# Representation of uncertainties in transmission planning

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# Some uncertainties

- Energy production and load
- Investment
- Financial
- Interface between regulated and competitive environments
- Dynamic decision-making

# Production and load uncertainties

- long-term load growth, daily or seasonal load fluctuations, plant availability, fuel cost and availability and hydrological conditions
  - As discussed in a previous session, dynamic simulation may be important for hydro-based systems
- planner has to "guess" which new plants are coming into the system, and how this affects system dispatch

# Investment uncertainty

- substantial capital expenditures
- financed through a combination of direct investment and borrowing
- uncertainties in interest rates, exchange rates (in the case of foreign financing) and delays in construction due for example to environmental constraints

# Financial uncertainty

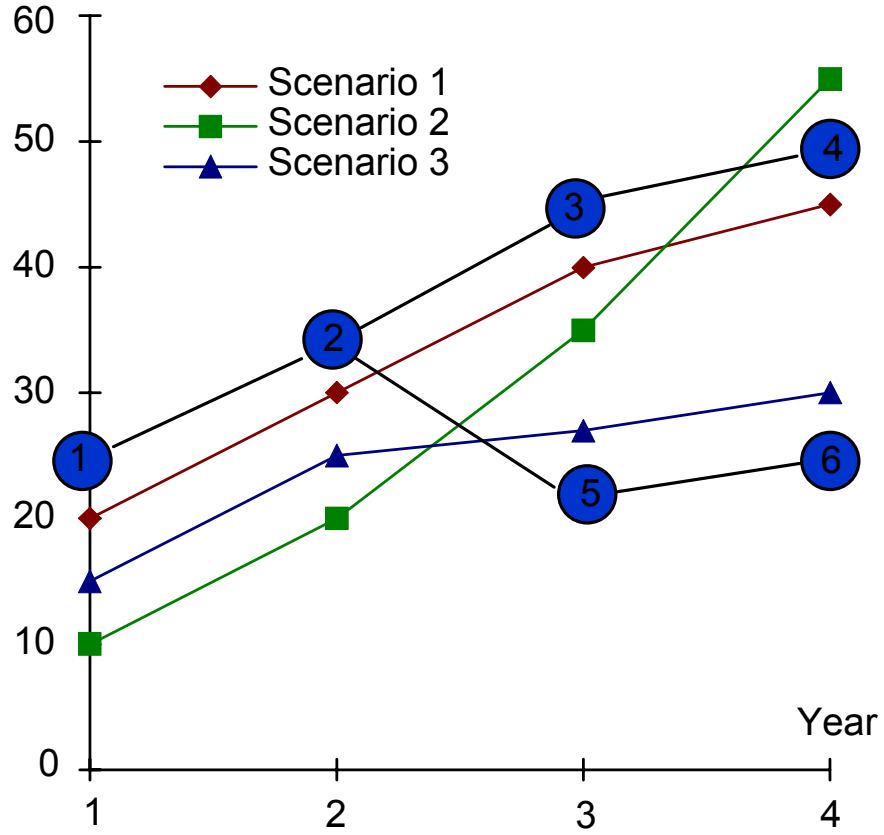
- regulated environment: financial risks of new transmission projects are transferred to customers though tariffs
- competitive environment: congestion revenues, FTR contracts etc. introduce additional uncertainty

# G&T Interfaces

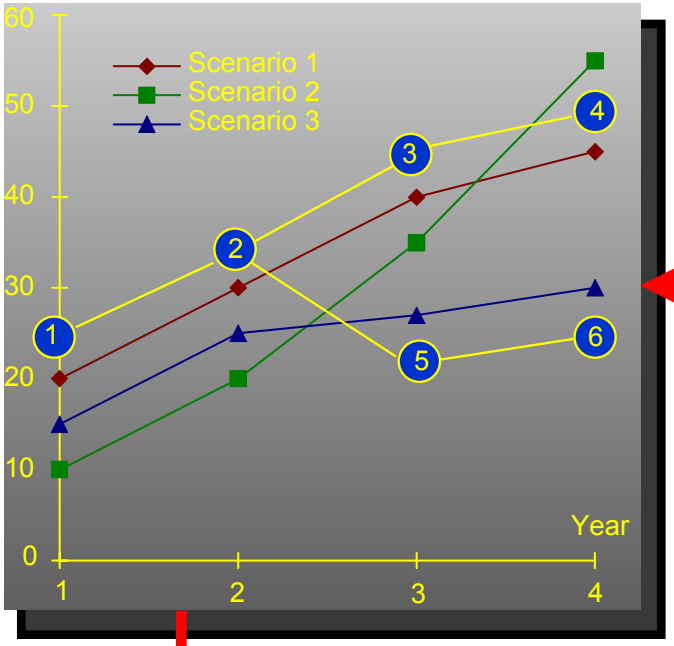
- traditional environment: economic system expansion takes into account both generation and transmission investments
- competitive environment: transmission network becomes a service provided by regulated transmission companies (RTOs)
- RTO charges have the dual function of covering network investment costs and provide siting signals to new agents

# Dynamic Hedging

- represent the dynamic aspects of decision making as uncertainties are resolved over time



# A possible analytical approach

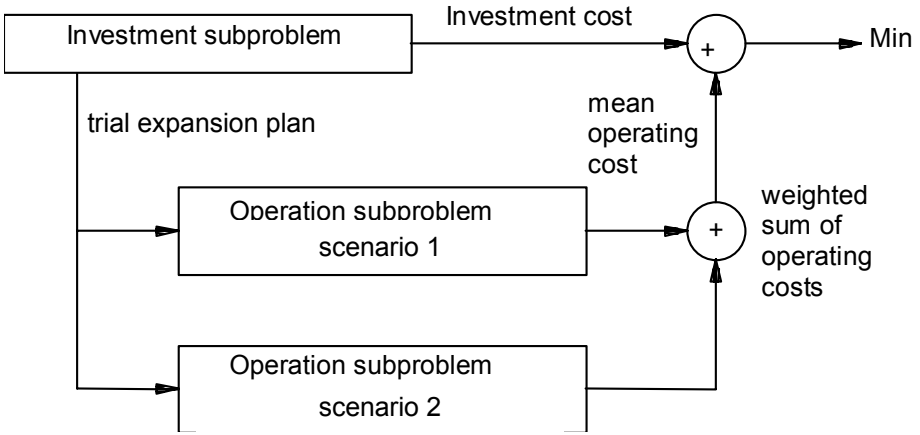



- decomposition:
  - investment subproblem
  - operations subproblem
- feedback: spot revenues
- Used in OPTGEN/OPTNET

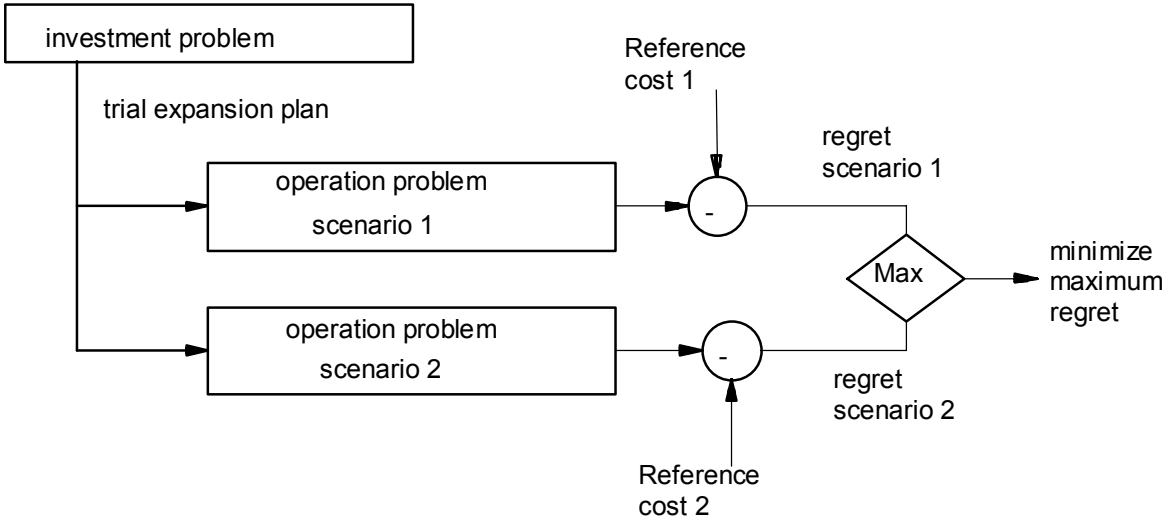
**production subproblem (SDDP)**

# Some objective functions

Min Expected value




Minimax regret




Max expected utility etc.

# Recent planning examples

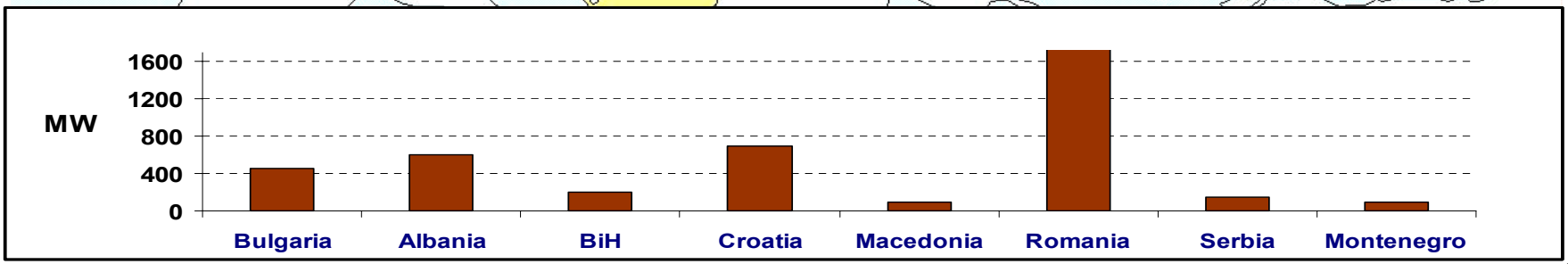
- SEETEC: Regional Electricity Market in the Balkans Region
- Venezuelan Generation and Transmission Expansion Plan
- Transmission planning in Brazil
- Transmission planning for El Salvador
- Analytical Tools:

  OPTGEN/OPTNET – generation/transmission expansion planning

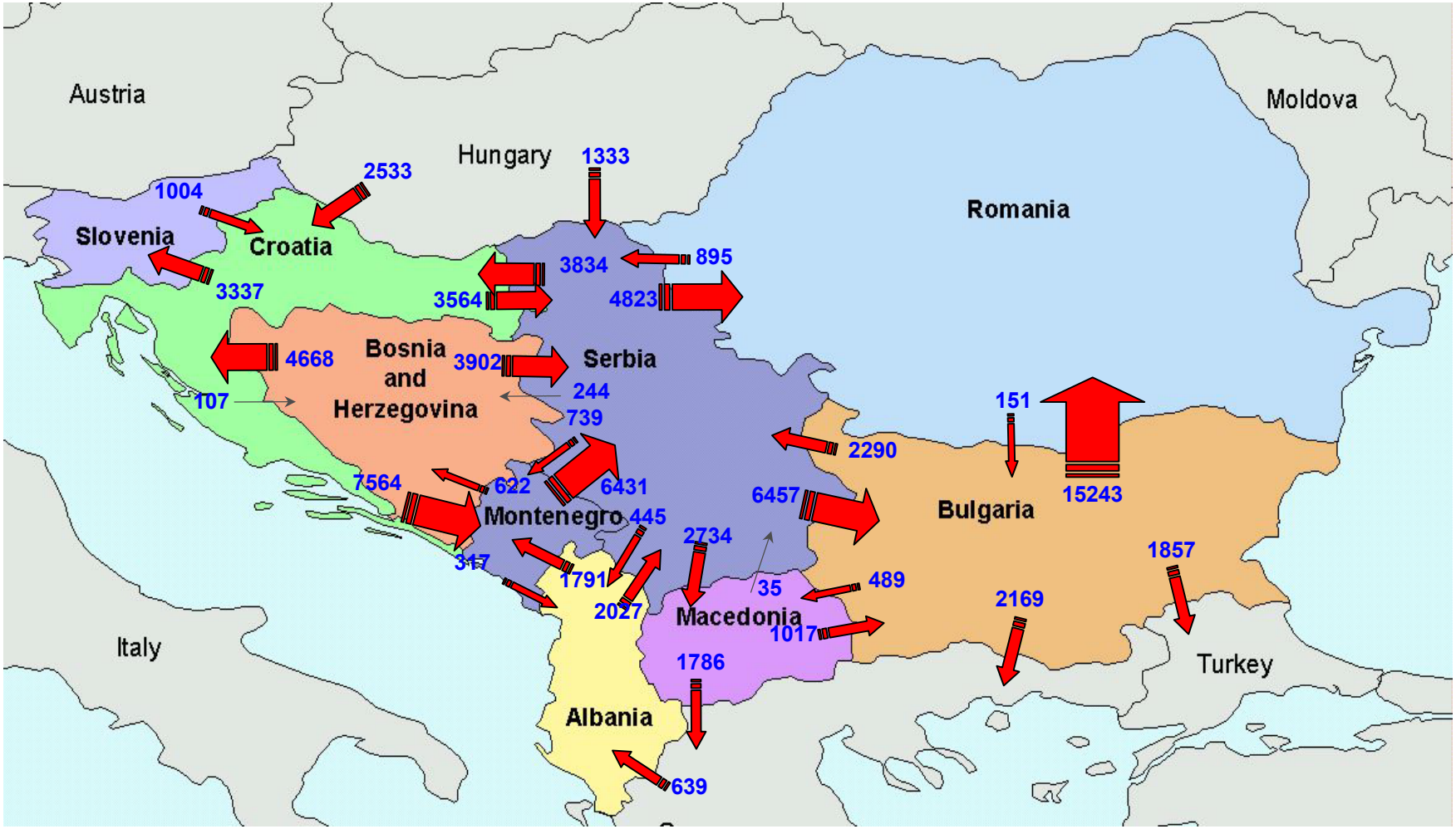
  +

  SDDP – transmission-constrained hydrothermal scheduling

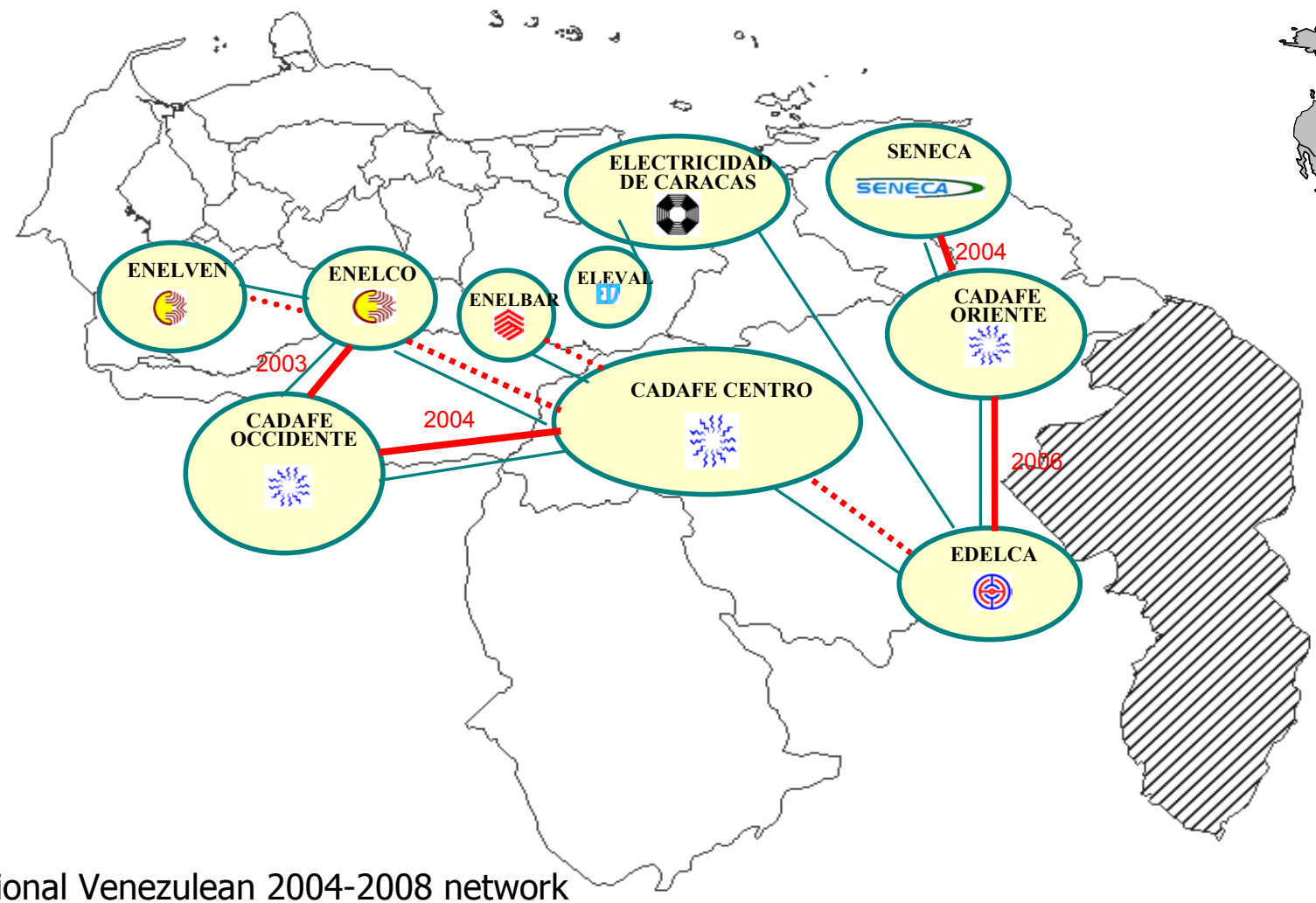
# Balkans: generation reinforcements by 2010

# Balkans: Power flows among the countries

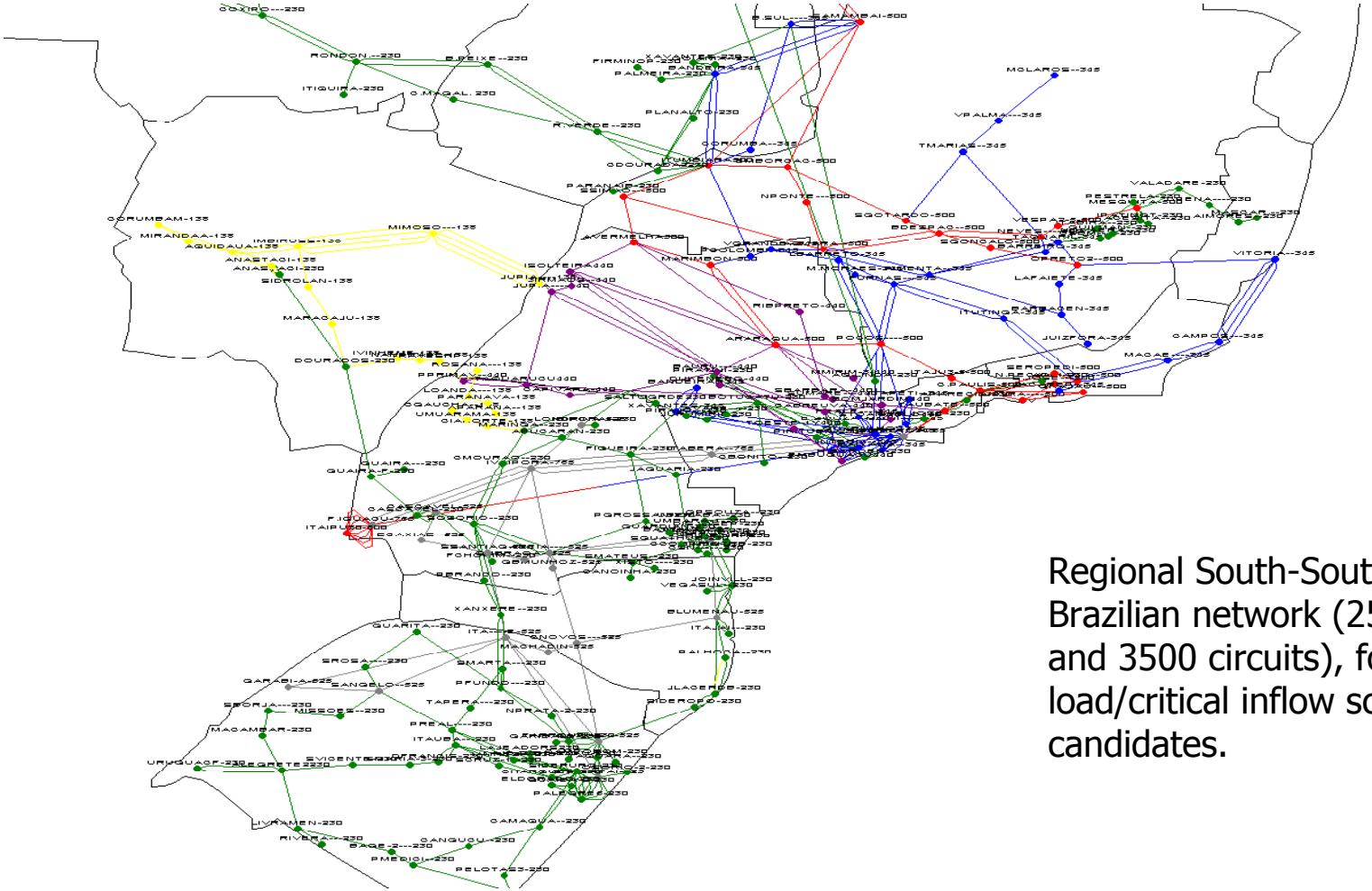


# Venezuelan G&T expansion plan




Regional Venezulean 2004-2008 network planning, considering 36 contingencies and the yearly peak load/critical inflow scenario; 125 candidate circuits

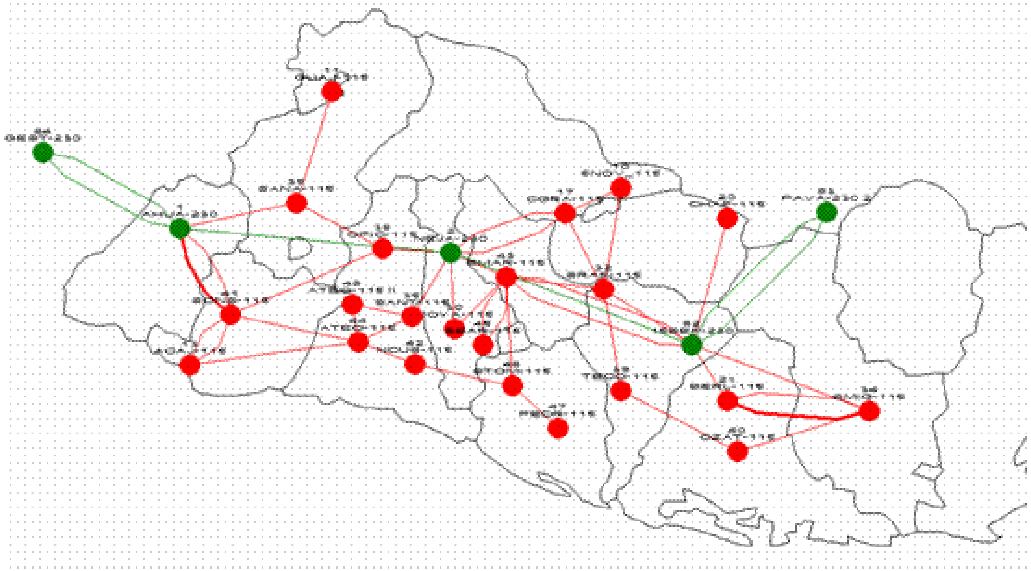
# Transmission planning in Brazil



Regional South-Southeastern Brazilian network (2500 busses and 3500 circuits), for the peak load/critical inflow scenario, 200 candidates.

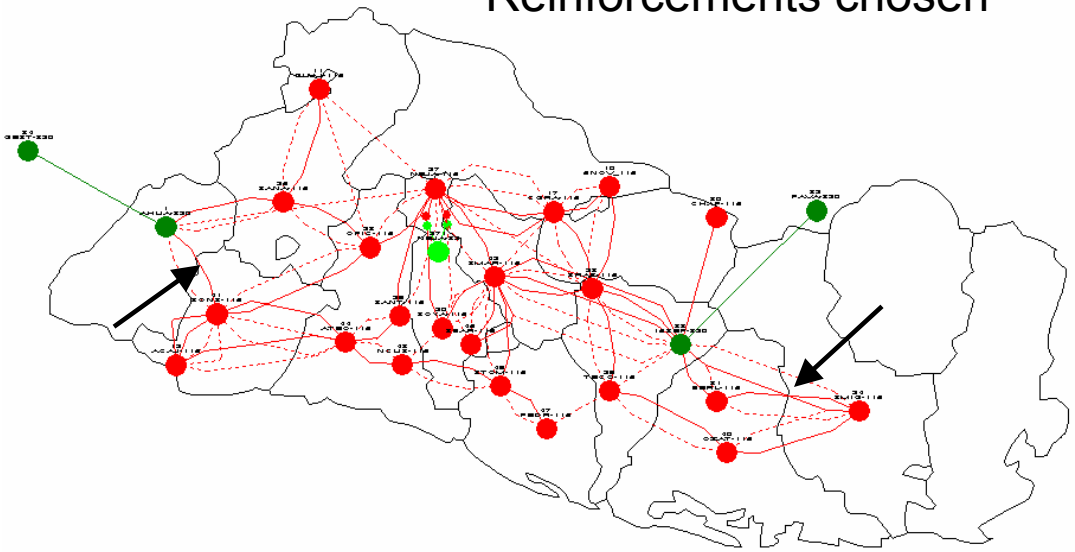
# Transmission planning in El Salvador

Candidate circuits



5-year expansion plan of Salvador's network, considering 34 contingencies, 2000 monthly dispatch scenarios, 47 candidates;

Reinforcements chosen



# Conclusions

- Planning studies should integrate several sources of uncertainty, including production, load, investment, financial
- Decomposition techniques provide an effective framework for planning under uncertainty
- Additional topics of interest to the West Coast:
  - Coordination of RTOs (similar to multi-country interconnection)