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Iberian Blackout: From Analysis to Action

Author's Note: Although I'm not an electrical engineer, I've worked as an economist and energy consultant since 1997, with a focus on electricity markets and infrastructure. I studied electricity in high school and have learned a great deal over the years by listening to engineers. This note isn't intended as a technical paper, but rather a reasoned reflection on how modern power systems behave—and sometimes fail. Any simplifications are mine, so please be understanding if I don't get every technical detail exactly right. 😇

This fourth reflection continues the series that began in the immediate aftermath of the Iberian blackout of 28 April 2025. In Part 1, I focused on understanding what had happened; in Part 2, on how the system responded; and in Part 3, on what we had learned and the need to rebuild trust.

This Part 4 builds on those earlier articles and moves the focus from understanding and learning to a more practical question: whether the system is adapting quickly enough to what we now know. Since then, two important pieces of the puzzle have been added: the final report of ENTSO-E and the recommendations issued by the CNMC. Taken together, they do not overturn the narrative developed over the past year. They confirm it. But they also point the discussion forward. The question is no longer whether we understand the event. It is whether we are acting on that understanding with sufficient urgency.

What the final reports confirm — and what they leave open

One of the striking features of the past year is the degree of convergence across institutions. REE, MITERD, ENTSO-E and now CNMC all describe, with different emphases, essentially the same physical reality. The blackout was not driven by a lack of inertia, nor by an inherent flaw in renewable generation. It was the result of a voltage-control problem, unfolding through a rapid sequence of generator disconnections under stressed conditions.

That conclusion matters because it closes a chapter. Much of the early public debate was shaped by narratives that, while understandable, were ultimately misleading: too much solar, insufficient synchronous generation, operator error. These explanations offered clarity at the cost of accuracy. The reports now make clear that the system behaved in a way that is consistent with its increasing complexity: small disturbances interacting with tight margins, protection systems reacting locally, and a cascade emerging from the interaction of many individually rational responses.

In that sense, the event was not exceptional. It was a manifestation of a system in transition.

What the ENTSO-E final report adds, beyond the earlier factual account, is less about identifying a single cause and more about reinforcing the nature of the system we are dealing with. It highlights the speed at which conditions evolved, the limits of existing models to fully capture non-linear dynamics, and the continuing challenges in reconstructing events due to incomplete or unsynchronised data. None of this contradicts the earlier analysis. If anything, it strengthens a point already made in Part 2: the difficulty is no longer managing known risks, but dealing with those that remain only partially understood.

From diagnosis to action

If ENTSO-E consolidates the diagnosis, the CNMC report seeks to translate it into action. Its starting point is explicit: the electricity system is undergoing a structural transformation driven by decarbonisation, electrification and the growing role of power electronics. The regulatory and operational framework, designed for a different system, is struggling to keep pace.

This is not presented as a failure of any single actor. On the contrary, CNMC acknowledges that mechanisms were in place and operators acted within that framework. But it also makes clear that those mechanisms are no longer sufficient on their own. What is required is system-wide adaptation — technical, operational and institutional.

At the technical level, the message is consistent with what has been emerging since the summer of 2025: voltage control must be strengthened and broadened. In a system where inverter-based generation is becoming dominant, the traditional reliance on synchronous machines is no longer adequate. The question is not only how much voltage control is needed, but who provides it. The system still relies heavily on synchronous generation, even as inverter-based resources account for an increasing share of capacity. The latter can provide this support, but only if explicitly configured and required to do so, since—unlike synchronous machines—it is not inherent to their operation. Renewables are not the problem; they are part of the solution—provided they are enabled and incentivised to contribute actively to voltage management. Until this transition is completed, the system will continue to rely on solutions that, while technically effective, are not economically efficient.

A clear manifestation of this incomplete transition is the use of so-called “reinforced operation”, which increases the presence of synchronous generation to maintain security margins. From a technical standpoint, this is effective. But it is also transitional: a way of managing risk by relying on assets designed for a different system, with economic implications that cannot be ignored.

Requirements around voltage control — including those formalised in the revised P.O. 7.4 — had been under discussion for some time, but their implementation accelerated in the aftermath of the blackout. In that sense, the event acted as a catalyst, turning a pending evolution into an immediate priority. The direction is correct: a shift from static, compliance-based requirements towards more dynamic, real-time voltage support.

This shift also raises a broader question about how system response is organised. Traditionally, these capabilities have been defined as technical obligations. In a system of growing complexity, that may no longer be sufficient. There is a need for mechanisms that not only require, but also incentivise and explicitly value these services. The challenge is therefore not only technical, but also one of market design.

A further lesson of the blackout, also highlighted by ENTSO-E, is that parts of the system remain insufficiently visible in real time. Without comprehensive data — from distribution networks, smaller generators and embedded resources — the system operator is left managing a system that is only partially visible. In such conditions, control becomes reactive rather than anticipatory.

A third element is coordination, both within Spain and at European level. The Iberian system does not operate in isolation. Oscillations, cross-border flows and interconnection management all played a role in the events of April 2025. The response, therefore, cannot be purely national. It requires common methodologies, shared tools and a more integrated approach to system operation across borders.

This also applies within the Iberian system itself. While much of the public debate has focused on Spain, the blackout was a joint Iberian event, and the restoration process demonstrated strong operational coordination between REE and REN. Portuguese sources have been more restrained in public commentary, but the technical conclusions are broadly aligned: the issue was one of system behaviour under stressed voltage conditions, not a national failure. The lesson, therefore, is shared.

None of these conclusions is particularly surprising. They follow logically from the diagnosis. The relevant question is not what needs to be done, but how quickly and decisively it will be implemented.

Why pace matters more than direction

A year on from the blackout, the direction of travel is broadly correct. The technical debate has matured, the initial noise has subsided, and there is a clearer understanding of priorities. The revision of procedures such as PO 7.4, the ongoing consultations, and the proposals outlined by CNMC all point towards a system that is adapting.

And yet, there remains a sense of gradualism. The response is being developed through consultations, reports and staged regulatory adjustments. This is understandable in a complex system involving multiple actors, each with legitimate interests and constraints. But it also raises a concern. Electricity systems do not wait for regulation to catch up. The conditions that characterised April 2025 — high renewable output, strong exports, reduced synchronous generation and narrow reactive margins — are not exceptional events. They are increasingly common, particularly in spring and autumn.

In that context, the risk is not that we are moving in the wrong direction, but that we are moving too slowly relative to the speed of change in the system itself. CNMC itself acknowledges this implicitly, emphasising the need for a more dynamic regulatory framework capable of adapting to rapidly changing system conditions. The implication is clear: a framework based on incremental adjustments may struggle to keep pace with a system whose behaviour is evolving more rapidly.

Where the real constraint lies

It is worth noting that the solutions being discussed are not speculative. Enhanced voltage control from inverter-based resources, wider deployment of grid-forming capabilities, and improved system observability are already being implemented in systems such as Australia’s National Electricity Market, parts of the United States (notably California and Texas), and more recently in the UK.

The constraint is not technological but rather one of implementation: defining clear requirements, aligning incentives, ensuring compliance, and coordinating across institutions. In short, it is a question of governance.

This echoes a point made in Part 3, albeit from a different angle. There, the focus was on trust — between the system operator, generators and the regulator. That remains relevant. A system in which actors do not fully trust each other's behaviour under stress will tend towards defensive operation, with wider margins and lower efficiency. But trust alone is not enough. It must be complemented by clarity: clear expectations, clear responsibilities, and clear consequences.

From learning to delivery

Over the past year, the Iberian blackout has been analysed from multiple perspectives: technical, regulatory, institutional. We have moved from speculation to evidence, from competing narratives to a broadly shared understanding. That is an achievement in itself, but understanding is only the first step.

The next phase is less visible, but more demanding. It involves turning recommendations into requirements, ensuring that new capabilities are not only specified but deployed, and building a system that can operate reliably under conditions that are no longer exceptional but routine.

This is not about eliminating risk. No system of this complexity can ever be made immune to failure. It is about reducing the likelihood of similar events and, equally important, ensuring that when disturbances occur, they do not escalate into system-wide collapse.

Final reflection

When I wrote the first article in this series, the Iberian system — not just Spain, but the interconnected Spanish and Portuguese grids — had just experienced a major shock. The natural reaction was to seek explanations. A year later, explanations are no longer in short supply. The challenge now is different.

We are moving, broadly, in the right direction. The diagnosis is sound, and the solutions are known. But the effectiveness of the response will depend less on what we know than on how quickly and decisively we act on that knowledge.

Beyond direction, progress will also need to be measured. A more resilient system should not only reduce the likelihood of extreme events, but also operate more efficiently. If the measures being implemented are working, we should expect a reduced reliance on costly back-up mechanisms and, with it, a gradual decline in overall system costs. If this does not happen, the risk is different: not that we are failing to understand the problem, but that we are simply learning to live with it at a higher cost.

Because the system is not standing still. And if there is one lesson from April 2025, it is that complexity does not forgive delay.

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