Managing Flexibility in MISO Markets

Clean Energy Regulatory Forum

November 9, 2012

Outline

- Impacts of Variable Generation on Ancillary Services
- Dispatchable Intermittent Resources
- Introduction to Proposed Ramp Products
- Ramp Products in Day Ahead and Real Time Markets
- Simple Example for Cost / Benefit Analysis
- Questions

Impacts of Variable Generation on Ancillary Services

Regulation

- MISO Peak Load: 105 GW
- Wind generation Installed Capacity over 12 GW
- MISO Regulation Requirements
  - MISO requirement is a bidirectional value varying between 300 MW to 500 MW depending on load level and time of the day
- Impact of Variable Generation
  - In general is little to none
  - Wind Generation can impact the net load variability and uncertainty
    - One minute wind generation variation has very little impact on net load one minute variability
    - Standard deviation of Short-term wind generation forecast error is approximately 1% of wind generation capacity
    - The impact of short-term wind forecast error in net load uncertainty is low

Contingency Reserve(s)

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- **MISO Contingency Reserve Requirement**
  - Criterion: largest generation unit / unit + transmission corridor
  - It is set to 2000 MW
  - Approx. 50% is set as spinning reserve
  - The rest is the supplement reserve (provided by on-line and off-line resources including Demand Response Resources)
  - Due to the deliverability issues there are zonal requirements
    - Up to seven zones
  - Main Characteristics of the Contingency Event
    - Occur very quickly (seconds)
    - Needs to be compensated in 10 minutes
  - Current RTO / ISO practice does not use the contingency reserve for other shortages in the system

Contingency Reserve(s) – Cont'd

- **Impact of Variable Generation**
  - None. Unless a single wind farm is exceeding the current 2000 MW (system wide) or zonal requirement
  - Forecasted wind generation (and / or actual wind generation) variability has its own latency much longer than a contingency event
    - MISO has experienced loosing wind generation in the magnitude of 6000 to 7000 MW in about 8 hours (majority of these drops were forecasted) – In opposite direction to the load variation
    - Wind generation variation of +/- 2000 MW in 20 minutes (rare events)

Fundamental Issue

- **No increase in the conventional reserve requirement**
- **What is the most challenging issue in the day to day operation?**
  - *Ramping Capability*
    - Keeping enough rampable capacity in the system to go after the net load variability and uncertainty
  - Enforcing system wide Ramp Up and Down capacity constraints in the Day Ahead process (partly covering intra-hour ramp requirements)
  - Intra Day RAC process updates commitment of the generation resources to make sure upon changes in the system conditions there is enough headroom in the system
  - Following the ramp needs close to the real-time and committing fast start up units if needed
  - Enforcing an offset value in the dispatch function partly to enforce specific positioning of the units

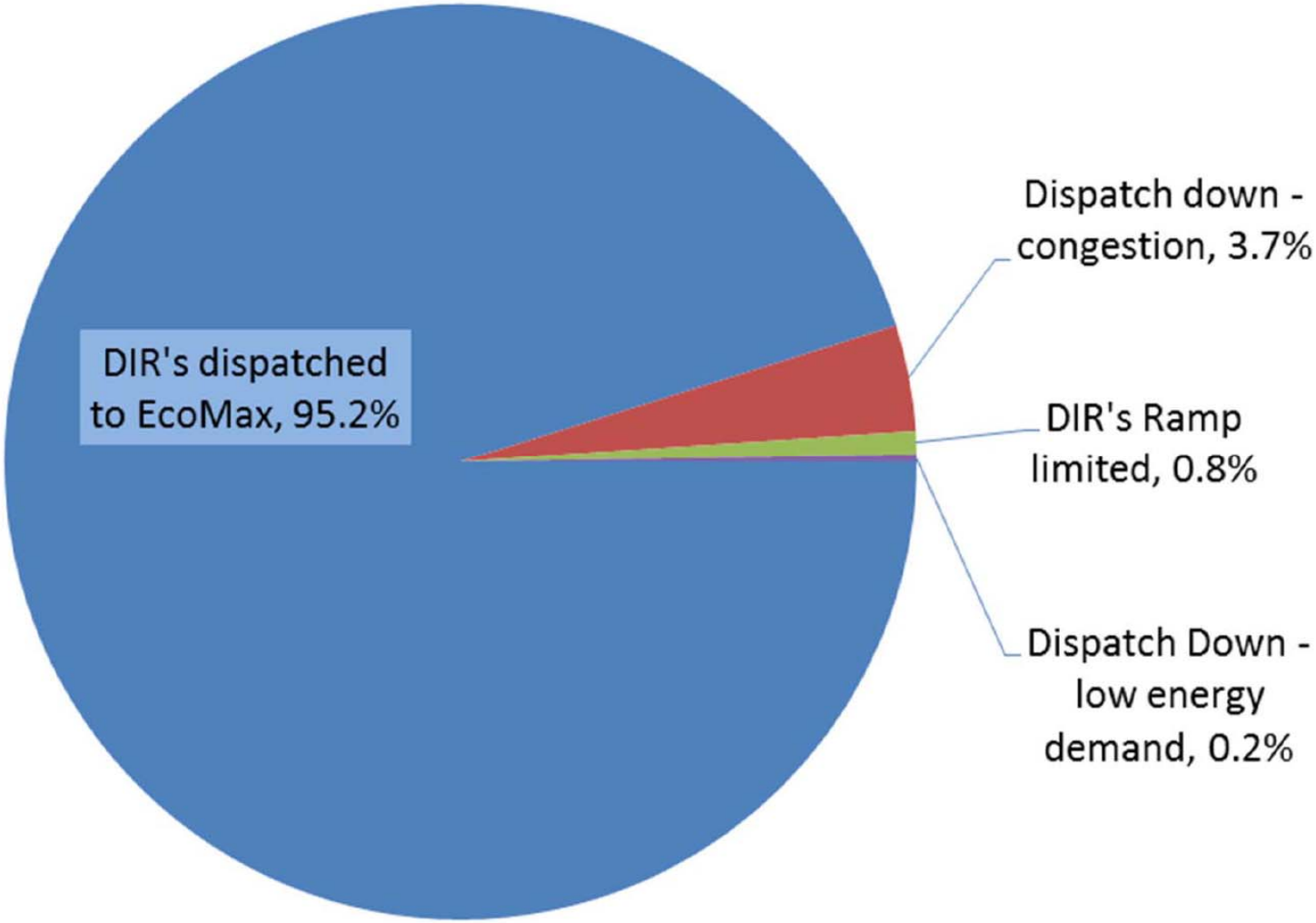
Dispatchable Intermittent Resources

Dispatchable Intermittent Resources (DIR)

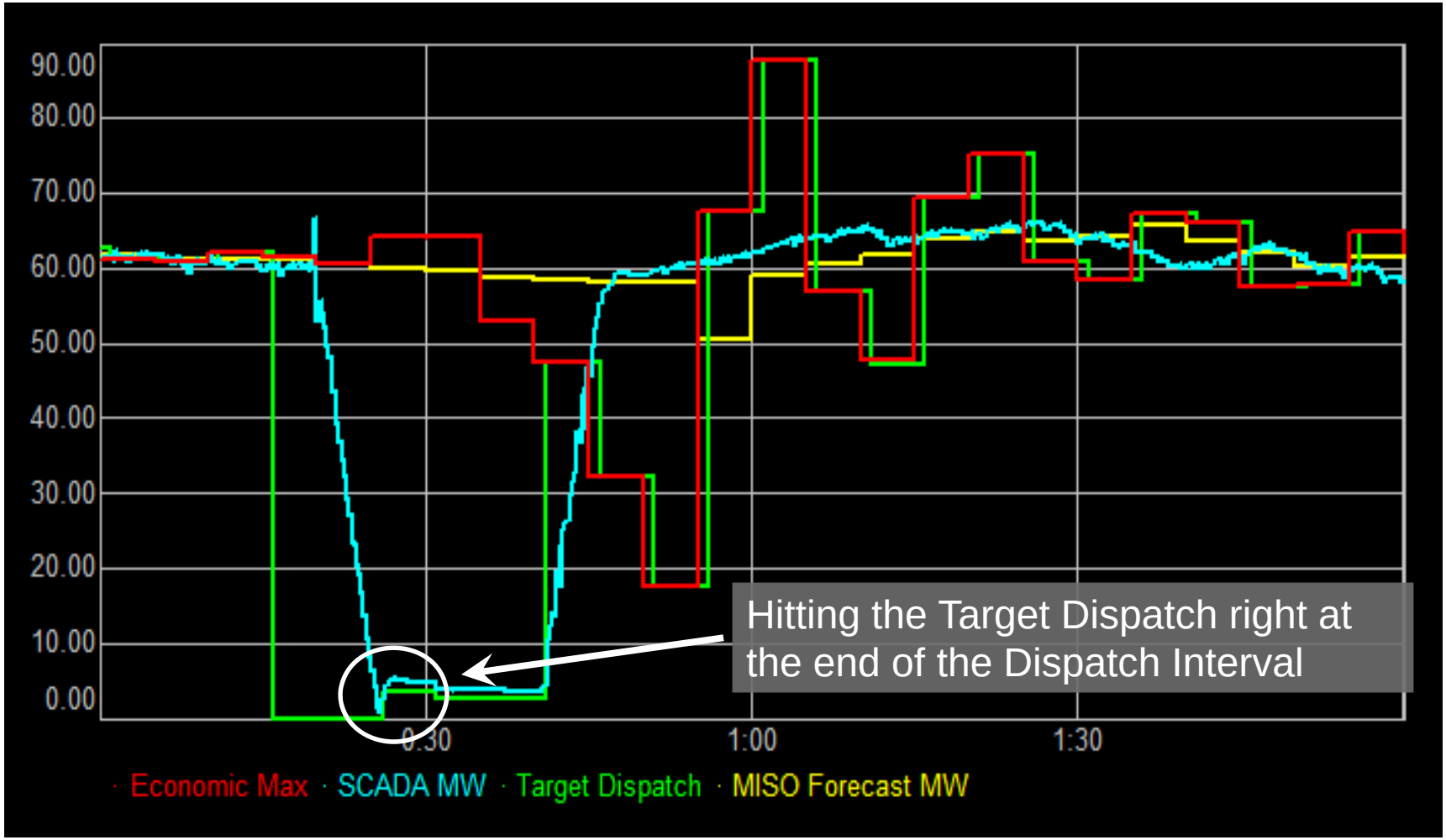
- A new class of generation resources
- Market and settlement treatment very close to conventional generators
- Utilize Forecast Maximum Limit to allow full market participation
- DIR registration required for Resources with “Intermittent” Market Registration
- Same setpoint tolerance as generation resources
- All Resources with “Intermittent” Market Registration subject to RSG for *positive and negative differences* between DA schedules and RT capability

General DIR Market Rules

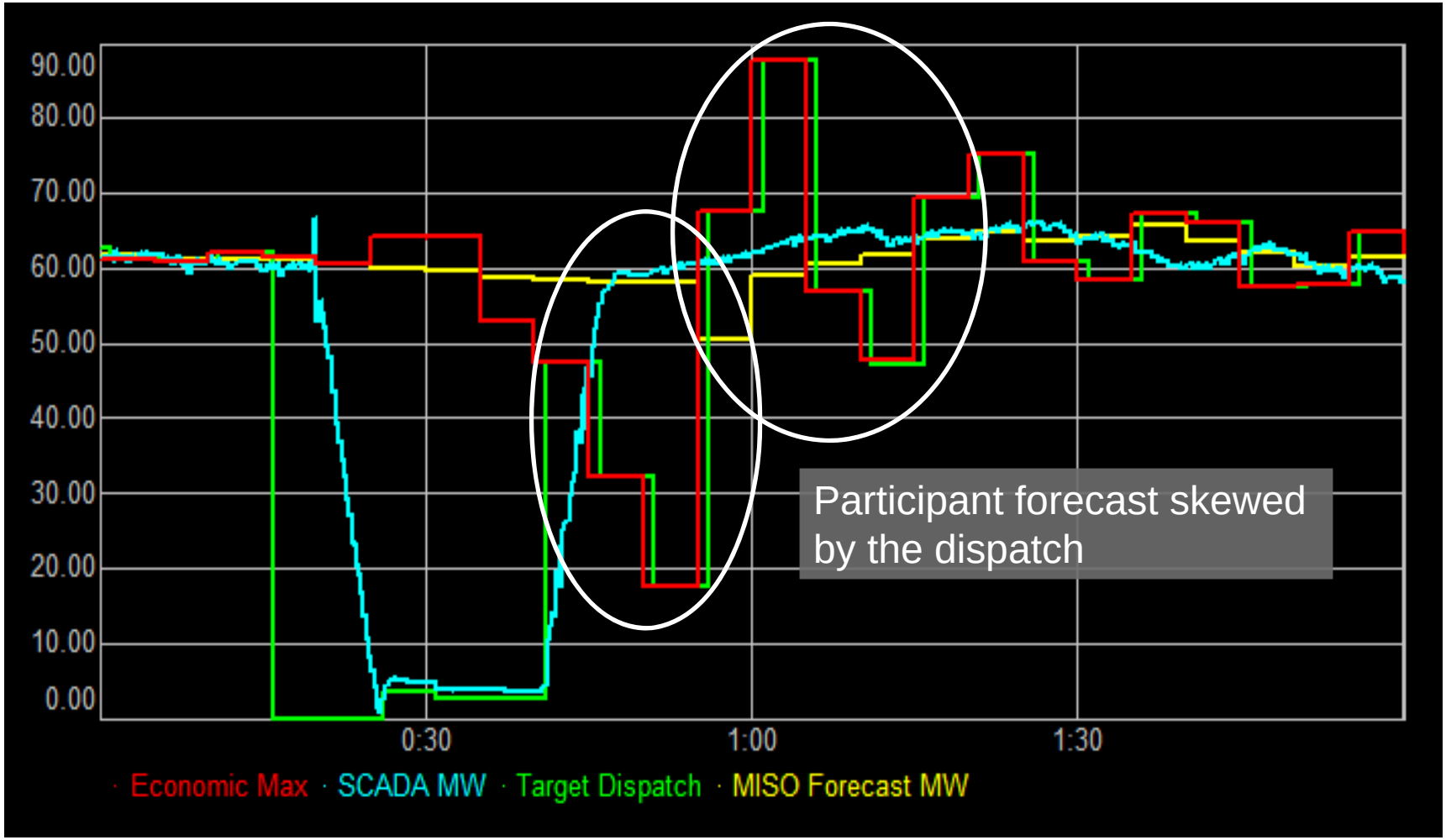
- DIRs are eligible to supply Energy, but not Operating Reserves (Regulating, Spinning, or Supplemental)
- DIRs and traditional generation have same market behavior in Day-Ahead Market (DA)
- Primary difference between DIRs and traditional generation in RT is source of Maximum Limit
  - Participants submitted short term Forecast value
  - MISO generated short term Forecast value
  - Sate Estimator
- DIRs can Self-Schedule Energy (self-schedule will be reduced if greater than RT capability)


DIR's dispatched to EcoMax, 95.2%
Dispatch down - congestion, 3.7%
DIR's Ramp limited, 0.8%
Dispatch Down - low energy demand, 0.2%

Example – (Single DIR – Correct Initial Response)



Example – Continued



Introduction to Proposed Ramp Products

The Ramp Problem

- Maintaining sufficient ramp capability is a significant challenge in operating the MISO system
  - Online capacity may be available but operations must push resource ramp capabilities to meet immediate real-time net load
  - RT-UDS load offset MWs, quick start resources, and other tools are currently used to manage the real-time variations / uncertainties
- Ramp shortages are the most common cause of scarcity
  - Scarcity reflects reduction of real-time robustness / reliability
  - Scarcity pricing has big market impact for short-term ramp issues
- Reliability and economic benefits from reducing ramp-induced events and managing real-time ramp availability
  - Redispatch for ramp flexibility when cost effective
  - Select flexible resources for commitment

Motivation for the proposed Ramp Products

- Operational flexibility is limited within a fleet of resources
  - Flexibility from online resources can be inexpensive compared to committing offline resources
  - Increasing levels of reserve/regulation is an expensive and less efficient approach for managing operational flexibility
  - Market-based incentives will provide efficiency and transparency to obtain additional flexibility from the existing fleet
- Resource mix changes require retention or increase of flexibility to deal with increasing variability and uncertainty
  - Fuel prices making flexible resources less expensive and more heavily loaded can erode available responsiveness
  - Increasing penetration of renewable resources and interchange flexibility require additional ramp capability to ensure reliability

What are the proposed Ramp Products?

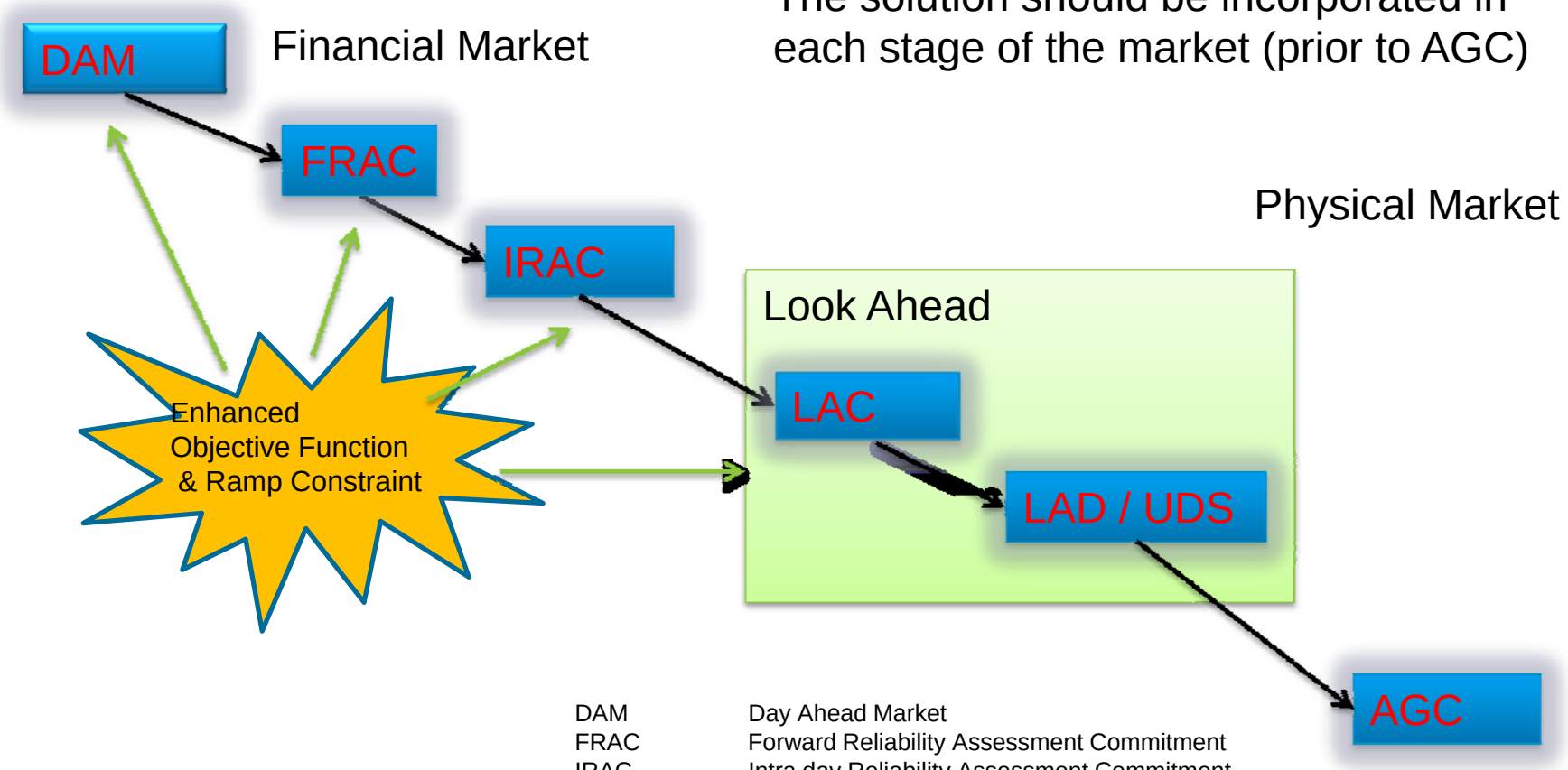
- New products to explicitly manage the ramp available from the controllable generation thru market incentives
- Up and down ramp products reserve a specified level of resource ramp capability to meet RT dispatch variability
  - Ramp requirements vary to support different operating conditions, forecasts, uncertainties, time of day and / or year
  - Ramp products reserve exclusive resource capacity and are co-optimized with energy and Ancillary Service products
  - Cleared ramp for future variations is automatically reduced when ramp capacity is needed to meet requirements in the current RT dispatch interval
  - Ramp product prices determined by resource opportunity cost
    - Ramp prices are expected to frequently be zero when ramp availability is not constrained

What are the proposed Ramp Products? (p.2)

- Ramp products in Commit & Dispatch for DA, RAC, RT
  - Redispatch can create operational ramp cushion reducing the need for real-time commitments
  - Ramp pricing and settlement for transparent market incentives
  - Ramp products are measured similar to today's Market-Wide Ramp-Up and Ramp-Down (Headroom) Capacity Constraints
    - These constraints currently apply only to commitment functions and cost increases are covered by make-whole payments
    - Ramp products would extend these constraints
- Current markets can be extended with minimal impact
  - Existing energy and AS products are not changed (although the interaction of pricing and dispatch may change clearing results)
  - Versatile ramp product formulation is compatible with current markets and future changes such as ELMP and LAD

Market Coverage

The solution should be incorporated in each stage of the market (prior to AGC)

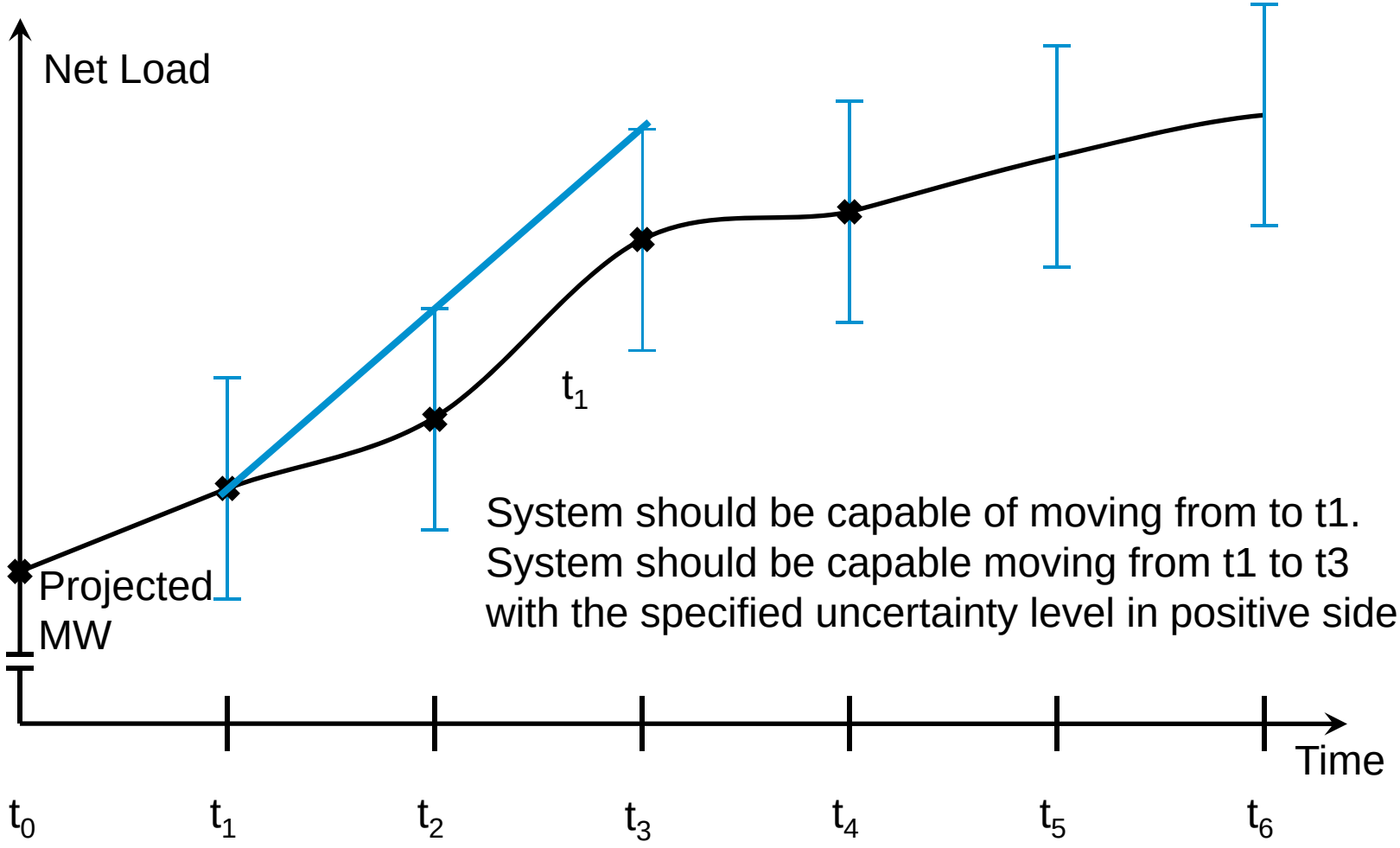


DAM	Day Ahead Market
FRAC	Forward Reliability Assessment Commitment
IRAC	Intra day Reliability Assessment Commitment
LAC	Look Ahead Commitment
LAD	Look Ahead Dispatch (Currently UDS)
AGC	Automatic Generation Control

What Changes from Current Operations?

- Ramp products are designed to support current process
  - Reflect today's operations with a systematic market approach
    - Reduce operator efforts
    - Provide market incentives for participants
- Commitment functions – nothing new
  - Impact is similar to today's Market-Wide Ramp-Up and Ramp-Down Capacity Constraints
- Real-Time Headroom Monitoring – no process impact
  - Will help ensure available capacity has needed ramp flexibility
- Real-Time and Day-Ahead Dispatch – new products
  - New ramp products impact market clearing quantities and prices

Ramp Products in Real Time



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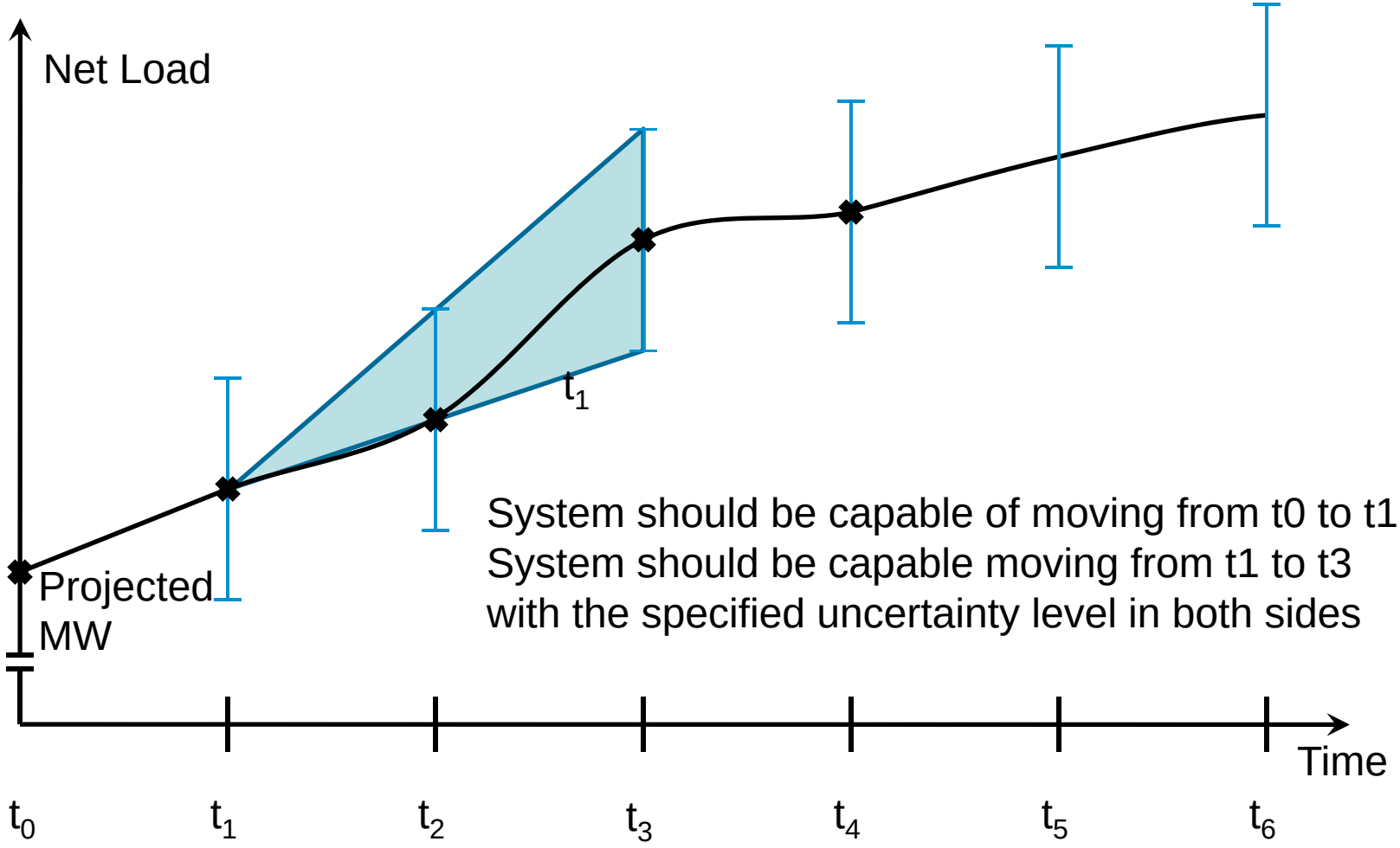

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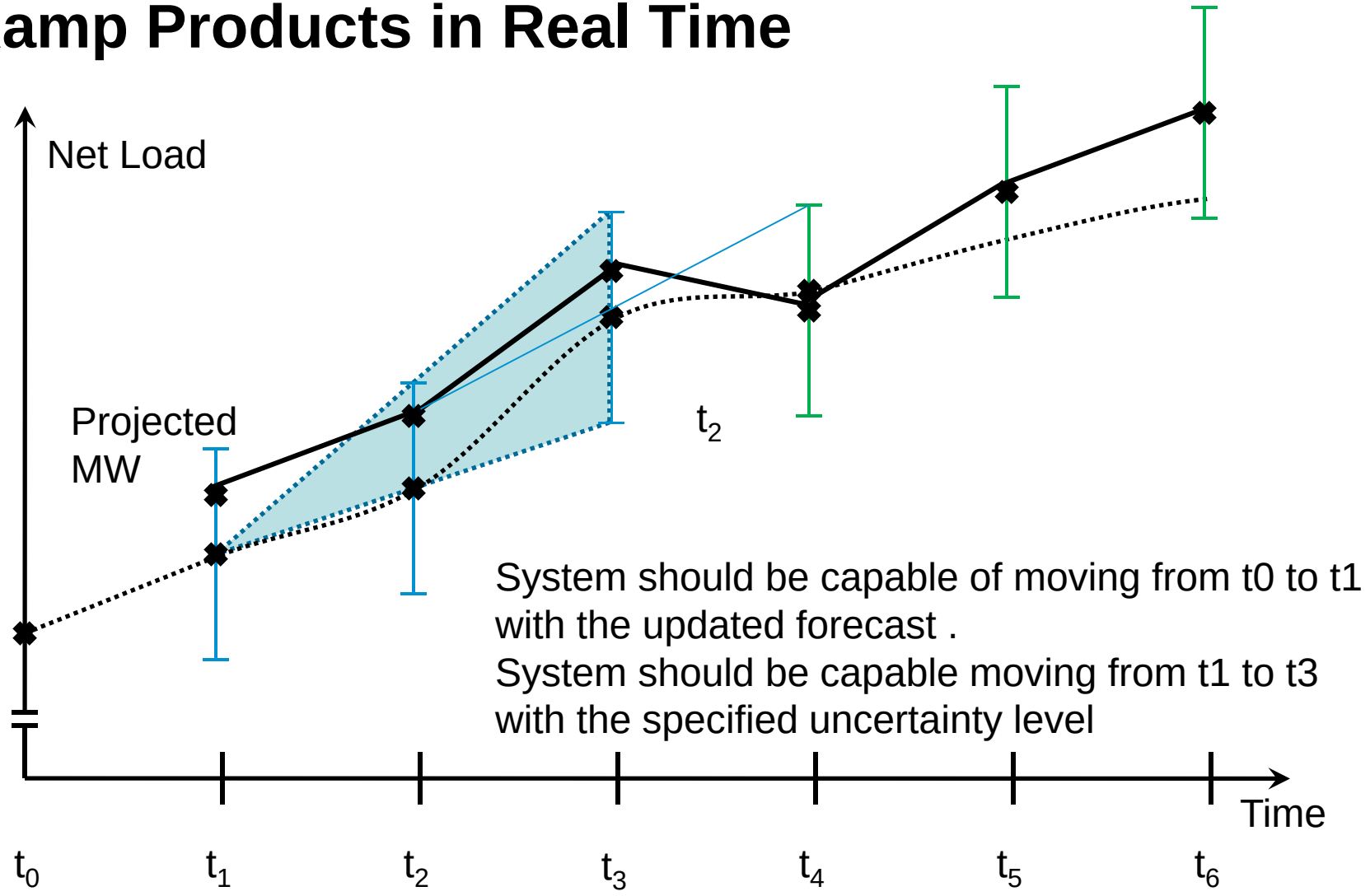

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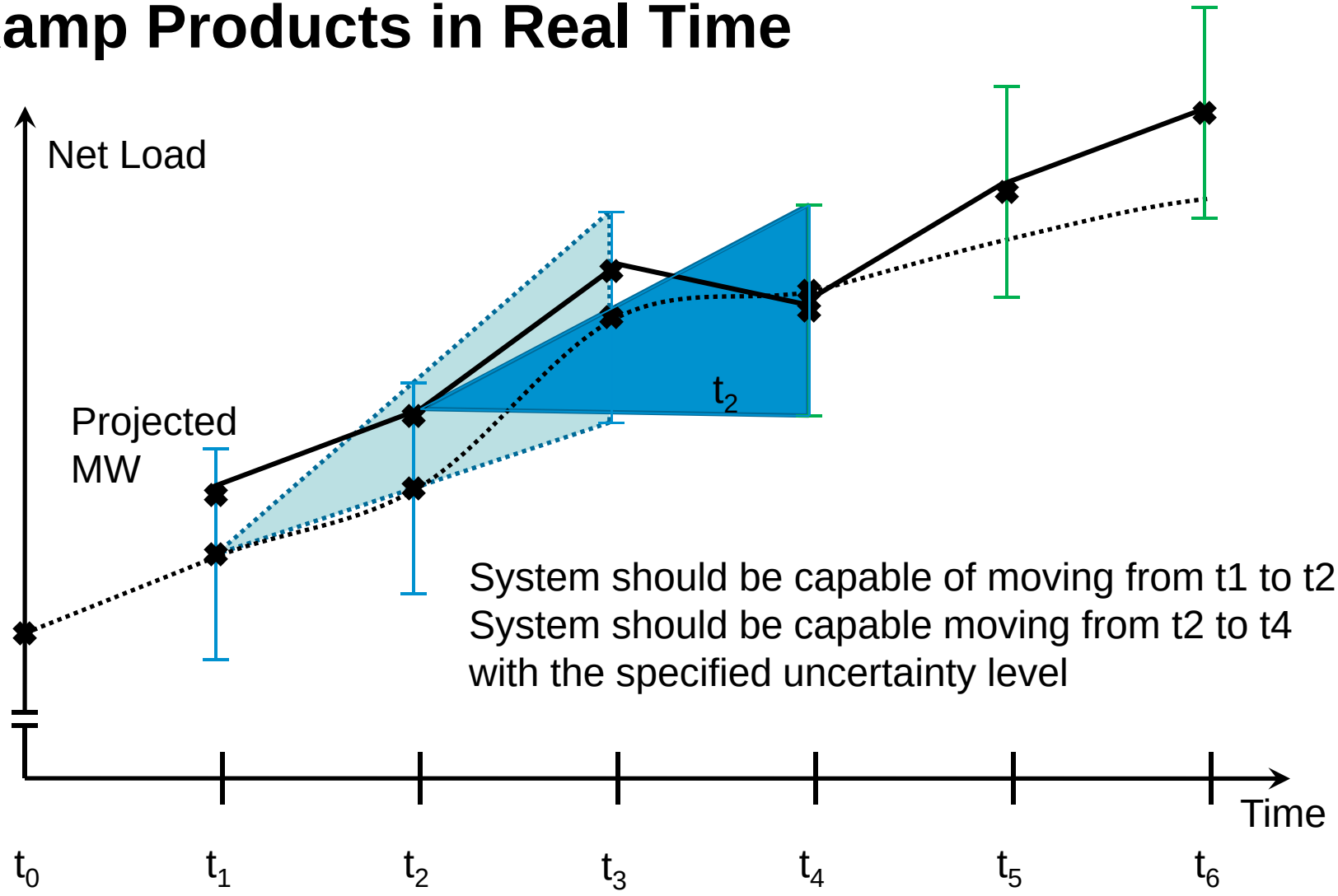
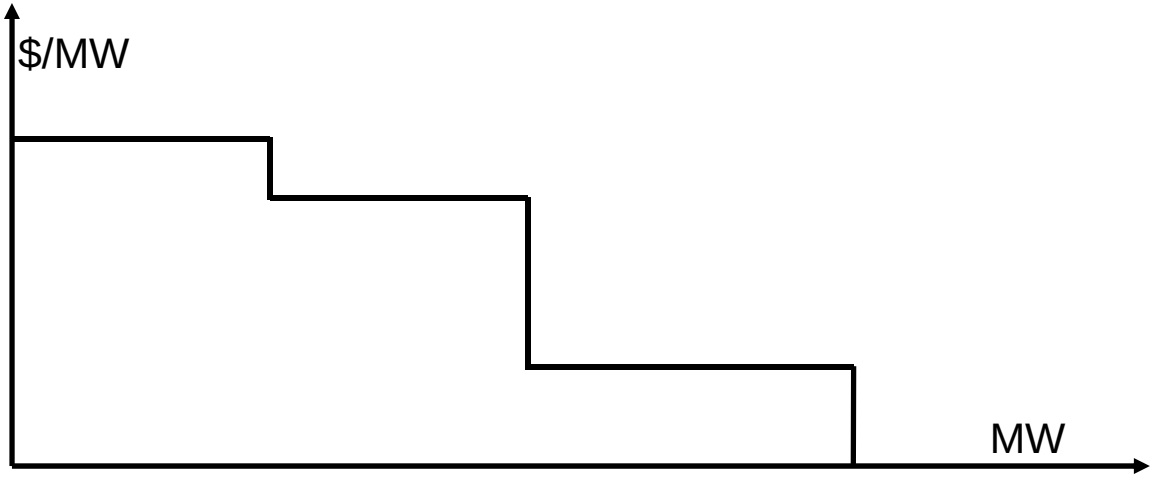


Ramp Product Demand Curves

- Ramp capability acts as a buffer to absorb forecasted and unexpected operational variability
  - Ramp retained in a previous dispatch is available for energy dispatch in the current RT dispatch
- Multi-step demand curve pricing allows automatic tradeoff between reserving ramp capacity for a future interval and using the ramp for current needs



Operational Benefits of Ramp Products

- Reduced instances of short-term ramp-induced scarcity
  - Improved operational reliability
  - Reduce dependence on operator adjustments for short-term variations using ramp products as operational shock absorbers
    - Reduce scenarios requiring CT startup
    - Reduce need for RT UDS delta MW adjustments
- Market transparency providing economic incentives for resources to provide ramp
  - Resources are paid opportunity cost so would not make more money by providing a different product
  - Long-term incentives to offer and potentially improve resource flexibility

Operational Benefits of Ramp Products (p.2)

- Ability to manage operational flexibility needed for increasing penetration of variable energy resources
  - Less expensive and effective alternative to increasing regulation requirements
  - Maximize ability to extract ramp capability from current fleet within limited online headroom
- Maintain ramp flexibility when resource mix changes
  - Changes in relative fuel prices and/or environmental laws can cause difference in operational resource mix (e.g., more gas generation online and priced to be loaded at max)
  - Ramp products bias market commitment toward a more flexible resource available at slightly higher cost
  - Dispatch to maintain ramp capability on fast responding resources when more ramp is needed

MISO

Ramp Products in Day-Ahead and Real Time Markets

Day Ahead Market – Ramp Requirements

- Requirements
  - Up and Down Ramp Capability requirements in Day Ahead Market are based on expected average hourly Real Time needs
    - Addressing variations in ramp requirements arising from forecast errors in NSI, load, intermittent resources, and resource deviations
    - Real Time requirements may vary each interval within the hour
  - Day Ahead ramp capability requirements are estimated based on anticipated Real Time requirements
  - Requirements are identified on system and / or zonal levels
- Resource Participation
  - Eligible resources (dispatchable resources) can clear for Up Ramp and Down Ramp products in Day Ahead Market
  - Self scheduling of ramp products is not allowed in Real Time or Day Ahead Markets

Day Ahead Market – Payments and Charges

- Pricing
  - Dispatch solutions produce Ramp Capability clearing prices for the incremental cost of additional Ramp Capability products
  - Prices include opportunity costs of not providing other products, and demand curves if not fully cleared
- Payments
  - Similar to AS products
  - Awarded Ramp Capability is paid product clearing price
    - Revenues from Ramp Capability included in make whole payment calculation
- Charges
  - Similar to AS products
  - Load charges are increased to compensate for Ramp capability payments to resources (although savings are expected in other areas)

Real Time Ramp Capability Payments & Charges

- Awarded Ramp Capability is paid product clearing price
  - Subject to real-time performance monitoring of allowable deviation
  - Revenues from Ramp Capability included in make whole payment calculation
- Charges for Ramp Capability are similar to other ancillary services (MISO proposal)
  - Load charges are increased to compensate for ramp capability payments to resources, however reduced scarcity pricing, CT commitment, etc. decreases load payments (*causing an overall production cost saving*)
- MISO is exploring alternative charging mechanism (e.g., 80/20)

Cost / Benefit Analysis

Empirical Analysis

Analysis of an actual price spike shows potential for significant benefits using a $10 penalty value.

MISO Alternative Up Ramp Analysis
Spike on January 26, 2011
$10 Cap, No Ramp Capacity Cap

[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]	[K]	[L]
Interval	LMP	Change in LMP[1]	Change in Production Cost[2]	Spin Shortage	Change in Available Spin	Change in Spin Shortage Costs[3]	Up Ramp Left in Original Dispatch	Up Ramp Used in Original Dispatch	Original Total Up Ramp [H] + [I] - [E]	Additional Ramp in New Strategy	Total Up Ramp in New Strategy [J] + [K]
1:00	44.2	0.00	0.00	0	0	0	80	221.1	301.1		301.1
1:05	41.42	0.22	6.63	0	0	0	132.7	134.5	267.2		267.2
1:10	36.6	1.83	64.09	0	0	0	150.6	107.6	258.2	4.1	262.3
1:15	35.68	3.76	142.39	0	0	0	237.9	90.6	328.5	18.3	346.8
1:20	47.28	1.61	3.12	0	0	0	39.9	334.7	374.6	48.4	423
1:25	191.75	-10.75	-2145.01	156.9	13.5	-1105.2	2.7	403.8	249.6	13.1	262.7

Total Production Cost	**-1928.78**
Total Production Cost and Shortage	**-3033.98**
Production Cost Benefit in Spike Interval	**2145.01**
Total Production Cost Benefit in Spike Interval Including Shortage	**3250.21**
Average Production Cost in Non-Spike Intervals	**43.25**
Ratio without Shortage Benefits	**49.60**
Ratio with Shortage Benefits	**75.15**

Questions

- MISO Web Page for Ramp Management
  - www.misoenergy.org/WhatWeDo/StrategicInitiatives/Pages/RampManagement.aspx