

Stratum Electricity Markets: Toward Multi-temporal Distributed Risk Management for Sustainable Electricity Provision

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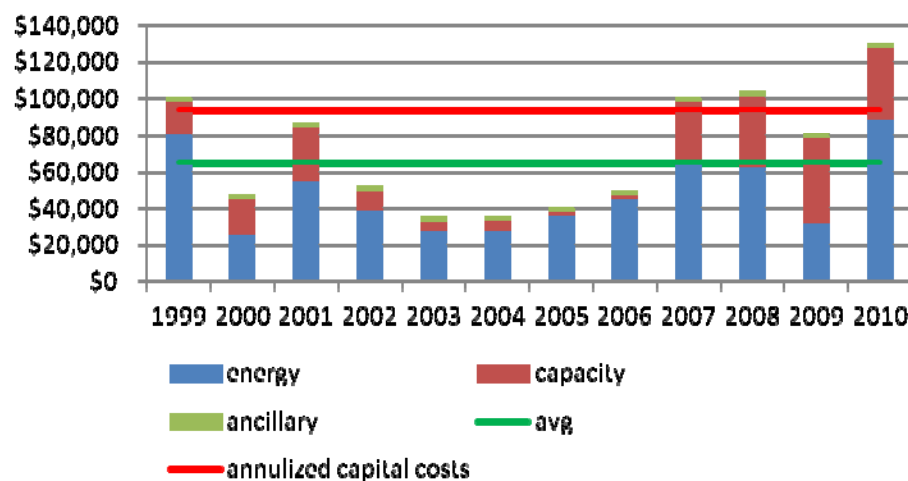
Marija Ilic (CMU)

Resource Adequacy

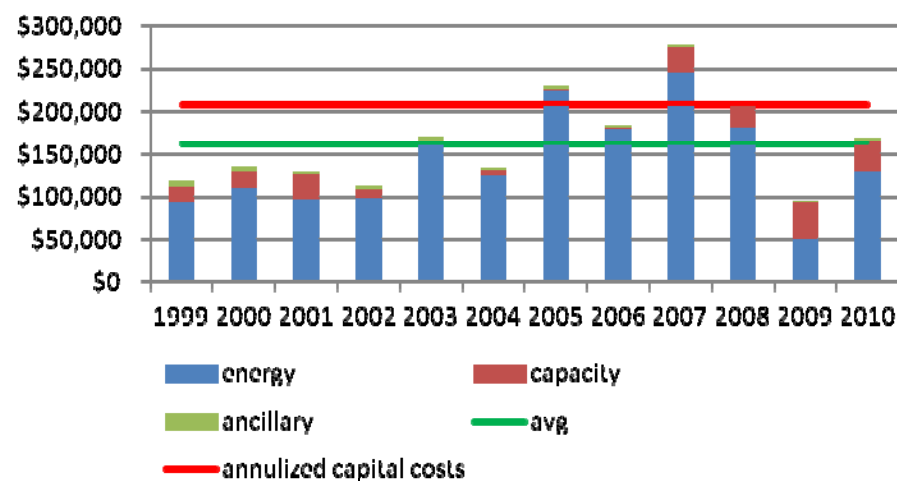
- Few investments w/o policy subsidies
- The “missing money” problem

PJM new entrant net revenue study (PJM 2011)

New Natural Gas CC Generator



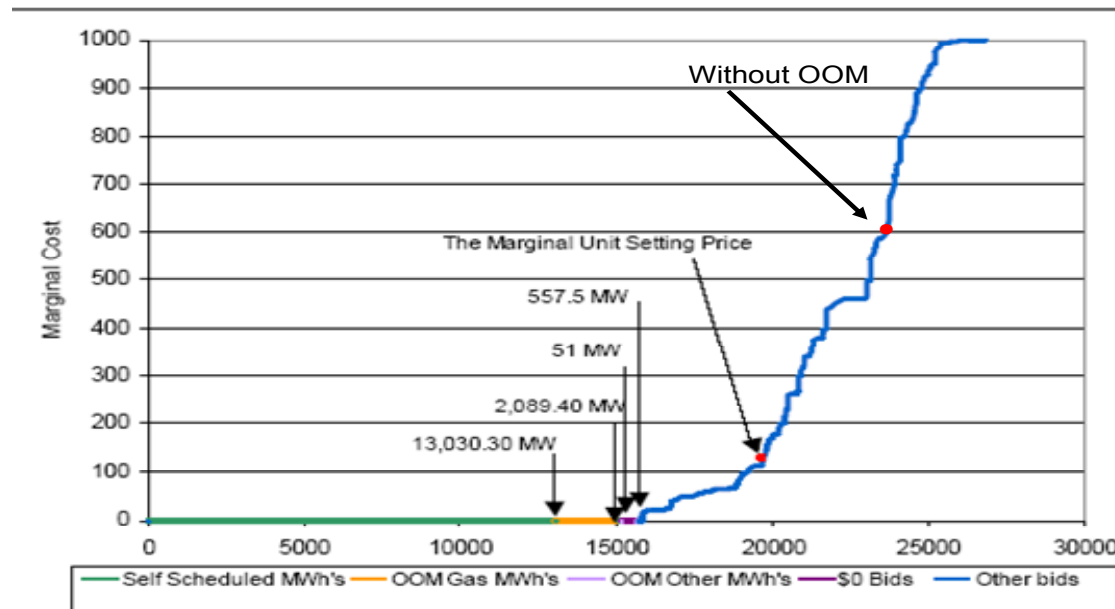
New Pulverized Coal generator



Spot Market Improvements

- Restore right spot market price signals
 - Remove price caps
 - Encourage demand response
- OOM /RMR commitments depress prices
 - Uplifts are socialized by LSEs

Figure 29 - Supply Stack for 1 SPD run, January 15, Hour Ending 2:00 p.m.



Spot Market Improvements

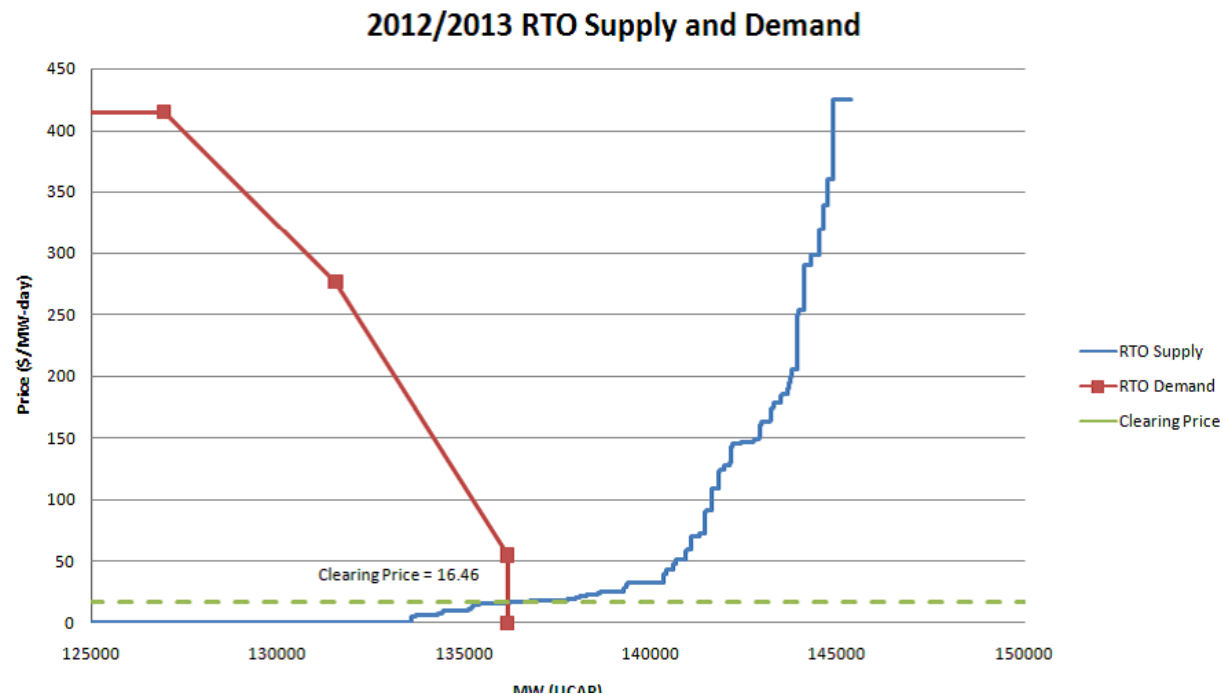
- Pricing reliability: allow RMR units to set LMPs
 - Modifying the transmission constraints
 - G1: \$50, G2: \$100, L1=L2=100MW, line limit 200 MW
 - RMR: G2 dispatch 10 MW => Line limit 190 MW



	G1 output (MW)	G2 output (MW)	LMP1 (\$/MWh)	LMP2 (\$/MWh)	Uplift (\$)	Cost of Electricity (\$)
Solution w/o RMR	200	0	\$50	\$100	\$0	\$10,000
Solution with RMR	190	10	\$50	\$50	\$500	\$10,500
Proposed Solution	190	10	\$50	\$100	\$0	\$10,500

Capacity Market

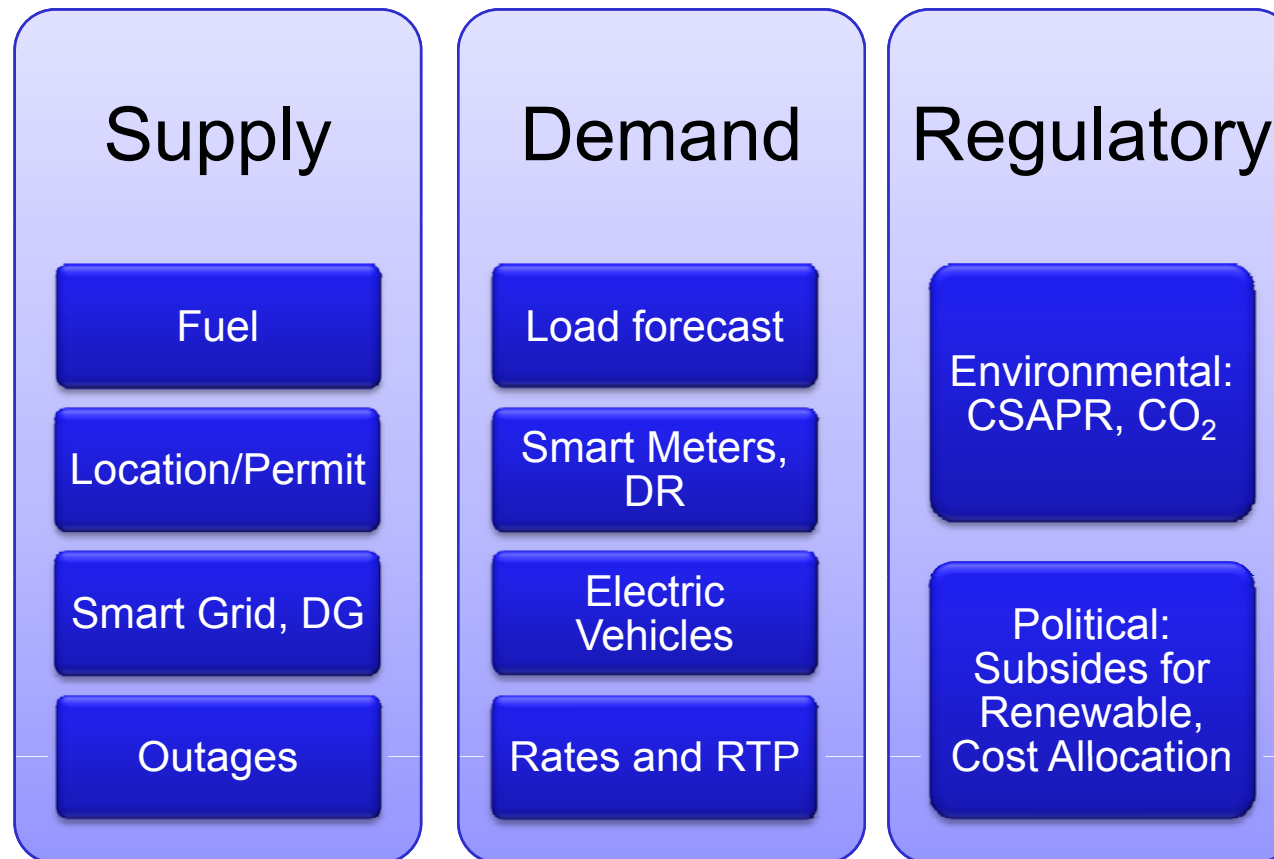
- Explicit capacity target with mandatory participation
- Administrative demand curve sets the price:
 - Target capacity level
 - Cost of New Entrant (CONE)
 - Net energy and A/S offsets



Capacity Market

- Administrative demand curve
 - CONE is based on one new natural gas CT unit
 - Susceptible to market power
 - 1% decrease in supply => 20% in price
- Rewards with few performance requirements
 - Commitment obligations don't necessarily translate to cleared energy
 - Reverse selection: mothballed unit reactivation and delayed retirements
 - Uneconomic entrants with subsidies
 - NJ and Maryland legislations and FERC rulings
 - Large Renewable Portfolio Standard integration in the future

Uncertainties and Risks



Spot market prices too volatile for long-term investments

Uncertainties and Risks

- These factors interplay with each other
 - Old coal fired generators in western PJM

Low Revenues due to congestions



Delayed retirements due to capacity payments

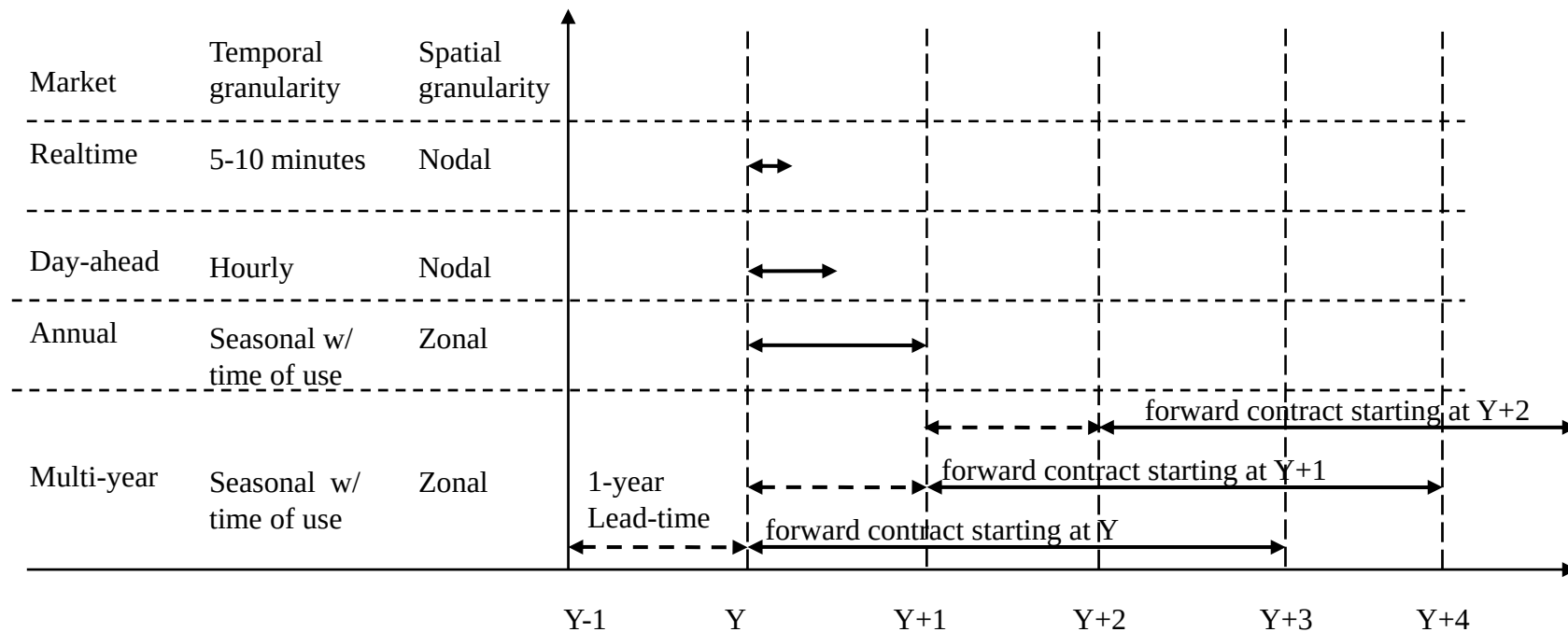


Expedited retirements due to CSAPR

- Accelerated coal plant retirements coincide with large integration of renewable resources: long-term reliability implications

SEM: Market Design

A series of sequentially cleared forward markets
+ Spot markets w/ improvements



Market Interactions

- Long-term forward contracts are financial
 - Arbitrages between the markets are allowed
 - Centralized credit management
- Short-term market products are physical
 - Net long-term positions => short-term obligations
 - Penalty for non-delivery
 - Bids/offers need to be backed up by physical assets
 - Generators/loads
 - Confirmed demand response projects
 - Firm imports/exports at interties

Financial Settlement

- Incremental settlement rule
 - Cleared quantity is the sum of all existing layers
 - Only the difference is settled against the new price

Markets	Price	Quantity	Settlement
Y+3 contract at Y auction	P1	Q1	$P1Q1$
Y+3 contract at Y+1 auction	P2	Q2	$P1Q1 + (Q2-Q1)P2$
DA Markets	P3	Q3	$P1Q1 + (Q2-Q1)P2 + (Q3-Q2)*P3$

Financial Settlements

- Example 1: Arbitrage by financial player: price convergence

Markets	Price	Qty	Settlement
Y+3 contract at Y: buy	\$10	-20	-200
Y+3 contract at Y+1: sell	\$14	0	$-200 + (0 - (-20)) * 14 = 80$

- Example 2: incremental offers by Gencos: risk distribution

Markets	Price	Qty	Settlement
Y+3 contract at Y auction	\$10	20	$10 * 20 = 200$
Y+3 contract at Y+1 auction	\$14	30	$200 + (30 - 20) * 14 = 340$
DA Markets at location 1	\$5	10	$340 + (10 + 30 - 30) * 10 / (10 + 30) * 5$ $+ (10 + 30 - 30) * 30 / (10 + 30) * 30$ $= 577.5$
DA Markets at location 2	\$30	30	

Key Features

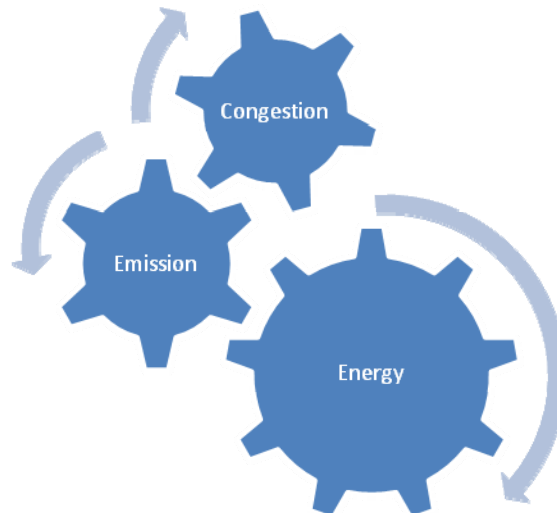
- Provide right performance incentives
 - Link performance with rewards (penalties for non-delivery)
 - Link risks with rewards by promoting forward hedging
- Provide flexible platform to manage risks
 - Forward hedging promotes stability
 - Risk premium as means to recover the missing money
 - Feedback mechanism provides price discovery and portfolio realignment
 - Centralized credit management reduce default risks
 - Possible natural solution for unit commitment problem

Risk Allocation

- In regulated industry, consumers bear risk
- In deregulated spot markets, investors bear risk
- Risks are better managed by those who have more knowledge
- Risks should be allocated to the entities who are prepared and able to take that risk
- Market rewards “right” risk taking with a premium
- Risks can be turned into incentives

The Bigger Picture

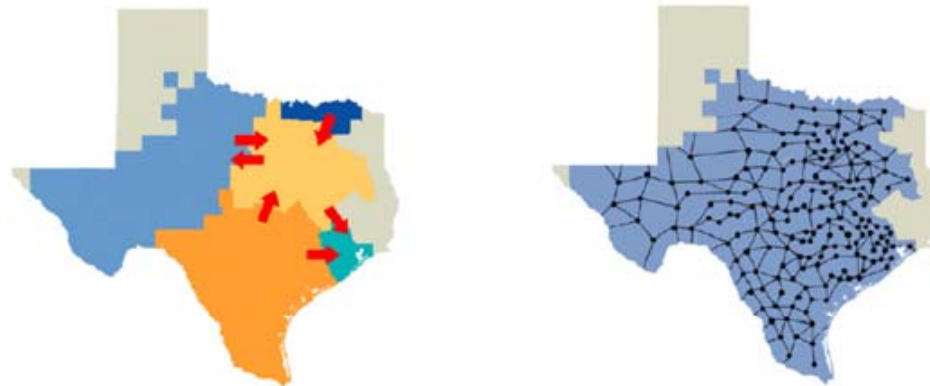
- SEM could be expanded to account for other externalities
 - Transmission congestions: long-term FTR market
 - Air Pollutant emissions: Cap and Trade emission markets
 - Fuel price uncertainty: long-term fuel market
- Achieving long-term sustainability by addressing multiple risk factors and their interdependence



Questions?

Market Design

- Temporal granularity
 - Long-term tenor: 3-5 years in advance with necessary lead time for construction
 - Long-term: seasons with different time of use
 - Short-term : hourly in DAM and 5-10 mins in RTM
- Spatial granularity
 - Long-term : zonal settlement
 - Short-term : nodal settlement w/ full network models



RA: In Theory

- Deregulated industry
 - Under ideal market conditions, spot market should work
 - Optimal capacity and technology mix are achieved in a long run equilibrium when profits of marginal units received from energy markets can recover capital and O&M costs
 - Investors/developers bear the risk

