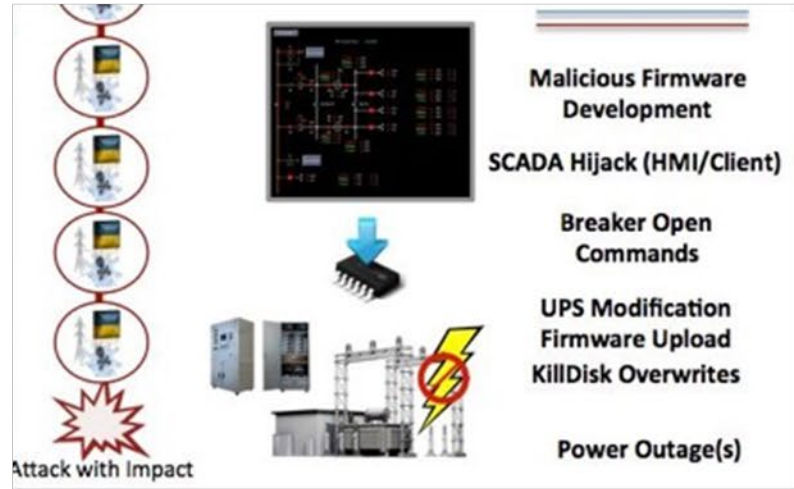# North American Energy Resilience Model (NAERM)
Status Update

Gil Bindewald – Office of Electricity
Guohui Yuan – Office of Energy Efficiency and Renewable Energy
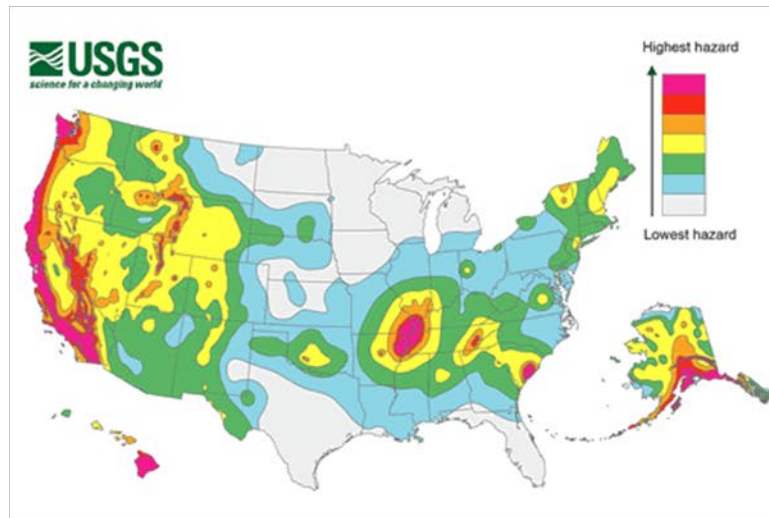
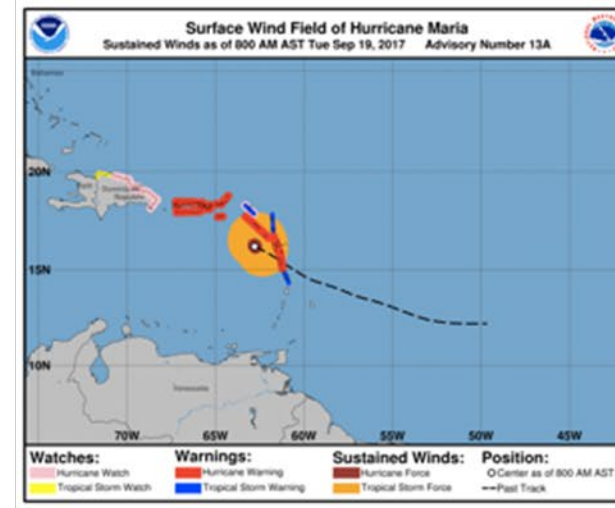May 29, 2020

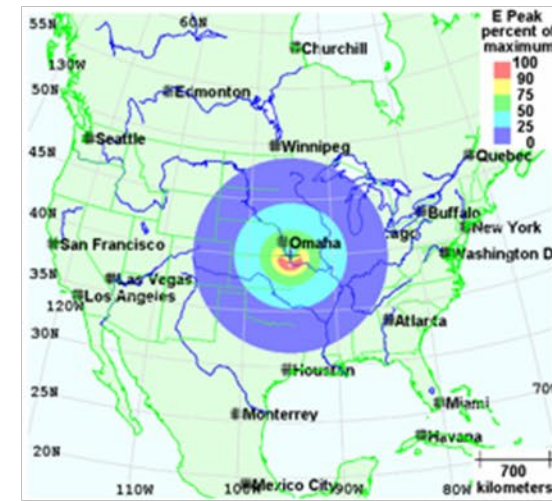# Context – US energy infrastructure faces many threats

Cyber Attacks

Malicious Firmware Development

SCADA Hijack (HMI/Client)

Breaker Open Commands

UPS Modification Firmware Upload KillDisk Overwrites

Power Outage(s)

Attack with Impact

Extreme Weather

Earthquakes

Ballistic Protection

High Altitude EMP
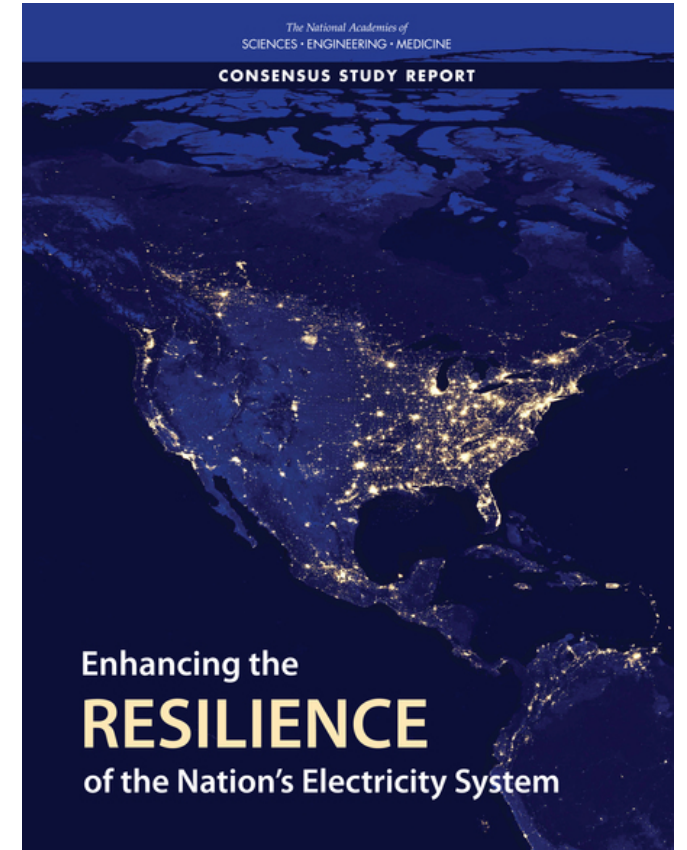
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Resilience Defined

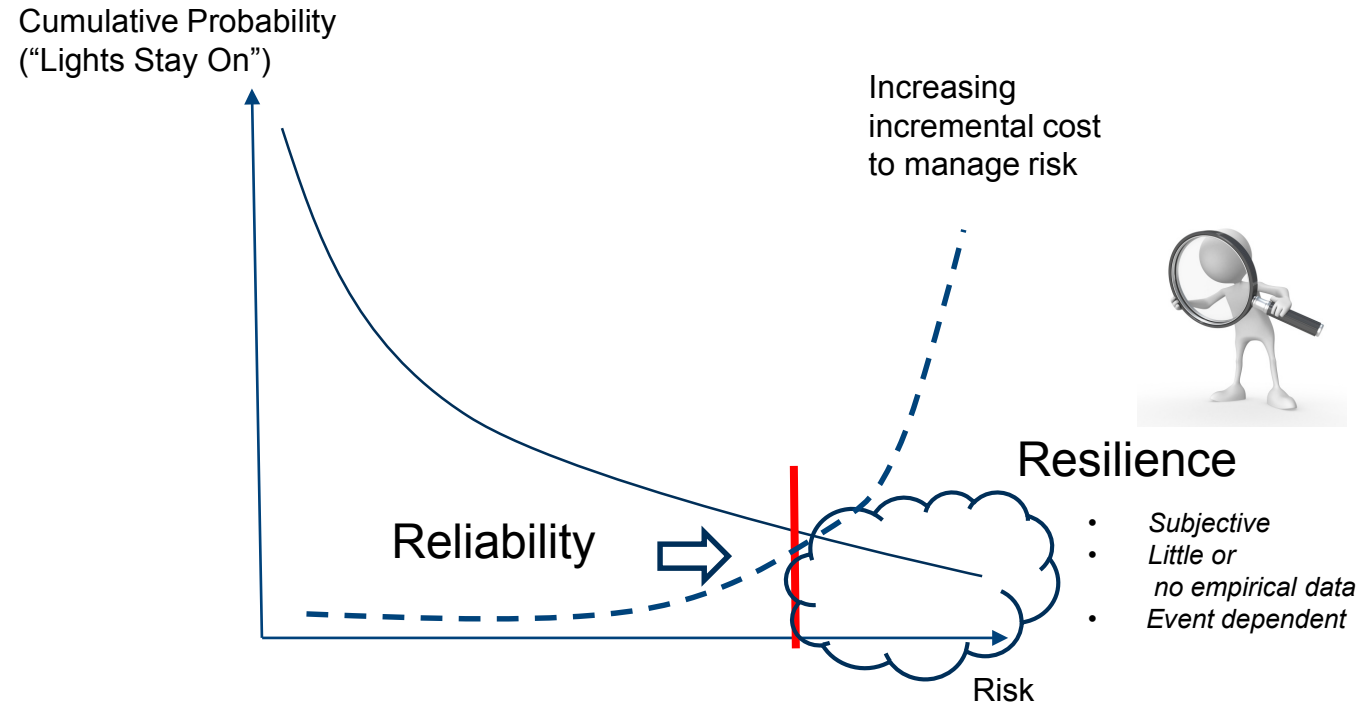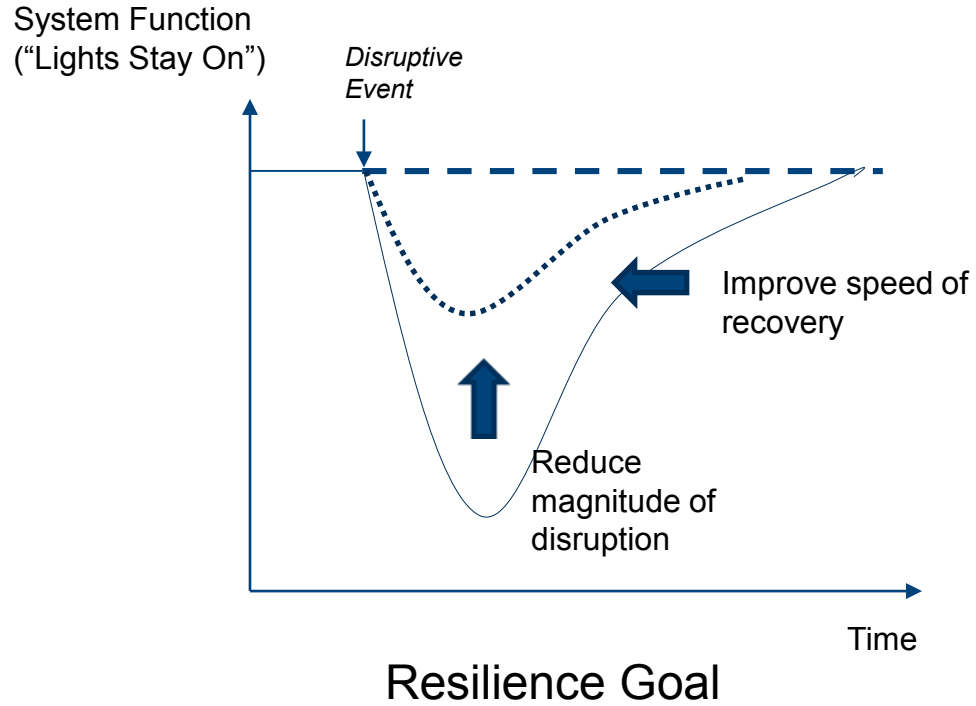The term "resilience" means *the ability* to **prepare for and adapt to changing conditions** and **withstand and recover rapidly from disruptions.** Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.

– Presidential Policy Directive 21 (Feb. 2013)

National Academies (2017)

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Reliability vs. Resilience

System Function
("Lights Stay On")

Disruptive Event

Improve speed of recovery

Reduce magnitude of disruption

Time

Resilience Goal

Cumulative Probability
("Lights Stay On")

Increasing incremental cost to manage risk

Reliability

Risk

Resilience
- *Subjective*
- *Little or no empirical data*
- *Event dependent*

NOTE: Curves are illustrative

Roles of Modeling

- **Facilitate understanding of complex data**
- **Demonstrate how physics govern dynamics of the power system**
- **Estimate values of parameters that cannot be directly measured**
- **Predict (simulate) potential events/scenarios**
- **Evaluate optimal resilience design**
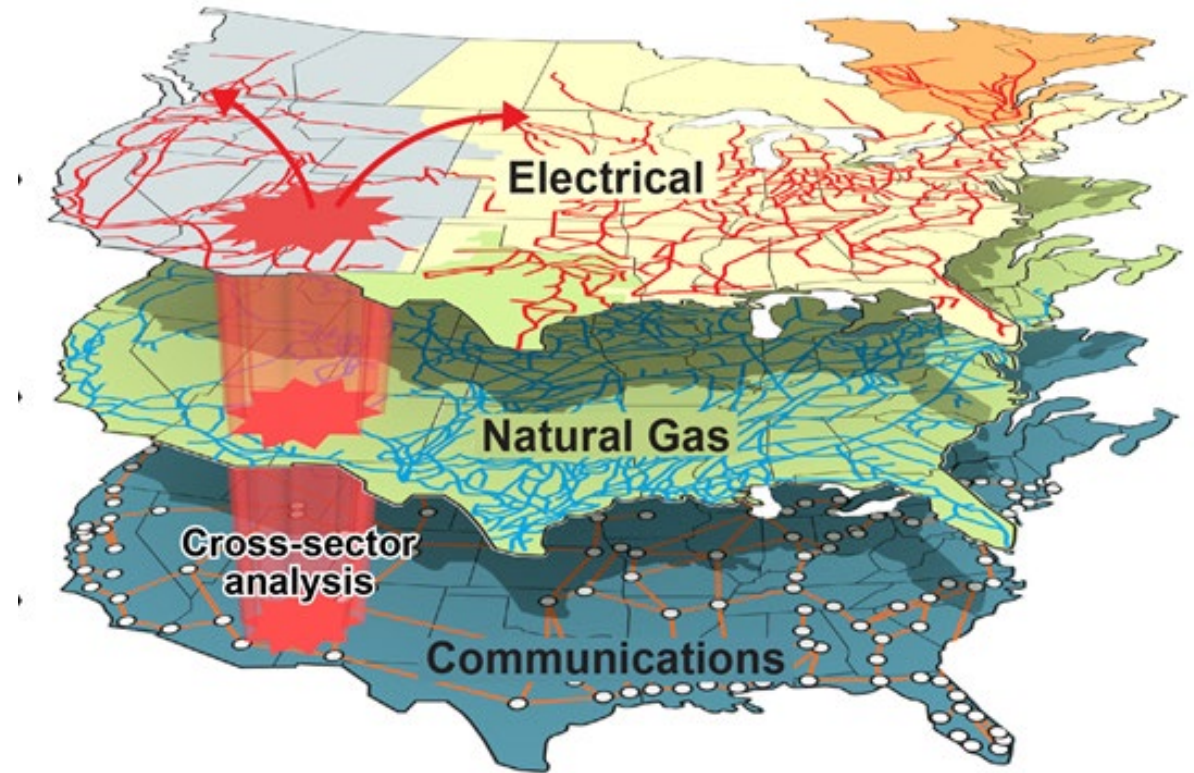 - e.g. placement of energy storage

North American Energy Resilience Model (NAERM)

Vision - Rapidly predict energy system interdependencies, consequences and responses to extreme events at a national scale
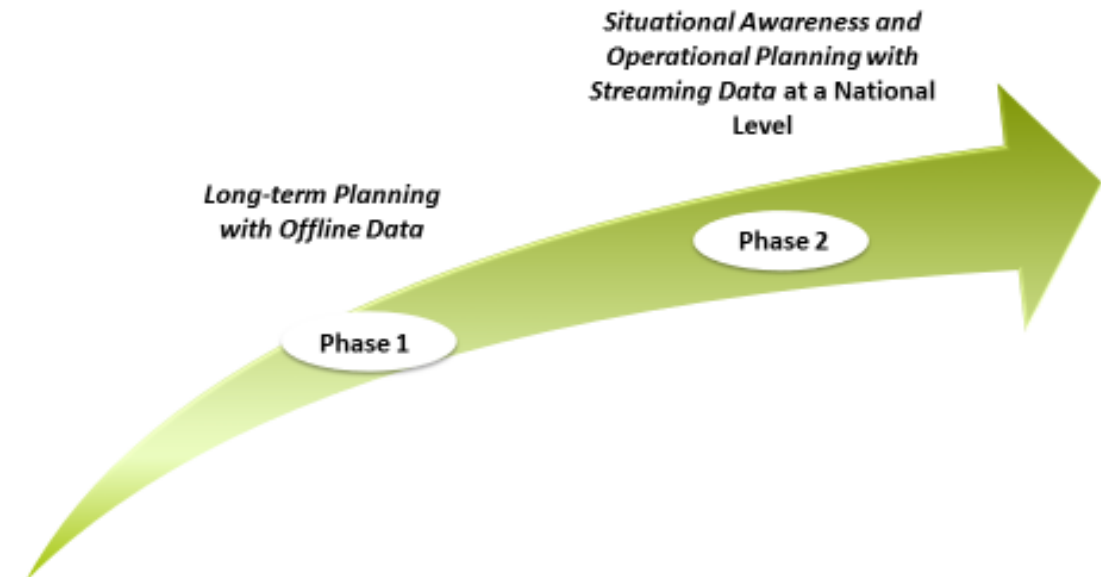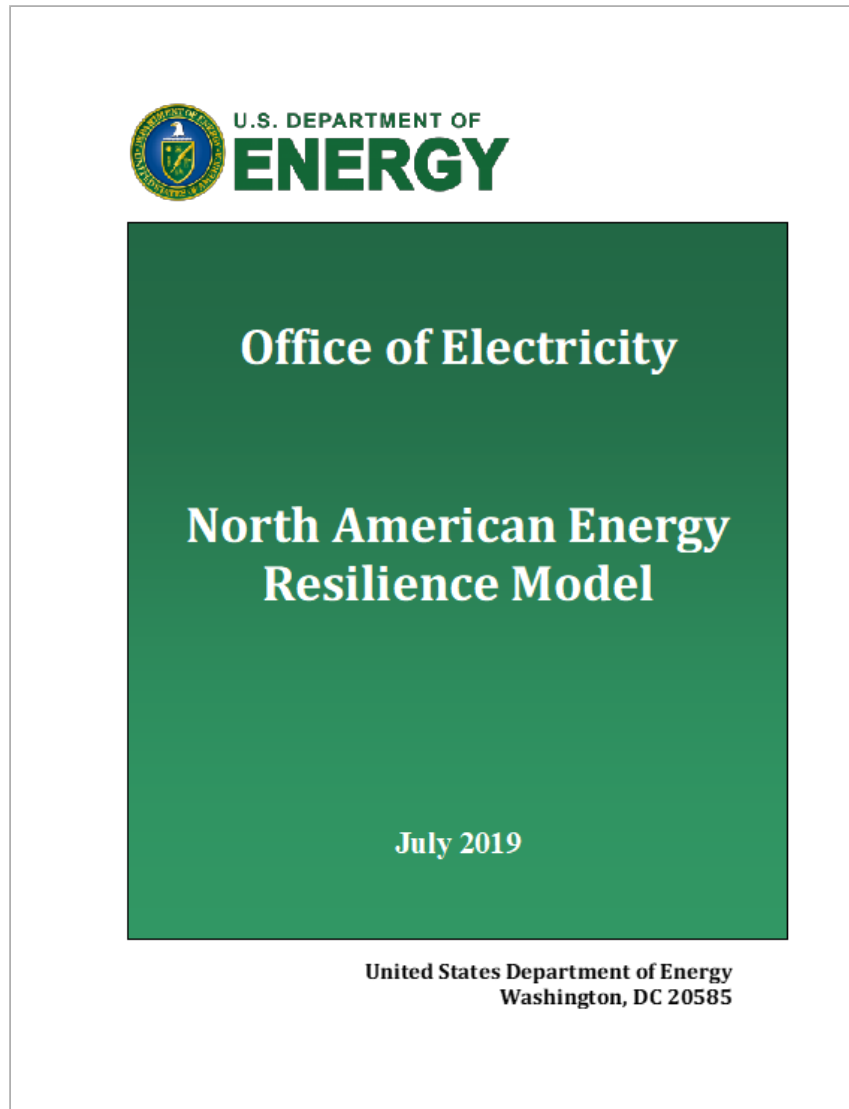
Mission - Develop and deploy engineering-class modeling system for planning and real-time resilience analysis

Key Objective – Catalyze partnerships with industry, national labs, states/communities and other federal agencies to enhance coordination to support energy resilience
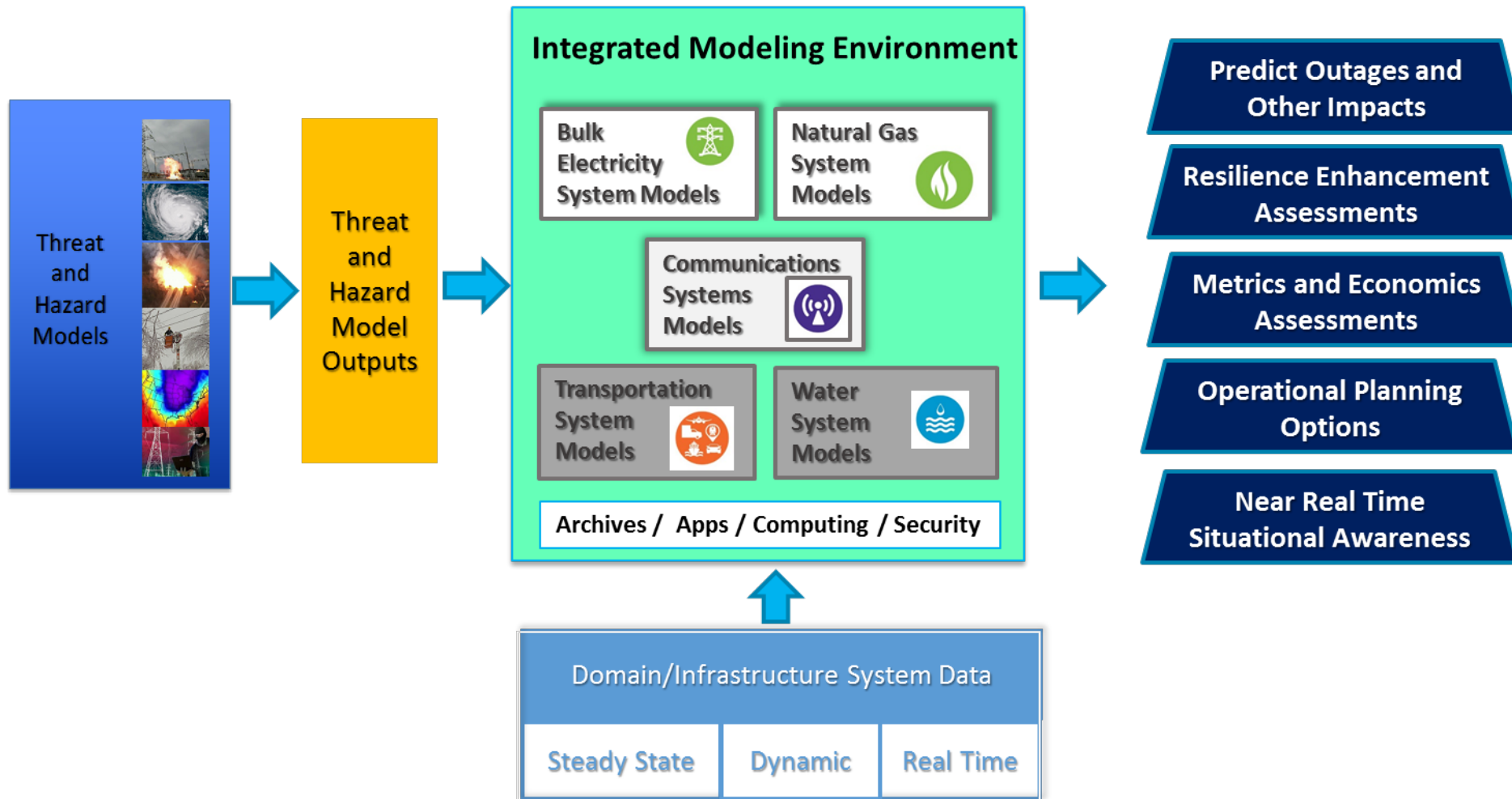
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Office of Electricity

North American Energy Resilience Model

July 2019

United States Department of Energy
Washington, DC 20585

NAERM is a Departmental effort, drawing on the expertise and capabilities of multiple offices and national laboratories (including ANL, INL, LANL, LLNL, NREL, ORNL, PNNL, and SNL).
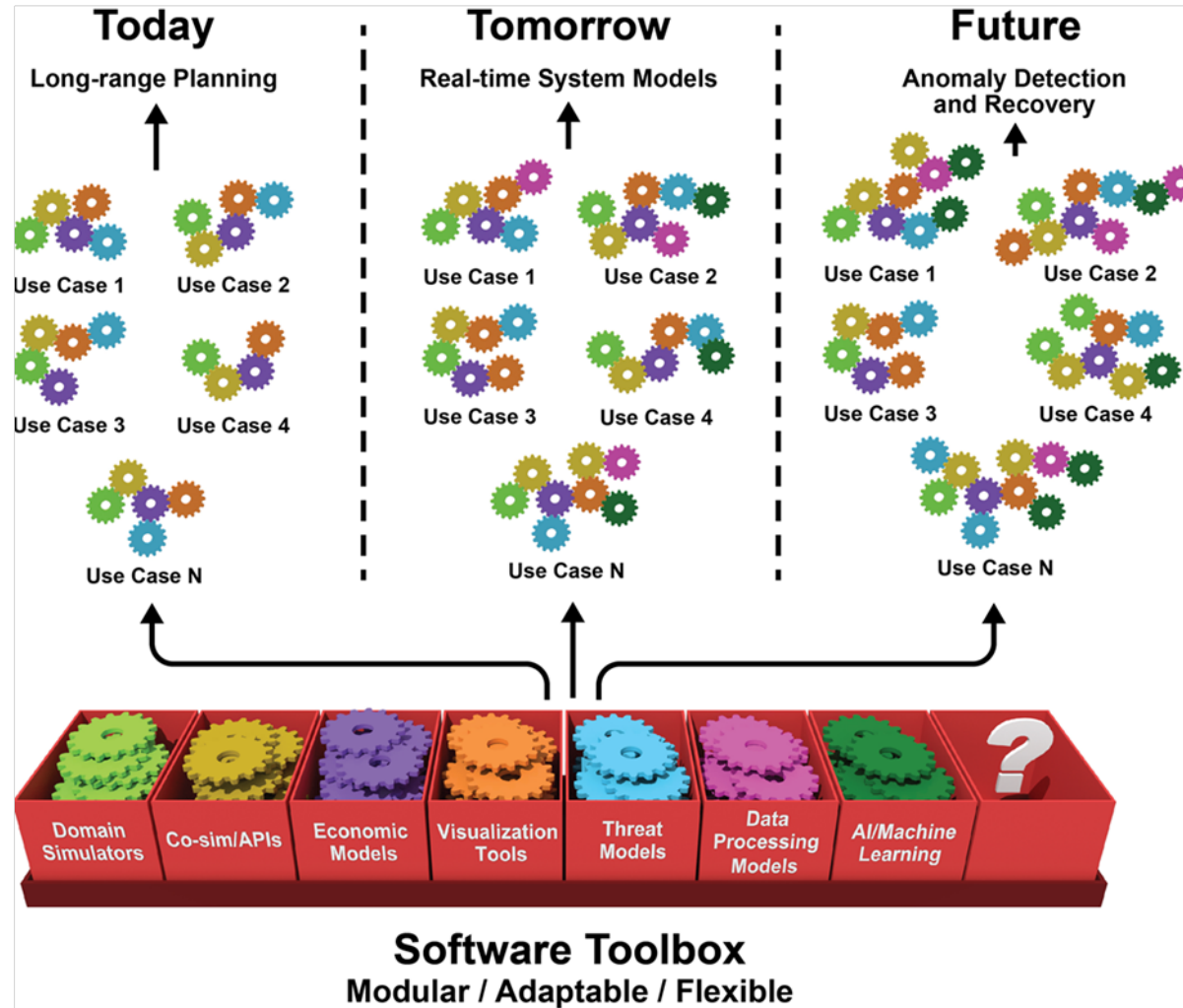
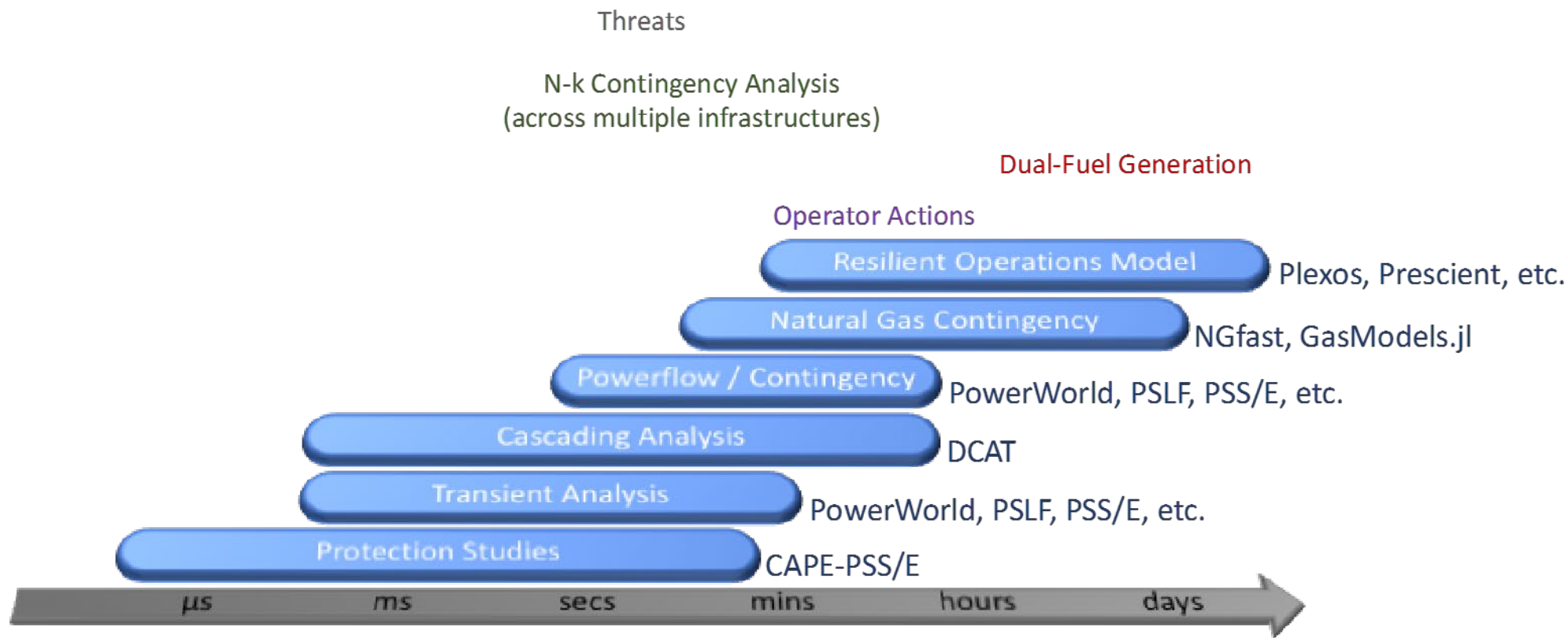*Situational Awareness and Operational Planning with Streaming Data at a National Level*

Long-term Planning with Offline Data

Phase 1

Phase 2

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The different elements are assembled in relation to the threat and hazard scenarios being addressed

Threats

N-k Contingency Analysis
(across multiple infrastructures)

Dual-Fuel Generation

Operator Actions

Resilient Operations Model — Plexos, Prescient, etc.

Natural Gas Contingency — NGfast, GasModels.jl

Powerflow / Contingency — PowerWorld, PSLF, PSS/E, etc.

Cascading Analysis — DCAT

Transient Analysis — PowerWorld, PSLF, PSS/E, etc.

Protection Studies — CAPE-PSS/E

μs   ms   secs   mins   hours   days

5

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Agile Development Strategy will enable adaptation to changing requirements

DOE/NAERM Planning → Sprint Task Planning → Sprint Execution "Do Work" → Releasable Product Increment

DOE Product Vision/Strategy

NAERM Deliverables/Roadmap

Quarterly Backlog Release Plan

Sprint Prioritized User Stories

Daily "Standups"

2-4 week Sprints

End of Sprint
- Review
- Demo
- Retrospective

Customer Feedback

Compliance Reporting with Jira

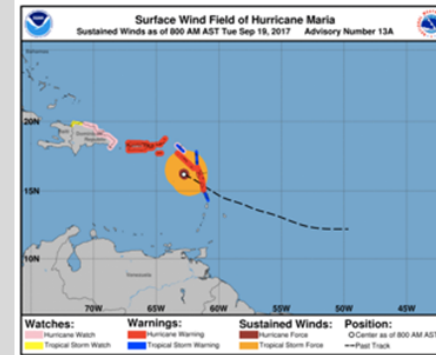U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY

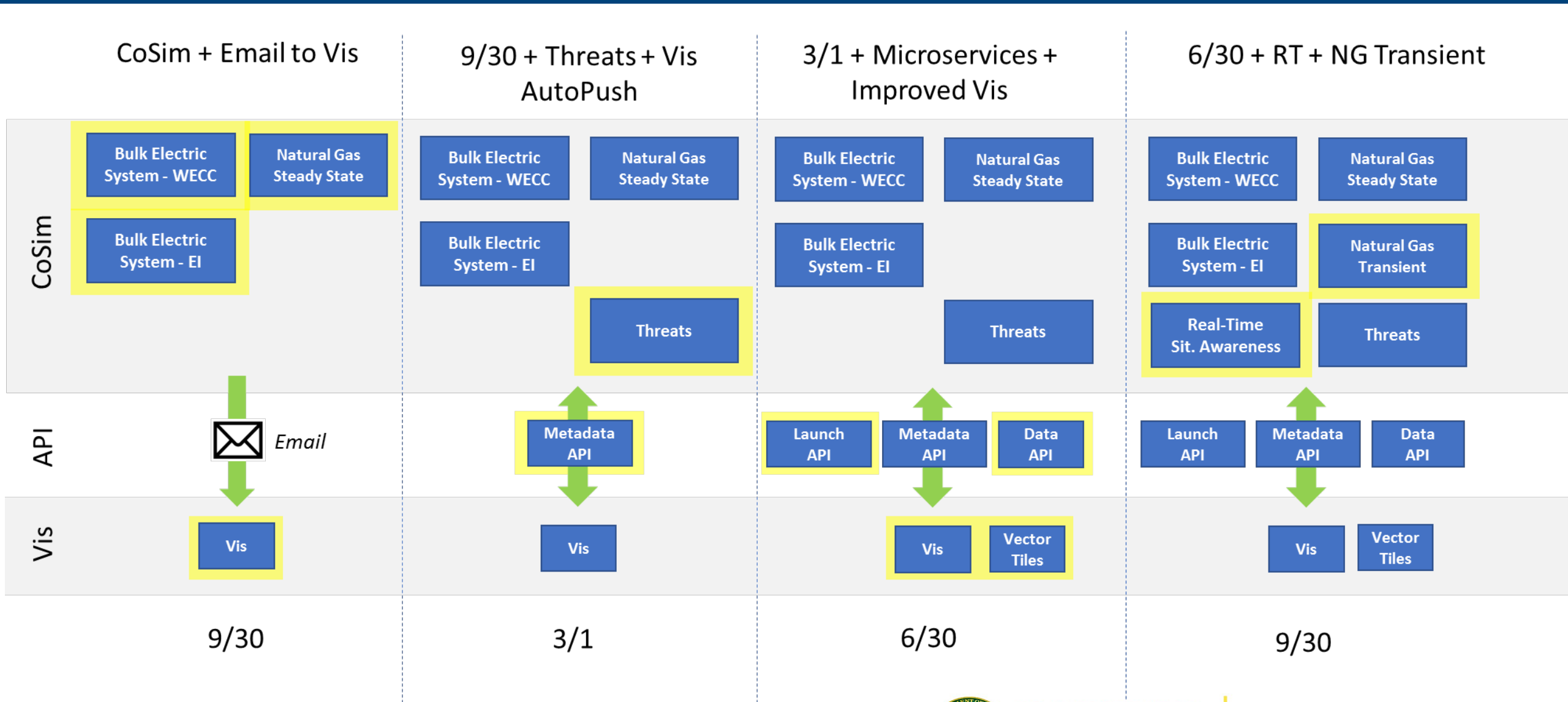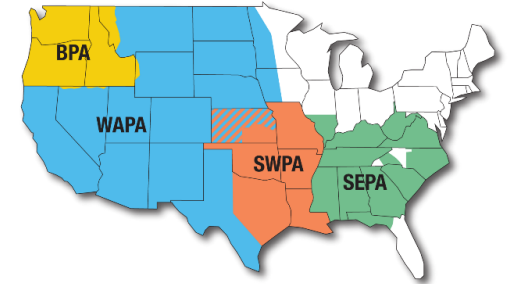# NAERM Releases Increase Capability Across ...
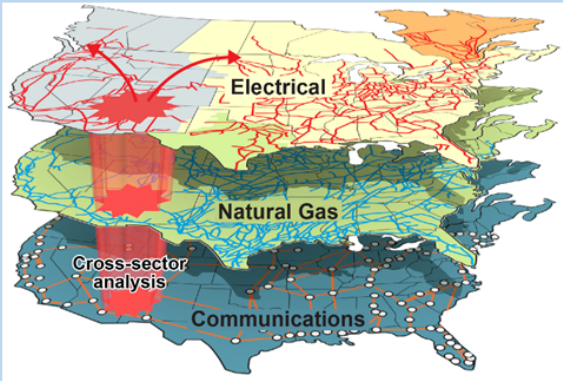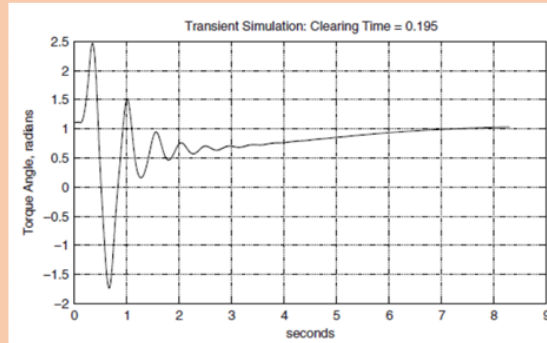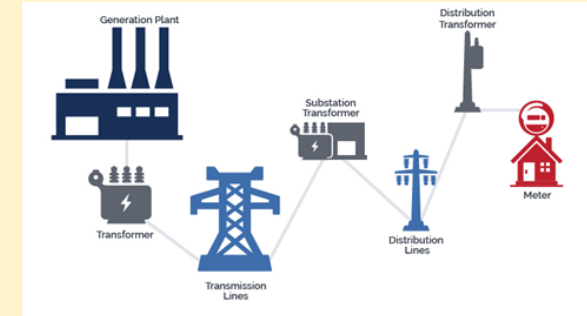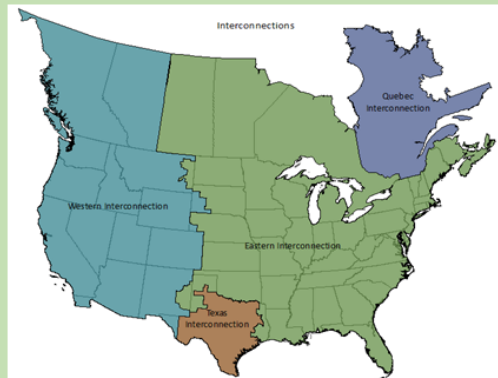
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Rapid Architecture Evolution via Quarterly Releases

Where are we going in CY20?

Real-Time Situational Awareness

Provide a holistic, multi-domain, near-real-time view of evolving conditions and enable analysis to support critical functions during an event.

www.wapa.gov

Infrastructure Modeling

Analyze options to affect energy resilience, improve rapid restoration and recovery, and enable risk-informed planning and coordination to mitigate large-scale energy disruptions (earthquakes, wildfires, etc.).

www.eia.gov

Software Architecture

Enable a complex, multi-component software system in a structured, open, integrated, and interoperable approach that leverages existing commercial and open source software.

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Questions?

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