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

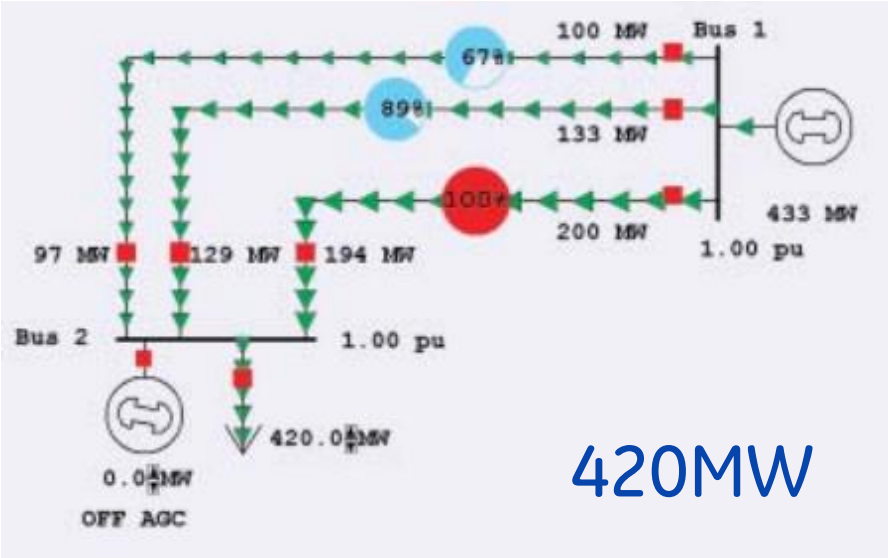
Progress and Challenges in Integrating Renewable Energy

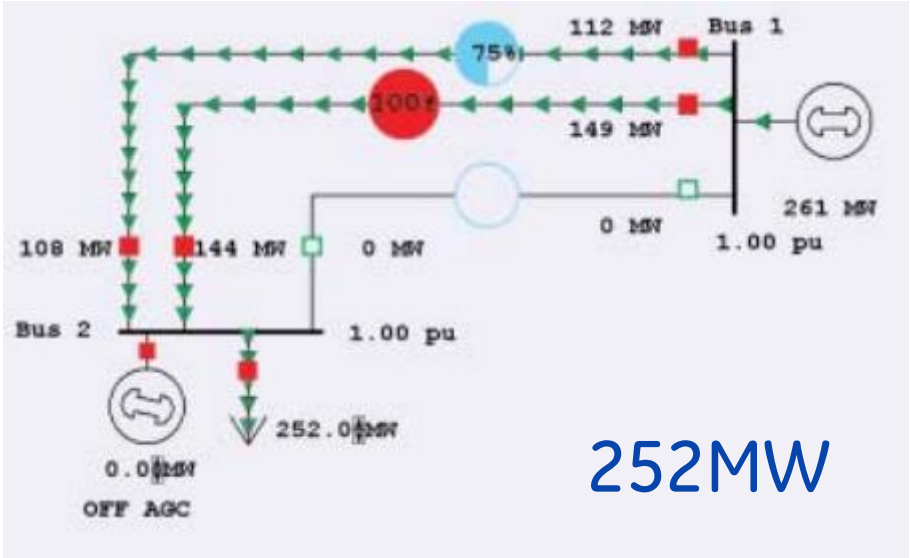
- Distribution connected
- Transmission connected

Discussion

Power Systems Operation

Key Concepts in Power Systems Operation: Available Transfer Capacity

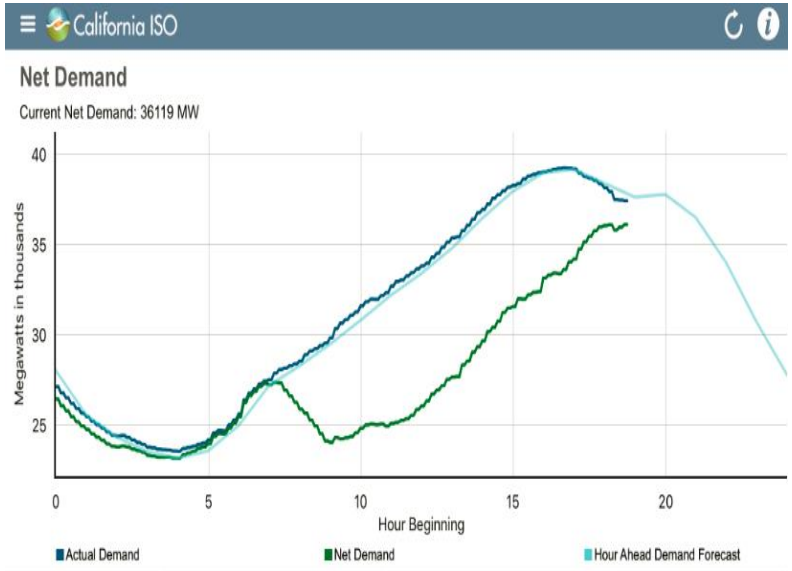




J. Hauer, et al. "Advanced Transmission Technologies" National Transmission Grid Study Issue Papers, US DOE May 2002

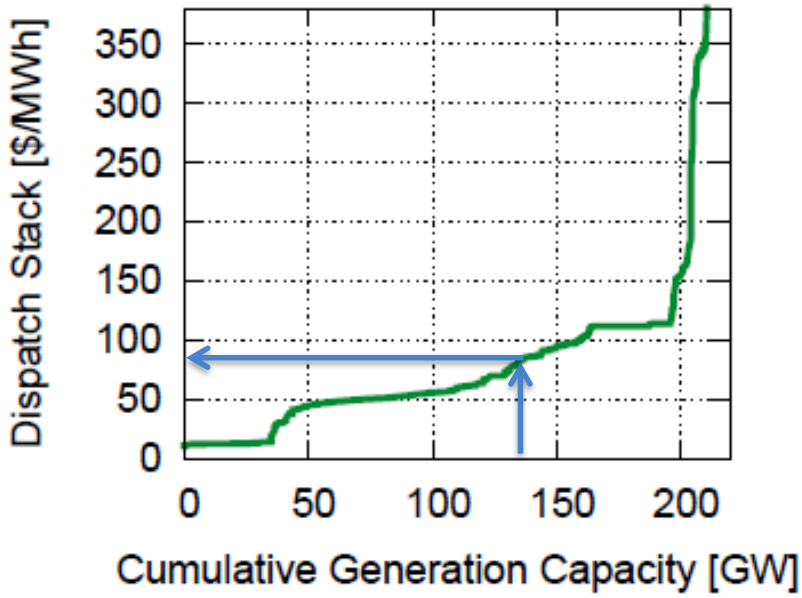
A typical reliability criterion is that a system be able to withstand the unexpected outage of any single system element
As a result, the ATC is 40% lower than the unconstrained case

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



Hour	Actual Demand	Net Demand	Hour-Ahead Forecast
13	35378	27671	34796
14	36952	29675	36463
15	38281	31579	37948
16	39022	33154	38978

CAISO "ISO Today App" Accessed on 20160928

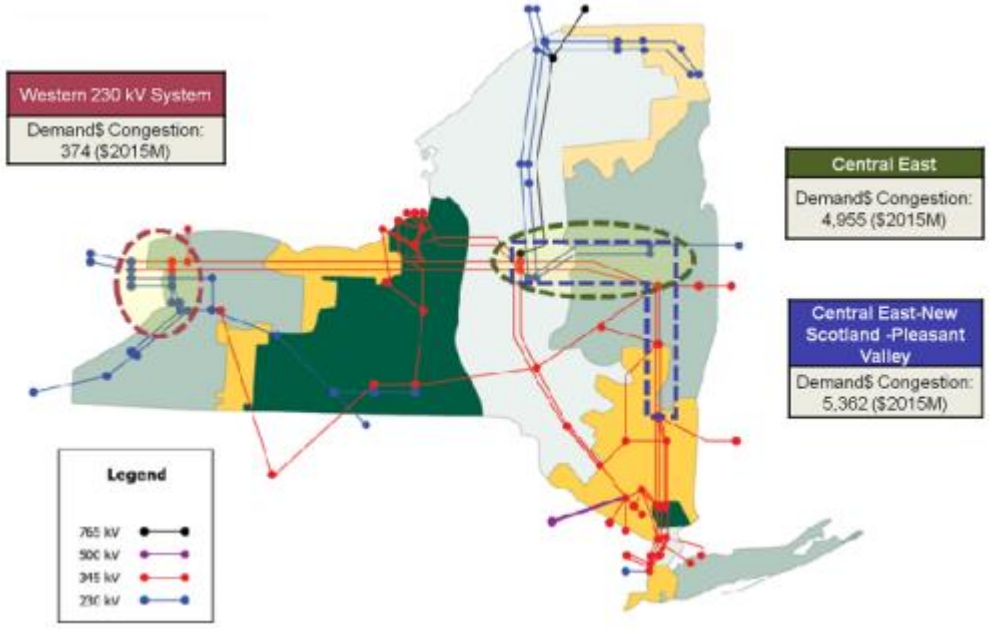


J. Bebic, et al. "Grid of the Future…" Scoping study for NODES, GE Energy Consulting, January 2015

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

LMP = f (Load, Dispatch Stack, Congestion)

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



NYISO "2015 Congestion Assessment and Resource Integration Study"

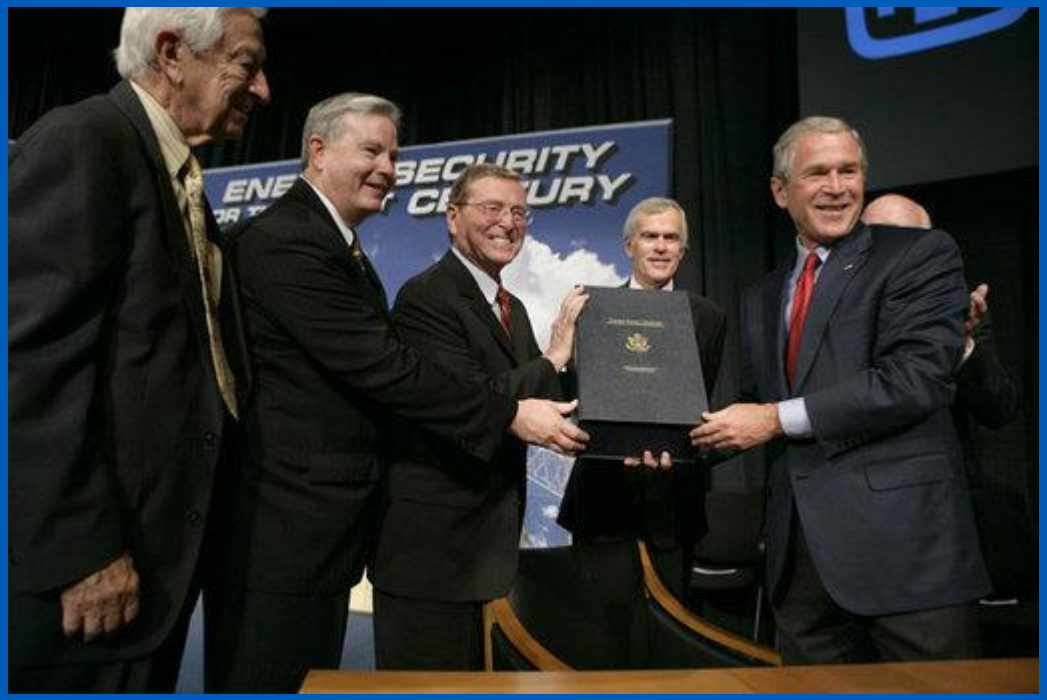
Transmission Congestion Contracts (TCC):

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.

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

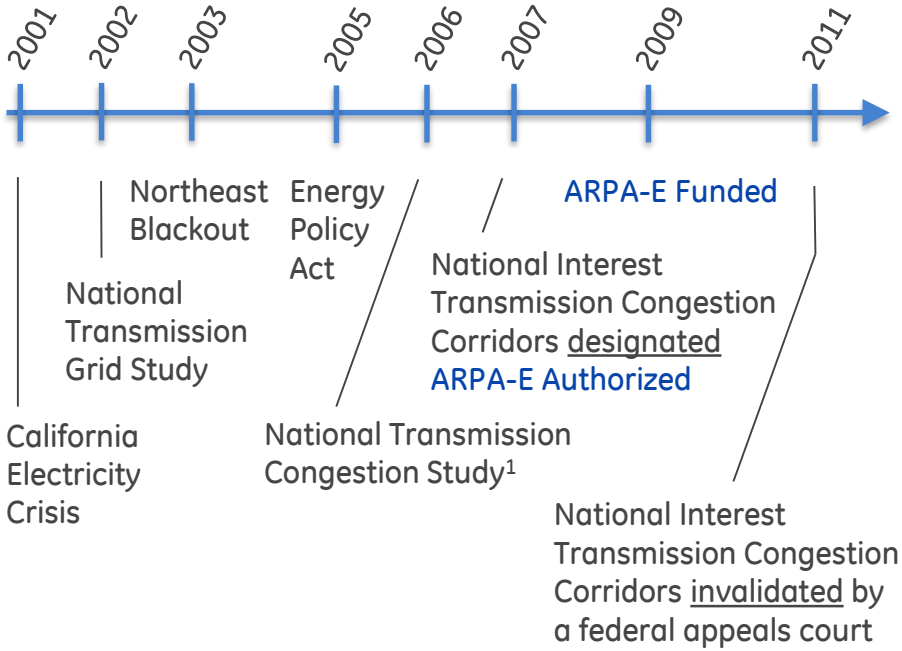
Regulatory Framework



President George W Bush signing the Energy Policy Act of 2005

Image credit: Eric Draper (Public Domain)

Notable Events and Roles of Different Entities



[1] Required by section 216(a) of the Federal Power Act, repeated every 3 years
[2] Definition by CPUC

Federal Energy Regulatory Commission

"An independent agency that regulates the interstate transmission of electricity, natural gas, and oil"

National Electric Reliability Council

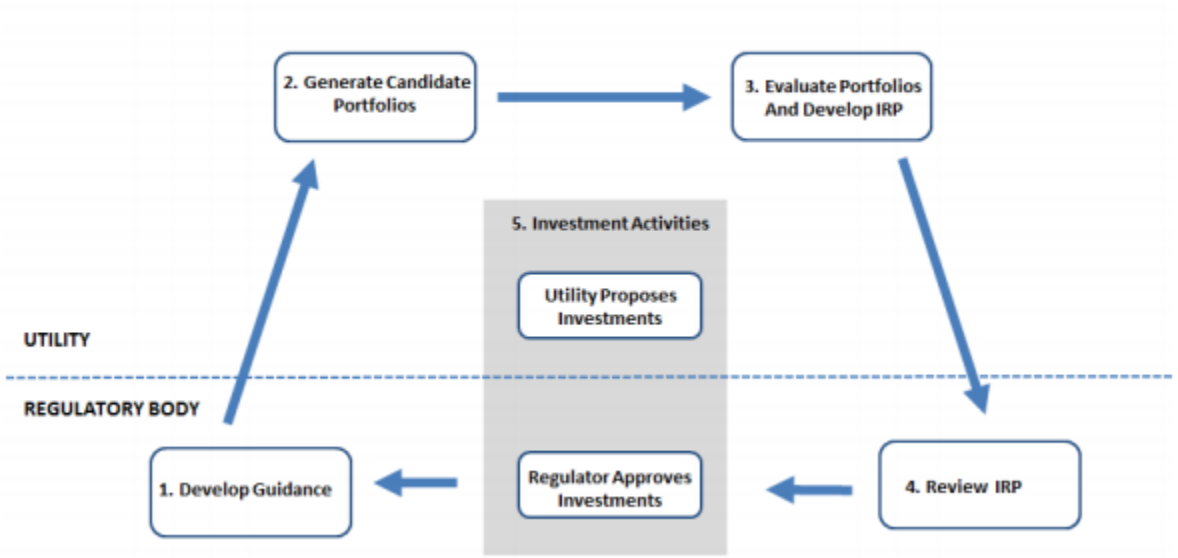
"A not-for-profit international regulatory authority whose mission is to assure the reliability of the bulk power system in North America"

Public Utilities Commissions

State agencies that regulate privately owned electric, natural gas, telecommunications, water, railroad, rail transit, and passenger transportation companies…[2]

Business Model of Regulated Utilities

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



CPUC Energy Division *"CPUC Staff Concept Paper on Integrated Resource Planning"* August 11, 2016

Utilities invest into projects aligned with the objectives of their PUCs and get a guaranteed rate of return via electricity rates they charge

Power Systems Planning

Planning Stakeholders and Their Objectives

Stakeholders:	Objectives:
• Public Utilities Commissions, representing interests of rate payers and enforcing mandates set by the state	• Ensure provision of safe and reliable utility service at reasonable rates
• NERC - mandating reliability requirements	• Ensure system reliability
• Regional Planning Organizations (mandated by FERC e.g. FERC Order 1000)	• Defines coordination objectives (data sharing, procedures for evaluation of projects…)
• Project developers	• Make money

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:	Tools:
• Energy Policy Planning	• The EIA's NEMS + TRADELEC = POEMS, CRA's NEEM
• Reliability assessment and determination of reserves	• Reliability simulations (e.g. GE MARS)
• Production cost modeling	• Energy Exemplar's Plexos, GE MAPS
• Steady State and Dynamic Simulations	• PSS/E, PSLF, PowerWorld, Power Factory
• Study of control interactions and transients	• 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