RISK-PREPAREDNESS REGULATION - IDENTIFICATION OF NATIONAL ELECTRICITY CRISIS SCENARIOS FOR CYPRUS

June 2025

Any correspondence for this document should be sent to the Cyprus Energy Regulatory Authority

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1. CERA Mission Statement

The Cyprus Energy Regulatory Authority (CERA) is responsible for establishing and implementing an effective and transparent regulatory framework that supports the development of a secure, competitive, efficient and sustainable energy sector in Cyprus.

CERA's mission is to facilitate the smooth, orderly and effective integration of Cyprus into the European energy market, while safeguarding the security, reliability and continuity of energy supply. In fulfilling this role, CERA seeks to ensure that the energy system remains resilient to potential risks and disruptions, while promoting efficient market functioning and protecting the interests of consumers and the wider national economy.

CERA therefore aims to balance the objectives of energy security, market integration, sustainability and consumer protection, ensuring that energy remains available, reliable and reasonably accessible to consumers and to the Cypriot economy.

2. Executive Summary

In accordance with Article 7 of Regulation (EU) 2019/941 on risk-preparedness in the electricity sector (the “Risk Preparedness Regulation” or “RPR”), the Cyprus Energy Regulatory Authority (CERA), as the competent authority for Cyprus, has identified the national electricity crisis scenarios considered most relevant to the Cypriot electricity system. This is the second report prepared by CERA on the identification of national electricity crisis scenarios, following the first report published in December 2020.

The identification of the national scenarios has been undertaken taking into account the risks set out in Article 5(2) of the RPR, the ENTSO-E methodology for the identification of electricity crisis scenarios and, where relevant, the regional electricity crisis scenarios identified by ENTSO-E. While the regional scenario process under Article 6 does not currently apply to Cyprus, pursuant to the specific derogation provided under Article 21 of the RPR for Member States that are not directly interconnected with another Member State, the ENTSO-E methodology and relevant regional scenarios have been used as an appropriate reference to support a consistent and structured assessment. This consideration does not imply that Article 6 regional scenarios or related regional measures are legally binding on Cyprus.

The assessment has resulted in the identification of 17 national electricity crisis scenarios considered relevant to Cyprus. These scenarios cover a broad range of potential events that could adversely affect the security of electricity supply, including extreme weather conditions, significant variations in demand and renewable generation, fuel shortages, natural hazards, technical failures, industrial incidents, pandemics, social disruption, physical attacks, cyber-attacks, unauthorised actions by personnel and the increasing penetration of renewable energy sources. Each scenario has been assessed and assigned a likelihood classification using the six-level scale set out in the ENTSO-E methodology.

The scenarios have been developed in consultation with the Transmission System Operator of Cyprus (TSOC), the Distribution System Operator (DSO), and relevant electricity producers through their respective trade bodies, in accordance with Article 7(2) of the RPR. The consultation process provided technical and operational input on the relevance, likelihood and potential consequences of the identified scenarios for the Cypriot electricity system. CERA has reviewed and taken into account the comments received and has incorporated the relevant observations and clarifications into the final assessment and presentation of the scenarios.

Given the current absence of a direct electricity interconnection between Cyprus and another EU Member State, the identified scenarios concern the national electricity system of Cyprus and no cross-border electricity system impact has been assumed as part of the assessment. The specific characteristics of Cyprus as an isolated electricity system have therefore been taken into account, including the limited availability of interconnection support, the structure and concentration of generation capacity, the increasing penetration of renewable energy sources, and the particular exposure of the system to certain climatic, technical and security-related risks.

The identified scenarios are not intended to constitute forecasts that any particular crisis will occur. Rather, they represent plausible and relevant stress situations against which Cyprus's electricity system can be assessed in terms of its resilience, security of supply and ability to prevent, prepare for and manage an electricity crisis. The scenarios will provide the basis for the subsequent development of the preventive, preparatory and response measures to be included in Cyprus's Risk-Preparedness Plan, in accordance with Article 10 of the RPR.

Overall, the assessment provides a structured national framework for identifying and evaluating the principal risks that could lead to an electricity crisis in Cyprus. It also provides the basis for further strengthening the preparedness and resilience of the Cypriot electricity system, while ensuring that the national approach remains consistent, where relevant, with the wider European risk-preparedness framework.

3. General Information

The Cyprus Energy Regulatory Authority (CERA) is the competent authority for the preparation of the Risk Preparedness Plan.

In accordance with the preamble No. 38 of the Regulation (EU) 2019/941, Cyprus is currently the only Member State which is not directly connected to another Member State. It should be clarified with respect to certain provisions of the Regulation (EU) 2019/941, that, for as long as this situation persists, those provisions, namely provisions on the identification of regional electricity crisis scenarios, including regional and bilateral measures set out in risk-preparedness plans, and on assistance, do not apply with respect to Cyprus. Therefore, Cyprus at the time being is not required to develop any regional or bilateral procedures and measures with other Member States since in accordance with the Regulation (EU) 2019/941 Cyprus is isolated and is not part of any relevant region.

In this respect, Cyprus has developed, with the support of the Commission, alternative measures and procedures in the fields covered by those provisions, that do not affect the effective application of the Regulation (EU) 2019/941 between the other Member States.

3.1. Electricity Market in Cyprus

The year 2025 marks a milestone for Cyprus' energy sector, as it signifies the transition to a fully competitive electricity market model. CERA Decision No. 185/2025, providing for the commencement of the commercial operation of the Competitive Electricity Market (CEM) on 15 September 2025, with the first Trading Day on 1 October 2025, constitutes a major step towards alignment with the European acquis and the European Union.

Basically, the Competitive Electricity Market of Cyprus is designed based on the European Net Pool market model (combining a power pool with bilateral contracts) and regulates all wholesale energy purchase and sale transactions. The CEM allows for:

- the conclusion of bilateral contracts between Independent Producers and Independent Suppliers; and
- participation in the Day-Ahead Electricity Market, with settlement on a half-hourly basis, enabling more accurate load forecasting and facilitating the integration of variable Renewable Energy Sources (RES).

4. Public Impact Statement

Regulation (EU) 2019/941 on risk-preparedness in the electricity sector (the "Risk Preparedness Regulation" or "RPR") requires Member States to identify and assess electricity crisis scenarios and to establish arrangements for preventing, preparing for and managing situations that could result in a significant shortage of electricity or an inability to supply electricity to customers. Such situations may arise from a wide range of events, including extreme weather conditions, technical failures, fuel shortages, natural hazards, cyber-attacks, physical attacks or other events affecting the operation of the electricity system.

As part of this process, CERA, as the competent authority for Cyprus, has identified a set of national electricity crisis scenarios that are considered relevant to the Cypriot electricity system. The scenarios have been developed taking into account the specific characteristics of the Cyprus electricity system, including its isolated nature, the structure of electricity generation, the increasing penetration of renewable energy sources and the particular risks to which the system may be exposed.

The scenarios are not predictions that any particular event will occur. Rather, they represent plausible situations that could, under certain circumstances, lead to significant disruption to electricity supply. Their purpose is to enable CERA and the relevant electricity-sector stakeholders to assess the potential consequences of such events and to ensure that appropriate preventive, preparatory and mitigating arrangements can be developed in advance.

The identification of the scenarios does not, in itself, introduce new obligations or restrictions on electricity customers. The scenarios provide the risk-assessment basis for the subsequent development of Cyprus's Risk-Preparedness Plan, which will set out the procedures and measures to be followed by the relevant authorities and electricity-sector stakeholders in order to prevent or mitigate the effects of an electricity crisis and, where necessary, minimise disruption to customers.

The scenarios have been developed following consultation with the Transmission System Operator of Cyprus (TSOC), the Distribution System Operator (DSO) and relevant electricity producers through their respective trade bodies. The consultation was intended to ensure that the range of scenarios considered is sufficiently comprehensive and that their likelihood and potential impacts on the electricity system are appropriately assessed. The comments and technical input received have been taken into account by CERA in finalising the national scenarios.

In accordance with the specific provisions of Article 21 of the RPR, Cyprus is not currently subject to the regional electricity crisis scenario identification process under Article 6, as Cyprus is not directly interconnected with another Member State. Nevertheless, the ENTSO-E methodology and relevant regional scenarios have been considered, where appropriate, as a reference in developing the national assessment. This approach supports consistency with the wider European risk-preparedness framework while ensuring that the scenarios remain appropriate to the specific circumstances of Cyprus.

The public should also note that CERA and the relevant electricity-sector operators have historically undertaken work to maintain the security and continuity of electricity supply in Cyprus. The present exercise builds on that existing preparedness framework and brings the relevant risks and scenarios together within the common framework established by the RPR.

The scenarios will be used in the next phase of work under the regulation, which will involve drawing up detailed preparations to manage such events. The plans will contain the arrangements for the electricity sector to follow during the different crisis scenarios, in order to mitigate and minimize the disruption caused to customers.

The purpose of this consultation is to ensure that a reasonable range of potential crisis scenarios have been identified, and that their likelihoods and possible impacts on the electricity system have been fully considered.

The public should note that similar work has historically been undertaken by CERA in close cooperation with the TSOC in order to ensure security of supply in Cyprus.

5. Introduction

5.1. Risk Preparedness Regulation

The Risk Preparedness Regulation (RPR, EU 2019/941) sets out a requirement for Member States to develop transparent risk-preparedness plans to prevent, prepare for and manage electricity crises, indicating the agreed coordination and cooperation within regions and between Member States.

In developing the risk-preparedness plans, the RPR requires each Member State to produce a set of nationally relevant electricity crisis scenarios. The scenarios are intended to represent situations in which there is a shortage of electricity or an inability to provide electricity to customers.

Under Regulation (EU) 2019/941 on risk-preparedness in the electricity sector, Cyprus is subject to a specific derogation due to its lack of direct interconnection with another Member State. Pursuant to Article 21 of the RPR, Article 6, concerning the identification of regional electricity crisis scenarios, does not apply to Cyprus for as long as Cyprus is not directly connected to another Member State. Accordingly, Cyprus is not required to establish or participate in the establishment of regional electricity crisis scenarios under Article 6, nor is it required to treat such regional scenarios as legally binding for the purposes of its national risk-preparedness framework.

This derogation does not relieve Cyprus of its obligations under Article 7 of the RPR. The competent authority remains responsible for identifying the most relevant national electricity crisis scenarios and for ensuring that these are appropriately reflected in Cyprus's Risk-Preparedness Plan. In developing its national scenarios, Cyprus may take into account the ENTSO-E regional scenarios and methodology as a relevant methodological reference, where appropriate, in order to support consistency and comparability with the wider European risk-preparedness framework. However, such consideration should not be interpreted as an obligation for Cyprus to implement or follow the Article 6 regional scenarios as legally binding scenarios. The key distinction is therefore that Cyprus is required to develop and maintain national electricity crisis scenarios, while the Article 6 regional scenario obligation does not currently apply to Cyprus under the specific derogation provided by Article 21 of the RPR.
Therefore, document presents the set of national electricity crisis scenarios developed by CERA, in its role as competent authority, in fulfilment of the requirement of Article 7 of the RPR. The scenarios were prepared taking into account the set of regional electricity crisis risk scenarios established by the European Network of Transmission System Operators for Electricity (ENTSO-E)

in line with Article 6 of the RPR. Many of the scenarios considered relevant for Cyprus as well even though is not interconnected with any other Member State.

Article 7(2) requires that the competent authority consult with ‘the transmission system operators, the distribution system operators that the competent authority considers to be relevant and the relevant producers or their trade bodies’. As the body responsible for the operation of the transmission system, TSOC and DSO has been closely consulted and has contributed significant expertise to the development of the scenarios. Apart from TSOC and DSO, CERA has also consulted the relevant producers through their trade bodies.

5.2. Related Documents

The most related documents with this report that are worth to note are the following:

- Regulation (EU) 2019/941 on risk preparedness in the electricity sector.
- Council of Ministers’ Decision designating CERA as Competent Authority.
- CERA report no. 07/2020, “Identification of national electricity crisis scenarios” – December 2020.
- ACER Decision no. 02/2024, “on the amendment of the methodology for identifying regional electricity crisis scenarios”.
- ENTSO-E report, “Identification of the Most Relevant Regional Electricity Crisis Scenarios (2024)”.
- Electricity Coordination Group’s Recommended amendments to ENTSO-E’s identification of regional electricity crisis scenarios dates 16 April 2025

6. Electricity Crisis Scenarios

6.1. Scenario Development

The electricity crisis scenarios presented in this section are identified as being the most relevant for the case of Cyprus. The electricity crisis scenarios identification has taken into account the risks referred to in Article 5(2) of the Risk Preparedness Regulation and in the “Methodology to Identify Regional Electricity Crisis Scenarios” of ENTSO-E.

In identifying the Cyprus’ electricity crisis scenarios, CERA consulted the Transmission System Operators of Cyprus (TSOC), the DSO and the relevant producers through their trade bodies.

Each scenario has been rated according to its likelihood of occurrence. For the classification of the likelihood of crisis, the six-step classification scale of the “Methodology for Identifying Regional Electricity Crisis Scenarios” of ENTSO-E was used. Table 1 presents the crisis likelihood scale and Table 2 the electricity crisis scenarios of Cyprus and their likelihood of occurrence.

Table 1: Crisis likelihood scale

Classification	Events per year	1 x in … years	Description/example of initiating event
Very likely	≥ 0.5	2 or less	Event expected practically every year, e.g. winds/storms causing multiple failures of overhead lines may be expected nearly every year in some areas.
Likely	0.2-0.5	2-5	Event expected once in a couple of years, e.g. heat wave causing limits on output of open-loop water-cooled power plants, low water levels at hydro plants, higher load, etc.
Possible	0.1-0.2	5-10	Event expected or taken into consideration as a potential threat, e.g. cyber or malicious attack.
Unlikely	0.01-0.1	10-100	Rare event, e.g. simultaneous floods causing unavailability of generation, distribution and transmission infrastructure.

Very unlikely	0.001-0.01	100 - 1000	Very rare event, e.g. earthquake causing a huge destruction of transmission, distribution and generation infrastructure
Extremely unlikely	≤ 0.001	1000 or more	Not applicable, impossible, or extremely rare event, expected beyond 1 in 1000 years.

Table 2: Cyprus' electricity crisis scenarios likelihood of occurrence

Crisis Scenario	**Name**	**Likelihood**					
		Very likely	**Likely**	**Possible**	**Unlikely**	**Very unlikely**	**Extremely unlikely**
1	Severe Summer	√					
2	Severe Winter		√				
3	Heavy Flooding		√				
4	Dunkelflaute (extremely low wind/solar generation)				√		
5	Usually bid demand/RES forecast errors		√				
6	Earthquake				√		
7	Space weather						√
8	Fossil Fuel Shortage			√			
9	Large industrial incident			√			
10	Serial Technical Defects			√			
11	Pandemic			√			
12	Industrial action, strikes, riots				√		
13	Physical Attack on critical assets			√			
14	Physical Attack on control centres			√			

15	Loss of ICT systems to cyber-attack			√			
16	Unauthorised action by personnel				√		
17	High penetration of RES	√					

7. Individual scenario details

This section indicates the national electricity crisis scenarios that apply in the case of Cyprus:

7.1. Crisis Scenario 1: Severe Summer

7.1.1. Description of the scenario

High and temporarily extreme temperatures, well above seasonal averages, are accompanied by drought/dry periods and forest/bush fires leading to increased demand (primarily due the increased use of air conditioning), lower generation availability, and reduced transmission capacities.

7.1.2. Season(s) of the year when the scenario is relevant

This scenario is relevant in Summer.

7.1.3. Preconditions and initiating events

Initial conditions

The power system is in Normal state and operational conditions are normal (the system is N-1 secure with no unusual / excessive outages, and sufficient power reserves are available). Cyprus experiences national load maxima in summer. Seasonal maintenance outages will have been planned accordingly.

Electricity market is in normal operation.

Meteorological forecasts have announced periods with severe weather conditions and remedial actions have been taken.

Initiating event and chain of events

Cyprus presents high load in summer which has most power plants not in maintenance.

In the case of prolonged extreme temperatures, stable operation of the power system will come up against several restrictions.

- System demand increases, primarily due to increased use of air-conditioning.
- Low/no rainfall reduces the level of surface water in reservoirs & rivers.
- Wind generation is extremely low during heat waves.

- PV generation is reduced due to higher temperatures, forest fires, and dust.
- Generation capacity may further be limited due to thermal ratings on transmission and distribution assets (lines, cables, transformers).
- The higher possibility of forest and bush fires causes additional unavailability of grid assets (unplanned outages due to the fires and longer lasting repair time of impacted lines and pylons).

7.1.4. Evolution of the scenario

The evolution of this scenario will be characterised by significantly increased summer demand, reduced generation availability and reduced transmission capacity (internal and cross-border), which cannot be resolved by normal grid and system operation. An overview for possible evolutions paths caused by some events is given here:

Operational impacts

- Significant N-1 violations in the transmission grid are observed as overloaded grid assets are automatically disconnected, with the risk of cascading trips.
- Redispatch is necessary to change active power flow, but there is a decrease in the number of generation units or reduced production capacities of power plants.
- A combination of heavily loaded grid assets and lower generation raises the risk of voltage instability (due to increased reactive power demand); there may be significant voltage drops, leading in the extreme to voltage collapses).

Structural or systemic degradation

- Maintenance or repair of affected power lines may be delayed due to working conditions and safety considerations for personnel (with transfer capacities at their limits).
- Construction, maintenance, and emergency services may be stretched due to the number of incidents and reduced personnel resources.
- The risk of asset degradation increases.
- Security of supply impacts:
- Transmission lines affected by fire may impact available generation and may result in reduction in demand.
- Peak demand may exceed maximum of available generation and import capacity.
- Reserves are called up rapidly and are diminishing due to unavailability.

7.1.5. Description of impacts on the national perimeter

A prolonged and severe summer heat wave may place significant stress on the Cyprus electricity system through the simultaneous occurrence of exceptionally high electricity demand, reduced generation availability and adverse operating conditions for electricity network infrastructure. The impact may be particularly significant given the isolated nature of the Cyprus electricity system and the resulting reliance on domestic generation capacity and available operational reserves.

Unplanned unavailability of grid assets or reduced thermal capacities due to the temperatures could lead to the need for demand curtailment or disconnection (load shedding) in some areas to balance supply and demand and manage voltage and thermal constraints.

<u>Security of supply impacts</u>

The principal risk associated with this scenario is a significant reduction in the security margin between available generation capacity and electricity demand. Prolonged high temperatures may result in a substantial increase in electricity consumption, mainly due to air-conditioning demand, while the availability of certain generating units may be reduced due to planned or unplanned outages, technical limitations or adverse operating conditions.

Under a severe combination of high demand and reduced generation availability, operating reserves may become significantly depleted. If available generation capacity is insufficient to meet demand while maintaining the required operational reserves, the TSOC may need to implement emergency measures, including controlled demand reduction or load shedding, in order to maintain system balance and prevent a wider system disturbance. In an extreme case, the inability to maintain the generation-demand balance could result in partial or widespread interruption of electricity supply.

The risk may be further aggravated during the evening period, when solar PV generation decreases rapidly while electricity demand may remain high. Consequently, the system may experience a rapid increase in net demand and a corresponding need for conventional generation and balancing resources.

<u>Operational impacts</u>
Extreme temperatures may adversely affect the operating conditions of generation, transmission and distribution assets. Thermal limitations on transmission and distribution equipment may reduce the available transfer

capacity of the network, while the increased loading of transformers, lines and cables may increase the probability of equipment failures or forced outages.

In addition, the ability to carry out corrective maintenance and emergency repairs may be affected by extreme weather conditions, including high temperatures, wildfires and restricted access to affected infrastructure.

Infrastructure impacts

Prolonged exposure to extreme temperatures may increase the risk of thermal stress and degradation of electricity infrastructure. Transmission and distribution assets may operate closer to their thermal limits, while forest and vegetation fires may damage or temporarily disconnect overhead lines and other network infrastructure.

Dust accumulation and other environmental conditions associated with prolonged hot and dry periods may also affect the performance of electrical equipment and increase maintenance requirements. Damage to critical infrastructure could result in longer restoration times, particularly where several assets are affected simultaneously or where access to affected locations is restricted.

Overall national impact

The overall impact of the Severe Summer scenario would depend on the duration and intensity of the heat wave, the level and timing of peak demand, the availability of generating units, the availability of operational reserves and the condition of the transmission and distribution infrastructure.

A severe but short-duration event may be manageable through normal operational measures and the activation of available reserves. However, a prolonged heat wave coinciding with the unavailability of one or more major generating units or critical network assets could significantly reduce the system's operational margin and increase the likelihood of controlled demand reduction or, in an extreme case, widespread electricity supply interruptions.

The scenario should therefore be considered a significant national electricity security risk, particularly where extreme temperatures persist for several consecutive days and coincide with high electricity demand and reduced generation or network availability.

7.1.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

Operational measures

Seasonal maintenance outages on lines and substations may be delayed.

Medium to long-term measures

Vegetation management to reduce the potential impact of fires on powerlines. Climate adaptation measures to enhance the resilience of potentially affected infrastructure.

7.2. Crisis Scenario 2: Severe winter

7.2.1. Description of the scenario

Cold and temporarily extreme temperatures, well below seasonal averages, are experienced for a period leading to increased demand with lower availability of thermal generation, accompanied by reduced renewable generation.

7.2.2. Season(s) of the year when the scenario is relevant

This scenario is relevant in Winter.

7.2.3. Preconditions and initiating events

Initial conditions

The power system is in normal state with normal operational conditions (the system is N-1 secure with no unusual / excessive outages, and sufficient power reserves are available).

Electricity market is normal operation.

Initiating event and chain of events

The following conditions may occur:

- Temperatures below seasonal averages.
- Demand increases due to cold weather.
- Strong winds and/or intense lightning activity.
- Disrupt power supply and/or damage transmission lines.

7.2.4. Evolution of scenario

Security of supply impacts

Strong winds and/or intense lightning activity could cause multiple circuit tripping, particularly where towers carry more than one circuit. This could lead to overloads on remaining circuits.

7.2.5. Description of impacts on the national perimeter

Given the mild Mediterranean climate of Cyprus, prolonged periods of very low temperatures are relatively uncommon and are not expected to constitute the principal driver of electricity system stress during winter. The main risk associated with this scenario is therefore related to severe and rapidly developing winter weather conditions, particularly strong winds, intense lightning activity and associated storms, which may affect electricity transmission and distribution infrastructure.

Security of supply impacts

Strong winds and intense lightning may result in multiple faults or tripping of transmission and distribution circuits, including damage to conductors, towers and other network components. Faulted conductors and towers could cause loss of load, fragmentation of the network and possible islanding. If key substations are knocked out of service, a black-out is also possible. Fault repair times could be longer than normal due to the storm.

The loss of a critical transmission line, substation or other key network element could restrict the transfer of available generation to demand centres and may result in localised interruptions of electricity supply. In a more severe combination of simultaneous outages, network fragmentation or islanding may occur, with the potential for a wider loss of supply.

Although winter electricity demand in Cyprus is generally lower than during the summer peak period, an unusual cold spell may nevertheless result in a temporary increase in demand, particularly for space heating. This effect is considered secondary to the weather-related infrastructure impacts but may contribute to system stress if it coincides with multiple network outages or the unavailability of generating units.

Operational impacts

The TSOC may need to implement a range of operational measures to maintain system security, including network reconfiguration, activation of available reserves, redispatch of generation and, where necessary, controlled interruption of supply.

The effectiveness of these measures may be constrained where several network components are simultaneously unavailable. Severe weather may also restrict access to affected infrastructure and create unsafe working conditions for operational and maintenance personnel, potentially increasing response and restoration times.

Infrastructure impacts

The principal infrastructure impacts are expected to arise from strong winds, lightning and severe storms affecting overhead transmission and distribution lines, towers, substations and associated equipment. Damage may be localised but, in the event of a particularly severe weather system, multiple assets may be affected within a relatively short period.

Where critical infrastructure is damaged, restoration may take longer than under normal conditions due to difficulties in accessing affected sites, adverse weather conditions and the need to coordinate multiple repair activities. The impact may be further aggravated where several faults occur simultaneously and available repair resources become constrained.

Overall national impact

The overall impact of the Severe Winter scenario is expected to depend primarily on the severity, geographical extent and duration of the weather event, the number and location of affected network elements, the availability of generation and reserves, and the ability of the TSOC and DSO to restore affected infrastructure.

For Cyprus, the scenario should therefore be understood primarily as a severe winter weather and network disruption scenario rather than a prolonged cold-weather adequacy scenario. A short-duration storm affecting a limited number of assets is expected to be manageable through normal operational and restoration procedures. However, a severe event involving multiple simultaneous faults affecting critical network infrastructure could result in localised or, in an extreme case, wider interruptions of electricity supply.

7.2.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

Operational measures

Use of higher dynamic line ratings may be applied.

Long-term measures

Climate adaptation measures to enhance the resilience of potentially affected infrastructure may be applied.

7.3. Crisis Scenario 3: Heavy flooding

7.3.1. Description of the scenario

Heavy rain gives rise to the flooding of electric power substations and power plants, as well as damage to electrical infrastructure (lines and substations).

The scenario is more relevant during the winter period, when most of the annual rainfall takes place. However, it should be noted that Cyprus has a generally arid climate, and any issues are usually limited to short duration localised flash flooding.

The system may initially be stressed by failures, extreme weather, high or low load. The scenario is more relevant during the winter period when storms are more likely and during the summer when heat waves are more likely.

7.3.2. Season(s) of the year when the scenario is relevant

Any season.

7.3.3. Precondition and initiating events

Initial conditions

The power system is in Normal state and operational conditions are normal.

The operation of energy markets is normal.

Initiating event and chain of events

The initiating event may involve multiple failures caused by the extreme weather situation. In particular, multiple network components of the same type, start failing unexpectedly due to a heat wave in a short period of time, or multiple transmission lines fail at the same time due to strong winds.

7.3.4. Evolution of the scenario

Security of supply impacts

Flash flooding results in substations being de-energised. The effects are likely to be localised.

Infrastructure impacts

The possible impacts on the infrastructure include loss of critical grid elements, possible cascading effects and system instability.

7.3.5. Description of impacts on the national perimeter

Structural or systemic degradation

The scenario can result in flooding of substations, as well as difficulties to travel for personnel, inducing a higher response time.

Security of supply impacts

There could be unexpected loss of load in the areas where the flooding is high enough to damage generation and/or transmission and/or distribution infrastructure. In case of single point generation, a blackout is also possible.

Operational impacts

There could be a limitation or total loss of availability of ancillary services as well as a risk of blackout.

Infrastructure impacts

The possible impacts on the infrastructure include loss of critical grid elements, possible cascading effects and system instability.

7.3.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

Operational measures

Risk mitigation measures in Annex in response to weather forecasts (including grid reconfiguration, maximising generation, calling on additional resources, and coordinating with DSOs).

7.4. Crisis Scenario 4: Dunkelflaute (extremely low wind/solar generation)

7.4.1. Description of the scenario

Total available energy resources are insufficient to meet demand, due to lack of renewable generation (particularly, the lack of solar PV at winter evening peak associated with periods of very low wind).

7.4.2. Season(s) of the year when the scenario is relevant

This scenario is more relevant primarily during Winter months, but also other seasons (Autumn, Spring, Summer).In addition, during Summer months with high energy demand, the system could be vulnerable in case of lack of RES generation

7.4.3. Preconditions and initiating events

Initial conditions

The power system is in Normal state and operational conditions are normal.

The operation of energy markets is normal.

Initiating event and chain of events

Over an extended period, there are minimal to no wind conditions, both day and night, limited solar energy during the day, and a critical shortage of operational conventional power plants, or restricted import capabilities (e.g. due to grid incidents), culminating in a convergence of these factors. As a result, the affected energy market areas do not have adequate electricity generation to match demand.

This event can also happen in Cyprus during noon in summer with very high temperatures and a severe dust storm, which are frequently affecting Cyprus. In this case, the reduction of PV generation during the peak demand can lead to energy shortage without any available reserves.

7.4.4. Evolution of the crisis scenario

The situation worsens over several days, particularly during periods of high demand. As evening demand peaks, the strain on available energy resources approaches capacity limits.

Any additional faults, whether technical, human errors, unsolved N-1 contingencies, or depleted redispatch options, can deplete all available reserves. The TSOC must implement additional measures to maintain grid balance.

Operational impacts

- Increasing number of N-1 violations in the transmission grid observed. Tripping off certain grid elements. Automatic disconnection of the overloaded element, risk of the cascading trips.
- Redispatch is necessary to change active power flow, but decreased number of generation units available for redispatch.
- Especially during situations with a high loaded a certain risk of voltage instability (reactive power demand) could occur. Therefore, there may be significant voltage drops (in the extreme, leading to voltage collapses) in the grids.

Structural or systemic degradation

- Reduced transmission or distribution capacities due to low level of redispatch possibilities.
- Energy price increases due to high load and insufficient available power generation and import.
- The given energy mix with conventional power plants and renewable injections could be unbalanced, unable to fulfil all demand in time of no sunlight and no wind (evening/nights in dark periods of the year).

Security of supply impacts

- Peak demand begins to exceed maximum of available generation + import capacity.

- Operational and intervention reserves are being called and rapidly (in a short time) diminishing up to unavailability.
- Available redispatch possibilities are getting lower due to the demand and market activities using all available power from power plants to supply energy to customers.

7.4.5. Description of impacts on the national perimeter

Not enough production to cover demand with the consequence to lower the load not to jeopardize the whole system balance.

Possible N-1 violations due to missing power plants acting against flows.

7.4.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

<u>Operational measures</u>

Prior engagements with national authorities may be needed in the activation of emergency reserves or to prepare for activation of load shedding procedures.

<u>Longer-term measures</u>

Coordinated planning as part of the transition to a power system with high levels of RES.

7.5. Crisis Scenario 5 – Unusually big demand / RES forecast errors

7.5.1. Description of the scenario

Unusually big errors in the forecast of demand and/or renewable generation, leading to problems balancing supply and demand in the power system.

7.5.2. Season(s) of the year when the scenario is relevant

Any season.

7.5.3. Initiating Event and chain of events

<u>Initial conditions</u>

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating event and chain of events

This scenario may be initiated by remarkably different levels of electricity generation of renewables generation units (wind or solar) due to unusually big forecasting errors, errors in forecast data or fast and unforeseen weather changes.

7.5.4. Evolution of the crisis scenario

Operational impacts

Differences in the planned and actual electricity generation could exceed the dimensioning fault. The actual generation could be significantly higher than expected and lead to the unexpected need of downregulation, or significantly lower than expected and lead to the unexpected need of additional conventional generation. In a worst-case scenario, TSOC will exhaust all available remedial actions.

7.5.5. Description of impacts on the national perimeter

Security of supply impacts

A big shortfall in renewable generation could lead to temporarily insufficient power generation on the system and forced demand curtailment.

Operational impacts

There could be a limitation of ancillary services: The needed amount of downregulation may not be available which may lead to RES curtailment, or the necessary additional generation may not be available.

7.5.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

Operational measures

- Evaluate the possibility of a high deviation in demand or RES generation and ensure adequate reserves to offset any frequency deviations.
- Use of several forecast service providers and exploit the capabilities of forecast combination/reconciliation techniques to reduce forecast errors.
- Probabilistic forecast to have a measure of the uncertainty around the forecast and integration of the uncertainty measure in operational procedures.

Non-market-based measures

RES generation curtailment.

7.6. Crisis Scenario 6 – Earthquake

7.6.1. Description of the scenario

A significant magnitude earthquake occurs, damaging transmission infrastructure and power plants – requiring significant time to repair.

7.6.2. Season(s) of the year when the scenario is relevant

Any season.

7.6.3. Initiating Event and chain of events

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating event and chain of events

The scenario would be initiated by a significant magnitude earthquake occurring. The earthquake could damage transmission infrastructure and power plants.

7.6.4. Evolution of the crisis scenario

Corruption of control

If operational control centres are affected, severe damages could disrupt system control.

Security of supply impacts

Power plants could be out of operation, leading to possible forced demand disconnection.

Structural or systemic degradation

In the event that major substations are affected, a severe earthquake could substantially disrupt the operational capabilities of the TSOC/DSO, posing a serious threat to the stability and continuity of the power system.

7.6.5. Description of impacts on the national perimeter

Security of supply impacts

There could be a massive reduction of transmission and generation capacity, and the inability to balance the system. There may be unavailability of transmission elements and power plants and possible load shedding to keep system security functioning during peak hours or all the time. Damage to key power stations and/or substations could lead to a black out, persistent adequacy issues, an inability to serve certain areas and/or persistent split of the system into islands.

Structural or systemic degradation

The scenario may cause damage on building structures, displacement of equipment cabinets and batteries as well as GIS components, porcelain damage of apparatus and the displacement of unsecured transformers. Damage to road infrastructure could impact repair times due to access restrictions. It may also cause a fault or failure of grid elements such as transformers and civil structures.

7.6.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex.

Operational measures

Structures, plans, and agreements for close cooperation between TSOC and DSO, and restoration – the availability of strategic spares (transformers and other primary electrical equipment) and availability of mobile backup generators.

7.7. Crisis Scenario 7: Space weather

7.7.1. Description of the scenario

A Coronal Mass Ejection (CME) from the sun causes geomagnetically induced currents (GICs) that circulate in the power grid through the grounded transformer neutrals, resulting in the tripping of circuit elements, degradation of or permanent damage to grid infrastructure (particularly transformers), and disturbances of the ionosphere (disrupting high-frequency and satellite communications, navigation, and air travel).

Though significant solar storms can occur at any time, historical data suggests that these are more likely in the peak of the 11-year solar cycle. The next solar peak is expected in 2025.

The threats presented by solar storms are greater at high latitudes than middle latitudes, although lower latitudes can also be impacted by extreme storms. Ground conductivity can influence the intensity of solar storms.

The frequency of extreme space weather events is difficult to estimate, but the data suggests that relatively strong events happen about every 50 years, and that extreme storms such as the Carrington event may occur between 150 to 500 years.

7.7.2. Season(s) of the year when the scenario is relevant

Any season.

7.7.3. Preconditions and initiating event(s)

Initial Conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating event and chain of events

A series of strong CMEs occur on the sun. A “severe” geomagnetic storm watch may be issued 3 days ahead, with an indication that the CMEs could combine. This may be upgraded or downgraded as time progresses. 15-45 min before it hits earth this could be upgraded to an (extreme) incident with a planetary index in the upper 9’s when it impacts earth.

This gives rise to:

- Disturbances of the earth's magnetic field, giving rise GICs. These low-frequency currents enter the power system through grounded-neutral of transformers and are significant enough to saturate some types of magnetic cores of substation transformers. This in turn results in:
  - Significant heating of the transformer core and windings, potentially resulting in longer-term degradation (increasing the risk of failure in the future) and possible destruction of the transformer.
  - Significant reactive power flows, giving risk to voltage problems and possible collapse.
  - Distorted currents, potentially impacting reactive power compensation and protection equipment that is sensitive to harmonic distortion.
- Satellite communications, high-frequency radio communications, and global navigation satellite system services are impacted.

7.7.4. Evolution of the crisis scenario

Given the advance warning TSOC may take operational measures to mitigate the potential impact.

Security of supply impacts

- Preparation for a blackout.
- Progressive restoration of the system, complicated by the damaged telecommunications and equipment.

Infrastructure impacts

- Interventions on equipment to protect them from the incoming solar storm.
- Induction on power lines and transformers causing voltage disturbance leading to isolation failures.
- Necessity to analyse the grid to identify faulty equipment.
- Intervention on protected equipment to put them on service again.

Corruption of control

- Due to the unavailability of telecommunication impacted by the solar storm.
- Stability problems.

7.7.5. Description of impacts on the national perimeter

The heavy reliance of modern society on electrical and digital technology means that the disruption to energy supplies could have serious consequences.

Security of supply impacts:
- A lack of available spare equipment on a large scale might lead to a longer grid restoration time or a limit on the consumption of energy.

Operational impacts:
- It may become impossible to coordinate with various personnel because the communication systems could be damaged.

Infrastructure impacts:
- Overload of equipment, especially transformers.

Long term damage to primary equipment that have not been properly secured.

Structural or systemic degradation:
- Local interruptions or wide-area blackouts.

Energy markets impact:
- Necessity to suspend markets for the duration of the voluntary blackout.

Consequential / related impacts:
- Long term telecommunication damage.

7.7.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

Operational measures

Solar storm response plans in response to early warning may include:
- The cancellation of maintenance outages and connection of all assets to reduce the potential flow of GICs in individual circuits (transformers) in the power system.
- An associated request for staff / contractors to vacate substations given an increased safety risk.
- Demand management measures: maximising generation and transmission circuit availability to reduce the loading on individual circuits (particularly transformers) so that the risk of magnetic core saturation and overheating is reduced.

7.8. Crisis Scenario 8 – Fossil Fuel Shortage

7.8.1. Description of the scenario

Fossil fuels cannot be delivered for an extended period due to supply chain disruptions caused by an accident, attack, and/or geopolitical developments.

7.8.2. Season(s) of the year when the scenario is relevant

This scenario is relevant at Summer and Winter due to high demand.

7.8.3. Preconditions and initiating event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system. Relevant fossil fuel supply and storage systems remain operational. Fuel supply capacities are not constrained.

Initiating Event and chain of events

The initiating event occurs due external events (e.g. Political/economic) leading to a disruption in international oil markets and/or shipping routes.

7.8.4. Description of impacts on the national perimeter

Security of supply impacts

There could be forced supply curtailments (selected areas/entities/hours), an increased risk of load shedding or even curtailments that would result both from fossil power plant shutdowns and from curtailing renewable generation.

Operational impacts

There could be a limitation or total loss of availability of ancillary services as well as a risk of blackout.

Consequential/related impacts

Fuel shortages could be disruptive to many sectors of the economy.

7.8.5. Evolution of the crisis scenario

Operational impacts

Initially, electricity generation is dispatched to power plants not dependent on the fuel, then power generation from affected power plants is limited to save fuel. A prolonged supply limitation leads to the shutdown of power generation from some of the power plants affected.

Corruption of control

There could be limited availability of reserves, voltage stability support and inertia.

Security of supply impacts

There could be possible electricity shortages from affected power plants that were forced to limit generation. Prolonged shutdowns of fossil fuel power plants may require limiting the renewable generation.

7.8.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex.

7.9. Crisis Scenario 9: Large Industrial accident

7.9.1. Description of the scenario

An incident at an industrial facility leads to widespread contamination, causing disruptions in electricity supply and rendering large areas inaccessible for extended periods.

7.9.2. Season(s) of the year when the scenario is relevant

Any season.

7.9.3. Preconditions and initiating event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

This scenario is initiated when a serious industrial accident occurs (e.g. an explosion, toxic substance release, etc.) due to any reason (technical failure, earthquake, sabotage, terrorist attack, human error, etc.).

7.9.4. Security of supply impacts

In case of an accident, if power plants are shut down, electricity supply may be reduced for a prolonged time. In a worst-case scenario, a partial or total blackout is possible, with the possibility of long-lasting lack of adequacy, as important parts of the system are damaged and out of service.

Operational impacts

Because of limitation in electricity generation and unusual consumption patterns, it is difficult to balance the power system. Staff shortage and potential unavailability of control centres will make managing the system riskier and more difficult. Both planned repair work and emergency repairs may be delayed. Increased human error risk may lead to further technical failures and blackouts.

Infrastructure impacts

Some of the power system infrastructure may be damaged beyond use for weeks, months or even years.

7.9.5. Evolution of the crisis scenario

Operational impacts

Critical transmission system equipment and/or power stations are severely damaged, rendering them unavailable to the system.

Corruption of control

In this scenario, not all control is available. Some control centre staff (from any part of the electricity supply chain) may be affected directly and could be unable to work for a prolonged time.

7.9.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex.

7.10. Crisis Scenario 10: Serial technical defects

7.10.1. Description of the scenario

The same critical equipment from specialised vendors/manufacturers is used in many grids or power plants. A serial / common failure or safety risk associated with potential failure of this equipment could impact many grids and power plants.

7.10.2. Season(s) of the year when the scenario is relevant

Any season.

7.10.3. Preconditions and initiating event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

This scenario is initiated by some elements of the transmission or distribution network exhibiting abnormal behaviour that increase their risk of failure or lead directly to failure. An analysis finds that the root cause is a systematic failure in manufacturing, installation or maintenance. All elements of the same type or series are assumed to be susceptible to the same failure. All suspected elements are assumed unsafe but can't all be immediately replaced or repaired.

7.10.4. Evolution of the crisis scenario

Operational impacts

The affected operators (e.g. TSOC/DSO/Power station operators) analyse all instances of the same or similar elements for such faults but depending on the actual scope of application of the affected element (electrical grid, power generation, electricity distribution, end-user installation), the full risk assessment may require weeks or even months.

Furthermore, sections of the electric power system are considered unsafe to operate at full capacity.

Corruption of control

It is not known if the faulty equipment may operate safely and it is not known what (if any) operating conditions are safe. Depending on the role of the faulty equipment in controlling the electricity system, some control may be lost, or risk of loss of control is increased. There may be a possible need for maintenance services.

7.10.5. Description of impacts on the national perimeter

Security of supply impacts

Multiple faults, especially occurring in a short period, may lead directly to power supply interruption, as well as cascading events and in extreme cases, to blackouts. If power plants employ the same types of potentially faulty elements, there is a risk that they will need to be shut down as a preventive measure. If the faulty equipment is directly involved in supplying electricity to end-users, the supply may be affected immediately – either due to failures, or due to limitations imposed on operating conditions.

Operational impacts

The electrical grid (and to some extent, other parts of the power system) may have to be operated on, despite the identified risk of failure for many months or even years - until most or all of the potentially faulty elements are replaced or repaired. The continuous failures of system components can lead to violation of the N-1 security constraint for a prolonged duration, until the affected equipment is replaced.

Infrastructure impacts

There is high risk of damage to the power system infrastructure. A large investment may be required on the power system infrastructure to replace or repair faulty equipment. Emergency replacements or repairs may require other power system investments to be delayed or halted.

7.10.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. Grid and power plants operators could reduce dependency on single suppliers, and store failure-free elements, potentially from multiple vendors.

7.11. Crisis Scenario 11: Pandemic

7.11.1. Description of the scenario

A highly infectious disease across Europe leads to prolonged staff shortages in the energy sector, which in turn causes problems with energy supply and a safe operation of the power system. Other sectors are also affected, impacting system demand as well as services provided to the sector. Energy markets may also be adversely affected.

7.11.2. Season(s) of the year when the scenario is relevant

Any season.

7.11.3. Preconditions and initiating event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

The scenario would be initiated by the international spread of a disease. TSOC operating staff could be infected. Infections could happen at Control Centres, power stations, power plants and the DSO, which could lead to insufficient staff. Furthermore, containment measures of governments might follow restrictions for operation directly (by directives) or indirectly (e.g. by other affected critical infrastructures).

7.11.4. Evolution of the crisis scenario

Operational impacts

The stressed or curtailed operational staff for field work results in failure to carry out repairs in the field. Collateral governmental containment measurements could further impede field work.

Corruption of control

Stressed or curtailed personnel resources of control centres and their processing facilities may jeopardize the performance of system control. Additionally, staff may still choose to be absent once precautions are established due to their circumstances, either personally or in their families.

Security of supply impacts

The scenario could create stressed or curtailed operational staff or personnel of service providers, which causes an unscheduled downtime of power plants. Collateral governmental containment measurements could impede maintenance or revision services, followed by unscheduled downtime of power plants.

7.11.5. Description of impacts on the national perimeter

Security of supply impacts

There could be emergency load shedding/power outages.

Operational impacts

Depending on the spread of the pandemic, the impacts on the power system may vary, but could include limitations in the availability of generation units. It could also lead to an increased risk of human errors. Furthermore, reduced personnel availability may result in increased response times to failures.

Infrastructure impacts

There could be a possible decrease of the quality of the maintenance due to understaffing (rescheduling or prolongation of maintenance) as well as supply chain limitations for equipment and limited availability of contractor resources due to a pandemic. There may also be a delay on scheduled maintenance and/or new projects (new grid elements could be ready later) and an increased risk of human error (planning, operations, maintenance, etc.).

7.11.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. As well as:

Operational measures

- Personnel of critical importance for the stability and reliability of the energy system must limit their exposure by isolating in their workplaces.
- Sizing the critical staff in such a way, that in the case of such an emergency, the TSOC / DSO / power plant operator / market operator has sufficient personnel.

Non-market-based measures

In case of critical staff shortages, some of the market participants, energy market operators or power system operators, may limit the market activities.

7.12. Crisis Scenario 12: Industrial action, strikes, riots

7.12.1. Description of the scenario

The unplanned unavailability of staff to operate power plants, grids, markets. Depending on the nature of the incident, actions taken during this time may impact control of the system or assets.

7.12.2. Season(s) of the year when the scenario is relevant

Any season.

7.12.3. Initiating Event and chain of events

Initiating conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

The initiating event may involve disputes of some kind that lead to industrial action at scale. It also may include riots, blockades or other massive social unrest (regardless of motivation or inspiration). As a direct consequence, staff in the energy sector (power plants, transmission and distribution) refuse to work, work to rule or are prevented from work.

7.12.4. Evolution of the crisis scenario

Operational impacts

There could be a staff shortage in the control centres of power plants or control centres of the TSOC and DSO. There may also be a possible shortage of fuel needed in some power plants.

Corruption of control

There could be less experienced staff in the control centres, with an increased risk of human error.

Security of supply impacts

There may be possible limitations on power generation, due to security concerns or fuel supply issues.

7.12.5. Description of impacts on the national perimeter

Security of supply impacts

If power plants are impacted by staff or fuel shortages, the risk of generation inadequacy increases. Possible emergency shutdowns or blackouts will lead to a limitation on the power supply.

Operational impacts

Human errors are more likely in this scenario, as employees are working long hours and doing their best to cover multiple roles, with a high level of pressure. Social disturbance on a large scale will lead to unusual energy demand patterns, thus making power system behaviour less predictable. Planned and emergency repairs in the energy sector may be prolonged for a considerable time, possibly towards the period of a year, when energy demand is increased. A combination of difficult conditions may lead to human errors. Faults on the power system may also cause local (or larger) blackouts, and technical problems as well as potential blackouts will take longer than normal to rectify due to staff shortages.

7.12.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in the Annex, as well as:

- Due to the guarantee of the right to undertake industrial action, companies in the energy sector would need to focus on working conditions to employees.

- Political measures to limit the consequences of strike actions to the security of supply.

7.13. Crisis Scenario 13: Physical attack on critical assets

7.13.1. Description of the scenario

A coordinated attack on one or more physical power system assets such as subsea interconnectors, critical lines, HVDC converter stations, transformers, substations, and power plants at sensitive points of the electric power system.

7.13.2. Season(s) of the year when the scenario is relevant

This scenario is relevant at all times. It does not depend neither on season nor on load.

7.13.3. Preconditions and initiating event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

This scenario would be initiated by a physical attack against power lines, transformers, substations, power plants or data centres.

7.13.4. Evolution of the crisis scenario

Operational impacts

The attacker is destroying technical equipment in the TSOC or DSO grid or power plants. Such an attack – or even multiple attacks – could affect the system beyond N-1 criteria, with restoration of N-1 security not possible. Electricity delivery for all loads could be impossible. Remedial actions (e.g. redispatch) could be necessary.

Security of supply impacts

The destroyed assets and the time for repairing them as well as emergency measures can cause loss of supply in different areas for weeks, while lack of adequacy in case of the destruction of a major power station could persist for months or even years.

Infrastructure impacts

The destroyed assets can require a long time for restoration.

Structural or systemic degradation

Depending on the amount of destroyed assets and the time to repair them, a long-lasting violation of N-1 security may occur.

7.13.5. Description of impacts on the national perimeter

Security of supply impacts

The attack could directly disconnect load from the grid. The security of supply is in danger due to violations of N-1 security. Electricity transport is in danger and could lead to loss of load, loss of part of the system and even a blackout, particularly in case key substations are destroyed. Destroyed power plants are no longer able to deliver energy. System reserves are no longer sufficient, and the imbalance of load/generation will lead to frequency deviations with automatic load shedding or power plant shedding. Due to the small, isolated nature of the system, a successful attack on a major power station could lead to long lasting lack of adequacy. This will be exacerbated as reliance on a single power station (Vasilikos) increase.

Operational impacts

The TSOC and/or the DSO may have to react by switching off the remaining elements in order to restore N-1 security. Activation of redispatch measures or energy reserves may be needed.

Structural or systemic degradation

Due to the amount of destroyed equipment and/or loss of load, frequency and/or voltage will be impacted. Loss of grid elements may cause overloads on other lines locally.

Infrastructure impacts

Destroyed/damaged assets are no longer available for electricity transport and distribution as assets have to be repaired. The time needed for this would depend on the level of damage and the physical security and safety situation in the locations affected. This maintenance possibly needs additional planned outages with a riskier situation for the security of supply.

7.13.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex, as well as:

Operational measures

Risk mitigation measures:
- Periodic safety exercises for critical objects of the energy system.
- Real time surveillance of sites of relevant critical infrastructure and reactive measures in case of attack.
- Inclusion of the protection of critical infrastructure facilities in defence exercise plans.

Depending on the method and scope of attack:
- Neutralization of the attack.
- Audit for the identification and elimination of possible physical vulnerabilities.

Non-market-based measures

Depending on the scope of direct impacts of the attacks, limitation of some market activities may be justified.

7.14. Crisis Scenario 14: Physical attack on control centres

7.14.1. Description of the scenario

A successful physical attack on both primary and backup control rooms of TSOC, or DSO is undertaken. Critical staff may be impacted. As a result, control over the power system is lost and recovering it will require a substantial time. A disruption of power supply may be immediate and will last for a prolonged time.

7.14.2. Season(s) of the year when the scenario is relevant

This scenario is relevant at all times. It does not depend neither on season nor on load.

7.14.3. Preconditions and initiating event(s)

Initial condition

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating event and chain of events

This scenario would be initiated by a physical attack of control centres and backup control centres of TSOC or major EAC power plants.

7.14.4. Evolution of the crisis scenario

Operational impacts

The attacker attempts to destroy the main and back-up control centres of TSOC or a major EAC power plant operation centre. TSOC is no longer able to operate the grid or give instructions to power plants. Power plants could be stopped by the attacker.

Corruption of control

TSOC or major power plant operation centres are no longer able to operate their assets. Back-up centres are also not available.

Security of supply impacts

The security of supply could be directly/indirectly affected by further network failures or changed conditions.

Structural or systemic degradation

The overall controllability of the power system is lost.

7.14.5. Description of impacts on the national perimeter

Security of supply impacts

Electricity transport and supply are still possible, but in case any actions are needed to react to incidents, the security of supply will be in danger and possibly interrupted with even a blackout being a possibility due to the small, islanded nature of the system.

Operational impacts

The grid or power plant operators are no longer able to monitor or control the grid/power plants. Operational staff may have to be sent to substations or parts of the power plants to get information via telephone, thus receiving a very low-level knowledge of the current grid and power plant situation. Advice can be given by phone and would have to be performed by staff on site.

Structural or systemic degradation

The operation of the electricity grid is no longer under control. Due to missing communication (online or by phone) to reserve power plants and loads, the ongoing operation of the electricity grid could have overloads, frequency deviations, etc. Actions needed to secure the grid cannot be taken.

Infrastructure impacts

The scenario could result in destroyed control centres.

Corruption of control

There would be a full loss of control functions for the grid or power plants.

7.14.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in the Annex, as well as:

Operational measures

Risk mitigation measures:
- The dispatch control system of the transmission system operator is built in a way to increase its resistance to external attacks.
- The security services should take measures to prevent attacks against the relevant control centres.
- Special forces anti-terrorist forces are ready to take action in case of an attack; training exercises are carried with these units.

Depending on the method and scope of the attack:

- Neutralization of the attack.
- Audit for the identification and elimination of possible physical vulnerabilities.

Non-market-based measures

Possible implementation of contracts for emergency reserve, which are reserved for use only in emergency cases by the TSOC.

Communications measures

Ministry of Energy, CERA and/or TSOC could stimulate the consumers and industry to lower their demand to support the system, using pre-defined incentives.

7.15. Crisis Scenario 16: Loss of ICT systems to cyberattack

7.15.1. Description of the scenario

Loss / unavailability of one or more ICT systems critical for real-time planning and operation of the power system operations due to a cyberattack leads to disruptions in energy supply and possibly a loss of some other power system assets. Energy market may be adversely affected, as well.

7.15.2. Season(s) of the year when the scenario is relevant

This scenario is relevant at all times. It does not depend neither on season nor on load.

7.15.3. Preconditions and initiating event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

This scenario would be initiated by an attack against critical ICT systems of TSOC, EAC, major RES producers and major loads such as the Vasilikos Cement Works (e.g. central SCADA/EMS, substation SCADA, data storage, power plant's operating systems, office IT).

The initiating event occurs either from the unavailability of a substantial part of telecommunication infrastructure used for power system operation or from the unavailability of one or more ICT systems used in real-time planning and operation of the power system, due to technical failures.

7.15.4. Evolution of the crisis scenario

Operational impacts

The attacker (or attackers) is able to enter one or more critical ICT system of TSOC, EAC, major RES producer or major load (Vasilikos Cement Works). During this scenario, the attacker can act as any employee working within these systems and may manipulate lines, transformers, reactive power compensation devices, or change set points of generators.

Remedial measures may need to be invoked, due to unavailability of some of the ICT systems & services.

Corruption of control

The attacker is controlling the system and is also able to deny access of regular users to the system.

Control of the electricity system is lost or limited and may go unnoticed for some time (in particular, erroneous forecasts or measurements may be noticed after many hours). TSOC, DSO and power producers/large consumers affected have to switch to backup solutions that may not provide all the normal functionality (or may be affected by the same failures). During the time needed to regain control, the system is susceptible to any additional disruption and switching to backup solutions could increase reaction times and is prone to human error.

Security of supply impacts

Whilst the attacker is able to take control, they can switch off a particular load or an entire area.

7.15.5. Description of impacts on the national perimeter

Security of supply impacts

The attack could cause unintended outages of lines, transformers, power plants, etc. with possible overloading on remaining lines and transformers and/or direct loss of supply. Due to the small-isolated nature of the system, a successful intrusion into a single power station or disconnection of critical transmission equipment could lead to a blackout. The attack could also cause unintended outages of DSO lines and transformers (loss of supply) with effect on frequency or load flows in the TSOC's grid.

There could be a possible use of forced (but controlled) disconnection as a remedial measure or a possible emergency disconnection of some demand or supply. In a worst-case scenario, a cascading event may be triggered.

Operational impacts

The attack could limit the TSOC ability to react to the situation due to the SCADA becoming unavailable and/or corrupted.

Structural or systemic degradation

Through switching of devices on the grid and/or manipulating generating units, the attacker may cause system voltage and/or frequency to fall outside allowable limits.

Consequential/related impacts

An emergency disconnection (especially a blackout) will result in potential other damages outside the electricity system.

7.15.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex, as well as:

Operational measures

Depending on the method and scope of the attack:
- Neutralization and isolation of the attack.
- Restoration of control and operation of the dispatching command system.
- Manual control of the electricity system.
- Restoration of the system after a blackout (black start).
- Standards introduced by NCCS and NIS2.

Non-market-based measures

Limitation or suspension of the markets, when necessary.

Other measures

Cyber risk mitigation measures:
- Enforced strict and effective ICT security policies.
- Established cybersecurity incident and emergency response teams.
- Cooperation and coordination with relevant national agencies for cybersecurity.
- The employees of the company are isolated from any outside influence which could result in cyber security risks.

Loyalty risk mitigation measures:
- Motivating employees in critical positions in the company; periodic evaluation of any loyalty risk.
- Cybersecurity exercises conducted at regular intervals (e.g. at least once a year).

7.16. Crisis Scenario 16: Unauthorized action by personnel

7.16.1. Description of the scenario

An unauthorised action by key personnel with high levels of authorisation, destabilizes the power system (using a system such as SCADA). The action may be due to an insider attack, holding key employees hostage, or threatening/blackmailing key employees.

7.16.2. Season(s) of the year when the scenario is relevant

This scenario is relevant at all times. It does not depend neither on season nor on load.

7.16.3. Preconditions and initial event(s)

Initial conditions

This scenario may be initiated without any preconditions, in particular also in the normal state and operation of the electrical power system.

Initiating Event and chain of events

This scenario is initiated by critical personnel who are forced to perform system destabilizing actions. Those affected could include system operators, IT administrators, people with access rights to critical systems and installations, Chief Executive Officers, Chief Financial Officers, etc.

The scenario would be initiated through sabotage by employee(s) or subcontractor(s) via physical intervention or misuse of ICT systems.

7.16.4. Evolution of the crisis scenario

Operational impacts

An employee(s) or subcontractor(s) takes control of the grid. In addition to controlling the grid, they can also physically destroy assets.

Corruption of control

The TSOC and DSO or power plant operators are no longer in control. In particular, critical assets are no longer controllable.

Security of supply impacts

The security of supply is in danger, as either a significant volume of load or generation may be disconnected.

The insider can also destroy assets of the electrical energy supply for major customers or whole DSOs, power plant connection points or whole power plants.

Infrastructure impacts

The insider could use physical means to destroy the assets of TSOC, DSO or power plants.

Structural or systemic degradation

The insider could force a blackout.

7.16.5. Description of impacts on the national perimeter

Security of supply impacts

The insider might be able to shut down the grid thus causing a blackout.

Operational impacts

The employee is in control of the grid at the threat of the attacker. Multiple faults of transmission network elements are possible.

The operation of the grid is unstable by being under the control of this insider. This could lead to shutting down the grid.

Structural or systemic degradation

Multiple faults of transmission network elements are possible.

Infrastructure impacts

The insider or the attacked or threatened employee is able to destroy infrastructure elements.

Corruption of control

The control of the grid is unstable by being under the control of this insider.

7.16.6. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex, as well as loyalty risk mitigation measures:
- Motivating employees in critical positions in the company.
- Periodic evaluation of any loyalty risk.
- The employees of the company are isolated from any outside influence which could result in loyalty risk; and
- Key employees of the company and the contractors it employs are subject to security assessment by state security services.

7.17. Crisis Scenario 17: High penetration of RES in the energy system

7.17.1. Description of the scenario

The growing share of RES (particularly solar PV and wind) in the electricity mix leads to challenges in balancing supply and demand, ensuring system stability, and maintaining secure operation. The variability and intermittency of RES can result in frequent imbalances, operational uncertainty, and increased reliance on flexible resources and grid services.

7.17.2. Season(s) of the year when the scenario is relevant

This scenario can occur year-round but is particularly relevant during Spring, Autumn and Winter, when solar generation peaks, and electricity demand patterns fluctuate. It also affects low-load periods during weekends or public holidays. During Summer the risk of high RES generation is mostly offset by high electricity demand

7.17.3. Preconditions and initiating event(s)

Initial conditions

The power system is operating under normal conditions with a high contribution from RES to the overall energy mix. The system may appear stable but operates closer to technical limits due to variability and limited inertia.

Initiating Event and chain of events

A period of prolonged high renewable generation leads to excess electricity production, surpassing local demand. Curtailment of RES becomes necessary. Simultaneously, the system lacks sufficient dispatchable and flexible generation to manage ramp-downs when solar and wind output sharply drop. Rapid changes in net load require fast-response balancing, which may not be sufficiently available, leading to instability.

Also, a sudden disturbance due to the unexpected loss of a generating unit has a severe impact on the frequency due to the low inertia conditions. The correct operation of underfrequency protection schemes is critical for maintaining frequency stability.

7.17.4. Evolution of the crisis scenario

System stress increases as conventional power plants operate below technical minimums or are offline, reducing inertia and frequency stability. RES variability and forecast errors exacerbate the difficulty of maintaining grid balance. Inadequate flexibility, insufficient storage, or lack of demand response options result in frequency deviations, grid congestion, and difficulty covering peak demand when RES drops.

Operational impacts

- Frequent redispatching due to congestion or oversupply in certain areas.

- Risk of frequency instability due to low system inertia.
- More frequent activation of curtailment procedures for RES.
- Increasing dependence of reliable 3rd party telecom connections for RES curtailments.

Structural or systemic degradation

- Possible 'breakdown' of conventional plants due to frequent start-up and shut-down operations.
- Inefficient use of grid infrastructure or RES assets due to curtailment.
- Limited market signals to incentivize flexible demand or storage investments.

Security of supply impacts

- Risk of not meeting demand during sudden RES drop.
- Reduced availability of fast-reacting backup capacity.
- Strain on operational reserves.

7.17.5. Possible measures to prevent or reduce the impact and/or expected duration

Relevant general measures in Annex. In particular:

Operational measures

- Evaluate the possibility of a high deviation in demand or RES generation and ensure adequate reserves to offset any frequency deviations.
- Use of several forecast service providers and exploit the capabilities of forecast combination/reconciliation techniques to reduce forecast errors.
- Probabilistic forecast to have a measure of the uncertainty around the forecast and integration of the uncertainty measure in operational procedures.

Non-market-based measures

RES generation curtailment.

8. Consultation Results

The approach followed for Cyprus was to develop and maintain national electricity crisis scenarios tailored to the specific characteristics of the Cypriot electricity system, while using the ENTSO-E methodology and, where relevant, the regional scenario work as a reference to ensure methodological consistency and comparability. Such consideration of ENTSO-E regional scenarios should not, however, be interpreted as creating a legal obligation for Cyprus to establish or implement Article 6 regional scenarios, or to comply with regional measures that are inapplicable to Cyprus under Article 21.

In accordance with Article 7(2) of Regulation (EU) 2019/941, CERA consulted the Transmission System Operator of Cyprus (TSOC), the Distribution System Operator (DSO) and the relevant electricity producers through their respective trade bodies during the development of the national electricity crisis scenarios. The purpose of the consultation was to obtain technical and operational input from the stakeholders responsible for the generation, transmission and distribution of electricity and to ensure that the identified scenarios adequately reflect the specific characteristics, risks and vulnerabilities of the Cypriot electricity system.

The comments and observations received during the consultation were reviewed by CERA and assessed against the requirements of the Risk Preparedness Regulation, the risks identified under Article 5(2), and the methodology used for the identification of electricity crisis scenarios. Particular consideration was given to the potential causes and consequences of each scenario, its relevance to the Cypriot electricity system, the likelihood of occurrence, and the potential implications for security of supply, system operation, infrastructure and the ability of the relevant system operators and market participants to respond effectively.
The consultation also provided an opportunity to assess the applicability of the scenarios identified at European level to the specific circumstances of Cyprus. While Cyprus is not currently subject to the regional electricity crisis scenario process under Article 6 of the RPR, due to the specific derogation provided under Article 21, the ENTSO-E methodology and relevant regional scenarios were considered as a reference in order to support a consistent and structured approach. The consultation confirmed the importance of adapting the assessment to the particular characteristics of the Cypriot electricity system, including its isolated nature, limited generation flexibility, increasing penetration of renewable energy sources and absence of interconnection with another Member State.
Following the consultation, CERA reviewed the proposed scenarios and their respective likelihood classifications and made the necessary amendments and

clarifications where appropriate. The consultation process did not change the fundamental approach adopted for the identification of the national scenarios, but contributed to improving their technical description, relevance and completeness. The final set of scenarios presented in this report therefore reflects CERA's assessment following consideration of the input received from the relevant stakeholders.

The final national electricity crisis scenarios are intended to provide the basis for the subsequent development of Cyprus's Risk-Preparedness Plan under Article 10 of the RPR. The scenarios should not be understood as predictions that a particular crisis will occur, but rather as plausible and relevant stress situations against which the resilience of the Cypriot electricity system and the adequacy of the available preventive, preparatory and response measures can be assessed.

9. Next Steps

CERA in the coming months will use the final electricity crisis scenarios in order to develop the Risk Preparedness Plan as required under Article 10 of the Regulation. CERA's Risk Preparedness Plan, is scheduled for publication in January 2026.

10. List of Acronyms and Abbreviations

CERA	Cyprus Energy Regulatory Authority
DSO	Distribution System Operator
EAC	Electricity Authority of Cyprus
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
GIS	Gas-Insulated Switchgear
ICT	Information and Communications Technology
IT	Information Technology
RES	Renewable Energy Sources
RPR	Risk Preparedness Regulation (EU) 2019/941
SCADA	Supervisory Control and Data Acquisition
TSO	Transmission System Operator
TSOC	Transmission System Operator - Cyprus