



## Updates from the November 2009 Brazilian Blackout

A simplified account based on public documents



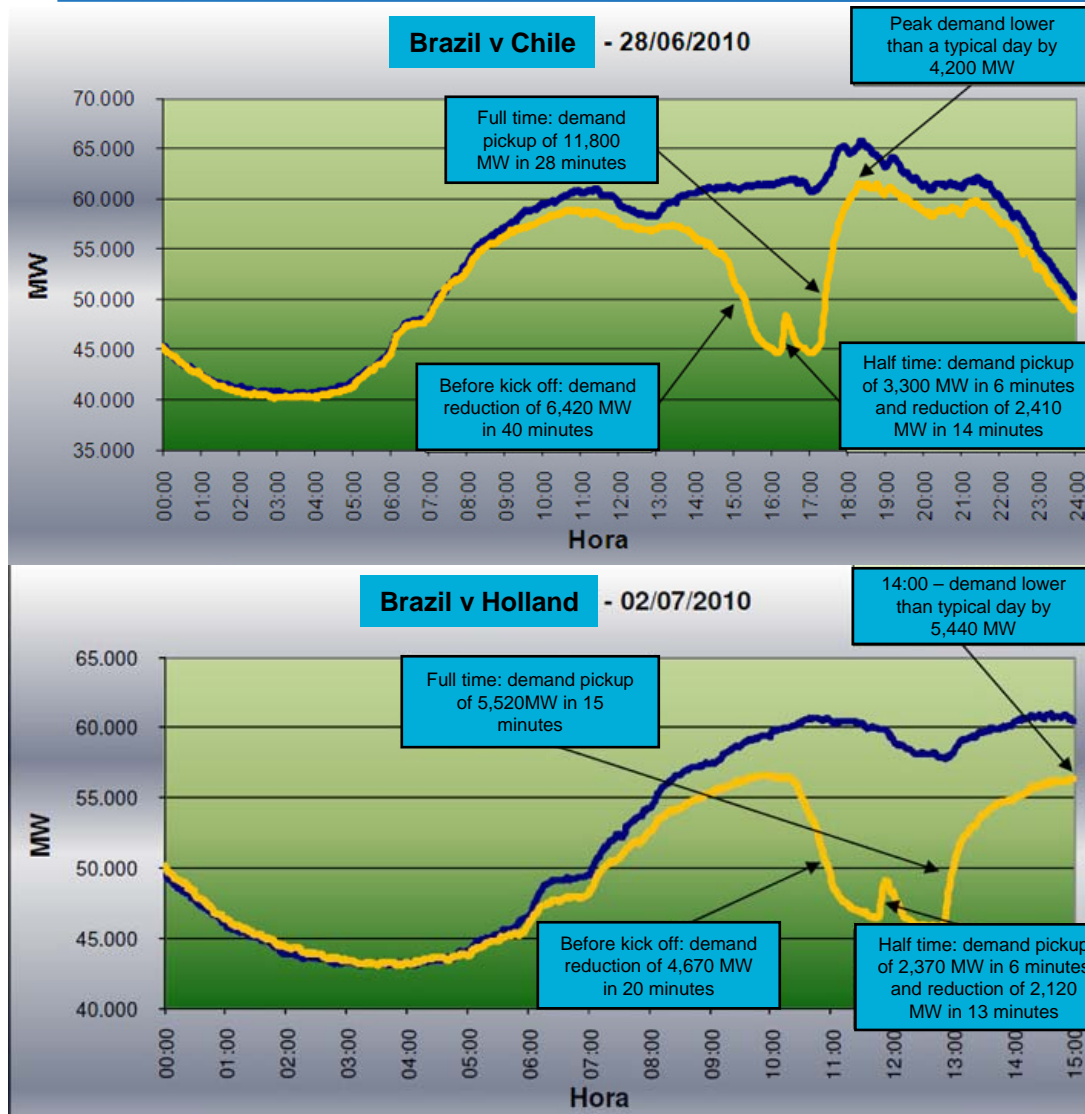
Guilherme Susteras – Future Requirements Manager

# Agenda

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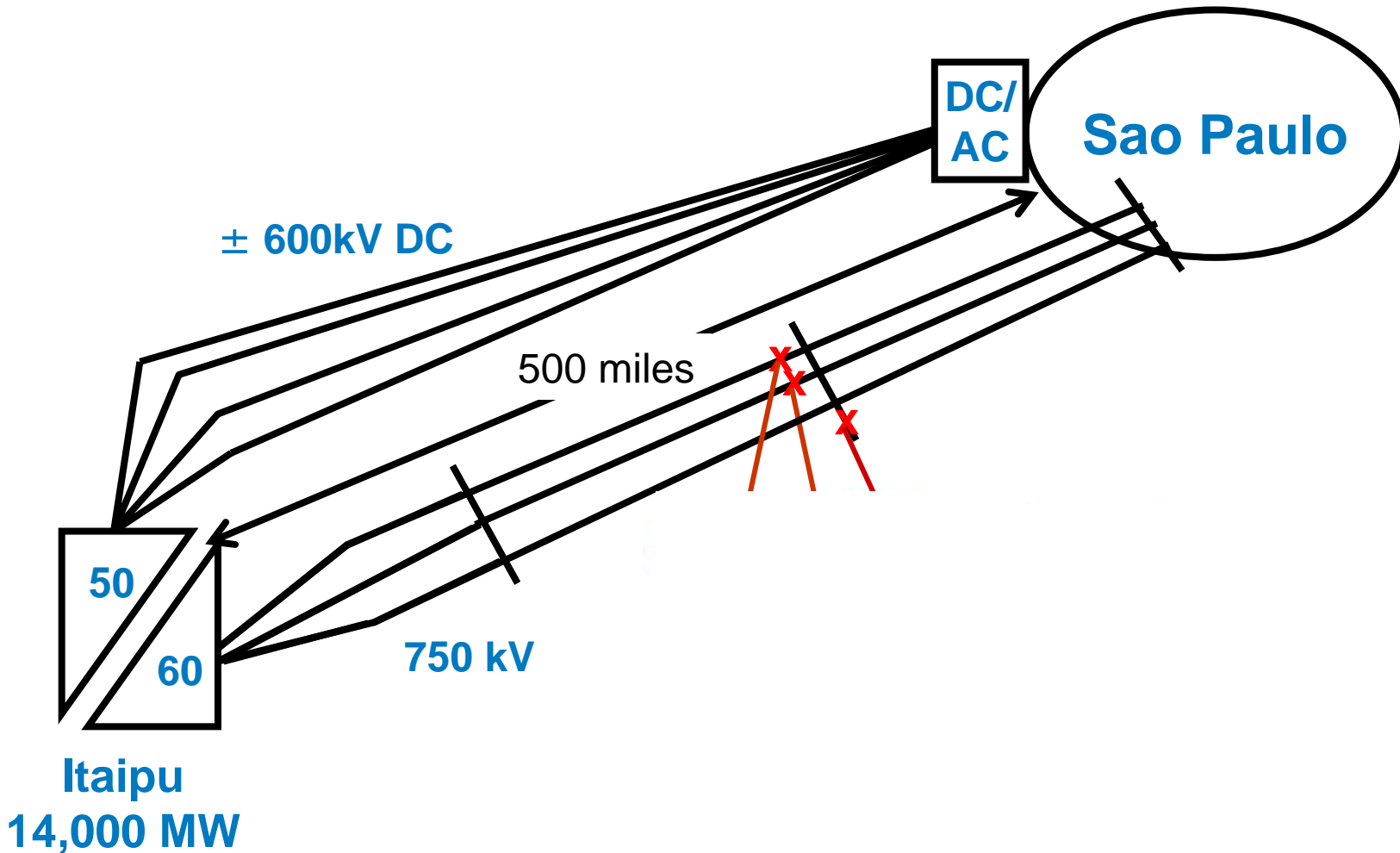
- Overview of the Brazilian system
- Sequence of events leading to blackout
- Identified causes and remedial actions

# Brazilian system dimensions

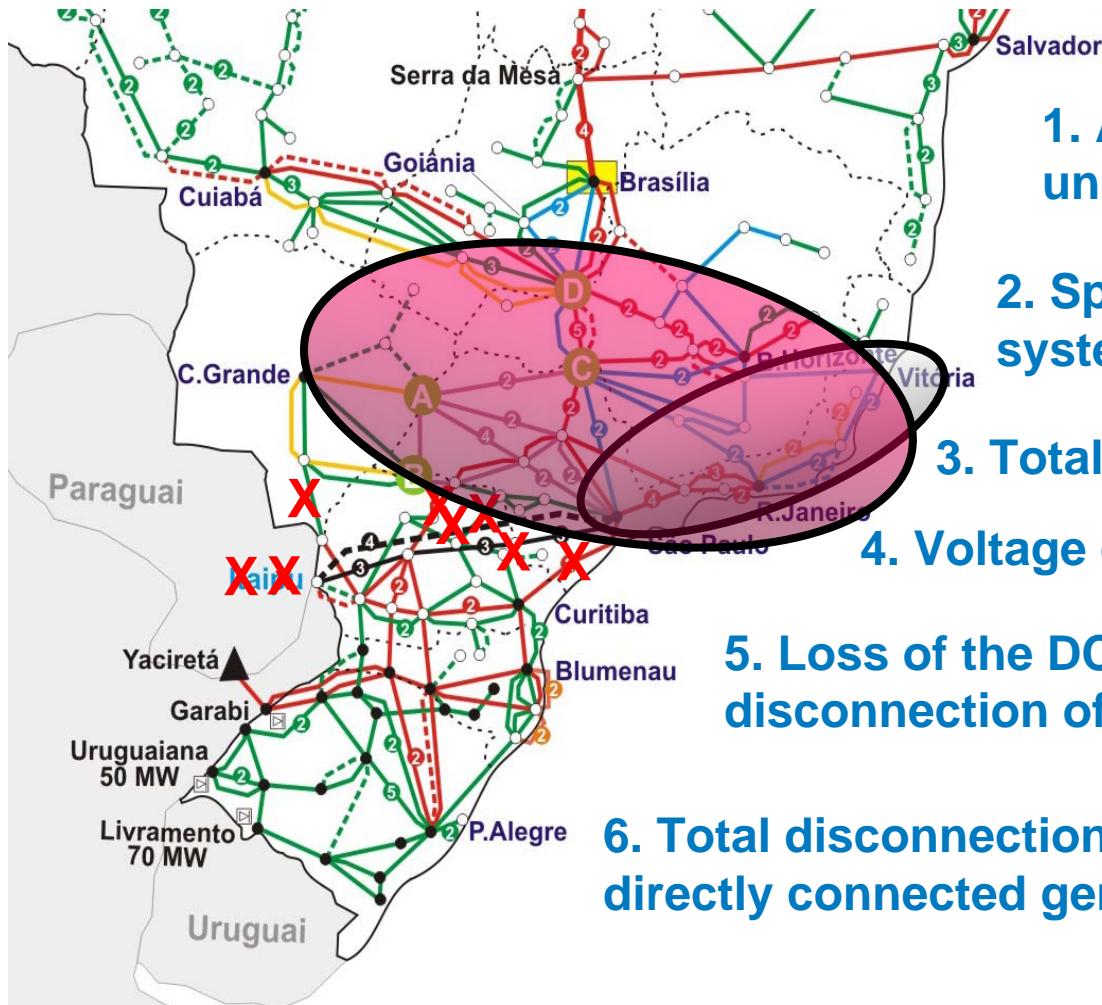


- 108 GW installed generation capacity
- 71 GW peak demand
- 450 TWh consumption
- 95,000 km of overhead transmission lines in 230/345/440/500/750 kV
- 63 different TOs
- World Cup Pick Up
- Interconnected system divided into 4 sub-markets

# Itaipu transmission system and events of the 11<sup>th</sup> November 2009



# Cascading effect of loss of Itaipu 750kV corridor



**1. Automatic disconnection of 5 units in Itaipu 60 Hz**

**2. Splitting of South/Southeast systems**

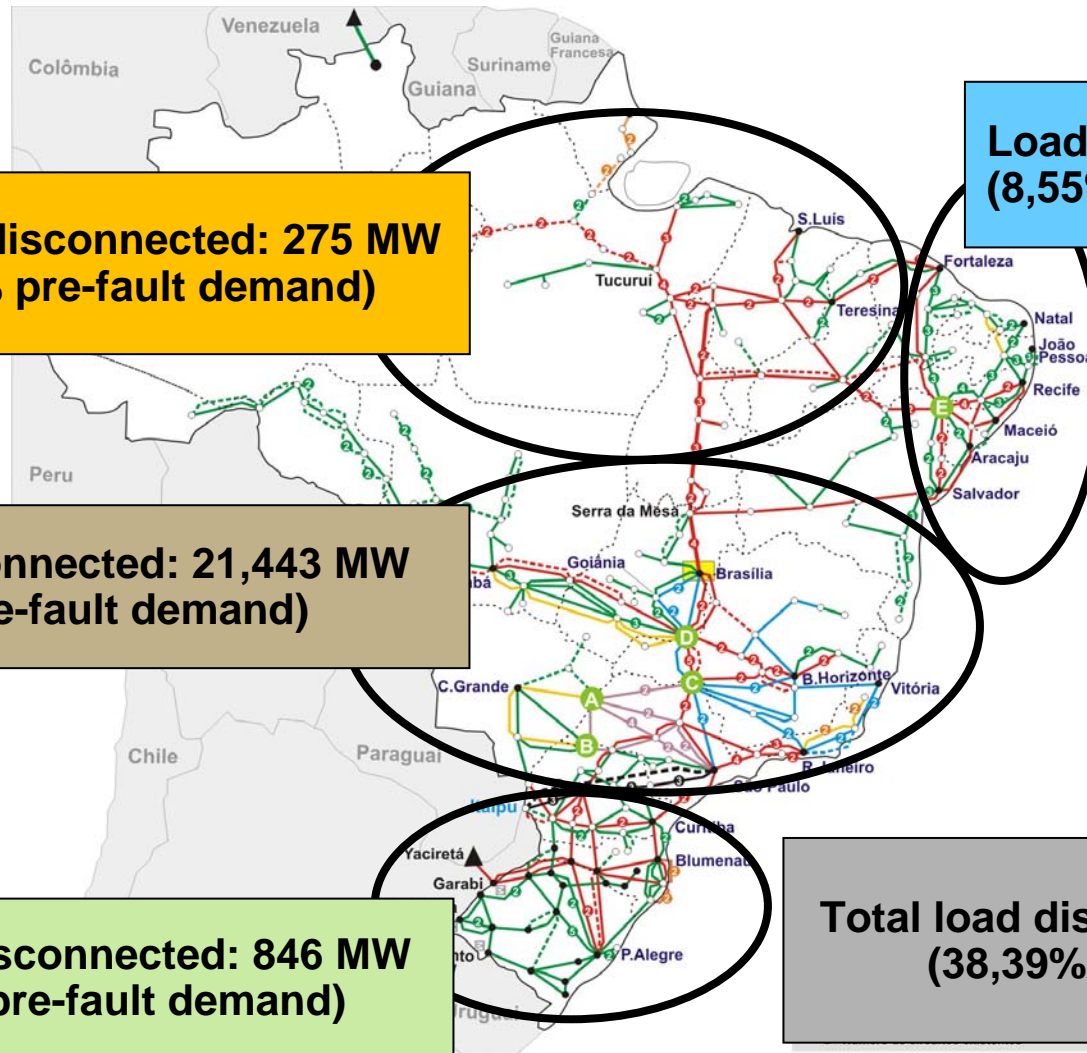
**3. Total loss of Itaipu 60 Hz (5.6 GW)**

**4. Voltage collapse**

**5. Loss of the DC link and automatic disconnection of Itaipu 50 Hz (5.3 GW)**

**6. Total disconnection of transmission system and directly connected generation**

# Effect on demand per sub-market



**Load disconnected: 275 MW  
(7,02% pre-fault demand)**

**Load disconnected: 767 MW  
(8,55% pre-fault demand)**

**Load disconnected: 21,443 MW  
(56,08% pre-fault demand)**

**Total load disconnection: 23,331 MW  
(38,39% pre-fault demand)**

**Load disconnected: 846 MW  
(8,77% pre-fault demand)**

## Causes and remedial actions



- Short circuits caused by the reduction of the effectiveness of the isolators submitted to adverse meteorological conditions, characterized by intense rain and squalls.

- Remedial actions include a full revision of planning/operating standards, protection systems, maintenance programmes and the installation of booster sheds (a.k.a. Chinese hats) to improve isolators resilience to heavy rainfall



# Summary

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- Brazilian system: continental dimensions
- Instantaneous infeed loss of over 5 GW provoked voltage collapse and cascaded into partial system shutdown
- Root cause: reduced effectiveness of isolators submitted to adverse weather conditions
- National Grid system is operated such that the instantaneous infeed loss following a busbar fault is limited to 1320 MW
  - Sufficient reserve is held in the system to withstand such sizeable loss

*Question?*

**E-mail – [energy.operations@uk.ngrid.com](mailto:energy.operations@uk.ngrid.com)**