Note on the Iberian Blackout – Causes, Consequences, and Policy Implications

EEFI Centre

On April 28–29, 2025, a massive power black-out occurred, disrupting the electricity supply across Spain, Portugal, and parts of southern France. This incident affected approximately 6 crore people for over 12 hours, highlighting vulnerabilities in Europe's energy infrastructure.

The blackout has highlighted the issues related to grid modernization, renewable energy integration, and the impacts of privatization. At the time of the blackout, wind and solar energy contributed approximately 80% of the electricity supply in Spain and Portugal. A sudden 1.2 GW drop in solar output, possibly due to cloud cover, caused frequency fluctuations. Private operators focused on renewable energy generation rather than grid resilience. Aging 400 kV transmission lines, some over 30 years old, experienced oscillations that exacerbated cascading failures.

Grids of European countries are coupled (connected) without any proper public control over the utilities. The frequency fluctuation in Spain created a cascading effect in the neighbouring countries. Recall the monetization (privatization) of Indian Grids, the increasing heavy dependence on the Renewable sources and the One Sun-One Earth-One Grid (Grid coupling) project of the Modi government. For understanding and campaigning to the workers of POWERGRID and NTPC, we have prepared a short informative note furnished below. Please go through this and discuss among the workers.

Introduction

Event Overview

The outage began at 10:30 GMT on April 28, 2025, with immediate effects on critical infrastructure:

- **Transportation**: Metro systems in Madrid, Barcelona, and Lisbon suspended operations. Madrid-Barajas Airport faced delays for 220 flights, leaving 12,000 passengers stranded.
- **Healthcare**: Emergency services in Madrid attended to 167 cases of respiratory distress due to failed ventilation systems.
- **Economic Disruptions**: The Madrid Open tennis tournament was suspended, and Lisbon’s tourism sector reported €52 million in cancellations.

At the time of the blackout, wind and solar energy contributed approximately 80% of the electricity supply in Spain and Portugal, raising initial concerns about the

reliability of renewables. However, investigations later shifted focus to systemic weaknesses.

Technical and Systemic Causes

1. Grid Instability and Low Inertia

Spain's grid, heavily dependent on renewables, lacked sufficient inertia—a stabilizing force traditionally provided by fossil fuel or nuclear plants. Inertia is crucial for maintaining grid frequency during disruptions, but systems reliant on renewables need alternative stabilization technologies. Key findings include:

- A sudden 1.2 GW drop in solar output, possibly due to cloud cover, caused frequency fluctuations.
- Aging 400 kV transmission lines, some over 30 years old, experienced oscillations that exacerbated cascading failures.
- Only 18% of Spain’s renewable infrastructure was equipped with grid-forming inverters, which are critical for frequency control.

2. Interconnection Vulnerabilities

Cross-border electricity exchanges, intended to enhance energy security, became liabilities:

- Spain's grid abruptly disconnected from France’s network, which typically provides 1.4 GW of backup power.
- Portugal reported unexplained faults in cross-border transmission lines, delaying recovery efforts.

3. Infrastructure and Investment Gaps

Spain’s rapid expansion of renewables outpaced grid modernization:

- Renewable capacity grew by 300% between 2020 and 2025, but grid investment increased by only 15%.
- Battery storage capacity (2.1 GW) met just 40% of the required threshold for stabilizing variable renewables.

Role of Privatization and Governance

1. Private Sector Priorities

Private operators focused on renewable energy generation rather than grid resilience:

- Private developers accounted for 70% of Spain’s new solar and wind projects but contributed less than 10% to grid upgrades.
- In Portugal, 40% of grid maintenance roles were outsourced to subcontractors with limited training, reducing operational expertise.

2. Underinvestment in Resilience

- Spain's grid operator, Red Eléctrica de España (REE), reduced permanent engineering staff by 25% between 2015 and 2025, relying on contractors for critical roles.
- Privatized grid segments in southern France operated with outdated cybersecurity protocols; 60% of critical nodes lacked updated encryption.

3. Comparative Analysis

- **Germany** (50% privatized grid): Grid modernization lagged 30% behind France's state-managed RTE.
- **UK** (fully privatized): Experienced 40% more outages than the EU average in 2024.

Socio-Economic Impacts

1. Immediate Costs

- Business losses totaled €380 million in Spain, mainly in manufacturing and retail.
- Rentals for emergency diesel generators surged by 300%, with prices reaching €1,000 per day.

2. Long-Term Risks

- Grid modernization costs for Spain and Portugal are projected to reach €14 billion by 2030, potentially increasing consumer bills.
- Over 45,000 insurance claims were filed for spoiled goods, medical emergencies, and business interruptions.

Strengthening Integrated Public Governance

While the exact reasons for the blackout have not yet been fully identified, the shift towards privatization in the power sector can be seen as a major contributor to vulnerabilities. The technical causes could range from loss of generation, malfunctioning grid components, or interconnection failures, but all point to the critical need for an integrated approach and planning, which is lacking due to an overemphasis on profit motives. Therefore, integrated public governance of the power system is essential to provide a comprehensive solution and prevent such failures from recurring.

1. Integrated Public Governance of Power Systems

- **Adopt a Unified Utility Model**: Transition to state-led, vertically integrated utilities (e.g., France's EDF framework) that holistically manage generation, transmission, distribution, and system operations. This ensures alignment between infrastructure planning, renewable deployment, and grid stability.

- **Resist Fragmentation**: Advocate for EU exemptions to protect integrated models from market-driven unbundling. France's partial privatization of EDF (16% shares sold in 2023) highlights risks of diluted accountability.

2. Grid Modernization Under Public Oversight

- **Mandate Grid-Forming Technologies**: Accelerate the deployment of inverters and storage to cover 80% of renewable infrastructure by 2030. This requires governmental control and public capital funding, where private investment may not be a viable solution.
- **Phase Out Ageing Infrastructure**: Replace 400 kV transmission lines over 20 years old by 2030, prioritizing regions with high renewable penetration. This also requires significant public investment.

3. Workforce Centralization and Expertise

- **Rebuild Public Sector Capacity**: Source experienced and responsible technical personnel for critical operations like grid management, requiring permanent staffing rather than outsourcing.
- **Establish National Training Programs**: Fund public universities and technical institutes to develop specialized curricula for grid management and renewable integration.

4. Funding Through Public Investment

- **Create National Grid Modernization Funds**: With projections indicating a €14 billion investment needed for grid modernization in Spain and Portugal by 2030 to keep pace with renewable generation growth and transmission requirements, these funds should come from public budgets, thus reducing reliance on private-sector contributions.
- **EU Solidarity Mechanism**: Establish a €50 billion EU Resilience Fund, financed by member-state contributions, to upgrade cross-border interconnections and enforce N-2 or higher security standards, given the high probability of multi-component failures within the system.

5. Strengthen Cross-Border Coordination

- **Harmonize EU Grid Protocols**: Develop binding regulations for real-time data sharing, joint crisis drills, and aligned technical standards (e.g., inertia thresholds, cybersecurity). This also requires greater public control over the power system, rather than reliance on the profit-driven priorities of the private sector.
- **Public Control of Interconnections**: Shift management of cross-border links (e.g., Spain-France interconnection) to state-led consortia to prevent profit-driven neglect.

Conclusion

The Iberian blackout underscores the necessity to centralize energy systems under public governance, emphasizing integration over fragmentation. By adopting models like EDF—while guarding against privatization pressures—Spain, Portugal, and the EU can ensure grids are resilient, equitable, and fit for a renewable future. Energy security must be treated as a public mandate, not a market commodity.