

Restructured Wholesale Electricity Markets

A New Design for a New Millennium

Ben Fram

PhD Research Scholar (& Electricity Market Enthusiast)

Department of Business and Management Science, NHH

What's with a title of this presentation?

- **“Deregulated”** is often used to describe modern markets for wholesale power
- This term is problematic: in the United States, there are more regulations for wholesale power markets than there ever have been (if you don't believe me, take a look at the PJM Open Access Transmission Tariff – it's about 3,000 pages long!)
- A more accurate term is **“restructured”**

My background

- After graduating college, I worked for two years at the New Jersey Board of Public Utilities, the agency responsible for regulating power, natural gas, water, cable, etc. in NJ. Every US state has a Public Utility Commission.
- I obtained my master's degree in Economics at the University of Gothenburg in Sweden. My master's thesis was written about a policy implemented in Nordpool, specifically the Western Danish zone (DK1)
- I then worked for 3 years as an analyst at the Independent Market Monitor for PJM, the largest market for wholesale power on planet earth.
- I'm no expert but I've spent the past 7 years studying/working in the energy and electricity sector so I know a thing or two!

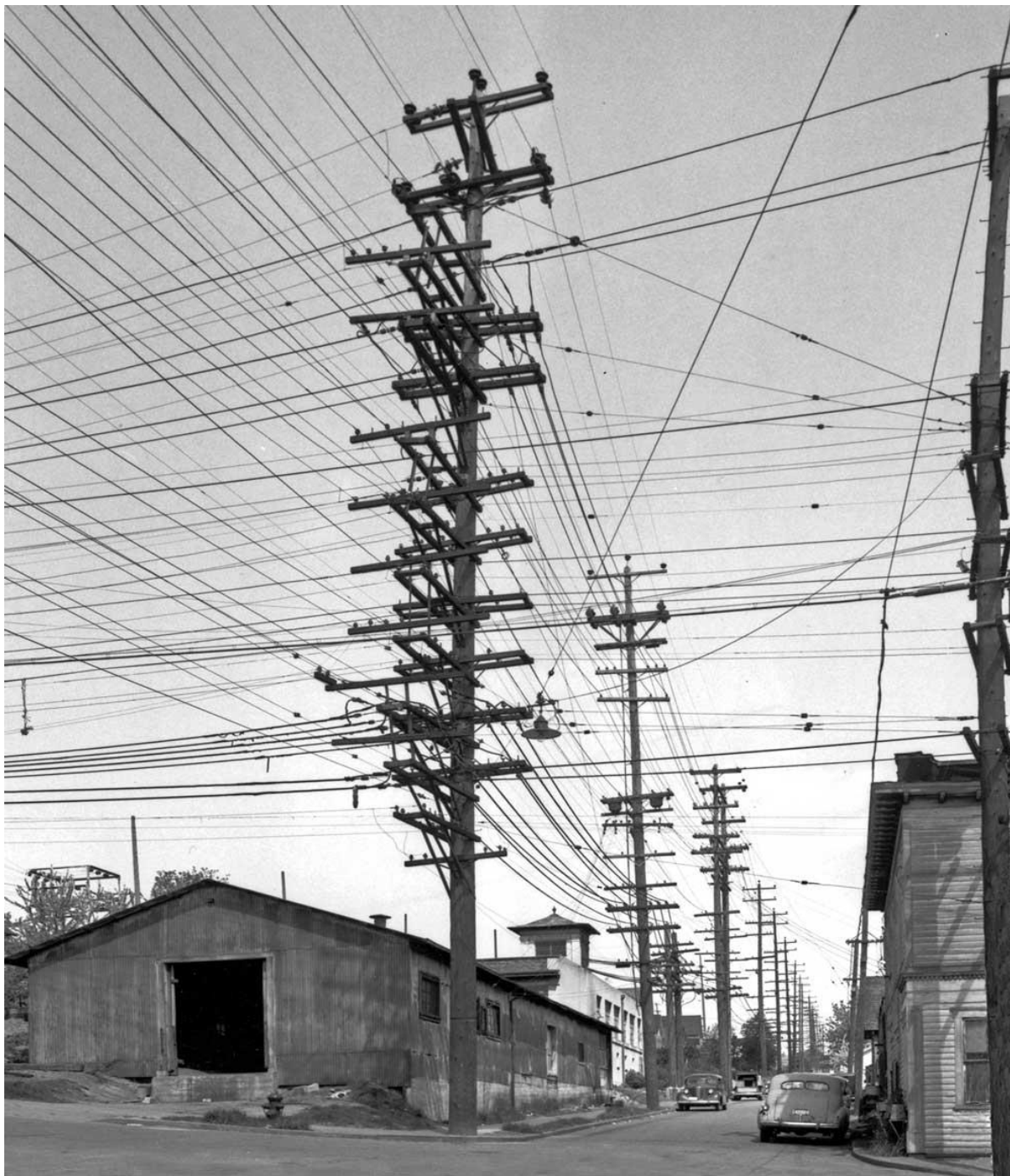
It pains me to admit it but...

- I'm most familiar with the details and intricacies of PJM – covers the mid-Atlantic USA. Ergo, I'll be referencing PJM a lot in this presentation.
- I'm **not** as familiar with all of the design components of the other markets that exist on planet earth, relatively familiar with Nordpool and the New York market (NYISO)
- The good news: the underlying fundamental characteristics of most markets is approximately the same, even if certain components of the market designs differ

Fiat Lux... Electrica!

- During the turn of the 19th century, electrification began to spread throughout the Western World
 - Thomas Edison – electrified New York City, parts of London
 - Nikola Tesla – pioneered Alternating Current transmission
- Electricity companies and regulators quickly recognized that it was inefficient for 100 different power companies to set up 100 different power lines on every utility pole
- Why is this? Electricity transmission is a network industry and has long been considered a natural monopoly where it is more cost-effective to have one (local) company in charge of the grid infrastructure

<https://pauldorpat.com/2013/06/07/seattle-now-then-a-fremont-trolley-derailed/>



Cost of Service Regulation – 1880's to 1990's

- Working together, industry and the government developed a new business model
- Instead of allowing competitive markets choose who would provide electricity, state utility commissions allowed vertically-integrated, state-sanctioned monopolies to **generate, transmit** and **distribute** power
- Utility companies operated their own transmission and distribution networks to deliver power
 - They would simply produce more or less power based on the demand over the course of the day
- As regulated monopolies, they made money by being reimbursed for their costs – and were typically paid a rate of return that mimicked profits
- So what do you do if your business model looks like this? If your (almost) guaranteed rate of return is 7% for every dollar you spend?

A quick aside: three main components of the power business

- **Generation** – produce the magnetic power itself in a power plant
- **Transmission** – deliver it to the distribution system via high voltage lines (or directly to the customer if they're a factory or big industrial user)
- **Distribution** – ramp the high voltage power down to levels safer for humans and deliver it to the end user's residence
- Are all of these components network industries? Which seem ripe for competition?

A Brave New World – Restructuring

- With the advent of high voltage transmission (usually defined as above 138 kV in the US) and subsequent lower line losses, countries began to “deregulate” the **generation side of the power business** in the 1980’s
 - Chile, the United Kingdom went first
 - PJM established in 1997 – now the biggest wholesale power market on earth
- The idea was simple – introducing **competition** into generation should lower costs for consumers and lead to more innovations in the power sector
- Vertically integrated electricity companies were forced to spin off their generating capacity from the transmission/distribution side of the business
- The newly formed generation companies were now forced to compete with each other in a giant auction for electricity run by a federally regulated entity called the **System Operator**

Transmission and Distribution

- In the United States, the transmission and distribution systems remain largely privately owned by utility companies as they have been for over 100 years
 - The transmission and distribution markets have **not** been “deregulated”
- **But, in the areas of the country where there are power markets, the System Operators have control over the transmission system**
 - They need access to the transmission system to control the flow of power
- System Operators do not, however, typically have access to the distribution network
 - Distribution networks are still owned and operated by utilities and are **not** typically part of wholesale power markets

Deus Ex Machina – The System Operator

- The System Operator (SO) is most commonly described as a sort of “air traffic controller.” This description is accurate but incomplete.
- The System Operator has **two** main responsibilities:
 1. It acts as a **market clearing house** or **auction house** for electricity. Power producers submit offers to sell electricity and buyers submit bids to buy. The System Operator takes these bids and offers, builds demand and supply curves and then sets the price for electricity at the intersection of these curves.
 2. After creating the supply and demand curves from the auction, it **operates the power grid** by dispatching generators (power plants) to meet the demand for electricity

The System Operator Continued

- System Operators are federally regulated entities in the US – the Federal Energy Regulatory Commission is responsible for their oversight
- They are non-profit entities – they collect membership fees to cover their operating expenses but run the market and dispatch power without any financial incentives
- Just to clarify – since the System Operator doubles as the market clearing house, sometimes the word “market” is used interchangeably with the System Operator

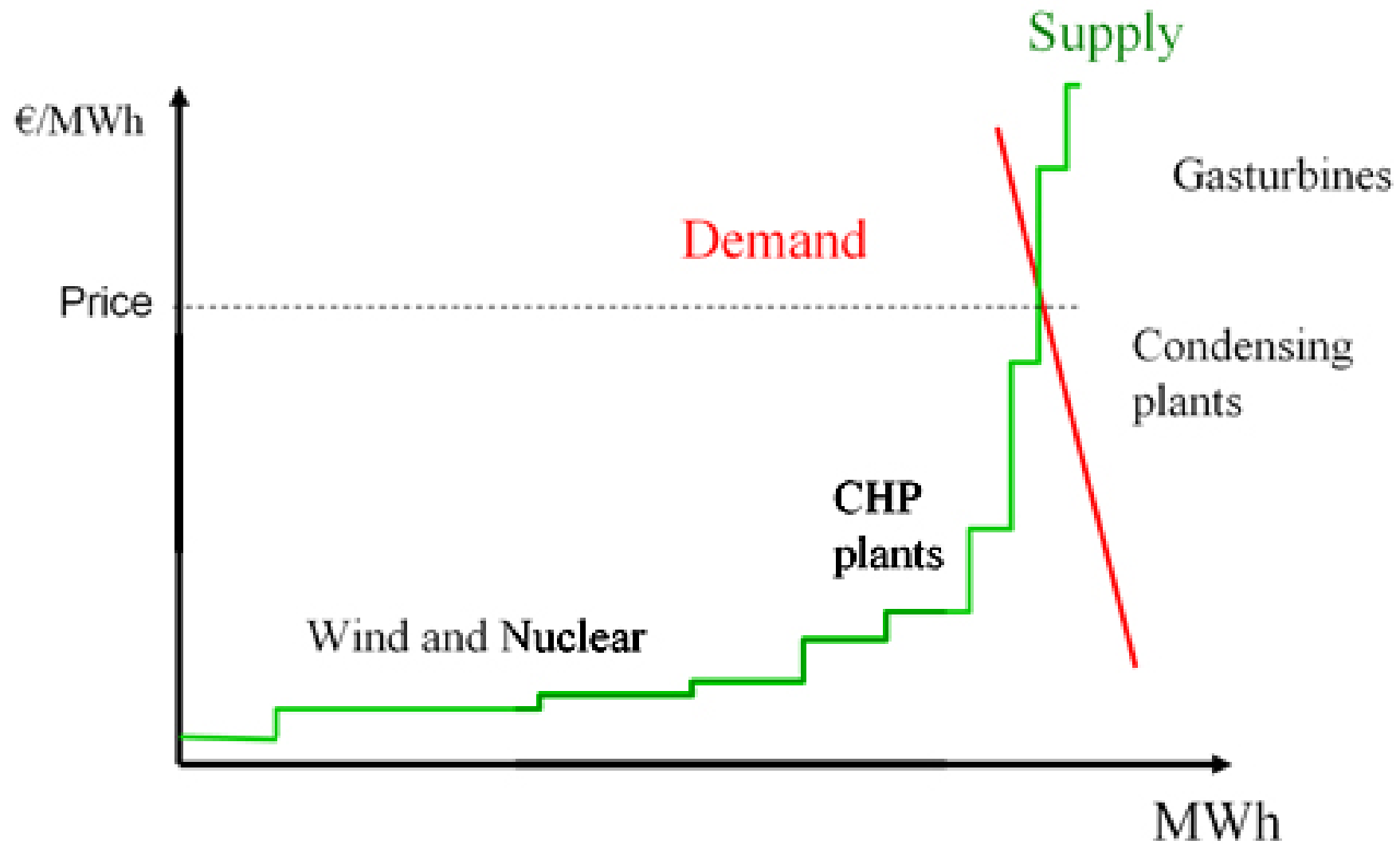
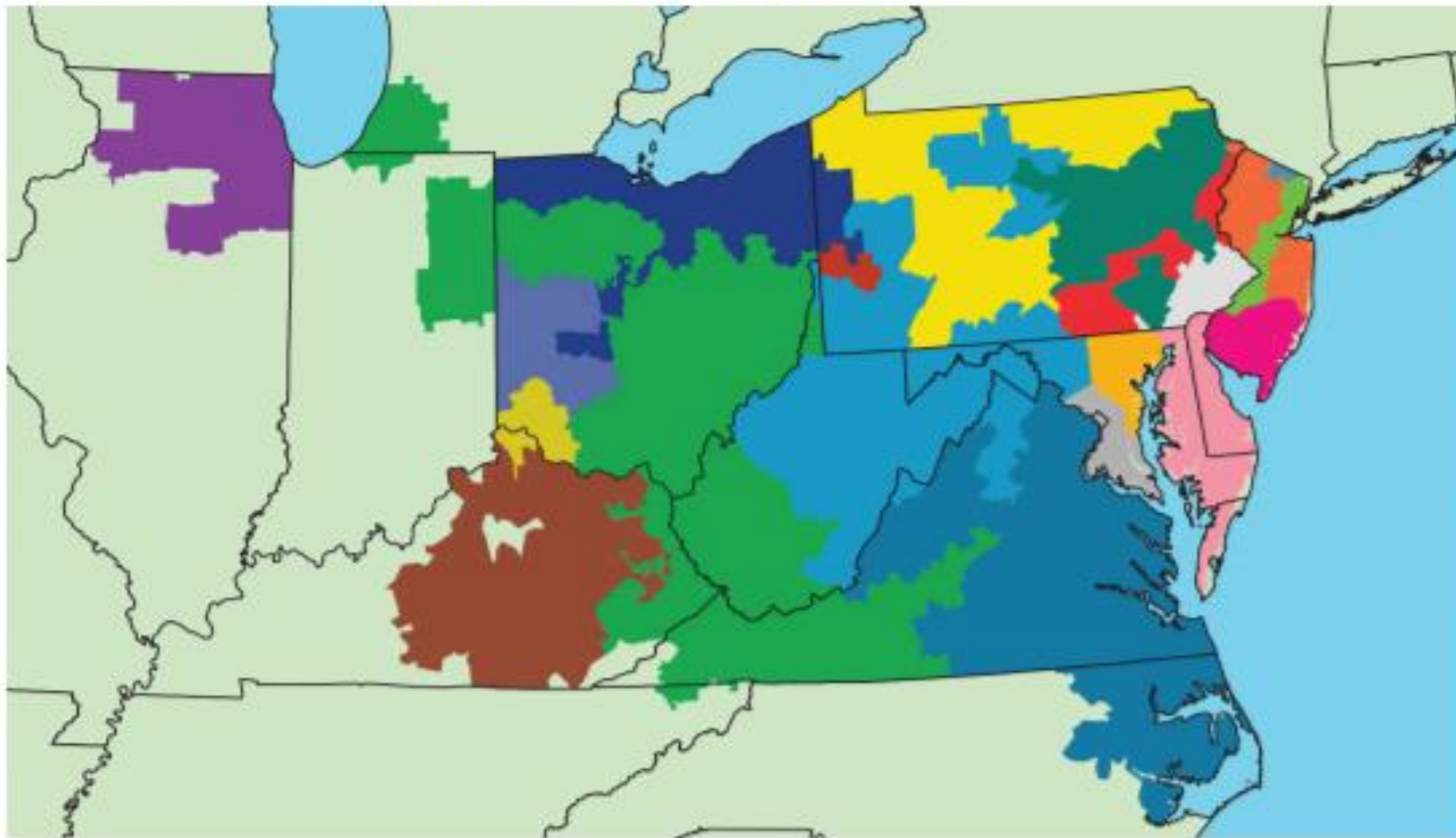




Figure 1-1 PJM's footprint and its 20 control zones



http://monitoringanalytics.com/reports/PJM_State_of_the_Market/2017/2017q2-som-pjm-sec1.pdf

Vital Professions for Operating and Designing Restructured Power Markets

- Engineers
 - Electrical, mechanical, civil
- Experts in Operations Research/Applied Mathematics
- Economists
 - Microeconomics, Industrial Organization and Auction Theory
- Finance Specialists
 - Risk management, derivatives, commodity markets,
- Lawyers - last but not least ;)
 - Competition/antitrust law, securities law, interstate/international commerce

Key Takeaway Points – Part I

- For about 100 years, electricity in the USA, Europe and elsewhere was produced and delivered to end users by vertically-integrated, state-sanctioned monopolies
- These companies owned both generation (power plants) and transmission/distribution infrastructure and were responsible for balancing supply and demand in their defined territories
 - They faced no competition for any part of their business and were reimbursed for their costs with an additional rate of return

Key Takeaway Points – Part II

- Under the new restructured markets that emerged in the 80's and 90's, power companies were no longer allowed to be vertically integrated entities but instead had to spin off their **generation** assets and compete with one another in centralized markets to sell electricity
 - Companies now must **compete** with one another to produce electricity in an auction run by a System Operator
- The System Operator acts as a market clearing house and operates the power grid. In the US, it does not typically own transmission infrastructure but it has full access and control of this infrastructure
- Utility companies typically still own the transmission and distribution infrastructure and are responsible for maintaining it

Bibliography/Sources for those interested

- Power System Economics (2002) by Steven Stoft
 - An intermediate economics text book. Covers a great deal of information. It's a bit dated but still a solid resource and relevant to this day.
- The Economics of Electricity Markets (2014) by Darryl R. Biggar and Mohammad Reza Hesamzadeh
 - For the more technically inclined, this is a very thorough and more up-to-date tour of power market economics.
- The Power Makers: Steam, Electricity, and the Men Who Invented Modern America (2008) by Maury Klein
 - Excellent book about the history of the power industry and the inventors who revolutionized the way we live
- The Monitoring Analytics PJM State of the Market Reports
 - http://monitoringanalytics.com/reports/PJM_State_of_the_Market/2017.shtml