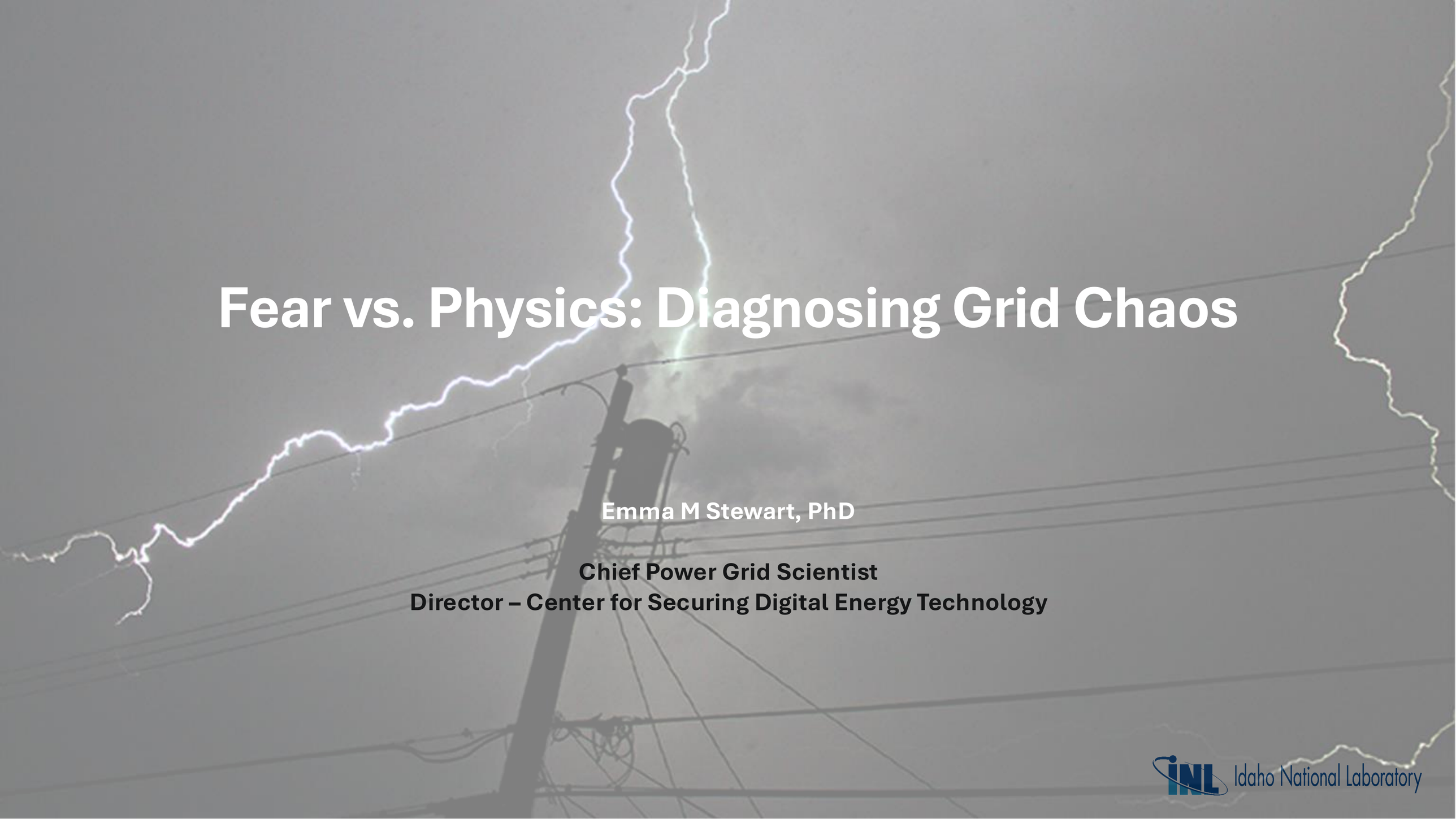


Fear vs. Physics: Diagnosing Grid Chaos

Emma M Stewart, PhD

Chief Power Grid Scientist
Director – Center for Securing Digital Energy Technology

Idaho National Laboratory

Emma M Stewart



- Pre-USA - Scottish Power, Scottish and Southern
- INL
  - Center Director
  - Chief Power Grid Scientist
- Education: MEng, PhD – Electrical Engineering (Strathclyde)
  - Other: Race car engineering
- NRECA – Chief Scientist
- A few national labs…Hydrogen, Defense, Grid, Cyber
- DNV GL – interconnection and high pen PV analysis, restoration modeling - model validation
- Power Grid my whole career

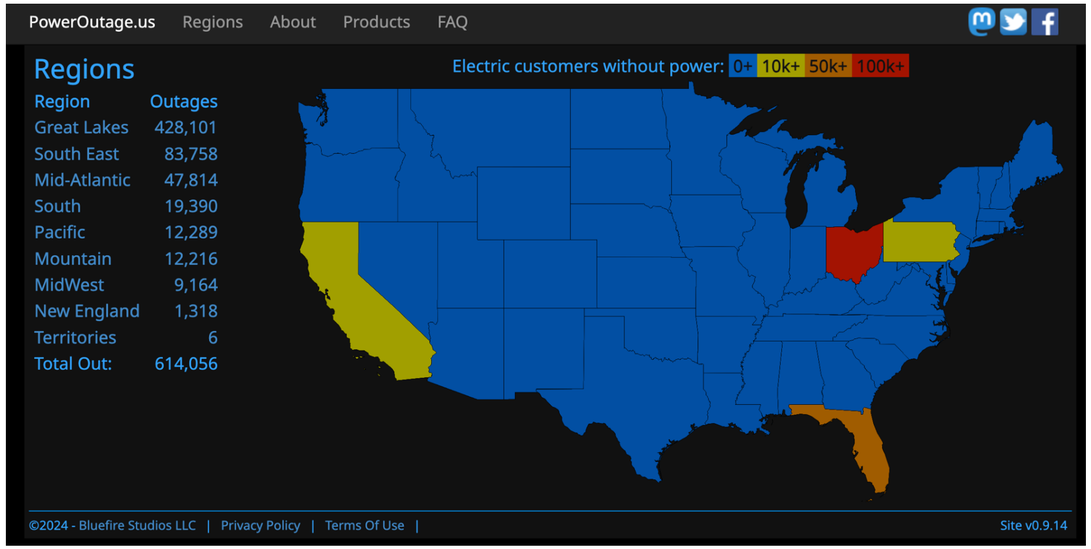


The Current and Future State of the Electric Grid

Industry 4.0 = Analog to digital

More: Power, Reliability, Expectations, Independence, Choice, Complication

Large Spinning Machines become Solid State Devices, Distributed Controls, Devices, Data and Communications





3000 utilities
$1.2B into modernization
Misinformation everywhere (surprise sunsets)
Contributes ~35% to global emissions
Weather events are the biggest threat
Insane load growth (6x Scotland in the next 6 years)
Still pretty reliable…

INL Idaho National Laboratory

During Grid Events… CyberFear leads the way

Spain says blackout caused by grid failures and poor planning not a cyber attack

WORLD

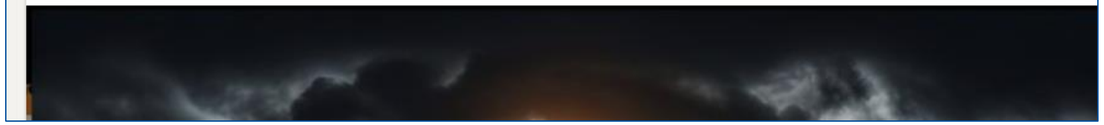


The massive power and comms outage across Spain has been blamed on "'rare' atmospheric phenomenon" - Mmmmmmm just chatting with a colleague about this and without getting too conspiratorial, I did remind her that Murcia hosts NATO military assets, including the NATO Communications and Information Agency facilities and military bases (e.g., the San Javier Air Base). NATO members and their military infrastructure are high-priority cyber targets for Russia, especially given heightened East-West tensions after the Ukraine invasion.

Let's just watch this space .....

39 8 comments

🔌 Time to Rethink OT Security: After the Blackout in Spain 🇪🇸 and Portugal 🇵🇹
A recent widespread power outage in Spain reminded us how vulnerable critical infrastructure still is in the face of disruption. ...more



Cyber Resilience for All: What Spain's Power Outage Teaches Every Business

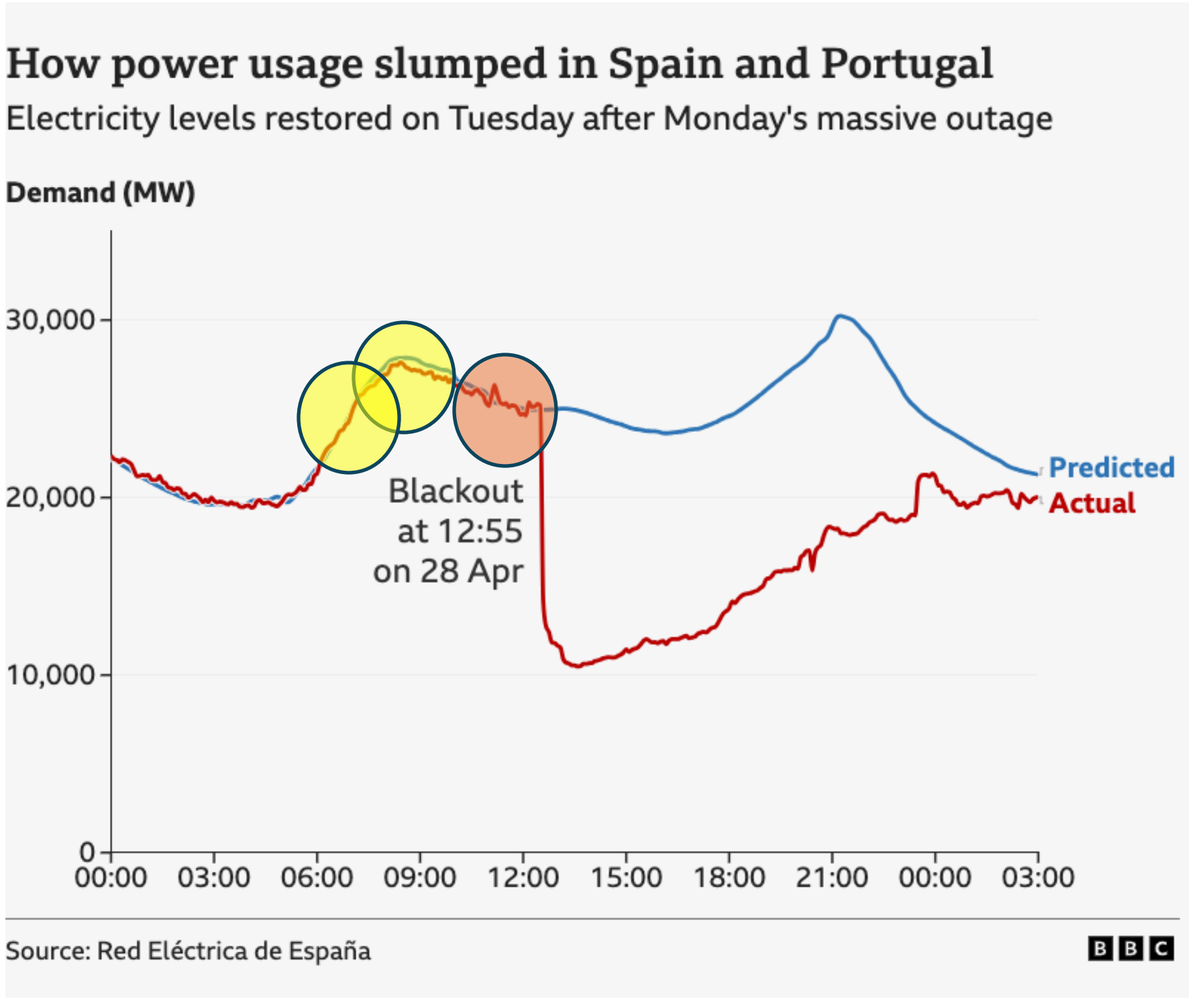
#CyberResilience #BusinessContinuity #IncidentResponse #DigitalSecurity



I was humbled to be asked by CNN to give my views on behalf of THINGSRECON on the recent outage in Spain and Portugal and what lessons can be learned to protect critical national infrastructure from cyber incidents and how counties consider the importance of supply chain security in the ever evolving world of digital complexity and threat.

#CNN #ThingsRecon #CNI #AttackSurface #SupplyChain #CyberResiliance #StoryTelling #SCBOM

Spain – Outage Event – Timeline 1



9 – 12AM

Early Warning Signs

Abnormal voltage fluctuations.

Light load & weak reactive support

Solar Trip 1.2GW

12:44 – 13:30

Grid Oscillations:

Multiple oscillations detected.

Voltage continues rising.

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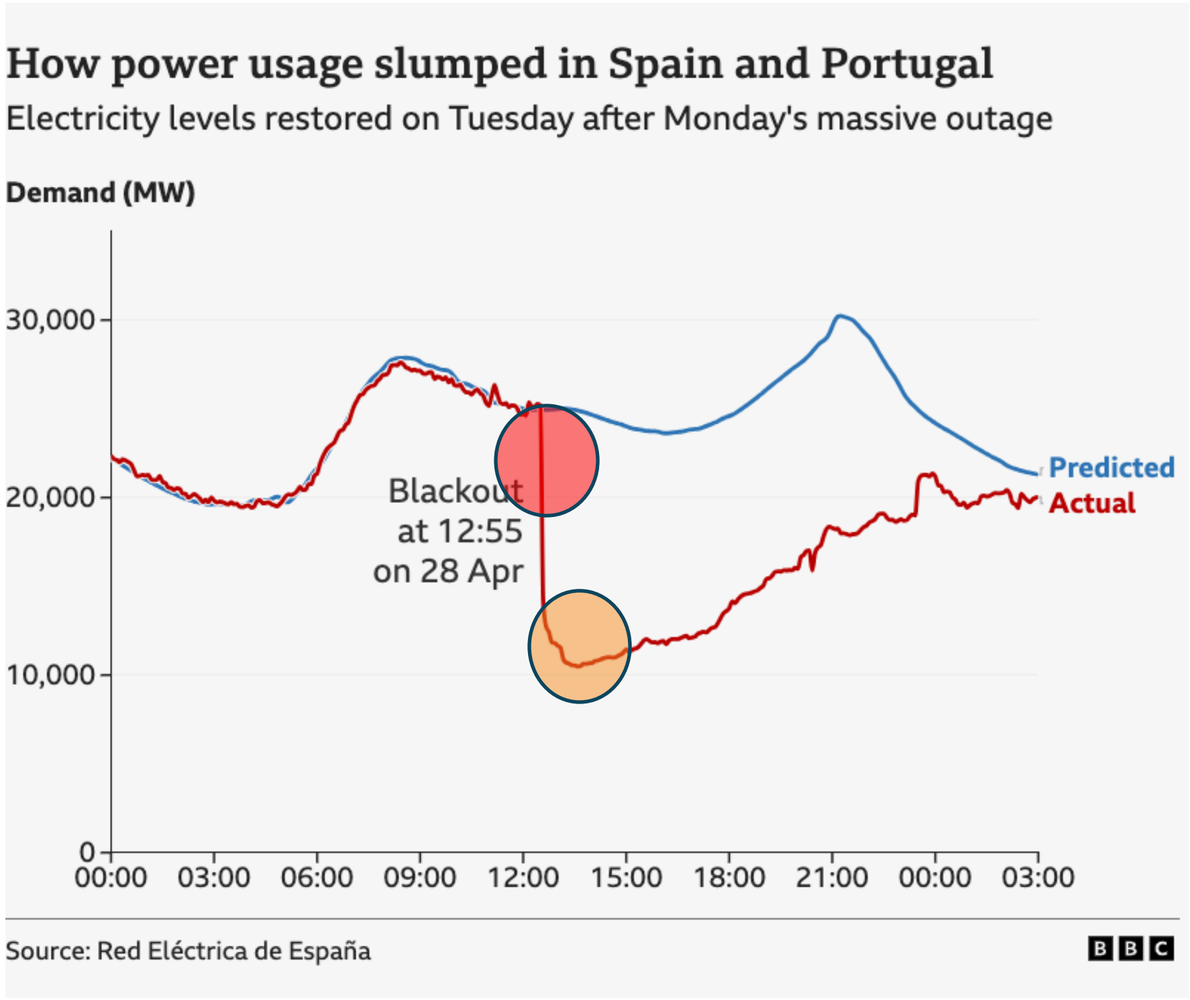
Spain – Outage Event – Timeline 2



12:32 – 12:34

System Collapse:

Generator trips (~2.2 GW lost).

Full blackout of Spain, Portugal, Andorra.

12:44 – 13:30

Initial Recovery:

Spain-France 400KV line restored.

Hydroelectric black-start plants boot

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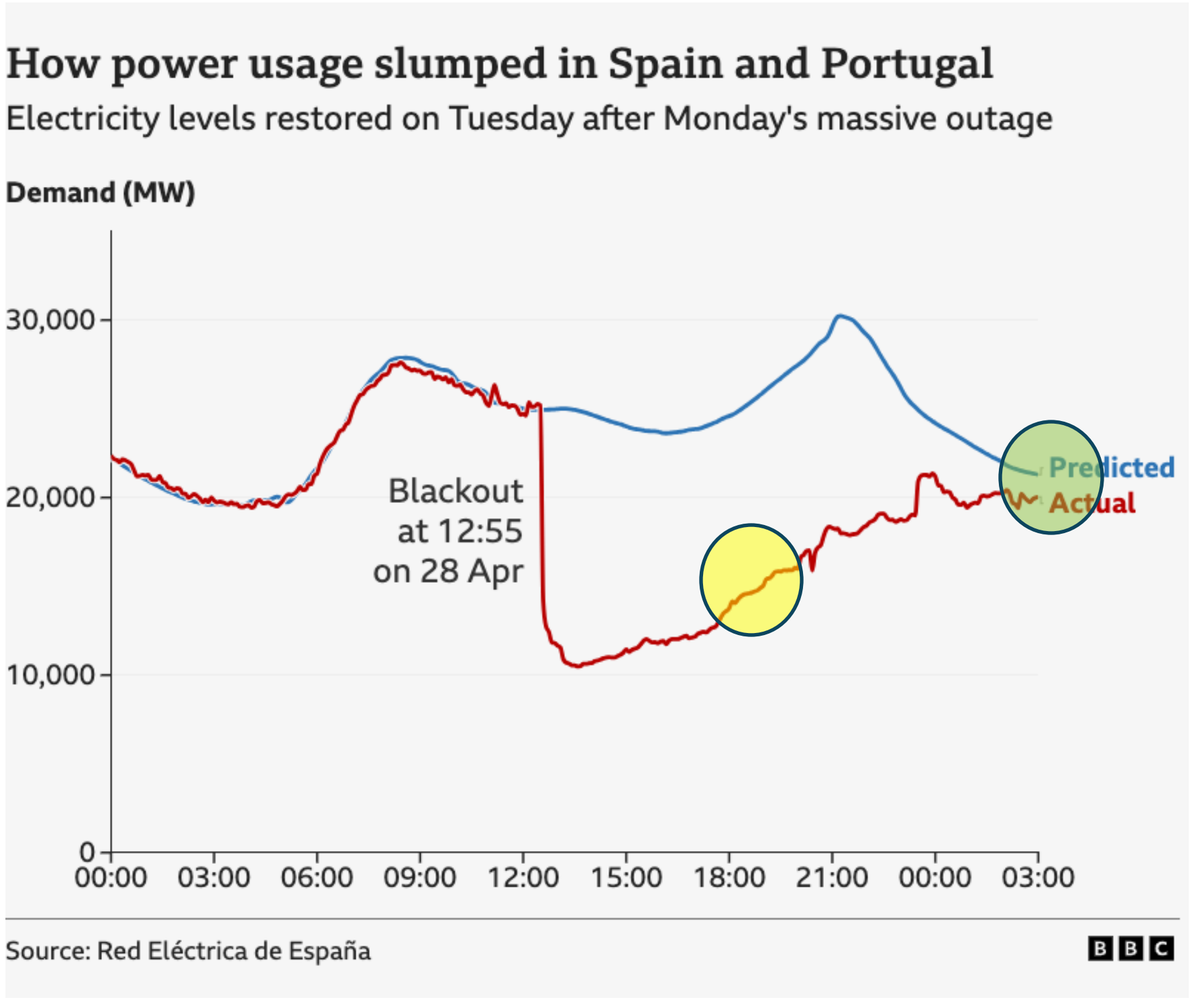
Spain – Outage Event – Timeline 3



13:35 – 16:11

Broader Restoration: Portuguese black-start plants re-energize grids. Spain-Portugal interconnect restored.

4AM April 29

Restoration: Portugal 100% online. Spain grid fully restored by 04:00.

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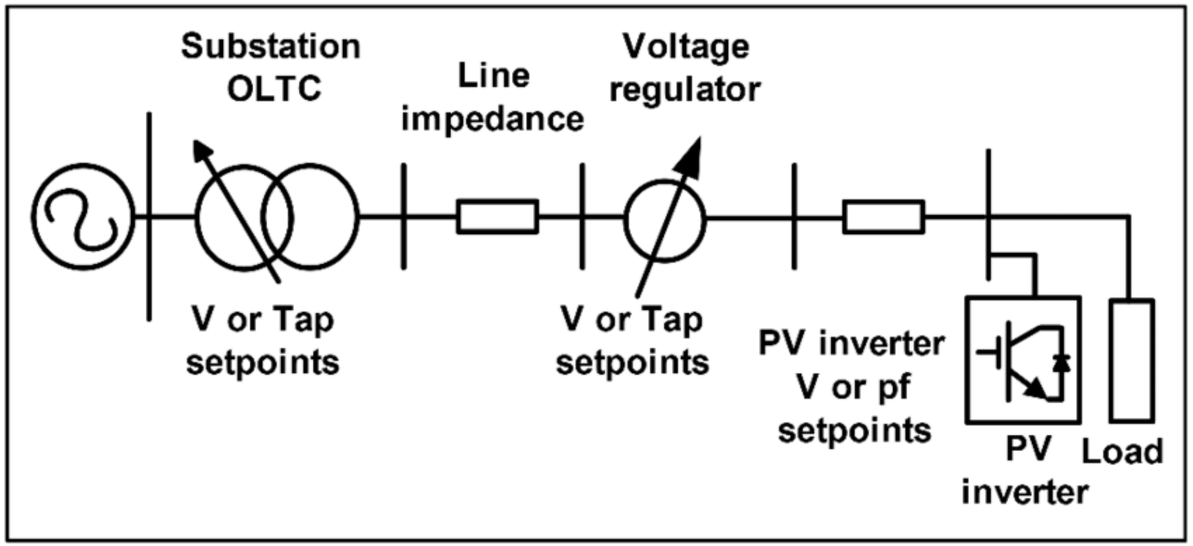
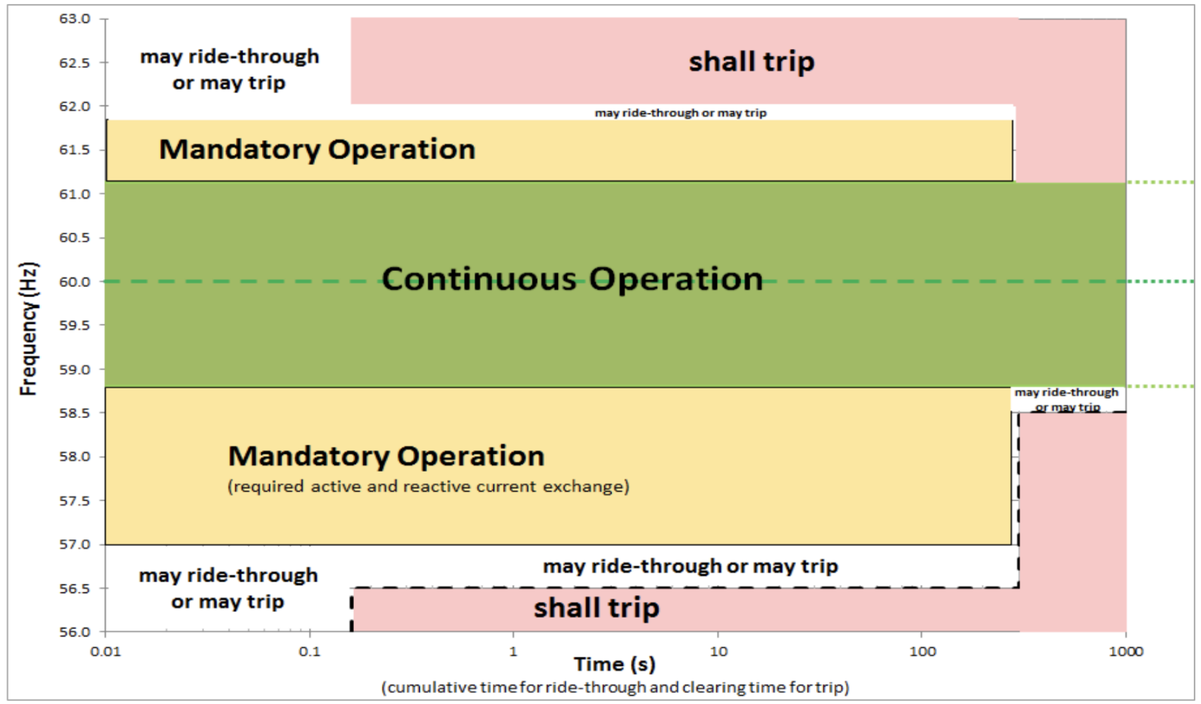
So why did all the solar trip momentarily at 930AM?...was it because of the solar vulnerabilities....?

Nope....





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Electric Grid BlackStart - Now

Preparation

- Assess damage – field crew and data
- Define plan, assign roles
- Incident response

System Restoration

- Reconnect big lines, generators
- Major load blocks to stabilize

Load Restoration

- Restore load in each island
- Resynchronize pockets









What do these events actually show?

- For Infrastructure
  - Recovery is key
  - Plan to Fail
  - Communication stops FUD
- Sometimes the safest strategy is a power outage..

- For Cyber Research
  - Context and hybrid information is important
  - Don’t assume its cyber and everyone else has to answer why its not
  - FUD is dangerous and limits action
  - Systems of systems are difficult, no one component will realistically break it in many cases

But….Electric Grid BlackStart - Future

Preparation	• Hyperscale loads criticality • Gather data & process from robotic assistance • Cyber Assessment and Root Cause/IR
System Restoration	• Reconnect big lines, generators • Major load blocks to stabilize • New critical loads and re-synchronization of cloud
Load Restoration	• Dispatch Cyber/Physical Teams • Restore load in each island, Restore Data Service • Resynchronize pockets







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Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy. INL is the nation's center for the nuclear energy research and development, and also performs research in each of DOE's strategic goal areas: energy, national security, science and the environment.