

Potential Customer Baselines for the Demand Response Mechanism

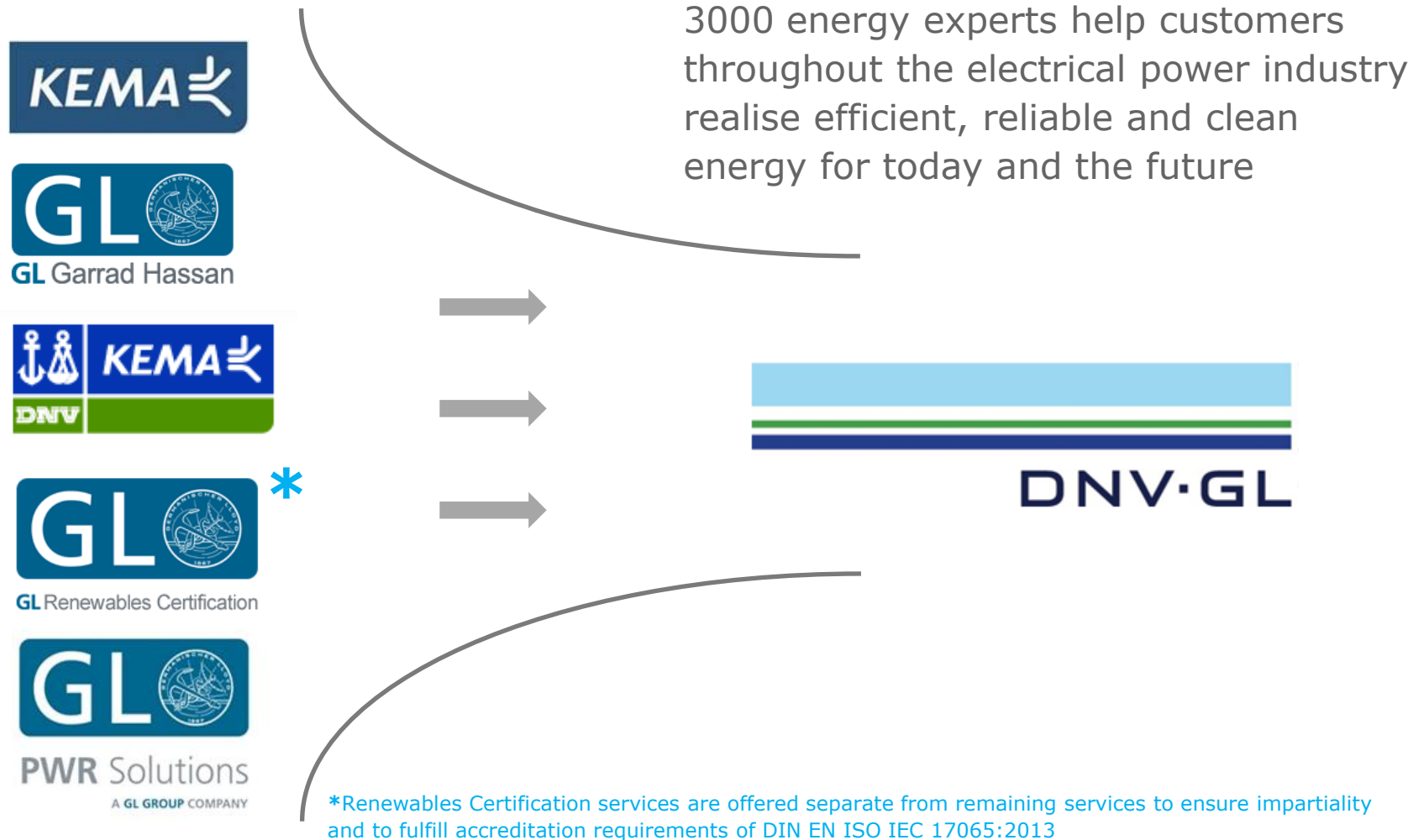
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Agenda

- Introduction to DNV GL - Energy
- Background to the Demand Response Mechanism and Customer Baselines
- Project Requirements from the AEMO
- Phase 1 - Baselines Reviewed from the International Review
- Phase 2 - Testing Customer Baselines with Australian Data
 - Customer Baseline Results
- DNV GL - Energy Project Recommendations

Introduction to DNV GL – Energy - Combined strength to support Energy customers



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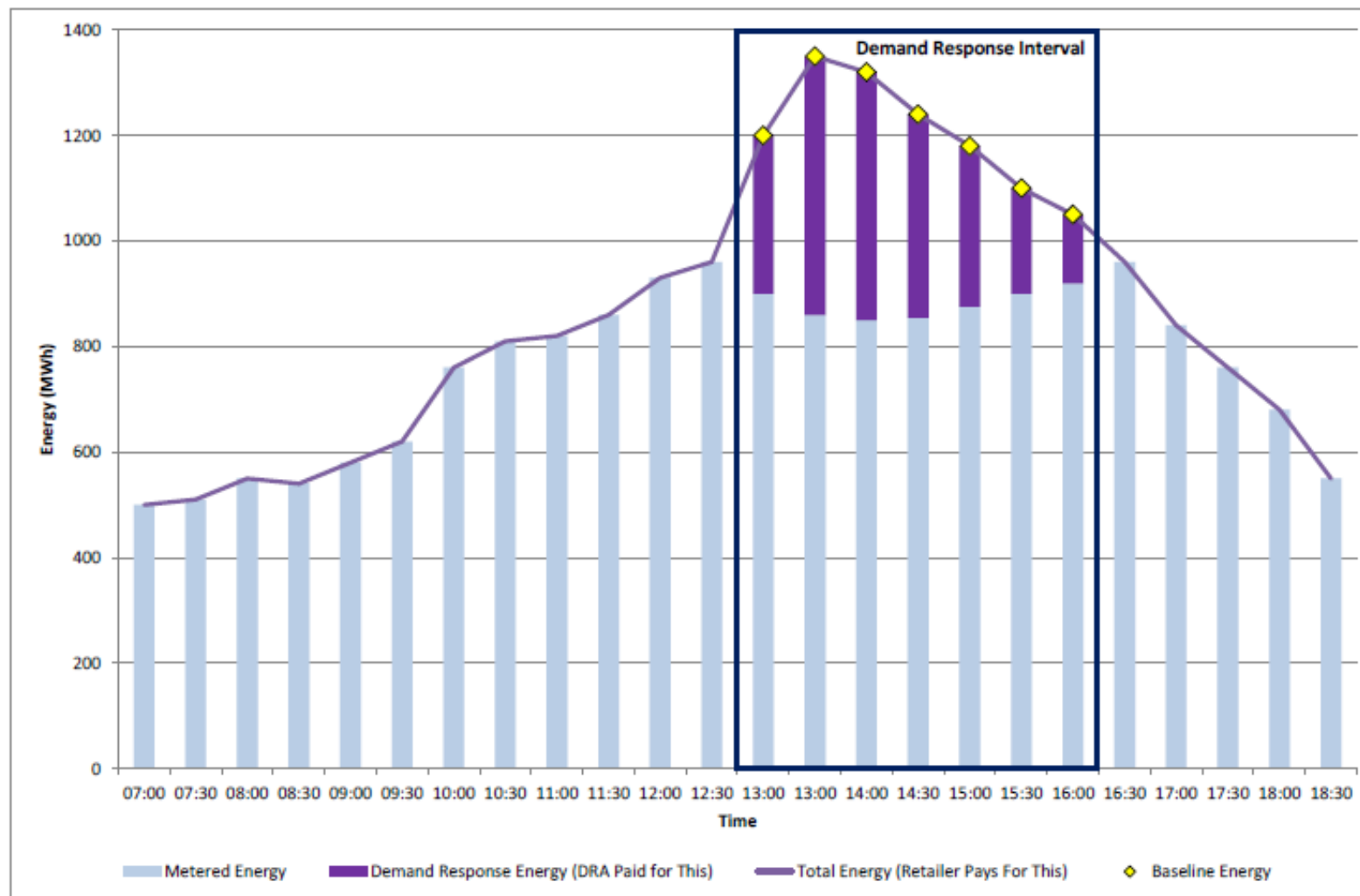
Why do we need a Demand Response Mechanism?

- AEMC in its Power of Choice Report recommended a new Demand Response Mechanism that pays customers via the wholesale market for demand reductions
 - Concern on the current level of demand participation in the market
- Efficiently operating market should incorporate dynamically changing supply and demand. However, under the current market arrangements:
 - Risks and costs result in large consumers choosing not to participate directly
 - Tariffs to reflect risks are feasible, but not attractive
- New DRM will allow consumers to see the value of changing their consumption in line with market signals (wholesale price)
 - Avoids range of costs with direct market participation
 - Leads to efficient consumption in the market
 - Longer term – reduce spot prices and price volatility and benefit all consumers

Proposed Demand Response Mechanism (DRM)

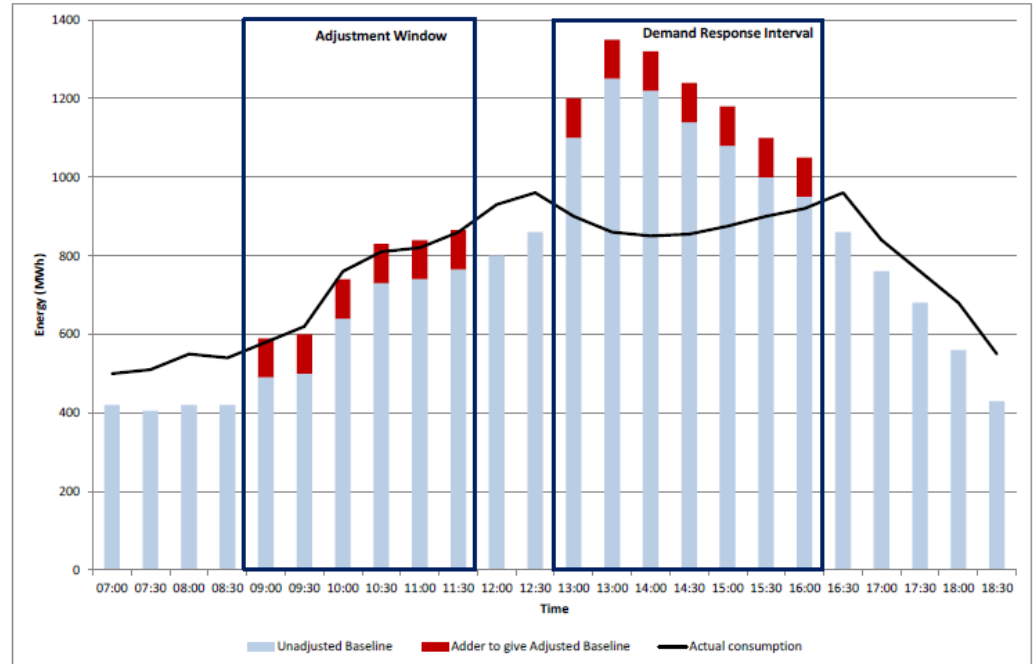
- Proposed demand response mechanism requires customers expected consumption to be predicted (Customer baseline)
 - Customers can choose to reduce demand below this baseline level in response to wholesale prices and their opportunity cost of responding
- Level of demand response is the difference between the customers' actual consumption and what a baseline predicts consumption to have been without demand response
 - Customers will get paid the wholesale spot price for the demand response
 - Retailers are settled in the market according to the estimated baseline consumption not the actual consumption during demand response events
 - Retailer will charge customer using this baseline profile
- Expected that a Demand Response Aggregator will act as an agent for a number of customers
 - Responsible for scheduling of the demand response
- AEMO have produced a detailed design for this mechanism in 2013

Operation of the Demand Response Mechanism (slide from AEMO Detailed Design)



What is the Customer Baseline?

- Customer baseline is the forecast of consumption without any demand response
 - Accurate baseline will be key to successful operation of the market
- Likely to consist of 2 elements
 - Baseline consumption over the longer period
 - Baseline adjustment to reflect customer consumption prior to the event
- Statistical methods needed to test the baselines
 - May end up excluding some highly variable loads



Picture sourced from AEMO Detailed Design

AEMO Project Requirements

- Purpose

- How has DRM and baseline consumption methodology been implemented in other electricity markets;
- Identify components of DRM and baseline consumption methodology that perform well and those that need improvement in other electricity markets;
- What lessons can be learnt to advise AEMO on the development of the baseline consumption methodology for the DRM implementation in the NEM; and
- Test the efficacy of potential baseline consumption methodology options using customer data provided by NEM

- Phases Approached

- Phase 1 included research into the baseline methodologies applied in the US where there are successful implementations
- Phase 2 involves using regional specific data to test the efficacy of potential baseline consumption methodologies for consideration in NEM

Overview of Baseline Methodologies

- The most common type of baseline, the "X of Y" baselines:

ISO	Average of	Out of
CAISO 10-in-10	10 most recent weekdays	10 most recent weekdays
ERCOT Mid 8-of-10	10 most recent weekdays, dropping highest and lowest kWh days	10 most recent weekdays
MISO 10-in-10	10 most recent weekdays	10 most recent weekdays
NYISO	5 highest kWh days	10 most recent weekdays
PJM	4 highest kWh days	5 most recent weekdays

Note: These are generalizations of the weekday baseline calculation. Weekend baselines are calculated in a similar nature, but generally require fewer days (e.g., 4 most recent weekend days).

Overview of Baseline Methodologies (cont.)

- ISO-NE 90/10
 - Consists of a weighted average of the preceding day's baseline (90%) and the current day's actual metered load (10%)
 - The baseline is updated on every non-event weekday
 - On (weekday) event days, the baseline is defined as the previous day's baseline
- ERCOT – Choice of Options available as well as 'X of Y'
 - Regression model to predict consumption
 - The explanatory variables in the model including calendar variables, weather variables and daylight variables
 - Matching Day Pair
- Baseline Adjustment
 - Most of the baselines included a 'day of adjustment'
 - Mixture of multiplicative (with and without cap) and additive

US Baseline Methodology Selection and Challenges

- Reasons for selecting baselines:
 - Empirical performance
 - Administrative burden / simplicity of implementation
 - Minimize gaming/free-ridership
 - Looked to other ISOs with experience / precedence
 - Consistency with NAESB
- Challenges, when selecting:
 - Getting everyone to agree on one baseline (weighing simplicity vs. accuracy)
 - Industry had little or no experience with baselines
- Challenges, now implemented:
 - Large volumes of data to store
 - Methods are somewhat sophisticated and hard for participants to understand
 - Computationally intensive to evaluate all choices for each customer
 - Determining an accurate baseline for customers with highly variable loads

Gaming and Customer Baselines Responses

- ISOs do have concerns about paying participants for something they would already be doing (free-ridership)
- One ISO observed gaming issues:
 - As season changed and loads were decreasing due to weather, participants locked in high baselines from high usage season, and then bid load when consumption was naturally low
 - Turned off behind-the-meter generator during baseline period, turned it back on during DR event
- Participants are sophisticated, the rules need to be VERY clear
- Concerned about gaming the adjustment period
 - Harder to catch than gaming the baseline period
- Solutions have been to change the market rules and/or the baseline methodology

Phase 2 – General Approach

- Dataset of 10,000 customers was provided with a random sample of 2,500 customers to make the analyses runs more manageable
 - Removed highly variable customers and those below 175kW MD
- Selected baselines were calculated and compared for each of the selected customers for all days (approximately 66 million baselines)
- “Candidate” event days were identified based on system load conditions, regional weather conditions, and localized price
- Summary statistics for the candidate baselines were developed and ranked for each of the candidate baseline (overall and by segment) based on three criterion:
 1. **Accuracy** – How closely a baseline method predicts resource actual loads in the sample
 2. **Bias** – The systematic tendency of a baseline method to over- or under-predict actual loads
 3. **Variability** – The measure of how well the baseline is at predicting hourly load under many different conditions and across many different customers

Results – Overall Accuracy

- How closely a baseline method predicts resource actual loads in the sample
- Metric: Median of the relative root mean squared error (RRMSE)
- A baseline for a typical customer with a median RRMSE of 0.10 is one where that baseline could expect to have a half-hourly error, on average of 10% of their actual load
- The smaller, the better**

Baseline Type	PJM H4 of 5	Middle 4 of 6	PJM Comp Day	PJM Same Day	PJM WeathSens	ISONE	CAISO 10 of 10	Weekends	Weekend M2 of 4	Weekend H2 of 3
Unadjusted Baseline	0.143	0.151	0.146	0.141	0.142	0.149	0.151	0.187	0.197	
Additive Adjustment	0.107	0.108	0.127	0.142	0.123	0.101	0.103	0.136	0.141	
Multiplicative Adjustment	0.109	0.110	0.132	0.142	0.127	0.102	0.103	0.137	0.139	
Multiplicative Adjustment (Cap)	0.111	0.114	0.135	0.143	0.126	0.106	0.109	0.143	0.145	

Color coded, green = good, rank over all rows combined. Weekend baselines are colorcoded independently.

Results – Overall Bias

- The systematic tendency of a baseline method to over- or under-predict actual loads
- Metric: Median of the Average Relative Error (ARE)
- A median value of 0 would indicate that the typical customer in the sample had no systematic tendency to over- or under-predict loads using that baseline
- The closer to 0, the better

Baseline Type	PJM H4 of 5	Middle 4 of 6	PJM Comp Day	PJM Same Day	PJM WeathSens	ISONE	CAISO 10 of 10	Weekends	Weekend M2 of 4	Weekend H2 of 3
Unadjusted Baseline	0.003	0.030	0.013	0.055	0.004	0.039	0.034	Weekends	0.027	0.025
Additive Adjustment	0.008	0.000	0.003	0.013	0.004	0.000	0.000		0.000	0.008
Multiplicative Adjustment	0.009	0.001	0.007	0.013	0.007	0.001	0.001		0.002	0.012
Multiplicative Adjustment (Cap)	0.005	0.007	0.003	0.036	0.001	0.006	0.007		0.011	0.014

Color coded, green = good, rank over all rows combined. Weekend baselines are color coded independently.

Results – Overall Variability

- The measure of how well the baseline is at predicting hourly load under many different conditions and across many different customers
- Metric: Relative Error Ratio (RER)
- The smaller the median RER, the less variable the baseline's error is for the typical customer, and therefore the better the baseline performs across a wide variety of circumstances

Baseline Type	PJM H4 of 5	Middle 4 of 6	PJM Comp Day	PJM Same Day	PJM WeathSens	ISONE	CAISO 10 of 10	Weekends	Weekend M2 of 4	Weekend H2 of 3
Unadjusted Baseline	0.142	0.146	0.144	0.102	0.141	0.140	0.144	0.182	0.191	
Additive Adjustment	0.106	0.107	0.126	0.120	0.122	0.101	0.103	0.133	0.139	
Multiplicative Adjustment	0.108	0.109	0.131	0.120	0.127	0.100	0.102	0.136	0.137	
Multiplicative Adjustment (Cap)	0.110	0.113	0.135	0.115	0.125	0.104	0.107	0.140	0.143	

Color coded, green = good, rank over all rows combined. Weekend baselines are color coded independently.

Customer Segmentation Results

- Segmentation by Size
 - Baseline for smaller and larger customers only slightly less accurate
- Segmentation by Load Variability
 - Unsurprisingly accuracy diminishes with increased variability
- Weather Sensitivity
 - Same day adjustment factors improve all customer baselines

Weather Sensitive	Baseline Type										
		PJM H4 of 5	Middle 4 of 6	PJM Comp Day	PJM Same Day	PJM WeathSens	ISONE	CAISO 10 of 10	Weekends	Weekend M2 of 4	Weekend H2 of 3
Not Weather Sensitive	Unadjusted Baseline	0.097	0.100	0.099	0.100	0.115	0.099	0.099	Weekends	0.116	0.114
	Additive Adjustment	0.086	0.085	0.102	0.108	0.105	0.081	0.082		0.100	0.104
	Multiplicative Adjustment	0.087	0.088	0.106	0.108	0.108	0.082	0.084		0.103	0.105
	Multiplicative Adjustment (Cap)	0.087	0.087	0.101	0.108	0.108	0.082	0.083		0.101	0.106
Weather Sensitive	Unadjusted Baseline	0.171	0.177	0.163	0.148	0.153	0.175	0.176	Weekends	0.213	0.209
	Additive Adjustment	0.136	0.137	0.159	0.189	0.151	0.127	0.130		0.160	0.163
	Multiplicative Adjustment	0.141	0.142	0.168	0.189	0.161	0.130	0.132		0.171	0.168
	Multiplicative Adjustment (Cap)	0.137	0.140	0.155	0.178	0.151	0.130	0.133		0.168	0.165

Color coded, green = good, rows are ranked within each category. Weekend baselines are color coded independently.

Observations and Recommendations I

Observation	Recommendation
<ul style="list-style-type: none"> ▪ The level of baseline complexity is one of the key drivers of demand response adoption and activity; the more complex the baseline method, the less likely the demand response mechanism will attract resources to participate 	<ul style="list-style-type: none"> ▪ Next to accuracy, administrative and other factors are important considerations in determining the final CBLs <ul style="list-style-type: none"> – Empirical results for non-variable load customers are similar, it is important to understand the administrative cost and other factors in the final decision ▪ Scalability of systems and processes should be considered
<ul style="list-style-type: none"> ▪ Most US ISOs have preferred to start with simpler baseline methods, and some have performed evaluations of baselines as they have gained experience with their demand response mechanism. 	<ul style="list-style-type: none"> ▪ AEMO should proceed slowly implementing the DR market in increments <ul style="list-style-type: none"> – Start simple and gain some practical experience before opening up the market to a wider array of baseline offerings
<ul style="list-style-type: none"> ▪ Gaming is an ongoing concern of the ISOs and has been observed in a few instances 	<ul style="list-style-type: none"> ▪ Strategic behaviour in the market to artificially inflate the CBL should not be permitted <ul style="list-style-type: none"> – Any CBL can be manipulated to the market participant's economic advantage, and it is recommended that rules be established to identify and mitigate this behaviour

Observations and Recommendations II

Observation	Recommendation
<ul style="list-style-type: none"> ▪ For weekdays, the ISO-NE and CAISO 10-of-10 had the best overall performance, followed closely by the Middle 4-of-6 and PJM Economic (High 4-of-5) ▪ For weekends, the Middle 2 of 4 performed better than the High 2 of 3 	<ul style="list-style-type: none"> ▪ We recommended implementing DRM using two baseline methodologies to start <ul style="list-style-type: none"> – One for weekdays, one for weekends – Choice of weekday depends on relative importance of ease of operation and accuracy – Start simple and gain some practical experience before opening up the market to a wider array of baseline offerings <ul style="list-style-type: none"> – However, experience does show that allowing the demand response aggregator to choose the baseline does not create undue or inappropriate results
<ul style="list-style-type: none"> ▪ The additive and multiplicative adjustments provide significant improvement to the unadjusted baselines 	<ul style="list-style-type: none"> ▪ Utilizing an additive adjustment is recommended <ul style="list-style-type: none"> – Potential for greater susceptibility of multiplicative adjustments to gross inaccuracies
<ul style="list-style-type: none"> ▪ None of the baselines perform very well for the highly variable loads, especially in terms of accuracy and variability 	<ul style="list-style-type: none"> ▪ Highly variable load customers should be segmented for the purpose of applying a different CBL or market rule <ul style="list-style-type: none"> – Some experimentation by PJM with alternative baselines



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