Retail Market Regulation to Foster Active Consumer Participation in Wholesale Electricity Markets

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Motivation for Talk

- Describe three sets of initial conditions necessary to maximize benefits consumers receive from active participation in wholesale electricity markets
  - Technological
  - Regulatory
  - Market design
- Describe ongoing regulatory oversight necessary to protect consumers
  - Retail competition with no output price regulation creates new role of retail market regulator

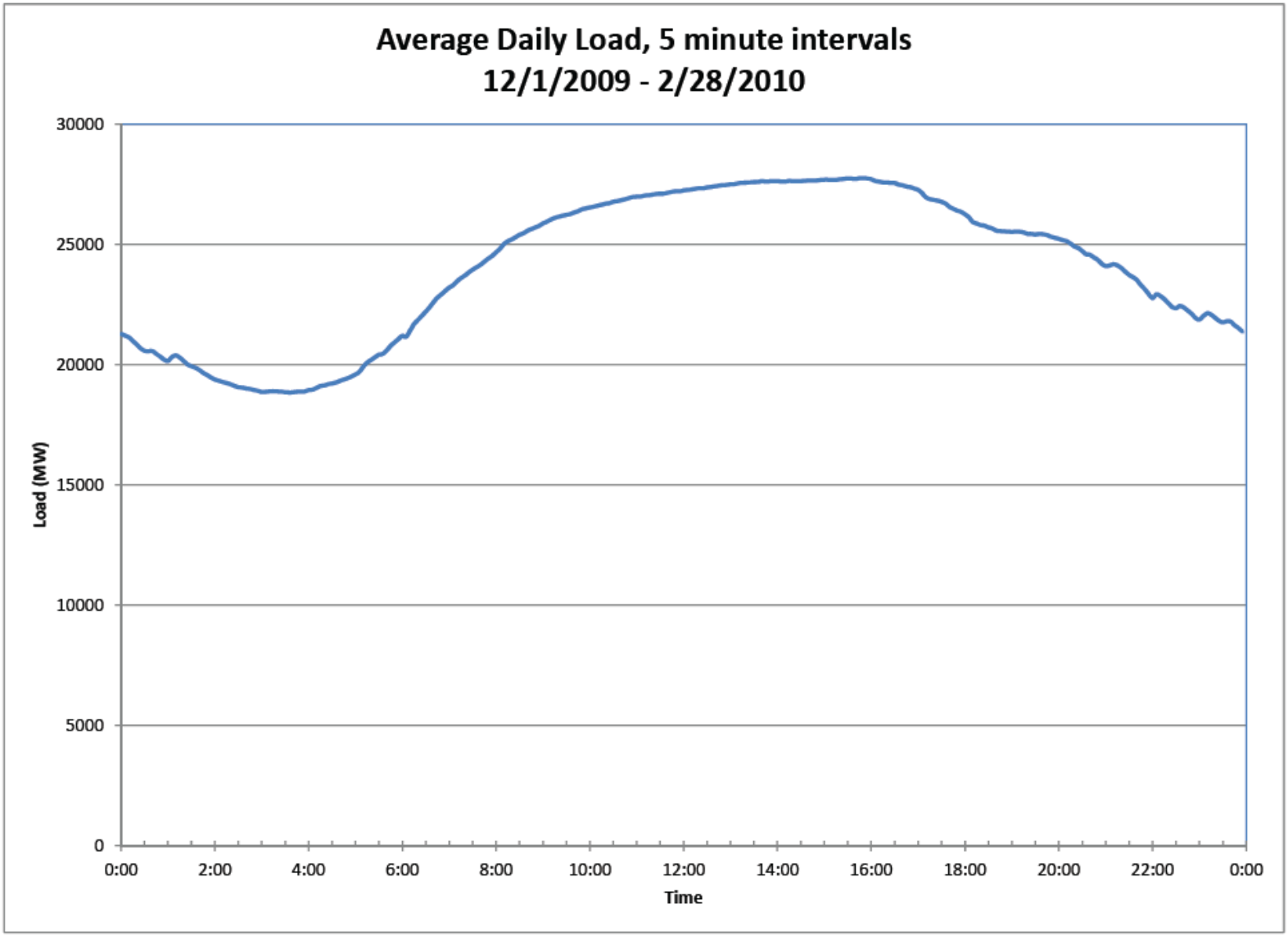
Outline of Talk

- Why active participation of consumers is essential
  - Managing intermittency
  - Managing unilateral market power
- Necessary initial conditions for active participation
  - Technological
    - Interval meters
    - The downside of load-profile billing
  - Regulatory
    - Necessity of default symmetric treatment of load and generation
    - Adequate and timely information provision to consumers
    - Prudent hedging of wholesale price risk
  - Market design
    - Multi-settlement market
- Ongoing role for retail market regulator

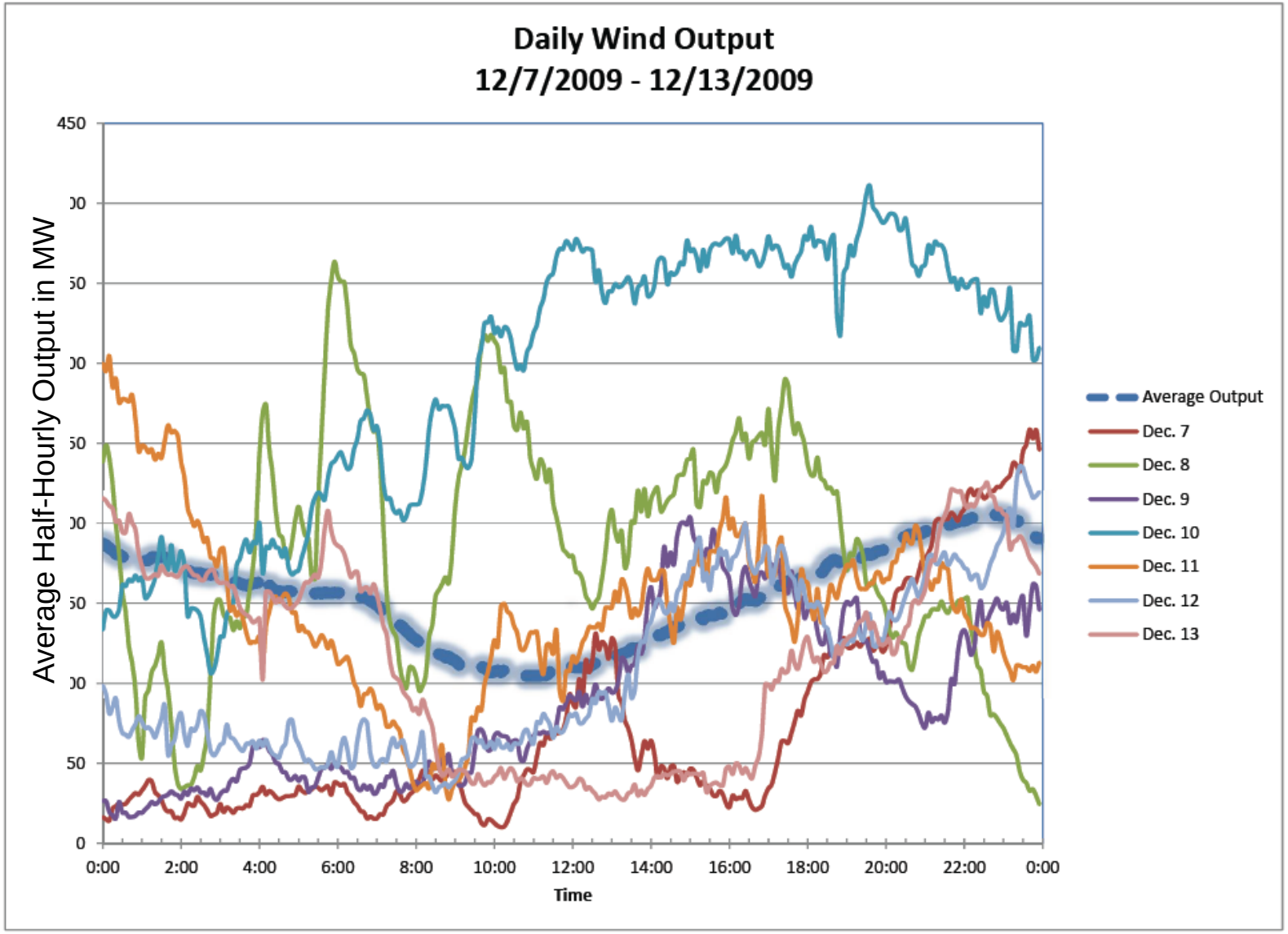
Why Active Participation is Essential

- Many jurisdictions have ambitious renewable energy goals
  - California has 33 percent renewable energy share goal by 2020
- Renewables are often unavailable during peak periods
  - During July 2006 heat storm, July 24 demand in California ISO control area hit a 1 in 50 year peak of 50,200 MW
    - Less than 5 percent of installed wind capacity was operating at the time
  - In California, wind energy comes primarily during night and solar energy can only come during the day
    - Cloud cover can significantly reduce solar PV output
  - Wind and solar output are highly positively correlated across locations in California
    - If there is no wind at one location, there is likely to be no wind at others
- Major factor driving need for dynamic pricing—High wholesale prices do not cause more wind or solar energy to be produced
  - As share of renewable energy grows final consumers must supply more "dispatchable negawatts" to maintain system balance
    - Load-shifting or investments in energy storage technologies

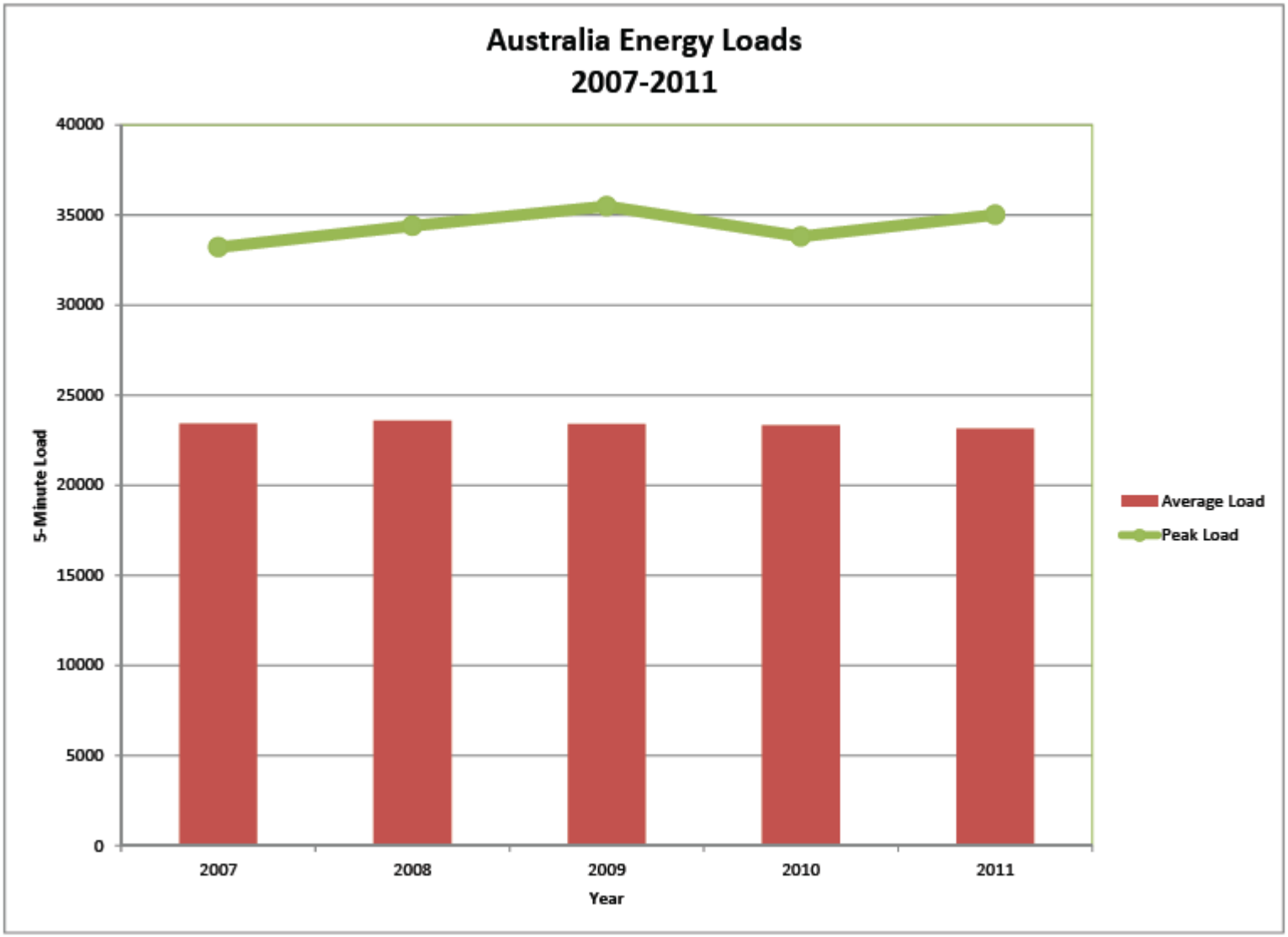
Daily Load Shape in Australia



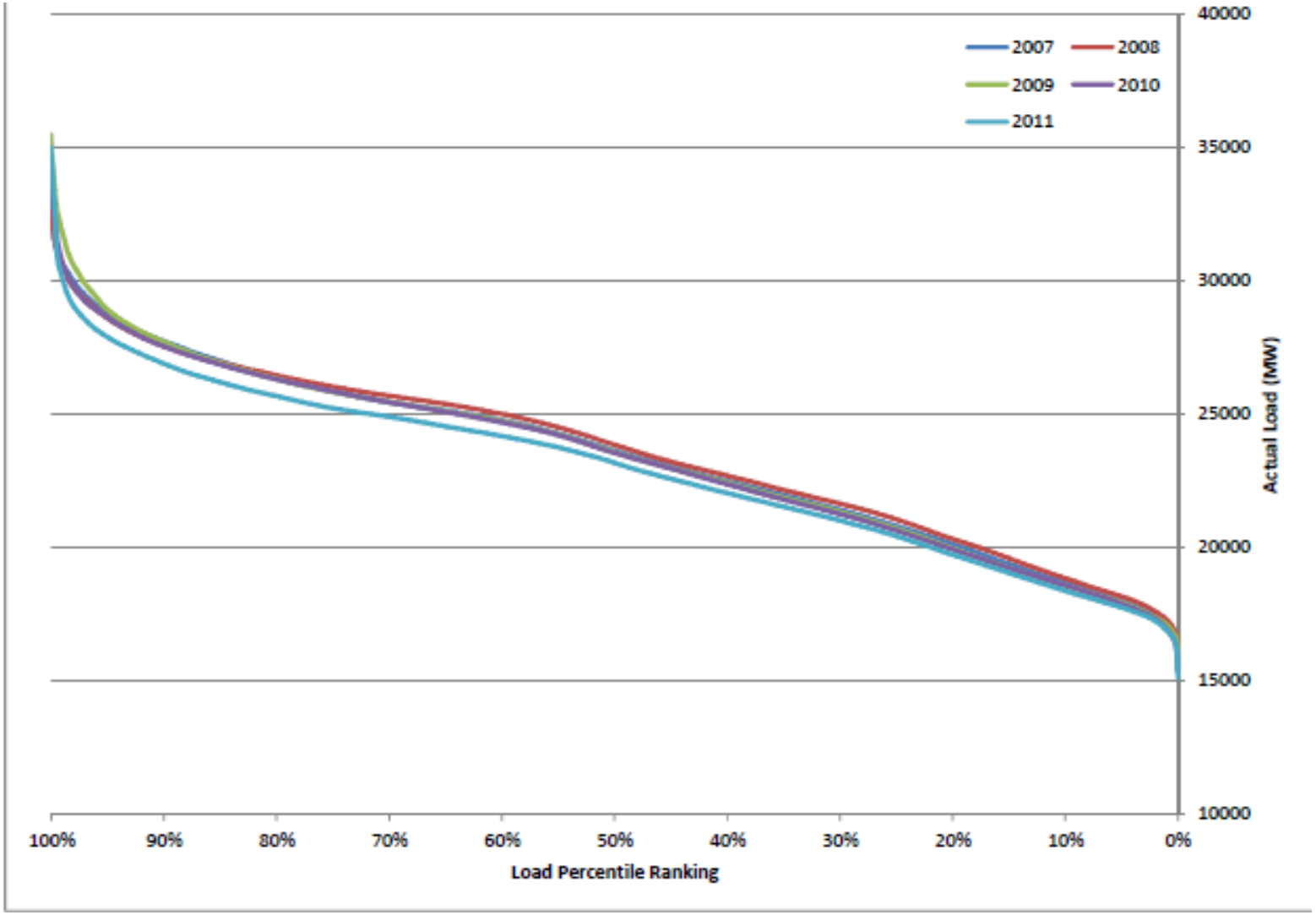
Daily Output of Wind Units in Australia



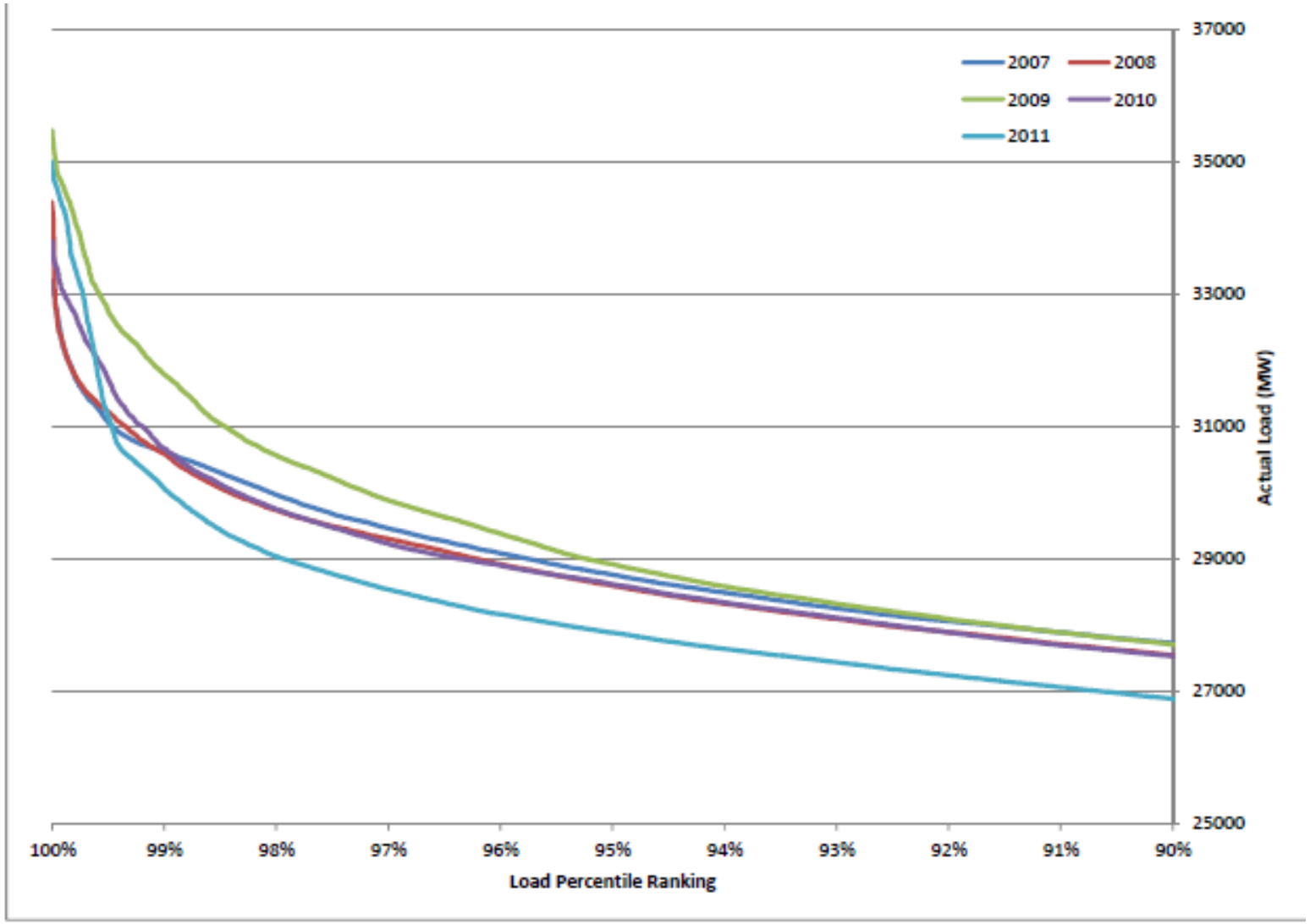
Average versus Peak Demands in Australia (Peaks are More Variable than Total Demand)



Load Duration Curves for Australia



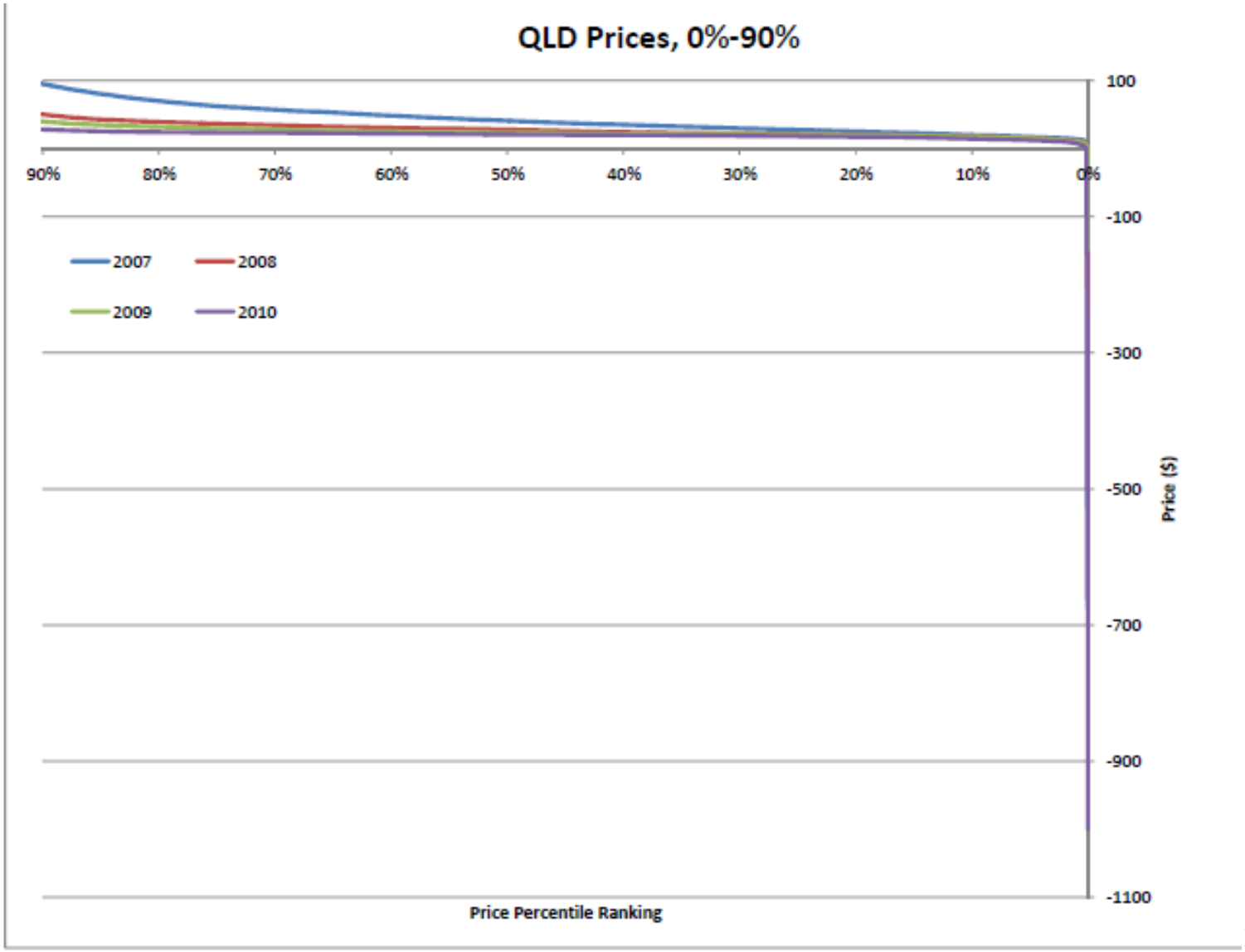
Load Duration Curves Australia



Economics of Energy Efficiency

- Variation in electricity demand throughout day and year
  - On average summer day ranges 18,000 MW to 28,000 MW
  - Historic peak greater than 35,000 MW
- Average MW consumption per hour during 2009
  - Approximately 23,000 MW
  - Peak demand for 2009 is 35,478 MW
- Reducing peak demand through active participation
  - Eliminate need to construct new generation capacity
  - Can retire old inefficient units located close to load centers
- Significant fraction of generation capacity used very infrequently
  - In Australia approximately 5,000 MW (15 percent of peak demand) used less than 2 percent of hours of the year
  - With climate change larger fraction is likely to be used even less frequently
  - With $AU 13,100/MWh offer cap and -$1,000 offer floor, Australia has price variation to incent significant demand reductions from active participation and substantial storage investments

Price Durations Curves for Australia



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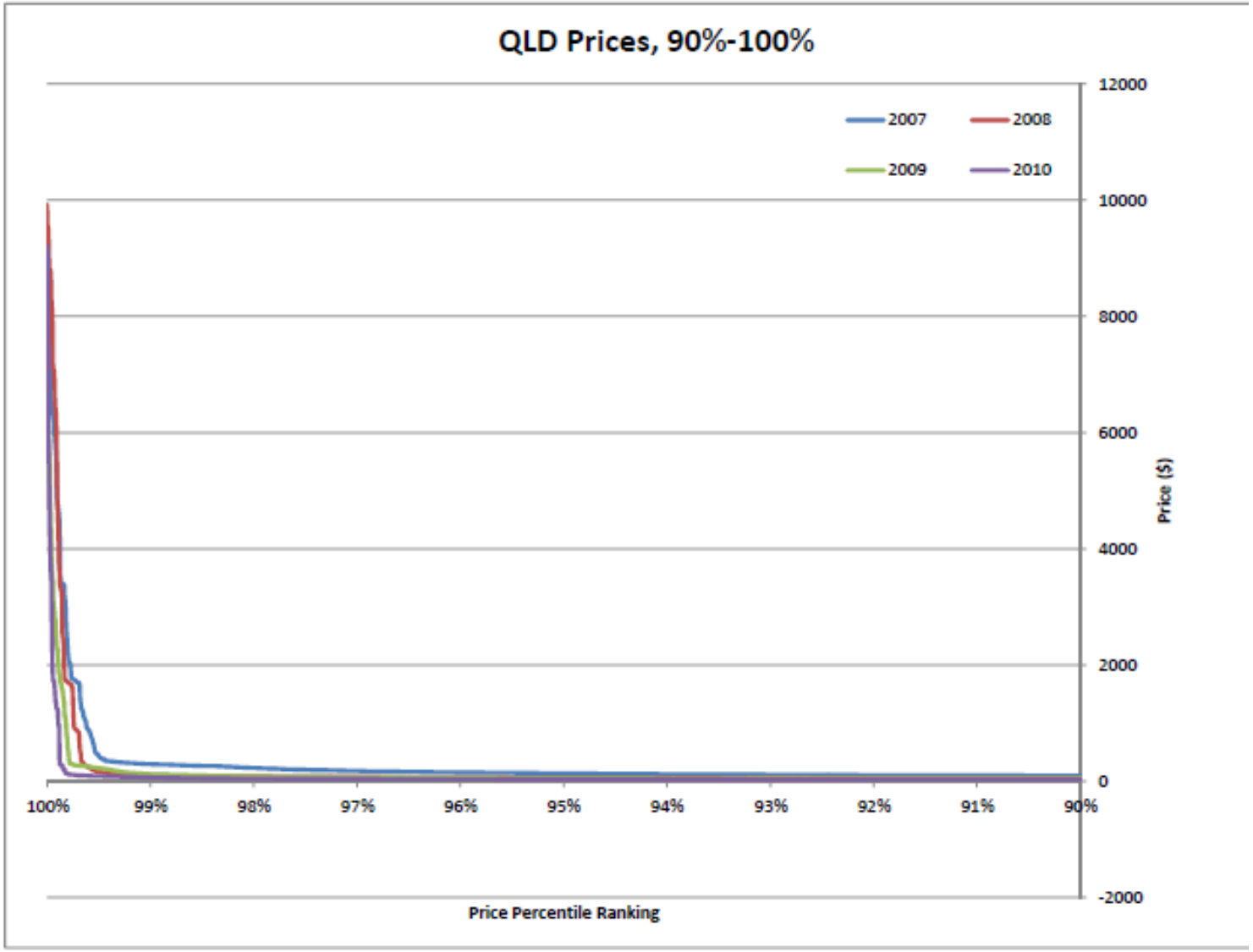

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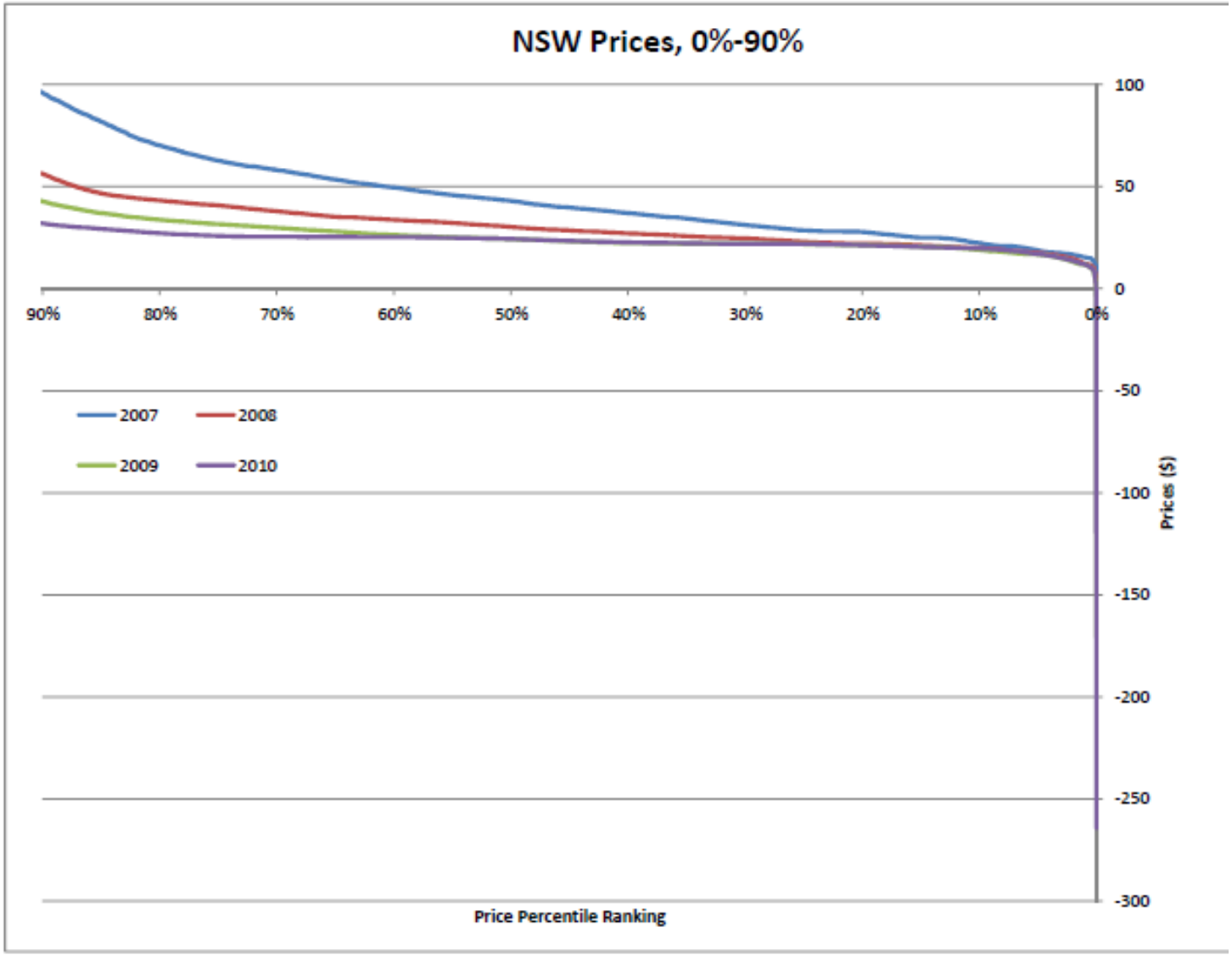

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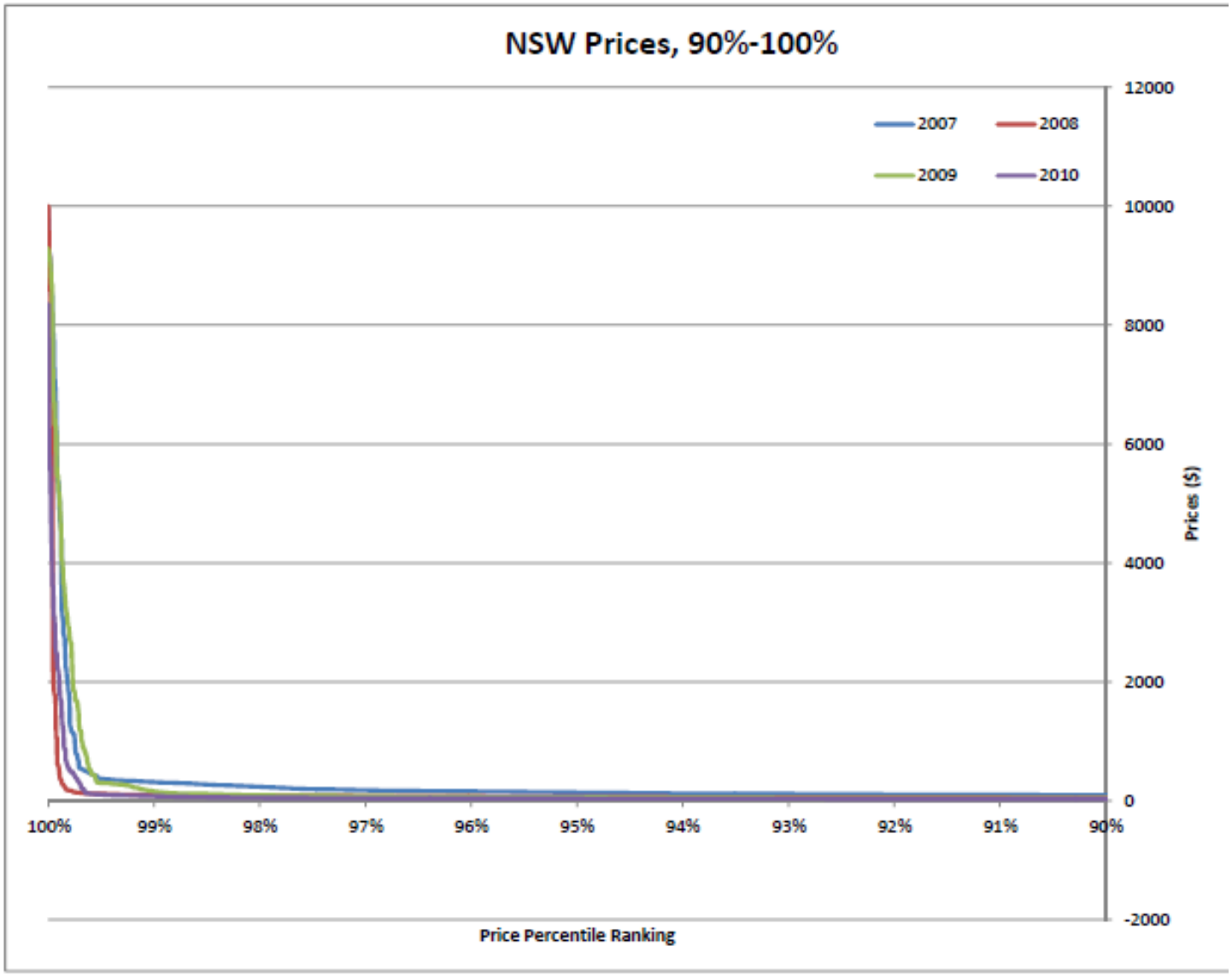

Technological Initial Conditions

Technological Barriers

- Without interval metering, retailers can only sell electricity based on monthly quantity consumed
  - Conventional meters only measure total monthly consumption
    - Read meter at beginning of month and end of month, monthly consumption is difference between two meter reads
- Retailers have no idea (and little incentive to care) who in a given customer class is more expensive to serve in terms of true wholesale energy purchase costs
- Retailers are *assigned* hourly "wholesale withdrawals" for their customers based on standardized load profiles
  - w(h,d) = load profile weight for hour h of day d
  - Q(m) = monthly consumption
  - Q(m)*w(h,d) = assigned hourly consumption during hour h of day d for customer, which may bear no relation to actual hourly consumption of customer

Technological Barriers

- Retail competition without interval metering involves competition to supply monthly energy purchased on an hourly basis using a standardized load shape
  - Hard to see how consumers realize significant benefits from this form of retail competition
    - Does any retailer have comparative advantage in providing load-profiled hourly consumption of consumer?
- Without interval metering, customer reduces monthly bill by same amount by reducing consumption by 1 KWh during hour when wholesale price is $13,100/MWh as he does when price is $0/MWh or negative
  - It is likely to be much easier for customer to reduce demand during periods of low wholesale prices
    - On hot, high-priced day, consumer is unlikely to reduce air conditioning use during peak hours of day, instead consumer reduces demand in middle of night when outside temperature is lower

Technological Initial Conditions

- With hourly metering, retailers can be required by regulator to purchase customer's *actual* hourly consumption at hourly price wholesale price
  - This is *symmetric treatment of load and generation*
  - Customer's actual consumption during the hour can be measured, so actual cost of serving customer is known
  - Little reason for regulator not to require that retailer pay for actual hourly consumption of customer rather than load-profiled monthly consumption
- Initial condition--Retail competition for customers with interval meter should involve serving consumer at actual hourly cost, rather than load-profiled cost
  - Can charge customer an hourly price that reflects cost of serving customer than hour
  - Substantial potential benefits to consumer and market from substituting away from high-priced hours to low-priced hours

Universal Interval Metering

- Cost is not a barrier to ubiquitous interval metering
  - Savings on manual meter reading costs comes very close to paying for interval metering technology in high-wage countries such as the US and Australia
  - Price of metering technology falling rapidly
- Regulator can coordinate a competitive procurement process for provision of interval metering infrastructure
  - Metering services can be sold as a regulated distribution service
- Purchase cheapest meter needed to read hourly consumption
  - Internet and smart phones can be source of all intelligence and interactivity
  - Automated response technology and behavioral response through these devices, not through meter

Regulatory Initial Conditions

Symmetric Treatment of Consumers and Producers

- In all markets, default price all consumers pay and producers receive is real-time price
  - Without symmetric treatment, maximum amount of beneficial active demand-side participation is unlikely to develop
  - Neither consumers or producers are required to pay or receive this price
    - To avoid it, customer must sign a hedging arrangement
- Example from airline industry
  - Customers always have option to show up at airport and purchase ticket for flight they would like to travel on at real-time price
  - To hedge risk, consumer purchases ticket in advance (fixed-price forward contract) with airline
- Electricity consumers must face same default price as generation unit owners
  - If an unhedged supplier produces during a load period, it is paid the real-time for its output

Symmetric Treatment of Consumers and Producers

- Regulator must mandate that all customers with interval meters face real-time price as default price
  - Setting fixed-retail price that gives customers a free hedge against real-time wholesale price and quantity risk severely limits benefits consumers will realize from active participation
- Customers without interval meters can continue with load-profile billing
  - No opportunity to engage in dynamic pricing with these customers because only monthly consumption determines their monthly bill
- Electricity consumers with interval meters must face same default price as generation unit owners in order to maximize benefits from active participation

Information Provision

- For effective active participation, consumers need to understand how their energy-consuming actions translate into dollars on their monthly electricity bill
  - Consumers do not directly consume electricity
  - Electricity is a derived demand from the consumption of services from electricity-consuming durable goods
    - Watching television, washing clothes or dishes, using computer
    - Consumers have little idea how many KWh are consumed in these activities
- Consumer needs to have information on costs of its energy-consuming actions to make informed choices
- Most electricity utilities in California charge according to nonlinear price schedule which complicates this process
  - Price paid for incremental electricity use depends on cumulative use
  - Empirical evidence that consumers do not have sufficient knowledge of how nonlinear pricing works to respond to these prices

Information Provision

- If consumers understand how electricity consuming actions translate into dollars on their monthly electricity bill they can make more efficient consumption choices
  - Evidence from information experiment (discussed in next talk) is that these cost and energy savings are economically significant
  - Kahn and Wolak (2013) “Using Information to Improve the Effectiveness of Nonlinear Pricing: Evidence from a Field Experiment” on web-site
- Types of information that regulator can compile and make available to consumers
  - Pricing plan and how customer’s bill is determined
  - How electricity using actions transaction into dollars on customer’s monthly bill
  - Availability of alternative pricing plans and what customer’s monthly bill is likely to be on these plans
  - Expected saving from energy efficiency and storage investments by household

Forward Market for Energy

- Electricity is a just-in-time market
  - Supply must equal demand at all locations in transmission network at all instances in time
  - Because of how electricity is historically priced to final consumers real-time demand is price inelastic
- Analogy to market for air travel
  - Can purchase on spot market—arrive at airport and purchase ticket to destination
  - Significant price risk associated with this strategy, product can stock out (infinite price), so customers purchase forward contract for air travel to hedge this price risk
- Similar incentives exists in the case of electricity, except that technology of production and delivery of electricity does not allow stocking out individual customers
  - Typically, can only curtail groups of customers
  - This creates “reliability externality” that can justify regulatory intervention on contracting requirements to ensure a reliable supply of electricity for all consumers

Forward Market for Energy

- High-level of fixed-price forward contract coverage of expected sales provides strong incentives for suppliers to submit offer curves close to their marginal cost curve
  - Increases competitiveness of short-term market outcomes
- Political constraints and existing technology make it difficult provide the efficient incentive for retailers to purchase a sufficient quantity of long-term contracts
  - Political constraints prevent setting hourly prices sufficiently high to clear market under all possible system conditions
  - Lack of technology to curtail individual customers or record their hourly consumption
  - Retailers and large consumers know that system operator can only curtail demand to specific areas
- Customers recognize that purchasing forward contracts benefits all customers, but only costs them
  - This is “reliability externality”, which creates incentive for under-contracting by retailers and final consumers
  - Justification for regulatory intervention to ensure sufficient levels of fixed-price forward contract coverage of aggregate demand

Monitoring of Retailer Hedging Strategies

- Regulator must monitor hedging strategies of retailers to ensure they are not gambling with ratepayer's money
  - Sell fixed-price retail commitment that is not hedged with fixed-price wholesale market commitment
- Incentive for retailers to purchase from short-term market at low price and sell on retail market at low fixed-price
  - Significant bankruptcy risk for retailer associated with this strategy because short-term price may rise for sustained period of time
- A number of US retailers and retailers in other international markets have gone bankrupt pursuing this strategy with their retail customers experiencing significant economic harm because they must find an alternative retailer at a time when wholesale prices are usually very high

Multi-Settlement Market

Multi-Settlement Market

- Australia runs a single settlement market
  - All energy sold at real-time price
- All US wholesale electricity markets operate a day-ahead forward market and real-time imbalance market.
- Both markets trade "megawatt-hours (MWhs) of energy delivered in hour h of day d“
  - Firm financial commitment to sell energy at a firm price
- Supplier receives revenue from day-ahead forward market sales *regardless of real-time output of its generation unit*.
  - Sell 40 MWh at a price of $25/MWh receive $1,000 for sales.
  - Any deviation from day-ahead generation or load schedule is cleared in real-time market.
  - If supplier only produces 30 MWh, it must purchase 10 MWh of day-ahead commitment from real-time market at real-time price

Multi-Settlement Market

- Same logic applies to a load-serving entity. Buy 100 MWh in day-ahead market for $40/MWh and pay $4,000 regardless of real-time consumption.
  - If load-serving entity consumes 110 MWh, must buy additional 10 MWh in real-time market at real-time price
- Multi-settlement market overcomes problem of demand selling something it does not own
- In multi-settlement market, demand can purchase 50 MWh in day-ahead market and then only consume 48 MWh to effectively sell 2 MWh of demand reductions
  - Day-ahead market purchase establishes “baseline” relative to which demand reductions can be sold
- Continues symmetric treatment of load and generation to day-ahead and real-time markets

Multi-Settlement Market

- In single settlement market, if demand consumes 48 MWh, then pays real-time price for 48 MWh
  - Difficult to sell demand reductions because don't know what consumer would have consumed in absence of demand response
- Demand response in single settlement necessitates regulator setting an administrative baseline relative to which demand reductions are paid
  - Makes "negawatts" different from megawatts
- In multi-settlement market, demand can purchase baseline in day-ahead market and sell demand reduction relative to that in real-time market
- Introducing multi-settlement system in Australia would considerably reduce average short-term price volatility
  - Day-ahead prices tend to be much less volatile and most trading occurs in this market and most fixed-price forward contracts clear against this price
  - Real-time market only clears imbalances relative to day-ahead schedules

Ongoing Regulatory Oversight

Ongoing Regulation

- Retail market regulator has ongoing obligation to protect consumers
- Retail competition can only protect consumers if they are able to switch retailers if their retailer charges more than the competition
  - Regulator should provide information that reduces cost of switching suppliers
- Significant risk of retailers going bankrupt or ending up in a difficult financial situation
  - Current wholesale price offer cap of $AU 13,100/MWh suggests that retailers selling at a fixed retail price face a significant bankruptcy risk
- Regulator must engage in ongoing monitoring of retailer hedging strategy and manage any possible financial difficulties to protect customers of all retailers
  - Potential penalties for failure to meet “prudent retailer hedging” standards, much like retail banking regulation
- Regulator should have dispute resolution process for customers to deal with their retailer

Conclusions

- Low-cost interval meters increasingly likely to be cost effective in high-wage countries
- Default pass-through of real-time price for all consumers with interval meters (symmetric treatment)
  - Opt-in to symmetric treatment likely to lead to no active participation of final consumers
  - Symmetric treatment makes dynamic pricing, storage and automated load shifting technologies financially viable
  - No customer needs to pay real-time price for any consumption, only face it as a default price, just like in all other markets
- Regulator has important role in information provision and monitoring of retailer hedging strategies
- Multi-settlement market considerably simplifies active participation of final demand in the wholesale market
- Ongoing regulatory oversight of a market with retail competition is essential to protect consumers

Questions/Comments

For more information:

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