COORDINADOR
ELÉCTRICO NACIONAL

MEASURES AND RECOMMENDATIONS TO STRENGTHEN THE NATIONAL ELECTRIC SYSTEM

COORDINADOR'S PLAN POST BLACKOUT
OF FEBRUARY 25, 2025

INSTITUTIONAL COMMITMENT

July 2025

The Coordinador Eléctrico Nacional, as a technical and independent body in charge of coordinating the operation of the National Electric System (Sistema Eléctrico Nacional) between Arica and Chiloé under the principles of security, minimum cost and open access to the grid, assumed the institutional commitment to transparently provide all the information it possesses, receives and manages to systematize and analyze regarding the blackout of February 25, 2025, as well as to adopt immediate measures and propose other medium- and long-term measures required so that, in the event of a failure of similar characteristics, the scope and propagation of an event of this nature are not repeated, or its consequences can be limited.

This commitment has been reflected in various actions and activities carried out by the Coordinador during and after the event, including:

- Coordinating the restoration of the National Electric System supply in the shortest possible time, overcoming the unprecedented adverse conditions caused by the lack of grid visibility and the loss of dedicated communication channels belonging to key coordinated companies participating in the service restoration process.
- Analyzing and systematizing approximately 2,000 documents containing information, often incomplete or deficient, which was requested from the coordinated companies regarding the operation of their facilities during the blackout.
- Preparing the Failure Analysis Study (Estudio de Análisis de Falla, EAF) within a very short period of time, considering the magnitude of the event.
- Requesting, in several instances, additional information that would allow for evaluation of the adequate performance of the facilities of the coordinated companies.
- Contracting independent analyses of the event to gain a complete and objective understanding of its causes, propagation and recovery, thereby enhancing the analysis and defining the measures to be implemented.

- Instructing the initiation of technical audits of the protection and communication systems at the facilities related to the root cause of the failure and to the monitoring and communications systems that failed during the recovery process.
- Adopting operational measures and short-term limitations that allowed a secure operation until the correct functioning of the key system assets affected during the blackout was determined.
- Explaining and presenting all details of the event to various authorities, including Senate and Chamber of Deputies committees, as well as at public events.
- Responding to requests and inquiries from parliamentarians, authorities, the media and the general public.
- Working with industry experts to identify medium- and long-term measures to strengthen the security of the National Electric System, which are detailed in this document.

EVENTS THAT MARKED FEBRUARY 25, 2025

Origin of the failure

At 3:15 pm on February 25, without prior coordination or authorization from the Coordinador, personnel from the company that owns the 2x500 kV Nueva Maitencillo – Nueva Pan de Azúcar line intervened the facilities in an attempt to resynchronize the communication module of one of the line protections, which caused the disconnection of its two circuits.

Propagation

Following the disconnection of the double circuit of the 2x500 kV Nueva Maitencillo - Nueva Pan de Azúcar line, the National Electric System was separated into two islands after a few seconds: the North (with 30% of the demand) and the South-Center (with 70%).

In the **North** zone, the island remained operational for approximately four minutes, due to the operation of the automatic generation shedding schemes (AGSE), but finally, the total loss of supply occurred as a result of voltage instability.

The **South-Center** island became unstable within seconds of the failure, given the unbalance of the generation coming from the north of the country (1,800 MW), the malfunctioning of the contingency defense schemes at the facilities of the coordinated companies that had been instructed by the Coordinador in accordance with the grid code, and the poor performance of some power plants, which caused a drop in frequency until reaching the total collapse of the system.

Operation of automatic schemes to contain failures

Although the system has automatic remedial schemes to contain the propagation of failures, known as automatic load shedding schemes (ALSE), designed to prevent a total blackout from occurring, large part of these containment resources – which responsibility falls under the coordinated companies – functioned incorrectly or deficiently, either because they were poorly adjusted or implemented, in accordance with the grid code and instructions from the Coordinador. Furthermore, several power plants operated incorrectly, tripping at times and/or magnitudes different from those specified by the grid code and technical studies.

This resulted in the propagation of the failure, ending in a blackout of both the North and South-Center islands.

Analysis conducted by the Coordinador has found that at least 1,350 MW of power plants in the South-Center zone were disconnected prior to the island's collapse. In most of these cases, there was a failure to comply with the grid code by the companies that owned the facilities, which contributed to the propagation and deepening of the failure.

* The system was fully interconnected at 8:40 am on February 26.

Service Recovery

Two minutes after the February 25th event, the Coordinador activated the Service Recovery Plan (Plan de Recuperación de Servicio, PRS), instructing the coordinated companies to take immediate actions to prepare the system for recovery.

The PRS is a plan that is updated annually and subject to industry-wide review, defining the roles and functions of companies to restore system operation by region.

According to the EAF submitted to the authority, some power plants belonging to coordinated companies faced technical difficulties for various reasons – some beyond their control – when attempting to synchronize with the grid, which delayed the normalization of the electricity supply.

The reasons for these delays are explained mainly by the occurrence of unprecedented events, such as:

- The lack of visibility of the status of the generation and transmission facilities of the National Electric System, due to the failure of the supervision and control systems (SCADA) of some coordinated companies.
- The unavailability of remote control for the distance operation of facilities of coordinated companies, which forced the mobilization of personnel to substations at great distances, and,
- The failure of point-to-point voice communication channels of some coordinated companies.

It should be noted that the Coordinador's SCADA system, as well as its communication systems, did not register any failures during the event.

Despite these difficulties, by midnight on February 25th, 100% of the supply had been restored between the Valparaíso Region and Chiloé, equivalent to nearly 90% of the country's regulated demand.

OUR PERSPECTIVE ON THE BLACKOUT

The blackout of February 25th, 2025 represents a turning point for the National Electric System (SEN) and for the Coordinador Eléctrico Nacjonal as an institution.

An event of this magnitude, which resulted in a complete interruption of the electricity supply between Arica and Chiloé, confirms that electricity is an essential service, without which our daily lives, the functioning of the country, and public confidence are profoundly affected.

From the outset, the entire Coordinador organization and its Board of Directors addressed the situation with responsibility, a sense of urgency and technical commitment. Within a very short timeframe, considering the magnitude of the event, the detailed EAF was prepared, immediately activating audits of protection and SCADA systems, technical inspections of the failed facilities, a review of operating conditions, technical instructions to coordinated companies and measures to ensure the continuity of the operation in case of similar failures in the future.

The blackout has left profound lessons that must be incorporated by all stakeholders in the industry – both business and institutional – and consumers, who are our focus, for a proper functioning of the system.

Among the problems identified are the premature disconnection of power plants and failures in the calibration and configuration of protection and communication schemes for some assets of the coordinated companies, as well as the incorrect implementation of automatic load shedding schemes (ALSE), among others, which have been duly reported to the authority.

But it is also an opportunity to accelerate improvements in technical standards, processes and, above all, the need for the competent bodies to adopt effective oversight actions to ensure strict compliance with the obligations that the regulation requires to each stakeholder in the system.

The secure operation of the system is a collective task. All generation, transmission and distribution companies, as well as unregulated customers, must strengthen their commitment to strict regulatory compliance, especially with regard to the maintenance and configuration of their control, protection and telecommuni-

cations systems, their contingency response capacity, the registry of failure information and their participation in the design and construction of a resilient electricity system.

The Coordinador is committed to exercising its role with technical rigor, transparency and vocation for public service. We also hope to count on the support of the sectoral institutions in matters relevant to their responsibilities.

February 25th was a regrettable event, but we must transform it into an opportunity and a call to build a more robust system prepared to face the challenges of the energy transition.

WORK WITH TECHNICAL RIGOR

Once service was restored following the blackout of February 25th, 2025, the Coordinador's team began working to analyze the event in order to adopt actions that would allow the National Electric System to perform better if faced with a similar event in the future, but with the conviction that such a situation should not happen again.

The work presented here proposes measures and recommendations aimed at strengthening the system to minimize the impact and scope of events such as those that occurred on February 25th. These measures are complementary to other actions already taken and implemented by the Coordinador, to the instructions already issued to coordinated companies and to those taken within the framework of regulation, oversight as well as the processes and potential investments that coordinated companies must make.

Regarding the work of the Coordinador, we have acted with independence, seriousness and technical rigor to arrive at measures that require immediate implementation and actions that strengthen, in the short, medium and long term, the capabilities of the National Electric System (SEN) to face events of this nature.

The Coordinador's team has worked based on four guidelines:

1. **Recognition and management of risks:** deIn an extensive, radial and complex electric power system like Chile's, failures and their effects cannot be completely eliminated, but their impact can be limited and an effective recovery managed. After February 25th, we have instructed mitigation actions that urgently need to be implemented.

2. **Comprehensive and prioritized action plano:** Las medidas propuestas se estructuran en cuatro categorías que abordan la prevención, la contención, la reposición del servicio y el aprendizaje continuo.

3. **Rationalization and strategic focus:** E The work carried out in recent months has raised a significant number of measures. Considering their volume, a prioritization process was carried out to give them strategic focus and ensure their impact.

These measures will be addressed in the short, medium and long term.

4. **Immediate response and structural strengthening:** After the immediate measures have been implemented, the action plan will generate medium- and long-term actions to improve the technical and operational capabilities of the National Electric System.

The action plan is structured around a chronological sequence that addresses the development of these types of high-risk events, starting with failure prevention, containing their propagation, ensuring rapid recovery and, finally, the analysis of and lessons learned from these events.

However, it is essential to emphasize that the action plan defined by the Coordinador requires the commitment of all stakeholders in the industry to carry out its prompt and correct execution.


Ex-Ante preventing and mitigation
Contain the spread of failures
Rapid service recovery
Continuous learning and improvement
These measures seek to prevent a failure from occurring and reduce its probability and impact. They include mitigation actions such as improving planning, strengthening infrastructure, encouraging regulatory compliance and proposing regulatory improvements.
These measures focus on reducing the consequences when disruptive events occur, limiting their propagation and preserving stability. This includes operational settings, improvements in contingency response, encouraging regulatory compliance and strengthening backup systems.
These measures are designed to restore power securely and in the shortest possible time. They involve improvements in recovery protocols, coordination between stakeholders and monitoring tools.
These measures seek to improve the process of recording, analyzing and reporting failures, both to obtain the necessary learning and to determine corrective measures. They allow us to take advantage of knowledge and information.

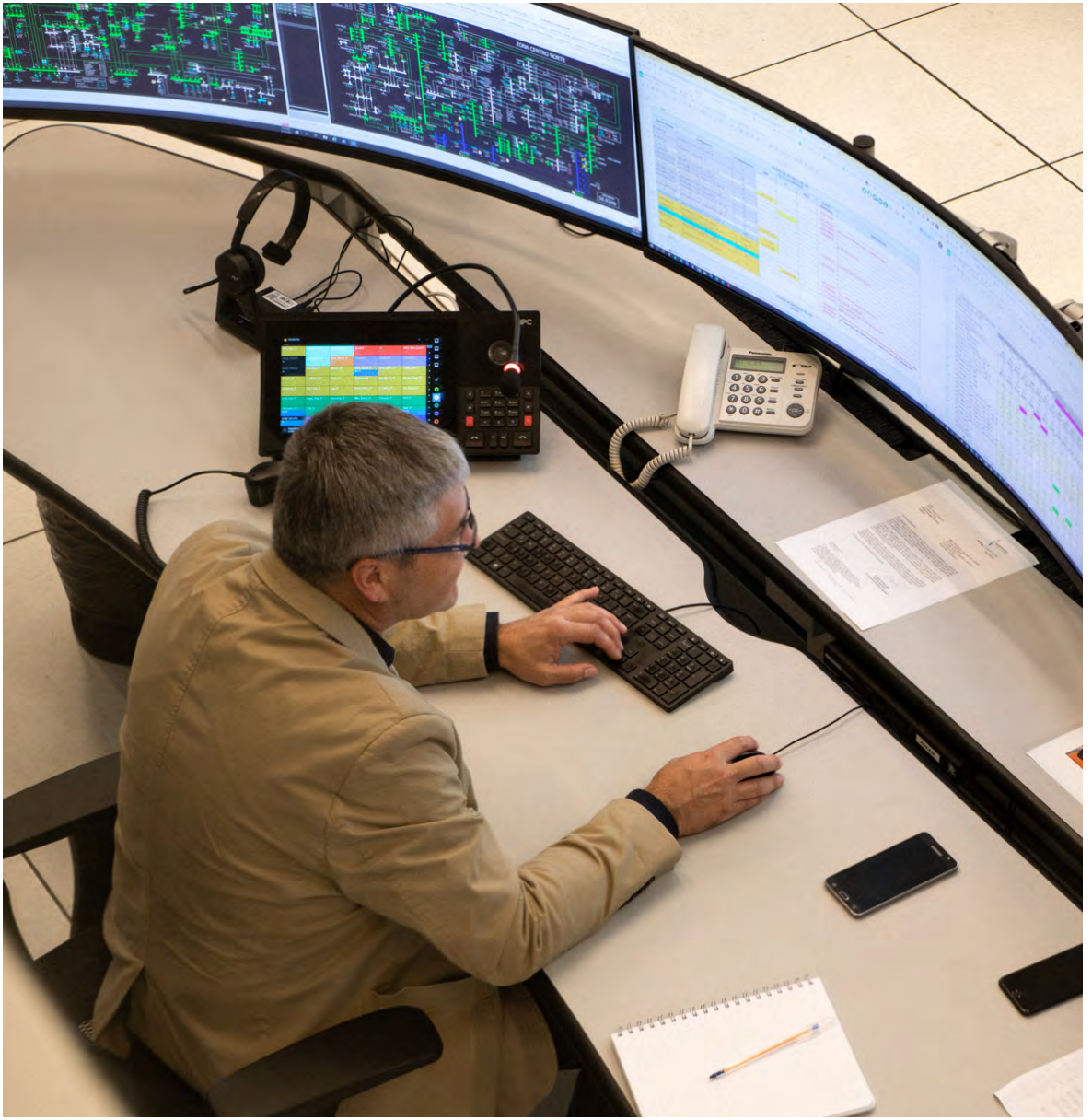
MEASURES AND INSTRUCTIONS ALREADY IMPLEMENTED

Following the total blackout on February 25th, the Coordinador has been instructing coordinated companies on short-term measures aimed at improving the performance of the National Electric System in the event of contingencies or similar events. The Coordinador has also proposed regulatory improvements to the competent authority.

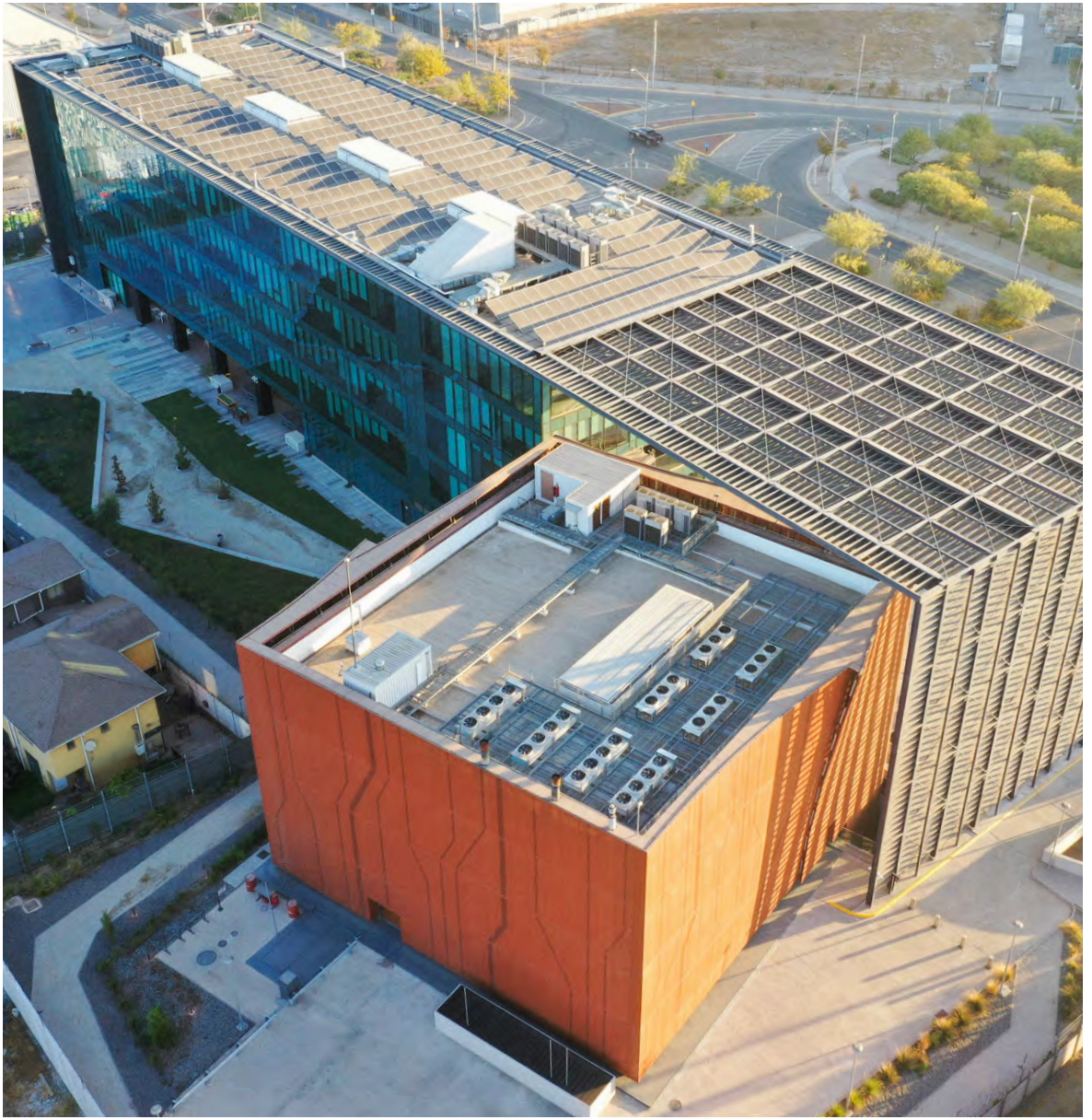
These measures are specific and respond to situations where there is evidence of aspects that need to be corrected in the short term. Furthermore, in cases where a possible regulatory breach has been detected, the Superintendency of Electricity and Fuels (SEC) has been informed of the situation.

Among the measures adopted to date are:

ACTION OR INSTRUCTION	STATUS AS OF JULY 2025
Technical inspection of the Interchile facilities where the February 25th failure originated, in order to subsequently authorize the normalization of its protection schemes.	**Completed** ✓
Interchile has been instructed to modify its communications schemes in order to adjust them to current grid code requirements.	Instructed but not performed by the company / Reported to the SEC
A technical audit was conducted on the protection and communications systems of the facilities where the failure originated on February 25th.	In progress
A complete technical audit was ordered on the infrastructure of the Cardones – Polpaico line, after new failures occurred.	In progress



ACTION OR INSTRUCTION	STATUS AS OF JULY 2025
Transelec has been instructed to have operating personnel close to the relevant substations for the recovery of service in case of events of these characteristics. Additionally, in late March, the company reported a change of battery banks associated with the uninterruptable power supply (UPS), as well as in the automatic start controller of the backup generator in its main control center, which seeks to avoid problems like those they experienced on February 25th.	**Completed** ✓
A technical audit was conducted on Transelec's SCADA and communication systems following the problems on February 25th.	In progress
Companies were reminded of their obligation to report and request work permits preventively, to reduce risks in the operation.	**Completed** ✓
Small-scale distributed generation (SSDG) plants were instructed to verify the adjustments of their protections, in accordance with current grid code, and implement the corresponding corrections.	**Support provided by companies completed and under review** ✓
Information was requested on the operation of the automatic shedding resources (ALSE and AGSE) for this type of event. Subsequently, checks and adjustments were instructed in cases where problems were detected.	**Completed** ✓
Distribution companies were instructed to review and transfer their automatic load shedding schemes (ALSE) for this type of event to feeders without SSDG plants, due to the effect that this configuration had on the failure of February 25th, where the action of these mechanisms also disconnected electricity generation, aggravating the problem of system imbalance in the south-central region.	**Support provided by companies completed and under review**
Coordinated companies that own power plants that operated incorrectly, in violation of current grid code, were instructed to update and correct their protection settings.	**Completed** ✓
The capacity of the automatic load shedding schemes (ALSE-BF) resource was increased in the ancillary services report.	**Completed. Report for industry observations** ✓
A regulatory recommendation was made to the Energy Ministry to increase requirements for small-scale distributed generation plants, in aspects such as operational signals, visibility and technical adaptation to the requirements for failure behavior.	**Completed** ✓
A regulatory recommendation was sent to the Energy Ministry to incorporate technical requirements for grid-following and grid-forming inverters in the grid code, based on the studies and technical guides already prepared by the Coordinador.	**Completed / CNE put changes to technical standard forward for consultation** ✓



MEDIUM- AND LONG-TERM MEASURES

Ex-ante prevention and mitigation

- Implement new technological tools that automatically detect situations of risk and reliability issues in the provision of ancillary services, to support decision-making in real-time operations.
- Propose new requirements for the provision of ancillary services for dynamic voltage and frequency control by solar and wind power plants, as well as storage systems.
- Incorporate a verification plan focused on power plants that perform inefficiently, reviewing their models, standards and dynamic behavior, in addition to the verification carried out by the plants required to provide ancillary services.
- Develop a dissemination and training program for coordinated companies regarding the obligation to use the work permit system and the evaluation of operational risks and critical procedures.
- Implement a preventive technical audit plan for critical transmission asset protection systems.
- Increase the scope and frequency of the Protection Verification and Coordination Study to incorporate the effect of new facilities being integrated into the system.
- Accelerate the implementation of advanced electromagnetic transient (EMT) simulations of the electrical system, to model, analyze and anticipate risk situations that could arise in operations under scenarios of low strength and high insertion of inverter-based resources (IBR).
- Expand the requirement for the implementation of real-time phasor measurement units (PMUs) to all power plants connected to the transmission system, in order to increase the grid's monitoring and fault recording capacity.

Contain the propagation of failures

- Improve the dynamic voltage control in the system, especially in areas of low strength and robustness, through the contribution of variable renewable plants and storage systems, based on an updated version of the Voltage Control and Reactive Power Requirements Study elaborated annually.
- Ensure efficiency in the allocation of resources for the provision of primary frequency control, considering geographical distribution and performance criteria.
- • Apply a new approach to develop the Extreme Contingency Defense Plan (Plan de Defensa ante Contingencias Extremas, PDCE) and to determine the resources needed to contain failures (ALSE and AGSE), with a focus on defining more demanding scenarios with a high participation of variable renewable generation, storage systems, and SSDG generation.
- Implement a real-time visualization platform for SSDG that enables their monitoring and supports the analysis and adoption of security measures.
- Implement the modifications currently under public consultation of the grid code on issues related to inverter-based resources (IBR) technologies: grid forming and grid following.

Rapid service recovery

- Introduce new scenarios and requirements in the 2026 Service Recovery Plan (Plan de Recuperación de Servicio, PRS), which as of July 2025 is in the stage of receiving comments from the industry.
- Review and, if necessary, update or redesign the functional and governance model between the Coordinador's Dispatch and Control Center, the Service Recovery Operation Centers (which are currently managed by relevant companies in the system) and the control centers of coordinated companies.
- Design and implement a comprehensive training, profiling and certification program for operators in the control rooms of the National Electric System, integrating adopting best practices in this area.

- In future modifications to the PRS, require operators to be located close to key generation facilities (autonomous black start plants) and transmission facilities with critical roles.
- Comprehensive strengthening of requirements, monitoring and preventive technical audits for dynamic models and control and protection systems of renewable plants and storage systems, as well as for the monitoring and remote-control systems (SCADA) of the coordinated companies.

Learning and continuous improvement

- Implement an internal procedure to standardize and automate the massive reception of technical information associated with the preparation of failure analysis reports (EAF), to make the process more efficient and allow for detailed analysis of events.
- Implement a platform for managing and controlling grid code compliance by coordinated companies.

This action plan will strengthen security in the National Electric System, in line with the expectations of citizens, authorities and stakeholders in the electricity industry.

Some of these measures require an additional budget, which will be requested by the Coordinador within the 2026 budget approval process.

A SYSTEM THAT ADAPTS TO THE CHALLENGES OF THE ENERGY TRANSITION

The action plan presented by the Coordinador is part of a process of continuous improvement, which shall encompass the entire electricity industry. Beyond the responsibilities of each stakeholder, preventing a situation like the one occurred on February 25th from happening again will require meticulous and demanding work, both from companies and institutions.

This requirement responds to the accelerated process of energy transition and technological transformation, which is increasing the operational challenges of the grid, both in the functions that are within the scope of action of the Coordinador, as well as those that are responsibility of the companies, the regulator and the sanctioning body.

We hope this plan will allow us to move forward on concrete measures, the development of which can be monitored and controlled, in a scenario where consumer and system demands will grow in line with the challenges of the energy transition.

The Coordinador Eléctrico Nacional invites all stakeholders in the industry to contribute to this process of continuous improvement, for which it reiterates its willingness and openness to dialogue, as well as to collaboration, so that the National Electric System raises its standards of security and reliability of supply.

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