

Why Are We Talking About Capacity Markets?



Composite photo created by NREL

**Workshop on Market
Design and Operation
With Variable Renewables**

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Outline

- Overview of capacity and why we are discussing capacity markets.
- Principles of efficient markets.
- Difficulties with capacity markets.
- The way forward.

Motivation for Capacity Markets

- Ensure investment/development of sufficient capacity;
- Overcomes some of the difficulties with relying on only an energy market;
- Metric is difficult issue – addressed later;
- Does not directly address “operational capacity.”

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PIX 00070

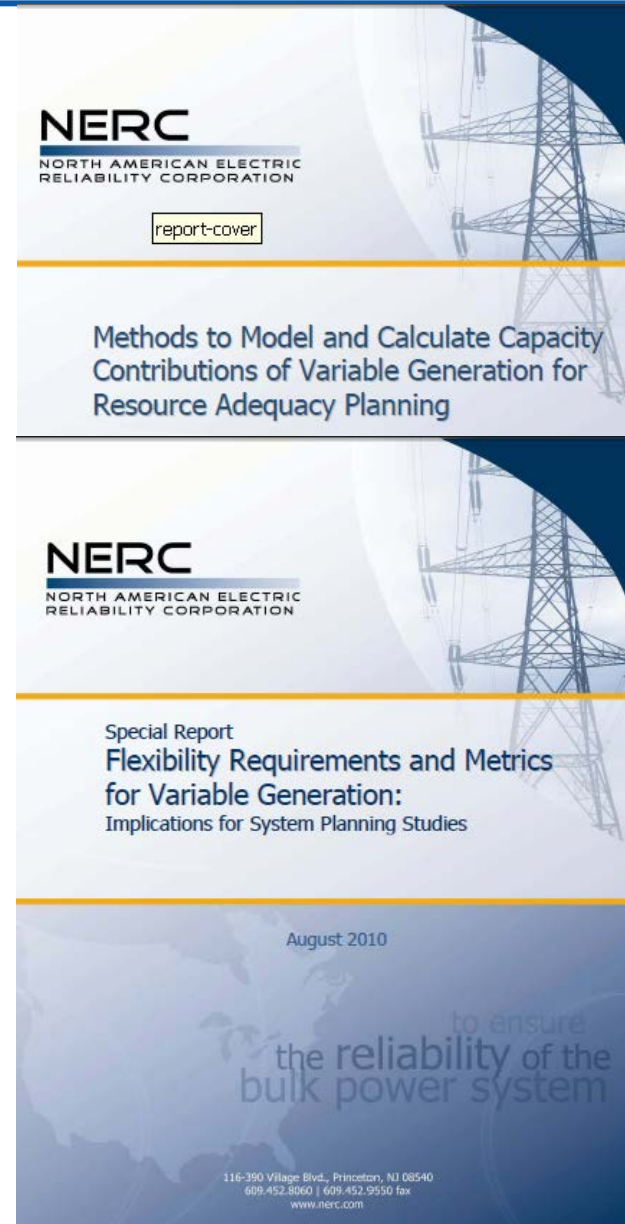


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High Penetrations of Wind/Solar

- Wind and solar (depending on technology) tend to have low contribution to planning reserves:
 - energy resources supply less capacity;
 - Partial separation of capacity and energy into more specialized resources.
- Wind/solar tend to induce lower capacity factors from conventional units.
- Wind/solar tend to increase the need for *flexible* capacity.



Market Properties

- What does the power system need to do?
- What are the attributes of a system that can provide for these needs reliably and economically?
- How do we design market(s) to provide for these needs?



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What Does the Market Reward?

- Whatever it is, you will get some, even if it is the wrong thing.
- Examples of markets-gone-bad:
 - Executive compensation in the early 21 century in the U.S.;
 - Market rules/constraints imposed in California during the power crisis.
- Market rules, metrics, and structure can drive behavior.
- So...it is important to know what to ask for and how to measure it.



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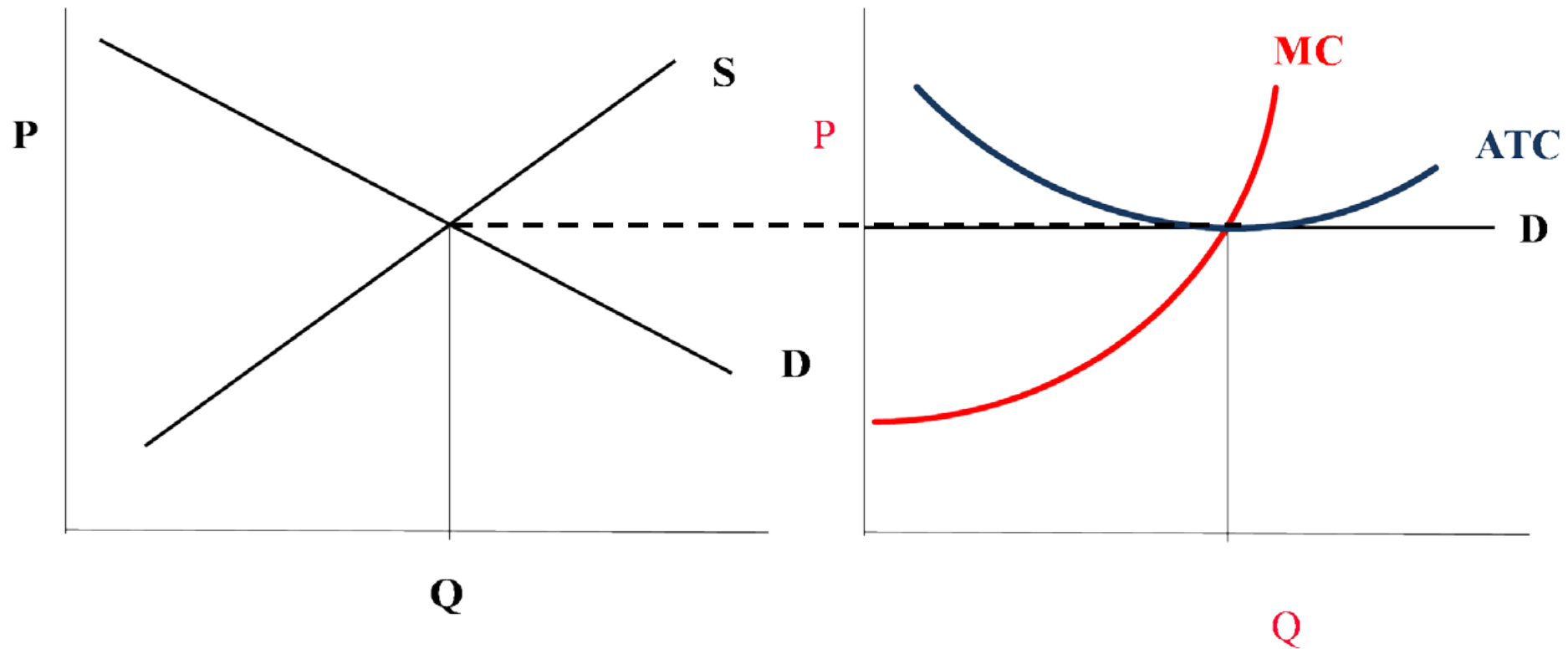
Principles of Competitive Markets

- Efficient: providing what society values most highly in cost-effective way;
- Transparent information to all buyers and sellers;
- Prices are an efficient signal;
- No externalities, free riders, or public goods;
- Sellers have no market power;
- Buyers have no market power;
- One then can prove:
 - Long-run equilibrium is stable;
 - Long-run equilibrium: $P = MC = \min(ATC)$ which assures revenue sufficiency and social optimum.



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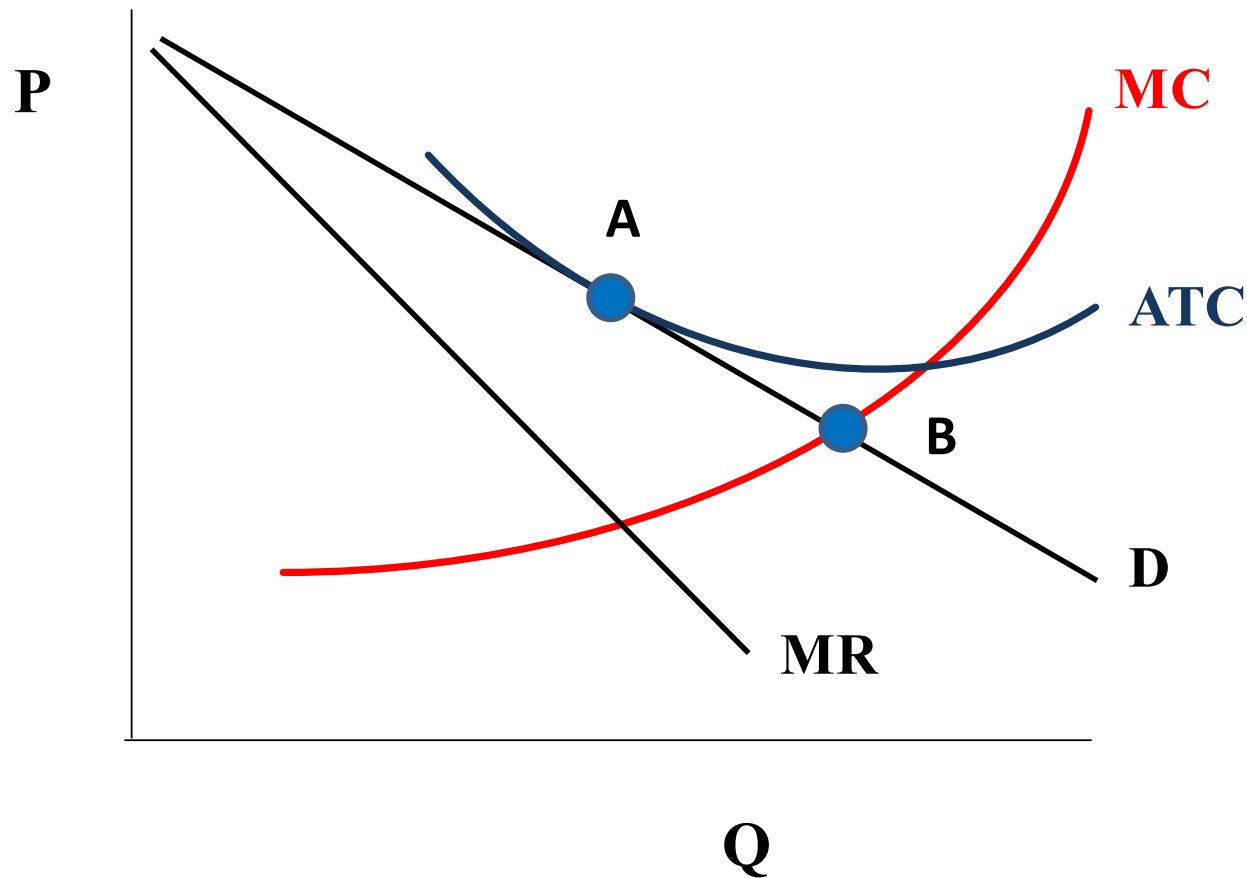
Long-run Competitive Equilibrium



Electricity (energy) Markets (most other markets too) Are Only Partially Competitive

- Expression of demand is muted by the absence of dynamic pricing → price signals are ineffective;
- Elements of supply (transmission, reliability) have attributes of public goods and potential free riders;
- Reliability can't be easily purchased or valued;
- Market power often exists and can be significant;
- Some resources (wind, solar) have near-zero marginal cost;
- Implication: MC pricing will not likely allow for revenue sufficiency for some generators.

Implication: Energy Market will not Deliver an Economically Efficient Solution



- Point A: excess capacity
- Point B: insufficient capital recovery

Capacity Markets

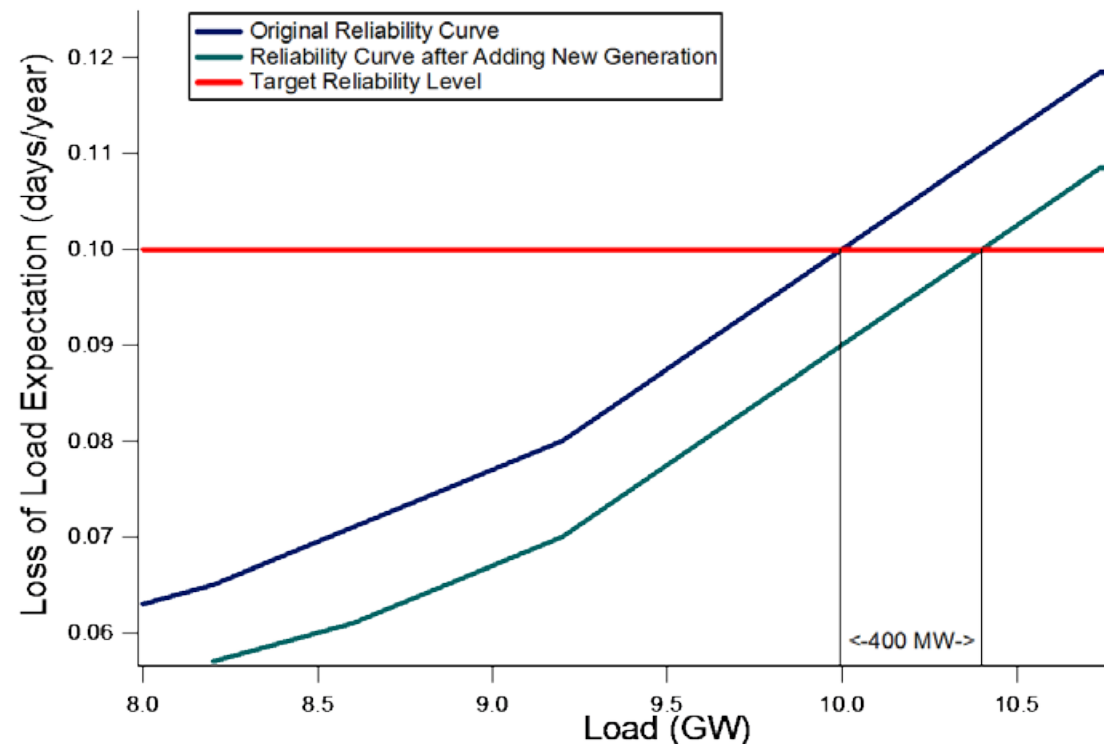
- Purpose: to incent investment in new generation in the absence of transparent signals that would result from efficient market.
- In principle, this should be easy.
- In practice, it is very difficult.



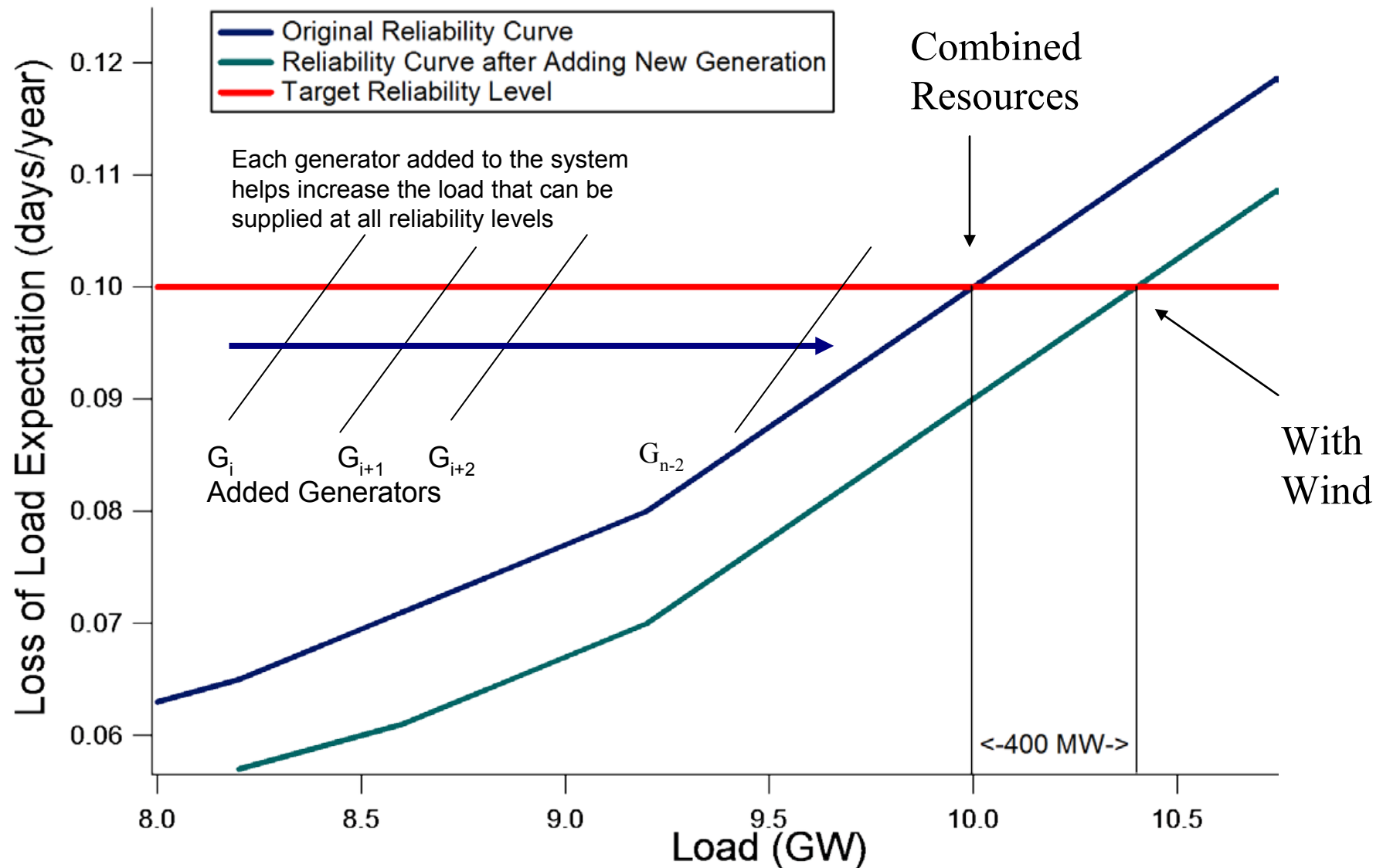
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What Are We Asking the Capacity Market to Provide?

- Sufficient capacity to provide for a target reliability.
- This would suggest a reliability-based metric to measure capacity contribution.



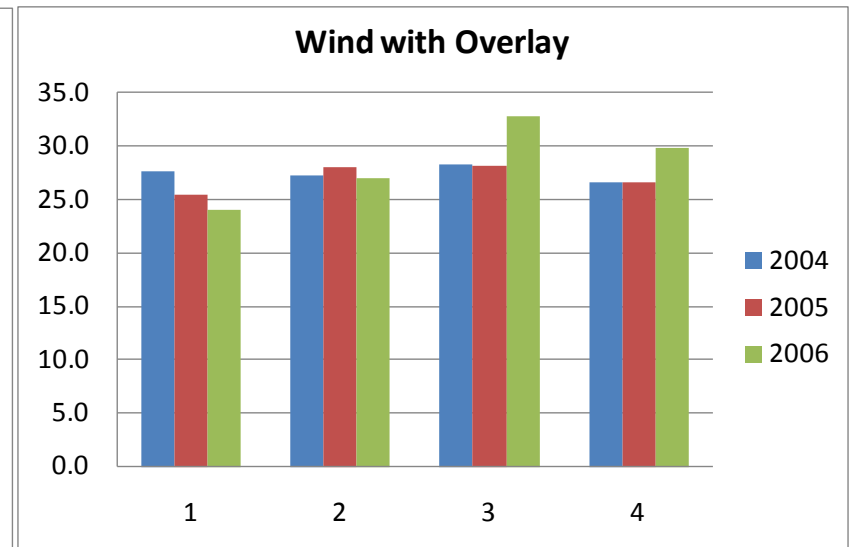
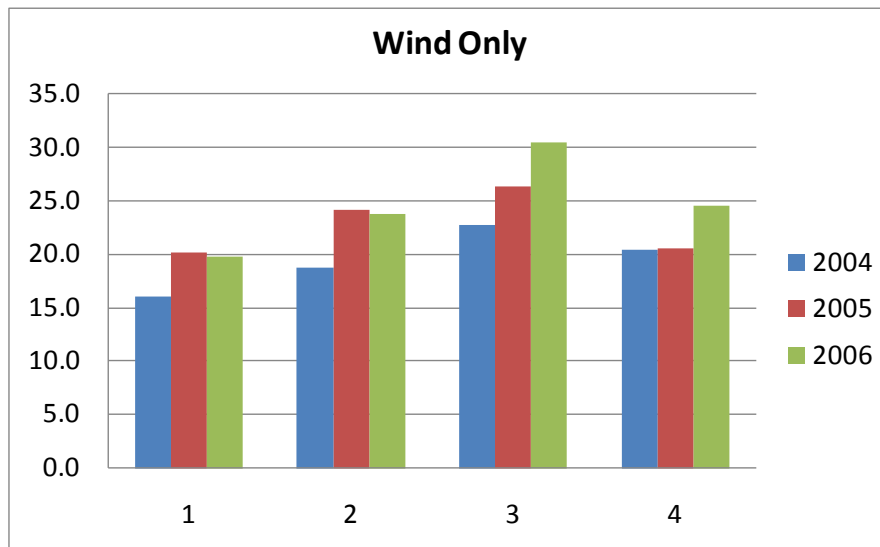
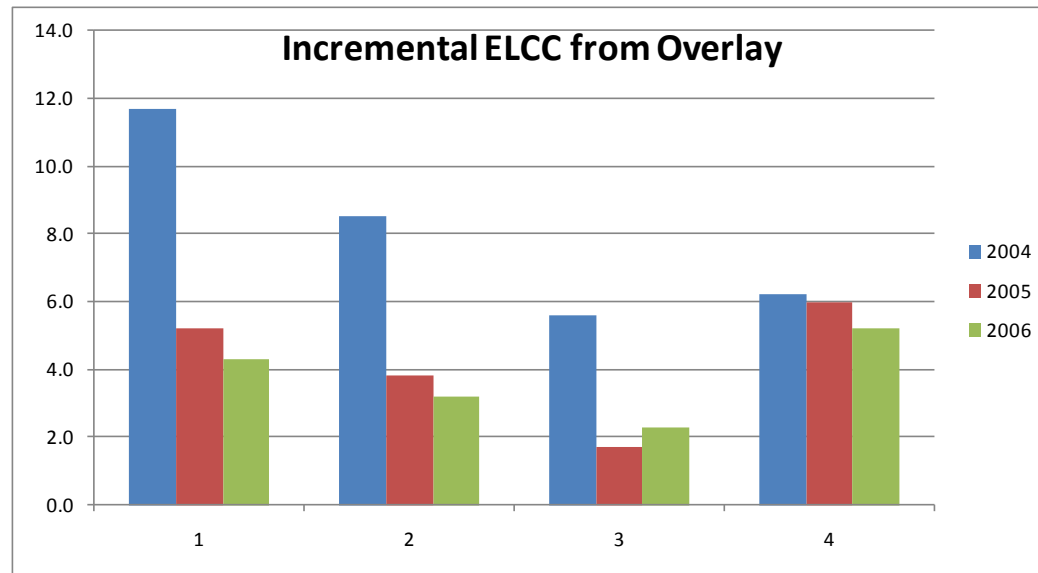
Effective Load-carrying Capability



Data and Metric Issues

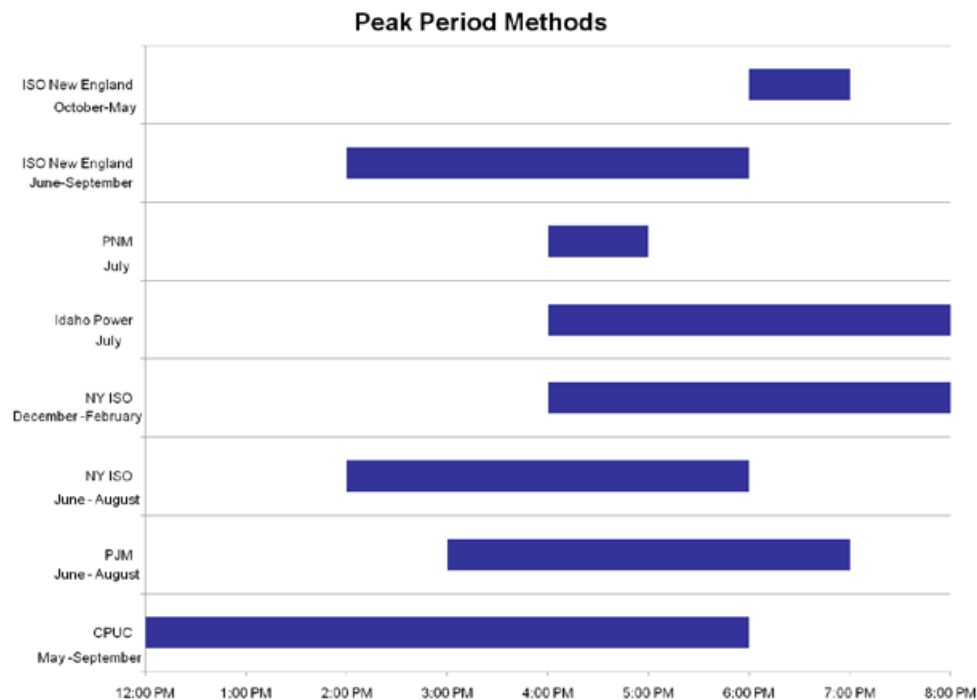
- Capacity market is essentially a future market.
- What forced outage rate (FOR) to use on conventional generation?
- Availability or performance? Trust but verify?
- FOR over non-maintenance hours?
 - Can this be gamed?
- How many years of wind/solar data are needed?
- What is reliability worth?
- Value of lost load (VOLL)?
- How do consumers purchase it and how do you measure it?
- How do you eliminate free riders?

Reliability Can Come from Many Sources

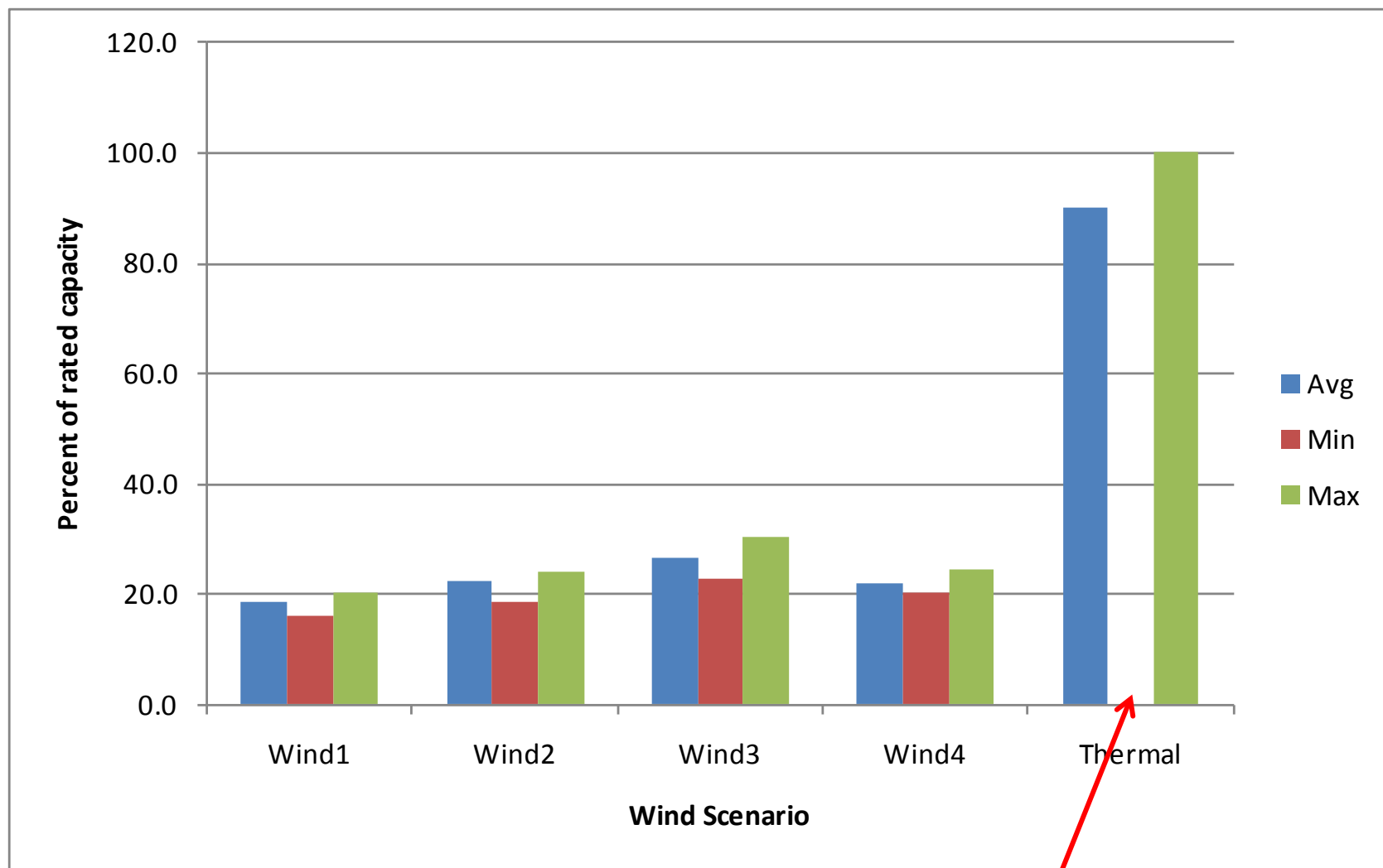


Other Issues

- Interdependency of generators/transmission contributions to reliability;
- Monthly capacity market?
- Annual capacity market?



Inter-annual Variability is Real

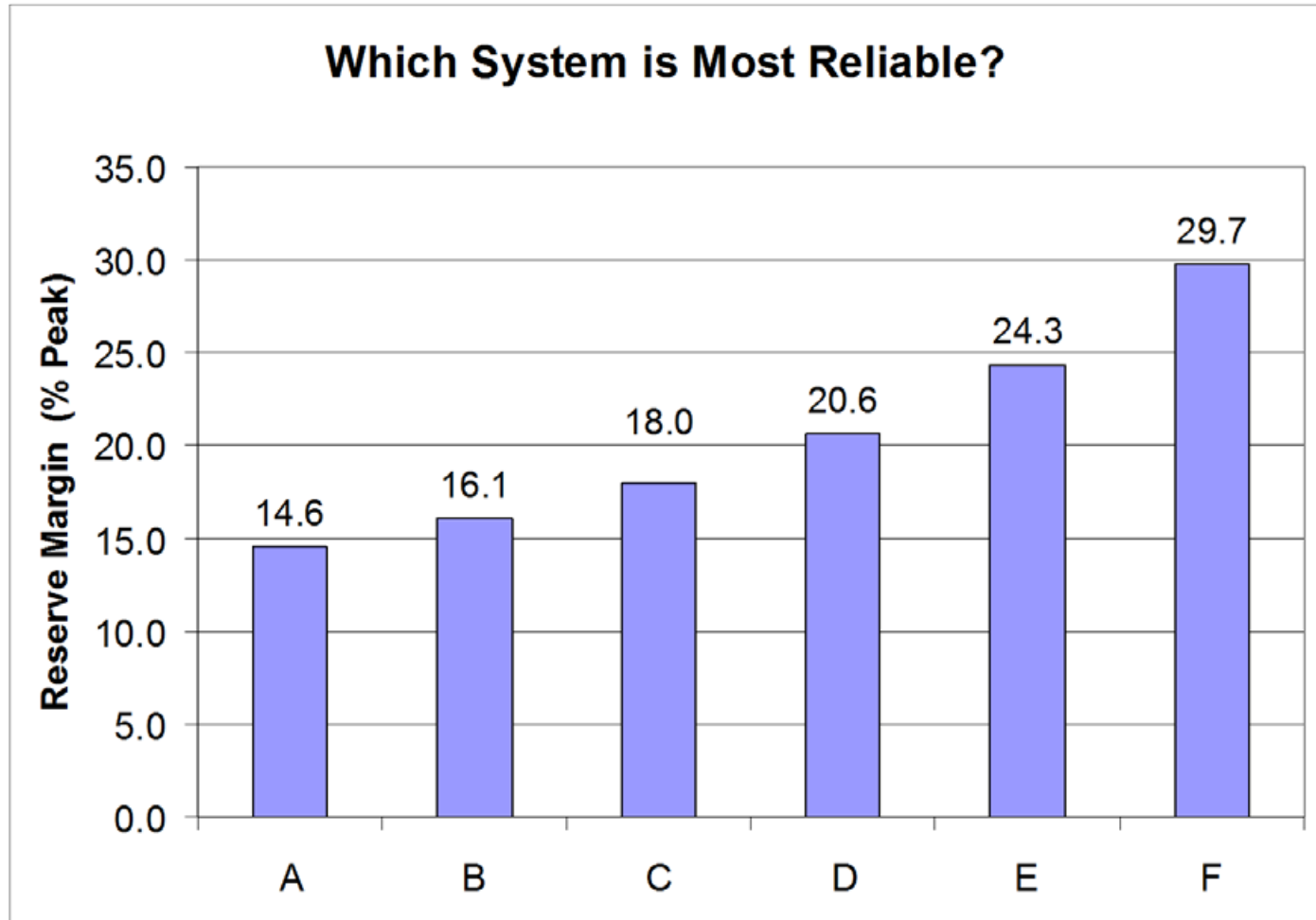


MW size also important!

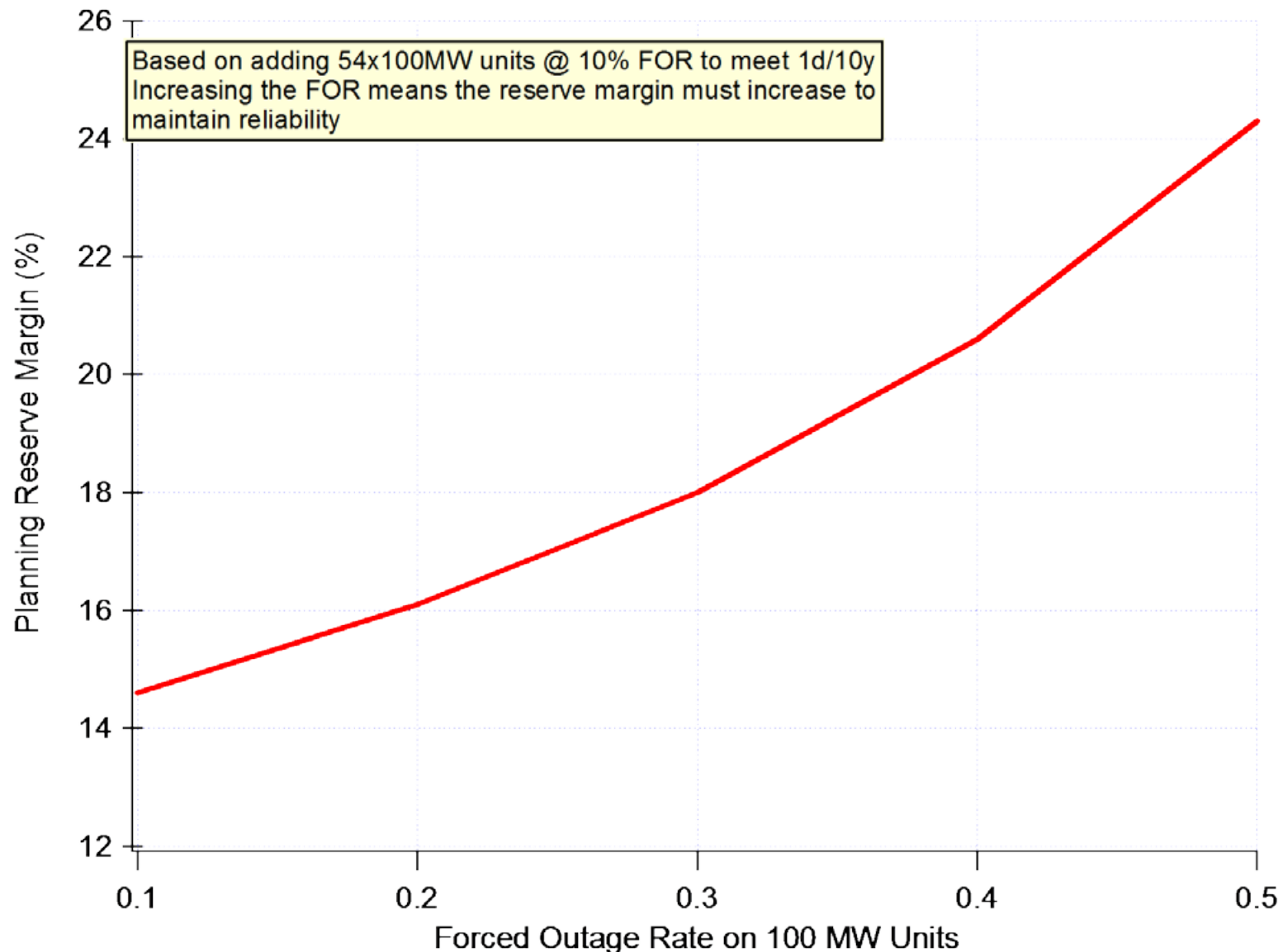
Minimum = 0

Other Potential Metrics

- Planning reserve market.



PRM is Silent Regarding Reliability



Simplifications

- Actual capacity factor calculated over high-risk periods;
- ISO-NE, NYISO, PJM all do something similar;
- Requires periodic “true-up” with a full reliability calculation;
- Advantage: takes individual generator performance into account (not by class/size);
- Disadvantage: lack of wind/solar data.

Milligan and Porter, 2008 available at <http://www.nrel.gov/docs/fy08osti/43433.pdf>.

NERC <http://www.nerc.com/docs/pc/ivgtf/IVGTF1-2.pdf>.

Some Potentially Useful Principles

- Horizontal consistency;
- Vertical consistency;
- Ability to account for multiple technologies using the same metric;
- “Thought experiments:”
 - What does the metric ask for?
 - Is that what we want?
 - If suppliers provide what the market asks for and values, do we achieve the objective?
 - Are there any perverse incentives?

Let the
discussion begin