THE COLOMBIAN POWER SYSTEM RESILIENCE

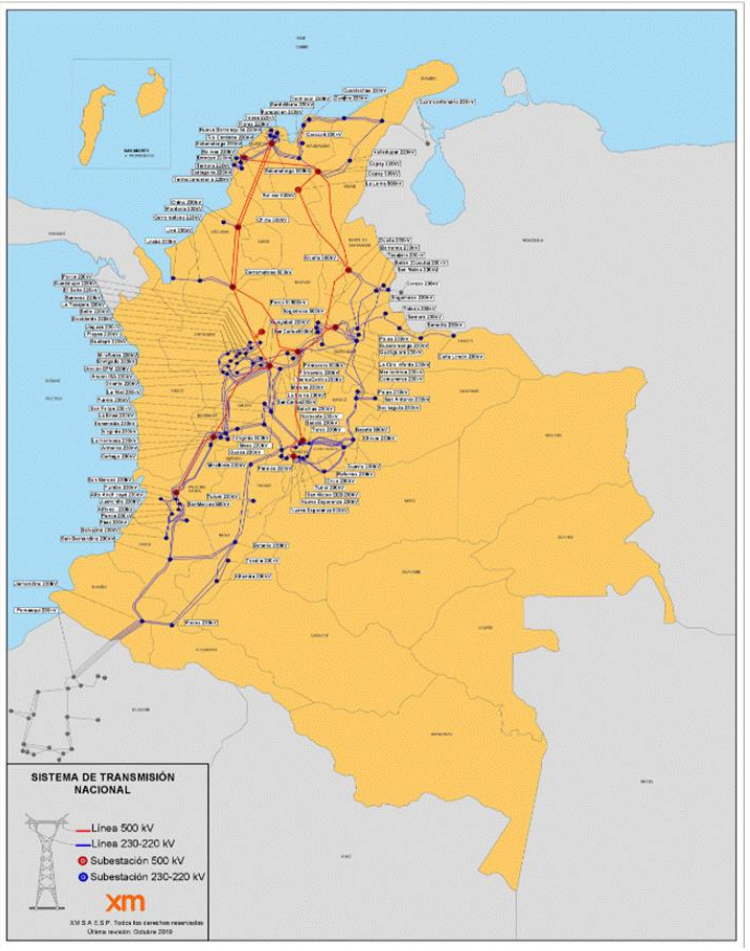
A recent history full of experiences

WEBINAR:
Approaches to Utility Resilience: Creating an Energy Sector that is Prepared for the Unexpected

USEA - June 16 2020

The Colombian power system

Main characteristics



Demand
68.000 GW/y

Peak demand
10 GW

Capacity
17.5 GW

VG
1.5 GW

Hydro
10.7 GW

Thermal
5.3 GW

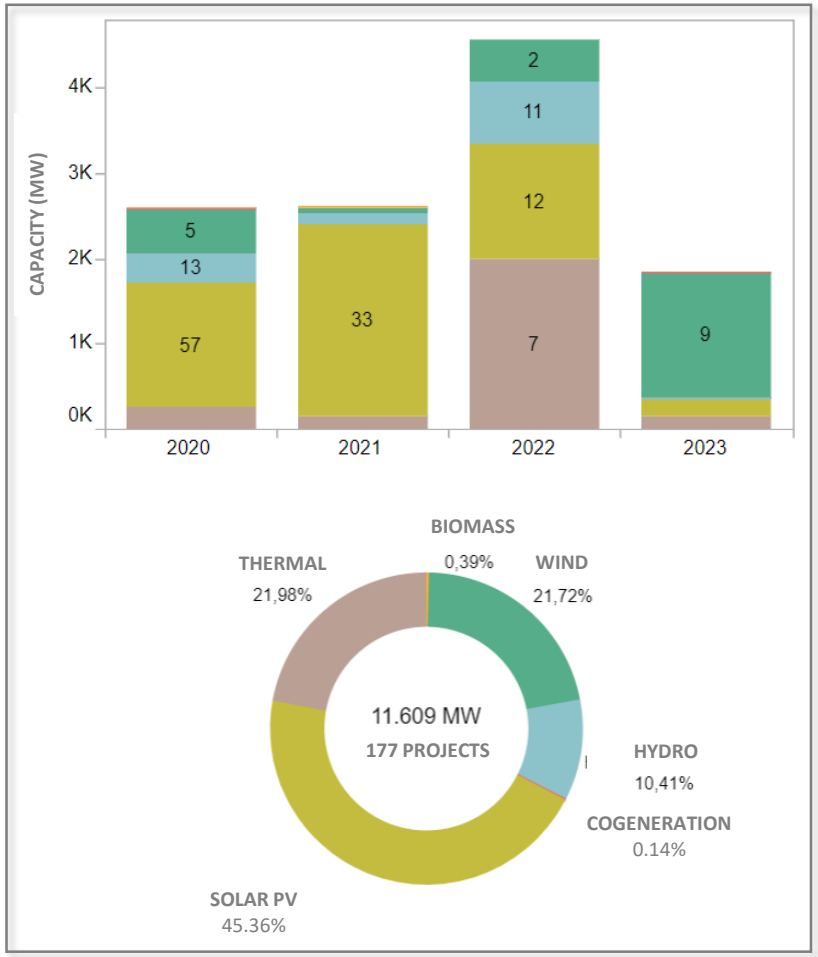
Wind
18 MW

Solar
28 MW

Hydro
1.5 GW

xm

is the Colombian power system and market operator

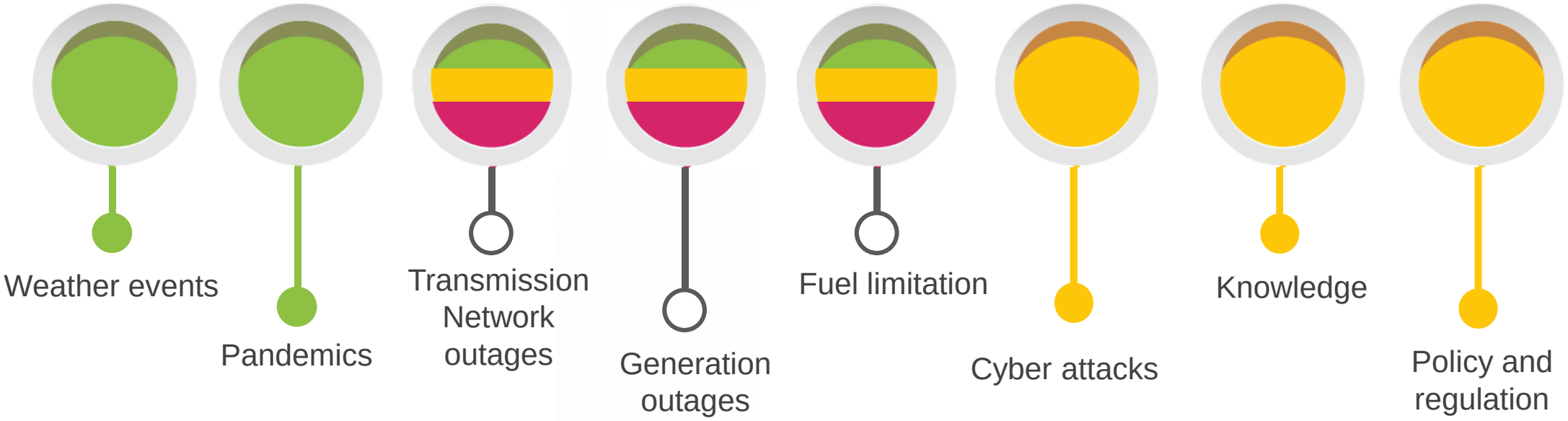


Taken from www1.upme.gov.co

What does XM understand as resilience?

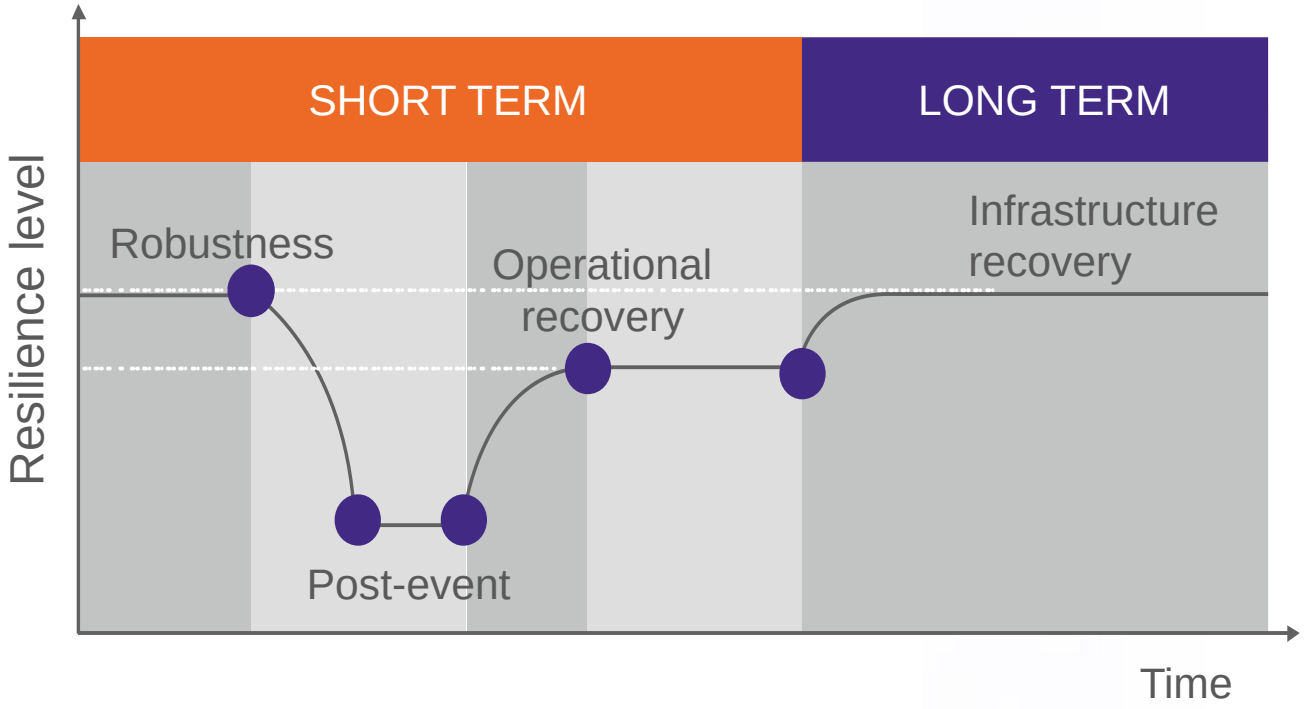
It’s all about sustainability

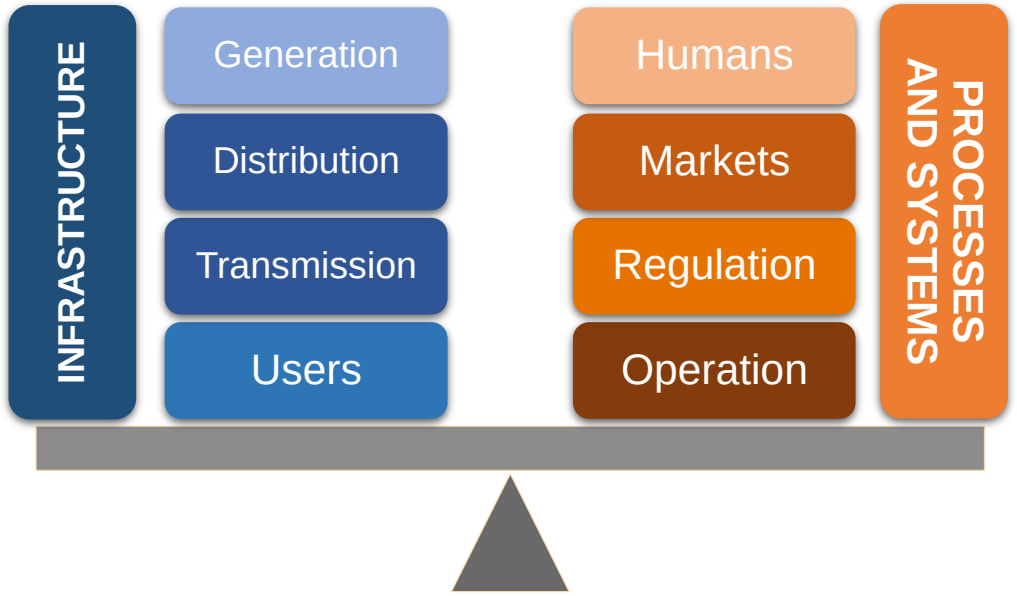
Resilience measures the ability to quickly anticipate, prepare, and adapt to changing conditions and to endure, respond, and recover from events of low probability and high impact.
Resilience + reliability studies allows anticipating, preparing and adapting to the different threats that may reveal vulnerabilities in the electricity system



Resilience analysis

Detecting vulnerabilities

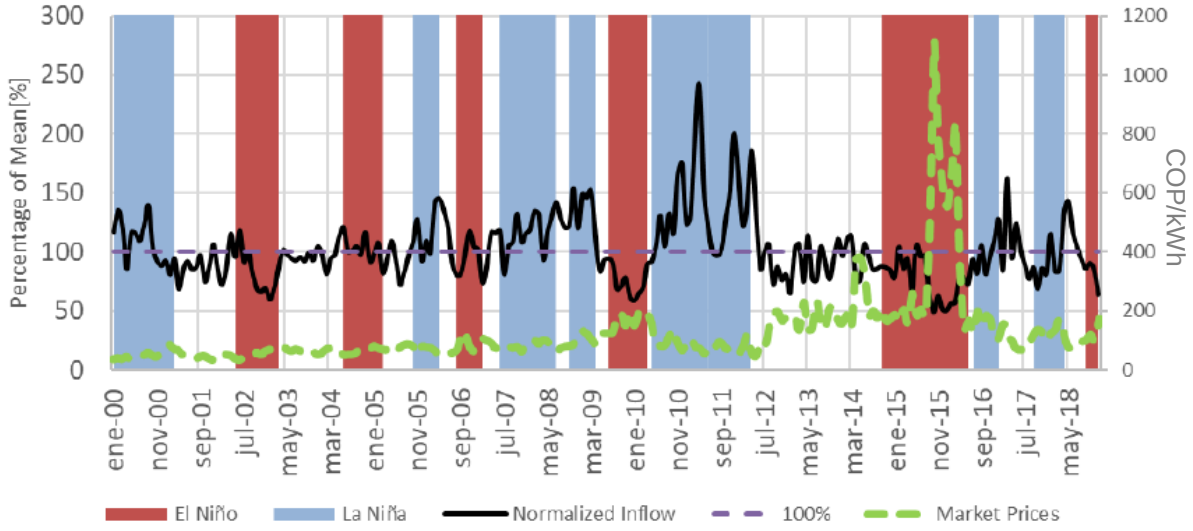


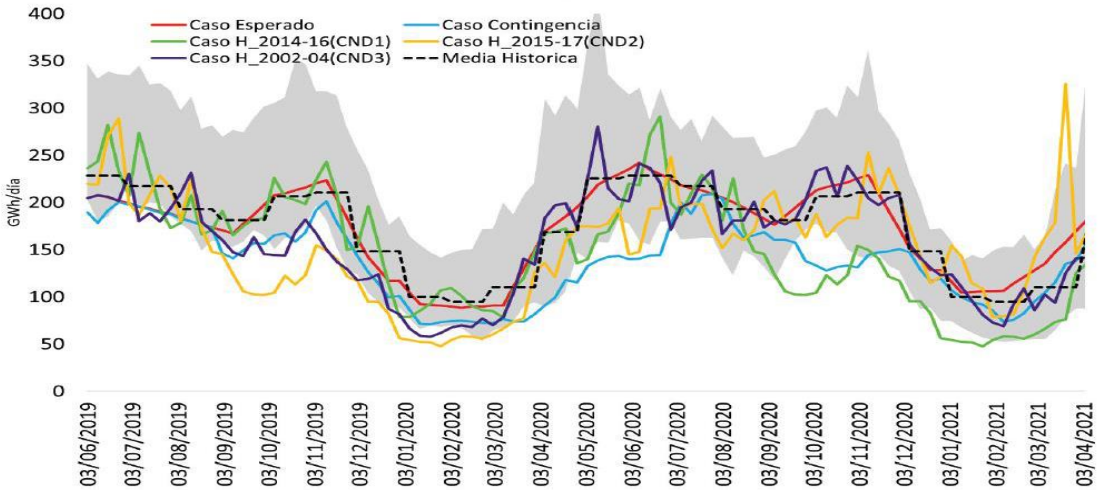


Panteli, Mathaios, and Pierluigi Mancarella. "The grid: Stronger, bigger, smarter?: Presenting a conceptual framework of power system resilience." *IEEE Power and Energy Magazine* 13.3 (2015): 58-66.

Nature events: Extreme weather conditions

El Niño and La Niña





Challenges

- How to **optimize hydro** operation and ensure **fuel supply** for thermal generation.
- In **normal conditions**, close to **85%** of the power demand is fed with **hydro** resources. During **El Niño**, the hydro share is close to **50%**. The remaining demand is met mostly with thermal plants.

Actions taken

- Long and mid-term planning considering **stochastic optimization** and deterministic simulations for water inflows.
- Continuous **follow up weather** conditions
- Analysts trained for weather and climate **forecasting**
- Increased **coordination of power and gas** systems operation
- Increase **regional interconnection** capacity

Generation outages

Guatapé and Ituango

Events

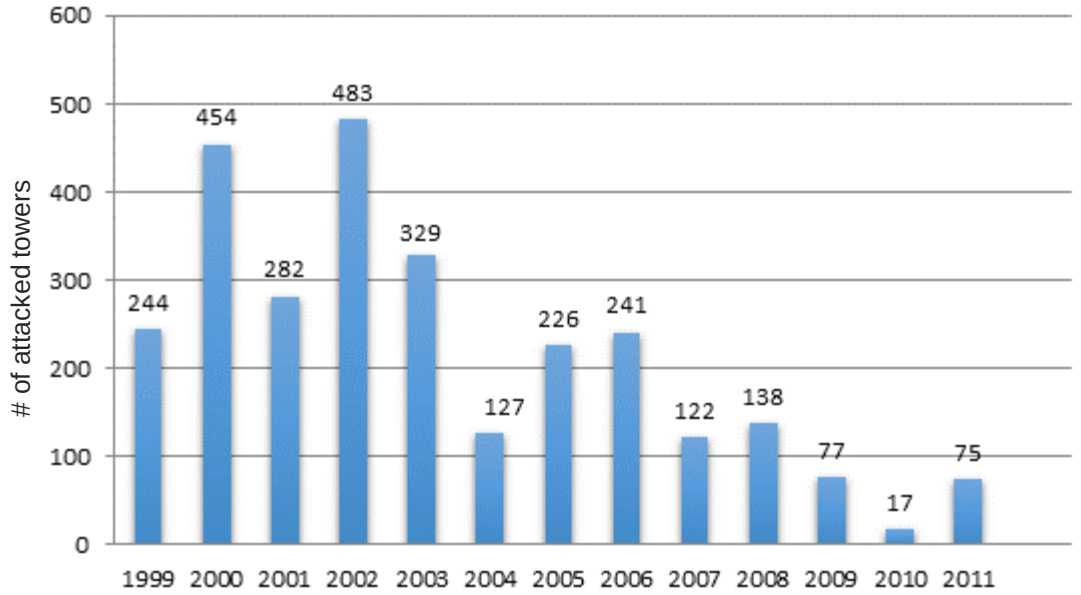
- During El Niño 2016, **Guatape's powerhouse caught fire**. The system lost the dam with greater regulation capacity and three generators placed downstream.
- In 2018, Hidro **Ituango's diversion tunnels were clogged**. To avoid a major catastrophe, engineers let the water flow through the yet-unfinished powerhouse, to stabilize the flow of the river on either side of the dam. The system future energy capacity is compromised.

Actions taken

- Scenario based planning
- **Flexibility analysis** in the midterm planning to detect lack of reserves
- **Policy development**: saving pays off campaign during El Niño 2016
- **Auctions for renewables**: 2.5 GW of solar + wind projects to be installed in the next 4 years under long-term contracts and reliability markets
- New regulation for integrating **storage**

Transmission network contingencies

Terrorist attacks



Events

- Late 90's and early 00's were marked for waves of high **attacks to the transmission network** by terrorist guerillas
- There has been also terrorist **attacks to the gas transmission** network
- Difficulties to recover the infrastructure because of mined fields

Actions taken

- **Network expansion**
- N-k criteria + **improved software** to evaluate system security
- CAOP state: the system operator can take **additional security measures**
- **Coordination** with the army and transmission companies

Pandemic episode

Operating the system under the COVID-19

June 12, 2020

Tests	12,027
New cases	1,646
Total cases	46,858
Recovered	18,715
Deaths	1,545

Strategies to keep the staff safe

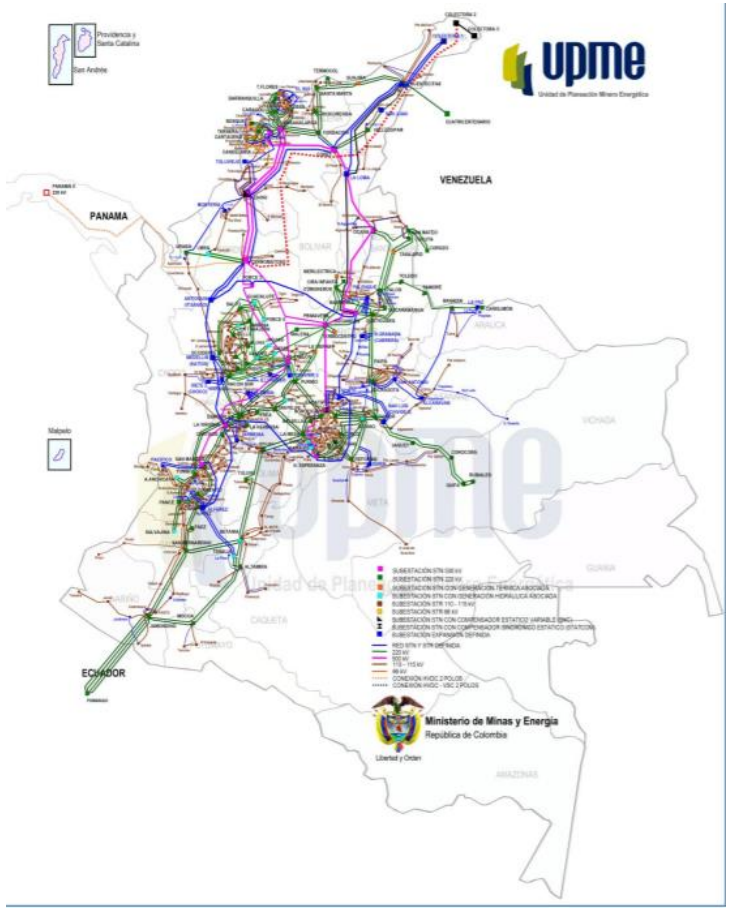
- 95% of the staff working from home since March 13, 2020
- Laptops, chairs and screens provided
- Weekly webcasts to provide guidance during the pandemic and how to face the quarantine
- Flexible schedules

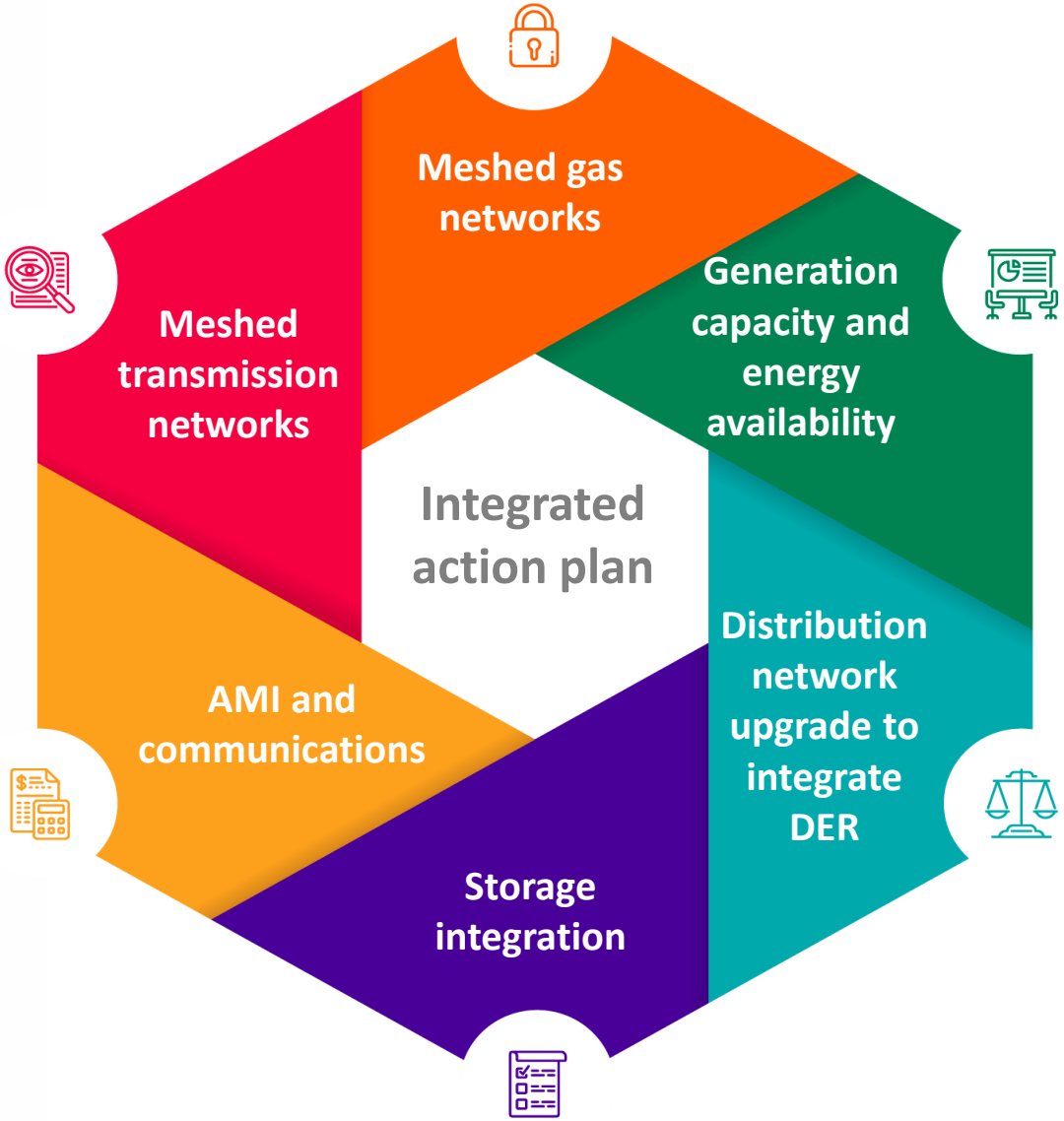
Strategies to keep the system operating

- **Distributed operation**: main + back up control centers
- **Sequestration** of control center personnel
- **Shifts** modifications: 3 people x 12 hours
- **Facilities** adjustments: keep distance, individual equipment, constant cleaning and disinfecting
- Health **monitoring**
- Crew **recruitment** and re-training

Actions to mitigate vulnerabilities

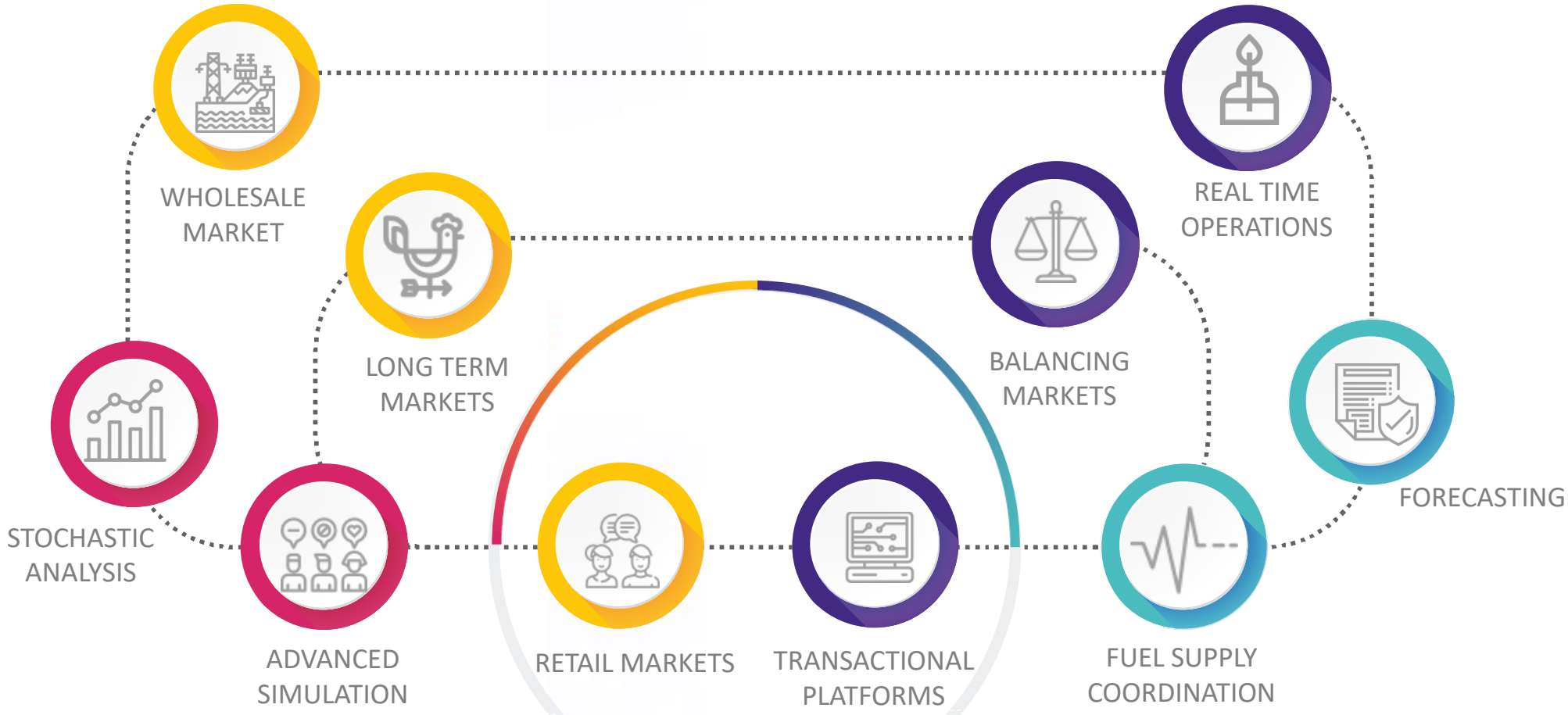
Infrastructure improvement





Actions to mitigate vulnerabilities

Processes and systems



POLICY AND REGULATION

CYBER SECURITY

ADVANCED ANALYTICS

KNOWLEDGE

Final thoughts

Some things to ponder

- System operator must perform **resilience studies to complement traditional reliability** analysis. Most of the actions taken from resilience experiences have been reactive instead of proactive
- Low probable and high impact events to include in resilience studies must be according to **each system's characteristics**
- **Who pays for resilience?**

  "Policymakers and regulators need to be more proactive, but the challenge is still the cost against an event's likelihood."

  "Currently, regulators and utilities haven't come to a common agreement about how to quantify resilience."

From "As extreme weather spurs billions in utility resilience spending, regulators struggle to value investments". Utility drive https://www.utilitydive.com/news/as-extreme-weather-spurs-billions-in-utility-resilience-spending-regulator/576404/

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