CONVERSATORIO :

Junio 10

Sistemas HVDC

SESIÓN 2 :
Operación e impacto de Sistemas HVDC en redes existentes

Issues derived from the Multiplicity of new HVDC Links Embedded to AC Transmission Grids Experience in Brasil

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President - Technical Council CIGRE
Eletrobras Chief Transmisson Officer

Un evento:

Philosophy for Implementing new HVDC Schemes in Brazil

- ✓ **Differently from China, Brazil has been planning the HVDC links in a pair of Bipoles**

- ✓ **Two standards in the country:**
  - ✓ **± 600 kV 3,150 MW 2,625 A; Itaipu and Madeira Bipoles**
  - ✓ **± 800 kV 4,000 MW 2,500 A: Belo Monte Bipoles**
- ✓ **In parallel, they can transmit, respectively:**
  - ✓ **6300 MW**
  - ✓ **8000 MW**
- ✓ **Itaipu and Madeira links: were designed to allow bipolar parallel operation**
- ✓ **Belo Monte links: the receiving end terminal selected differently for each Bipole: greater concern of loosing the entire two Bipoles for an AC fault at the receiving end terminal**

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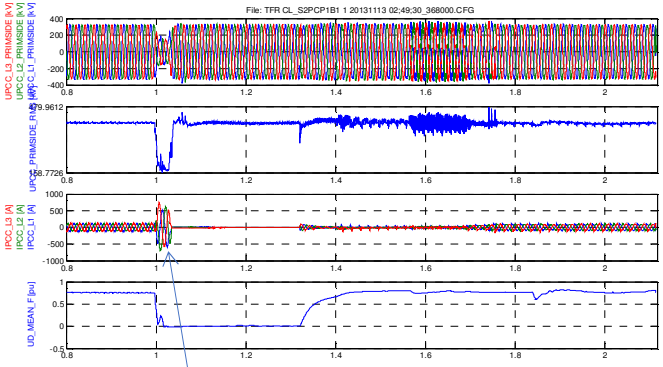
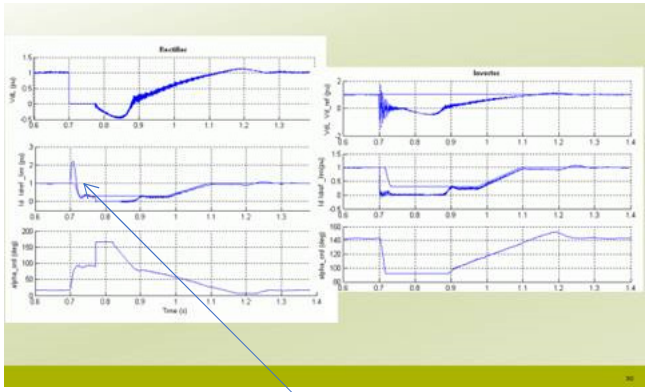
- ✓ Belo Monte links: the receiving end terminal selected differently for each Bipole: greater concern of loosing the entire two Bipoles for an AC fault at the receiving end terminal

VSC x LCC: Recovery from a DC line fault



Fault current cleared by AC breaker (3 cycles); full recovery time, from 700 to 1500 ms; with DC breakers or full bridge, time will be less



Fault current cleared by Thyristor control in 10 ms; typical straight forward recovery time in the range of 400 ms, including arc deionization

HVDC response due to a mid-line pole DC fault: left VSC System; right typical LCC Scheme

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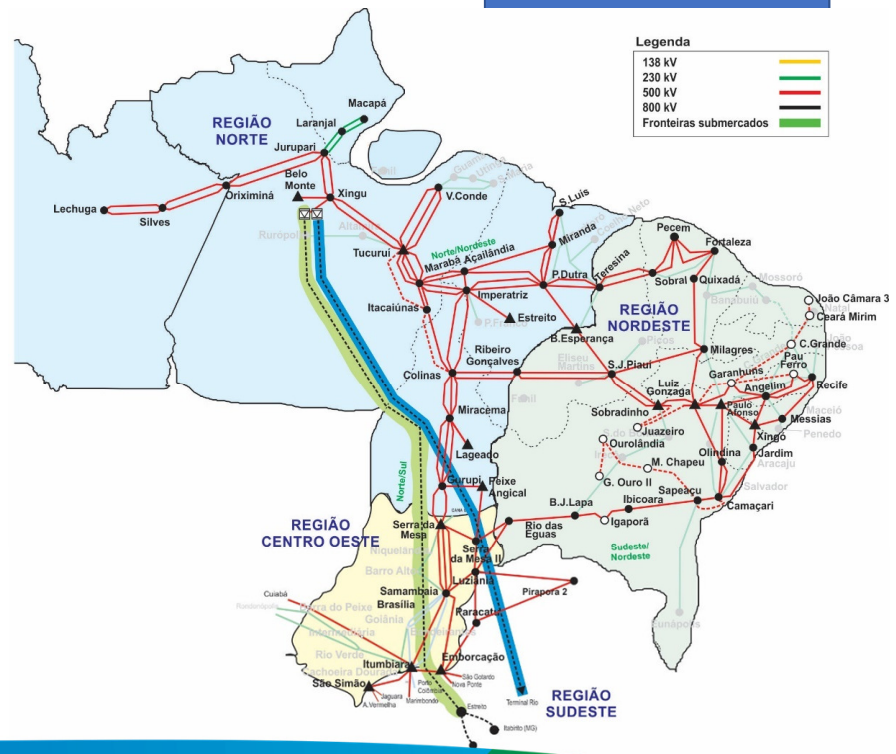
Configurations of Madeira and Belo Monte HVDC Projects

Madeira Project

Belo Monte Project



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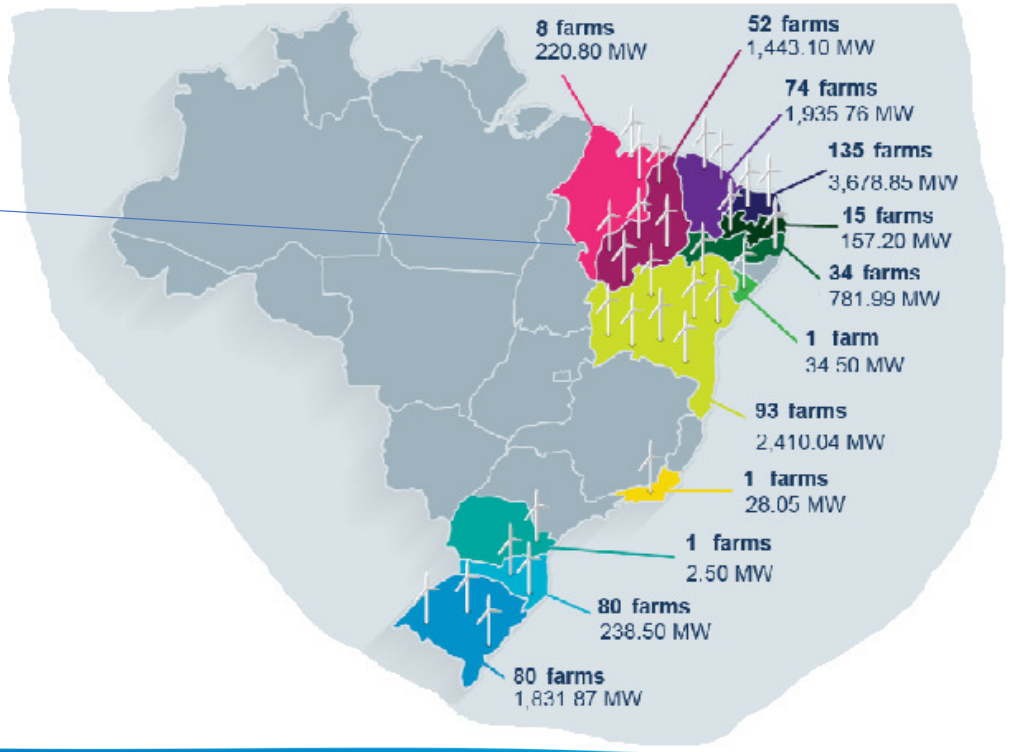
Need for a further HVDc link to power flow control in avery meshed network



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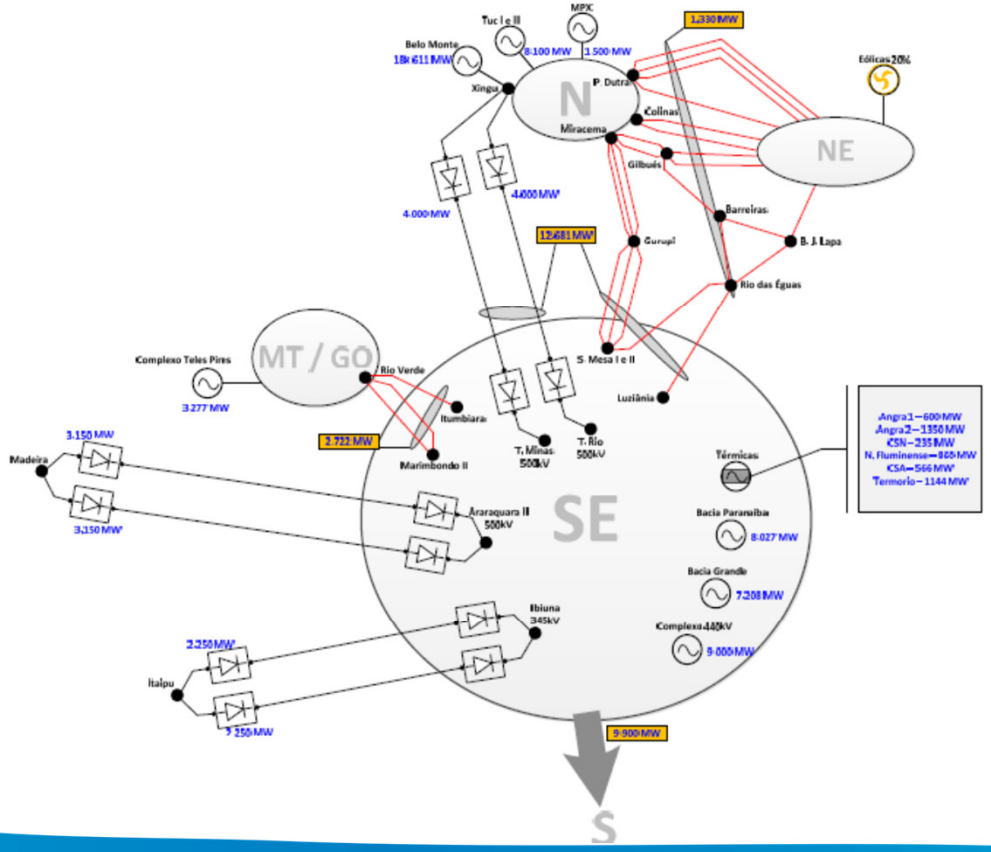
Therefore after completion of the Madeira and Belo Monte projects, we will have 4 PoC in the Southeast region (SE) where major load is placed.



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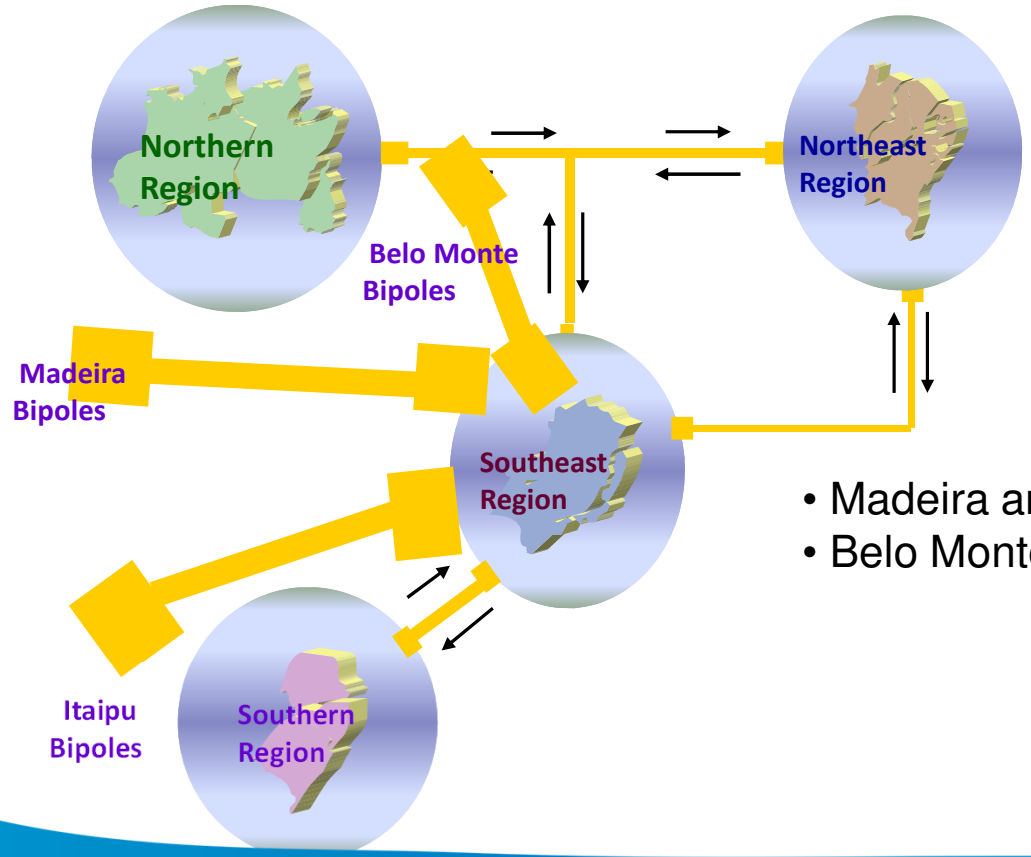
System Effect of HVDC Links



- Madeira and Itaipu: assinchronous
- Belo Monte: system embedded and bi-directional

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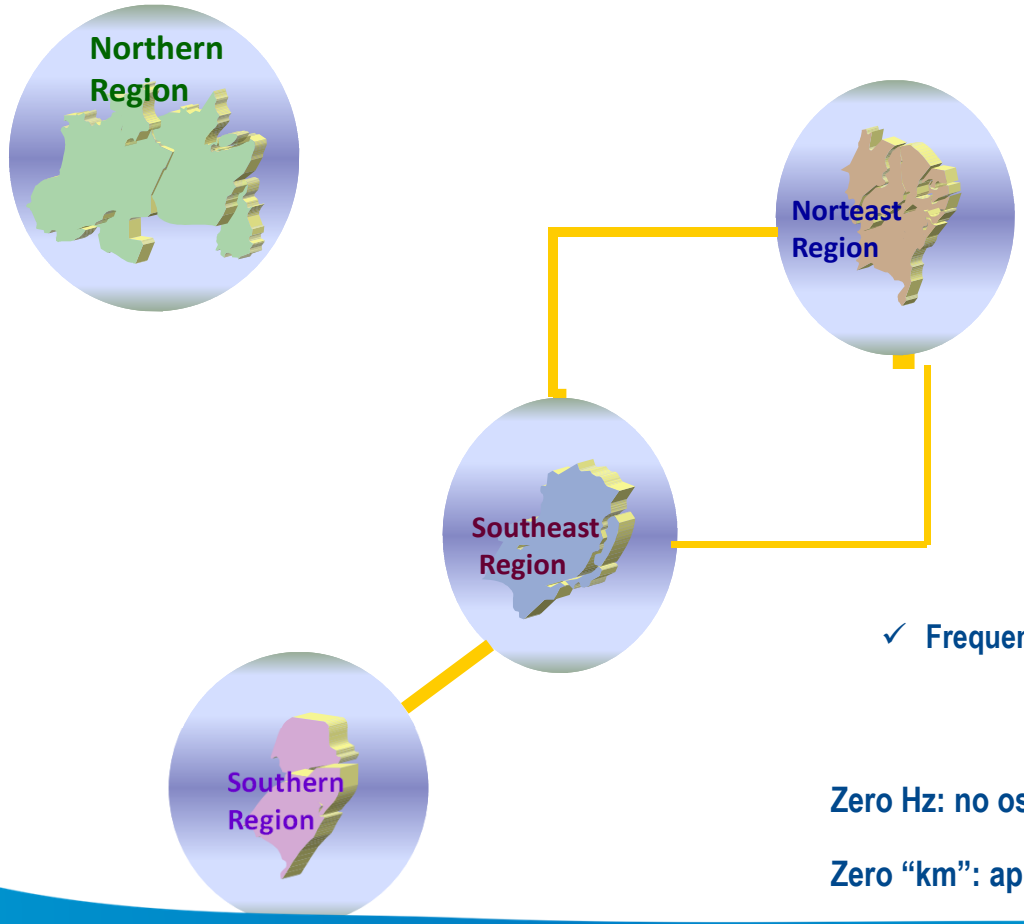
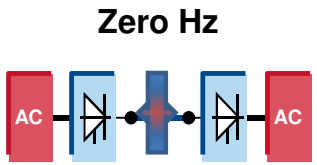
The Benefit of close integration of regions



✓ Frequency Decoupler



Zero Hz: no oscillation modes transfers

Zero “km”: approximation effect of sending and receiving end terminals

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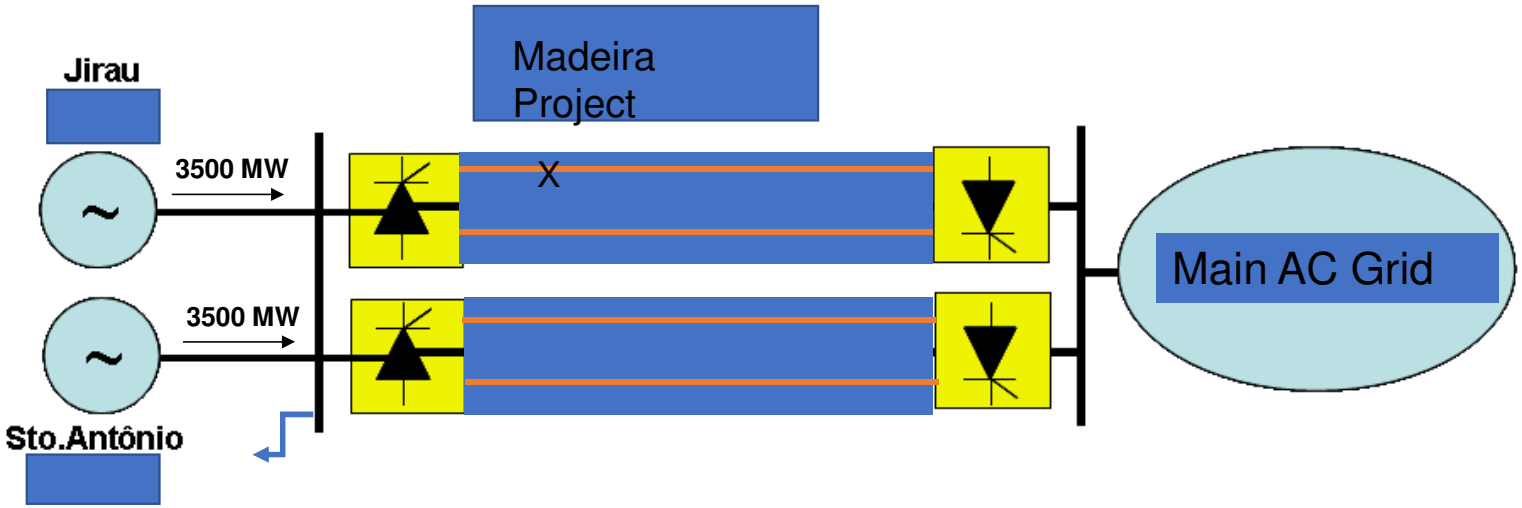
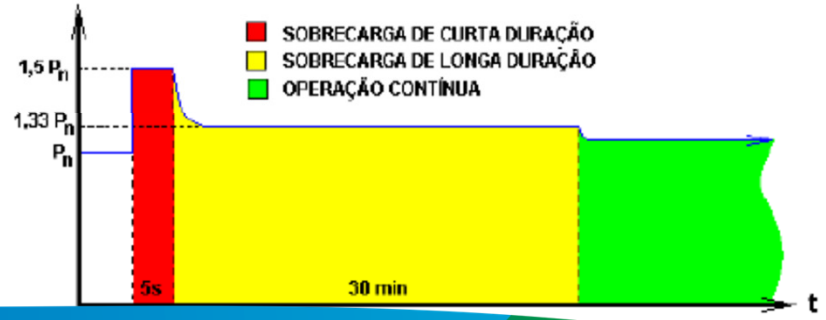
Overload Cycles Specified



For a pole outage, apply the overload in the other 3 Poles, so as to keep the same Pdc level.



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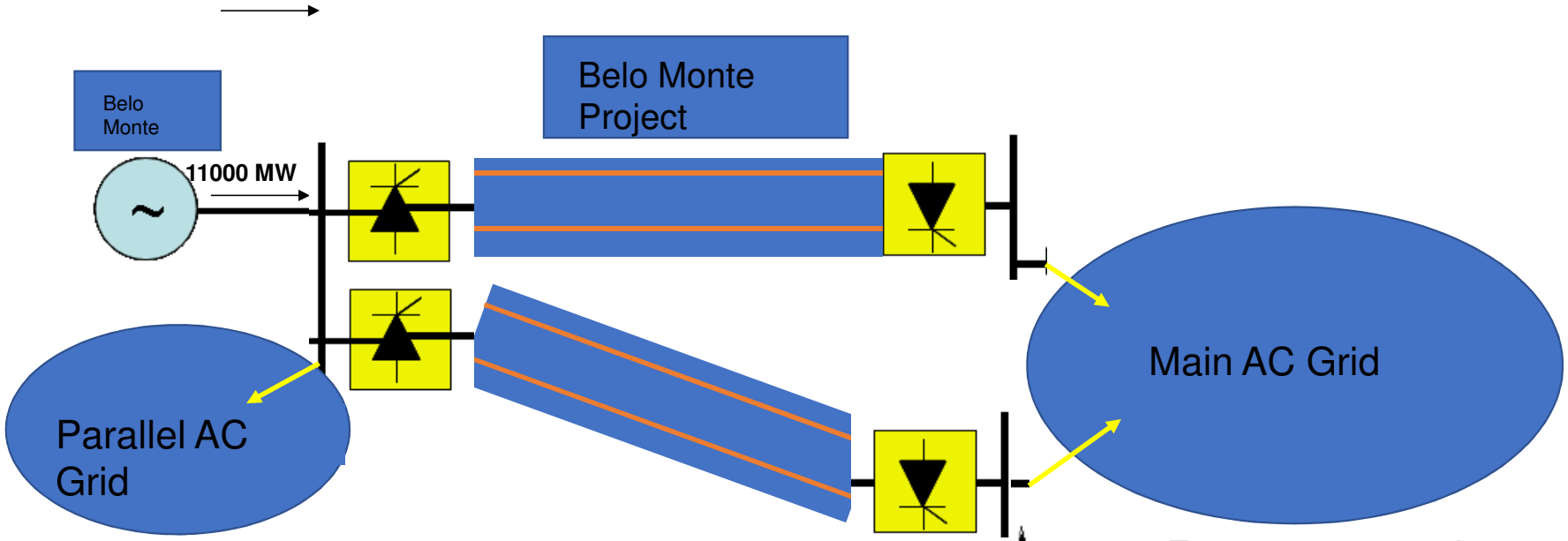
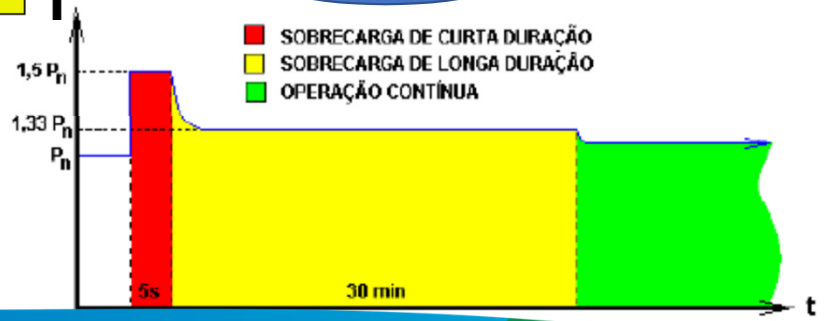


For any AC or DC contingency, apply the overload in all avaliable Poles or Bipoles.



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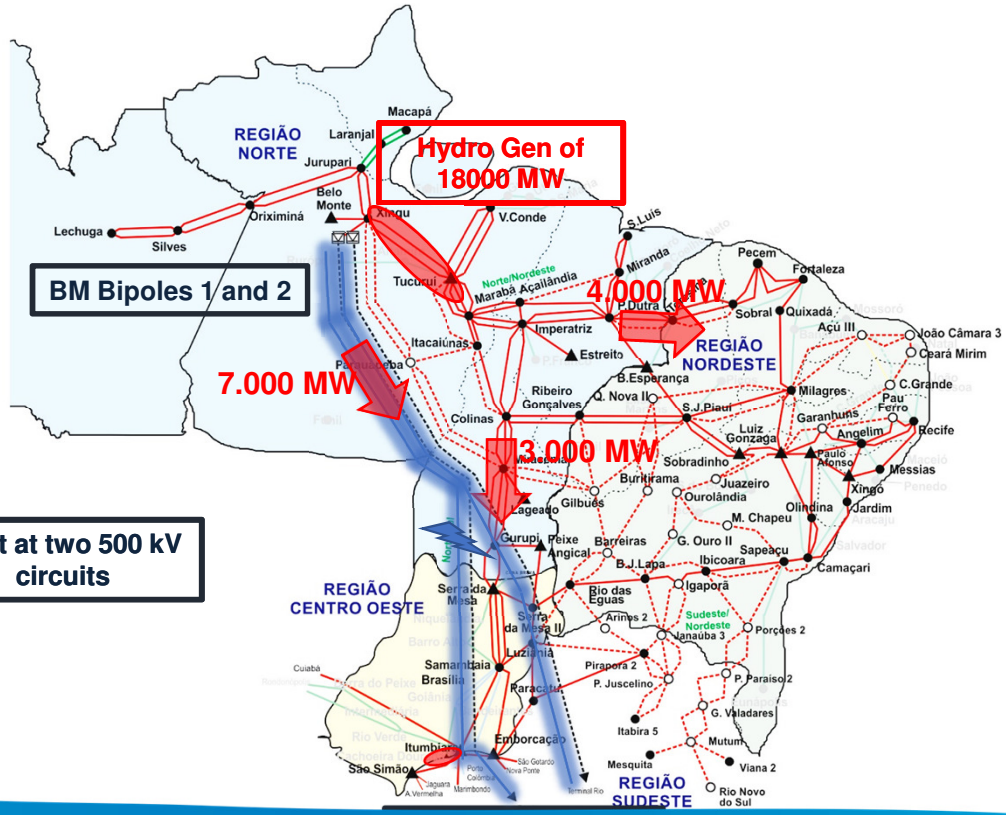
Stability Studies Results (Belo Monte)

Main Configuration:



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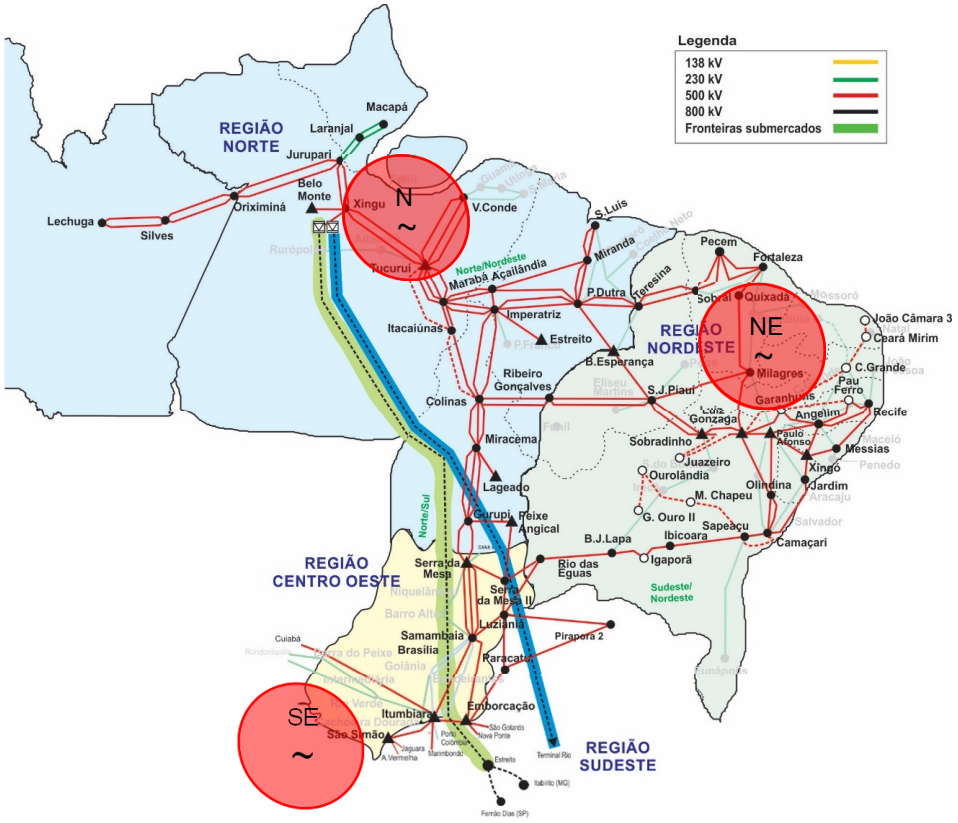
Stability Studies Results

Reference Machines:

N = Northern System (H)

NE = Northeastern (H + WP + T)

SE = Southeastern (H + T)



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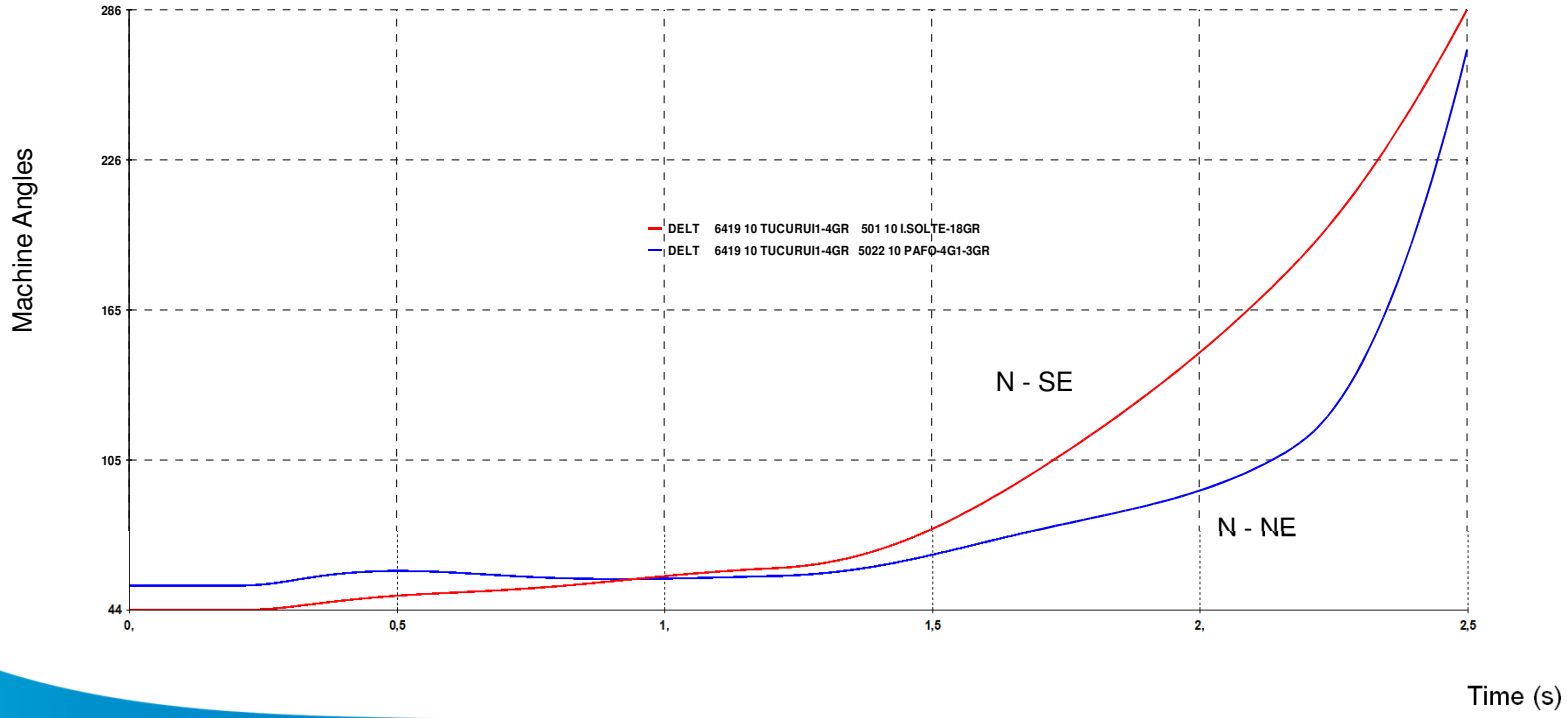
Results with no overload



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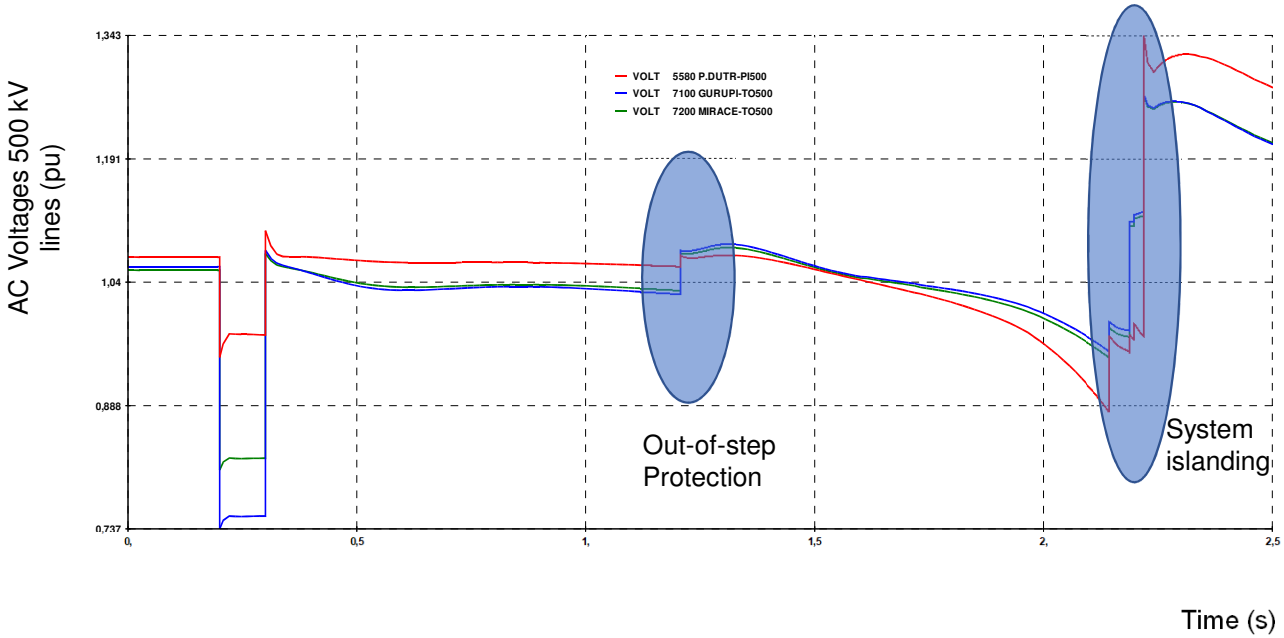
Results with no overload



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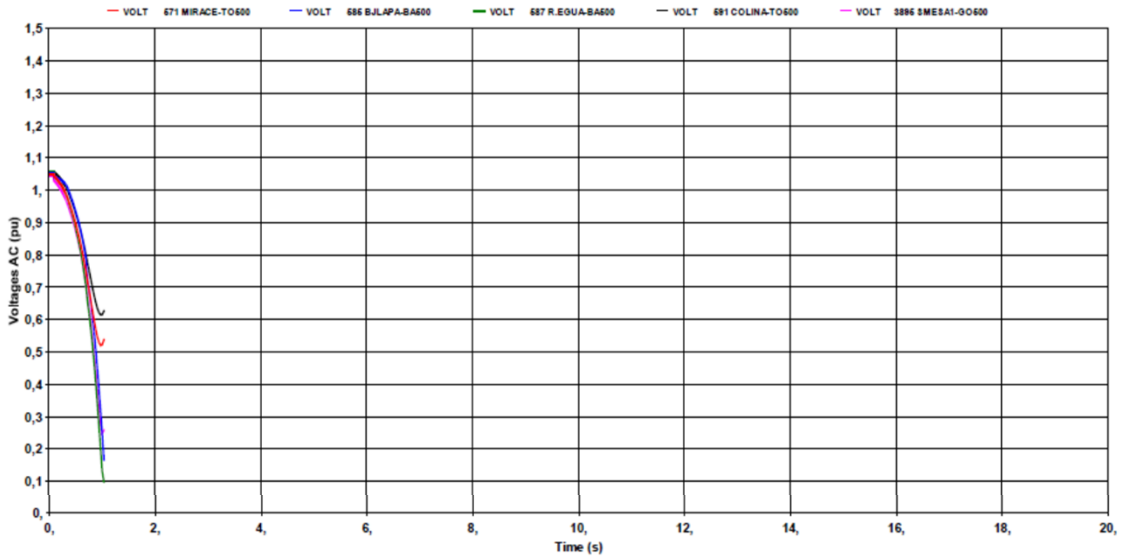
Results with no overload - worst

Machine Angles



Time (s)

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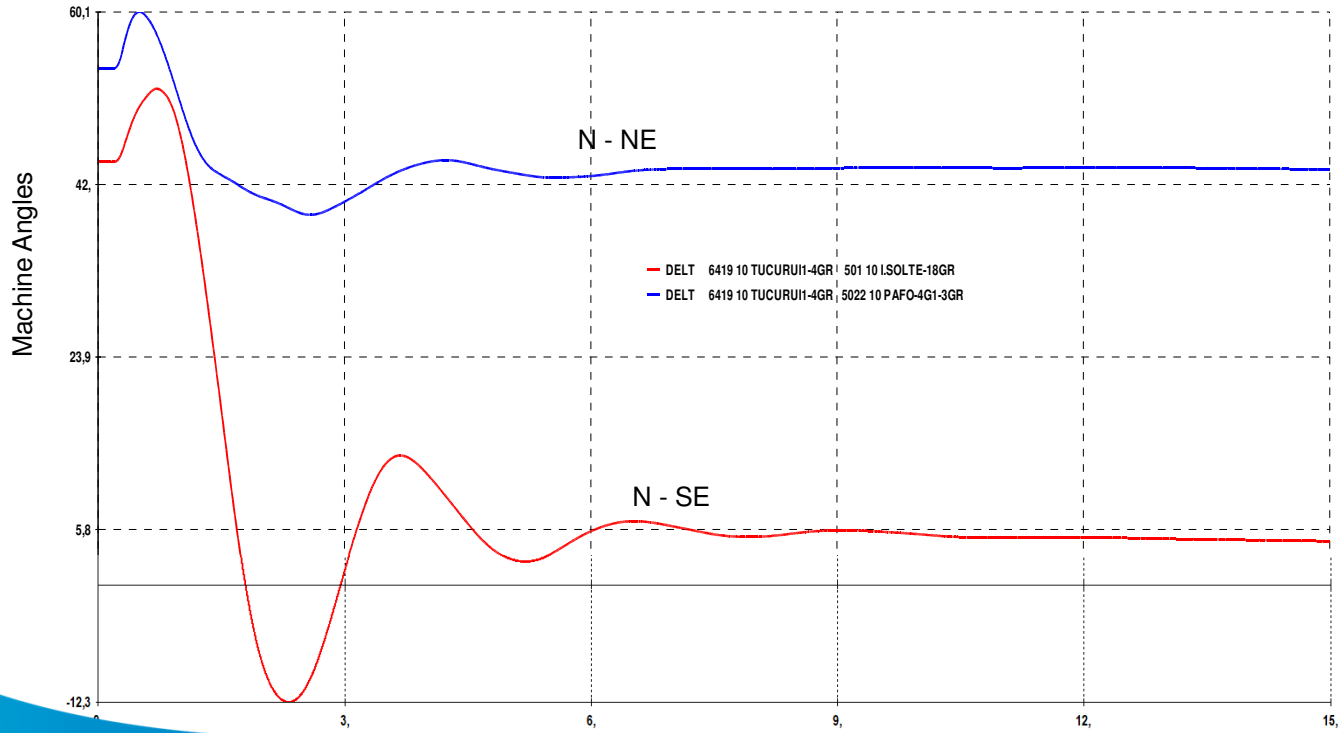
Results with 33% overload



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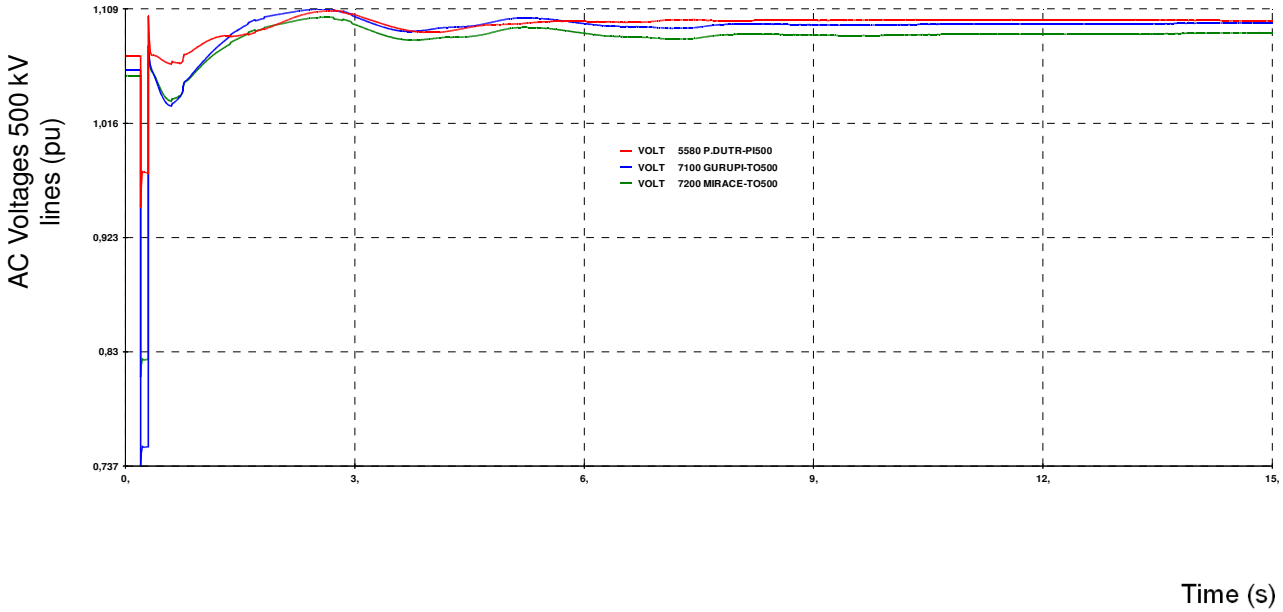
Results with 33% overload



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Conclusions

1. **HVDC links cannot longer be considered as separate “entities” in the Grid.**
2. **Coordination studies to assess the external signals (from the AC system) that may require run-up or run-down of the HVDC dispatch, are becoming of greater importance.**
3. **HVDC overload requirements have to be carefully analyzed.**
4. **HVDC embedded in the AC Grid may provide fundamental contributions to system stability and security.**
5. **Current studies contemplate: key external signals to be considered by the Master Control; flexibility in the overload level and ramp time to be set.**
6. **Objective is to minimize the number of Hydro machines to be dropped to maintain system stability.**

Muchas Gracias!!

Gracias


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