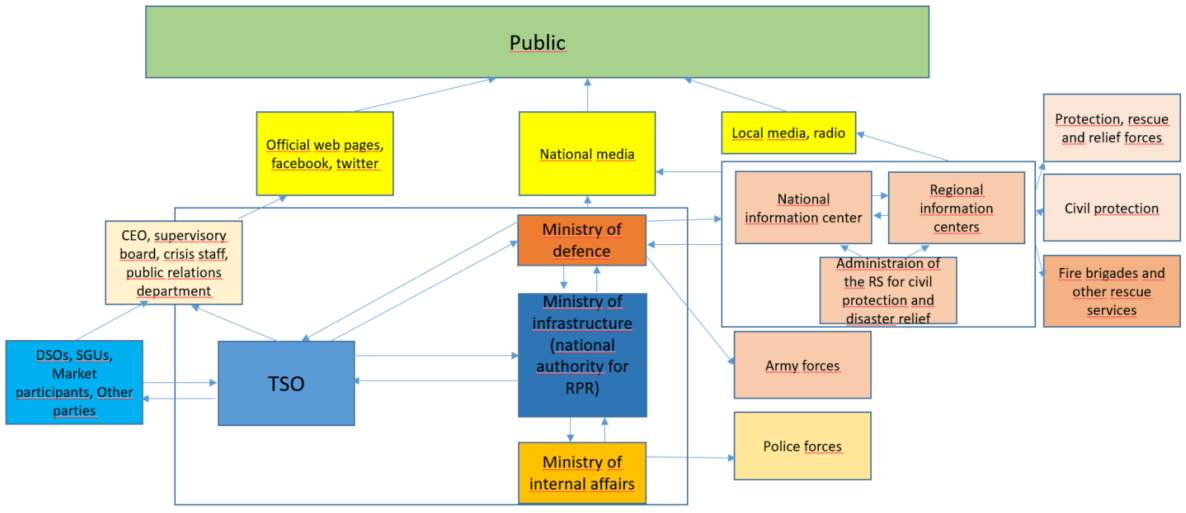

Figure 2: Public informing scheme

Communication with business partners such as production companies, SODO, direct customers, traders, European system operators, ENTSO-E, Information Centres (ReCO), etc. takes place in accordance with established procedures for communication with the listed

partners which are defined in the operating instructions and agreements and are in compliance with information security law.

4.2 Regional and bilateral procedures and measures

Similar to the national procedures/measures the regional and bilateral procedures/measures are also designed and harmonised based on the requirements of European and national legislation.

4.2.1 Agreed mechanisms for cooperation within the region

EAS-Entso-e-wide awareness system

EAS is an information platform allowing partner TSOs a real-time global view on the European grid. In case a stressed situation arises, a better comprehension of the conditions can be gained and in the case of disturbance, it is possible to identify the origins and to be helpful in problem solving.
In both cases and as much as possible, EAS enables partner TSOs:

- to enhance their assessment of the nature and the size of the disturbance,
- to make decision to react or not without aggravating the situation,
- to coordinate measures for resolving balance and transmission problems and restoration of the transmission system,
- to seek cross-border cooperation.

EAS uses system state definitions based on the article 18 of commission regulation (EU) 2017/1485. Using the below colour indication in Table 1, the TSOs are able to inform others about their system state on Pan-European level:

Table 1: colour indication of the system state

System state	Colour indication
Normal state	green
Alert state	yellow
Emergency state	red
Blackout state	black
Restoration state	blue

When activating a non-normal system state, the TSO shall send one of the predefined messages, named “Main Message” as defined in EAS usage procedure. To specify the cause and the issue, one or more optional predefined messages giving additional information to other TSOs can be activated. Further principles and guidance for the operational use of EAS are described in the ENTSO-E Awareness System – Usage Procedure [33.]

IBWT Operational procedure for critical grid situations (CGS)

Procedure involves the TSOs of the NIB Region, Terna, RTE, Swissgrid, APG and ELES, and the Regional Security Coordinators (RSCs) Coreso and TSCNET as service providers to the above mentioned TSOs. The Trigger, activation and coordination phases for critical grid situations can arise at any moment in the operational timeframe [34.] :

-ENTSO-E via the Seasonal Outlook
-RSCs with STA process
-TSOs via internal analyses at any moment.

The procedure comprises of the following steps:

- Day-ahead triggering: TSO foreseeing adequacy issues for the next day (day D) confirms the scarcity risk time frame by email to all TSOs belonging to the NIB Region and the involved RSCs;
- TSOs adequacy status communication: All the other TSOs of the region reply to the email acknowledging the request and sending information about the adequacy situation in their own grids. TSOs also give information about their resources available for supporting the requesting TSOs (generation margins and Remedial Actions);
- Pre-alignment teleconference: RSCs organise a teleconference with the TSOs in order to discuss how to perform the study (scenario to be studied, exchanges to be simulated, use of RAs);
- RSC analyses and report: RSCs perform the agreed analyses using the latest available DACF models. RSCs report by email about the outcome of the studies;
- Final coordination teleconference: RSCs organise a teleconference with the TSOs to discuss the results of the analyses. TSOs discuss on how to use the possible optimised capacity and the proposed RAs and how to implement exchange modifications. Possible means could be:
    - Adapt the NTCs given to the Intraday markets;
    - Use of Inter-TSO agreements (e.g. MEAS).

  The strategy for the next day is also to be discussed;
- Confirmation: Depending on the decision made during the teleconference, the TSO foreseeing adequacy issue will confirm the strategy using the appropriate template.

STA process- Short term adequacy process

STA process follows the Short Term Adequacy methodology [35.], developed pursuant to Article 81 of SOGL [20.].The STA process is performed at ENTSO-E level and it aims at forecasting potential adequacy issues. Forecasted load and generation capacity per type are submitted every day by all ENTSO-E TSOs for a rolling D-7 to D-1 timeframe. The results of the cross-regional adequacy analysis for the next 7 days are made available every day by latest at 11 p.m.

In case of adequacy issues detected in the cross-regional assessment, the regional STA process is triggered. During the regional STA, impacted and neighbouring TSOs fill a template

listing their potential regular or extraordinary remedial actions to solve the problem. Regional STA process is currently in external parallel run phase and is expected to go live in second half of 2021.

Regional Adequacy Assessment will be triggered automatically in case remaining capacity of any area on the deterministic calculation of cross regional (CR) STA is less than 0 MW for any timestamp between D-1 and D-3 timestamp. In case Regional Adequacy Assessment will be activated automatically appropriate remedial actions applied by TSOs to mitigate the lack of adequacy will be addressed. Regional Adequacy Assessment can also be triggered manually by the TSO stating clear reasons. Concerned RSCs and TSOs are identified by using Dynamic Zone Matrix created by TSOs. In order to ensure efficient mitigation of adequacy risks, TSOs and RSCs must work in cooperation. This TSOs-RSCs coordination starts with a teleconference. It allows the stakeholders to name an RSC leader, confirm the adequacy issues and prioritise the regional studies. Finally, when the adequacy problems and the involved TSOs-RSCs are identified, the Regional Adequacy calculation can start.

ITA-Inter TSO agreements

ELES has established or is currently in the process of establishing inter TSO agreements with below TSOs with the common objective of secure operation of interconnected power system:

- APG,
- HOPS,
- MAVIR (expected by the end of the year 2021).

The contracting TSOs are responsible for the maintenance of system balance in their respective control area. For this purpose, they deploy frequency containment reserve (FCR) as well as the automatic frequency restoration reserve (aFRR) and manual frequency restoration reserve (mFRR) contracted by them.

For the purpose of managing energy crisis, ITA agreements comprise the following guidelines and information [36.]:

- Inter-control area emergency support with reserve capacity (MEAS);
- System Defence Plan (Measures in critical network situations);
- Grid restoration;

Pentalateral handling of the control program on the Italian Northern Interconnection

The Instruction consists of two Proceedings [37.]:

- *Proceeding 1* dealing with the Day Ahead information exchange in case of security violations on the border grids forecasted at D-1 stage;
- *Proceeding 2* dealing with the Intra Day-Real Time operational handling of the Control Program on the Italian northern Interconnection, with the aim to prevent N-1 security violations.

Such Proceedings involve the following TSOs: Terna, RTE, Swissgrid, APG and ELES. RSC Coreso is involved in the D-1 Proceeding as service provider to Terna and RTE.

Mentioned Proceedings have to be considered as distinct from Emergency Procedures, in particular application of Proceeding 2 shall not involve the use of those remedial actions, agreed to face Emergency situations, which have to be guaranteed by the TSOs at all times.

The aim of the Procedure is:

- to solve security violations which could potentially initiate cascading events on the interconnected grid;
  The solution of local problems involving network portions, at voltage levels not higher than 220 kV, with a limited effect only on a restricted part of the bulk power system, is out of the scope of the Pentalateral Instruction;
- to manage reductions of the physical import towards Italy to allow voltage control and avoid dynamic instability problems;
- to manage serious unavailability of measures (balancing units outage, etc.) included in defence plan in Italy.

Cost coverage and financial settlement

Article 110 of Network code for the electricity transmission system [4.] provides a frame for financial settlement. Unplanned quantities of electricity exchange between LFC areas are settled in the agreed time period in accordance with the ENTSO-E rules. The return of settled unplanned deviations is compensated in the agreed time period in accordance with the compensation program, separately according to the prescribed tariffs and seasons in accordance with the ENTSO-E rules.

4.2.2 Agreed regional and bilateral measures

Agreement on mutual emergency assistance service (MEAS)

ITA establishes conditions and rules under which the Parties shall provide each other upward and downward Mutual Emergency Assistance Service (abbr. MEAS). The subject of this Agreement is the provision of emergency assistance from abroad through import (injection) of emergency energy or export (reduced import, if applicable) in order to cover the needs of each Party [36.].

MEAS procedure is specified below:

1. MEAS can be requested only in real time and the energy delivery has to follow on the same dispatching day. The request can be submitted any time during the dispatching day. Dispatching day in the sense of this agreement means a timeframe starting with the beginning of intraday process for delivery day D on the common border (e.g. dispatching day for delivery day D is from 22:00 in D-1 to 24:00 in D).

2. The respective herein mentioned undertakings of providing reserve power for MEAS will only be addressed by the Reserve Connecting Party if and only if there is sufficient production capability in its system and sufficient cross-border transmission capacity.

3. The Parties agree that at no time there is or will be, according to the terms and conditions of this Agreement, any reservation of the reserve provision service to each Party, unless specified otherwise in this Agreement.

4. As a result of this, the Parties agree that no flat fee or any fixed payment for available reserve capacity (in EUR/MW) is or will be applied amongst them for their respective undertakings hereunder.

5. When requesting MEAS the Reserve Receiving Party shall specify the time period of requested MEAS, which can be of minimum 1 hour and maximum of 8 hours. The activation of MEAS is limited for the time period of 12 hours in total within the same day.

6. The above-mentioned request shall be made by phone by the Reserve Receiving TSO. The request shall include start of activation, expected end of activation and exchange profile.

7. The Reserve Connecting TSO will reply to the request as soon as possible by confirming, amending or rejecting the requested exchange profile by phone. The communication shall include the offered price for setting the exchange.

8. The Reserve Receiving Party will reply to the offer as soon as possible by confirming (activating) or rejecting the offer by phone.

9. Activation shall be confirmed by email with the Confirmation of Emergency Energy Delivery form as soon as possible, but not later than 6 hours after the start of activation of MEAS.

10. MEAS shall be included in the relevant Exchange Schedules (CAS, CBS) of the Parties. The sending/receiving of agreed modified Exchange Schedules including MEAS and finalisation of accepted change have to be completed before the start time of the energy delivery.

11. Delivery does not have to start at a full hour. Preferably, delivery should start and end at any time according to a schedule resolution of 15 minutes. However, in exceptional cases delivery can also start regardless of quarterly intervals provided that confirmation process for schedule exchanges can be met.

12. In case MEAS delivery does not start at a round hour, the emergency energy in the first hour of delivery is considered to be the mean emergency energy in that hour (for instance: if the Service is activated at 10:20 for the time interval from 10:45 to 12:00 for 100 MW, in the first hour the emergency energy is delivered from 10:45 to 11:00 and amounts to: 100 * (60-45)/60 = 25 MWh). For accounting purposes, intervals of full quarters of an hour shall be used.

Measures in critical network situations

ITA specifies the measures in critical network situations for the contracting parties. It describes the following topics [36.]:

- Under-frequency control scheme;
- Over-frequency control scheme;
- Voltage deviation management procedure for low voltage;
- Voltage deviation management procedure for high voltage;
- Power flow deviation management.

Information on the common network restoration strategy

ITA provides information on the common network restoration strategy as described below [36.]:

Common provisions:

- When a neighbour TSO detects or is informed by the other TSO about a blackout, separation or collapse, the first action is to make a diagnostic of the grid and especially in the border area. In a second step, TSO can reinforce the grid respecting given constraints of neighbouring TSOs and their internal constraints. The aim of these actions is to reinforce the grid to give a stronger support to the neighbour and to have the most stable grid to allow reconnection with a higher security.
- Contracting TSOs shall do their best efforts in helping the neighbour, considering the respect of their internal rules (N-1 security,...). The active power exchanges between TSOs shall be jointly defined during the transitory stage of grid rebuilding and the physical flows shall reach commercial ones only once the TSO affected by the collapse is able to maintain the commercial flows without impact on its own system.
- Discussions concerning the cost of measures adopted by supporting TSO will be put aside in real time during the grid restoration phase and between the operators. Such discussions can only take place on ex-post.

Restoration of the ELES grid after black-out accident:

- Priorities of the ELES grid restoration
  Objective of ELES system restoration strategy is to put the power system in a safe way into normal operation as soon as possible. According to the provisions of Restoration Plan and SONPO priorities of ELES system restoration are:
  - restoration of the transmission system operation takes precedence over the re-energisation of load
  - restoration of 400/220 kV grid
  - providing of restoration paths for energisation of high priority significant grid users
  - synchronisation of generators to parts of network that are still energised
  - maintaining the appropriate voltage
  - maintaining system frequency in case of island operation
  - exchange of information with other TSOs about the system state.

- Basic Strategies of the Slovenian grid restoration:
  - ELES has prepared the top-down and bottom-up re-energisation strategies in the Restoration Plan;
  - In the top down strategy with help of the neighbouring TSOs grids, there are 3 main directions: from the West (Italy), from the North (Austria) and from the South (Croatia);
  - In combination with a top-down strategy the bottom-up strategy is also reasonably activated.

Additionally, these procedures are described in Articles 102-109 of Network code for the electricity transmission system [4.].

Measures of Pentalateral procedure

Proceeding 1 – Day Ahead (D-1) inter-TSOs warning information exchange

The aim of this Proceeding is the exchange of Day Ahead (D-1) inter-TSOs warning information in case of forecast violations of the N-1 security standards on the Relevant Grid [37.].
It refers to expected operational conditions.
Table 2: Proceeding 1 step

Reference Control Program	Control Program fixed at D-1 stage
Application Time of the Proceeding	Day D-1, 18:00 ÷ 23:00
Proceeding step: **18:00-23:00 Day Ahead**	Every day D-1 each TSO runs the DACF process of the day D and performs the forecast N-1 security assessment on the Relevant Grid; Coreso performs the mentioned security assessments for Terna and RTE.
Proceeding step: **Simulation of internal measures**	If a TSO forecasts a N-1 security violation on its internal grid or interconnectors belonging to the Relevant Grid, this TSO (Involved TSO) simulates the adoption of all internal remedial actions available in its system, for autonomous congestion relieving: topology changes, Phase Shifter Transformers set points' adjustments, internal generation re-dispatching, etc. Forecasted unavailability of any agreed remedial action or Special Protection Scheme (SPS) has to be reported without any delay as soon as a problem is detected: the Involved TSO sends all the other TSOs and Coreso the "Unavailability of Remedial Actions" template via e-mail in which at least the following relevant information has to be specified: • the involved TSOs; • the list of the unavailable remedial actions or SPS.

Proceeding step: **Simulation of coordinated measures**	The Involved TSO consults by phone partners with the aim of specific bi(multi)lateral coordination concerning the grid topology and the generation pattern on the interconnected grid making a proposal of remedial actions to be applied in real time in case the violations forecast at D-1 stage should be confirmed the day after. RTE and Terna have given to Coreso the possibility to discuss in D-1 with Swissgrid, ELES and APG the possible remedial actions.
Proceeding step: **D-1 Assessment Email**	Forecasted N-1 security violation not solved with the adoption of the available remedial actions: the Involved TSO sends all the other TSOs the "D-1 Security Assessment Email" in which at least the following relevant information has to be specified: • the considered DACF model • the contingency(ies) and the related violation(s) coming from its N-1 security assessment including the simulation of all the relevant internal measures; • the list of the simulated internal remedial actions. In any case the action to fill and send the "D-1 Security Assessment Email" remains to the TSOs.

Proceeding 2 – Intra Day-Real Time Handling of the Control Program

The aim of this Proceeding is the Intra Day-Real Time (ID-RT) handling of the Control Program for preventing/solving violations of the N-1 security criterion on the Relevant Grid [37.].
It refers to ID-RT operational conditions.

Table 3: Proceeding 2 steps

Reference Control Program	Control Program fixed at D-1 (Day Ahead) stage
Application Time of the Proceeding	As soon as at least one of the following events occurs: • N-1 security violation on the Relevant Grid • Voltage control and dynamic instability problems • unavailability of defence plans or special protection schemes in Italy. Forecasted unavailability of any agreed remedial action or Special Protection Scheme (SPS) has to be reported without any delay as soon as a problem is detected for the real time operation: the Involved TSO sends all the other TSOs and Coreso the "Unavailability of Remedial Actions" template via e-mail in which at least the following relevant information has to be specified: • the involved TSOs; • list of the unavailable remedial actions or SPS.
Control Program Curtailment Application	First applicable round hour

Control Program Curtailment Duration	As specified in the ID-RT Curtailment Email
Proceeding 2 step 1: **N-1 security monitoring**	Each TSO, under its responsibility, regularly and continuously performs ID-RT N-1 security calculations on its internal network and interconnectors of the Relevant Grid[3]
Proceeding 2 step 2: **Preliminary Action**	• Identification of N-1 security violation • 'Early Warning': If a TSO (Involved TSO) identifies a potential application of this Proceeding, this TSO provides all partners by phone with the "early warning". • The other TSOs, if feasible, propose and take, on a voluntary basis, unilateral complementary remedial actions. • Actions in case of Real possibility of application of this Proceeding. If the application becomes real when using the available transfer capacity (using the intra-day gate), partners proceed to the intra-day freezing: this measure consists in the *closure of the Intra Day exchange capacities* of the concerned countries (the capacities would be closed only in the directions that lead to increase the detected violation)
Proceeding 2 step 3: Coordinated actions	If the N-1 security violation is still ongoing: • the Involved TSO Implements all its available internal remedial actions: for the autonomous congestion relieving. • Involved TSO and the other TSOs Agree of bi(multi)laterally coordinated remedial actions (non-costly remedial actions and/or cross-border re-dispatching and bilateral exchange programs curtailments if agreed).
Proceeding 2 step 3: **Procedure Application and Control Program curtailment process**	If the N-1 security violation is still ongoing: ***1.*** The Involved TSO triggers the ID-RT Proceeding for Handling the Control Program by, first by phoning Terna and then sending the ID-RT Warning Email (document code: m02IO406DC) filled in all the required fields to all the TSOs. • the time interval related to the request. ***2.*** Terna collects the request coming from the Involved TSO and assesses, by performing network security analyses, the global Control Program curtailment for the whole Interconnection to restore security conditions, The split per the borders of the assessed global Control Program curtailment is then computed according to the Splitting Rules (ref. chapter 6). ***3.*** Terna sends all TSOs an email (ID-RT Curtailment Email, document code: m03IO406DC) which includes: • the global Control Program curtailment, • the splitting by border, and the related duration time. ***4.*** Terna also sends the updated exchange schedules by email,

[3] Annex a03IO406DC includes the coordinated External Contingency List of the TSOs involved in this Procedure.

	5. Each TSO adjusts its generation programs and\or bilateral contracts accordingly. ***6.*** In case of voluntary interconnectors opening for security violations relieving, the Control Program curtailment, if still needed, is carried out as in steps 2, 3, 4 and 5. In order to facilitate the reconnection, coordinated intentional deviations from the exchange schedules can be affected (Terna is in charge of the coordination of that).

Commercial issues arising from the application of the present Proceeding will be managed ex-post by TSOs' Commercial Departments.

Other procedures described in the pentalateral procedure are:

- Manual disconnection of interconnectors in case of security violations;
- Control program curtailment and security of supply;
- Restoration of the Control Program and
- Post operation Analysis.

4.2.3 Agreed mechanisms for cooperation outside the region

EAS-Entso-e-wide awareness system

EAS is an information platform allowing partner TSOs a real-time global view on the European grid. In case a stressed situation arises, a better comprehension of the conditions can be gained and in the case of disturbance, it is possible to identify the origins and to be helpful in problem solving.
In both cases and as much as possible, EAS enables partner TSOs:

- to enhance their assessment of the nature and the size of the disturbance,
- to make decision to react or not without aggravating the situation,
- to coordinate measures for resolving balance and transmission problems and restoration of the transmission system,
- to seek cross-border co-operation.

EAS uses system state definitions based on the article 18 of commission regulation (EU) 2017/1485. Using the below colour indication in Table 4, the TSOs are able to inform others about their system state on Pan-European level:

Table 4 : colour indication of the system state

System state	Colour indication
Normal state	green
Alert state	yellow
Emergency state	red
Blackout state	black
Restoration state	blue

When activating a non-normal system state, the TSO shall send one of predefined messages, named “Main Message” as defined in EAS usage procedure. To specify the cause and the issue, one or more optional predefined messages giving additional information to other TSOs can be activated. Further principles and guidance for the operational use of EAS are described in the ENTSO-E Awareness System – Usage Procedure [33.]

STA process- Short term adequacy process

STA process follows the Short Term Adequacy methodology [35.], developed pursuant to Article 81 of SOGL [20.]. The STA process is performed at ENTSO-E level and it aims at forecasting potential adequacy issues. Forecasted load and generation capacity per type are submitted every day by all ENTSO-E TSOs for a rolling D-7 to D-1 timeframe. The results of the cross-regional adequacy analysis for the next 7 days are made available every day by latest at 11 p.m.

In case of adequacy issues detected in the cross-regional assessment, the regional STA process is triggered. During the regional STA, impacted and neighbouring TSOs fill a template listing their potential regular or extraordinary remedial actions to solve the problem. Regional STA process is currently in external parallel run phase and is expected to go live in second half of 2021.

Regional Adequacy Assessment will be triggered automatically in case remaining capacity of any area on the deterministic calculation of cross regional (CR) STA is less than 0 MW for any timestamp between D-1 and D-3 timestamp. In case Regional Adequacy Assessment will be activated automatically appropriate remedial actions applied by TSOs to mitigate the lack of adequacy will be addressed. Regional Adequacy Assessment can also be triggered manually by the TSO stating clear reasons. Concerned RSCs and TSOs are identified by using Dynamic Zone Matrix created by TSOs. In order to ensure efficient mitigation of adequacy risks, TSOs and RSCs must work in cooperation. This TSOs-RSCs coordination starts with a teleconference. It allows the stakeholders to name an RSC leader, confirm the adequacy issues and prioritise the regional studies. Finally, when the adequacy problems and the involved TSOs-RSCs are identified the Regional Adequacy (RA) calculation can start.

Extraordinary procedure in case of alert state due to violation of system frequency limits

This procedure is in accordance with Article 118 of SOGL and section B-9 of Synchronous Area Framework Agreement for Regional Group Continental Europe (abbr. SAFA) [38.].

Two Coordination Centres located in Swissgrid and Amprion grid are taking turn in monitoring the System Frequency and determining the Stages according to System States defined in Article 152 of the SOGL. There are two possible stages:

- Stage 1: a continuous Frequency Deviation of more than 100 mHz over a time period of more than 5 minutes or a continuous Frequency Deviation of more than 50 mHz over a time period of more than 15 minutes.

- Stage 2: a continuing Frequency Deviation of more than 100 mHz over a time period of more than 10 minutes or a continuous Frequency Deviation of more than 50 mHz either over a time period of 20 minutes or manually triggered after Stage 1 took place. Each LFC area can ask for this manual trigger by contacting the responsible Coordination Centre. In case there are contradicting requests from TSOs, the Coordination Centre shall decide on appropriate actions and trigger of Stage 2.

In case of Stage 1 the Coordination Centres shall identify the Impacting TSO that is predominantly responsible for frequency domination and contact immediately their control rooms by phone or teleconference. A TSO shall be identified as Impacting TSO in case the following conditions are fulfilled in ENTSO-E Awareness System (EAS):

- the TSOs with an ACE exceeding the threshold of 375 MW and
- the TSO has declared Alert State.

The Impacting TSOs shall inform the Coordination Centre about:

- the estimated reason for the imbalance,
- the Remedial Actions that have already been taken,
- the time period when these actions are expected to become effective,
- if these actions are expected to be sufficient to solve the frequency deviation and
- which further actions are planned.

This first contact aims at clarifying from each Impacting TSO if some actions have been already set up, the delay for these actions and if these actions are expected to be sufficient in order to solve the frequency deviation. The Impacting TSOs are expected to set up all the measures that are possible regarding their own rules (market and security) in order to avoid the second step of this procedure as much as possible.
In case the Impacting TSO expects its taken and planned Remedial Actions to not be sufficient and an improvement of the System Frequency cannot be observed by the Coordination Centre, the Coordination Centre shall start the measures corresponding to Stage 2 without delay. Alternatively, the Impacting TSOs may ask the Coordination Centre for the immediate initiation of Stage 2.
In case of Stage 2 the Coordination Centre shall immediately start a phone conference with all relevant Supporting TSOs (Swissgrid, Amprion, RTE, TERNA and REE). If necessary, the Impacting TSOs may join the conference. As a result of the phone conference, one or more further Remedial Actions to return to Normal State shall be agreed by the participating TSOs. Possible Remedial Actions are:

- activation of additional aFRR by means of enforcing the frequency restoration controller to activate additional reserves, i.e. manually overwriting/adjusting the exchange program while – for example – using virtual tie-lines or cross-border schedules;
- activation of additional mFRR or RR;
- mutual emergency assistance services.

Cost coverage and financial settlement

Article 110 of Network code for the electricity transmission system [4.] provides a frame for financial settlement. Unplanned quantities of electricity exchange between LFC areas are

settled in the agreed time period in accordance with the ENTSO-E rules. The return of settled unplanned deviations is compensated in the agreed time period in accordance with the compensation program, separately according to the prescribed tariffs and seasons in accordance with the ENTSO-E rules.

4.3 The matrix of electricity crisis scenarios and corresponding mitigation measures

The matrix of electricity crisis scenarios and corresponding mitigation measures (attached bellow) correlates crisis scenarios and potential measures to mitigate them. Usage of some measure is highly dependent on specific crisis situation and it cannot be prescribed for all possible variations of crisis evolution. Therefore the correct handling of measures requires training and experience. The more severe the crisis evolves the more important correct handling of measures becomes and the more important is the coordination among crisis mitigation involved parties.

Legend

measure applies in all situation

measure applies partialy / dependent on the situation

measure does not apply

procedure/measure / Crisis scenario/severity		Preventive and preparatory measures			
		Measures for control centres	Measures for substations	Measures for power lines	Measures for information communication technology safety
Cyberattack on entities connected to electrical grid	mild				
	medium				
	severe				
Cyberattack on entities not connected to electrical grid	mild				
	medium				
	severe				
Physical attack on critical assets	mild				
	medium				
	severe				
Physical attack on control centres	mild				
	medium				
	severe				
Winter incidents	mild				
	medium				
	severe				
Heatwavee and dry periods	mild				
	medium				
	severe				
Cold spell	mild				
	medium				
	severe				
Fossil fuel shortage	mild				
	medium				
	severe				
Pandemic	mild				
	medium				
	severe				
Simultaneous multiple failures of system primary elements and power system control mechanism complexity	mild				
	medium				
	severe				
Forest fire	mild				
	medium				
	severe				
Local tehnical failure with regional importance	mild				
	medium				
	severe				
Earthquake	mild				
	medium				
	severe				

procedure/measure / Crisis scenario/severity		System defence plan				
		Frequency deviation management procedure	Voltage deviation management procedure	Power flow management procedure	Assitance for active power procedure	Manual demand disconnection procedure
Cyberattack on entities connected to electrical grid	mild					
	medium					
	severe					
Cyberattack on entities not connected to electrical grid	mild					
	medium					
	severe					
Physical attack on critical assets	mild					
	medium					
	severe					
Physical attack on control centres	mild					
	medium					
	severe					
Winter incidents	mild					
	medium					
	severe					
Heatwavee and dry periods	mild					
	medium					
	severe					
Cold spell	mild					
	medium					
	severe					
Fossil fuel shortage	mild					
	medium					
	severe					
Pandemic	mild					
	medium					
	severe					
Simultaneous multiple failures of system primary elements and power system control mechanism complexity	mild					
	medium					
	severe					
Forest fire	mild					
	medium					
	severe					
Local tehnical failure with regional importance	mild					
	medium					
	severe					
Earthquake	mild					
	medium					
	severe					

Crisis scenario/severity \ procedure/measure		System restoration plan			The rules for suspension and restoration of market activities
		Re-energisation procedure	Frequency management procedure	Re-synchronisation procedure	Market suspension
Cyberattack on entities connected to electrical grid	mild				
	medium				
	severe				
Cyberattack on entities not connected to electrical grid	mild				
	medium				
	severe				
Physical attack on critical assets	mild				
	medium				
	severe				
Physical attack on control centres	mild				
	medium				
	severe				
Winter incidents	mild				
	medium				
	severe				
Heatwavee and dry periods	mild				
	medium				
	severe				
Cold spell	mild				
	medium				
	severe				
Fossil fuel shortage	mild				
	medium				
	severe				
Pandemic	mild				
	medium				
	severe				
Simultaneous multiple failures of system primary elements and power system	mild				
	medium				
	severe				
Forest fire	mild				
	medium				
	severe				
Local tehnical failure with regional importance	mild				
	medium				
	severe				
Earthquake	mild				
	medium				
	severe				

Crisis scenario/severity \ procedure/measure		Other available measures			
		powering consumers via 110 kV and middle voltage	redispatch	Demand side response	Suspension of work on electricity grid
Cyberattack on entities connected to electrical grid	mild				
	medium				
	severe				
Cyberattack on entities not connected to electrical grid	mild				
	medium				
	severe				
Physical attack on critical assets	mild				
	medium				
	severe				
Physical attack on control centres	mild				
	medium				
	severe				
Winter incidents	mild				
	medium				
	severe				
Heatwavee and dry periods	mild				
	medium				
	severe				
Cold spell	mild				
	medium				
	severe				
Fossil fuel shortage	mild				
	medium				
	severe				
Pandemic	mild				
	medium				
	severe				
Simultaneous multiple failures of system primary elements and power system	mild				
	medium				
	severe				
Forest fire	mild				
	medium				
	severe				
Local tehnical failure with regional importance	mild				
	medium				
	severe				
Earthquake	mild				
	medium				
	severe				

procedure/measure / Crisis scenario/severity		Administration of the RS for civil protection and disaster relief activation				Slovenian computer emergency response team activation
		protection, rescue and relief forces activation	Civil protection activation	Fire brigades and rescue services activation	Army forces activation	
Cyberattack on entities connected to electrical grid	mild					
	medium					
	severe					
Cyberattack on entities not connected to electrical grid	mild					
	medium					
	severe					
Physical attack on critical assets	mild					
	medium					
	severe					
Physical attack on control centres	mild					
	medium					
	severe					
Winter incidents	mild					
	medium					
	severe					
Heatwavee and dry periods	mild					
	medium					
	severe					
Cold spell	mild					
	medium					
	severe					
Fossil fuel shortage	mild					
	medium					
	severe					
Pandemic	mild					
	medium					
	severe					
Simultaneous multiple failures of system primary elements and power system	mild					
	medium					
	severe					
Forest fire	mild					
	medium					
	severe					
Local tehnical failure with regional importance	mild					
	medium					
	severe					
Earthquake	mild					
	medium					
	severe					

Crisis scenario/severity \ procedure/measure		Inter TSO agreements		
		Agreement on mutual emergency assistance service	Measures in critical network situations (system defence plan)	Common network restoration strategy
Cyberattack on entities connected to electrical grid	mild			
	medium			
	severe			
Cyberattack on entities not connected to electrical grid	mild			
	medium			
	severe			
Physical attack on critical assets	mild			
	medium			
	severe			
Physical attack on control centres	mild			
	medium			
	severe			
Winter incidents	mild			
	medium			
	severe			
Heatwavee and dry periods	mild			
	medium			
	severe			
Cold spell	mild			
	medium			
	severe			
Fossil fuel shortage	mild			
	medium			
	severe			
Pandemic	mild			
	medium			
	severe			
Simultaneous multiple failures of system primary elements and power system	mild			
	medium			
	severe			
Forest fire	mild			
	medium			
	severe			
Local tehnical failure with regional importance	mild			
	medium			
	severe			
Earthquake	mild			
	medium			
	severe			

Crisis scenario/severity \ procedure/measure		Agreed mechanisms for cooperation inside and outside the region			
		EAS	STA	IBWT Operational procedure for critical grid situations	Pentalateral handling of the control program on the Italian Northern Interconnection
Cyberattack on entities connected to electrical grid	mild				
	medium				
	severe				
Cyberattack on entities not connected to electrical grid	mild				
	medium				
	severe				
Physical attack on critical assets	mild				
	medium				
	severe				
Physical attack on control centres	mild				
	medium				
	severe				
Winter incidents	mild				
	medium				
	severe				
Heatwavee and dry periods	mild				
	medium				
	severe				
Cold spell	mild				
	medium				
	severe				
Fossil fuel shortage	mild				
	medium				
	severe				
Pandemic	mild				
	medium				
	severe				
Simultaneous multiple failures of system primary elements and power system	mild				
	medium				
	severe				
Forest fire	mild				
	medium				
	severe				
Local tehnical failure with regional importance	mild				
	medium				
	severe				
Earthquake	mild				
	medium				
	severe				

5. Crisis coordinator

ELES is the designated crisis coordinator responsible for carrying out tasks prescribed in the REGULATION (EU) 2019/941 during and beforehand crisis situation. Before the event of the crisis, its main task is to try to prevent the crisis using the early alert mechanisms, and to prepare for crisis if it is inevitable. In preparation for the potential crisis, ELES regularly performs equipment testing and trains it's operational staff how and which procedures and measures to use in the event of crisis. During the electricity crisis ELES's main responsibilities are to act as a contact point and to coordinate measures for mitigating the crisis among participating parties. ELES also plays an important role in coordinating information flow among information centres, DSOs, ministries, civil protection, rescue and protection forces, public and, dependent on the scale and form of crisis, Slovenian army forces, fire brigades etc.

6. Stakeholders consultations

The Risk preparedness is developed and agreed after consultations with the following stakeholders:

- Ministry of Infrastructure of the Republic of Slovenia as competent authority;
- ELES as TSO;
- SODO d.o.o., Elektro Ljubljana d.d., Elektro Celje d.d., Elektro Maribor d.d., Elektro Primorska d.d. and Elektro Gorenjskad.d. as representatives for DSO;
- Borzen d.o.o. as Electricity Market Operator and
- Agencija RS za energijo (Energy Agency), as NRA.

The consultations took place via several teleconferences.

7. Emergency tests

7.1 Schedule of real time response simulations

Regional:
ELES participates in the Inter TSO real time response simulations for Alert and Emergency state management in the former CEE region. There are no exact schedules determined for these trainings, but they do take place twice a year in autumn and spring. The last training took place from 24 to 26 February 2021 and the next is scheduled to be from 22 to 24 September 2021.

National:
Currently, national real-time response simulations for emergency states are not scheduled in advance. These simulations are performed within regular training of operators with procedures related to ensuring the operation of critical infrastructure. In the future, we plan to establish some further real time crisis simulations, with the first step in mind to annually test the communications protocols and regularly update contact list of personnel for emergency state operations.

7.2 Agreed procedures and involved parties

7.2.1 Regional procedures

Currently Ministry of infrastructure in investigating and consulting with other member states in the region on possible future procedures for emergency real time response simulations.

On TSO level, ELES participates in inter TSO real time response simulation in the CEE region in cooperation with DUtrain Independent training and service centre for power system control. Every training contains two test scenarios, one regarding system Alert state and one regarding system emergency state. Trainings take place on DUtrain simulations platform.

Possible scenarios:

- CEE is split into several islands;
- Damaged cross border lines;
- Blackout of control areas;
- Loss of supply in major areas;
- High flows with lack of power;
- exceptional contingencies, etc.

Procedure for system alert state:

1. TSO remotely access the DUtrain simulation platform;
2. Alert state is predefined and triggered;
3. TSOs analyse the situation;
4. Available mFRR is predefined;
5. Repeating actions until the system state is returned to normal:

- TSOs coordinate among each other via teleconference and agree on remedial actions/measures;
- Nomination of frequency leader;
- Frequency leader coordinates the situation;
- TSOs perform coordinated measures.

Procedure for system Emergency state (example: CEE is split into several islands):

1. TSO remotely access the DUtrain simulation platform;
2. Emergency state is predefined and triggered;
3. Scenario starts without initial status analysis;
4. System analysis – Frequency/topology/available production;
5. Repeating actions until the system state is returned to normal:
   - TSOs of each island coordinate among each other via teleconference and agree on remedial actions/measures;
   - Nomination of frequency leader of the island;
   - Frequency leader coordinates the situation;
   - Nomination of resynchronisation leader;
   - TSOs perform coordinated measures;
   - Synchronisation of two islands;
   - Prior to reconnection, new frequency leader for the combined area shall be nominated.

Involved parties are the TSOs of the CEE region: ELES, 50Hertz, Amprion, APG, Čeps, MAVIR, PSE, SEPS, Tennet

7.2.2 National procedures

Current procedures for real time training simulations are taking place on training simulator within regular training of operators. Participating parties are operators in the national and regional control centres.

Procedure:

- Definition of emergency scenario (example: regional blackout, system restoration following the bottom-up procedure);
- Operator of national control centre coordinates with operator of the regional control centre;
- Operator follows procedure from System restoration plan.

Future procedures:
At first stage of emergency tests development, the aim is to test information flow among participating parties. At later stages, we plan to develop more procedures to be followed.
Procedure:
TSO triggers an electricity crisis test scenario;
TSO informs DSOs, Market participants, SGUs and Ministry of infrastructure about electricity crisis test via telephone and email;
DSOs, Market participants, SGUs and Ministry of infrastructure respond to TSO via email;

TSO creates a short report about the emergency test simulation indicating the involved actors and their response time;
TSO shares the report among all the participating parties.

Actors: TSO, DSOs, Market participants, SGUs, Ministry of infrastructure

8. Next steps

During the preparation of the risk preparedness plan, we have identified a few actions that would help improve overall preparedness to emergencies and provide an enhanced legal frame for crisis situation management:

- Decree on limiting loads and consumption of electricity in the electricity system is out of date and not completely consistent with Network code for the electricity transmission system and some other subplans like System defence plan. Therefore, we identify the need to rewrite the Decree;
- Financial settlement for measures taken in the event of crisis is determined via Electricity supply act, Network code for the electricity transmission system, Rules for suspension and restoration of market activities and by individual contracts with energy producers. Here, we identify a need to make some research and analyse, whether there is a need to sign further contracts with producers and large consumers;
- Emergency tests for electricity crisis scenarios are not supported by national legislation. Including these tests in the legislation would help the preparation and implementation of these tests and, therefore, improve overall risk preparedness;
- Decree on determining transmission system operator for coordinator in the preparation, definition and implementation of tasks for the operation of the defence system in a state of emergency, war or crisis, and in the event of major natural and other disasters in the field of electricity shall be harmonised with Critical infrastructure act.

9. Literature

[1.] Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0941&from=EN,

[2.] Decree on determining transmission system operator for coordinator in the preparation, definition and implementation of tasks for the operation of the defence system in a state of emergency, war or crisis, and in the event of major natural and other disasters in the field of electricity – Pravilnik o določitvi sistemskega operaterja za koordinatorja pri pripravah, opredelitvi in izvajanju nalog za delovanje obrambnega sistema v izrednem stanju, vojni ali krizah ter ob večjih naravnih in drugih nesrečah na področju elektrogospodarstva,

[3.] Energy Act-Energetski zakon (EZ-1), http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6665,

[4.] Network code for the electricity transmission system- Sistemska obratovalna navodila prenosnega omrežja, http://www.pisrs.si/Pis.web/pregledPredpisa?id=NAVO1112,

[5.] Decree on limiting loads and consumption of electricity in the electricity system- Uredba o omejevanju obtežb in porabe električne energije v elektroenergetskem sistemu http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED568,

[6.] Information security act – Zakon o informacijski varnosti (ZInfV), http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO7707,

[7.] National Cyber Incident Response Plan,

[8.] Decree determining essential services and the detailed methodology for determining essential service operators - Uredba o določitvi bistvenih storitev in podrobnejši metodologiji za določitev izvajalcev bistvenih storitev, http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED7808,

[9.] Critical infrastructure act – Zakon o kritični infrastrukturi (ZKI), http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO7106,

[10.] Electricity Supply Act- Zakon o oskrbi z električno energijo, http://pisrs.si/Pis.web/pregledPredpisa?id=ZAKO8141,

[11.] Defence Act – Zako o obrambi (Uradni list RS, št. 103/04 – uradno prečiščeno besedilo, 95/15 in 139/20), http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO532,

[12.] Decree on Defence Planning (Uredba o obrambnnem načrtovanju – Uradni list RS, št 51/13), http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED6393,

[13.] Decree on the content and elaboration of protection and rescue plan (Uredba o vsebini in izdelavi načrtov zaščite in reševanja - Uradni list RS, št. 24/12, 78/16 in 26/19), http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED5994,

[14.] Protection Against Natural and Other Disasters Act (Zakon o varstvu pred naravnimi in drugimi nesrečami - ZVNDN - Uradni list RS, št. 51/06 – uradno prečiščeno besedilo, 97/10 in 21/18 – ZNOrg), http://pisrs.si/Pis.web/pregledPredpisa?id=ZAKO364,

[15.] Decree on obligatory setting-up of security service (Uredba o obveznem organiziranju varovanja (Uradni list RS, št. 80/12)), http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED6002,

[16.] Commission Regulation (EU) 2017/2196 of 24 November 2017 establishing a network code on electricity emergency and restoration, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2196&from=EN,
[17.] System Defence Plan,
[18.] System Restoration Plan,
[19.] The rules for suspension and restoration of market activities https://www.eles.si/Portals/0/Novice/avkcije/sistemske%20storitve/T%26C%20za%20PSI/Pravila%20za%20prekinitev%2031012020_2.pdf,
[20.] Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=EN,
[21.] Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2195&from=EN,
[22.] National protection and rescue plans, http://www.sos112.si/slo/page.php?src=os121.htm,
[23.] Rescue and protection plan of ELES;
[24.] Rescue and protection plan of Elektro Ljubljana, https://www.elektro-ljubljana.si/Portals/0/O-nas-Elektro-Ljubljana/Nacrt%20zascite%20in%20resevanja%202021.pdf, Rescue and protection plan of Elektro Primorska, http://www.elektro-primorska.si/sites/www.elektro-primorska.si/files/upload/images/nacrt_zascite_in_resevanja_maj_2021.pdf
[25.] Rescue and protection plan of Elektro Maribor, https://www.elektro-maribor.si/media/2498/nacrt_zascite_in_resevanja_em.pdf,
[26.] Rescue and protection plan of Elektro Celje, https://www.elektro-celje.si/si/files/default/Na%c4%8drt%20za%c5%a1%c4%8dite%20in%20re%c5%a1evanja%20Elekktro%20Celje%20d.d_junij%202021.pdf,
[27.] Rescue and protection plan of Elektro Gorenjska, https://www.elektro-gorenjska.si/resources/files/pdf/Ursa_Gartnar/Nart_zaite_in_reevanja_ob_naravnih_in_drugih_nesreah_za_Elektro_Gorenjska__d_d__2021.pdf,
[28.] Administration of the RS for Civil protection and disaster relief, http://www.sos112.si/eng/,
[29.] Slovenian computer emergency response team, https://www.cert.si/en/about-si-cert/,
[30.] Organizational regulations of Information security incident management – Organizacijski predpis Upravljanje informacijskih varnostnih
[31.] decision on determining the criteria for determining the critical infrastructure of the Republic of Slovenia and their limit values and the priorities for the operation of the critical infrastructure sectors, https://silverbulletrisk.com/wp-content/uploads/2019/08/KriticnaInfrastruktura_Sektorji.pdf,
[32.] Risk assessment and Critical infrastructure protection measures,
[33.] ENTSO-E Awareness System – Usage Procedure
[34.] IBWT Operational procedure for critical grid situations
[35.] Coordinated Week ahead adequacy assessment – Short-term adequacy
[36.] Inter TSO Agreement
[37.] Pentalateral handling of the control program on the Italian Northern Interconnection
[38.] Synchronous Area Framework Agreement for Regional Group Continental Europe