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
  - Hydro: 10.7 GW
  - Thermal: 5.3 GW
  - VG: 1.5 GW
- Wind: 18 MW
- Solar: 28 MW

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

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, Guatapé’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

**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

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June 12, 2020

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Actions to mitigate vulnerabilities

Infrastructure improvement

- Meshed gas networks
- Generation capacity and energy availability
- Meshed transmission networks
- Integrated action plan
- AMI and communications
- Storage integration
- Distribution network upgrade to integrate DER
Actions to mitigate vulnerabilities

Processes and systems

- Wholesale Market
- Long Term Markets
- Retail Markets
- Transactional Platforms
- Balancing Markets
- Forecasting
- Fuel Supply Coordination
- Real Time Operations
- Stochastic Analysis
- Advanced Simulation
- Cyber Security
- Advanced Analytics
- Knowledge
- Policy and Regulation
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."
