RAP® Energy solutions for a changing world

Leveraging Power Markets to Achieve a Reliable, Least-Cost Transition to a Low-Carbon Power System

Webinar
25 August 2016

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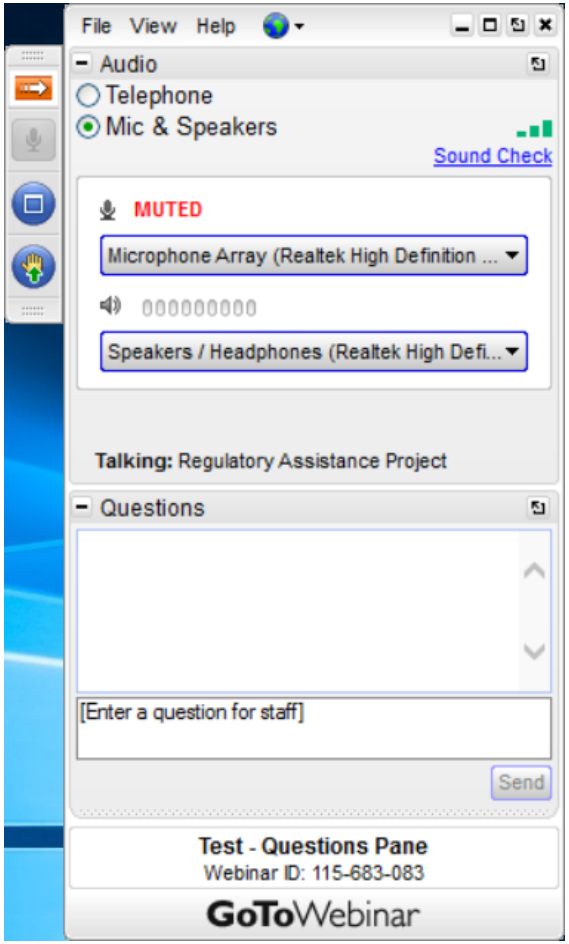
The Regulatory Assistance Project (RAP)®

Questions?

Please send questions through the Questions pane



Introduction: What is the question?

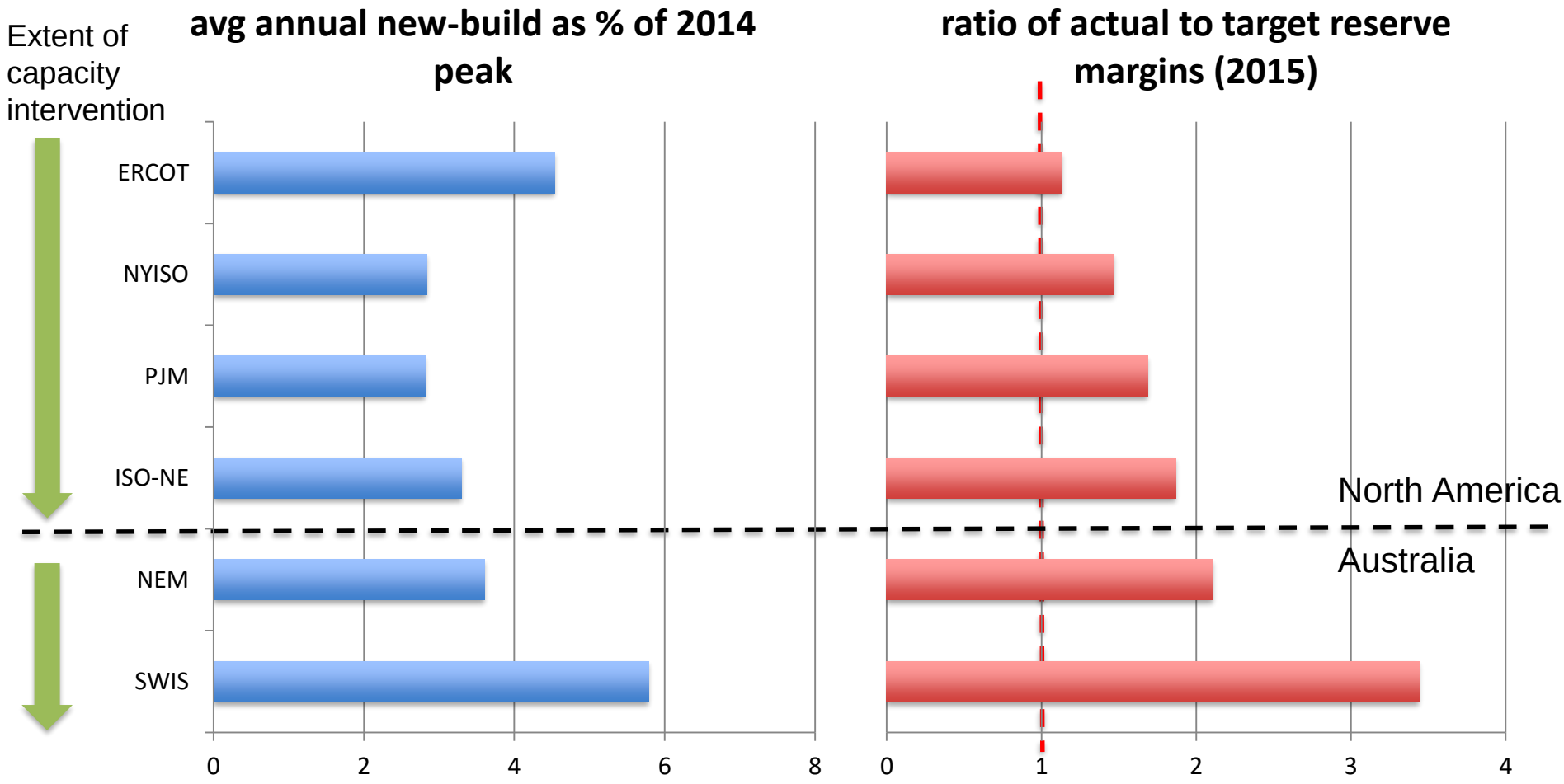
Low-carbon transition: Reliability is essential; ensuring reliability at least cost will be the pivotal issue

The "EOM vs. CRM" debate is fascinating but typically ignores a more fundamental question…

Is the market driving the *right* investments to ensure a reliable low-carbon transition *at least cost*?

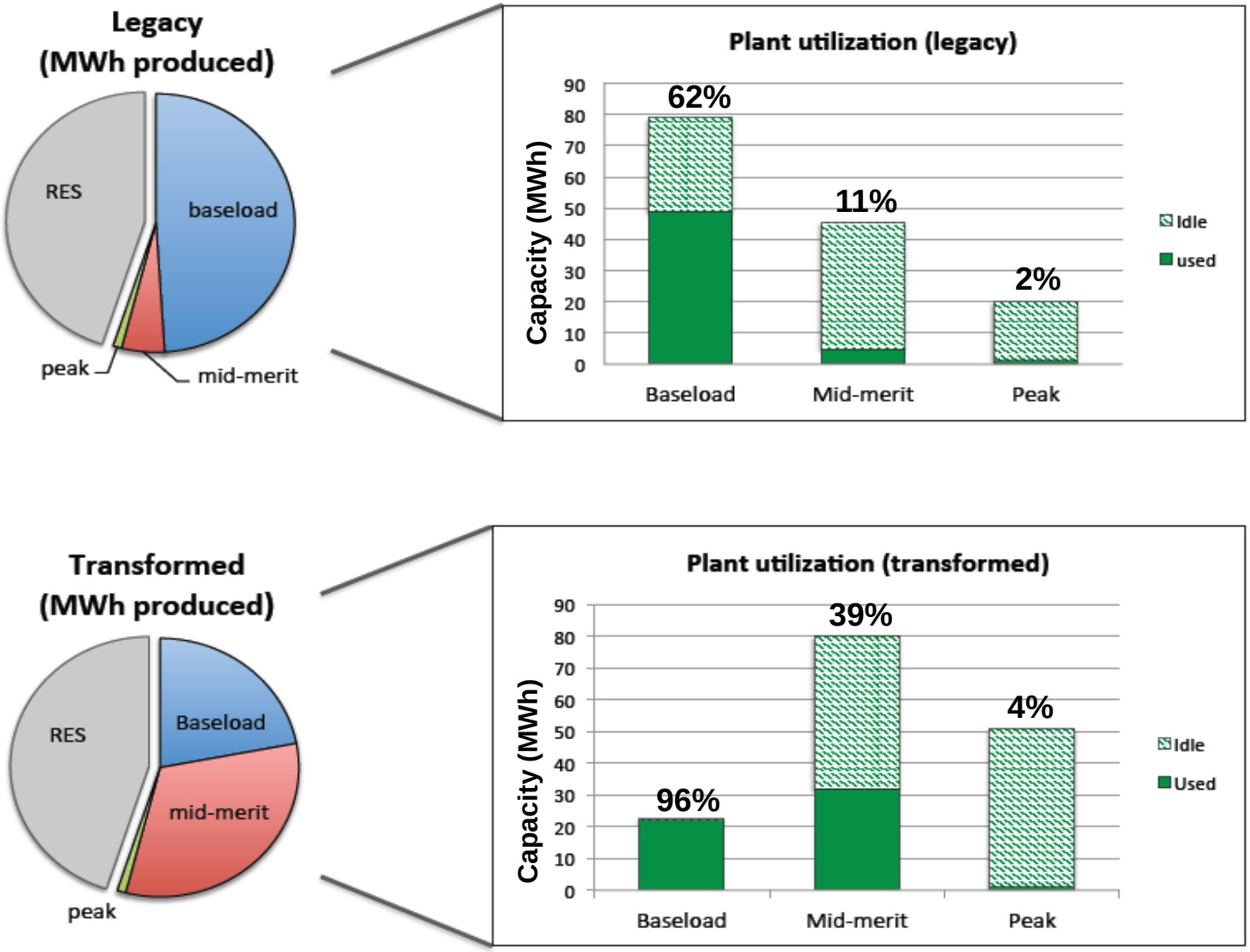
Resource adequacy at least cost: generation

Experience with various “capacity mechanisms”



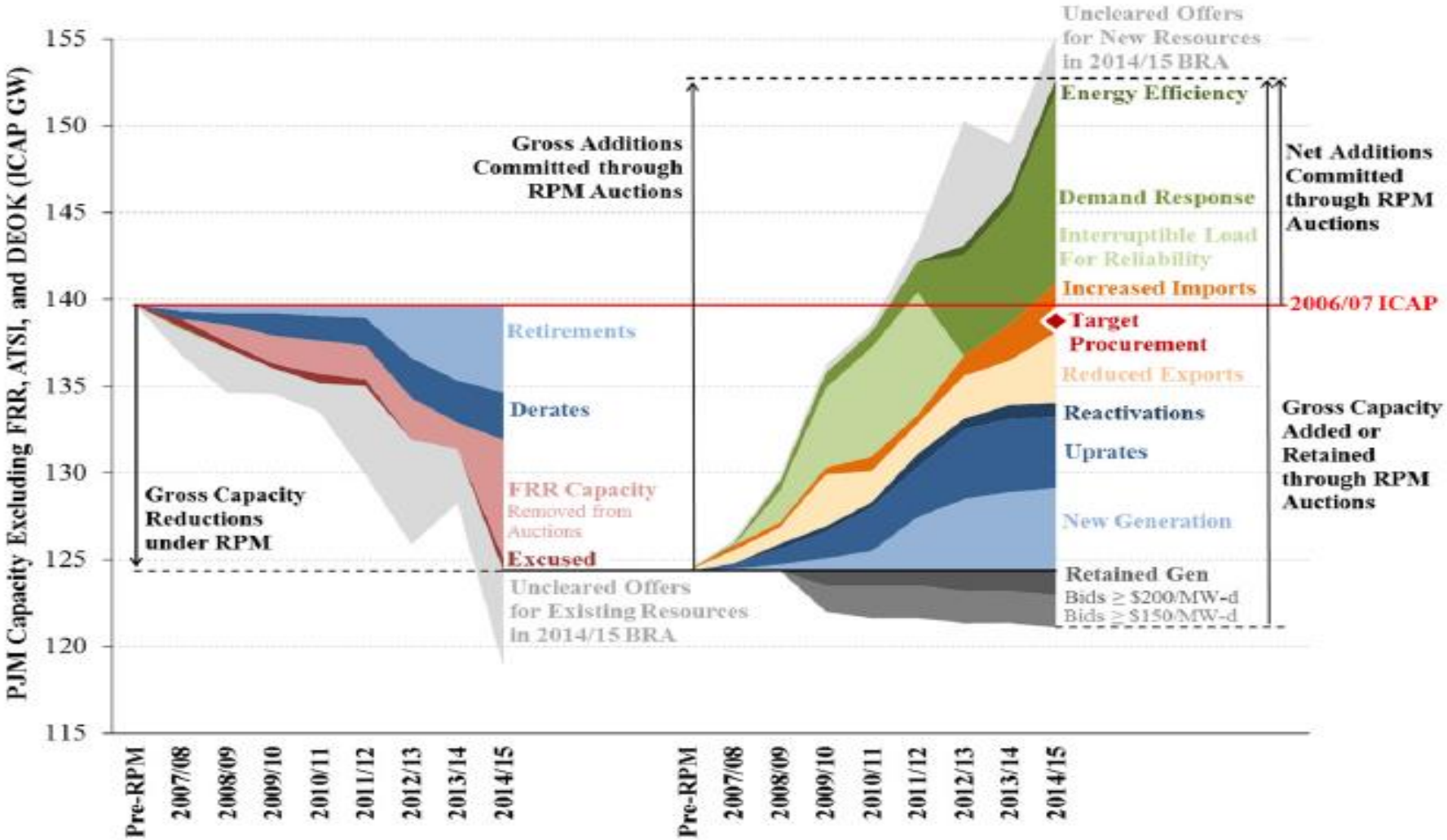
Source: RAP, from published system operator data

“How much?” depends on “what kind?”

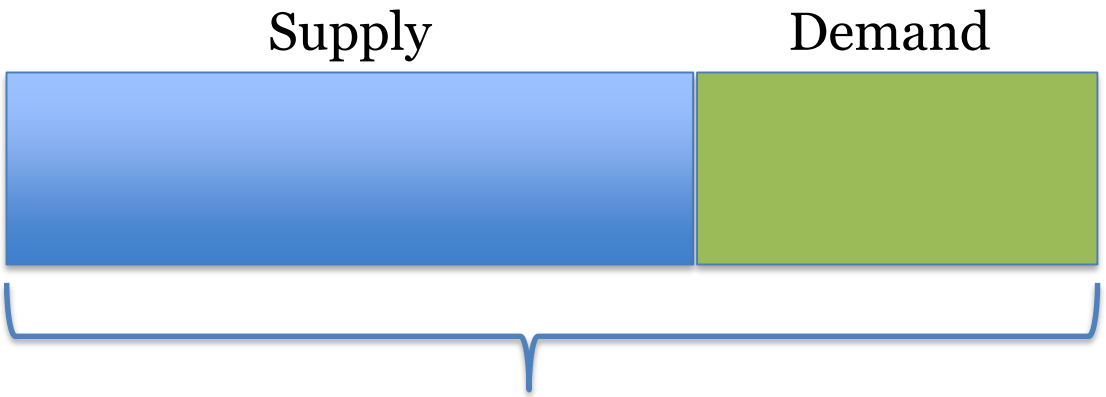


Source: Adapted from *The Power of Transformation* (IEA, 2014)

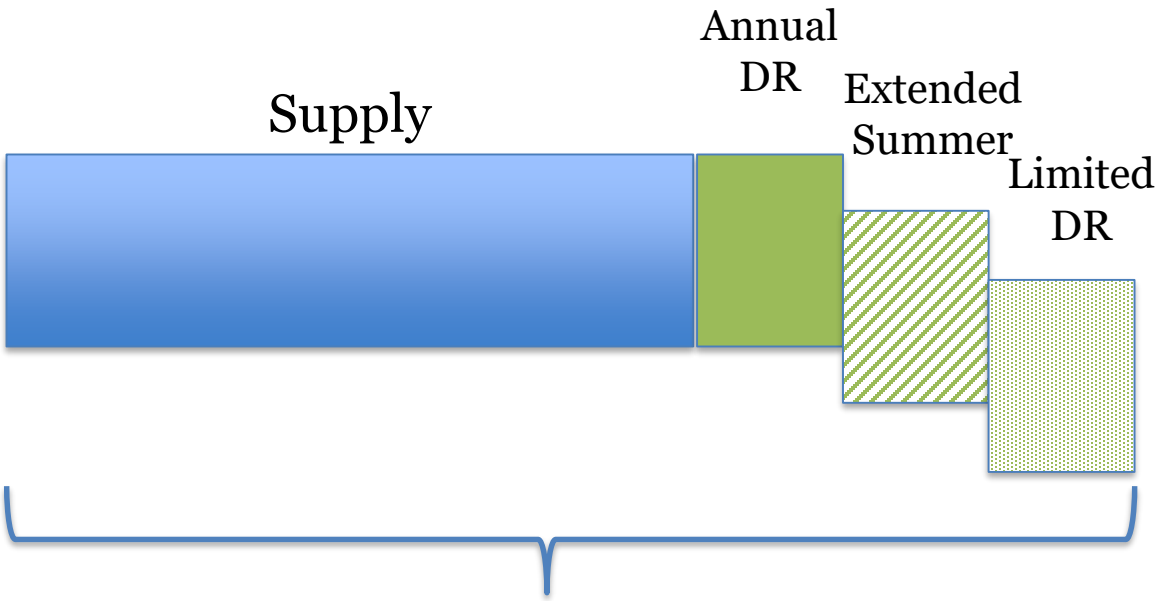
PJM: a decade of lessons learned



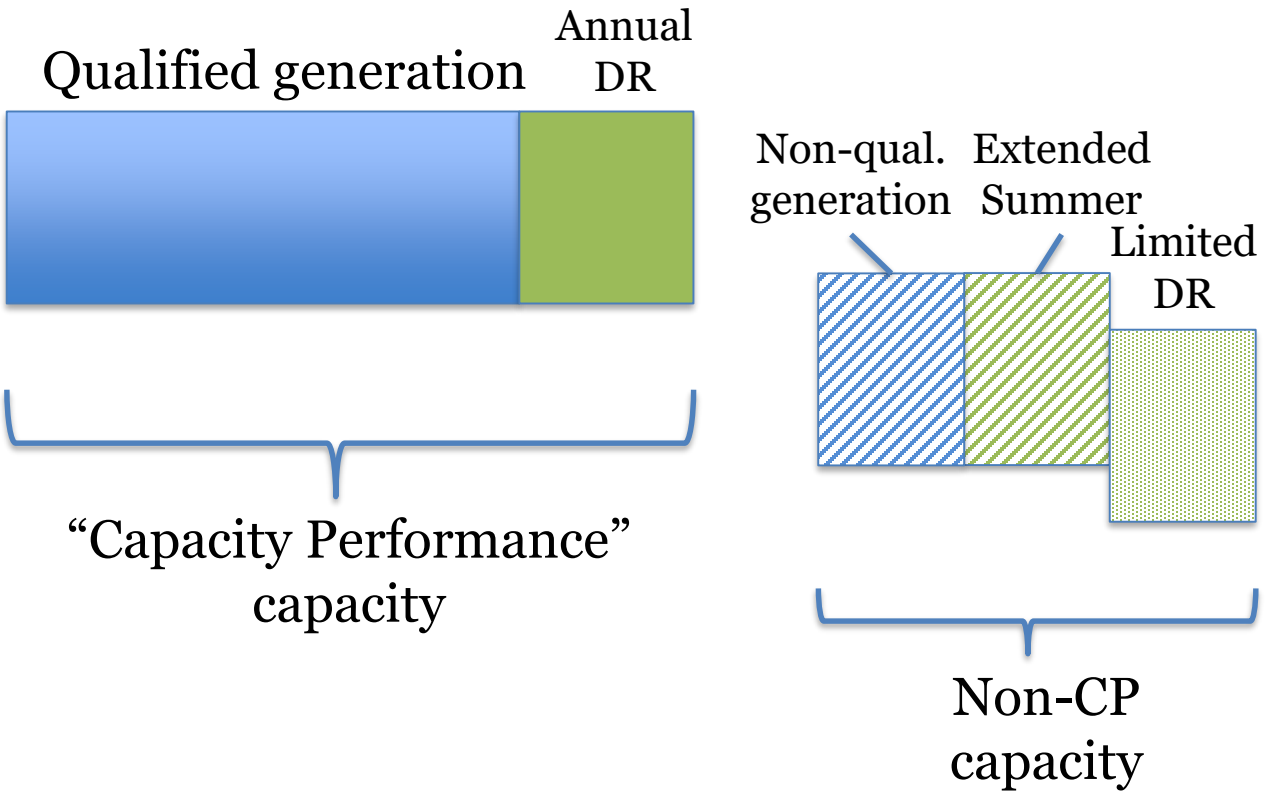
PJM Capacity Market 2007



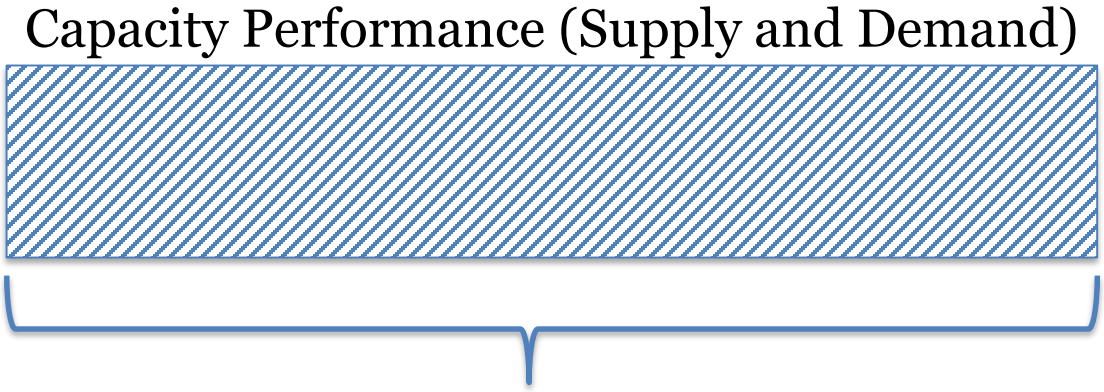
PJM Capacity Market 2011



PJM Capacity Market 2014 (proposed)



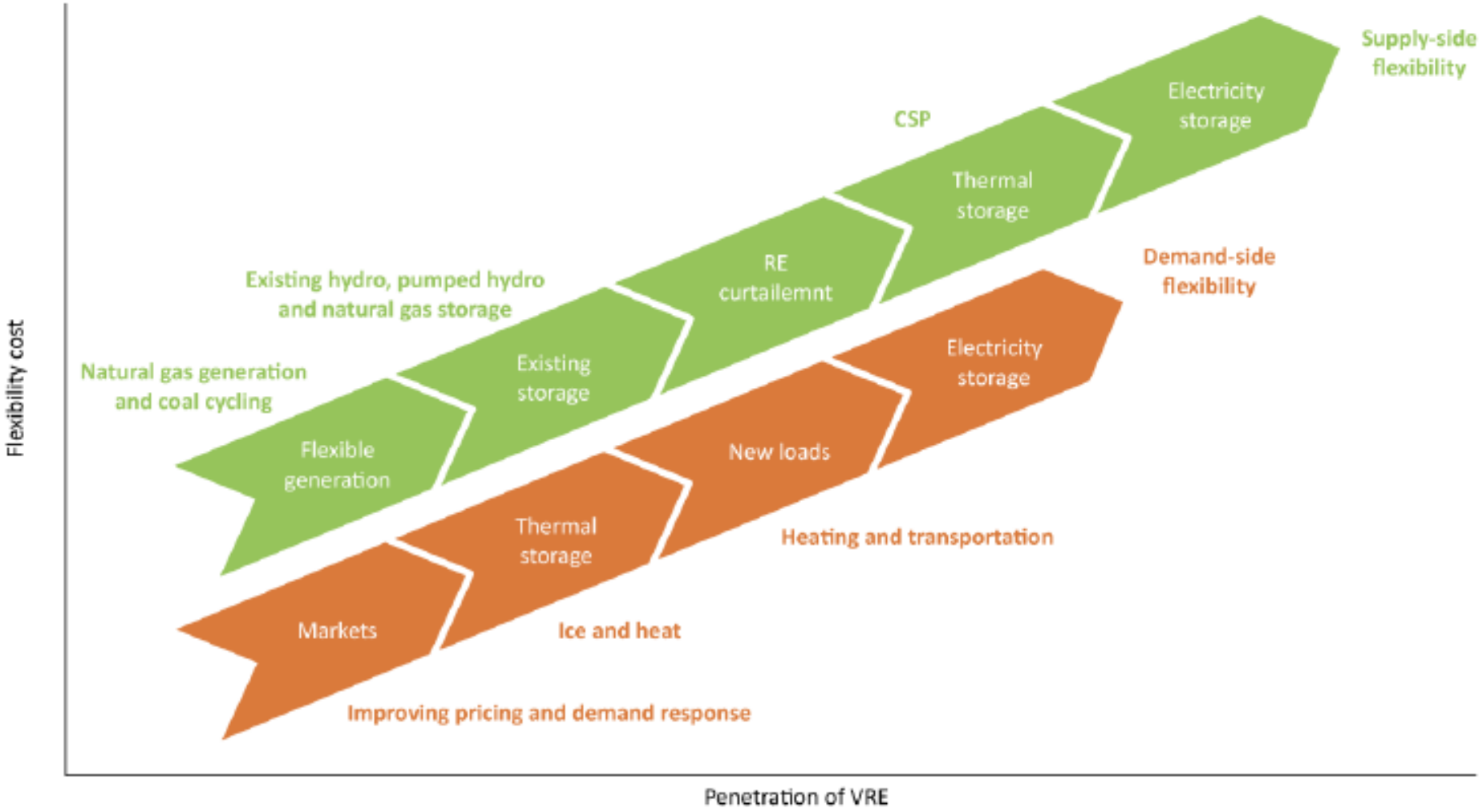
PJM Capacity Market 2016



…we need to get out of the “capacity market” box

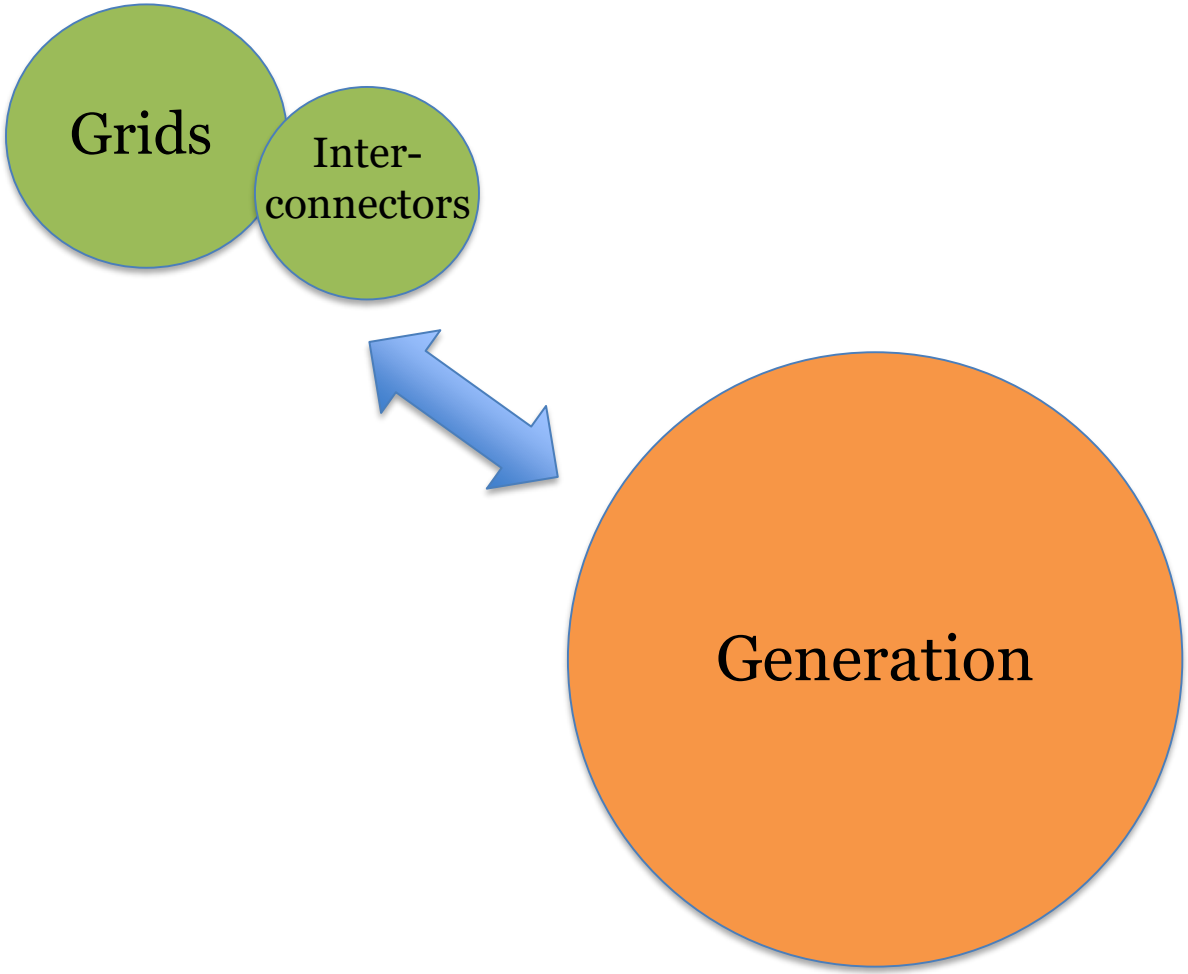
Cheap (and effective) alternatives to generator flexibility

Generation: just one piece of the puzzle

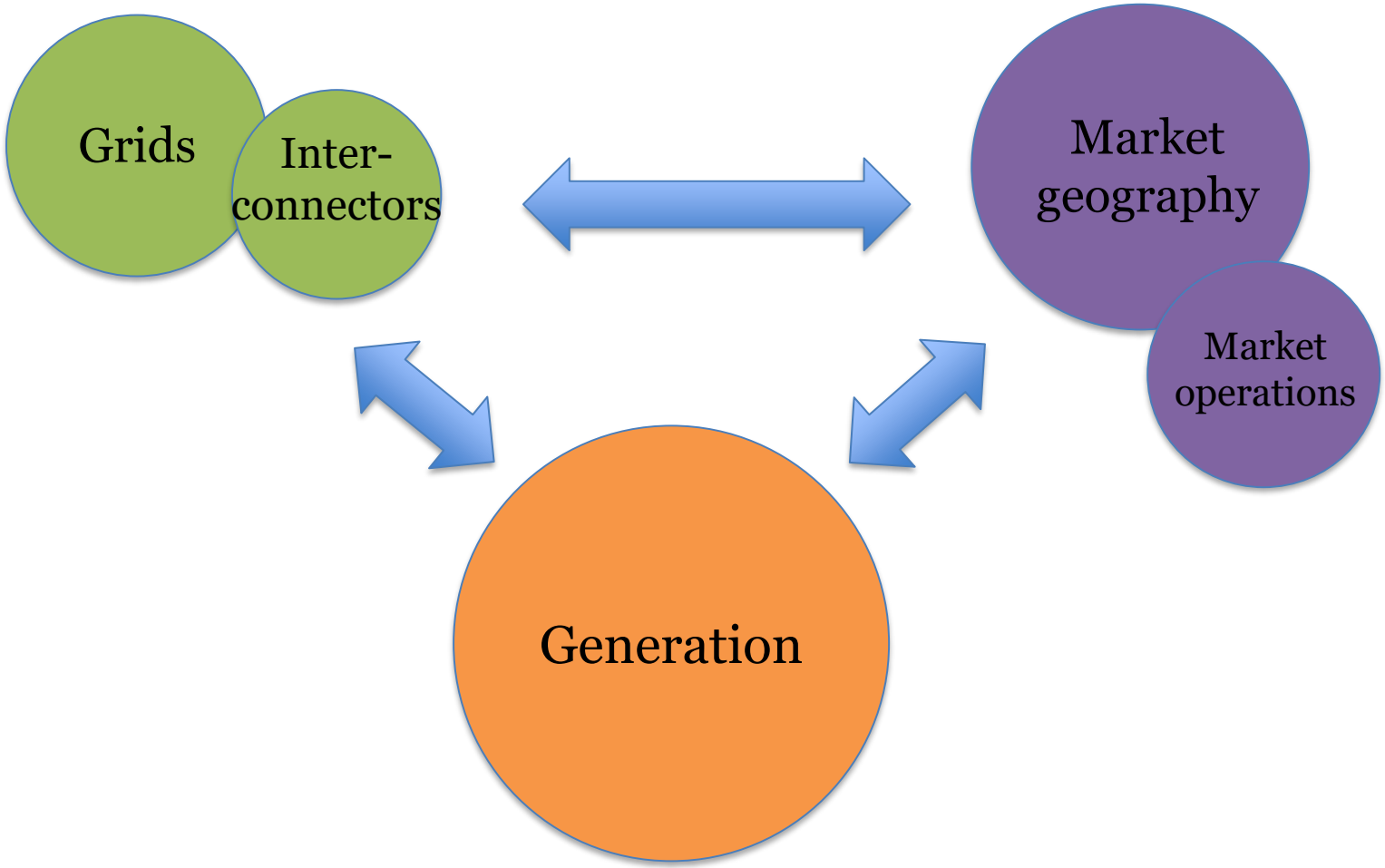


Source: IEA Energy Technology Perspectives 2014

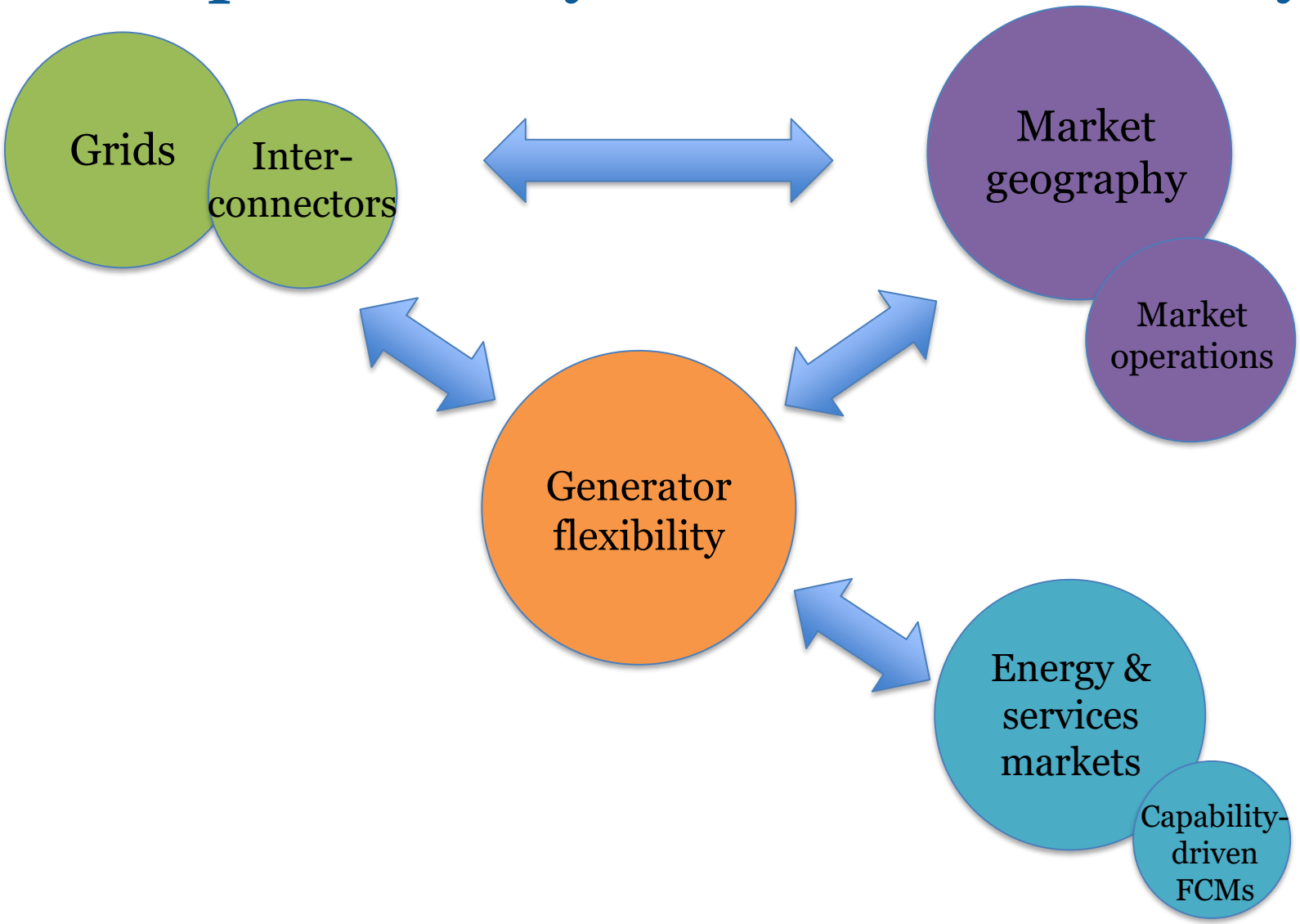
Complementary sources of flexibility



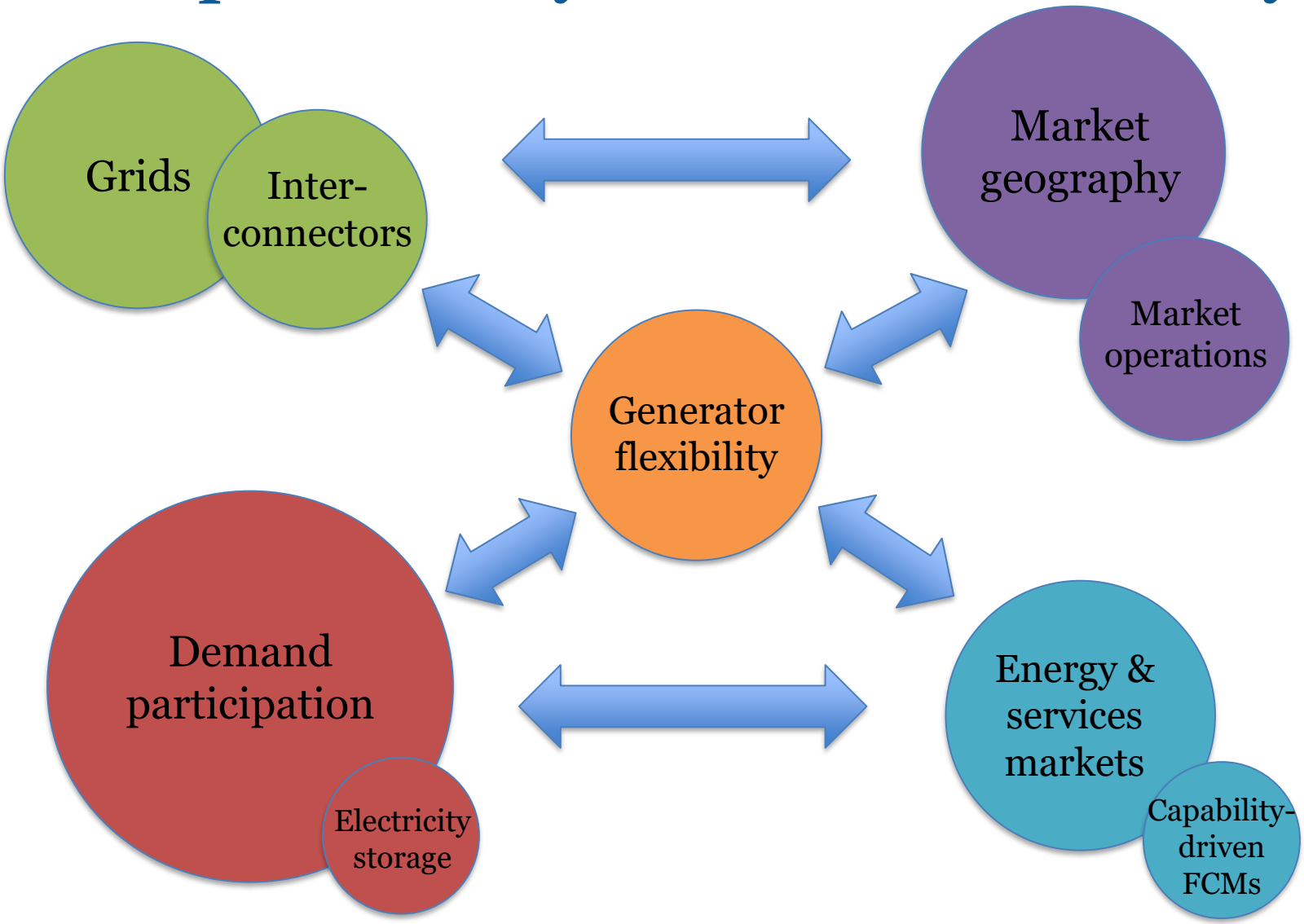
Complementary sources of flexibility



Complementary sources of flexibility

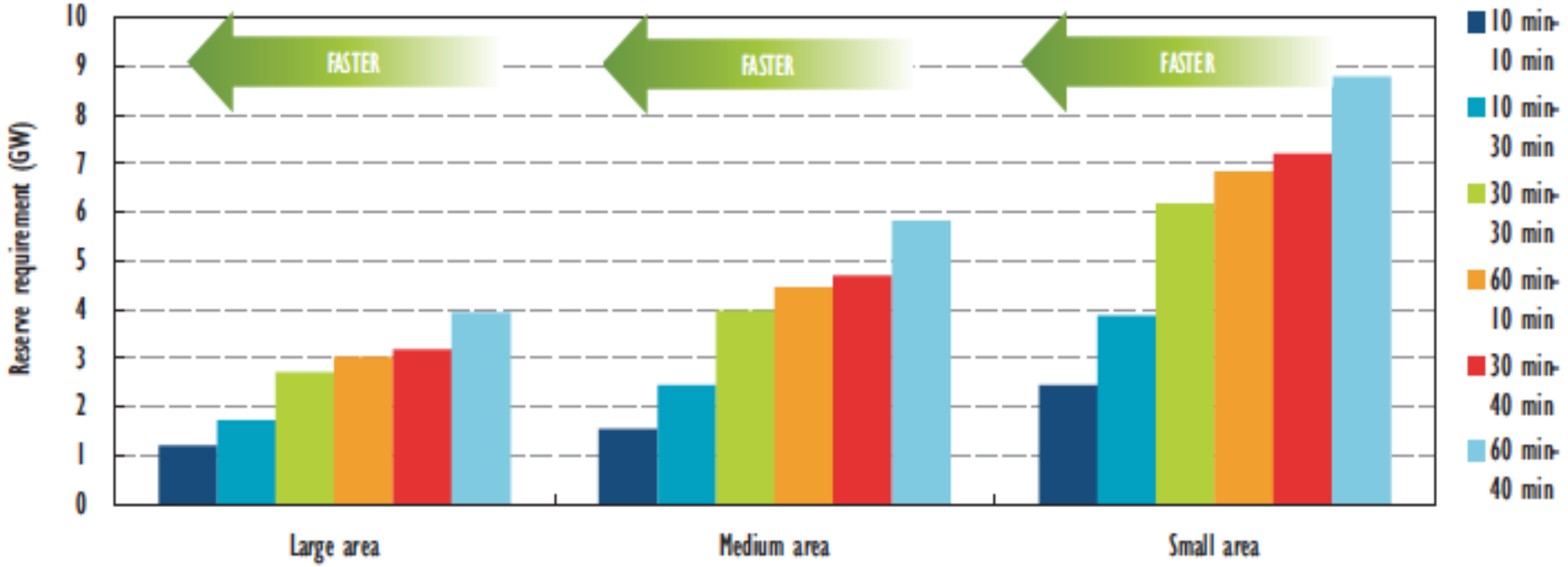


Complementary sources of flexibility



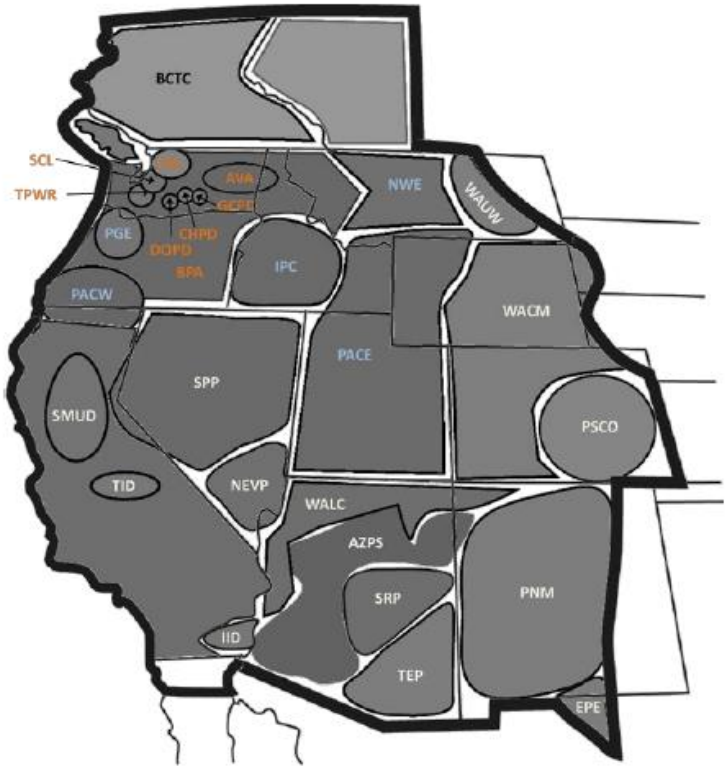
Market operations, market geography, and grids

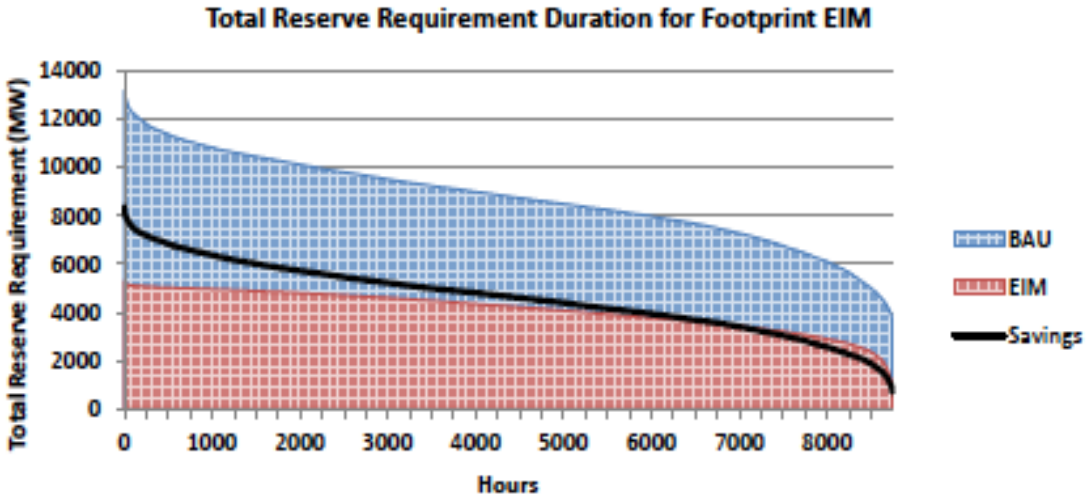
“Bigger,” “faster” markets

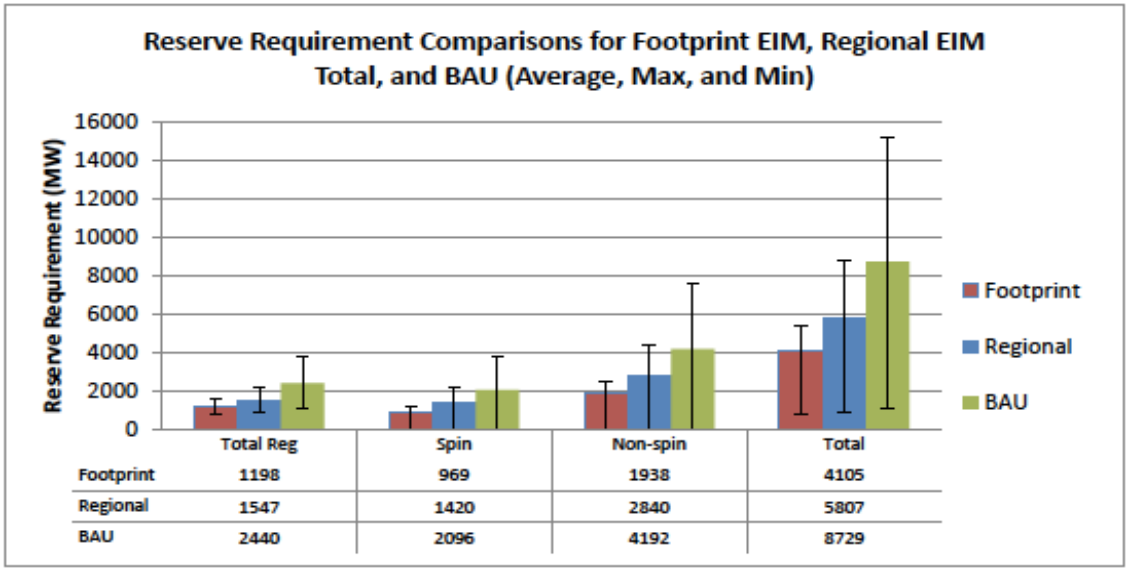


Source: National Renewable Energy Laboratory (U.S.), 2013

Regional independent market governance





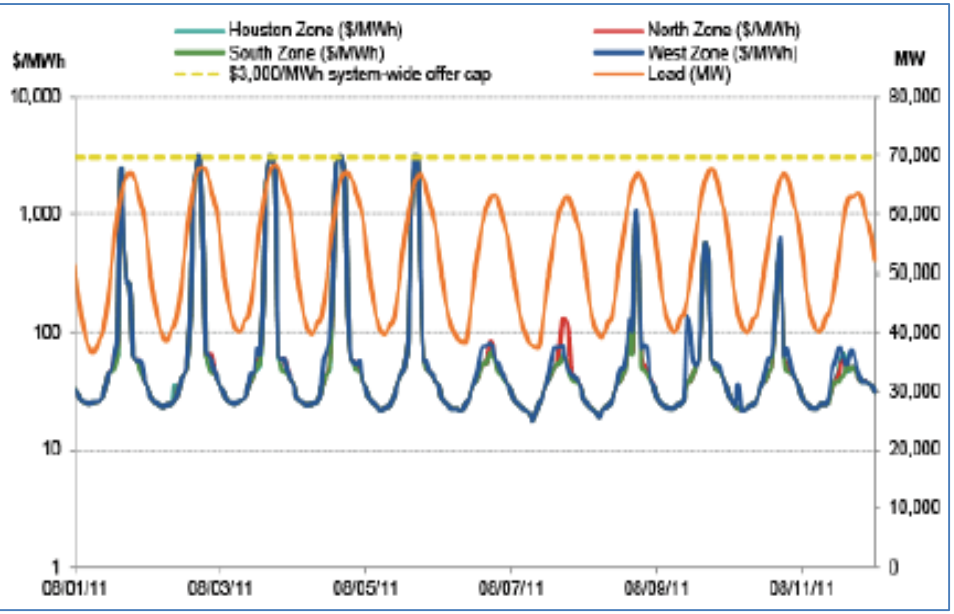


	Total Reg	Spin	Non-spin	Total
Footprint	1198	969	1938	4105
Regional	1547	1420	2840	5807
BAU	2440	2096	4192	8729

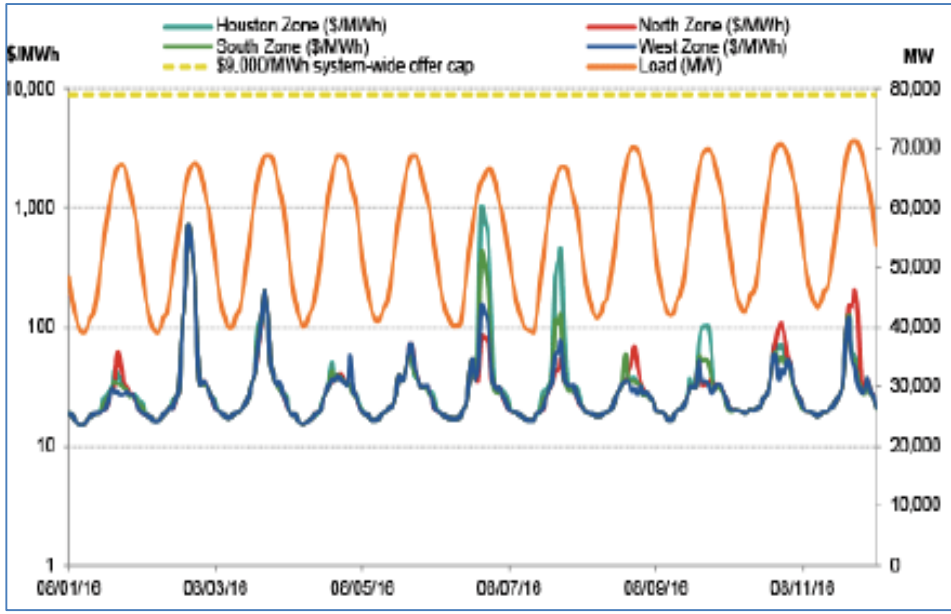
Energy solutions
for a changing world

Source: U.S. National Renewable Energy Laboratory, "Flexibility Reserve Reductions from an Energy Imbalance Market with High Levels of Wind Energy in the Western Interconnection" (http://www.nrel.gov/docs/fy12osti/52330.pdf)

Markets that reduce grid congestion



Record demand: ERCOT, August 2011



Record demand: ERCOT, August 2016

Source: ERCOT data via SNL Energy

Questions?

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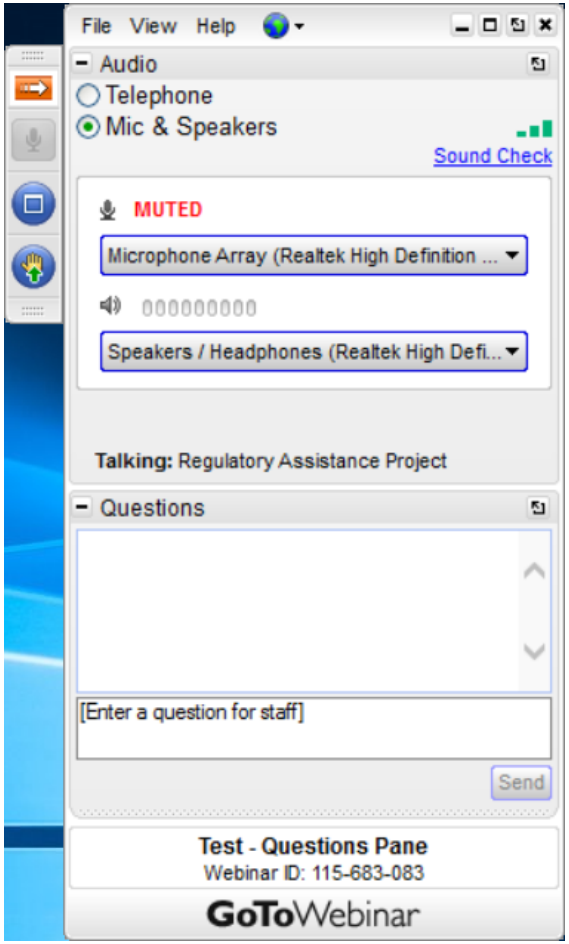
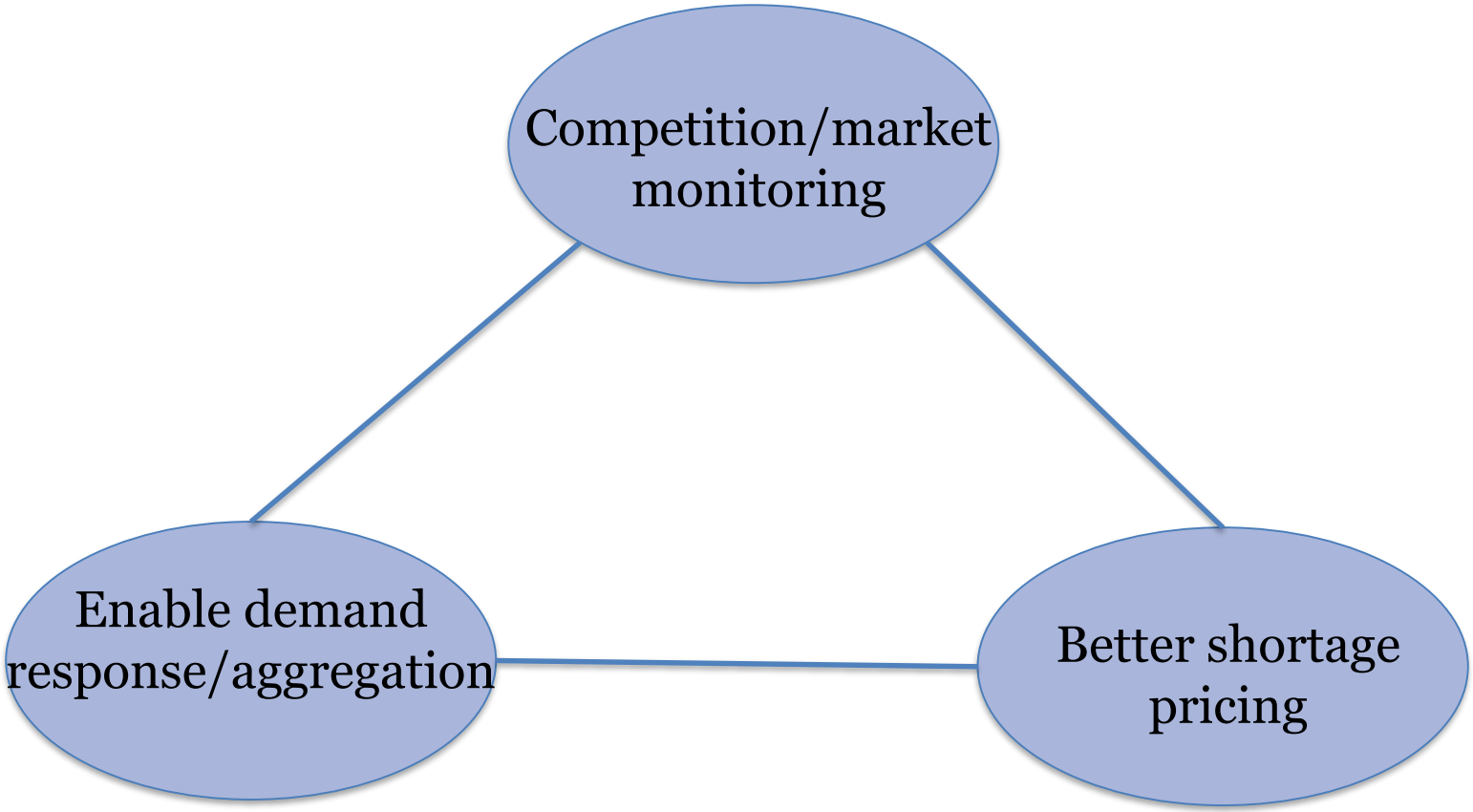
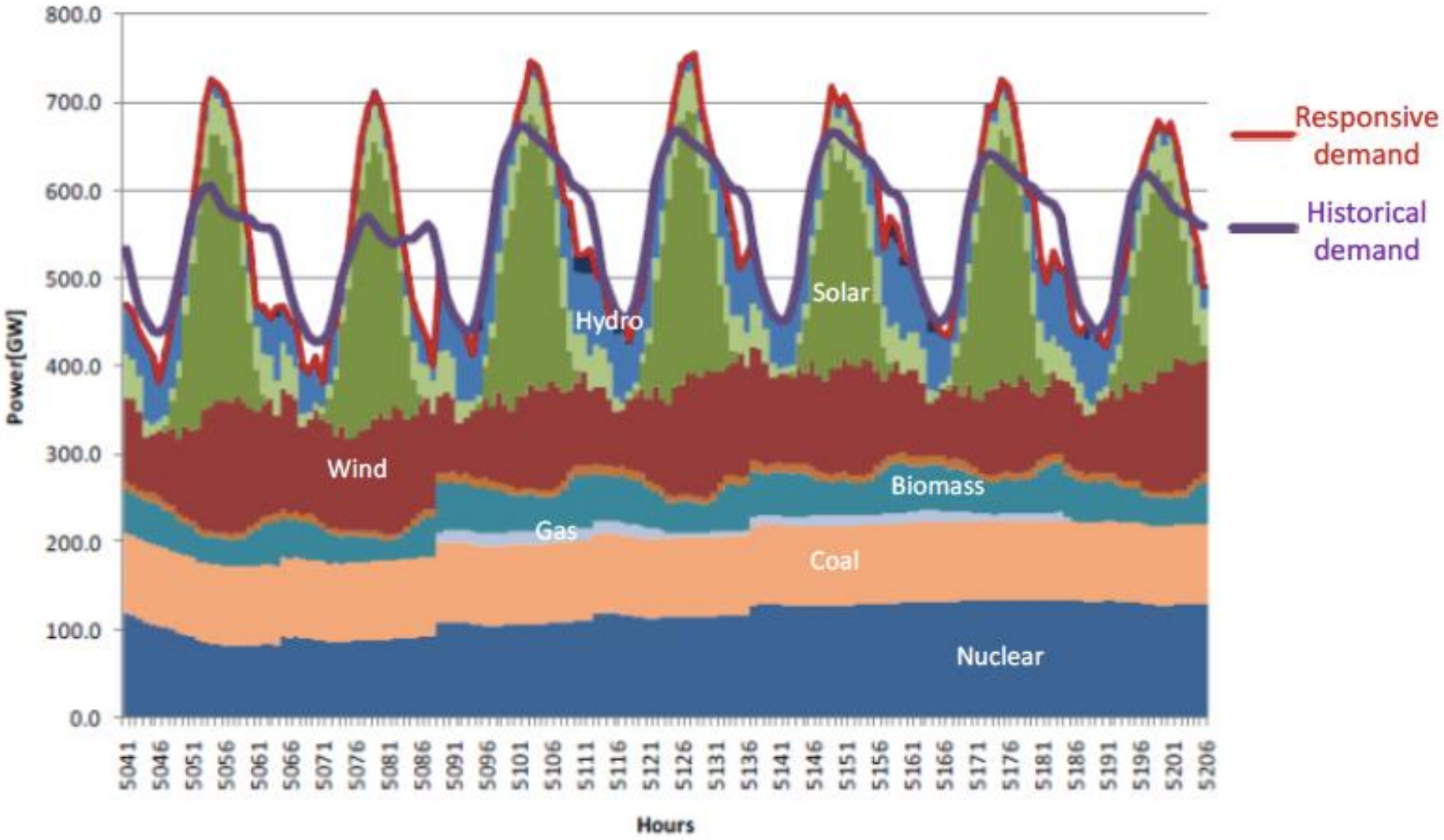


Tapping the untapped flexibility of demand

3 pillars of an effective energy market

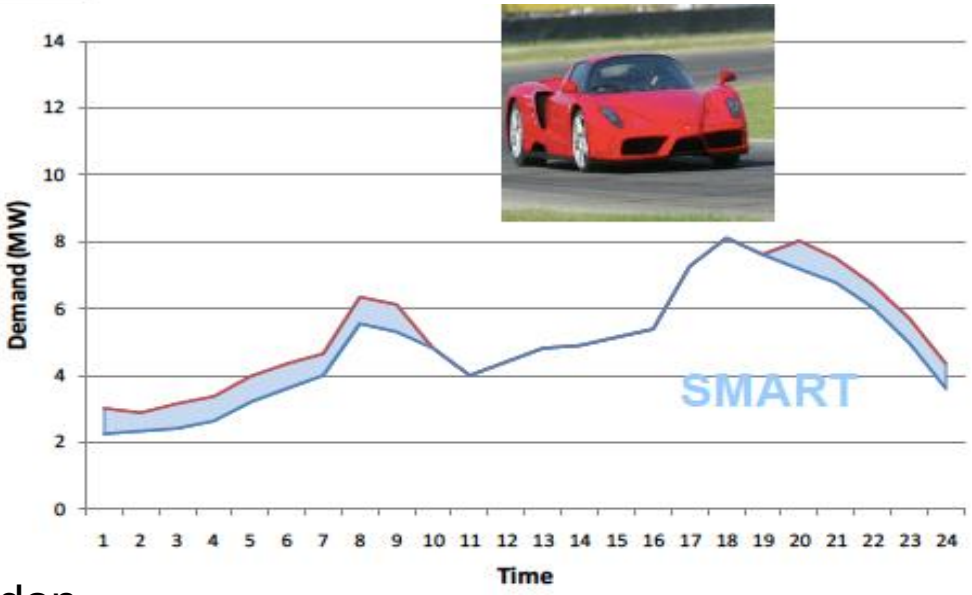


Demand-side flexibility



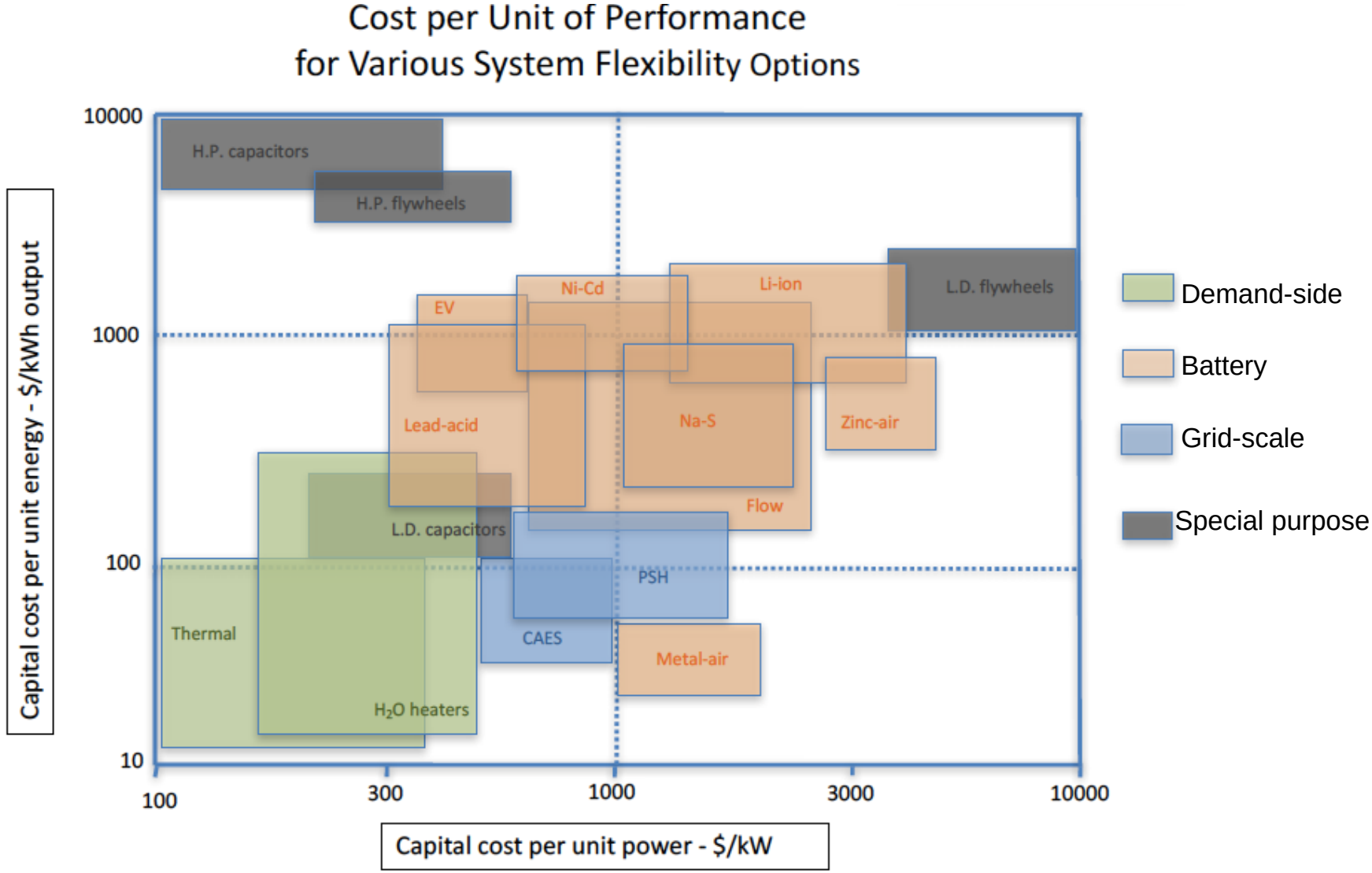
Source: *Roadmap 2050: a practical guide to a prosperous, low-carbon Europe* (McKinsey & Co., Kema, Imperial College London, European Climate Foundation, 2011)

Demand-side flexibility



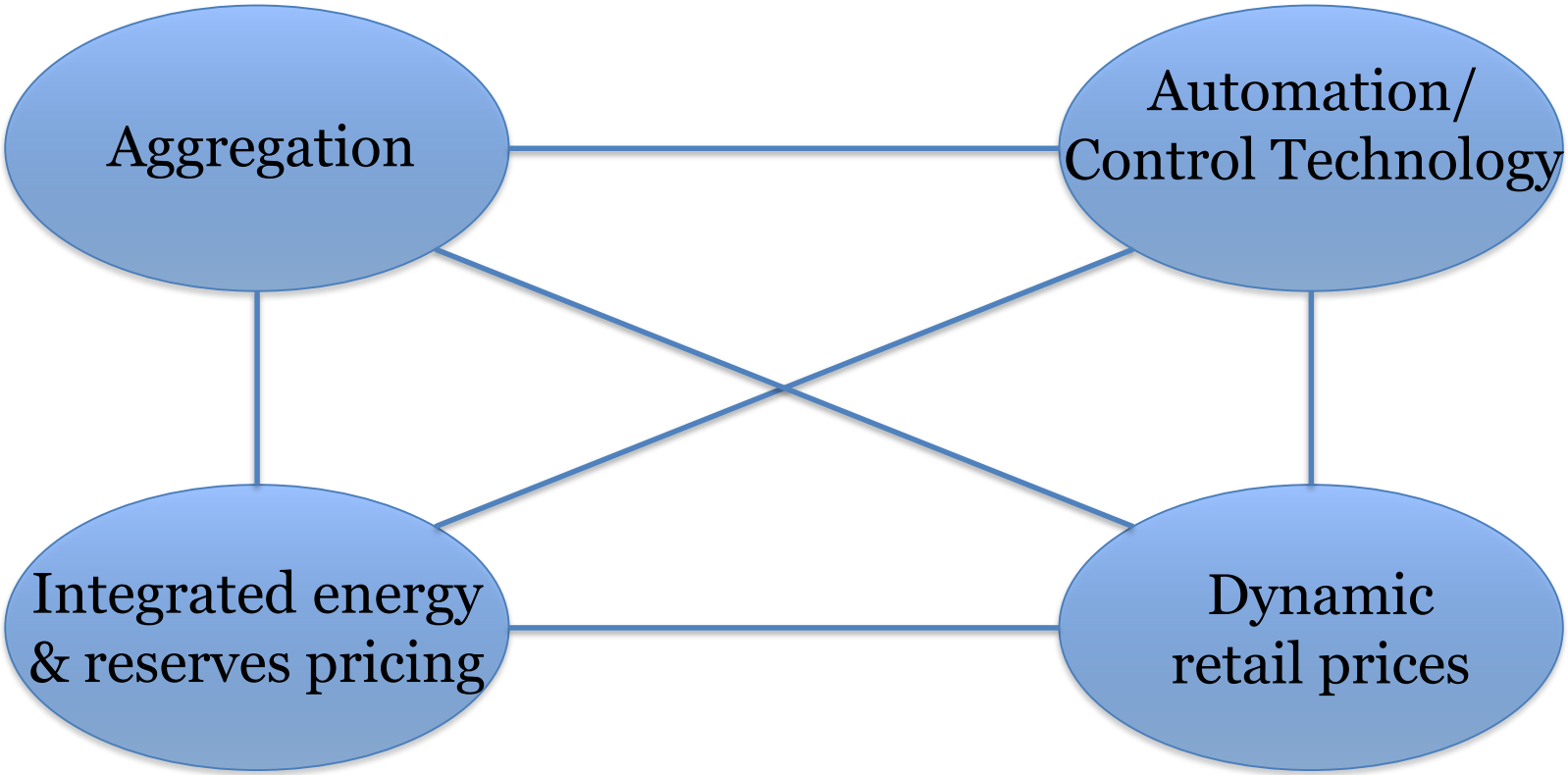
Source: G. Strbac, Imperial College London

Demand-side flexibility



Source: Sandia National Laboratory, Energy Storage Association & Ecofys

4 keys to effective demand participation



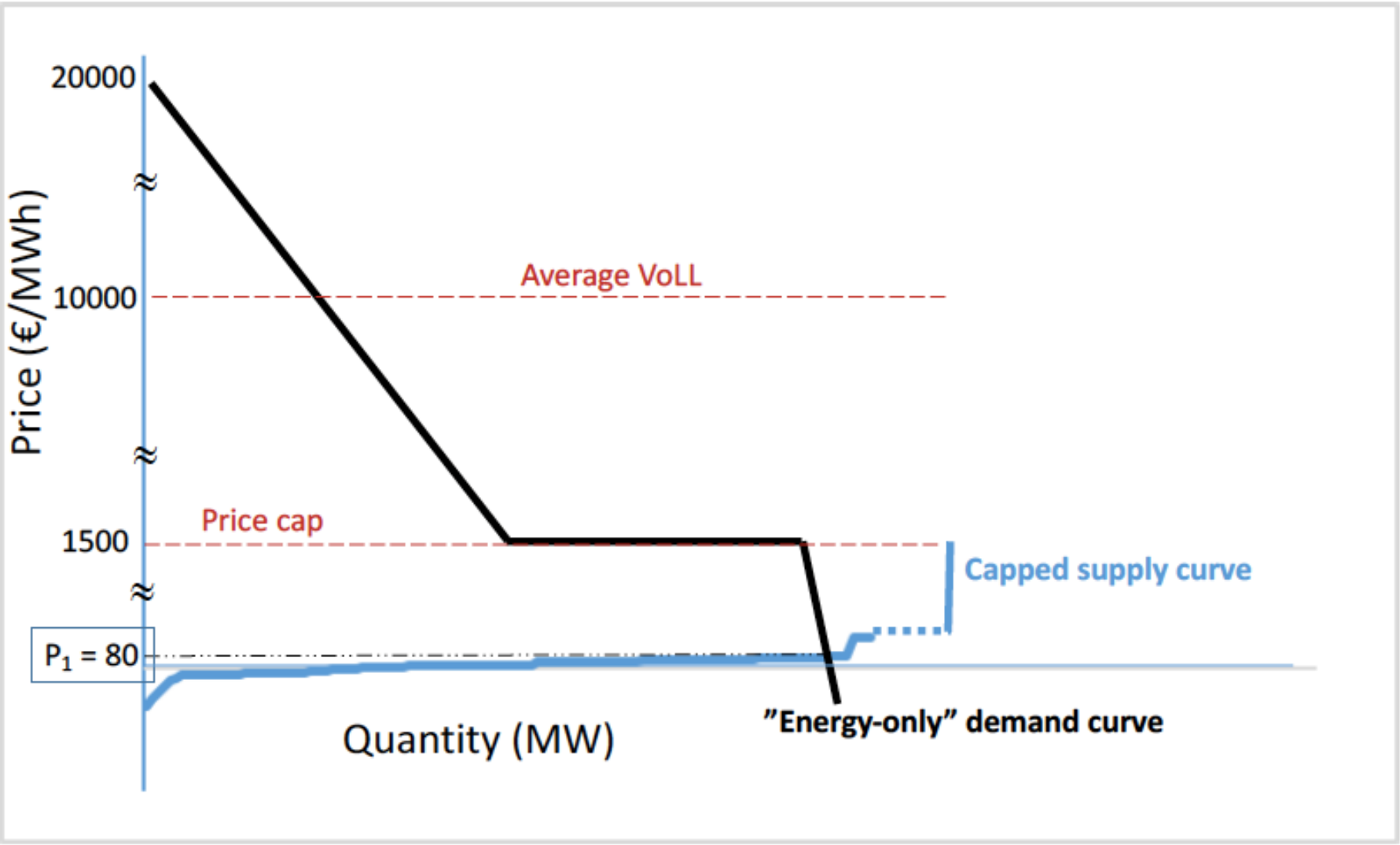
Energy pricing that exposes the value of investment in flexibility

Full range of marginal costs

System Resource	Full marginal cost (€/MWh)
Generation capacity ("firm" or "de-rated")	20-250
Imports	20-1000
Secondary (operating) reserves	250-5000
Emergency generation	500
Primary (regulation) reserves	500-9000
30-minute responsive back-up	1400
30-minute controllable demand response	2400
10-minute controllable demand response	2600
10-minute responsive back-up	3700
Emergency load-shedding	9000

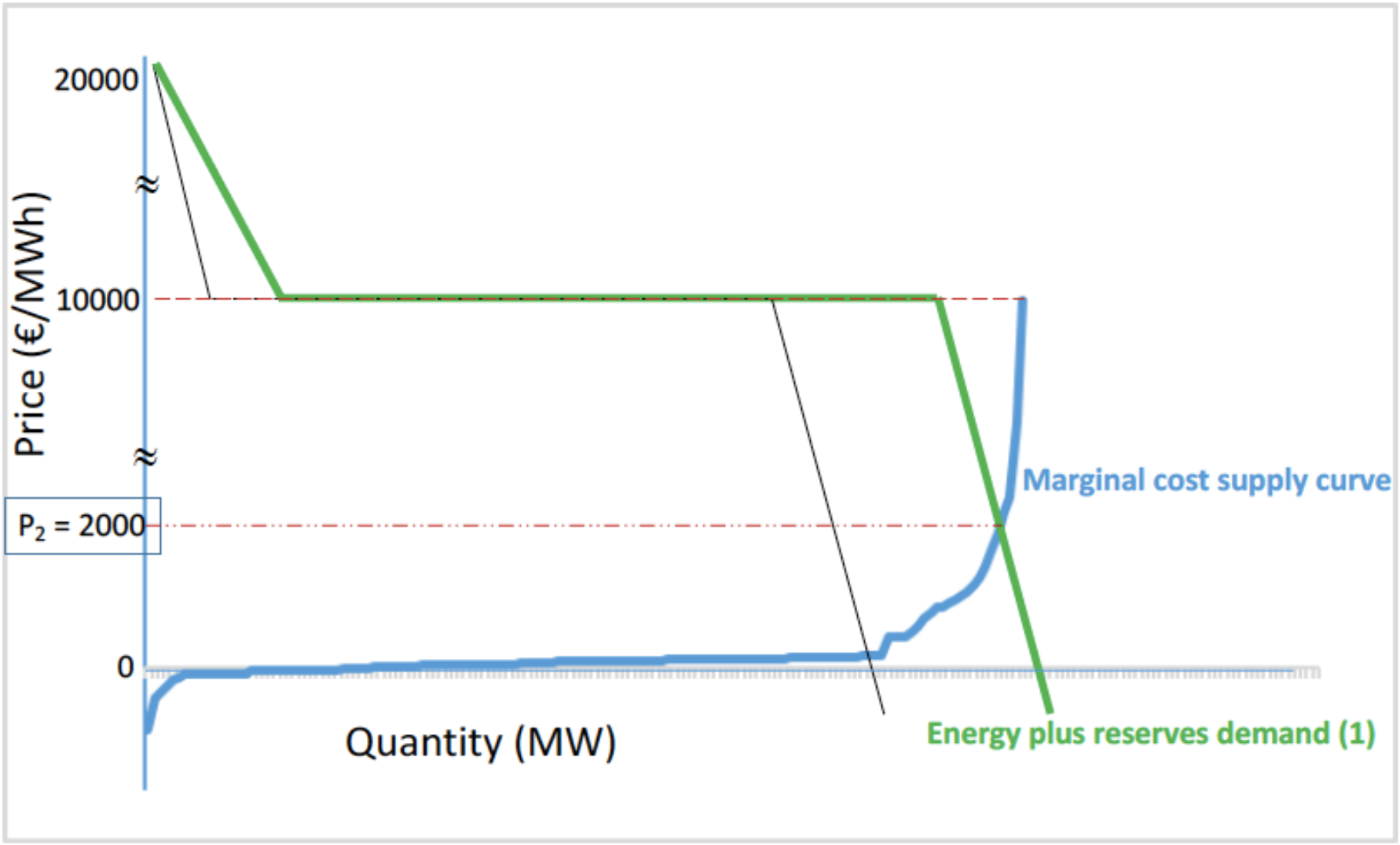
Source: Adapted from Brattle Group & Astrape Consulting (2014 report to Public Utilities Commission of Texas & 2013 report to the Federal Energy Regulatory Commission)

Energy price formation: legacy



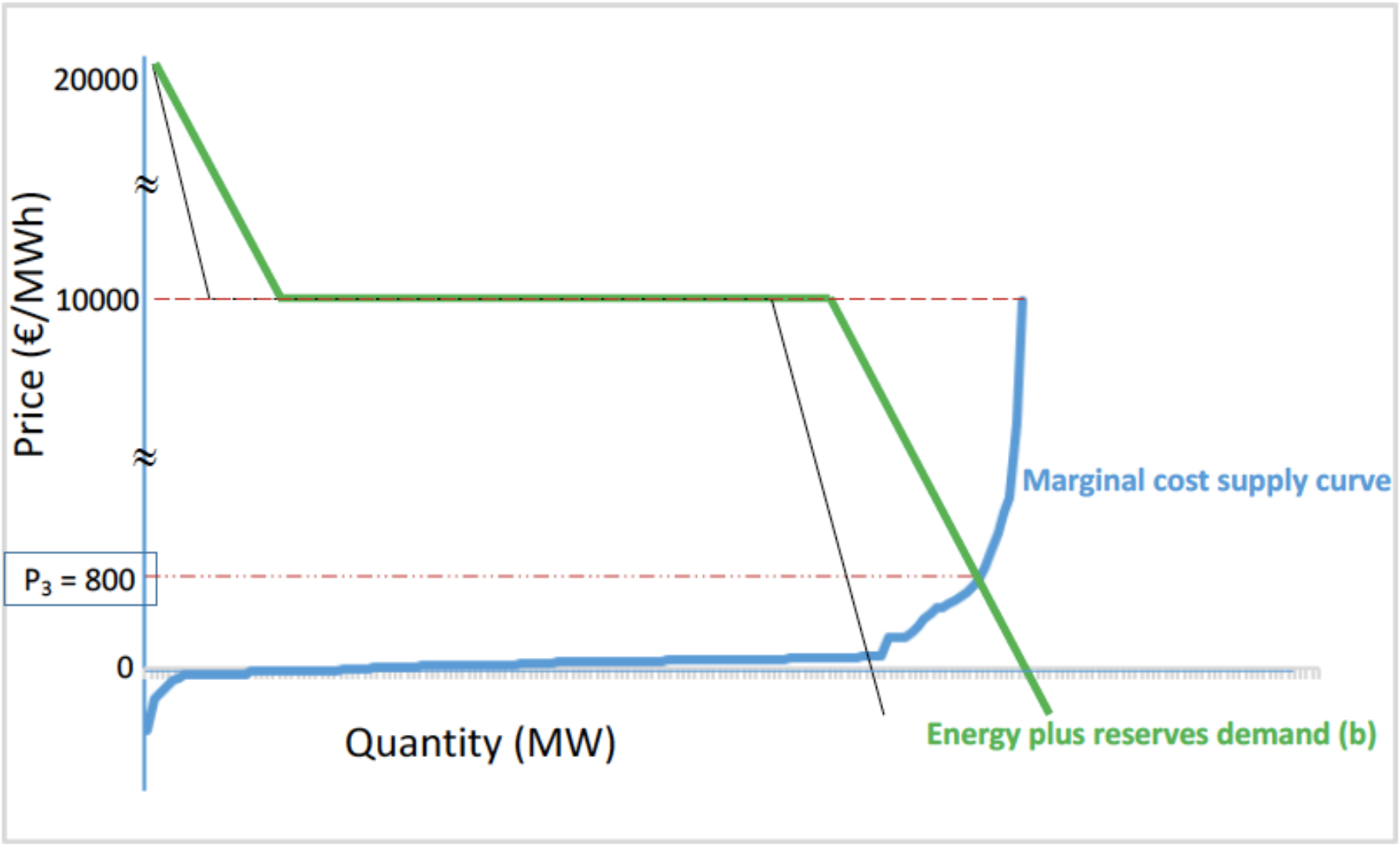
Source: Adapted from W. Hogan, "An 'Energy Only' Market Design for Resource Adequacy" (23 Dec 2005)

Energy price formation: corrected



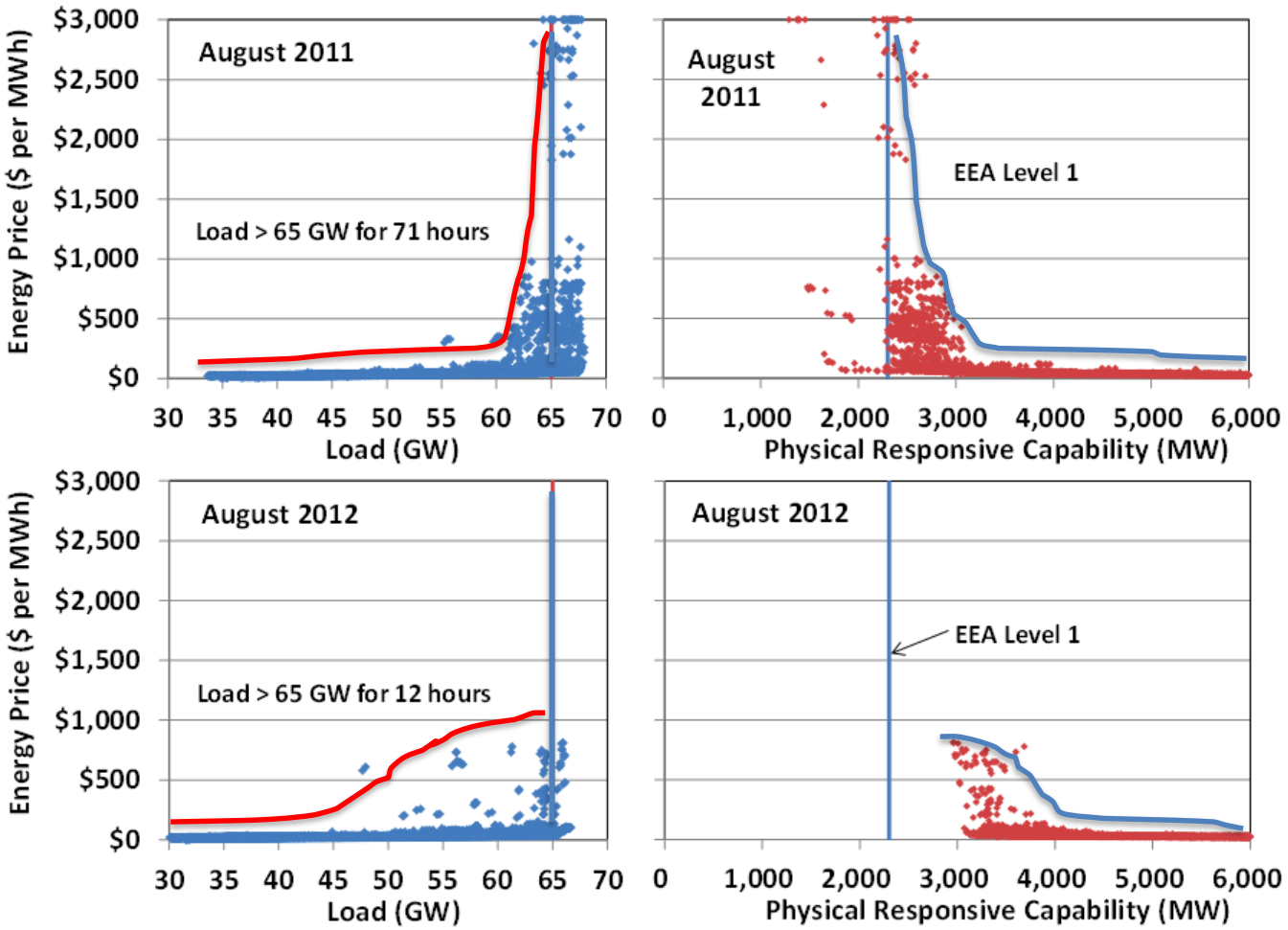
Source: Adapted from W. Hogan, "An 'Energy Only' Market Design for Resource Adequacy" (23 Dec 2005)

Energy price formation: evolved



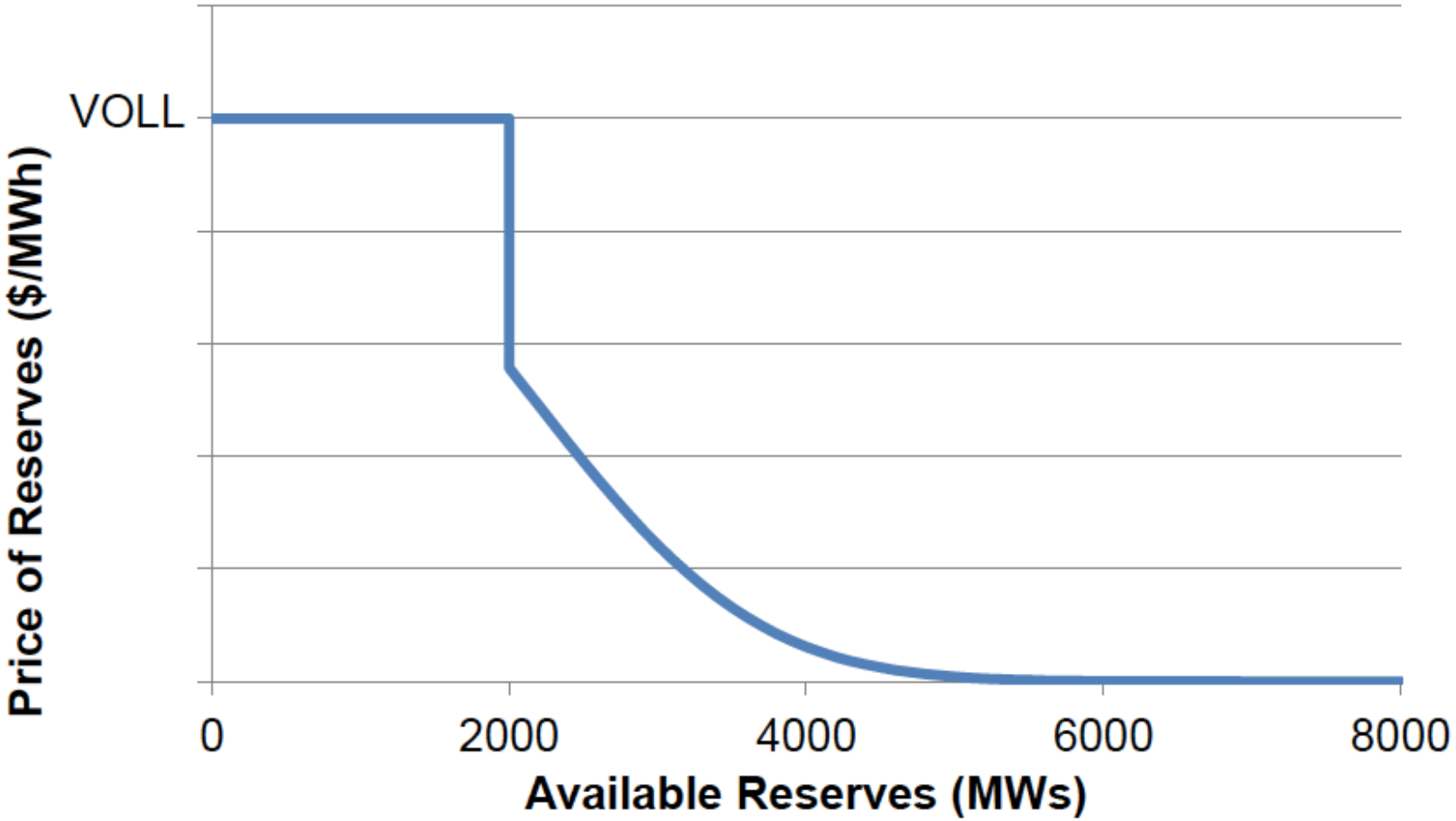
Source: Adapted from W. Hogan, "An 'Energy Only' Market Design for Resource Adequacy" (23 Dec 2005)

Better locational price formation



Source: Potomac Economics, "ERCOT 2012 State of the Market Report", June 2013

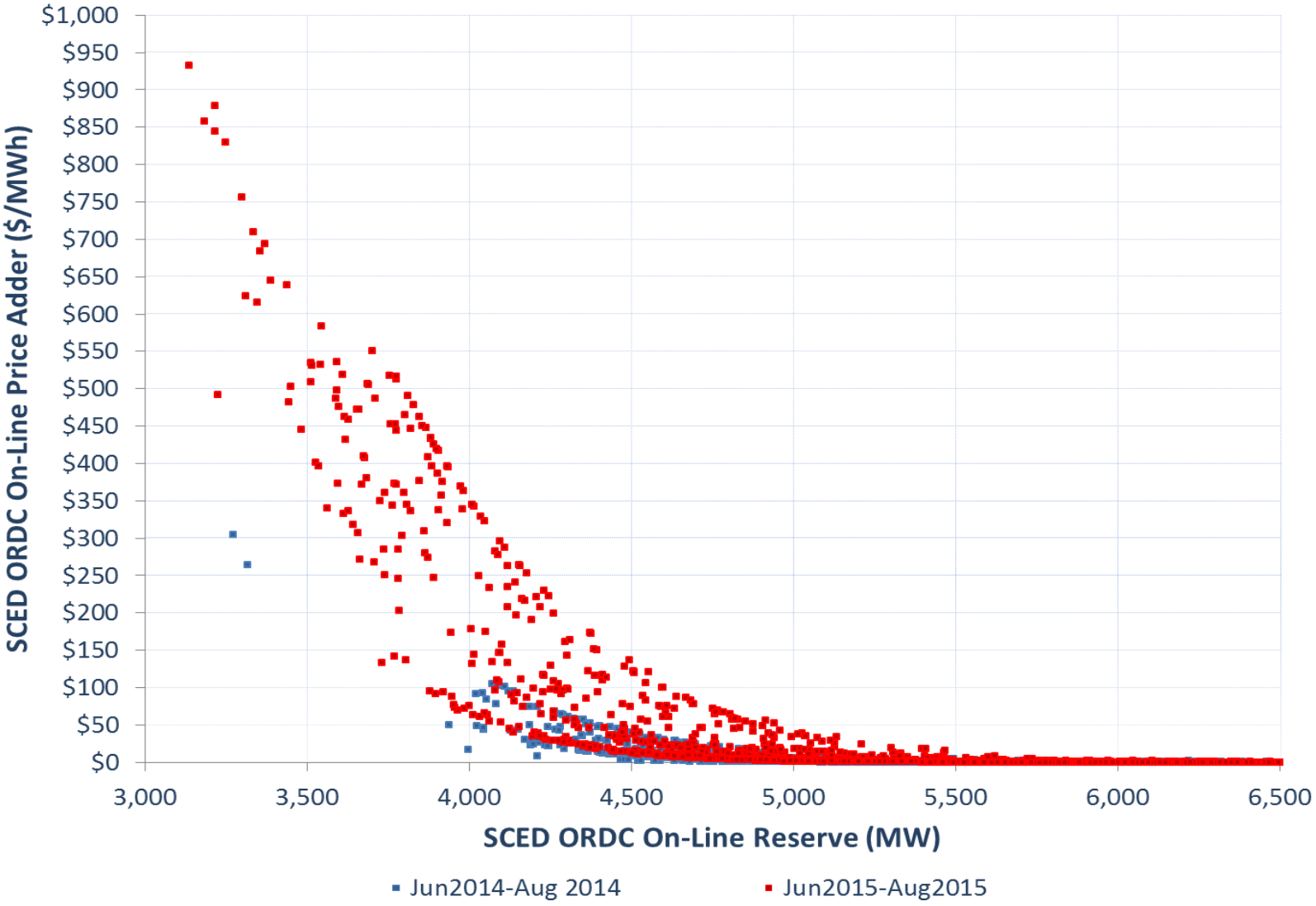
Administrative shortage pricing



Example: ERCOT Operating Reserve Demand Curve

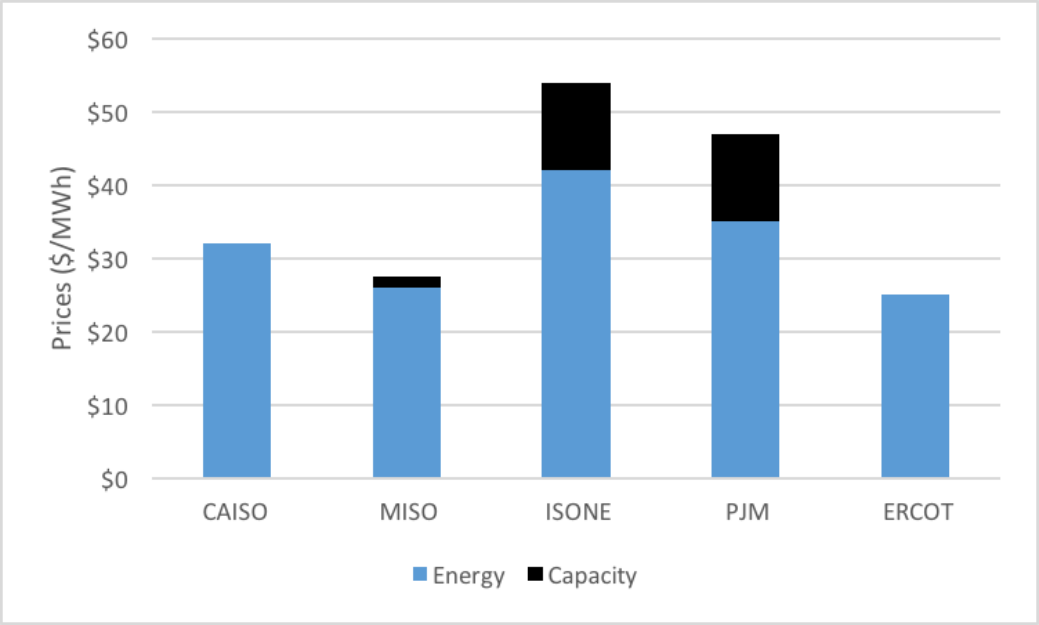
Source: ERCOT

Administrative shortage pricing

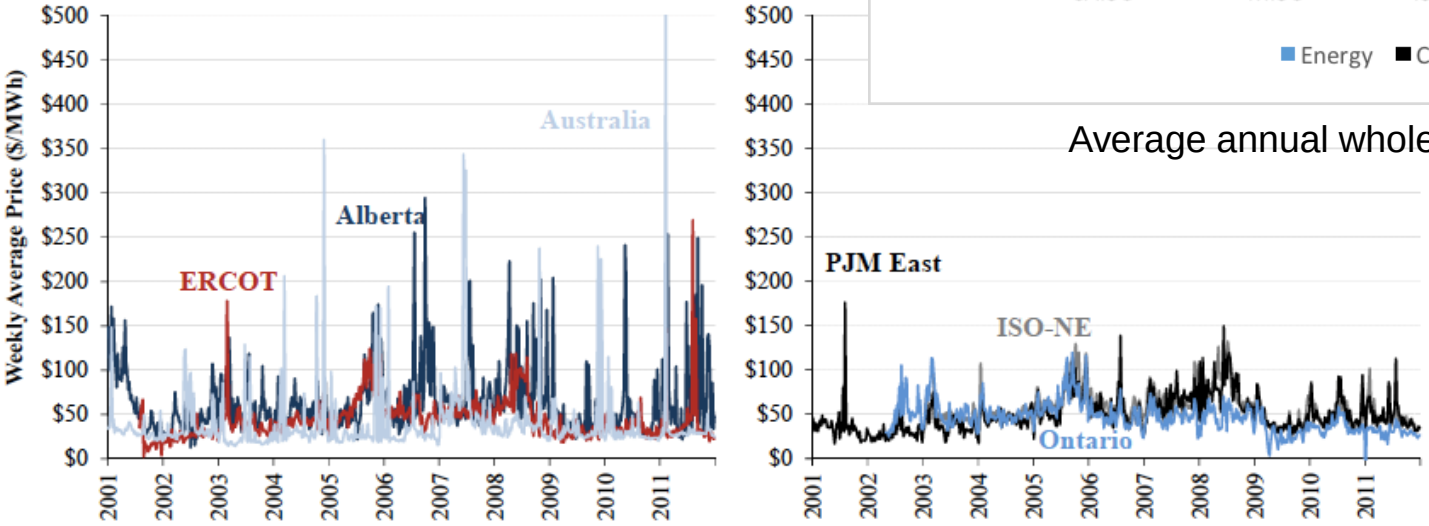


Source: ERCOT

Sharper prices ≠ higher prices



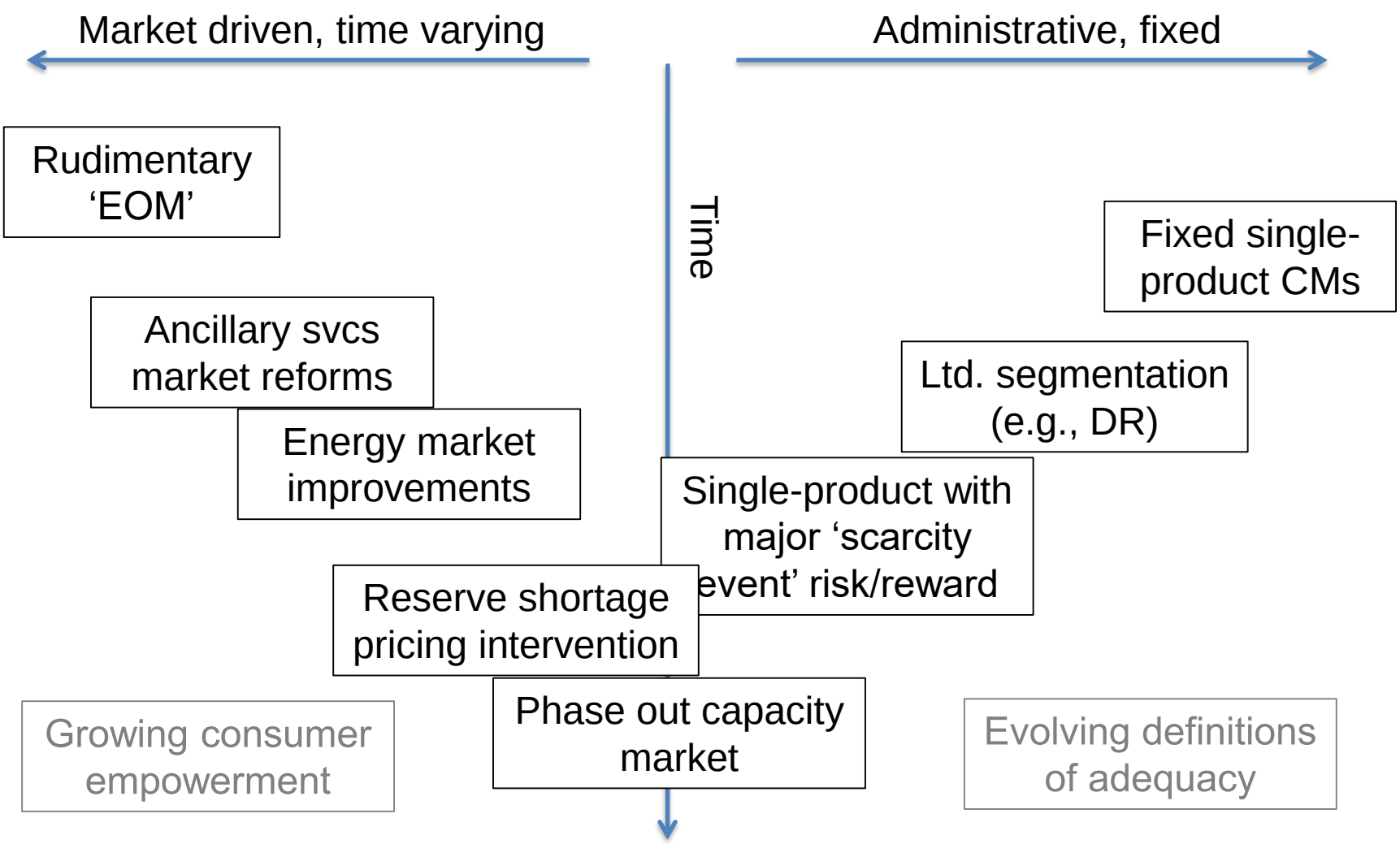
Average annual wholesale energy prices (2015)



Weekly average wholesale energy prices

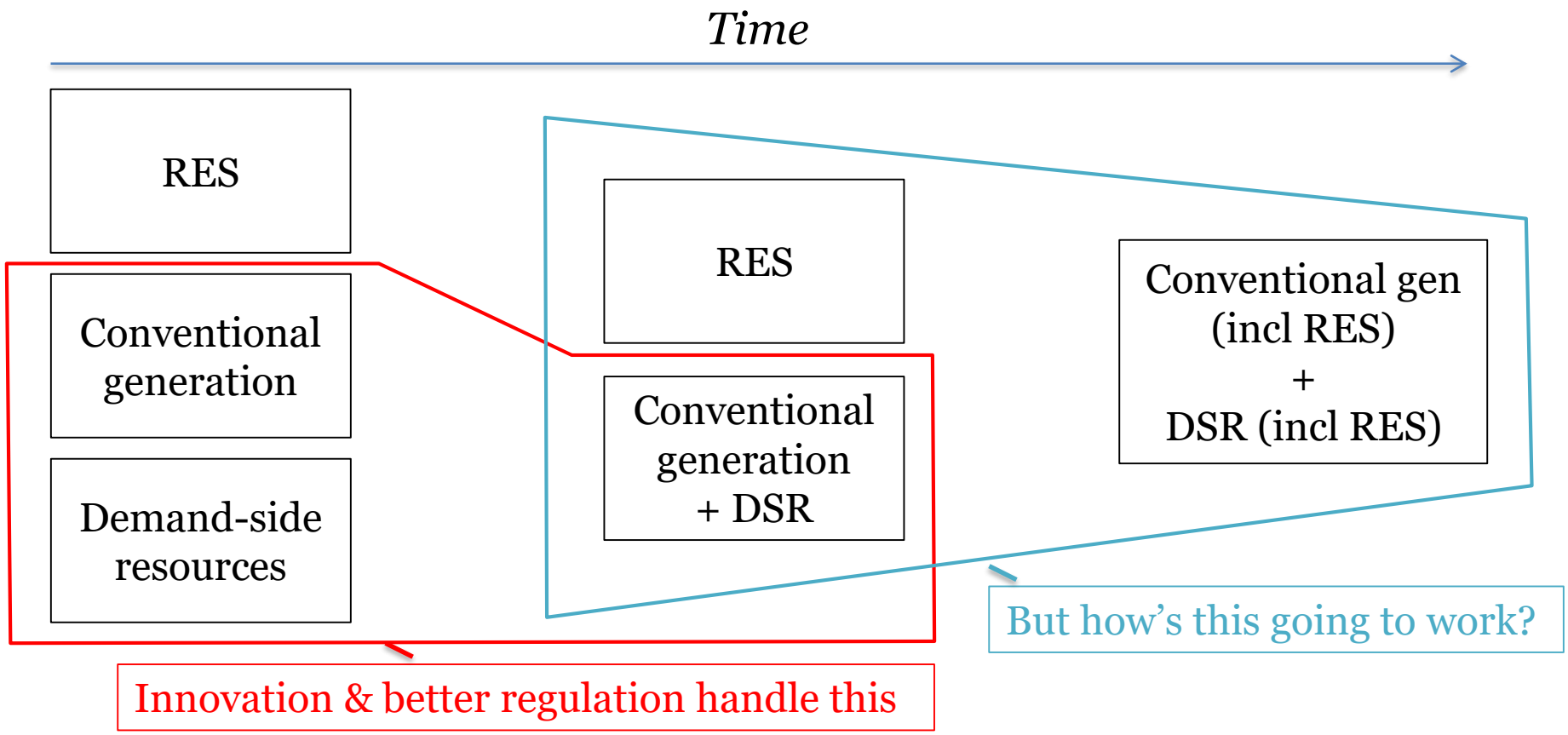
Source: Ventyx (via Brattle Group) & Northbridge

Evolution away from binary model

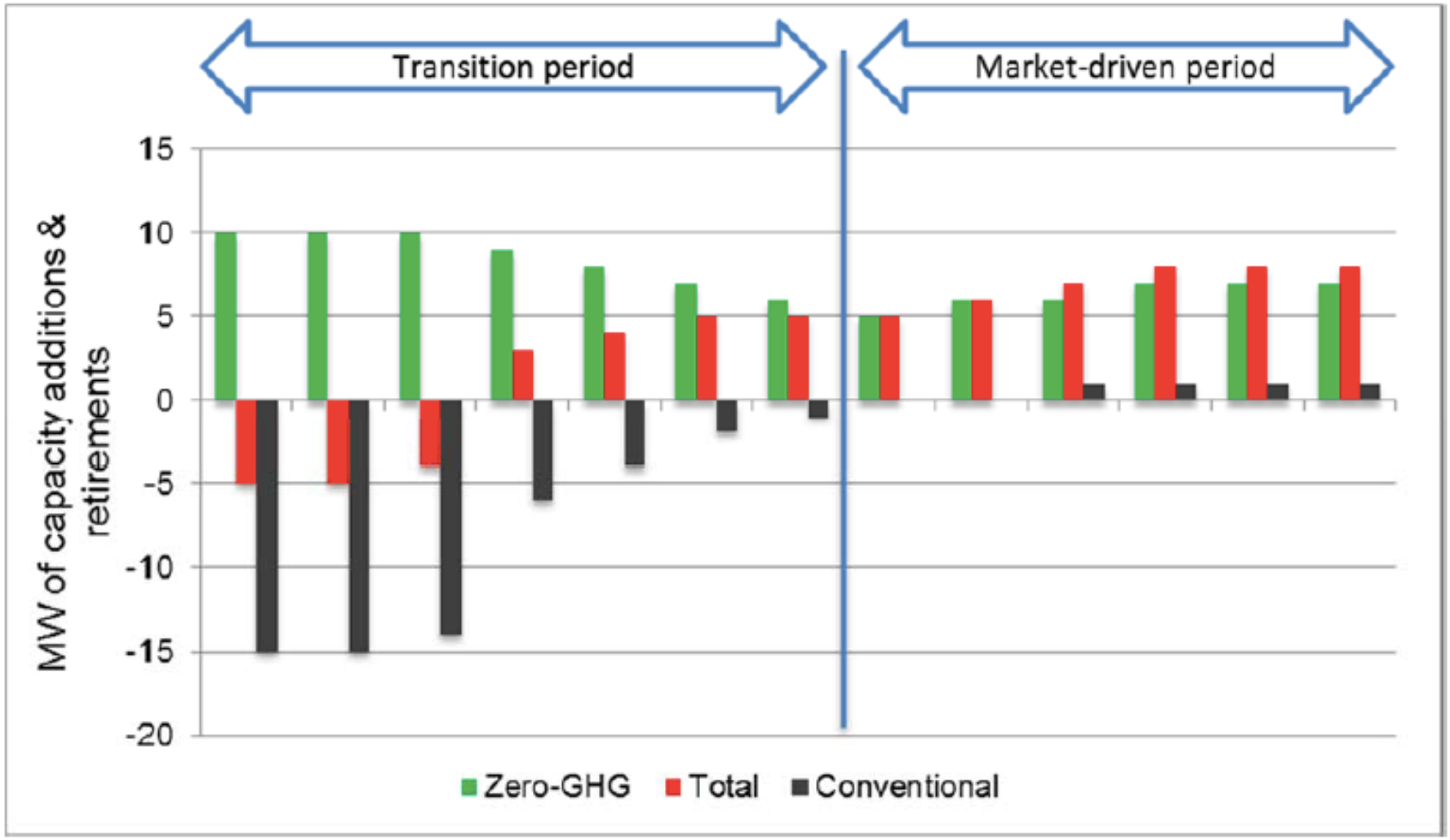


Continued deployment of renewables

What's the end-game for RES support? How do we get there?



Saturation, new investment & retirement



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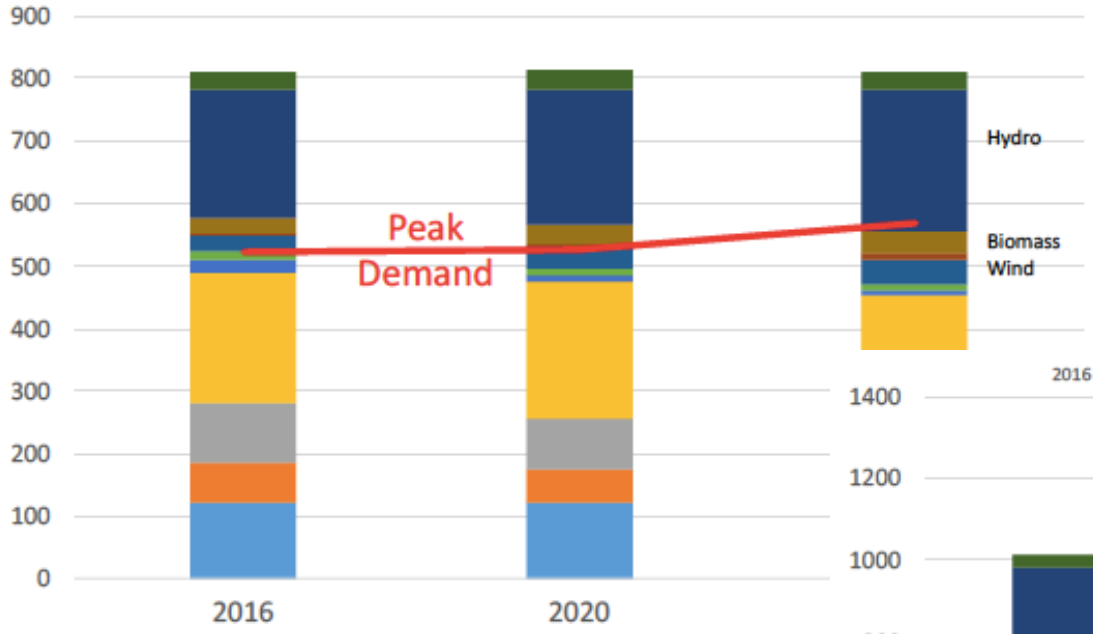
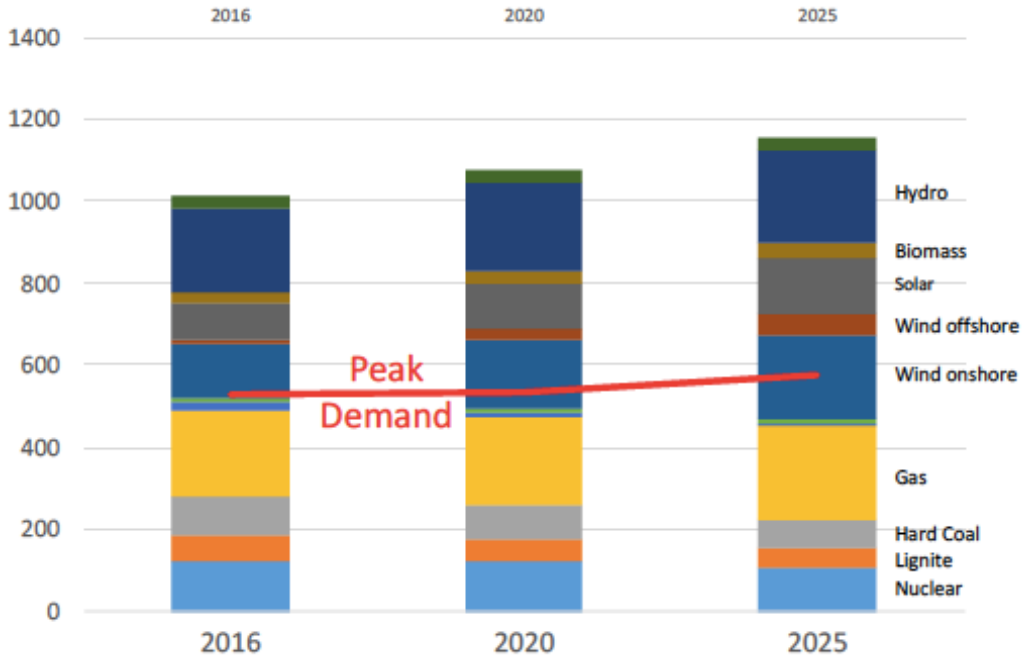


EU28 (assumes zero capacity for PV, 20% for wind)

EU28 (full nameplate capacity for PV and wind)



Support for deployment of "commercial" RES

203?: Full RES convergence w/market? What market?

Auctions + [2030 targets]

+

- "System-friendly" production support
  - but needs "RES-friendly" system
- "Capacity"-based revenue support
  - varied based on performance?
- Economic curtailment of RES
- Beginnings of x-border harmonization

Binding targets + deployment support

Discussion / Q&A

Key take-aways

Delivering clean, reliable electricity at the lowest reasonable cost through organized markets:

- "How much?" depends on "what kind?"
- Critical energy market design choices can make all the difference
- Net growth in zero-carbon investment will not be market-driven for the foreseeable future

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power sector. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raponline.org

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