INTERCONNECTED POWER SYSTEMS “POWER GRIDS”

Chapter 8
POWER GRID ADVANTAGES

Large Electrical Inertia
  Maximizes system stability, reliability and security
  Maintains frequency, voltage and load flows
Offers opportunities for sales, revenue, price sharing
Stabilizing the Grid improves reliability
Reduce cost of spinning reserves
Information and technology sharing

A Large Interconnected Power System is better than an Isolated Power System because it is more stable and reliable.
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)

Entity that ensures the bulk electric power system is reliable, adequate and secure.

Formed in 1968

Oversees and Enforces operating Compliance Standards

  CIP Standards – Critical Infrastructure Protection standards

N.A. Grid Interconnections: Eastern, Western, Texas (ERCOT), Quebec

U.S. Grid Interconnections: Eastern, Western, Texas
FERC

Federal Energy Regulatory Commission

Require power entities to form joint transmission operations areas

ISO – Independent System Operator – typically covers 1 State
RTO – Regional Transmission Operator – covers more than 1 State

Federally regulated to coordinate, control and monitor the operation of the electric power system.

Operate as a marketplace for wholesale energy exchange

OASIS – Open Access Same-Time Information System to coordinate transmission suppliers and customers.
5 ISO’s IN NORTH AMERICA

1. Alberta Electric System Operator (AESO)
2. California ISO (CAISO)
3. Electric Reliability Council of Texas (ERCOT)
4. Independent Electricity System Operator (IESO) Ontario Hydro
5. New York ISO (NYISO)
4 RTO’s in North America

1. Midwest Independent Transmission System Operator (MISO)
2. ISO New England (ISONE)
3. PJM Interconnection (PJM) {Pennsylvania – New Jersey-Maryland}
4. Southwest Power Pool (SPP)
NERC’s mission to improve reliability and security of the bulk power grid in N.A. evolved into 8 Regional Reliability Councils.

1. ERCOT – Electric Reliability Council of Texas
2. FRCC – Florida Reliability Coordinating Council
3. MRO – Midwest Reliability Organization
4. NPCC – Northeast Power Coordinating Council
5. RFC – ReliabilityFirst Corporation
6. ***SERC – Southeast Reliability Corporation
7. SPP – Southwest Power Pool
8. WECC – Western Electricity Coordinating Council
BALANCING AUTHORITY

NERC rules require all Generation, Transmission and load operating in an interconnection must be included in the Metered Boundaries of the balancing authority.

BA – A control group that balances generation with load for a given region.

Quite often a BA is the same as an Electric Utility (Duke)

BA responsibilities:
- Maintain generation reserves
- Have the ability to control generation w/ AGC
- Communicate data needed to calculate Area Control Error (ACE)
MORE TERMS...

Inadvertent Power Flow – Accumulated Error over time between scheduled power flow and actual power flow on a tie line.

Area Control Error (ACE) – Instantaneous power flow error between BA’s.

Inertia – More inertia in a power system is better.
  -Interconnection adds inertia.
  -Due to many large generators spinning at the same time
  -Object in motion wants to stay in motion (or at rest, stay put)
MORE TERMS...

Time Correction – Increase or decrease generator shaft speed corrects error.
- Subtle changes from 60Hz to 59.98 or 60.02Hz
- Corrects clocks to match NIST
  - 60 cyc/sec, 3,600 cyc/min, 5,184,000 cyc/day

Generator power out is a function of rotor angle.
- 0 power occurs at 0 rotor angle
- Maximum power occurs at 90 degree rotor angle
- All generators in a Power Grid are synchronized together

System Stability – how a power grid handles a system disturbance or fault
- Directly related to generator loading
MORE TERMS...

Native Load – Load within a utility’s territory

Load Following – Generation following the load curve up or down

Brown Out – A reduction in voltage. Can be long term and damage motors.

Frequency Decline – Occurs when Load exceeds Generation.