



Intermittent Resources in RTO Markets

Presented by:

Robert A. Sinclair
Potomac Economics

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Introduction and Summary

- In the US, as well as in many parts of the world, the electricity utility industry is changing because of the growth of Intermittent Resources (mainly solar and wind).
- In US, wind and solar production together is now close to one-half of nuclear power production;
 - ✓ Including hydro resources, renewable production is roughly on par with nuclear production (about 20% each);
 - ✓ Hence, 40 percent of energy production is at or near zero marginal costs.
- With continued growth of Intermittent Resources, energy and ancillary services prices will be set more frequently by zero or near-zero marginal cost resources;
 - Additionally, the output of the Intermittent Resources can be highly variable.



The “De-Marginalization” Concern

- The changing resource mix has raised concerns among some industry observers;
- One concern has been that existing LMP markets cannot adequately compensate conventional resources that provide flexibility to the grid (mainly natural gas resources).
 - ✓ The basic idea is that marginal energy prices at or close to zero will result in poor incentives to locate and operate where and when flexible resources are needed.
 - ✓ Some have used the term “de-marginalization” to describe this trend of reduced revenues for conventional resources.
 - Some have concluded that new products or market requirements are needed to compensate flexible resources;
 - As we explain, this is not necessarily true in well-designed LMP markets.



Efficient Pricing

- Growing intermittent capacity will tend to create market and operational impacts.
 - ✓ With wind and solar more often on the margin, energy and ancillary service prices will tend to be lower during non shortage intervals.
 - ✓ Wind and Solar production tends to be uncertain during the operating horizon, placing demands on flexible resources and regulation (and in shortage periods, operating reserves);
- While we agree these future trends and their impact will likely occur, LMP markets with well-developed shortage pricing rules will provide powerful incentives to handle these impacts:



Efficient Shortage Pricing

- Shortage pricing is critical because:
 - ✓ Growing output uncertainty from Intermittent Resources will lead to more frequent shortages.
 - ✓ MISO has experienced hourly changes in wind output reaching over 4 GW.
 - ✓ Resources that can ramp quickly or start quickly receive substantial revenues during shortages.
- Well-designed shortage pricing ensures real-time energy and ancillary services prices reflect the value of reserve and transmission shortages.

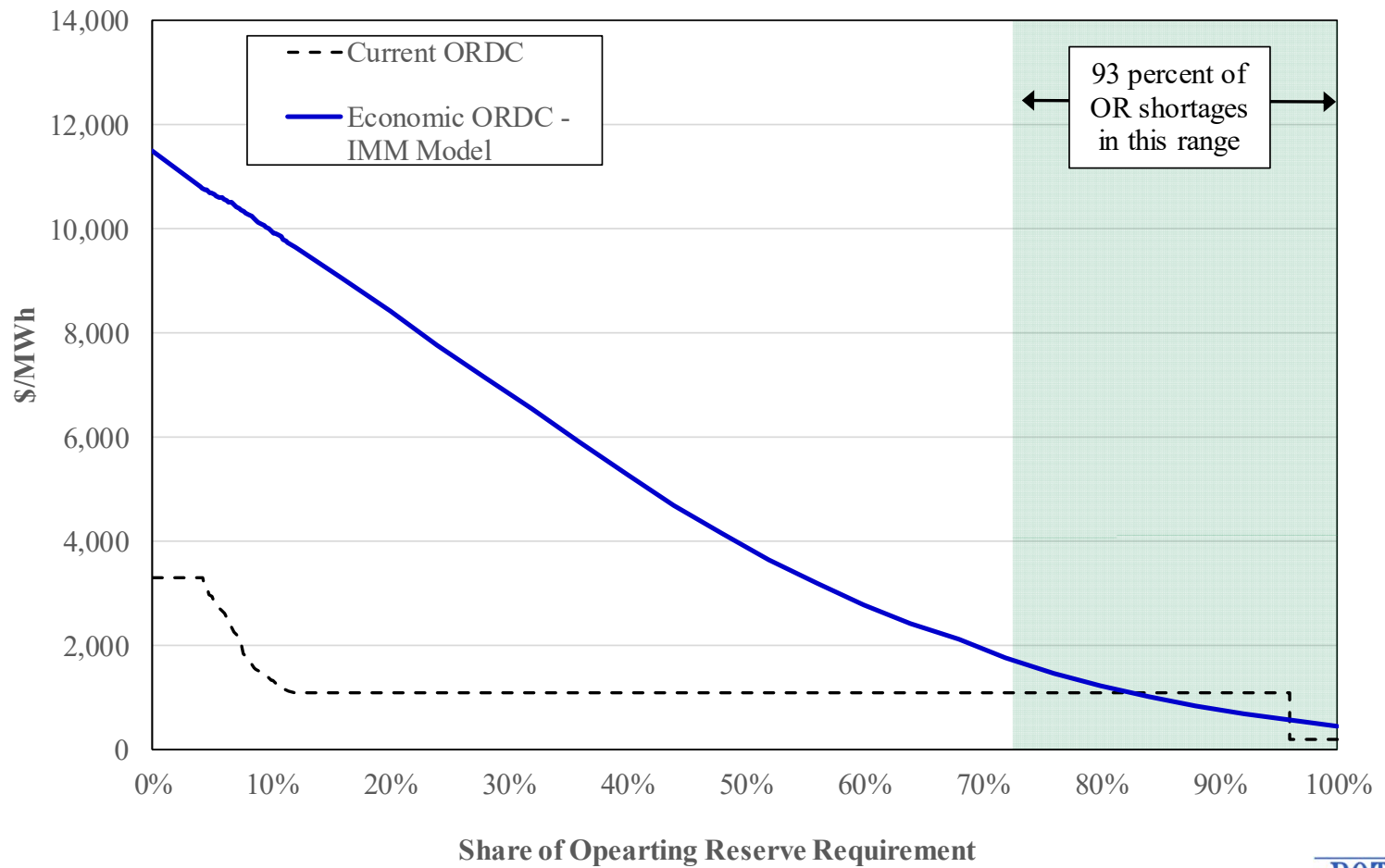


Efficient Shortage Pricing

- Reserve Shortages occur when demand for operating reserves, energy, and ancillary services is greater than available capacity.
 - ✓ Shortage prices increase when reserves are increasingly short.
 - ✓ Flexible units will have a strong incentive to be available at times when shortages are likely to occur.
 - ✓ Well-designed reserve demand curves reflect the expected cost of not serving the load when reserves are short:
 - Value of lost load * probability of losing load
 - See our estimated reserve demand curve for MISO in the following chart.



Estimated Operating Reserve Demand Curve for MISO





Efficient Shortage Pricing

- Transmission shortages occur when out-of-merit dispatch cannot fully resolve a facility overload.
 - ✓ Well-designed transmission demand curves provide incentives for flexible resources to be online and locate in areas when congestion is frequent.
 - ✓ More serious overloads should have higher demand curve prices to reflect the increase in expected security costs.
- The higher prices in areas where overloads jeopardize security provides incentives for offering in spot markets as well as and locating new flexible capacity in such locations.
 - ✓ Locational resource zones also contribute to incentives to locate due to higher capacity revenue;



Role of Capacity Markets

- Capacity markets are designed to provide additional revenue to help ensure investors can recover the cost of new investments when energy market revenue is not sufficient.
- An entrant seeking sufficient revenue for the Cost for New Entry (CONE) has three sources:
 - (1) Energy and Ancillary Services markets during non-shortage intervals;
 - (2) Energy and Ancillary Services markets during shortages; and
 - (3) Capacity Market.
- As Intermittent Resources increase, the concern is that category (1) will decline.
- However, due to the nature of Intermittent Resources, shortage pricing is likely to increase in frequency, raising (2);
- Even if (1) decrease more than (2) increases, capacity market revenues (3) increase due to its reliance on net CONE for pricing.