Grid Operations and Why They Matter for Air Quality – Part 1
Goals for Today’s Session

- Provide an overview of regional electricity system – the “PJM RTO”
- Discuss collaborating with your Utility Commissioners and Energy office – why and how
- Raise connections to your air quality work
- Introduce topics for Session 2
Topics for Today

• The Grid
  • Generation: Ownership and Dispatch
  • Transmission: Ownership and Operation
  • Distribution: Utilities and Retail Markets
• 5 min break
• Energy Planning
• Roles of Government Entities
• Q and A, Discussion
Introduction to the Grid
Today’s Grid (Simplified)

EIA, National Energy Education Development Project,
http://www.eia.gov/energyexplained/index.cfm?page=electricity_delivery
The “New” Grid (not so simple)

Illustrative modern electric system

- **Smart appliances**
  - Can shut off in response to frequency fluctuations.

- **Processors**
  - Execute special protection schemes in microseconds.

- **Demand management**
  - Use can be shifted to off-peak times to save money.

- **Sensors**
  - Detect fluctuations and disturbances, and can signal for areas to be isolated.

- **Storage**
  - Energy generated at off-peak times could be stored in batteries for later use.

- **Generators**
  - Energy from small generators and solar panels can reduce overall demand on the grid.

PJM: Your Regional Transmission Organization

Source: PJM
Poll Question on PJM
Generation
Electric Sector Emissions

PJM – Existing Installed Capacity
(CIRs – as of Dec. 31, 2019)

- Hydro, 8,332 MW
- Solar, 791 MW
- Oil, 9,424 MW
- Nuclear, 32,653 MW
- Waste, 849 MW
- Natural Gas, 78,047 MW
- Wind, 1,239 MW
- Coal, 52,838 MW

https://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Advisory%20Committees/Air%20Quality%20Technical%20Advisory%20Committee/2020/10-15-20/20201015%20PJM%20Presentation%20to%20PA%20DEP%20AQTAC%20on%20Generation%20Dispatch.pdf
PJM Generation Mix

Cleared Installed Capacity

- Coal
- Gas
- Nuclear
- Renewables
- Demand Response

Delivery Year

*Includes solar & wind at nameplate, hydro and wood

www.pjm.com | Public

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EIA Projects Trend to Continue

US Power Sector NOx Emissions (lb/MWh)

~40% decrease by 2030

Ownership of Power Generation

- In the U.S., wholesale power can be generated and sold onto the grid by:
  - Vertically integrated utilities
  - Independent power producers ("merchants")
  - Wholesale power marketers
  - Generation and transmission cooperatives
  - Customers ("distributed generation")
Transmission
Ownership, Access, and Operational Control of Transmission Lines

- Transmission lines in the U.S. are mostly owned and maintained by utilities or federal power marketing administrations.
- Owners are required by law to provide “open access” to their transmission lines.
- Some owners satisfy open access laws by allowing an independent entity to control the operation/use of their lines.
Source: NERC
Distribution Utilities and the Customer's Perspective
What are Distribution Utilities?

• Entities that have an *exclusive* franchise within a designated service territory, with *obligation* to serve

• Can be investor-owned (i.e., for profit) or consumer-owned (non-profit)

• Can be a “distribution only” utility or a “vertically integrated” utility that owns generating units
The Retail Customer’s Perspective

- Who owns and maintains the power lines connected to homes and businesses?
  - A distribution utility
- Who sells electricity to retail customers?
  - In some states, only the distribution utility can sell power to retail customers (monopoly)
  - Other “restructured” states allow companies to compete to sell power to retail customers
5 min break
Dispatch
Balancing is Essential

- PJM continuously balances generation and load
- Dynamic balancing historically - intensive management of supply-side resources
  - Reserve capacity, spinning reserves, etc.
  - Instantaneous balancing through frequency regulation
- Balancing needs now - demand-side resources:
  - Load management (system operator-controlled)
  - Demand response (customer-controlled)
RTO Information Requirements

- Expected load
- Available supply-side resources
  - Generating units
  - Capacity & flexibility of each
  - Costs of each
- Available transmission capacity
- Available load management and demand response (and costs)
Economic Dispatch – Marginal Pricing

Highest-priced Generator is not dispatched.

C
$20/MW
capacity: 200 MW
Not dispatched

B
$15/MW
capacity: 200 MW
199 MW @ $15
Marginal Pricing-next megawatt needed to serve load

A
$10/MW
capacity: 300 MW
300 MW @ $10

Dispatcher

Load
499 MW

$15/MWh
Marginal price of Energy

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Economic Dispatch – Marginal Pricing (cont.)

Highest-priced Generator sets price.

C
$20/MW
capacity: 200 MW
Not dispatched
Marginal Pricing-next megawatt needed to serve load

B
$15/MW
capacity: 200 MW
200 MW @ $15

A
$10/MW
capacity: 300 MW
300 MW @ $10

Dispatcher

Load
500 MW
501 MW
$20/MWh
Marginal price of Energy
Planning
Planning Occurs at Multiple Levels

- All utilities plan for meeting future needs
- Some states, e.g., Virginia, require “integrated resource planning” (IRP) that looks at reducing demand growth, as well as adding capacity to meet it
  - VA utilities update their IRPs every two years
- Regional reliability entities and RTOs (like PJM) also develop plans
One definition of IRP:

“A planning mechanism in which the costs and benefits of both demand- and supply-side resources are evaluated to develop the least total cost mix of resource options under a given set of technical, economic and environmental constraints. IRP typically includes full consideration of cost-effective energy efficiency and renewable energy options and may also include consideration of environmental and social impacts of different resource options.”

Source: Insights on Planning for Power System Regulators, IRENA, 2018
States with Integrated Resource Planning or Similar Processes

- **State has an IRP rule and filing requirement**
- **State is developing or revising an IRP rule and filing requirement**
- **State has a filing requirement for long-term plans**
- **State does not have filing requirements for long-term plans**

Government Roles
Roles for Regulators

- Define roles and responsibilities
- Create legal foundations
- Avoid regulatory capture and political interference
- Review proposals or draft plans
- Agree on status and treatment of final plan
- Create sufficient institutional capacity
- Ensure transparency and stakeholder involvement

Source: Insights on Planning for Power System Regulators, IRENA, 2018
Role of the Federal Energy Regulatory Commission (FERC)

• Broad authority over *interstate* transmission of electricity:
  • Rates and terms of service (i.e., tariffs)
  • Reliability (through NERC)
  • Planning requirements
Roles of the State Utility Commissions

- **Economic** regulation of utilities
- Ensure that utilities provide “safe, reliable, affordable” service to all customers in a manner “consistent with the public interest”
- Set retail rates & terms (i.e., tariffs) based on cost of service
- Review prudence of utility decisions
- Review energy efficiency programs – what is cost-effective?
Utility Commissioners and Staff

- Commissioners appointed or elected to set terms
- Quasi-judicial decision makers; Not bureaucrats or managers or executives
- Manage Staff with specialized technical/professional training
Role of the State Energy Office

- Designated “State Energy Office,” i.e., the conduit for federal Dept. of Energy grants
- Potential roles/responsibilities:
  - Provide energy education and outreach
  - Manage/direct energy efficiency programs
  - Promote new/innovative energy technologies and foster growth of emerging and sustainable energy industries and infrastructure
Ideas for Collaboration with Commission/Energy Office

- Understand and assist with air quality, climate goals
- Planning - IRP, SIPs, other
- Modeling of energy systems
- Cost/benefit calculations with environmental considerations
- Promote New technologies – demand response, distributed resources
- Consider new rate structures
Poll question on Session 2
Preview – Session 2

• The changing grid and why that matters – EVs, batteries, renewables, etc.
• Examples of energy connections to your work
• Ideas for collaboration
• Discussion, Q and A
Resources

- PJM presentation to PA DEP AQTAC
- Current real time info in PJM
- Participating in Power – how to read and respond to Integrated Resource Plans
- PJM App – see next slide
Power Up with the PJM Now App!

- See real-time demand
- Track power prices
- Get notifications

- Download on the App Store

PJM Now App Available
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org
Discussion – Q & A

Thank you!
Supplemental Slides
States Allowing Retail Competition

States that suspended restructuring – and still have some residual customer choice and competitive retail supply.

Restructured states as share of U.S.:
= 34% of residential MWh sales
= 38% of commercial sales
Capacity and Reserve Margins

- **Capacity** is the maximum amount of power a generating unit or transmission line can safely provide.
- **Reserve margin** is the amount of capacity on a system in excess of what is needed to meet peak demand, usually expressed as a percentage of peak demand.
PJM’s “Reliability Pricing Model”

- Resources commit to be available to meet system peak load three years in the future at a stated price per MW-day
- PJM accepts lowest bids needed to meet expected peak demand
- Capacity revenues paid to committed resource whether or not energy is produced by resource
Illustrative IRP process
May 2012 PJM Capacity Auction

- 165 GW of resources committed to be available for the 2015-2016 delivery year
  - 10% coming from demand-side resources
  - 1 GW of EE and 15 GW of demand response
- Clearing price was $136/MW, significantly less than expected
- Should keep the PJM grid reliable as dozens of coal plants retire