Imagination at work.

Power Systems Operation and Planning Practices and Challenges

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Imagination at work.
Overview

Power Systems Operation

Regulatory Framework
  • Notable events and roles of different entities
  • Business model of regulated utilities

Power Systems Planning
  • Stakeholders and their objectives
  • Planning tools

Progress and Challenges in Integrating Renewable Energy
  • Distribution connected
  • Transmission connected

Discussion
Power Systems Operation
Key Concepts in Power Systems Operation: Available Transfer Capacity

A typical reliability criterion is that a system be able to withstand the unexpected outage of any single system element. As a result, the ATC is 40% lower than the unconstrained case.

Key Concepts in Power Systems Operation: Load, Dispatch Stack, LMP

Locational Marginal Price (LMP) is the price to serve the last MWh of demand at a given location.

\[ LMP = f \left( \text{Load}, \text{Dispatch Stack}, \text{Congestion} \right) \]

Key Concepts in Power Systems Operation: Transmission Congestion Contracts (TCC)

Transmission Congestion Contracts (TCC): The right to collect, or obligation to pay, Congestion Rents in the Day Ahead Market for Energy associated with a single MW of transmission between a specified Point Of Injection and Point Of Withdrawal.

TCCs are financial instruments that enable Energy buyers and sellers to hedge fluctuations in the price of transmission.

NYISO “2015 Congestion Assessment and Resource Integration Study”

Net present value of “Demand$ Congestion” over 10 year study horizon is estimated to $10+bn, and the estimated TCCs that mitigate it are ~$1.6bn
Regulatory Framework

President George W Bush signing the Energy Policy Act of 2005
Image credit: Eric Draper (Public Domain)
Notable Events and Roles of Different Entities

Federal Energy Regulatory Commission
“An independent agency that regulates the interstate transmission of electricity, natural gas, and oil”

National Electric Reliability Council
“A not-for-profit international regulatory authority whose mission is to assure the reliability of the bulk power system in North America”

Public Utilities Commissions
State agencies that regulate privately owned electric, natural gas, telecommunications, water, railroad, rail transit, and passenger transportation companies...

1 Required by section 216(a) of the Federal Power Act, repeated every 3 years
2 Definition by CPUC
Utilities invest into projects aligned with the objectives of their PUCs and get a guaranteed rate of return via electricity rates they charge.

Figure 2. Schematic Diagram of a Generic Integrated Resource Planning and Procurement Process

Power Systems Planning
Planning Stakeholders and Their Objectives

**Stakeholders:**
- Public Utilities Commissions, representing interests of rate payers and enforcing mandates set by the state
- NERC - mandating reliability requirements
- Regional Planning Organizations (mandated by FERC e.g. FERC Order 1000)
- Project developers

**Objectives:**
- Ensure provision of safe and reliable utility service at reasonable rates
- Ensure system reliability
- Defines coordination objectives (data sharing, procedures for evaluation of projects…)
- Make money

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Project developers can invest into transmission reinforcement projects\(^1\) and are eligible to make guaranteed rates of return

\(^1\) E.g. Suncrest Dynamic Reactive Support Project, won by NextEra Energy Transmission
Planning Tools

Objective:
• Energy Policy Planning
• Reliability assessment and determination of reserves
• Production cost modeling
• Steady State and Dynamic Simulations
• Study of control interactions and transients

Tools:
• The EIA’s NEMS + TRADELEC = POEMS, CRA’s NEEM
• Reliability simulations (e.g. GE MARS)
• Energy Exemplar’s Plexos, GE MAPS
• PSS/E, PSLF, PowerWorld, PowerFactory
• PSCAD, EMTP

NEMS – National Energy Modeling System
POEMS – Policy Office Electricity Modeling System
NEEM – North American Electricity and Environment Model
Progress and Challenges in Integrating Renewable Energy
Renewables Integration in Distribution

Done or underway:

• Integration is within jurisdiction of PUCs, there are defined mechanisms to drive investment

• Technical impacts are classified and generally well known

• Next generation of inverter standards are under development

• There is an active debate on equitable rate designs and their long-term impacts

Challenges and gaps:

• Benefit Cost frameworks for Integrated Resource Planning are just being defined in CA and NY

• There is a lack of consistency in utility practices in mitigating impacts

• Interconnection rules will require updates

• No tools are available for quantifying impacts of rates disaggregation
Renewables Integration in Transmission

Done or underway:
• Many high-fidelity integration studies have been completed studying impact of renewable energy in most regions of North America
• Several studies evaluated cost of necessary inter-regional transmission upgrades using iterative removal of constraints in production simulations
• Able to predict capacity factors and production costs of the generation fleet

Challenges and gaps:
• Tools are not graceful in considering penetration levels at which much of the thermal fleet could get de-committed
• Studies do not co-simulate impact of renewable injection into receiving AC systems. Impeded by complexity and restricted access to dynamic data
• Limited if any consideration given to changes in capacity payments to the thermal fleet
• No quantification of the volume of bilateral transactions or value of TCCs
Discussion