

What is a Capacity Market?

- Mechanism that ensures sufficient generation to meet **reliability** and **peak load needs**.
- Additional potential benefit of capacity markets is the incentive to build **new generation**.
- Other potential benefits: price stability, competition of existing and new resources, market efficiencies, market power mitigation, transmission upgrades, increase in demand response.

Types of Capacity Markets

Capacity payment mechanisms: EU

- The actual quantity of capacity is unknown in advance
- Availability is rewarded through lump-sum payments or through higher energy payments that depend on the probability of outages
- Cons: the capacity payments can be artificially inflated by generators who can pull out resources and increase the probability of shortages

Quantity-based mechanisms: US

- Usually locationally-specific
- Fixed amount of capacity is committed based on expected load (forecast peak load) and reliability criteria
- Forward-looking centralized procurement auctions

PJM's Current Capacity Market

Reliability Pricing Mechanism

- Stakeholder effort continued for two years and resulted in litigation and settlement discussions.
- RPM was finally approved by FERC in December 22, 2006

Reliability Pricing Model (RPM)

Capacity vs. Energy

Capacity

- A commitment of a resource to provide energy during PJM emergency under the capped energy price.
- Capacity revenues paid to committed resource whether or not energy is produced by resource.
- Daily product

Energy

- Generation of electrical power over a period of time
- Energy revenues paid to resource based on participation in PJM's Day-Ahead & Real-Time Energy Markets
- Hourly product

Capacity, energy & ancillary services revenues are expected, in the long term, to meet the fixed and variable costs of generation resources to ensure that adequate generation is maintained for reliability of the electric grid.

Objectives of RPM

- Resource commitments to meet system peak loads three years in the future
- Three year forward pricing which is aligned with reliability requirements and which adequately values all capacity resources
- Provide transparent information to all participants far enough in advance for actionable response

Purpose of RPM is to enable PJM to obtain sufficient resources to reliably meet the needs of electric consumers within PJM.

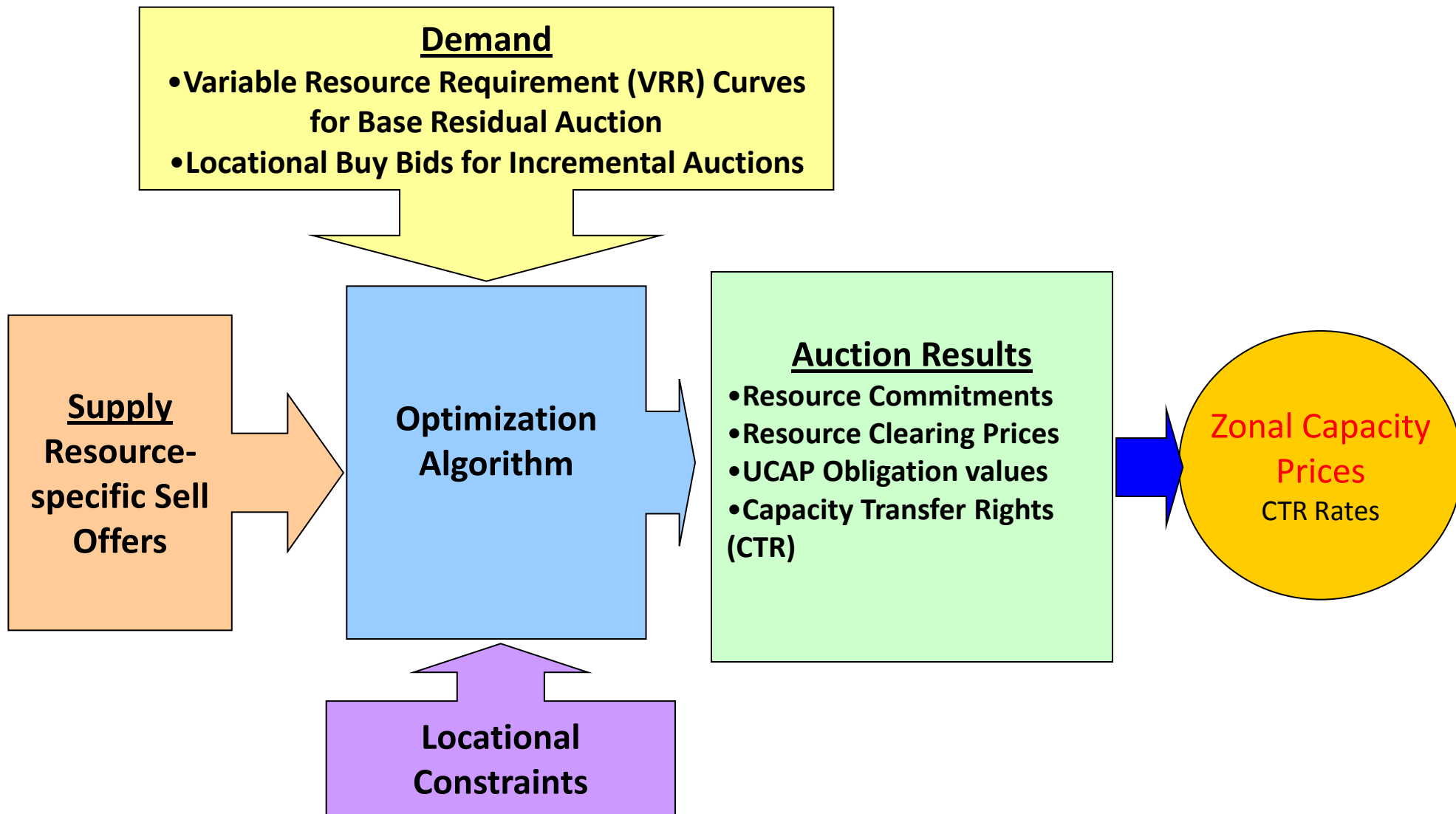
Resource Adequacy Requirement

- Determines the amount of capacity resources required to serve the forecast peak load and satisfy the reliability criterion.
- The reliability criterion is based on Loss of Load Expectation (LOLE) not exceeding one event in ten years.

An Installed Reserve Margin (IRM) = 15.3% satisfies the reliability criterion for the 2013/14 Delivery Year.

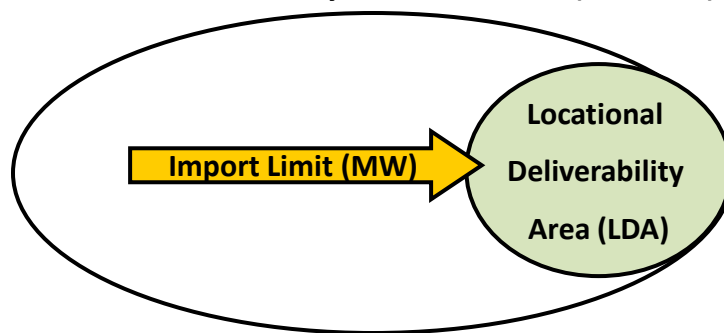
Resource Adequacy ICAP Requirement = Forecast Peak Load * (1+ IRM)

RPM Auction Process



What are Locational Constraints?

- Locational Constraints are capacity **import capability limitations** that are caused by
 - transmission facility limitations, or
 - voltage limitations.
- PJM determines constrained sub-regions (i.e., locational deliverability areas) to be included in RPM Auctions to recognize and quantify the locational value of capacity.
- Constrained regions are determined by comparing the import limit of a region (CETL) to the amount of capacity that needs to be imported into a region to meet the reliability criterion (CETO).



CETL = Capacity Emergency Transfer Limit

CETO = Capacity Emergency Transfer Objective

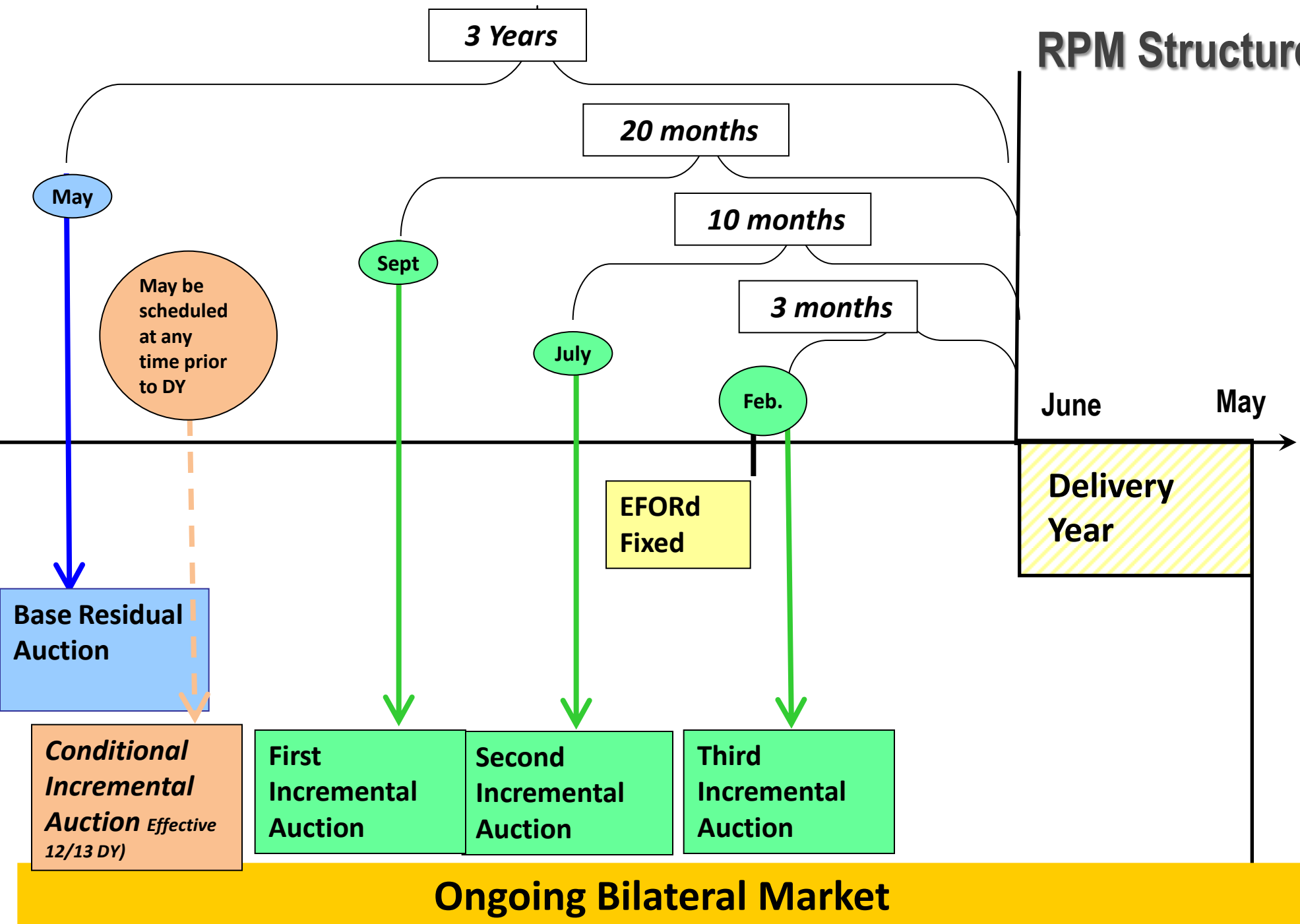
Locational Deliverability Areas

RTEPP has currently identified 25* sub-regions as Locational Deliverability Areas (LDAs) for evaluating the locational constraints.

- Regions
 - Western PJM (ComEd, AEP, Dayton, APS, Duquesne, ATSI, Duke)
 - Mid-Atlantic Area Council (MAAC) Region
 - Eastern MAAC (PSE&G, JCP&L, PECO, AE, DPL & RECO)
 - Southwestern MAAC (PEPCO & BG&E)
 - Western MAAC (Penelec, MetEd, PPL)
- Zones
 - AE, AEP, APS, ATSI, BGE, Comed, Dayton, DUQ, Dominion, DPL, Duke, JCPL, MetEd, PECO, Penelec, PEPCO, PPL, PSEG
- Sub-Zones
 - PSEG Northern Region (north of Linden substation)
 - DPL Southern Region (south of Chesapeake and Delaware Channel)

PJM required to make a filing with FERC before adding a new LDA.

RPM Structure



RPM Auctions (Starting with 12/13 DY)

Activity	Purpose	Cost of Procurement
Base Residual Auction	Procurement of RTO Obligation less an amount reserved for short lead time resources, less FRR Obligation	Allocated to LSEs through Locational Reliability Charge
1 st Incremental Auction	Allows for: (1) replacement resource procurement (2) increases and decreases in resource commitments due to reliability requirement adjustments; and (3) deferred short-term resource procurement (4) Delays in construction of a resource (5) EFORd increase	Allocated to resource providers that purchased replacement resources and LSEs through Locational Reliability Charge
2 nd Incremental Auction – held at PJM’s discretion - if there is > 100 MW shortage.		
3 rd Incremental Auction		
Conditional Incremental Auction	Procurement of additional capacity in a LDA to address reliability problem that is caused by a significant transmission line delay	Allocated to LSEs through Locational Reliability Charge

Base Residual Auction (BRA) Demand and Supply

Demand

- Variable Resource Requirement (VRR) curve is the demand curve for the Base Residual Auction
- Mandatory participation by load (LSEs).

Supply

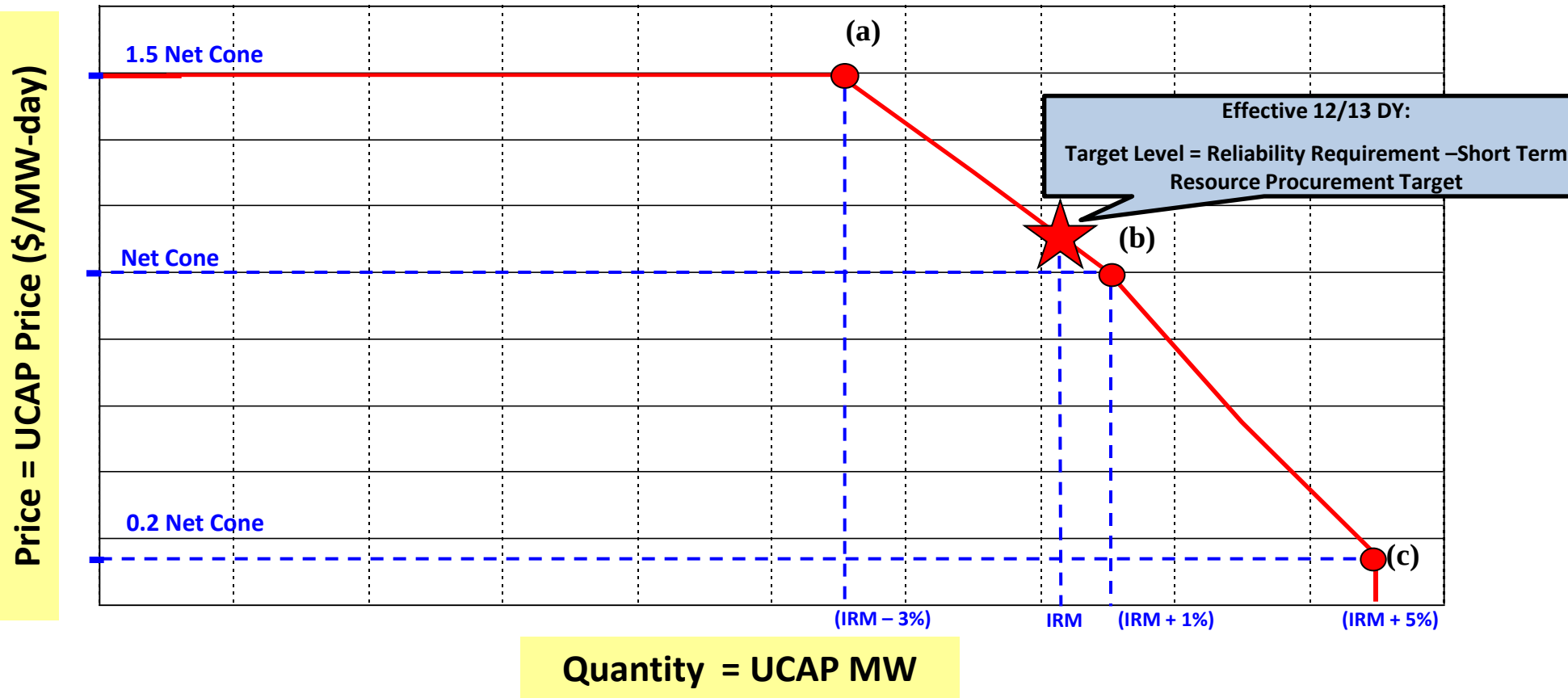
- Individual resource-specific offers are stacked to form the supply curve
- All resources with Available Capacity must offer into the Base Residual Auction

What is the VRR?

The Variable Resource Requirement (VRR) Curve is a downward sloping demand curve that relates the maximum price for a given level of capacity resource commitment relative to reliability requirements.

- The price is higher when the resources are less than the reliability requirement and lower when the resources are in excess.
- VRR Curves are defined for the PJM RTO and for each constrained Locational Deliverability Area (LDA) within the PJM region.

Illustrative Example of a VRR Curve



A VRR Curve is defined for the PJM Region.

Individual VRR Curves are defined for each Constrained LDA.

What is a Supply Resource in RPM?

In RPM, Resources are =

**Generation
Resources
(Existing and
Planned)**

**Demand
Resources
(DR)**

**Energy
Efficiency
Resources
(EE)**

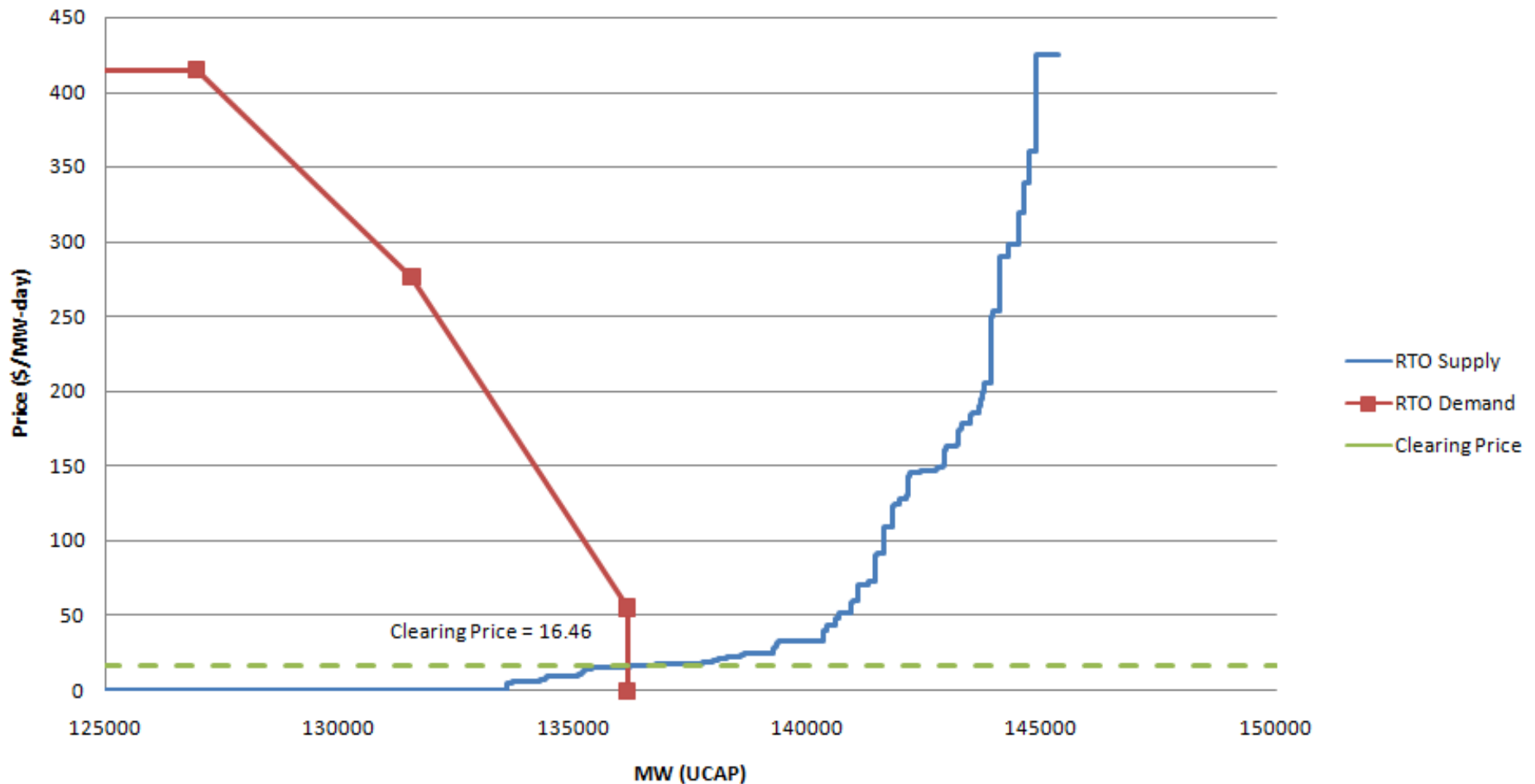
(Effective with 11/12 DY)

**Qualifying
Transmission
Upgrades
(QTU)**

- Smallest offer is 0.1 MW
- Can self-schedule – offer price = \$0/MW-day
- Market Monitor can mitigate price offers

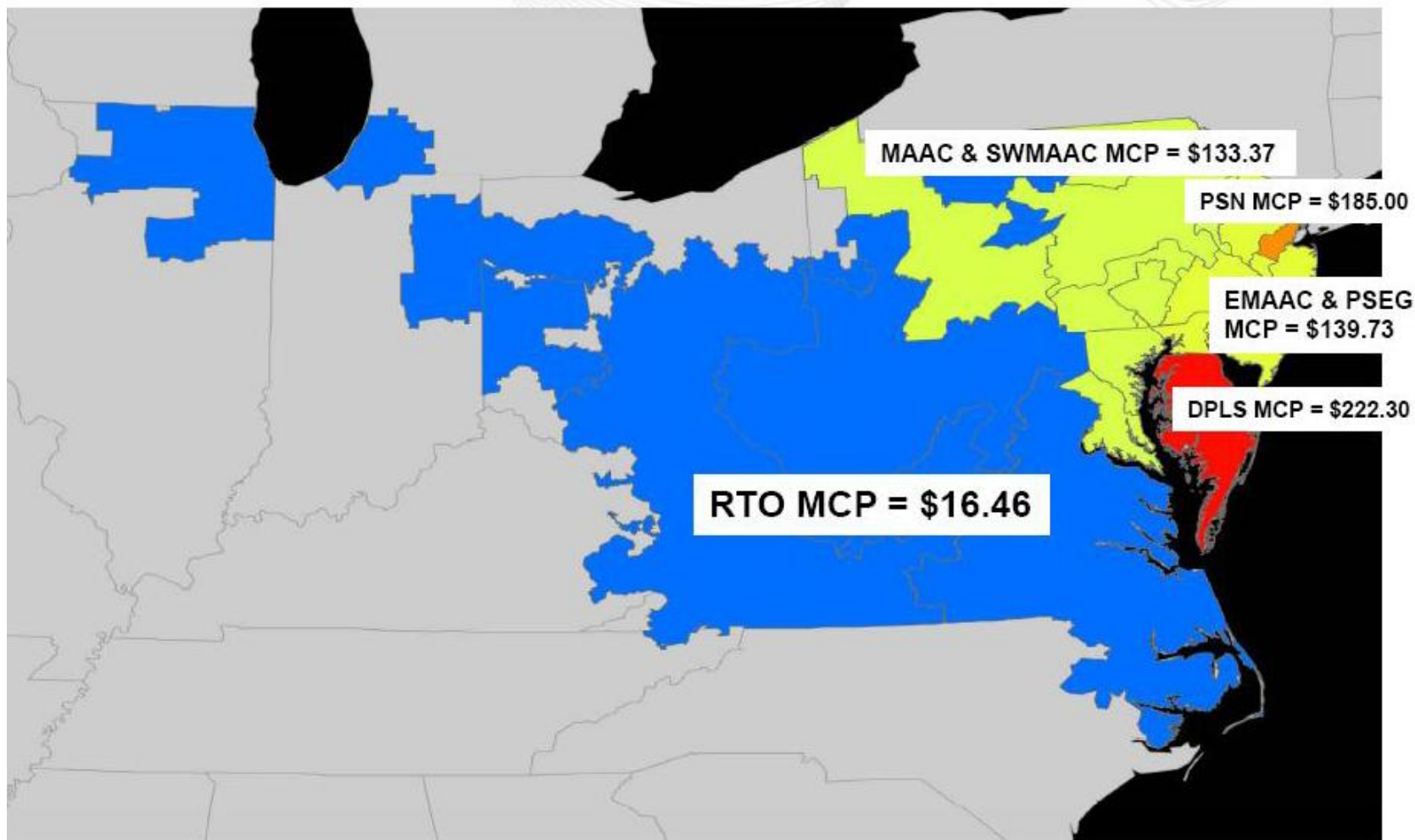
Clearing 2012/2013 Base Residual Auction

2012/2013 RTO Supply and Demand

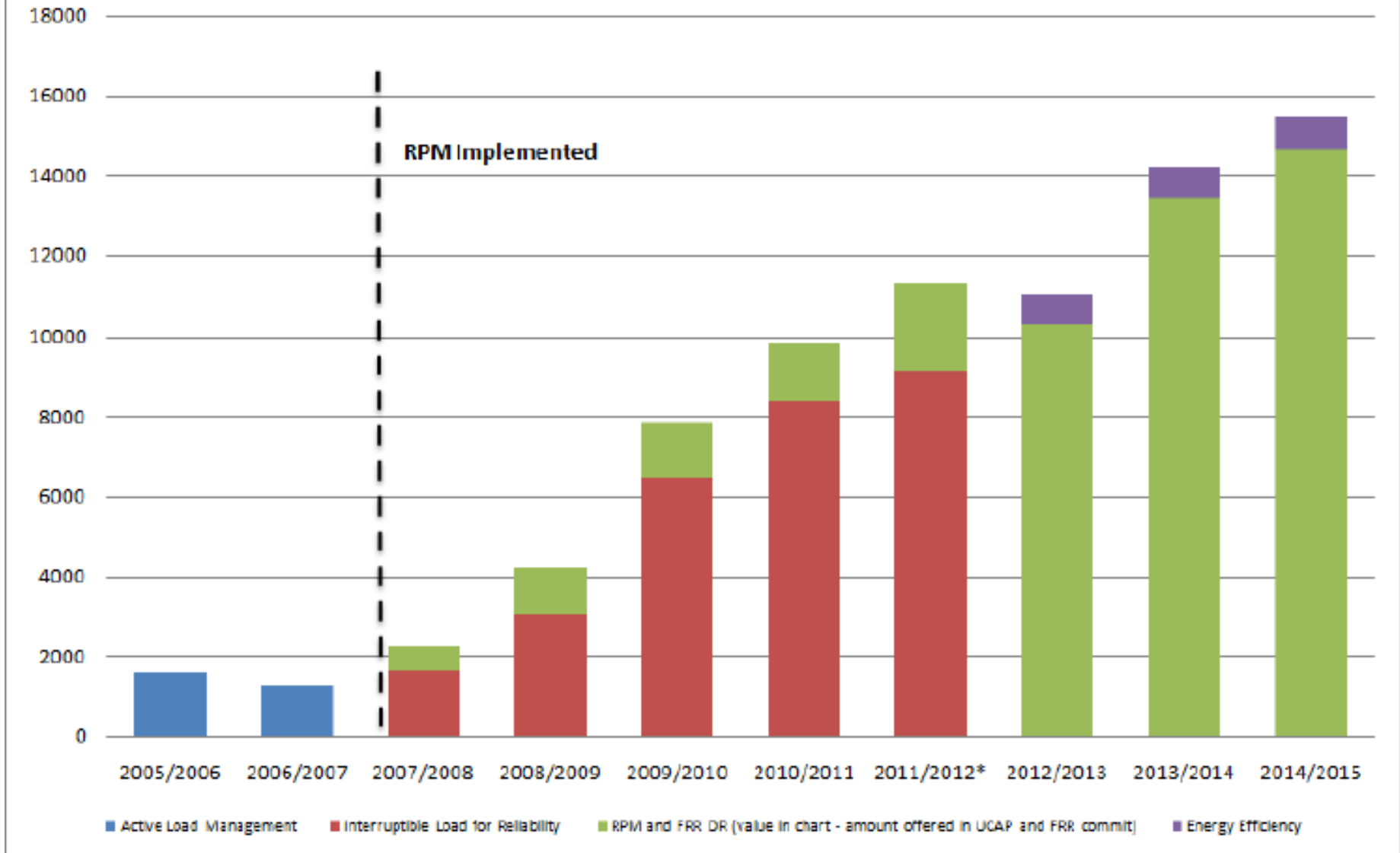


Clearing determined by the intersection of the supply and the demand curves.

2012/2013 Base Residual Auction Clearing Prices (\$/MW-Day)



Demand Side Participation in Capacity Market



Source: PJM 2014/15 Base Residual Auction Report

Percentage of total price per MWh

From Monitoring Analytics State of the Market 2010

Category	Totals (\$ Millions) 2010	2010 \$/MWh	2010 Proportion of \$/MWh
Energy	\$33,717.30	\$48.35	72.5%
Capacity	\$8,409.34	\$12.06	18.1%
Transmission Services	\$2,786.58	\$4.00	6.0%
Operating Reserves (Uplift)	\$547.68	\$0.79	1.2%
Reactive	\$310.08	\$0.44	0.7%
PJM Admin	\$248.02	\$0.36	0.5%
Regulation	\$241.39	\$0.35	0.5%
Synchronized Reserves	\$43.85	\$0.06	0.1%
Total	\$46,530.41	\$66.72	100.0%

Key Points to Remember

- RPM is designed to ensure sufficient generation, transmission and demand response to ensure system reliability.
- All RPM Auctions share the same objective of minimizing capacity costs given supply curves, demand curves, and locational constraints.
- RPM can foster competition among all types of new and existing capacity, including demand side resources.
- Still a process in development. Goes thru a triennial review by an independent consultant.