Study Committee C1

System Development and Economics

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FACTS and D-FACTS: The Operational Flexibility Demanded by the Transmission Expansion Planning Task with Increasing RES

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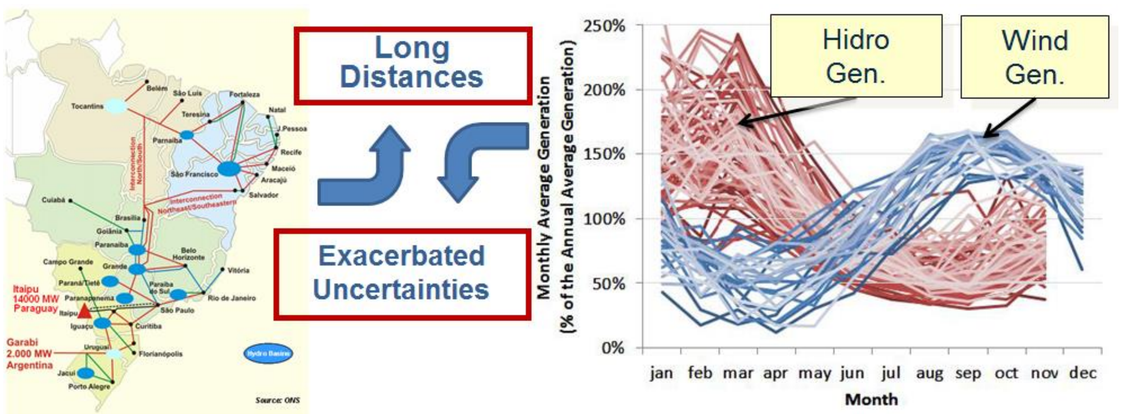
Motivation

There are several reasons to explain why transmission system loading is less than 100%:

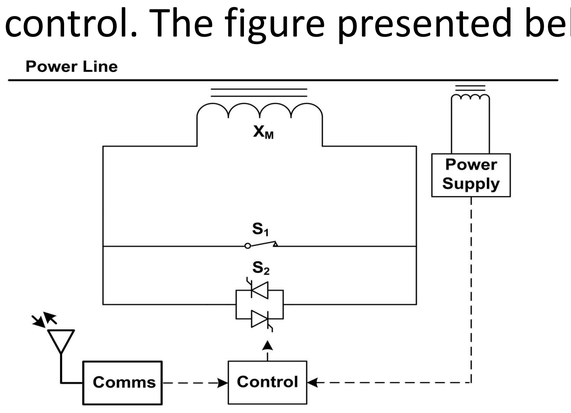
- Reliability;
- Uncertainties associated with the demand growth forecast;
- Different economic dispatch scenarios ➔ input data associated with RES;



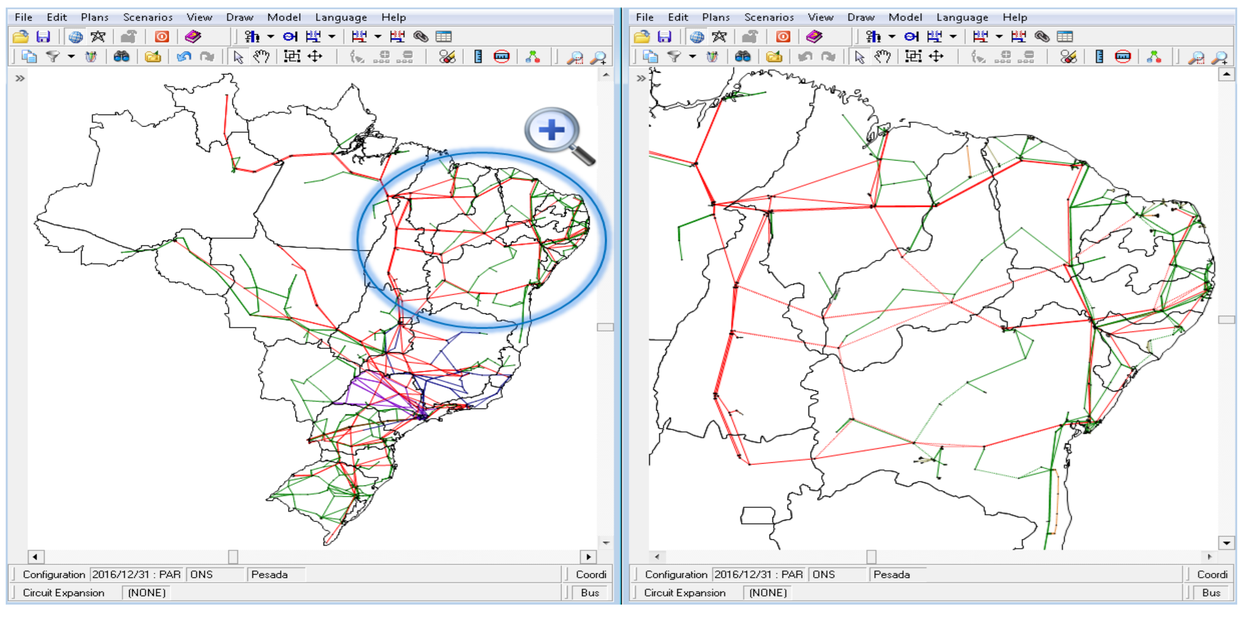
Objects of Investigation

The conjunction of the aforementioned facts leads to high investments to meet different dispatch scenarios and low loading throughout the year. These facts further emphasize the importance of operational flexibility in order to result in cost savings in the long-term transmission expansion planning task.

As electrons do not respect contracts, only Kirchhoff, FACTS and D-FACTS devices should be seen as key solutions for active power control. The figure presented below shows a D-FACTS device:



System under Analysis



Method/Approach

The following transmission expansion planning case studies will be solved through the software NetPlan®:

- Case Study 1 (CS1) ➔ Business as Usual (BAU): allow the Network Expansion Tool (NXT) to build new candidate lines;
- Case Study 2 (CS2) ➔ BAU + PLG: allow the NXT to a) build new candidate lines, b) deploy PLGs on existing lines or c) any combination of a) and b);
- Case Study 3 (CS3) ➔ BAU + TCSC + PLG: allow the NXT to a) build new candidate lines without TCSC, b) build new candidate lines with TCSC, c) deploy PLGs on existing lines or d) any combination of a) to c).

Discussion

- Expansion Plan for the BAU Case:

Scenario	P1	P25	P50	P75	P100	All Scenarios
Number of Line Additions - 230 [kV]	14	16	15	17	20	20
Number of Line Additions - 500 [kV]	5	3	1	1	6	5
Total Line Additions	19	19	16	18	26	25
Lines in the Robust Exp. Plan	11	15	12	18	18	All
Expansion Plan Cost [M$]	649	529	330	347	727	745
Expansion Plan Cost [%]	197%	161%	100%	105%	221%	226%
CPU Time [Seconds]	35	3	2	2	78	283

- Summary of the Case Study Results:

Case Study	Total Line Additions	Lines in the CS1 Exp. Plan	Total CSCD Additions	Investments in Lines [M$]	Investments in CSCDs [M$]	Expansion Plan Cost [M$]	Cost Savings [M$]	CPU Time [Minutes]
CS1	25	All	-	745	-	745	-	5
CS2	24	21	4	695	24	719	26	26
CS3	23	22	4	694	21	715	30	43

Conclusion

- Systems with increasing RES demand Operational Flexibility to reduce investments;
- FACTS and D-FACTS can be very important resources for transmission expansion planning by providing an operational flexibility to different dispatch scenarios and consequently increasing asset utilization and existing transmission capacity
- The transmission planning problem, including (or not) FACTS and D-FACTS, can efficiently be solved by commercially available models based on state of the art optimization techniques.