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# CRITICAL ANALYSIS OF THE NATIONAL POWER SYSTEM IN ORDER TO ENSURE EUROPEAN SECURITY

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**Abstract:** The need for critical analysis of National Power System – NPG, which generates critical infrastructure, comes in the context in which the possible occurrence of black/brown - out cases, generates major issues of national interest, with European and NATO implications. Because the critical infrastructure generated may be vulnerable to internal and/or external threats, it must be critically analysed in terms of ensuring and increasing national and European security in order to prevent possible national crises. The authors consider that the NPG approach is a strictly national security issue because the lack of electricity can cause enormous damage to industry, the economy and state systems, which are almost entirely dependent on electricity.

**Keywords:** National Power System, European Security, Critical Infrastructure, Critical Analysis.

## 1. INTRODUCTION

The increasing frequency of cases of energy instability and dynamism in the context of national and regional energy security and the desire of the great economic powers of energy influence, makes the topic very topical and significant, knowing very well that certain critical infrastructures can be vulnerable to internal and external threats, and in this context, the Critical Infrastructure Protection Management must form the most important security system within the National Power System [1], [4], [7], [10],

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[27]. Non-electricity supply to domestic and industrial consumers leads to national crises, as all sectors of the national economy depend on electricity. In this context, the National Power System becomes a strategic objective of national importance by the fact that it generates critical national and European infrastructures [5], [6], [9], [23].

## 2. CRITICAL ANALYSIS OF THE NATIONAL POWER SYSTEM

### 2.1. Identification of critical infrastructures

In table 2.1. the critical infrastructures identified within the National Power System are listed [2], [8], [11], [19].

*Table 2.1.* ***Critical infrastructures identified within the National Power System***

| **Owner Infrastructure critically** | **Responsible Authority Competence** | **Name CRITICAL INFRASTRUCTURE** | **NCI / ECI type** (international / European / national) | **Perimeter Location** |
|---|---|---|---|---|
| Hunedoara Energy Complex | Minister of Energy | Power Plant Branch DEVA (Mintia) | National | Hunedoara County |
| | | Power Plant Branch PAROŞENI | | |
| Oltenia Energy Complex | Minister of Energy | Power Plant Branch ROVINARI | | Gorj County |
| | | Power Plant Branch TURCENI | | |
| | | Power Plant Branch IŞALNIŢA | | Dolj County |
| | | Power Plant Branch CRAIOVA II | | |
| OMV Petrom | Minister of Energy | Thermoelectric plant PETROM BRAZI | | Prahova County |
| Romgaz | Minister of Energy | Thermoelectric plant IERNUT | | Mures County |
| Termoelectrica | General City Hall Bucharest | Thermoelectric plant BUCUREŞTI SUD | | Bucharest |
| Hidroelectrica | Minister of Energy | Hydroelectric Power Plant ŞUGAG | | Alba County |
| | | Hydroelectric Power Plant GÂLCEAG | | |
| | | Hydroelectric Power Plant | | Neamt County |

| | | | | |
|---|---|---|---|---|
| | | STEJARU | | |
| | | Hydroelectric Power Plant VIDRARU | | Arges County |
| | | Hydroelectric Power Plant PORŢILR FR FIER I, II | International | Mehedinti County |
| | | Hydroelectric Power Plant LOTRU | National | Valcea County |
| | | Hydroelectric Power Plant RETEZAT | | Hunedoara County |
| | | Hydroelectric Power Plant MĂRIŞELU | | Cluj County |
| Termoelectrica | Minister of Energy | Thermoelectric plant BORZEŞTI | | Bacau County |
| Nuclearelectrica | Minister of Energy | Nuclear Power Plant CERNAVODA | International | Constanta County |
| National Power Grid Transelectrica | Ministry of Economy and Business Environment | Power substation 400/220 kV ROŞIORI | European | Satu Mare County |
| | | Power substation 400 kV GĂDĂLIN | | Cluj County |
| | | Power substation 400/110 kV CLUJ EST | | Cluj County |
| | | Power substation 400/110 kV ORADEA SUD | | Bihor County |
| | | Power substation 400/220/110 kV ARAD | | Arad County |
| | | Power substation 400 kV NĂDAB | | Arad County |
| | | Power substation 400 kV RESITA | | Caras Severin County |
| | | Power substation 400/220 kV MINTIA | | Hunedoara County |
| | | Power substation 400 kV ŢÂNŢĂRENI | | Gorj County |
| | | Power substation 400 kV PORŢILE DE FIER | | Mehedinti County |
| | | Power substation 400 kV URECHEŞTI | | Gorj County |
| | | Power substation 400/220 kV SLATINA | National | Olt County |

| | | | | |
|---|---|---|---|---|
| | | Power substation 400/110 kV DRĂGANEȘTI OLT | | Olt County |
| | | Power substation 400/110 kV BRAZI VEST | | Prahova County |
| | | Power substation 400/220/110 kV BRADU | | Arges County |
| | | Power substation 400/110 kV GURA IALOMIȚEI | | Ialomita County |
| | | Power substation 400/110 kV PELICANU | | Calarasi County |
| | | Power substation 400 kV ISACCEA | International | Tulcea County |
| | | Power substation 400 kV STUPINA | | Constanta County |
| | | Power substation 400 kV RAHMAN | | Tulcea County |
| | | Power substation 400/220/110 kV LACUL SĂRAT | National | Braila County |
| | | Power substation 400 kV CERNAVODĂ | International | Constanta County |
| | | Power substation 400/110 kV MEDGIDIA SUD | | Constanta County |
| | | Power substation 400/110 kV CONSTANȚA NORD | National | Constanta County |
| | | Power substation 400/110 kV TARIVERDE | | Constanta County |
| | | Power substation 400/110 kV TULCEA VEST | | Tulcea County |
| | | Power substation 400/110 kV SMÂRDAN | | Braila County |
| | | Power substation 400/220/110 kV GUTINAȘ | | Bacau County |
| | | Power substation 400/220/110 kV SUCEAVA | | Suceava County |
| | | Power substation | | Bacau County |

| | | | | |
|---|---|---|---|---|
| | | 400/110 kV BACĂU SUD | | |
| | | Power substation 400/110 kV ROMAN NORD | | Neamt County |
| | | Power substation 400/220 kV IERNUT | | Mures County |
| | | Power substation 400/220/110 kV SIBIU SUD | | Sibiu County |
| | | Power substation 400/110 kV DÂRSTE | | Brasov County |
| | | Power substation 400/110 kV BRAŞOV | | Brasov County |
| | | Power substation 400/220/110 kV BUCUREŞTI SUD | | Bucharest |
| | | Power substation 400/110 kV DOMNEŞTI | | Ilfov County |
| | | OHL 400 kV ROŞIORI - MUKACEVO | European | Romania Ukraine |
| | | OHL 400 kV (750 kV gauge) ISACCEA - UKRAINA SUD | | |
| | | OHL 400 kV NĂDAB - BEKESCSABA | | Romania Hungary |
| | | OHL 400 kV ARAD - SANDORFALVA | | |
| | | OHL 400 kV RESITA - PANCEVO | | Romania Bulgaria |
| | | OHL 400 kV PORŢILE DE FIER - DJERDAP | | |
| | | OHL 400 kV ŢĂNŢĂRENI - KOSLODUY | | Romania Bulgaria |
| | | OHL 400 kV RAHMAN - DOBRUDJA | | |
| | | OHL 400 kV (750 kV gauge) STUPINA - VARNA | | |
| | | OHL 400 kV | | Romania |

| | | | | |
|---|---|---|---|---|
| | | ISACCEA - VULCĂNEŞTI | | Republic of Moldova |

### 2.2. Risk scenario identification

***Risk scenario:*** Succession of Technical Incidents 400 kV POWER SUBSTATION - Total decommissioning of the National Power System (black-out) [3], [16], [26].

### 2.3. Assessment of risk scenarios

***Assessment Risk scenario:*** Succession of Technical Incidents 400 kV POWER SUBSTATION - Total decommissioning of the National Power System (black-out) [12], [14], [20], [25], [29].

| Sequential scrolling |
|---|
| **SUCCESSION OF TECHNICAL INCIDENTS 400 kV POWER SUBSTATION:** |
| SUCCESSIVE OF TECHNICAL INCIDENTS → MISTAKES OPERATIVE / DISPATCH PERSONNEL → TOTAL OUTPUT FROM THE FUNCTION OF THE NATIONAL POWER SYSTEM (BLACKOUT) → ENERGY INSECURITY → INDUSTRIAL INSECURITY → ECONOMIC INSECURITY → NATIONAL INSECURITY → PROPERTY DAMAGE / LOSS OF LIFE → STATE OF INSTABILITY / CRISIS |

The causes and effects are described in *Table 2.2.*

*Table 2.2.* ***Causes and effects***

| **Causes:** | **Effects:** |
|---|---|
| - short circuits of energy equipment;<br>- charging of mains overhead power lines;<br>- loads of energy equipment;<br>- precarious condition of energy equipment;<br>- lack of investments in power substations;<br>- system automation malfunctions within energy groups;<br>- lack of revisions to energy equipment;<br>- non-refurbishment of power substations;<br>- wrong configuration of power substations;<br>- wrong maneuvers performed by the substation's operational staff;<br>- lack of specialized and / or trained operational staff;<br>- non-communication or poor communication with Territorial Energy Dispatcher or National Energy Dispatcher; | - stopping the energy market between Romania and the EU;<br>- stopping the energy market between Romania and Serbia, Ukraine, the Republic of Moldova;<br>- non-power supply to neighboring and EU energy systems;<br>- non-supply of electricity to important consumers and NPS main power lines;<br>- enormous material damage due to lack of electricity;<br>- enormous material damage resulting from the interdependence of other systems;<br>- the possibility of a local, regional or national blackout. |

| | |
|---|---|
| - non-specialized Territorial Energy Dispatcher or National Energy Dispatcher staff in times of crisis;<br>- lack of power substation work procedures in times of crisis;<br>- lack / non-compliance / ignorance of national / European procedures in case of serious damage (black out);<br>- lack of training in the field of Risk Management;<br>- failure to close Romania's 400 kV ring - becomes a vulnerability of NPS. | |

***a) Determining the probability***

The following probability scale was adopted to determine the probability of occurrence [13], [15], [17], [21]:

| **LEVEL/ SCORE ASSOCIATED** | | **DEFINITION PROBABILITY** | **PERIOD** |
|---|---|---|---|
| | **1. Very low** | It has a very low probability of occurring. Normal measures are required to monitor the progress of the event. | **over 13 years** |
| | **2. Law** | The event has a low probability of occurring. Efforts are being made to reduce the likelihood and / or mitigation of the impact produced. | **10 – 12 years** |
| **X** | **3. Medium** | The event has a significant probability of occurring. Significant efforts are needed to reduce the likelihood and / or mitigate the impact produced. | **7 – 9 years** |
| | **4. High** | The event has a probability of occurring. Priority efforts are needed to reduce the likelihood of mitigating and mitigating the impact produced. | **4 – 6 years** |
| | **5. Very high** | The event is considered imminent. Immediate and extreme measures are required to protect the objective, evacuation to a safe location if the impact so requires. | **1 – 3 years** |

***b) Determining the severity of the consequences***

The severity of the consequences is given by the most unfavorable level of vulnerabilities and impact levels [18], [28].

***Vulnerability and capability analysis,*** *according to table 2.3.*

*Table 2.3.* ***Vulnerability and capability analysis***

| **VULNERABILITIES AND CAPABILITIES** | **LEVEL** |
|---|---|
| **1. Failure to close the 400 kV ring of Romania**:<br>- lack of investment (non-refurbishment of power substations, overhead power lines and new energy targets); | **Very low** |
| | **Low** |
| | **Medium** |

| | |
|---|---|
| - the unpredictability of the political system; | **High** |
| - the possibility of a zonal, regional or national blackout, generating the stoppage of the electricity market between Romania and the EU;<br>- economic insecurity generating national insecurity; | **Very high** |
| **2. Degree of specialization and regular training of the personnel with attributions to restore the power supply process:** | **Very low** |
| | **Low** |
| - operative staff; | **Medium** |
| - maintenance staff; | **High** |
| - security personnel | **Very high** |

- ***Impact analysis***

Impact analysis is an analysis of management at certain levels that identifies the impact of the loss of resources of a critical European infrastructure (power substation of national importance) [22].

The severity of all the impacts of the scenario will be taken into account and then the level of severity of the consequences of the occurrence of the hazard / threat in the considered scenario will be established [24].

The highest level of impact severity levels will be chosen, *according to table 2.4.*

*Table 2.4.* **Impact analysis**

| IMPACTS | LEVEL | |
|---|---|---|
| **Enormous damage caused by lack of electricity** | **1. Very low** | temporary |
| | **2. Low** | significant damage |
| | **3. Medium** | average damage |
| | **4. High** | major damage |
| | **5. Very high** | very high damage |
| **Enormous damage caused by the interdependence of other systems** | **1. Very low** | 0 - 10% of VIC |
| | **2. Low** | 11 - 20% of VIC |
| | **3. Medium** | 21 - 30% of VIC |
| | **4. High** | 31 - 40% of VIC |
| | **5. Very high** | over 41% of VIC |
| **Potential environmental damage** | **1. Very low** | 0 - 20% |
| | **2. Low** | 21 - 40% |
| | **3. Medium** | 41 - 60% |
| | **4. High** | 61 - 80% |
| | **5. Very high** | over 81% |
| **Strong social impacts** | **1. Very low** | 0 - 10% of TP |
| | **2. Low** | 11 - 20% of TP |
| | **3. Medium** | 21 - 30% of TP |
| | **4. High** | 31 - 40% of TP |
| | **5. Very high** | over 41% of TP |
| *VIC - the volume of invested capital; TP - trust of the population* | | |

| LEVEL/SCORE ASSOCIATED | | SEVERITY CONSEQUENCES |
|---|---|---|
| | **1. Very low** | The event causes a minor disruption to the activity, without material damage. |
| | **2. Low** | The event causes minor property damage and limited business disruption |
| | **3. Medium** | Personal injury and / or loss of equipment, utilities and service delays. |
| | **4. High** | Serious personal injury, significant loss of equipment and facilities, delays and / or interruption of service provision. |
| **X** | **5. Very high** | The consequences are catastrophic resulting in deaths and serious injuries to staff, major loss of equipment, installations and facilities and cessation of service provision. |

***c) Calculation of the risk level***

| P R O B A B I L I T Y | | | | | | |
|---|---|---|---|---|---|---|
| | **Very high 5** | | | | | |
| | **High 4** | | | | | |
| | **Medium 3** | | | | | **Scenario TECH. INC.** |
| | **Law 2** | | | | | |
| | **Very law 1** | | | | | |
| | **0** | **Very law 1** | **Law 2** | **Medium 3** | **High 4** | **Very high 5** |
| | | **S E V E R I T Y / C O N S E Q U E N C E S** | | | | |

*Note: The risk is given by the product between the probability of occurrence of a hazard / threat and the severity of its consequences*

**The calculated risk is 15**
**(probability 3 x severity 5)**
**therefore there is a**
**HIGH RISK**
**production of the chosen scenario**

| CALCULATED RISK LEVEL | |
|---|---|
| **NIVEL** | **PUNCTAJ** |
| **Very low** | **1 – 3** |
| **Low** | **4 – 6** |
| **Medium** | **7 – 12** |
| **High** | **13 – 16** |
| **Very high** | **17 – 25** |

***d) Risk treatment***

In order to reduce the risk, measures are required to reduce the following vulnerabilities and / or to improve the following capabilities, *according to Table 2.5.:*

*Table 2.5.* ***Risk treatment***

| VULNERABILITY AND / OR CAPABILITY | PROPOSED MEASURES |
|---|---|
| **Failure to close Romania's 400 kV ring** | - major investments in national and European critical infrastructure;<br>- the predictability (security) of the political system;<br>- accessing European funds for the security of European critical infrastructures. |
| **Degree of specialization and regular training of the operative personnel with attributions to restore the power supply process** | - training and refresher courses for operational, maintenance and security staff;<br>- analysis of events, incidents, etc.;<br>- control of installations on the operating line and carrying out preventive maintenance. |

The application of risk mitigation measures results in:

*Table 2.6.* ***Measures after risk management***

| VULNERABILITY | IDENTIFIED | AFTER THE APPLICATION OF THE MEASURES |
|---|---|---|
| - Failure to close Romania's 400 kV ring;<br>- Degree of specialization and regular training of the operative personnel with attributions to restore the power supply process. | **1. Very low** | **1. Very low** |
| | **2. Low** | **2. Low** |
| | **3. Medium** | **3. Medium** |
| | **4. High** | **4. High** |
| | **5. Very high** | **5. Very high** |

***e) Recalculation of the severity of the consequences***

| LEVEL/SCORE ASSOCIATED | | SEVERITY CONSEQUENCES |
|---|---|---|
| | **1. Very low** | The event causes a minor disruption to the activity, without material damage. |
| | **2. Low** | The event causes minor property damage and limited business disruption |
| **X** | **3. Medium** | Personal injury and / or loss of equipment, utilities and service delays. |
| | **4. High** | Serious personal injury, significant loss of equipment and facilities, delays and / or interruption of service provision. |
| | **5. Very high** | The consequences are catastrophic resulting in deaths and serious injuries to staff, major loss of equipment, installations and facilities and cessation of service provision. |

***f) The level of risk after the application of the reduction measures***

| | | | | | | |
|---|---|---|---|---|---|---|
| **P r o b a b i l i t y** | **Very high 5** | | | | | |
| | **High 4** | | | | | |
| | **Medium 3** | | | **Scenario TECH. INC.** | | |
| | **Law 2** | | | | | |
| | **Very law 1** | | | | | |
| | **0** | **Very law 1** | **Law 2** | **Medium 3** | **High 4** | **Very high 5** |
| | | **S E V E R I T Y / C O N S E Q U E N C E S** | | | | |
| *Note: The risk is given by the product between the probability of occurrence of a hazard / threat and the severity of its consequences* | | | | | | |

*Table 2.6.* ***The calculated risk has a value of 9 (probability 3 x severity 3) therefore there is a MEDIUM RISK production of the chosen scenario***

| CALCULATED RISK LEVEL | |
|---|---|
| **NIVEL** | **NIVEL** |
| **Very low** | **Very low** |
| **Low** | **Low** |
| **Medium** | **Medium** |
| **High** | **High** |
| **Very high** | **Very high** |

## 3. CONCLUSIONS

The need to identify the risks, threats and vulnerabilities of critical infrastructures within the National Power System results from the following considerations:

- Knowing that the National Power System is of national strategic importance, it must be constantly evaluated and monitored in terms of security risks, in order to identify vulnerabilities, threats, risks and dangers;
- This need to assess the sectorial security risks also comes from the European perspective because Romania is interconnected to the Energy System of the European Union – ENTSO-E, which interconnects the various electricity buses from the Nordic countries to the southern countries or from the western countries to the countries you are what;
- Knowing and identifying vulnerabilities can automatically identify the risks and threats to which the National Power System is subject and engaged and can create national / European measures or strategies to protect and secure critical national / European infrastructures;
- Certain identified, constructed and developed risk scenarios have a very high level of risk with devastating effects on national security, and in this context,

Critical Infrastructure Protection Management must form an integrated, coherent, transparent and convergent security system towards the overall objective TOTAL SECURITY;

- Vulnerability in energy security must be combated and eliminated through major investments in energy infrastructure and staff specialized in critical infrastructure protection and security;
- The issue of critical infrastructure security must also take into account the Human-Infrastructure interaction, ie ensuring the safety and health of workers who use them in the workplace, and the risks, dangers and threats posed by the use of machinery and equipment by workers. critical areas of energy infrastructure, are a particular area of occupational risks, dangers and threats to which they may be exposed and, as a result, cannot be dissociated and treated separately, consider the complex set of conditions and interdependencies specific to modern work systems.

The intended results consist of the development and integration of applicable tools by security liaison officers, security experts or specialists and operational staff working and operating with critical infrastructures to prevent and minimize risks, combat and eliminate vulnerabilities, hazards and threats.

All these aspects support the importance and opportunity of scientific research dedicated to the assessment of sectorial security risks and the development of assessment methods dedicated to minimizing occupational risks, to be used by all actors involved.

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