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OF COMPETITION AND REGULATION INC.**

# **Forward Markets: *The Absent Day-Ahead Market***

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# Overview

- What is a day-ahead electricity market?
- Market design issues for day-ahead markets
- Benefits of operating a day-ahead market
- Why was the original day-ahead market in NZEM abandoned?
- Areas in NZEM where a day-ahead market may offer benefits
- What would day-ahead prices for NZEM look like?
- Actual day-ahead prices for PJM
- Day-ahead markets at a subset of nodes
- Conclusions



# What is a day-ahead market?

- Operates a day in advance of actual operating day
- Allows both 'financial' and 'physical' participation
- Distinct from real-time markets but linked by 'two-settlement system'
- Day-ahead price and quantity are 'locked in'. Deviations managed by real-time market



# Two-settlement system: example

Day-ahead mkt  
Wed 3/9/03  
1.30 - 2.00 am

Real-time mkt  
Thurs 4/9/03  
1.30 - 2.00 am

Load      Generator

Load      Generator

Buys forward 20MW at \$10/MW	Sells forward 20MW at \$10/MW
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Sells 5MW at \$9/MW	Buys 5MW at \$9/MW
Pays \$200 for forward contract	Paid \$200 for forward contract

Forward contract for 20MW

Actual delivery is only 15MW

$$\text{Total payment to generator} = (20\text{MW} \times \$10) - (5\text{MW} \times \$9) = \$155$$



# Incentive-compatibility of two-settlement system

- Two-settlement system is incentive-compatible in that a generator has generally the same incentives in real-time market as if day-ahead market didn't exist
- Generator offers entire desired generation into real-time market. Deviations or mistakes are managed by two-settlement system
- Symmetry means same incentives apply to electricity purchasers for their desired load



# Market design: centralised or decentralised trading (1)

(Trading Institution?)

- *Transaction costs*: centralising saves transaction costs

Closer to real time – electricity product more homogeneous, higher demand, more transactions

\_ trading platform to economise in transaction costs

\_ centralised trading may be more cost effective

Further from real time – electricity products differ, lower demand, fewer transactions

\_ higher transaction costs

\_ decentralised trading may be more cost effective



# Market design: centralised or decentralised trading (2)

(Trading Institution?)

- *Information Exchange*
- *Winner's Curse:*  
Common values \_ winner's curse, affects bidding/offering  
In electricity pay-as-bid auction, common value is price guessed.  
Winner's curse \_ submit higher offers
- *Forward markets*  
reveal information on common values so helps solve winner's curse problem \_ lower offers  
Centralised trading reveals information to more participants



# Market design: uniform-price or pay-as-bid (1)

## (Complementary?)

- Uniform-price – generators all paid market-clearing price  
Pay-as-bid – generators all paid what they offer
- Bidding behaviour:  
Competitive uniform-price – offer at marginal cost  
Pay-as-bid – offer at estimated price of electricity
- Potential Problems:  
Uniform-price – can be affected by exercise of market power  
Pay-as-bid – no dispatch order and large generators may have more resources to forecast price





# Market design: uniform-price or pay-as-bid

## (2): Complementary Markets?

- Combination of uniform-price real-time and pay-as-bid day-ahead may improve price discovery.
- Why?  
In real-time, uniform-price provides least-cost dispatch order  
  
In day-ahead, dispatch order is not needed, and pay-as-bid may limit incentives for exercise of market power
- Note virtual bidding (arbitrage) => the average price in each market should be the same but be affected by the DA Mkt presence



# Gaming the two markets

(Robert Michaels, 2003)

- At high loads, supply curve becomes very steep
- Demand-side can exercise market power:  
Understate load to achieve a lower day-ahead price, while making up the shortfall in the real-time market
- Requires:
  - no virtual bidding
  - uniform-price auction in both markets



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# Gaming the two markets

- Ways to counter this:
  1. Allow virtual bidding: generators submit a virtual load bid to counter understated load.  
This arbitrage across markets drives prices to converge
  2. Allow a pay-as-bid day-ahead market: flat supply curve limits the incentive to understate load



# Benefits of day-ahead markets

- Increase reliability/certainty
- Promote demand-side participation
- Assist in unit-commitment
- Reduce impact of price uncertainty/volatility
- Reduce incentive for gaming



# A day-ahead market in NZEM? Already tried and abandoned!

Possible reasons:

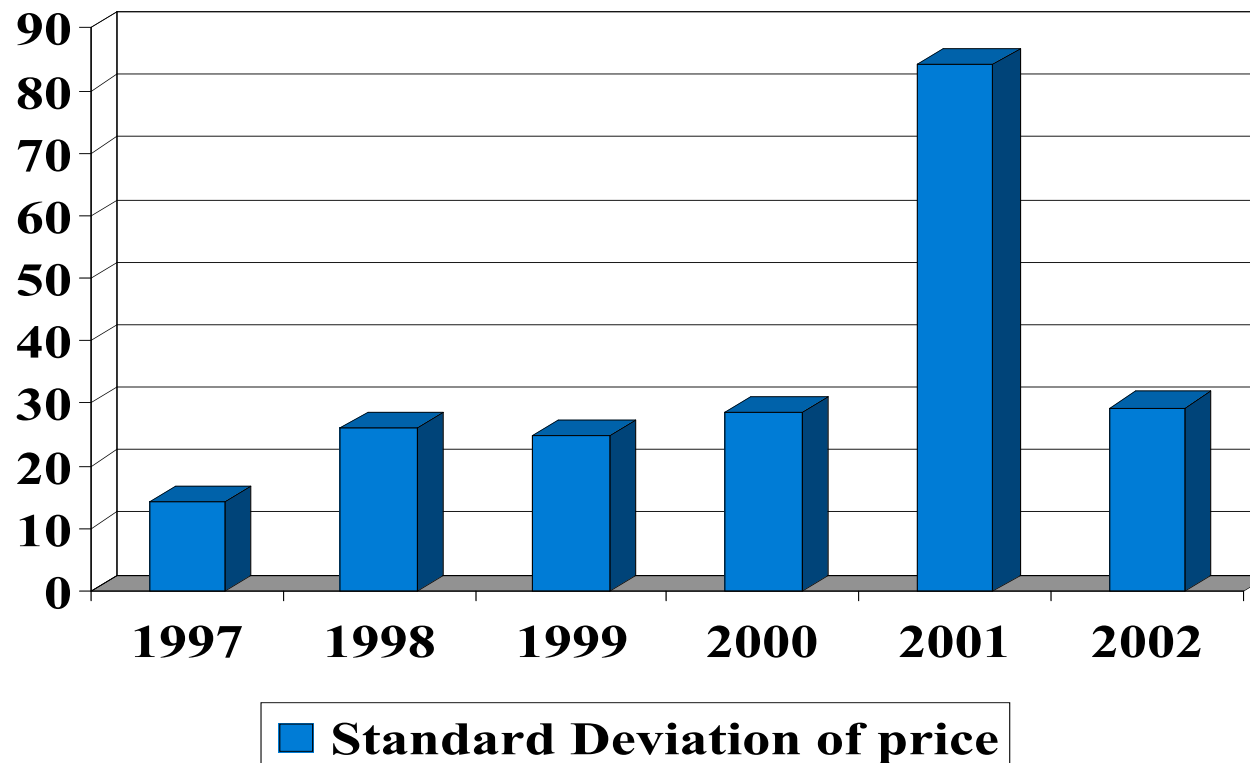
- Low price volatility
- ECNZ required to have 87% of capacity hedged in 1997
- Duopoly \_ less competition
- Quick-start hydro-generation  
\_ reliability and unit-commitment not such a problem



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# A day-ahead market in NZEM? Already tried and abandoned!

Low price volatility



# A day-ahead market in NZEM?

## Times have changed!

Potential benefits in areas of:

- Demand-side participation
- Impact of price volatility
- Incentives for gaming
- Must-run generation
- Volatility on a river chain
- Administrative costs



# Forecast of day-ahead prices in NZEM

- If DA market existed, how would prices compare with RT?

- For any node, for trading period  $i$  and day  $t$  estimate:

$$P_{it} = f(\text{previous day's price } P_{it-1})$$

- Use estimates to forecast day-ahead prices

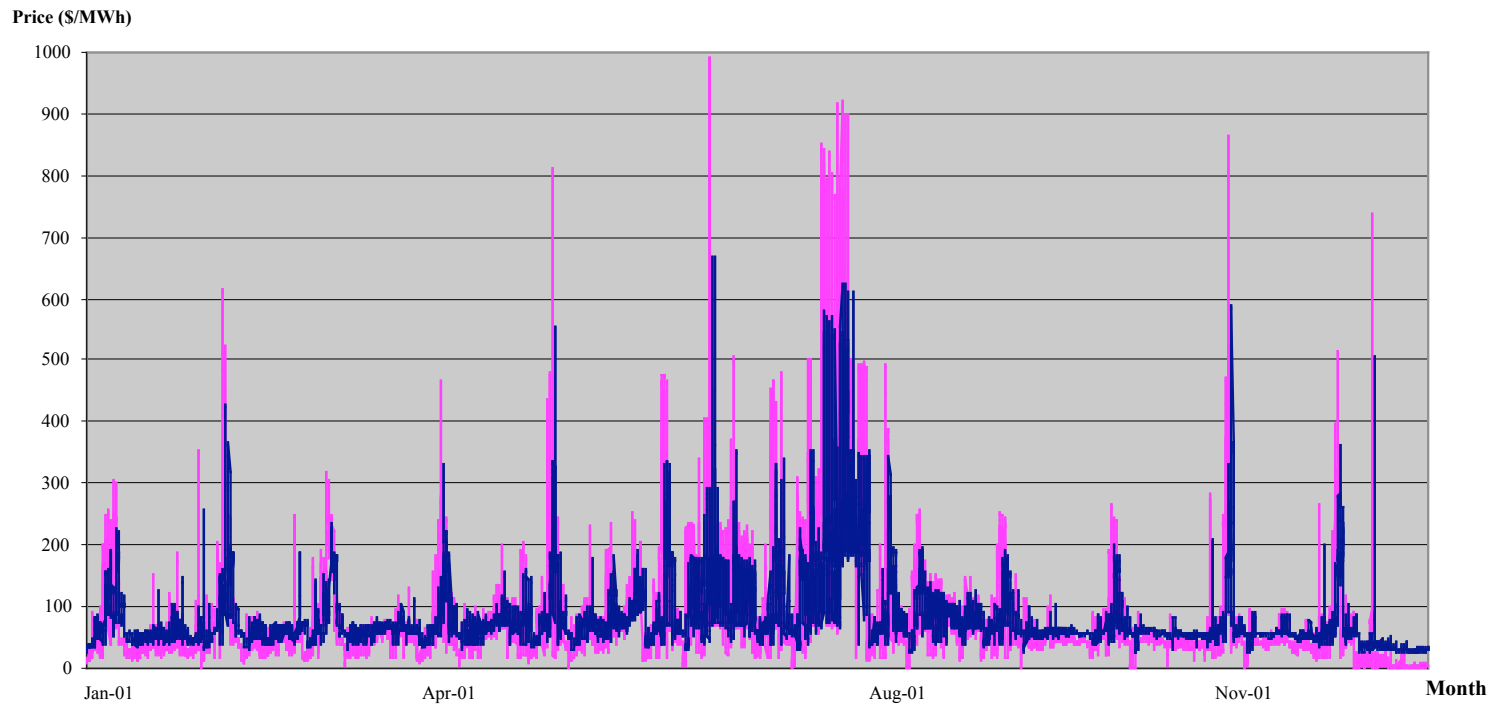
$$\hat{P}_{it} = \hat{f}(P_{it-1})$$

- Guthrie and Videbeck (2002) \_ forecasting prices from same trading period on the day before is reasonable





# NZEM Real-time and forecast day-ahead prices 2001

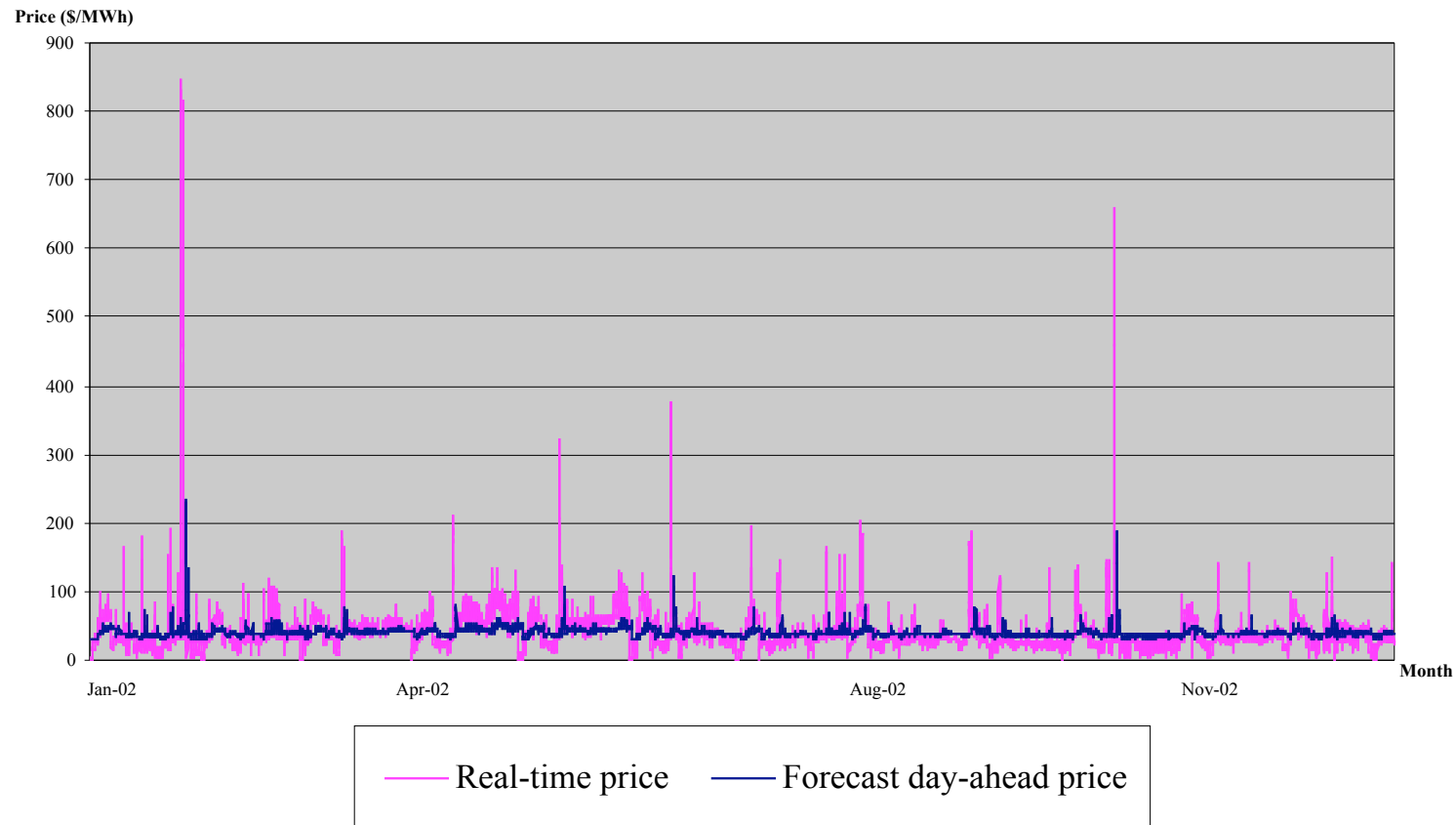


— Real-time price — Forecast day-ahead price



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# NZEM Real-time and forecast day-ahead prices 2002



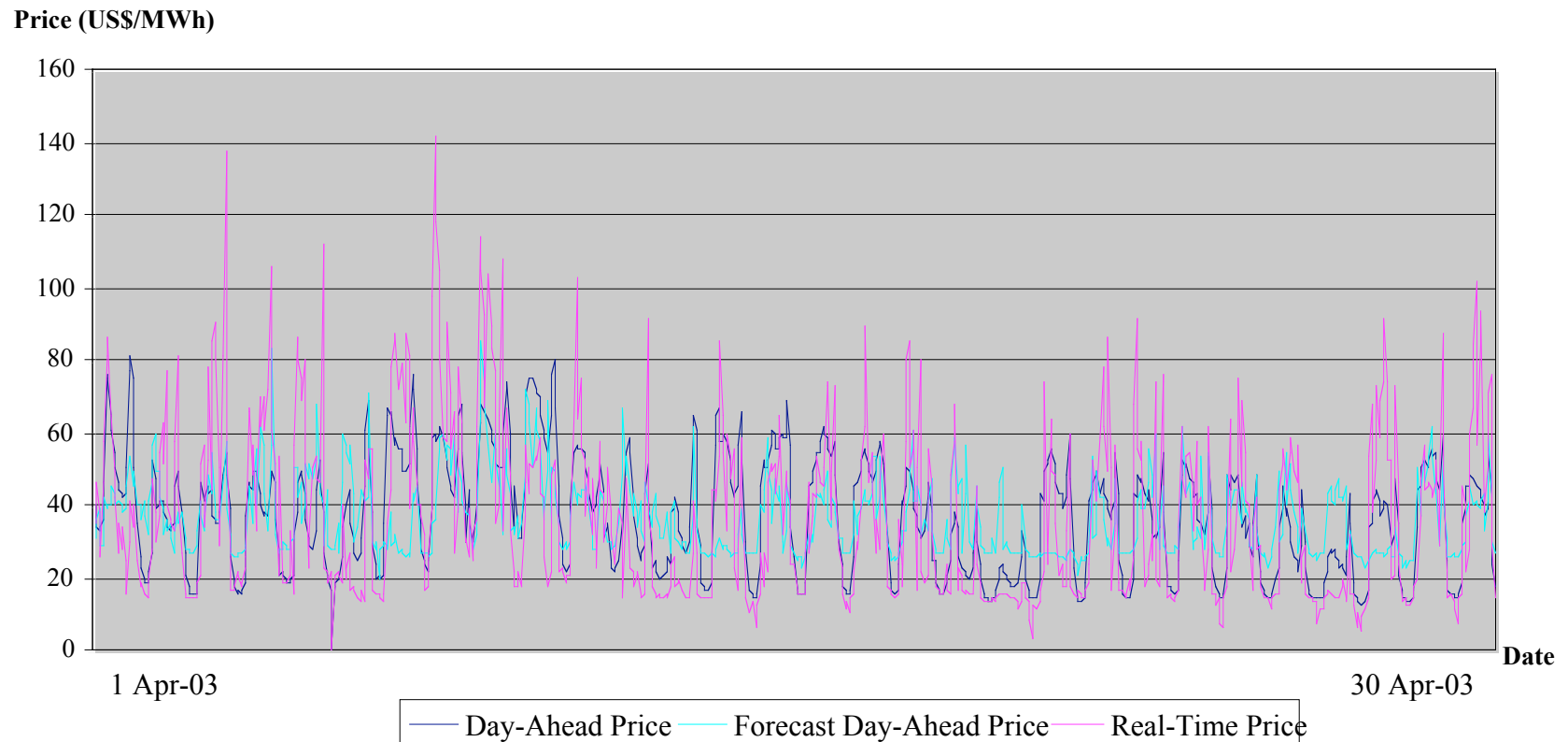
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# Is this a reasonable approach?

- Try where both a day-ahead and real-time market already exist
- PJM in Northeastern United States operates both day-ahead and real-time markets
- Following graph shows there is some merit in our approach



# PJM Real-time, day-ahead and forecast day-ahead prices April 2003



# Results of the forecasting experiment

- In NZEM, forecast day-ahead prices less volatile than real-time prices

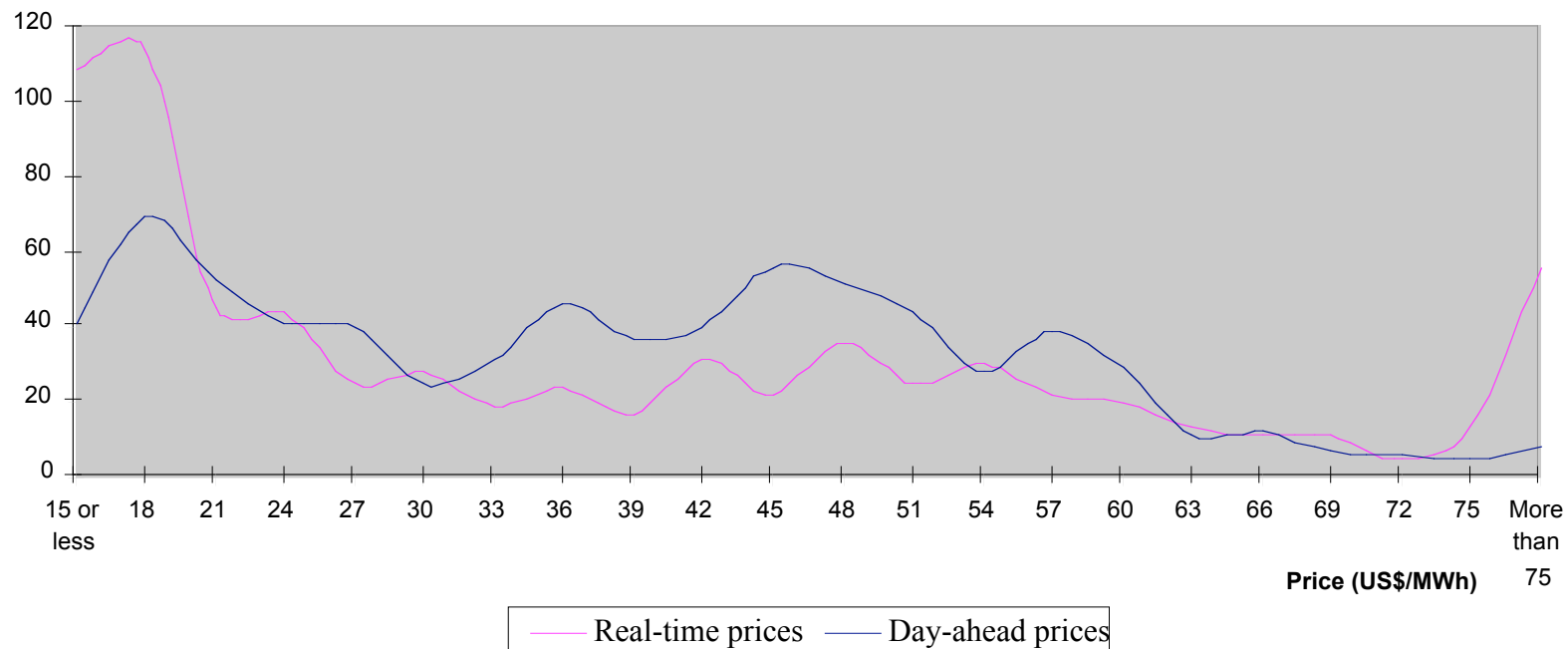
Year	Mean (\$/MWh)		Standard Deviation (\$/MWh)	
	Real-time Prices	Forecast Day-ahead Prices	Real-time Prices	Forecast Day-ahead Prices
2001	79.85	79.85	84.20	54.58
2002	40.16	40.16	29.32	7.04

- In PJM, actual day-ahead prices relative to real time prices
  - Have the same mean
  - are less volatile,
  - Have a less skewed and peaked distribution



# Results of the forecasting experiment: PJM (April 2003)

Number of observations  
in each price range

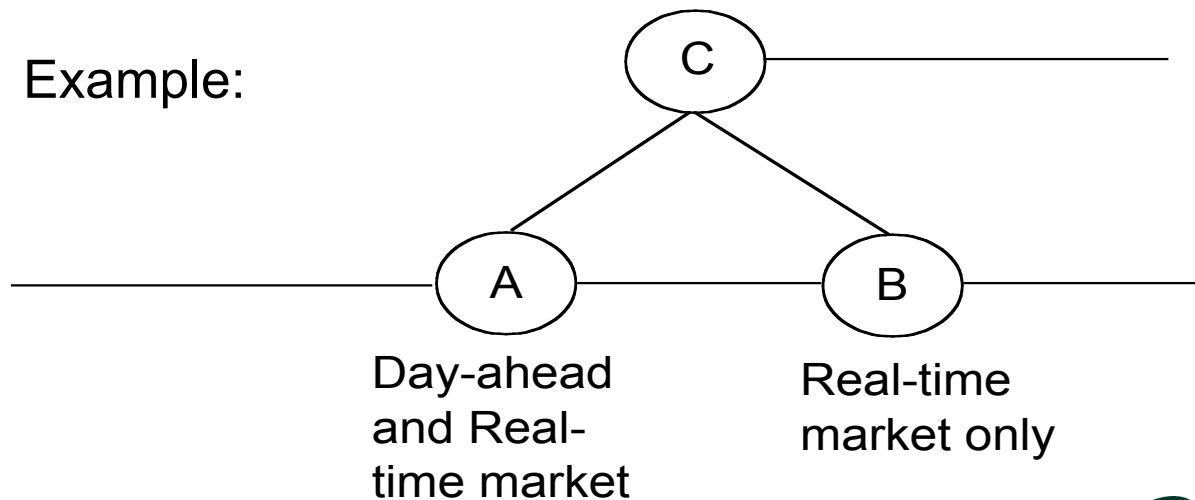


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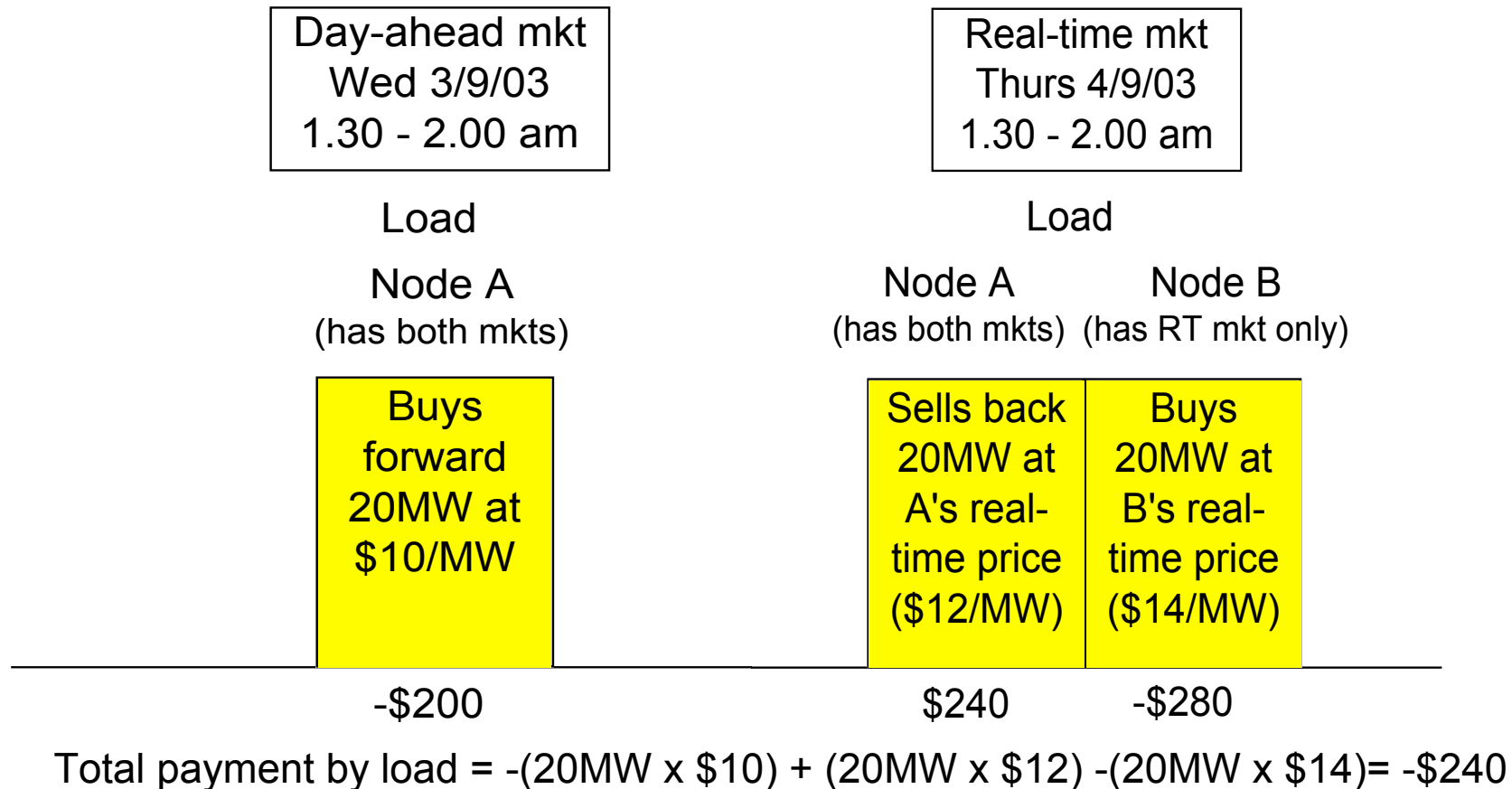
# Transactions and markets at different nodes

- Day-ahead markets need not operate at all nodes
- Fewer day-ahead nodes may give more participation at these nodes

- Example:



# Example: markets at different nodes





# Markets at different nodes and FTRs

- Day-ahead market at A provides a hedge for volatile real-time prices at B
- But only if real-time prices at A and B are ‘similar’
- Guthrie and Videbeck (2003):  
\_ prices are similar over upper North Island, lower North Island and South Island \_ suggests 2 or 3 day-ahead markets
- Financial Transmission Rights may complement day-ahead markets by limiting intra node volatility over longer periods



# Conclusions

- Day-ahead markets are not a necessity but do provide additional benefits
- As it is close to real-time, a centralised trading day-ahead market may be more effective than a decentralised one
- The combination of pay-as-bid day-ahead market and uniform real-time market may improve price discovery
- Although tried and abandoned, times have changed and a day-ahead market in NZEM would offer benefits in some key areas
- Day ahead markets are forward markets

