Toward future’s clean power system: lessons from the past

Berkeley Tsinghua Energy Forum
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劳伦斯引入大团队科学研究
劳伦斯伯克利国家实验室：能源部第一个国家实验室
• History of Deregulation of Utility since 1990

• Emergence of RTO/ISO and wholesale market
California: *the clean power frontier*

- Most ambitious goal for renewable power
  - 33% of renewables by 2020
  - 50% of renewables by 2030 (excluding hydro)
- Half of solar installation in US
- Leaders in energy efficiency in US
  - Appliance standards
  - Building codes (updated every three years)
  - “Decoupling” and strong utility efficiency programs
- Robust carbon market covering power sector
The Future: can the duck fly?

- Duck Curve
History of Deregulation since 1990

• Pre-1990
  – Vertically integrated utilities
  – Cost of services regulation

• 1990 Restructuring/deregulation
  – Unbundling of generations from T&D
  – Direct access/Retail competition
  – Wholesale power markets

• Current thinking
  – *Meeting environmental/climate targets*
  – Deregulation inactive
  – Emergence of ISO/RTO
  – Wholesale power market
  – Retail competition
  – *Future utility model (NY REV)*
History of Power Sector Reform

- **Goals:**
  - Reliable supply of power at least cost

- **Pre-1990**
  - Vertically integrated utilities
  - Cost of services regulation

- **Problems**
  - Overly optimistic forecast of future demand growth
  - High cost of generation

- **Solutions**
  - Lead to some separation of functions, ie, independent demand forecast
  - Lead to deregulation of utilities
Figure ES-1 Load forecasts from seven subsequent IRPs and actual load for a Western U.S. utility.
Planning reserve margins in China, 2014

Central: 10%
Eastern: 10%
Northern: 20%
Northeastern: 60%
Northwestern: 50%
Southern: 30%
National: 25%
Planning Reserve Margin in 2020 under the High Growth Scenario

- 62% in the西北 region
- 59% in the东北地区
- 42% in the西南地区
- 14% in the华北地区
- 12% in the华中地区
- 2% in the华东地区
Planning Reserve Margin in 2020 under the Low Growth Scenario
History of Power Sector Reform: mid-1990s to 2010

- **Goals**
  - Increasing economic efficiency and reduce costs

- **1990s Restructuring/deregulation**
  - Unbundling of generations/retails from T&D
  - wholesale market
  - Direct access/retail competition

- **Problems:** CA crisis in late 1990s
  - 2000-2001: poor market design and market manipulations led bankruptcy of two large IOUs

- **Solutions:**
  - Some states back to re-regulation
  - Many remain the unchanged
Deregulation has stalled in most states.
Figure 6. U.S. Average Retail Rates and Natural Gas Prices

Borenstein and Bushnell, 2015
Observation: Utility Deregulation in US

- Still heavily regulated industry
- Unbundling of generation and competition improved efficiency at power plants
- Open access to transmission grid is essential
- *Improved coordination of power grids (ISO/RTO)*
- Limited impact on *average* consumer costs
  - Economic vs social costs?
- Other benefits unclear:
  - how to value customer choice?
- Implementation poses significant challenge
Drivers of current reforms

• Environmental/Climate Change
  – Meeting GHG targets
  – RPS
  – Clean Power Plan

• Technological
  – Rapid cost reductions and expansion of solar and wind

• Business model
  – Leasing

• Utility model
  – Customer defection
  – Declining revenue base
RTOs/ISOs and wholesale energy markets in the US
What is an RTO/ISO?

- **Independent** organizations managing transmission access
- Responsible for the economic scheduling of generation that takes into account reliability and capacity constraints on transmission system
- Three key RTO/ISO roles:
  - Generation and load balancing for transmission reliability
  - Market operations
  - Planning
- Don’t own power lines, substations, or other utility equipment
- Are a neutral party monitoring the transmission network and managing competitive energy markets
Where are the RTOs/ISOs?

- Seven in the U.S. and market rules and tariffs are regulated by Federal Energy Regulatory Commission (FERC)
- Some parts of the U.S. have no RTO/ISO and instead utilities offer open transmission access tariffs and rely on bilateral energy contracts

Figure: http://sustainableferc.org/iso-rto-operating-regions/
Wholesale Energy Markets

- Purpose is for the economic efficient use of transmission and generation
- Market products and rules vary among RTOs/ISOs

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Lessons learned

• Utility industry is likely to remain carefully regulated
  – Wholesale market is complicated and takes time to form, needs to be carefully monitored and regulated
  – Need to balance economic, social, and climate goals
• Competitive generation has led most of the economic efficiency gains.
• Rate impact on average consumers has been limited.
• ISO/RTO have improved grid operation
• Independent demand forecast is foundational to good resource planning
• Meeting climate goals require new thinking
Research Questions

• What types of models are best suited for load forecast?
  – At what geographic/demographic resolution?
• What KPIs to evaluate retail competition/choice? Wholesale competition?
• Generation planning quota: is it time to phase it out?
• What mechanism to ensure environmental and climate goals?
• What infrastructure is needed to make both production and demand more “responsive”
  – Dynamic pricing?
  – Tools to allow operators and consumers to make smart choices
• Thank you
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