

Assessment of the Resiliency of the Colombian Power System

COLOMBIA

Robert Entriken

Technical Executive, Grid Operations and Planning

& our Project Team

XM Technical Conference

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Our Project Team!

- World Bank

- Patricia Marcos Huidobro
- Claudia Ines Vasquez Suarez
- David Reinstein

- XM

- Carlos Mario Correa Posada
- John Alexander Cardozo Duarte
- Carlos Andres Cano
- Henry Arles Lopez Mejia
- Angela Patricia Buendia Yanez
- Neby Castrillon
- Jorge Mola
- Nelson Chaparro
- Juan Camilo Gonzalez
- Carlos Arturo Vanegas
- Sergio Daniel Florez
- Julian Cardona
- Lina Ramirez

- EPRI

- Transmission Operations and Planning
 - Robert Entriiken
 - Adrian Kelly
 - Miguel Ortega-Vazquez
 - Jeffrey D. Roark
 - Vikas Singhvi
 - Aidan Tuohy
 - Eknath Vittal
- Cyber Security
 - Esther Amullen
 - Galen Rasche
 - Ben Sooter
- Technology Innovation
 - Sara Mullen-Trento
 - Heidi Scarth
- Member & Technical Services
 - Ricardo Mejia
 - César Poletto Alves

Agenda

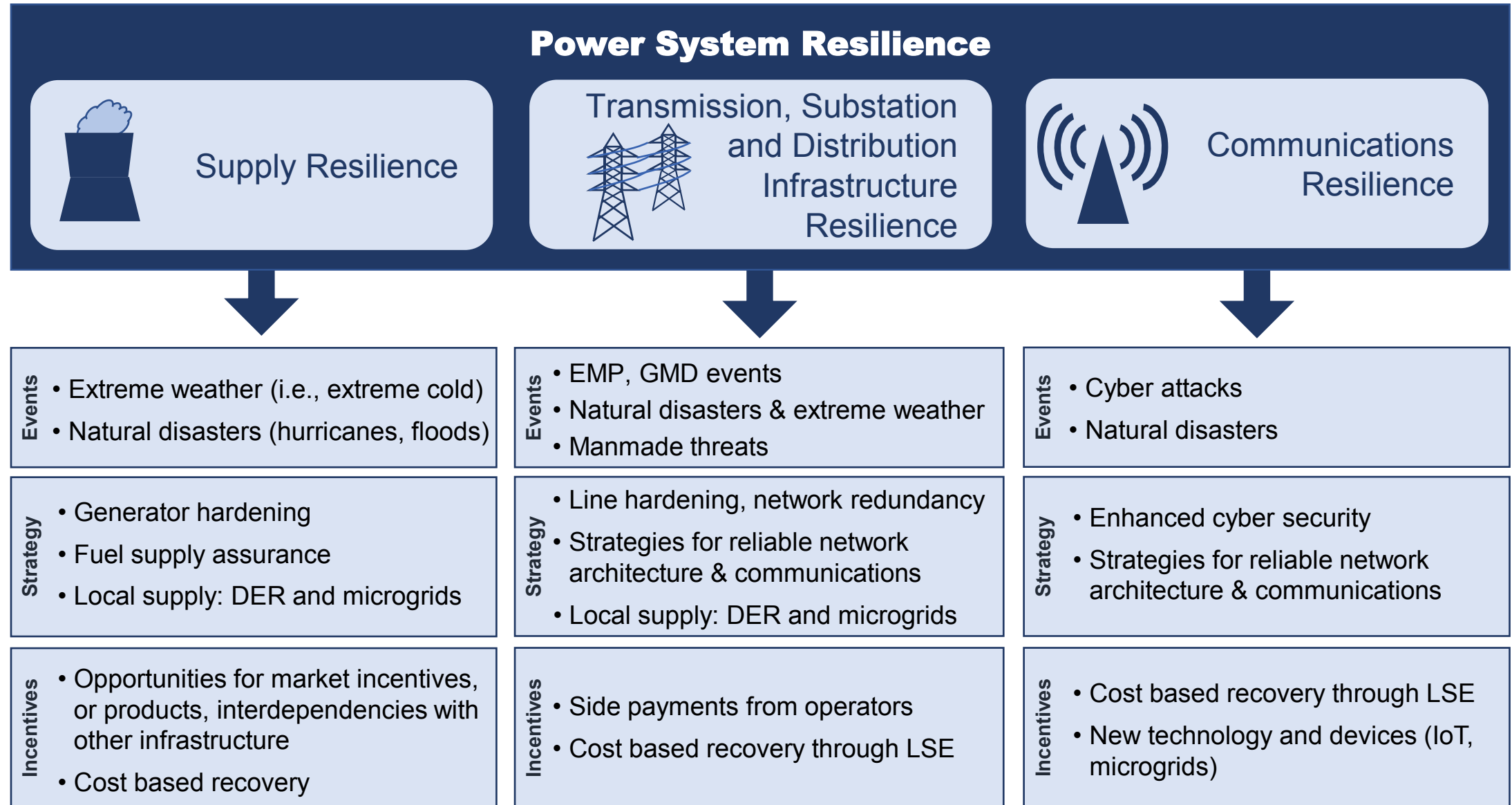
- Resilience Examples
- Overview of current practices
 - Transmission Resilience Maturity Model
- WB-XM Project Overview
- WB-XM Project Status
- Discussion





Resilience Examples

Different Types of Power System Resilience



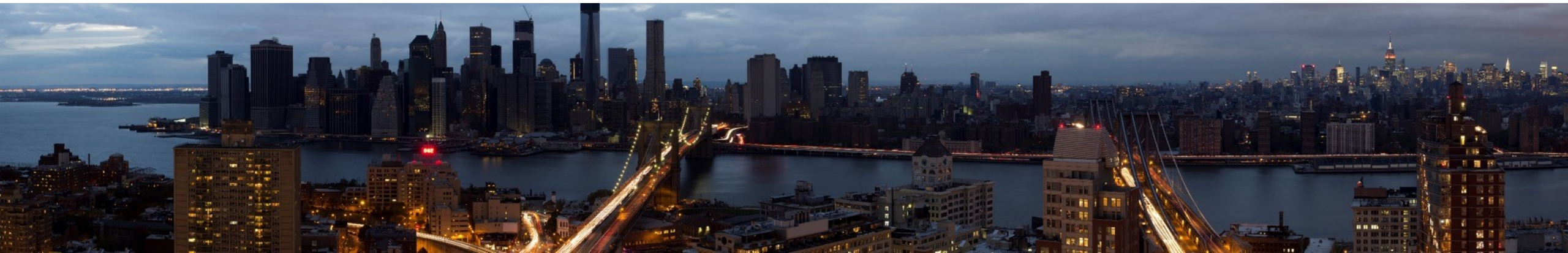
High-Impact Low Frequency (HILF) Events

- Traditional resource adequacy assessments
 - Statistical analyses for loss of load expectation (LOLE)
 - Compare with a performance target
 - 1 day in 10 years
- Metrics for non-traditional resources
 - Capacity credits
 - Effective load carrying capability (ELCC)
 - Unforced capacity (UCAP)
- How can externally driven-HILF events impact resource adequacy?
 - Certain events may have large impacts on short- and long-term electricity use
 - E.g., cold-weather event leads to high-risk not coincident with peak period
 - E.g., drought impacts available hydro energy
 - Extreme events can also impact load forecasting in different season
 - E.g., COVID has changed electricity use patterns

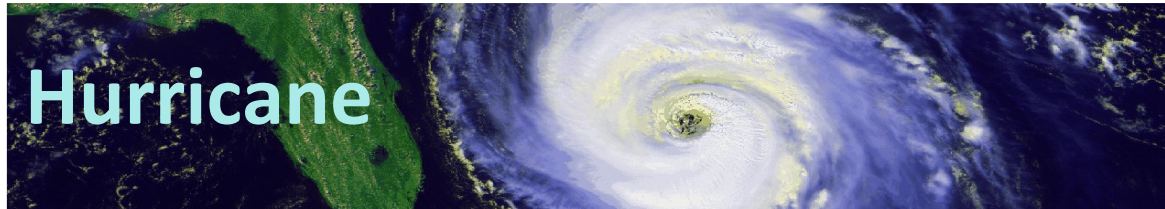


The Problems with Resilience

- Impacts are too complex to quantify
 - *Probabilities* of HILF events may be nonsensical
 - *Both* single-point and common-mode failures impact multiple supply resources
 - *Many* types of interruptions and restrictions
 - Emerging resource technologies (wind, solar, storage)
- Impact studies take a long time
- Difficult to integrate into existing business and regulatory processes



A Tale of Two Events



- Power System Impacts
 - Loss of access to generation
 - downed transmission lines
 - Timeframe to impact: days to weeks notice
 - Timeframe to recovery: **weeks to months**
- Market Impacts
 - **Normal (average) prices**
- Mitigations
 - Account for operator mitigations
 - Flexible, local generation
 - Demand response



- Power System Impacts
 - Loss of access to fuel
 - gas pipelines unavailable, coal piles frozen
 - Timeframe to impact: days to weeks notice
 - Timeframe to recovery: **days to weeks**
- Market Impacts
 - **High prices**
- Mitigations
 - Account for operator mitigations
 - Account for risk in day-ahead scheduling
 - Diversify energy sources



NATF (North American Transmission Forum)

TRMM (Transmission Resiliency Maturity Model)

NATF TRMM

Goals

- Evaluate and benchmark capabilities
- Prioritize actions and investments for improvements
- Share with internal and external business partners
- Contribute to increasing the national resilience

Structure

- *Domains*: categories that organize activities
 - *Objectives* - set goals of activities, within domains
 - *Maturity Index Levels (MILs)*: track progress

NATF TRMM Domains

Most Relevant Domains

- Risk Identification, Assessment, and Management (**RM**)
 - for identifying HILF events and their impacts
- Situational Awareness (**SA**)
 - for executing system restoration
- Event Response and Recovery (**ERR**)
 - for preparing in advance for system restoration

Secondary Domains

- Resilience Program Management (**PM**)
 - for organizing your efforts
- Transmission and Supporting Equipment Management (**EqM**)
 - for better ensuring restoration
- Information Sharing and Communications (**ISC**)
 - for exchanging data with related organizations

NATF TRMM Risk Identification, Assessment, and Management (RM)

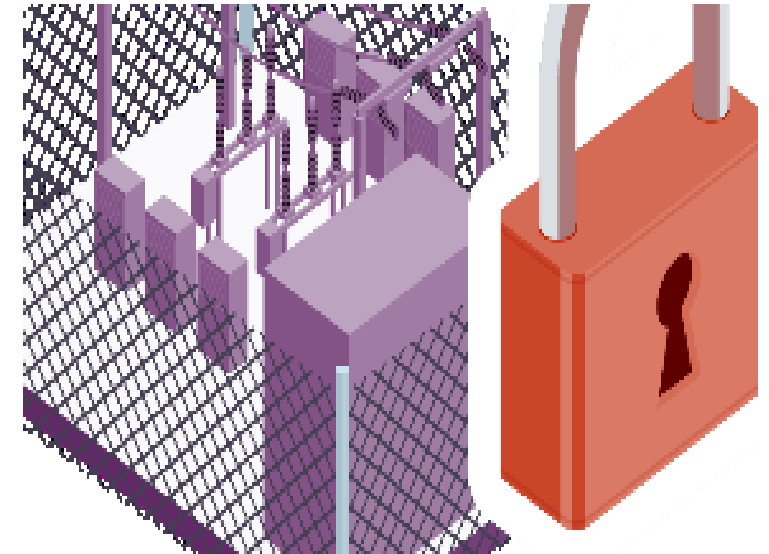
Objectives

1. Identify *threats* to transmission resilience
2. Identify *vulnerabilities* to transmission resilience
3. Identify the *consequences* of transmission resilience threats and vulnerabilities
4. Assess transmission resilience *risks*
5. Perform risk *mitigation* activities
6. Management *support* activities

Extreme Event Scenarios, Resilient System Investment Framework (RSIF)

RM: Use of Cyber Extreme Event Scenarios

- A **cyber extreme event scenario** is a realistic cyber-induced event in which the failure to maintain integrity, availability or confidentiality of a system creates a significant negative impact on the generation, transmission, and/or distribution of power
- **Benefits and value**
 - **Identify and Understand Risks**
 - Threats, vulnerabilities, and consequences
 - **Detection**
 - Increased anomaly detection readiness – early detection
 - Determine data collection requirements
 - Develop monitoring guidelines
 - Build analytics for detection
 - **Response**
 - Determination of response actions
 - Mitigations and defense strategy planning
 - Future architecture upgrades can implement longer term mitigation solutions
 - Improved operator training for abnormal conditions



NATF TRMM Situational Awareness (SA)

Objectives

1. Perform monitoring
 2. Establish, maintain, and communicate a Common Operating Picture (COP)
 3. Management support activities
- Feeds into Event Response and Recovery

ECCE, Risk Metrics, Alarm Mgmt, ISOC, Intrusion Detection

SA: Extreme Control Center Contingencies



RTU

Human Remote Terminal Unit (HRTU)

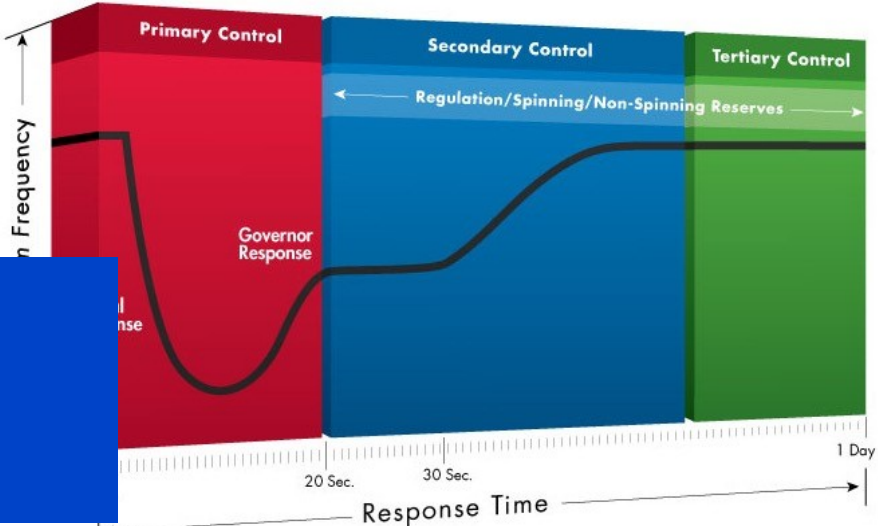
	Load		BUS Voltage			Line Flows									
	MW	MVAR	bus1 Name	KV	bus2 Name	KV	Line 1 Name	MW	MVAR	Line 2 Name	MW	MVAR	Line 3 Name	MW	MVAR
Manned Station 1															
Manned Station 2															
Generator 1															
Generator 2															
Tie Station 1															
Tie Station 2															
EHV Station 1															

Sparse Data Organization

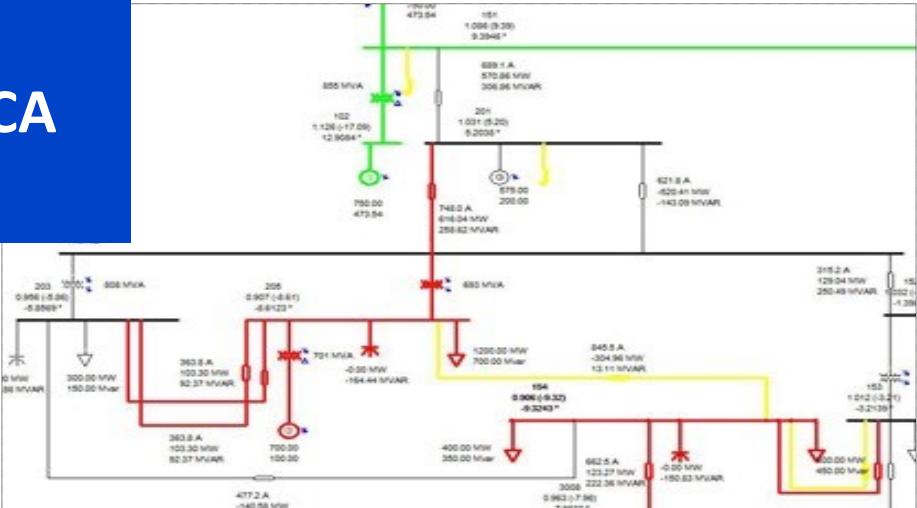
SCADA

AGC

SE/RTCA



Manual Frequency Control



Air-Gapped Power Flow Model

NATF TRMM Event Response and Recovery (ERR)

Objectives

1. Develop and maintain response and recovery capabilities
2. Exercise/drill response and recovery capabilities
3. Communicate and share pertinent information during an event
4. Provide support for personnel participating in response and recovery
5. Management support activities

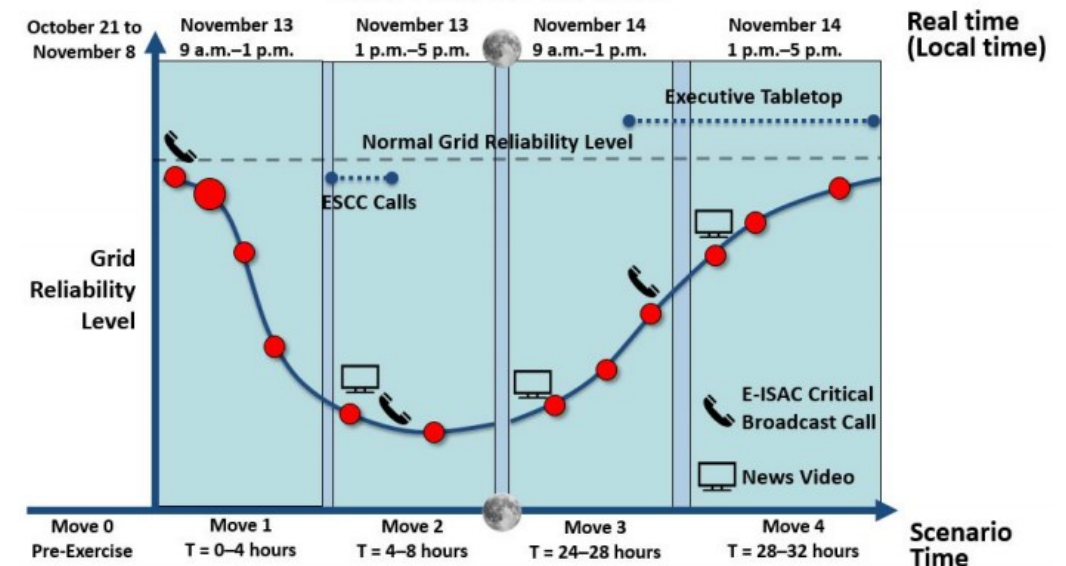
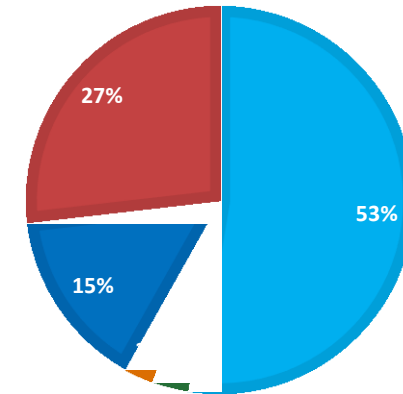
Blackstart, Restoration Navigation, GridEx

ERR: NERC GridEx – Grid Security Exercise

- Objectives:
 - Exercise incident response plans
 - Expand local and regional response
 - Engage critical interdependencies
 - Improve communications
 - Gather lessons learned
 - Engage senior leadership
- 526 total participants in GridEx V

PARTICIPATION BY ORGANIZATION TYPE

Electric Gas Water Other Government





World Bank – XM Resilience Project

World Bank-XM Resilience Project

N°	Activity											
		Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	Current Practices	X	X	X								
2	Methodology Proposal			X	X	X	X	X	X	X	X	
3	Workshop										X	X

Current Practices

- Deliverable 1: Kickoff Meeting, 11 November 2020
- Deliverable 2: State-of the Art (in review)

Methodology Proposal

- Deliverable 3: Recommendations, draft report and presentation
- Deliverable 4: Colombia Study Scope, draft report and presentation
- Deliverable 5: Executive Summary, final report and presentation

Workshop

- Deliverable 6: Workshop
- Deliverable 7: Final document and workshop summary

World Bank-XM Resilience Project Activities

Power Engineering

- Risk Identification, Assessment, and Management (RM)
 - Extreme Event Scenarios
 - Resilient System Investment Framework (RSIF)
- Situational Awareness (SA)
 - Extreme Control Center Contingencies (ECCC)
 - Risk Metrics
 - Alarm Mgmt
- Event Response and Recovery (ERR)
 - Blackstart
 - Restoration Navigation

Cybersecurity

- Risk Identification, Assessment, and Management (RM)
 - Extreme Event Scenarios
- Situational Awareness (SA)
 - Information Security Operations Center (ISOC)
 - Intrusion Detection
- Event Response and Recovery (ERR)
 - GridEx

Case Study on Risk Management in Transmission Planning



Discussion

A blue-tinted photograph of four people, two men and two women, standing in a row. They are all wearing white lab coats with the EPR2 logo on the left chest. The woman in the center is also wearing a white hard hat. They are all smiling and looking towards the camera. The background is a solid blue color.

Together...Shaping the Future of Energy™