PMUs and Blackout Prevention

(Blackouts Past, Present and Future)

Terry Boston

GPA, Founder and Board Member

October 24, 2024

Greatest Engineering Achievements of the 20th Century

10. Air Conditioning/ Refrigeration
9. Telephone
8. Computers
7. Agricultural Mechanization
6. Radio and Television
5. Electronics
4. Water Supply and Distribution
3. Airplane
2. Automobile (PHEVs Soon)

1. The Grid/ Electrification

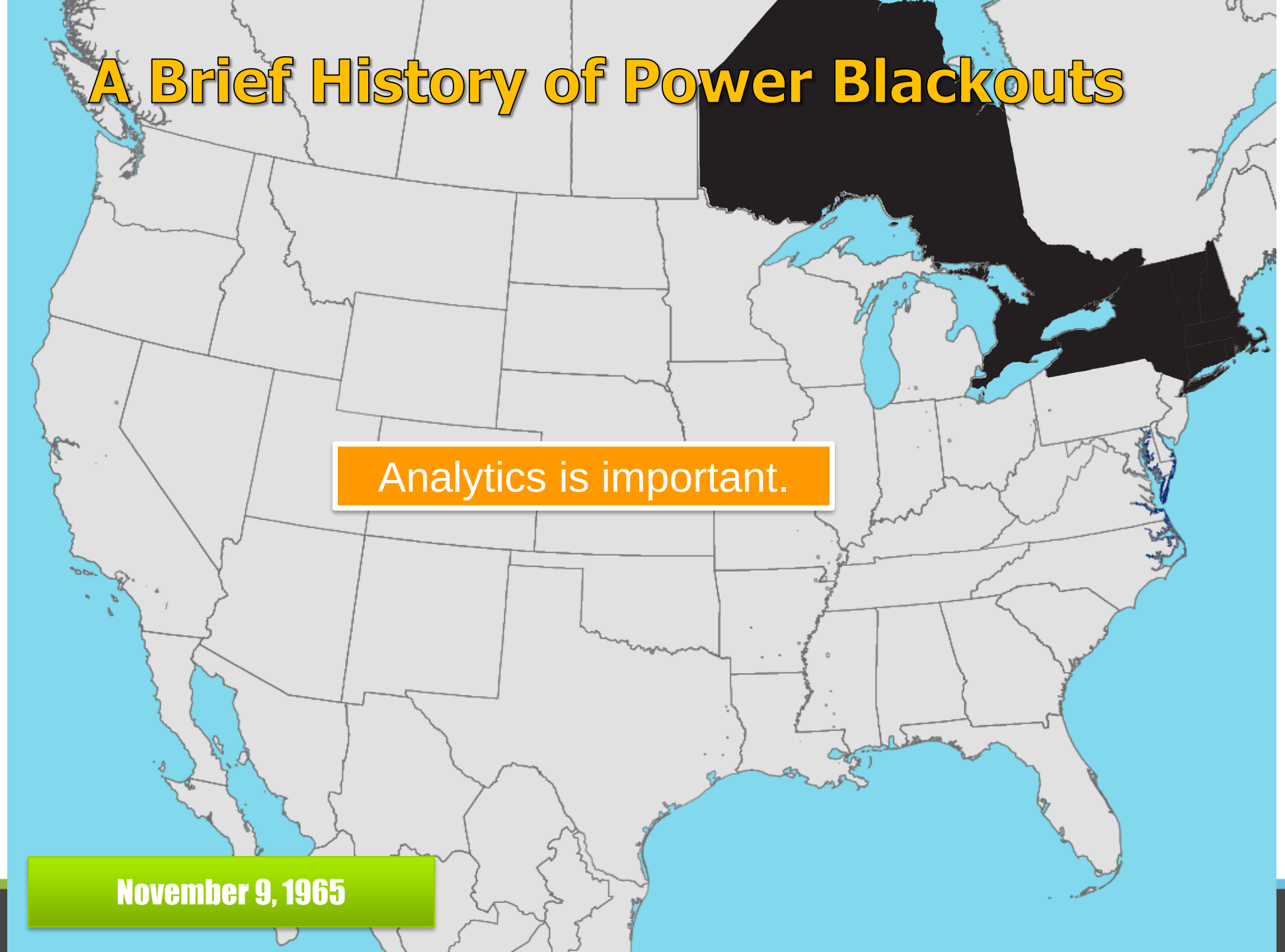
Source: National Academy of Engineering

Power Engineering is not Rocket Science. . .

. . . It is much more important than that!

GRID PROTECTION ALLIANCE

A Brief History of Power Blackouts



Analytics is important.

November 9, 1965

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1965: Northeast US and Canada

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Operating without Power in NYC

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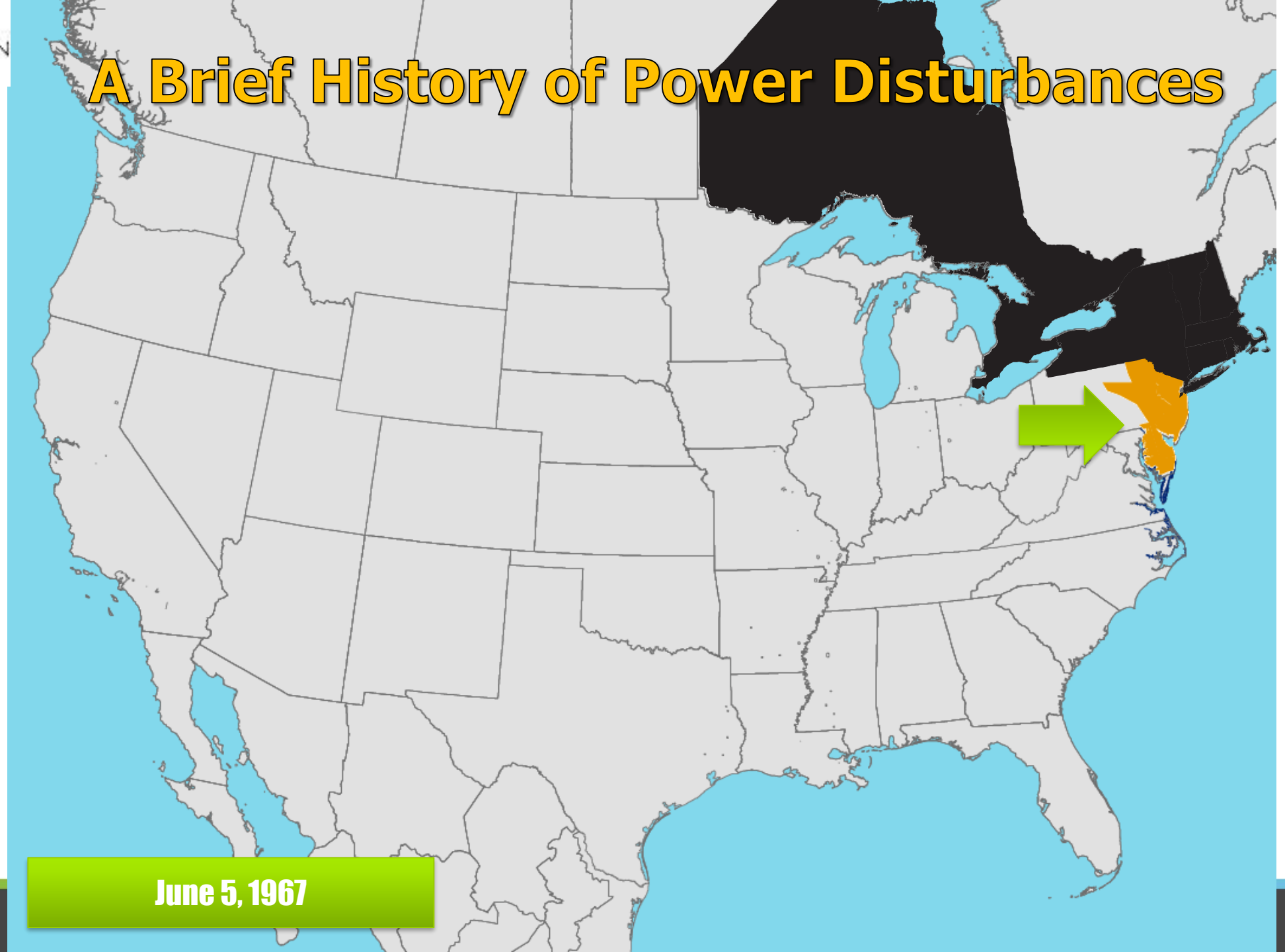
A Brief History of Power Disturbances



June 5, 1967

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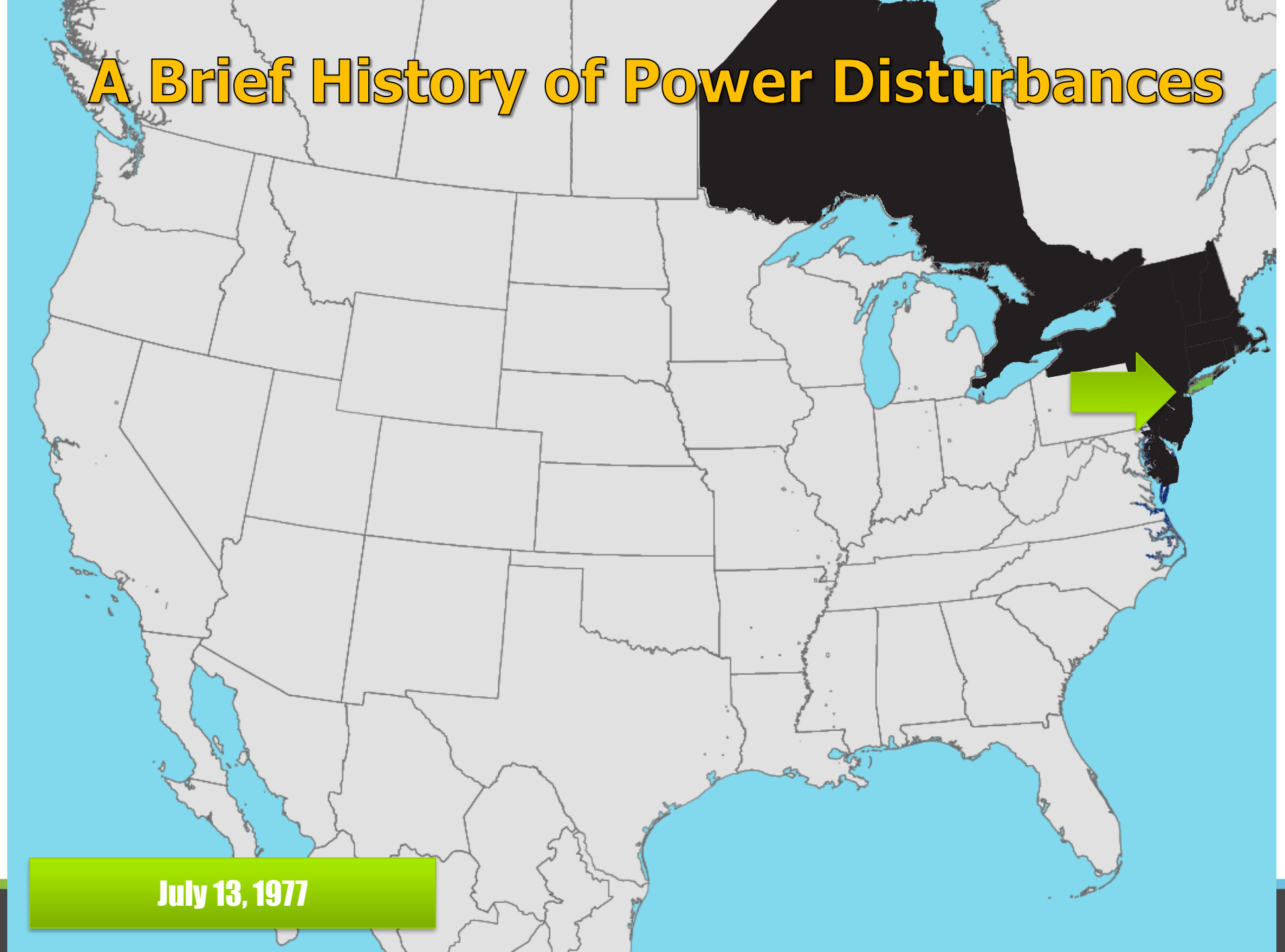
A Brief History of Power Disturbances



July 13, 1977

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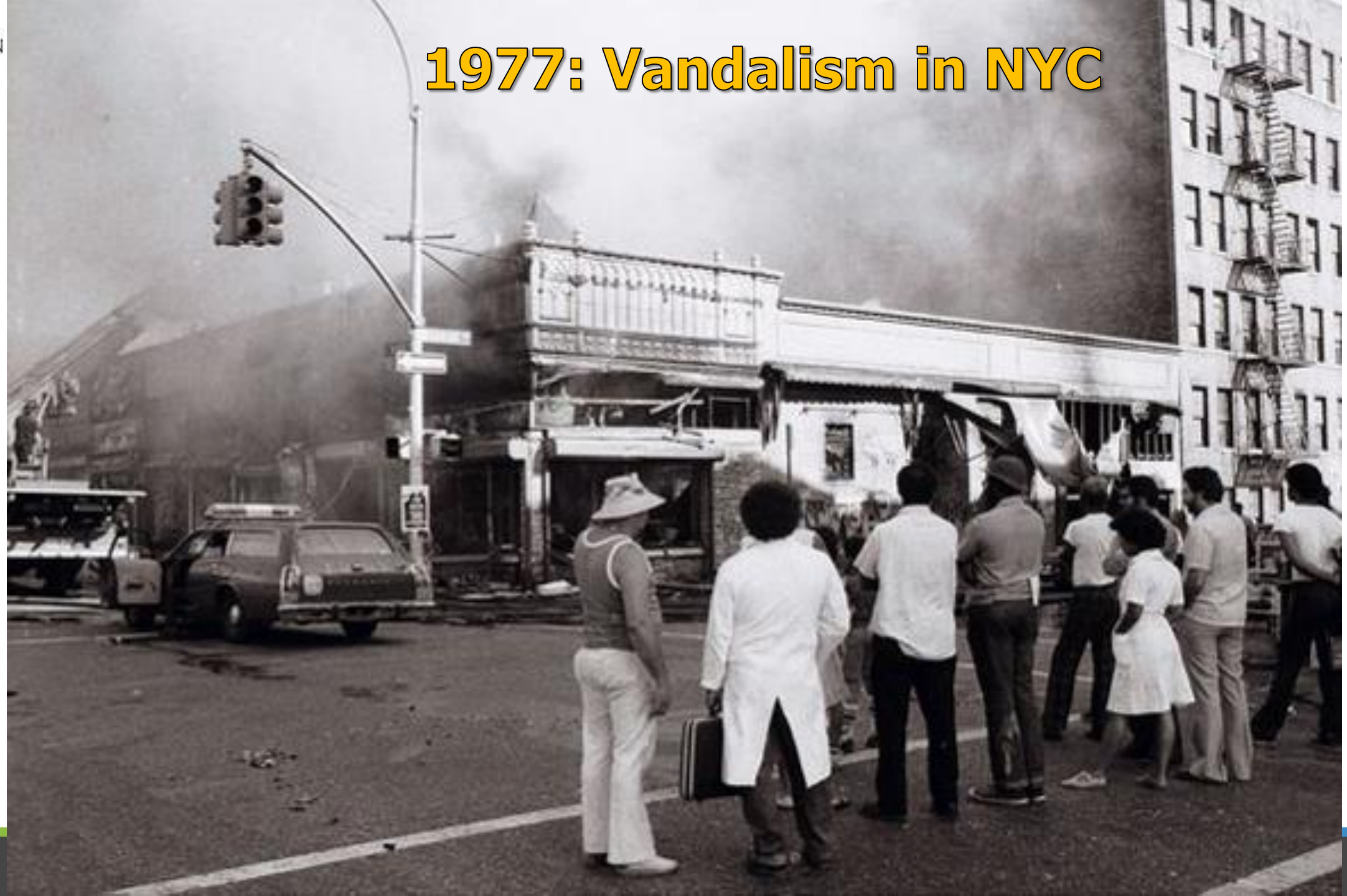
1977: Vandalism in NYC



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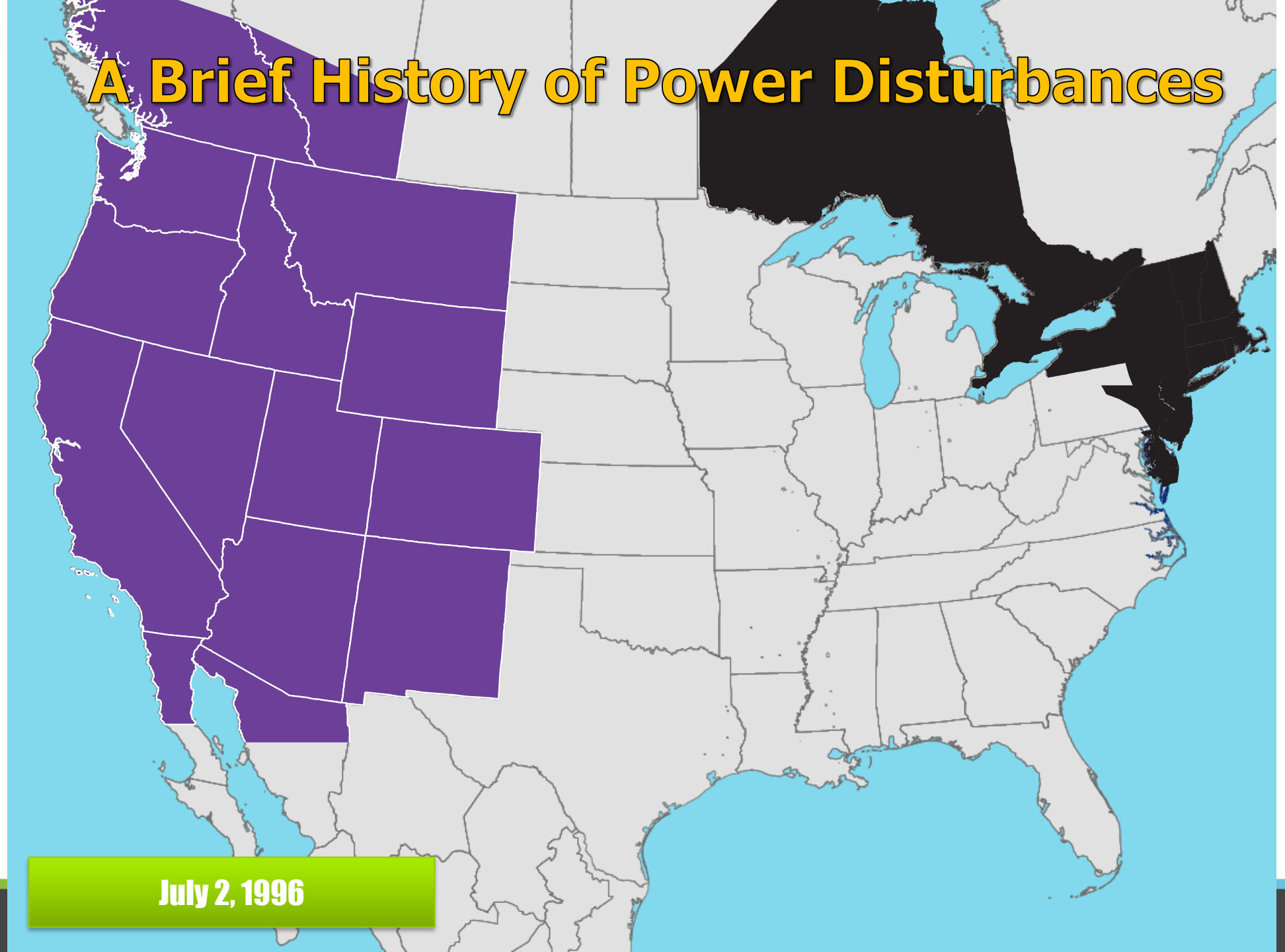
A Brief History of Power Disturbances



July 2, 1996

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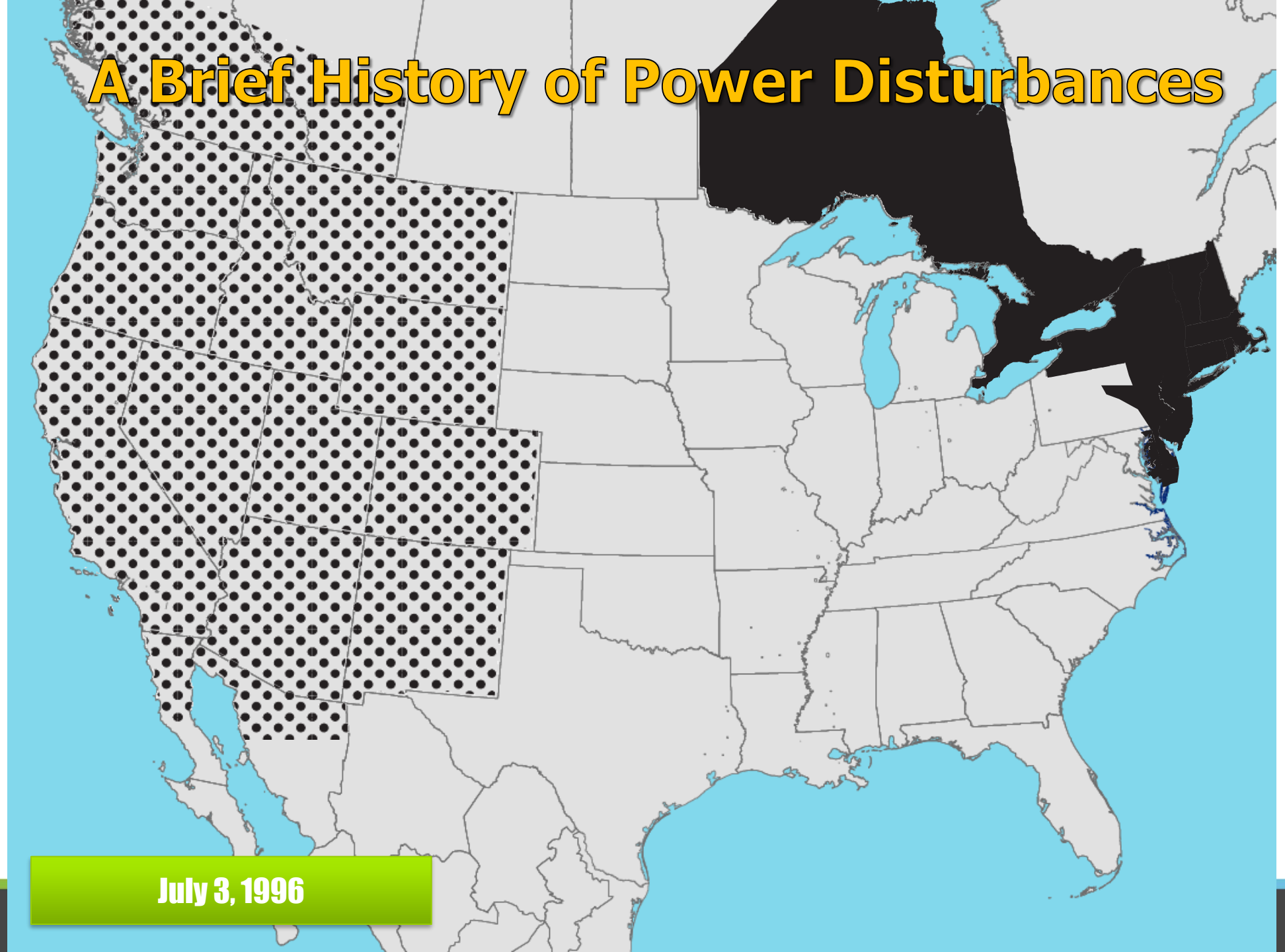
A Brief History of Power Disturbances



July 3, 1996

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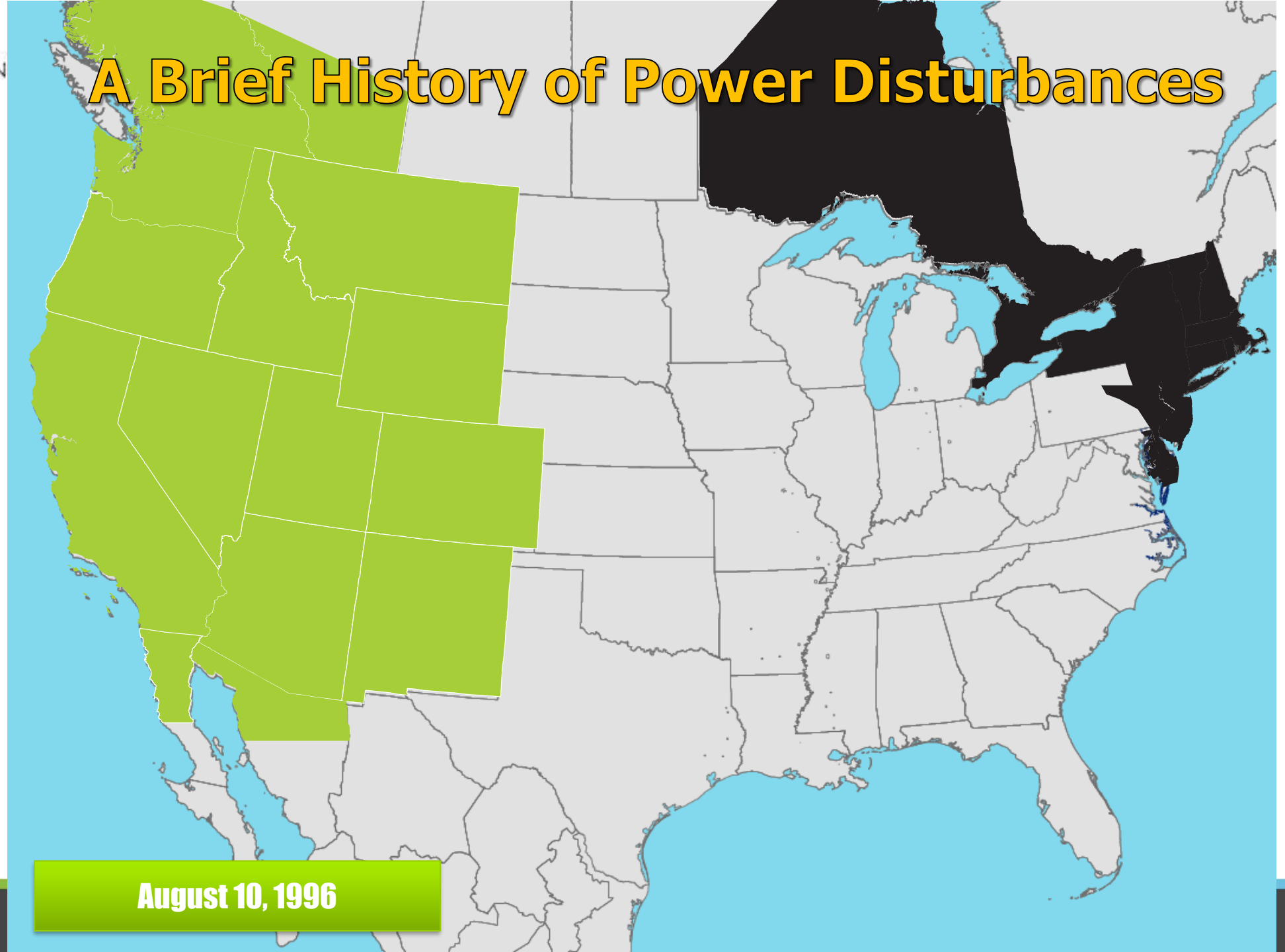
A Brief History of Power Disturbances



August 10, 1996

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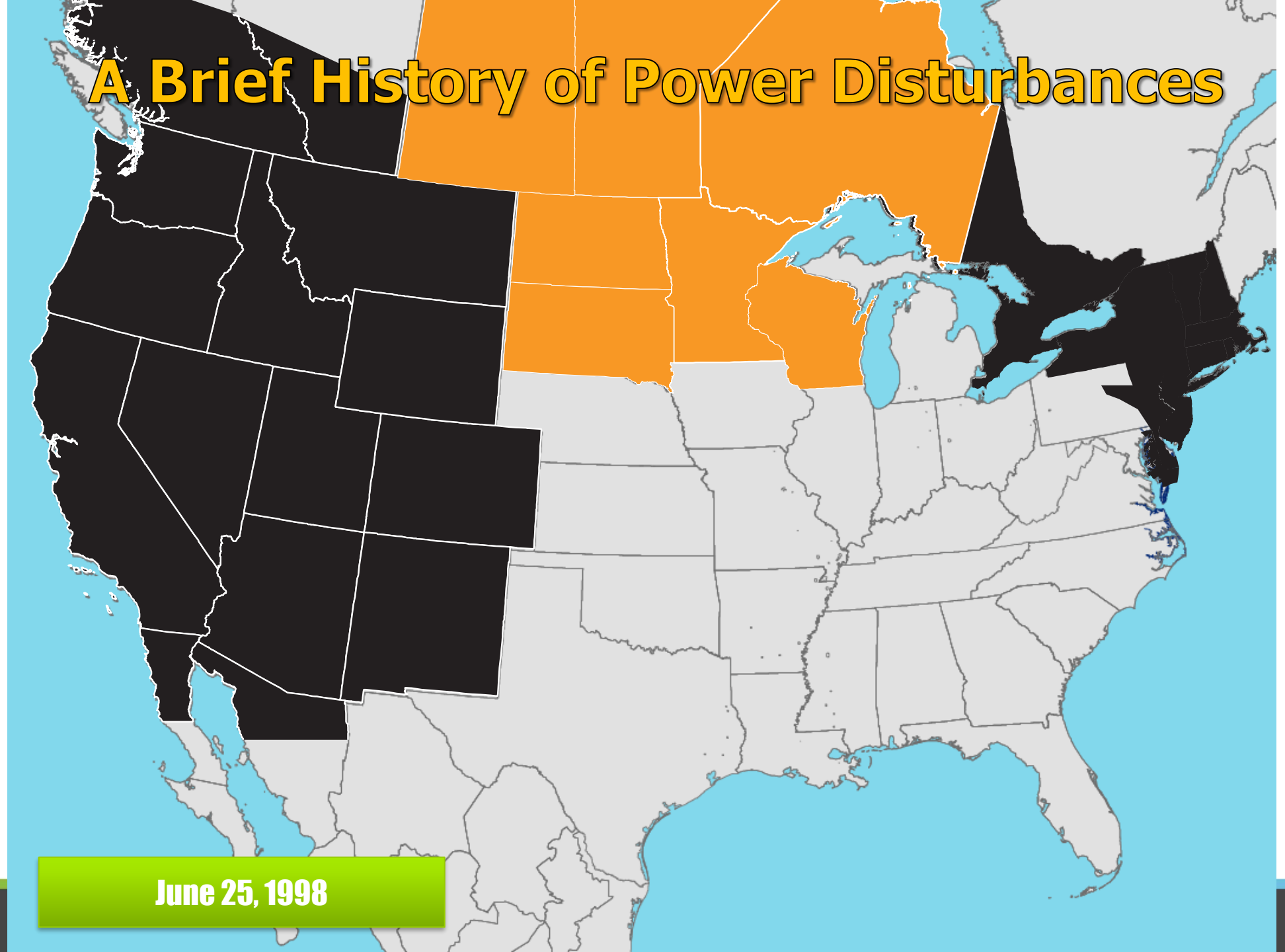
A Brief History of Power Disturbances



June 25, 1998

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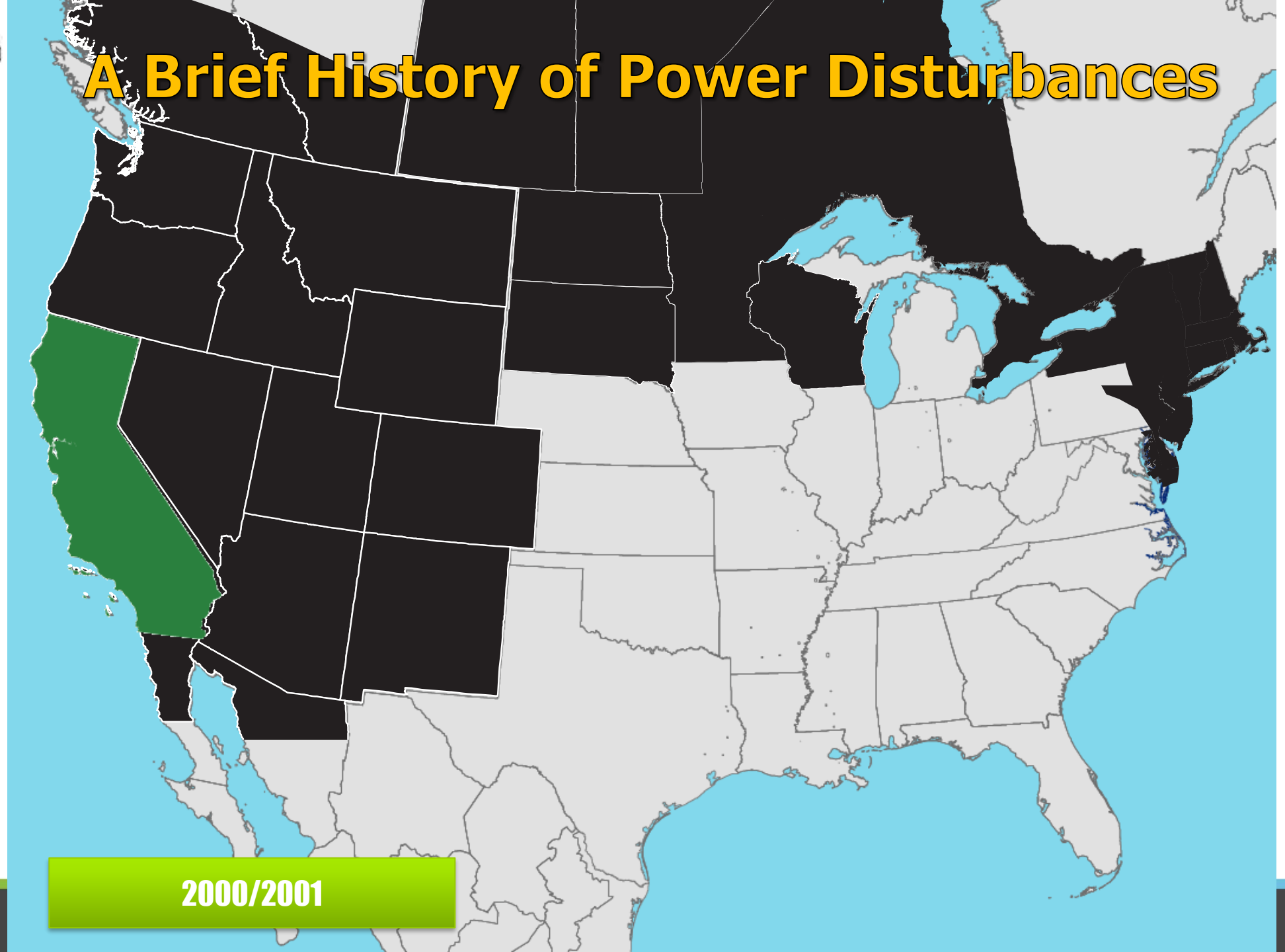
A Brief History of Power Disturbances



2000/2001

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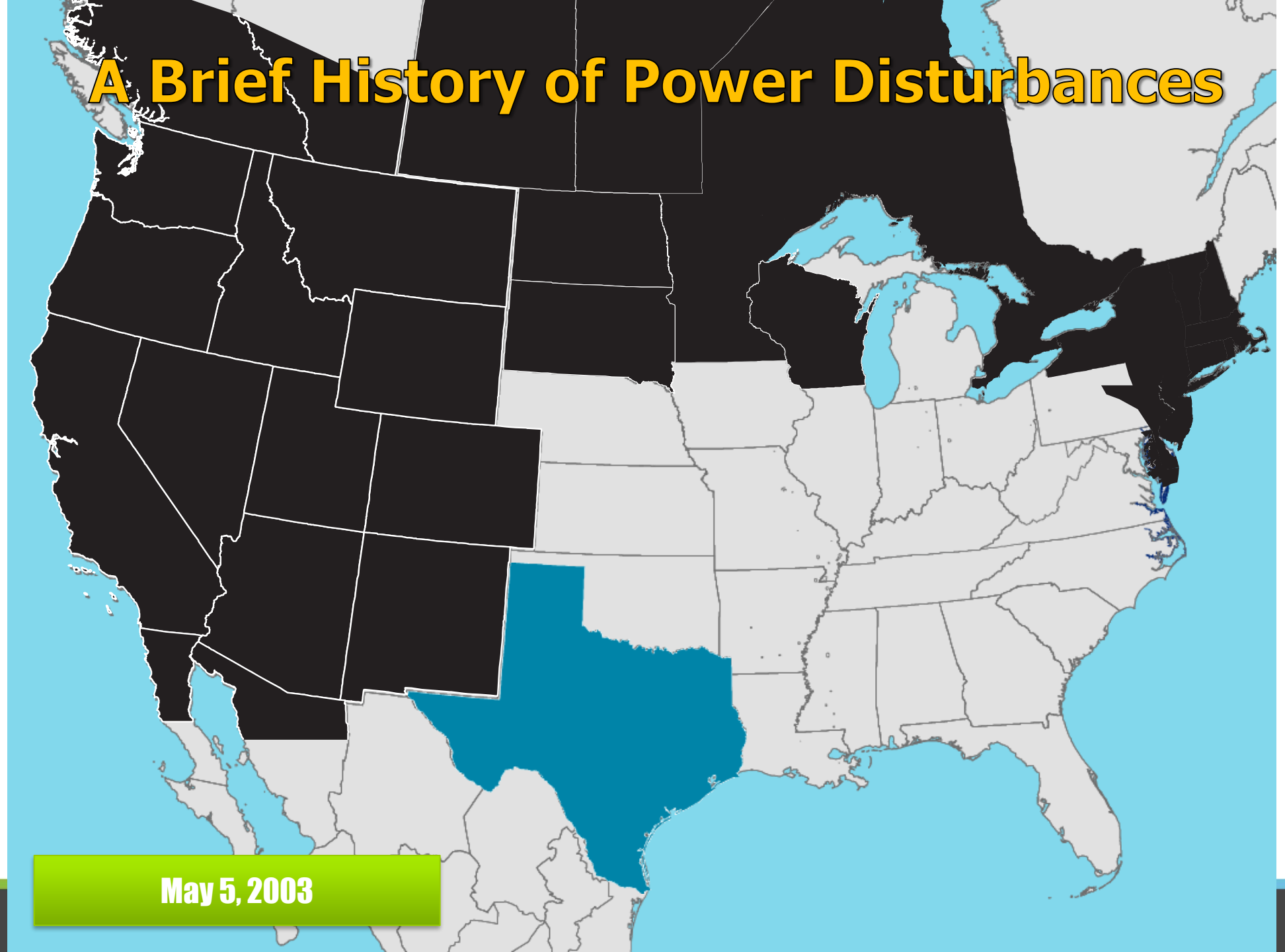
A Brief History of Power Disturbances



May 5, 2003

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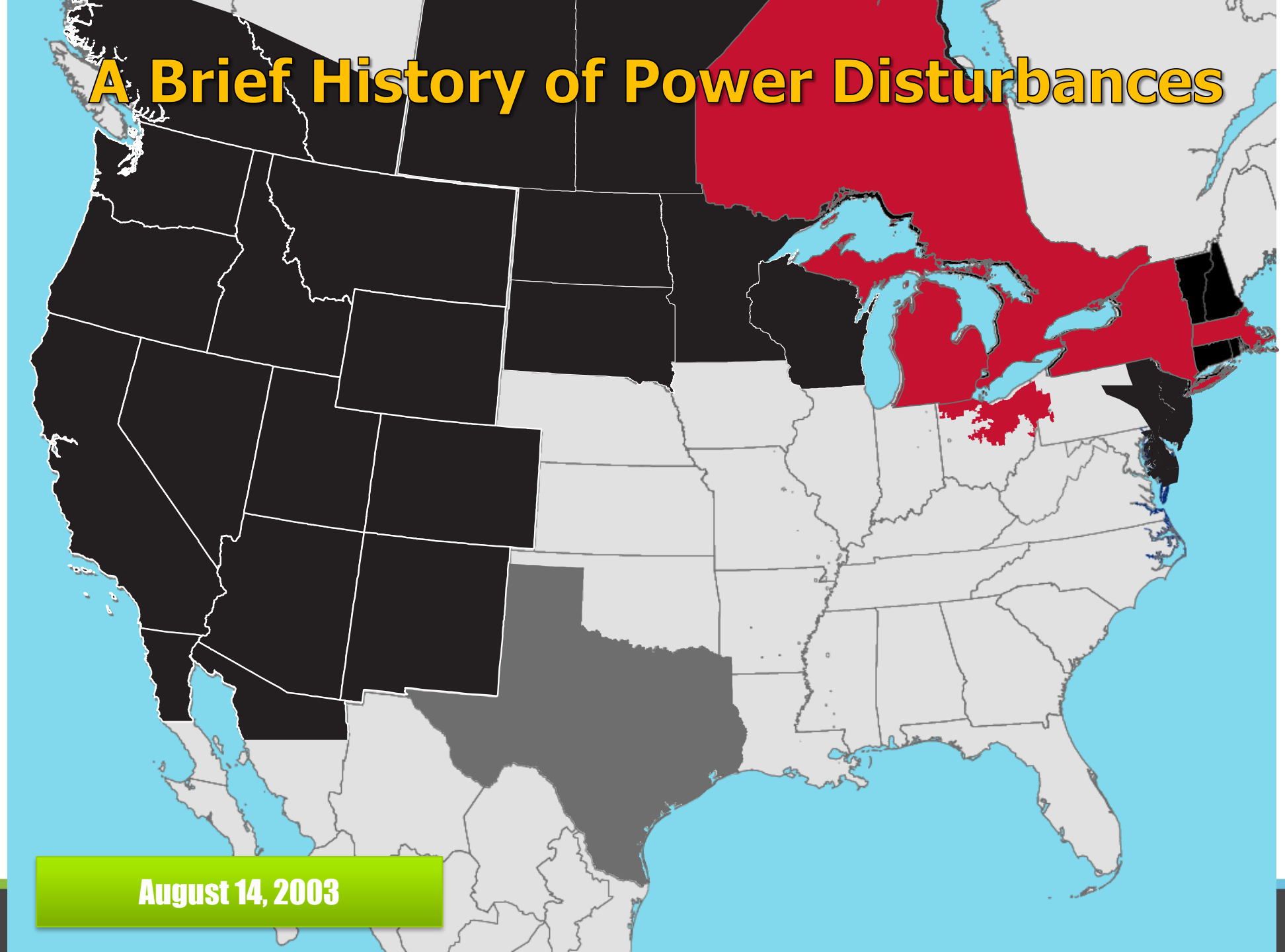
A Brief History of Power Disturbances



August 14, 2003

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2003: Midwest/Northeast & Canada

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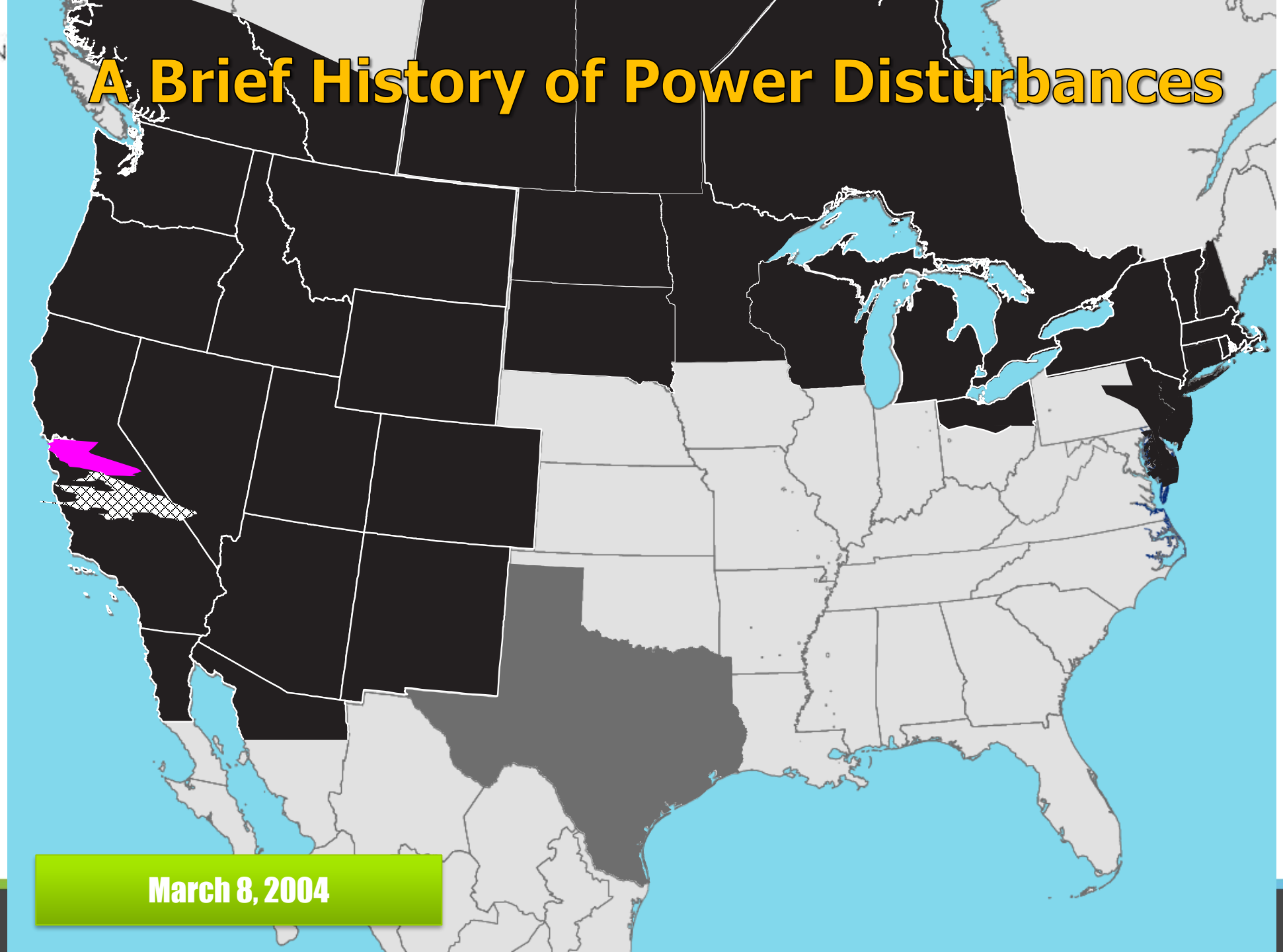

March 8, 2004

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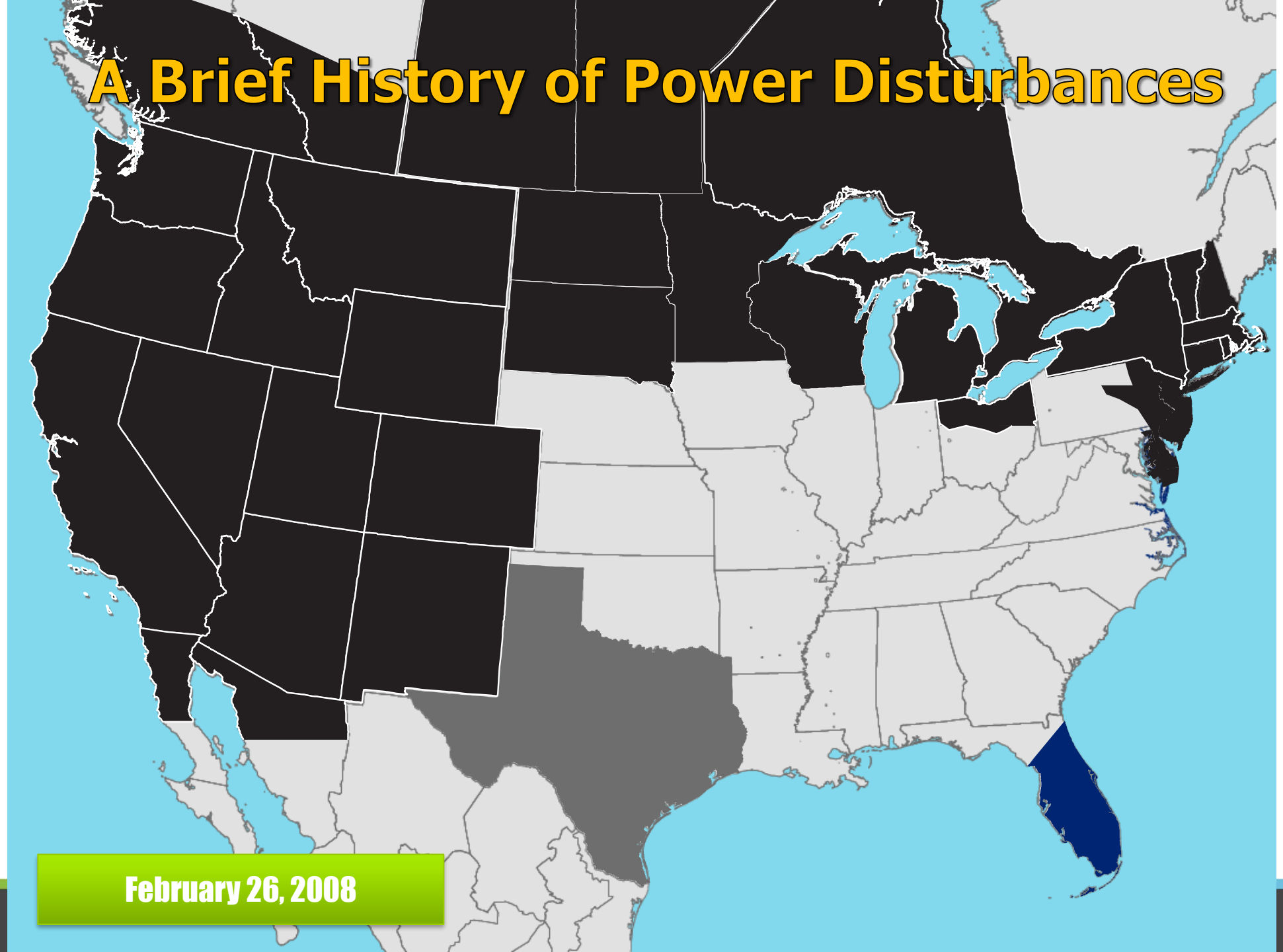
A Brief History of Power Disturbances



February 26, 2008

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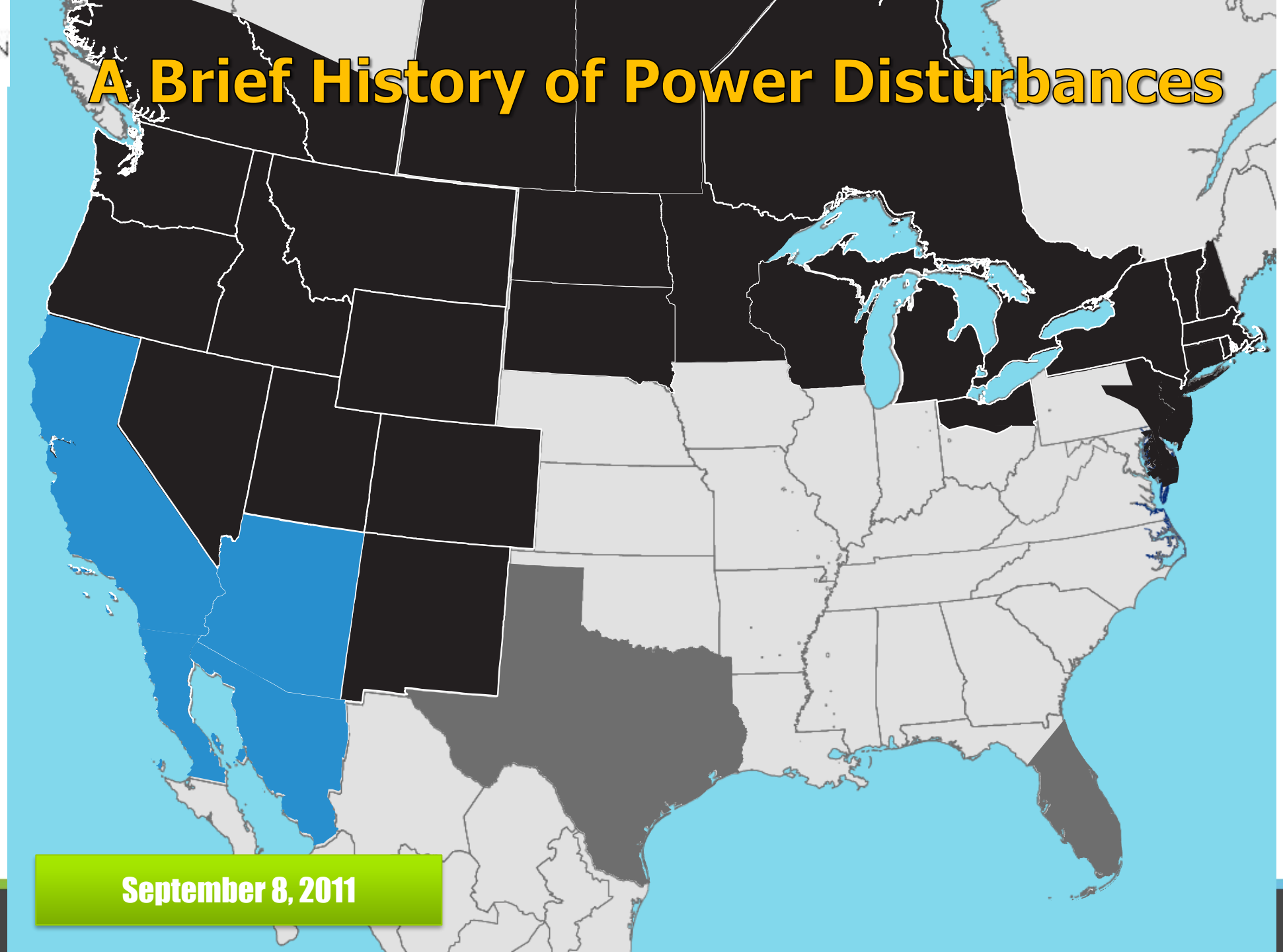
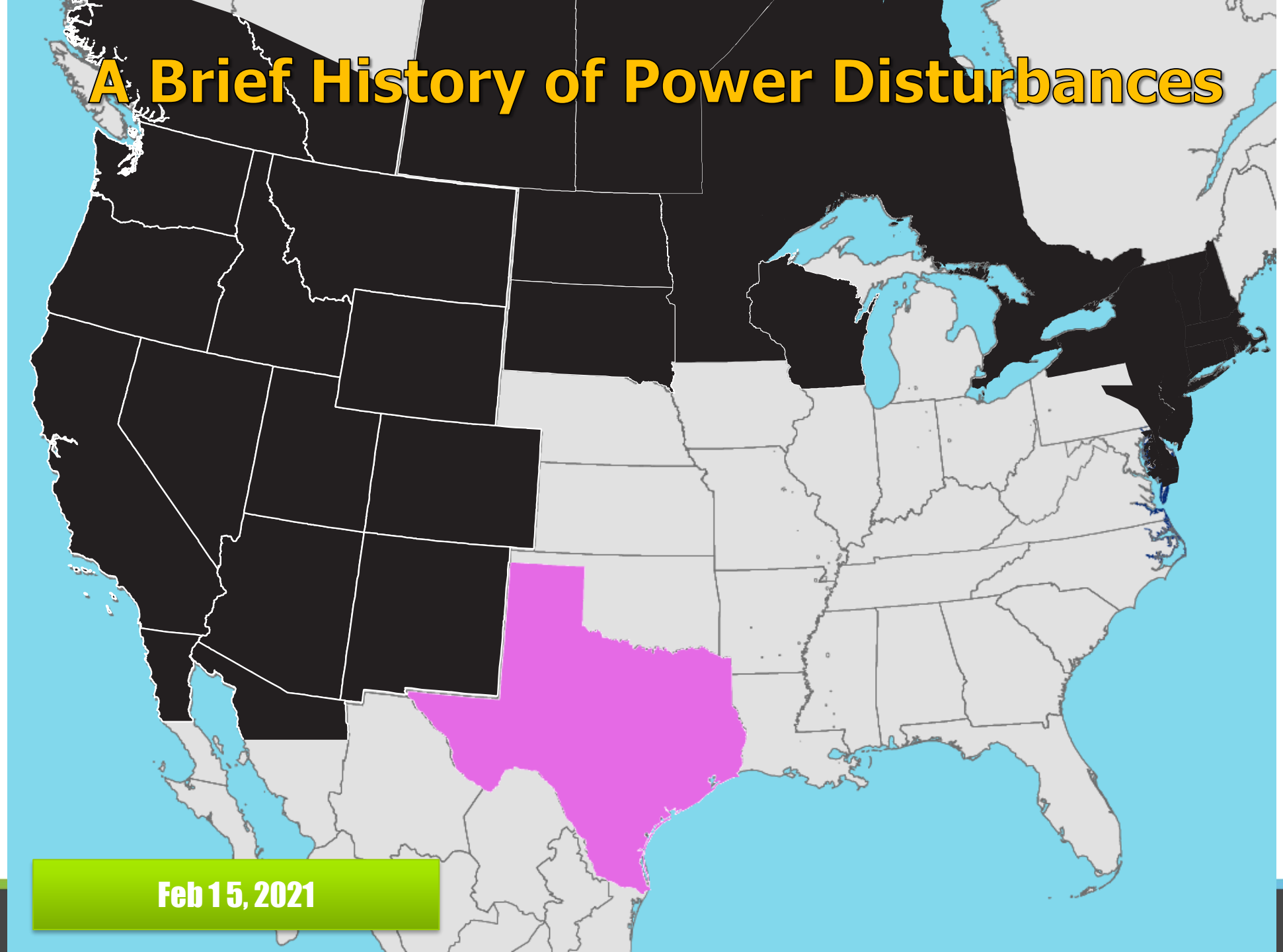
A Brief History of Power Disturbances



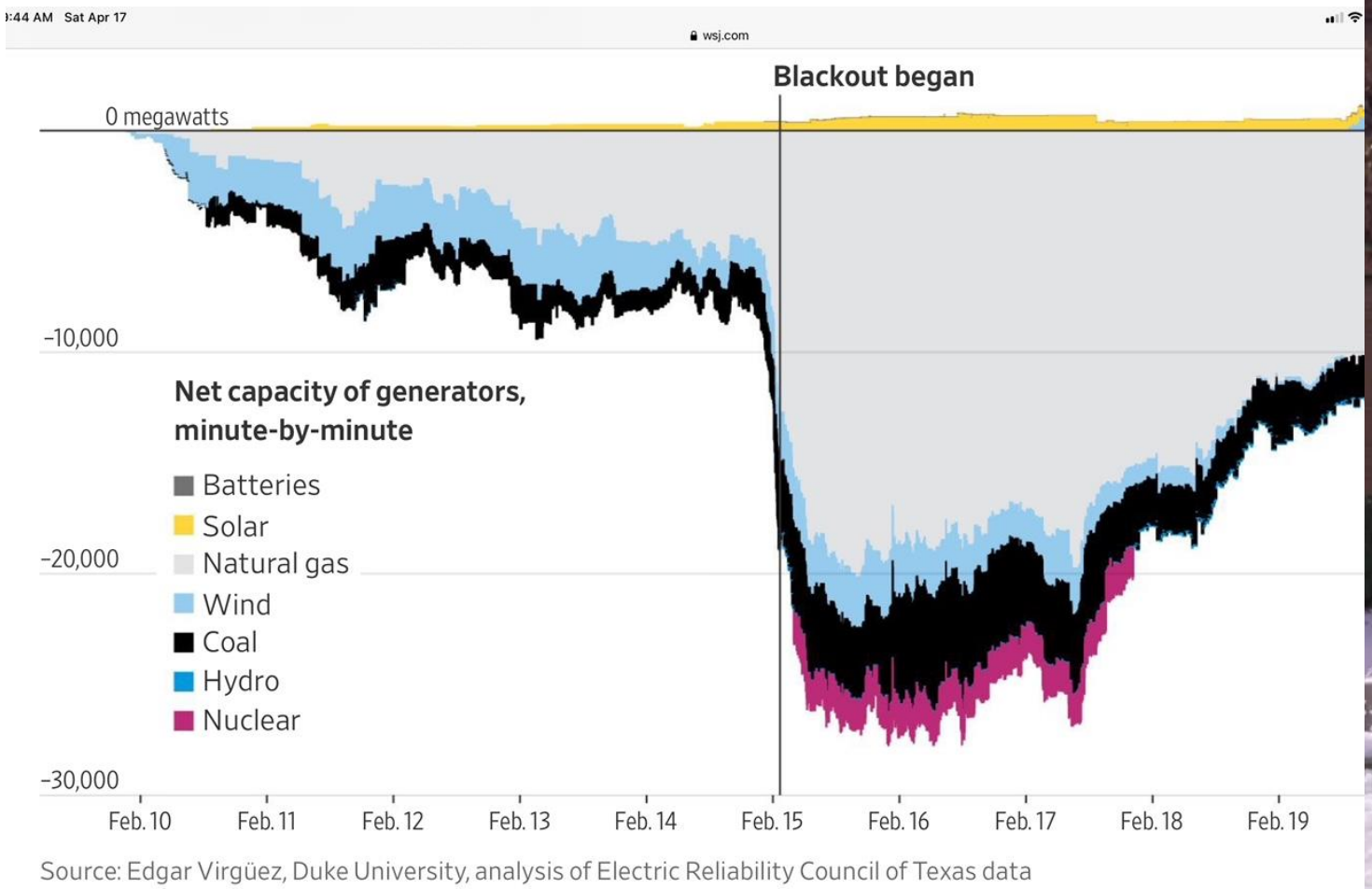
September 8, 2011

A Brief History of Power Disturbances



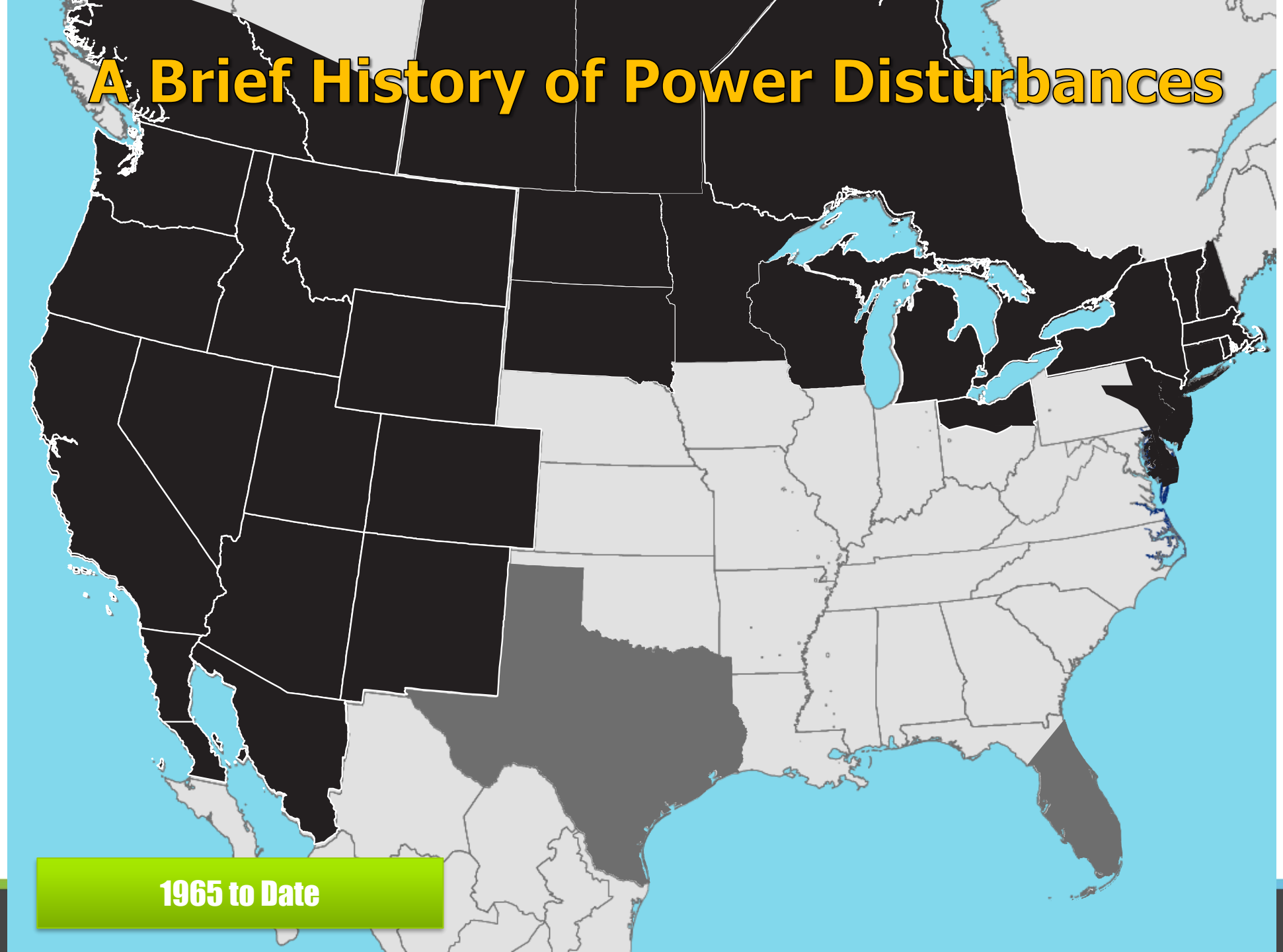
Feb 15, 2021

Texas Policy—No Payment for Capacity
No Penally for No Shows



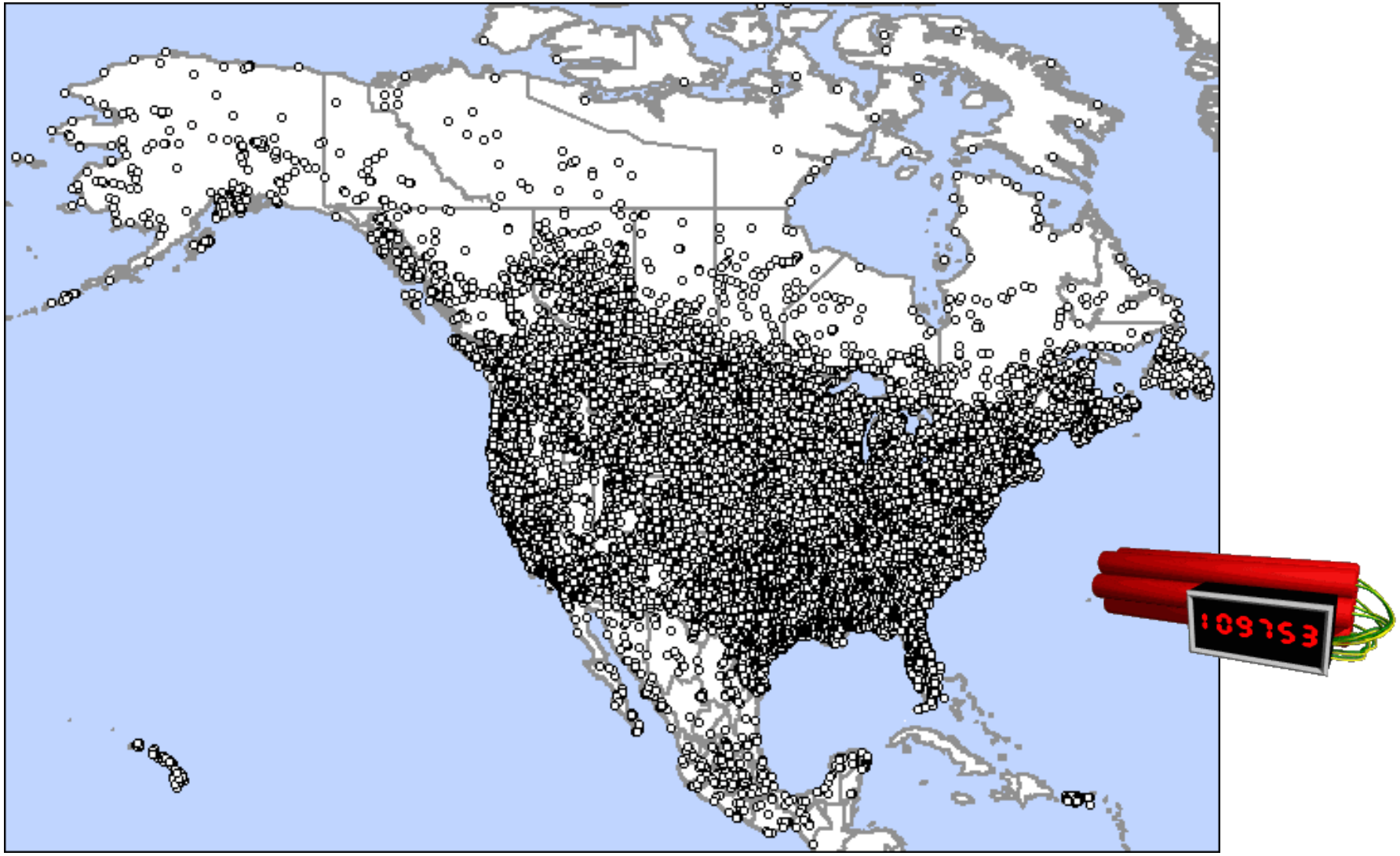
. . .Policy are Important—lives depend on them!

A Brief History of Power Disturbances

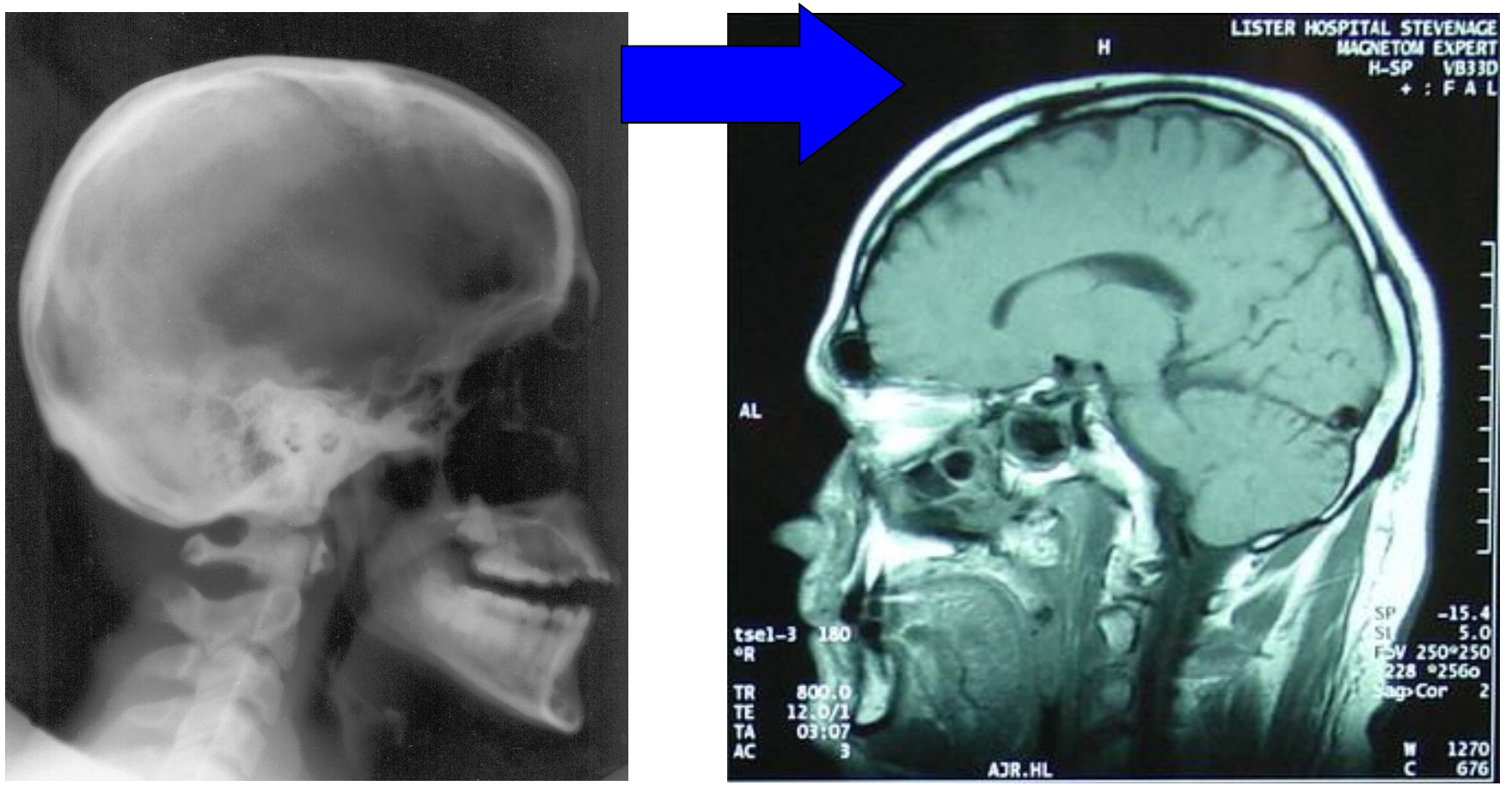


1965 to Date

Substations We Need to Protect in North America



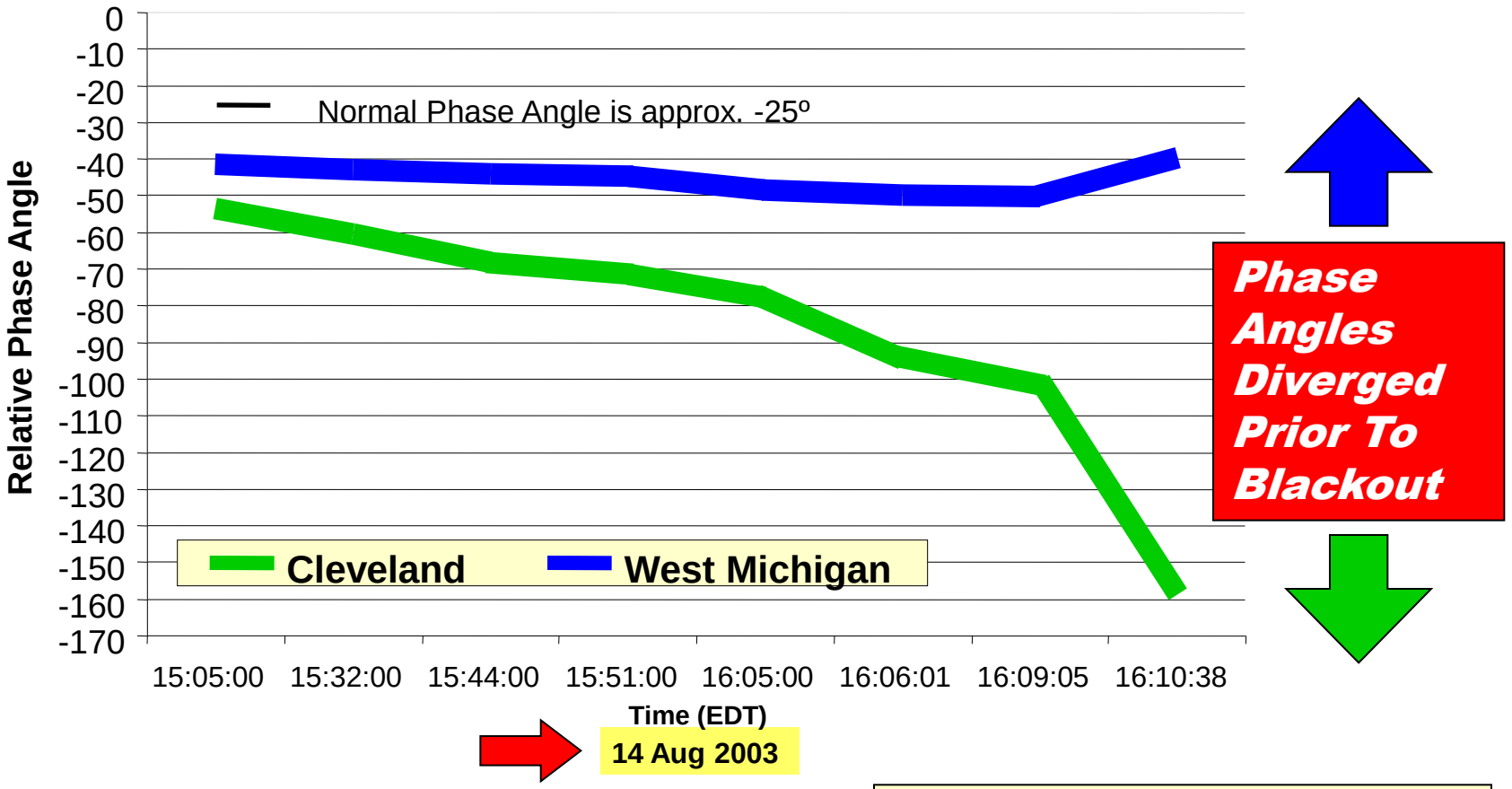
PMUs are Like –Going From X-Rays to MRIs



1952	1972	1977
Nobel Prize	1ST Patent	1ST Human Scan

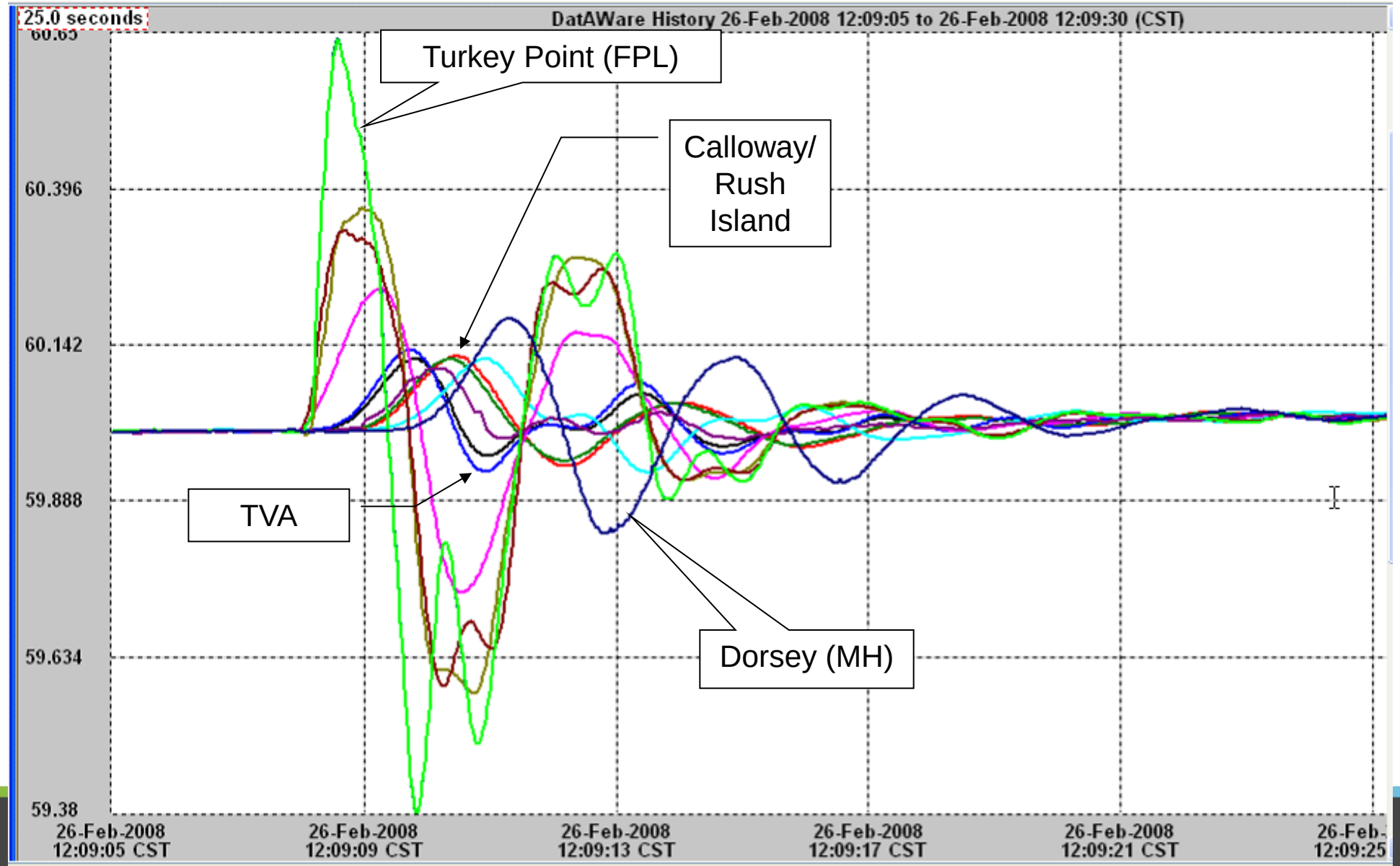
When Visibility is Lacking

August 14, 2003, Blackout

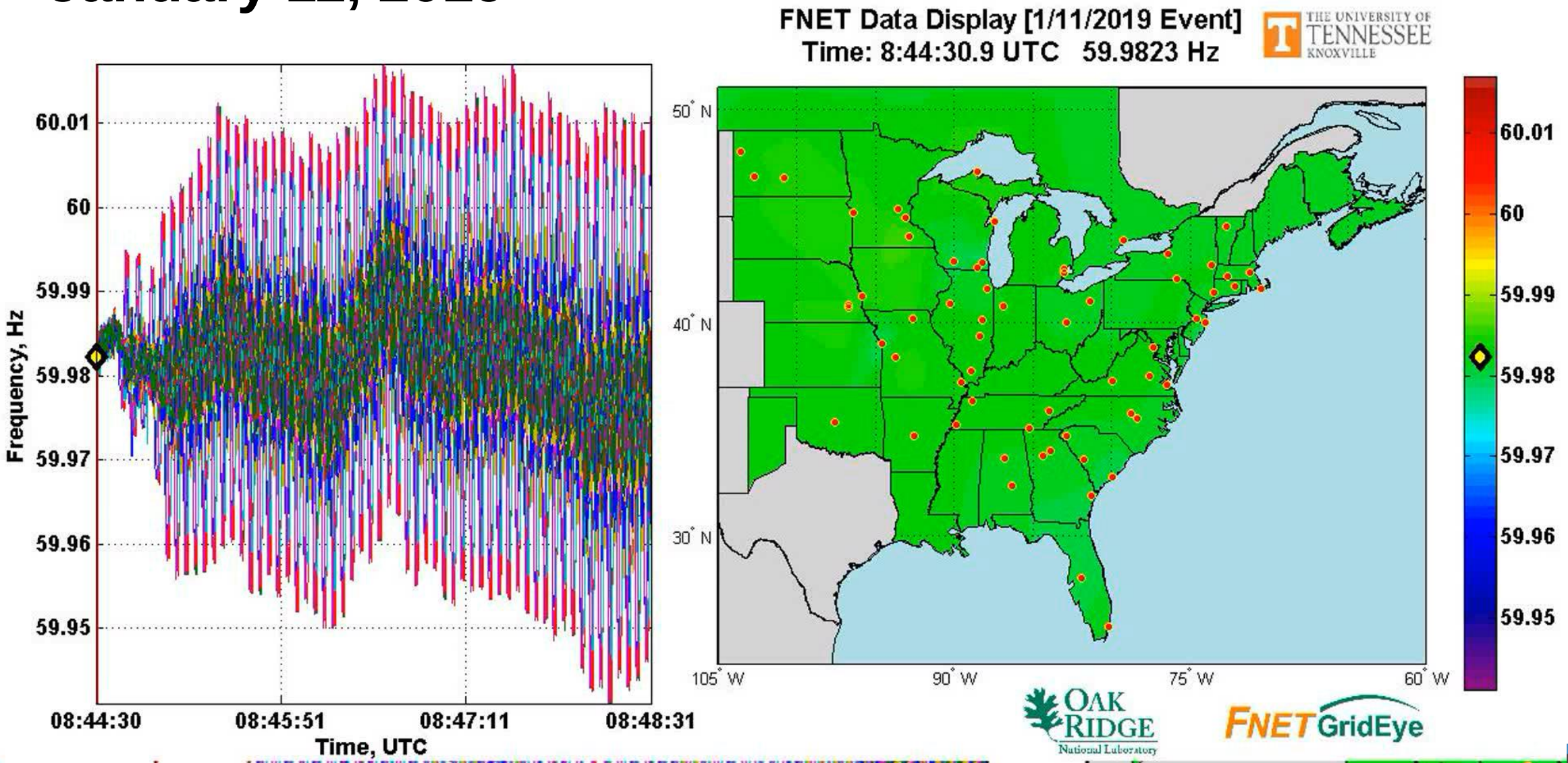


Notes:
Angles are based on data from blackout investigation.
Angles are calculated from a Power flow Simulation.
Angle reference is Browns Ferry.

Florida Disturbance – Non-Local Impacts February 26,2008



NERC Eastern Interconnection Oscillation Disturbance January 11, 2019



July 17, 2021

2 Solar Storms sends particles Into deep space missing earth

11-year cycle will peak in 2025

SOLAR KILLSHOT | The Sun Sent a Wake-Up Call

NREL Finding: Current DC to AC inverter designs may cause:

…”electromagnetic transients that can propagate throughout a large geographic area and trigger system-level problems—a cascading event”

Boston’s Finding: Achieving an effective level of resilience with DER requires sound planning, improved design standards and constructive solutions

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Union Station – 1908