APRIL 22, 2021

Resource Adequacy Engagement

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Agenda

- Discussion of mid-term Resource Adequacy needs and mechanism
- Capacity Auction
  - Capacity Auction process and administrative enhancements planned for the 2021 auction
  - Draft scope for hourly demand response baseline methodology review
  - Draft, high-level 2021 stakeholder engagement plan for Capacity Auction enhancements
- Recap and Next Steps

Resource Adequacy Framework Mid-term Recap

Shawn Cronkwright, Director, Reliability Assurance

Short-term Needs and Mechanism

- The annual Capacity Auction is the mechanism for satisfying short-term capacity needs
- Capacity procured can be adjusted year-to-year based on system needs above any minimum capacity floor quantities
- Separate floor quantities may be established for summer and winter periods

Mid-term Needs

- System needs emerging in the latter half of the decade
- Many facilities with contracts expiring and remaining useful life of assets
- Opportunity to enable these resources to compete to secure new mid-term contracts
- Energy production requirement is still to be determined, and expected to be at least 4 hours

Mid-term Mechanism

- An RFP is a well-proven tool to address approaching mid-term needs
- Alternative mechanisms, such as a multi-year capacity auction, may be explored in the future but would require extensive design and stakeholder engagement. We expect to need to use a mid-term mechanism sooner than that.
- The plan is to proceed with an RFP for the mid-term mechanism to address needs emerging as a result of resources coming off contract

Mid-term Mechanism (continued)

- Expectation of a new contract for the mid-term mechanism
- Resources expected to participate in the energy market as applicable,
  - The Market Renewal project is expected to be implemented by the time resources would be required to provide capacity
- RFP proponents will be expected to compete for a new mid-term contract, with an anticipated 3-year term

Mid-term Mechanism (continued)

- Competition will help ensure value for ratepayers
- It may also mean that not all existing facilities with expiring contracts will be successful in securing a new mid-term contract
- Unsuccessful proponents will be able to compete in successive capacity auctions until any subsequent mid-term opportunities arrive

Annual Acquisition Report (AAR)

- Important to get the AAR published to provide a forward look at upcoming needs and proposed actions to address the needs
- Targeting to have the first AAR published by the end of June
- 2021 AAR will be focused in its content, recognizing the need to establish the foundation and allow subsequent procurement activities to progress
- IESO welcomes stakeholders' review of the full report, and will be actively seeking feedback and suggestions for improvement in subsequent iterations

Capacity Auction

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Capacity Auction process and administrative enhancements planned for the 2021 auction

Adam Butterfield, Senior Manager, Resource Development & Procurement

Agenda

- Recap of February 2021 webinar including stakeholder feedback & IESO responses
- Stakeholder feedback requests and next steps

Recap of Initial List of Improvements

February 23, 2021 Webinar – Recap

During the webinar, the IESO announced that it would be undertaking the following administrative improvements ahead of the December 2021 auction:

- Clarifying language in Market Rules and Manuals based on feedback received during 2020 Capacity Auction pre-auction period
- Enhancing the Training Workbook and making it available earlier in the pre-auction period
- Hold training sessions earlier, prior to any pre-auction deadlines, to ensure participant understanding before key milestones have passed

February 23, 2021 Webinar - Feedback Requests

- Stakeholders were asked to provide feedback on:

  Based on your Capacity Auction Experience:

  - **What worked well and what could be improved?**
  - **What could be made more efficient? Were there gaps?**
  - **What learnings can be applied in Ontario from experiences in this auction and/or other capacity auctions?**

- The IESO received written feedback from two stakeholders in addition to verbal feedback received during the webinar

Feedback Theme: Enhance Guidance Documents

Stakeholder Feedback:

- More clarity desired on IESO contact roles and their responsibilities
- Greater clarity on post-auction period activities (forward period and obligation period)

Feedback Theme: Enhance Guidance Documents (2)

IESO Response

- The IESO is taking steps to provide more clarity and is working on publishing a guidance document that summarizes all contact roles in Online IESO and their associated responsibilities
- We will also enhance the Capacity Auction training guide with information regarding forward period and obligation period activities

Feedback Theme: Market Rule Changes

Stakeholder Feedback

- Amendments suggested to Capacity Auction point-in-time rules, prudential support and post-auction reporting

IESO Response

- The IESO will not be adding these proposed changes to the list of improvements for the 2021 auction as they require more time for consideration and stakeholder engagement than is available in advance of the next auction

Stakeholder Feedback Outcomes

- Feedback received did not lead to additional changes to the Market Rules and Market Manuals for the 2021 Capacity Auction beyond the initial list of administrative improvements presented in Feb. 2021
  - Much of the feedback received can be addressed through enhancing IESO participant training and guidance documents
  - Some feedback encouraged the IESO to consider further Market Rule changes; these changes would require more time for IESO assessment and stakeholder engagement than is available before the 2021 Capacity Auction, but are being examined for future consideration

Supporting Materials

- The following documents have been posted on the website with more information:
  - Full IESO responses to stakeholder feedback
  - A summary document of changes along with draft Market Rule and Manual amendments

Draft Market Rule Clarifications

The following Market Rule clarifications are being proposed:

Clarification	Market Rule Chapter
Definition of capacity auction eligible import resource clarified to specify MWs must be non-committed	Ch. 11
Clarity added to specify that if eligibility requirements not satisfied by first day of obligation period, both deposit and obligation may be forfeited	Ch. 7

Draft Market Manual Clarifications

The following Market Manual clarifications are being proposed:

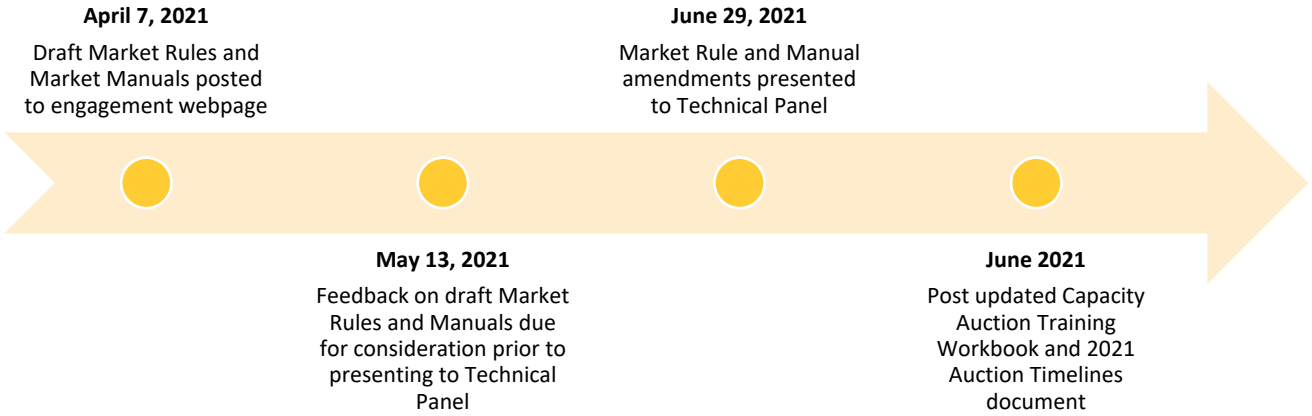
Clarification	Market Manual
Registration requirement that the CMP must be the owner of the capacity auction resource	Market Manual 12
General clarity added to registration requirements for physical and virtual hourly demand response resources	Market Manual 12
Application of the capacity charge for all resource types (on test activations)	Market Manual 12 Market Manual 5, Part 5.5
Effective period of obligation transfers	Market Manual 12
Ability to revise auction offers during offer window	Market Manual 12

Stakeholder Feedback on Market Rules and Manuals

- Written feedback on the draft Market Rules/Manual documents can be provided to engagement@ieso.ca using the feedback form on the engagement web page by May 13.
- Please use the feedback form provided to ensure stakeholder feedback is compliant with the Accessibility for Ontarians with Disabilities Act (AODA). If you choose not use the IESO feedback form, please provide an AODA compliant pdf document.

Next Steps

- Stakeholder feedback received on the draft Market Rules/Manual documents will be used to identify further clarification/clean-up items prior to the June 2021 Technical Panel meeting



Draft scope for hourly demand response baseline methodology review

Emma Ferner, Advisor, Demand Response Market Development

Tom Aagaard, Supervisor, Demand Response Market Development

Purpose

- To present the scope of the analysis that will assess the performance of the current "High 15 of 20 with in-day adjustment" baseline methodology for Commercial & Industrial (C&I) Hourly Demand Response (HDR) resources relative to alternative methodologies
- To seek stakeholder feedback on key study design elements and additional considerations relevant to an Ontario-specific analysis

Relationship to CA Enhancement Objectives

- This initiative is aligned with the Capacity Auction (CA) design enhancement objective of **Improving Performance**
- HDR baseline methodology changes are not part of the currently proposed Capacity Auction enhancements however, this initiative could inform future proposed changes that would enhance the reliability and market performance of acquired HDR resources

Objective

- To provide a statistical evaluation of how effectively different baseline methodologies predict load in absence of a DR event, in order to:

1. Respond to strong stakeholder interest for a review of the effectiveness of the C&I HDR baseline;
2. Ensure assessment of DR resources participating in the IESO-Administered Markets (IAMs) is reflective of performance; and
3. Inform future discussions on HDR resource design and capacity market enhancements as applicable

Background

- In early 2021, the IESO worked with stakeholders through the Demand Response Working Group (DRWG) to establish a prioritized list of demand response (DR) market development initiatives
- The list includes a review of the current 'high 15 of 20 with in-day adjustment' baseline methodology for C&I HDR resources
- The IESO has not reviewed the C&I HDR baseline methodology with stakeholders since the launch of the HDR market participation model
- Stakeholders have communicated that an evaluation of the current baseline methodology, particularly the impact of the in-day adjustment, is a priority to ensure fair performance assessment

Background (cont'd)

- Stakeholders have identified specific scenarios where they believe the current methodology misrepresents or creates opportunities to misrepresent load in the absence of an activation
- The review will build on work conducted in 2020 exploring whether the in-day adjustment factor (IDAF), as part of the baseline determination, should be revised to better reflect consumption patterns of certain loads
- A scan of baseline methodologies used in other electricity markets was also conducted to inform what baselines may be appropriate for Ontario

Overview of Proposed Analysis Approach

- IESO reviewed similar baseline assessment studies in other ISO/RTOs to inform the scope of an Ontario-specific analysis (see Appendix)
- Historical HDR consumption data will be used to predict load on proxy event days[1] for a range of baseline methodologies
- Estimated load and actual load on each proxy event day will be used to construct performance metrics that will enable a comparison of the relative accuracy of each baseline
- Baselines will also be qualitatively assessed for simplicity and integrity

[1] Proxy event days are days on which no DR curtailment occurs and load is known, meaning estimated load can be compared to actual load in order to assess baseline performance.

Proxy Event Days

- IESO proposes to leverage the definition of a Suitable Business Day (SBD)[1] to construct a set of proxy event days for analysis
- IESO proposes to estimate load for all availability window hours during the summer and winter obligation periods
  - The availability window is defined as hour ending (HE)13 to HE21 during the summer obligation period (May 1 – Oct 31), and HE17 to HE21 during the winter obligation period (Nov 1 – April 30)

[1] SBDs are any business days where a C&I HDR resource has placed at least one demand response energy bid (as defined in Chapter 11 of the Market Rules) for at least one hour within the availability window for the day; and, was not activated to provide DR

Data Selection

- Up until April 30, 2020, Demand Response Market Participants (DRMPs) were required to submit HDR consumption data on a monthly basis
- IESO proposes to use this historical interval data to assess two summer and two winter commitment periods (May 1, 2017 - April 30, 2019)
- Assessment is proposed to be conducted at the resource-level, given contributor-level data is limited to what is collected for audit purposes

Baselines to be Assessed

- IESO proposes to compare Ontario's existing baseline to 4 alternative baselines that are commonly used in other jurisdictions (see next slides)
- 5 variations of each baseline will be assessed including an unadjusted version and 4 other in-day adjustment versions (see next slides)
- 5 variations for each of the 5 baselines (including the current High 15 of 20) will be assessed for a total of 25 baseline methodology assessments
- IESO proposes to exclude regression-based baselines due to poor alignment with key principles of baseline development (e.g. simplicity)

Baselines to be Assessed (cont'd)

Baseline	Description
Ontario Standard	High 15-of-20 most recent qualifying days in the last 35-day business days
PJM Economic	High 4-of-5 most recent qualifying days with a 45-day lookback period
NYISO Standard	High 5-of-10 most recent qualifying days with 30-day lookback period
ERCOT Standard	Middle 8-of-10 most recent qualifying days over a 10-day lookback/forward period
Mean 10-of-10 (CAISO/ISO-NE/MISO)	Mean 10-of-10 most recent qualifying days with 45-day lookback period

Baselines to be Assessed (cont'd)

- 5 variations of each of the 5 baselines will be assessed, as follows:

Variation	In-Day Adjustment	Description
1.0	Unadjusted	Assess baseline performance with no in-day adjustment factor
2.0	Current IDAF	3 hours ending 1 hour prior to the start of the first dispatch hour
3.0	Shifted IDAF	3 hours ending 3 hours prior to the start of the first dispatch hour
4.0	Scalar Uncapped IDAF	Current IDAF, uncapped (adjustment not capped at 80% - 120%)
5.0	Additive Uncapped IDAF	Current IDAF, uncapped with additive rather than scalar adjustment

Assessment Criteria

- The North American Energy Standards Board (NAESB) Business Practice Standards for Measurement and Verification for DR provide a structure for designing performance evaluation methodologies that support fundamental criteria, including accuracy, simplicity, and integrity
- In this analysis, accuracy will be evaluated based on the performance metrics outlined in the following slide
- Simplicity (low administrative burden, high reproducibility) and integrity (low opportunities for gaming) will also be considered qualitatively

Performance Metrics for Accuracy

- IESO proposes to use three standard performance metrics to assess baseline accuracy (see Appendix for example calculations/interpretation)

Metric	Description	Calculation Method
Accuracy	How closely a baseline method predicts a resource's actual load on a proxy event day	Relative Root Mean Squared Error: the root of the mean squared errors divided by the average load during the event period (see Appendix for detailed description)
Bias	The systematic tendency of a baseline method to over- or under- predict load	Average Relative Error (ARE): Average error (baseline less actual) during the event period divided by average load during the period
Variability	How well the baseline method predicts load under many different conditions across many different resources	Relative Error Ratio (RER): Average standard deviation of the errors divided by the average load during the period

Implications of Analysis Findings

- The IESO will use the analysis to determine whether changes to the existing baseline methodology, or introduction of additional baseline methodologies, are warranted

Stakeholder Feedback Requested

Design Element	Feedback Requested
Data	Is the proposed source data appropriate? Is the analysis timeframe appropriate?
Suitable Business Days	Is the proposed method for choosing proxy event days appropriate? Should additional types of days be excluded from the set of proxy event days?
Baselines	Are there additional baselines that should be evaluated? Do stakeholders support the exclusion of regression-based baselines?
Performance Assessment	Are the proposed evaluation principles of accuracy, integrity, and simplicity appropriate? Are the proposed statistical performance metrics to assess baseline accuracy appropriate?

Submitting Stakeholder Feedback

- Please provide written feedback by May 13 to engagement@ieso.ca using the feedback form on the engagement web page.
- Please use the feedback form provided to ensure stakeholder feedback is compliant with the Accessibility for Ontarians with Disabilities Act (AODA). If you choose not use the IESO feedback form, please provide an AODA compliant pdf document.
- The IESO will consider any additional feedback as articulated in today's discussion, as well as written feedback submitted after this meeting, in order to finalize the scope of the baseline methodology review.

Next Steps

- **June 22-24 Resource Adequacy meeting**: Present the finalized study scope
- **Q3 2021**: Present preliminary study results for discussion and feedback
- **Q4 2021**: Present final study results and discuss next steps

HDR Activation Process Clarification

HDR Activation Process Clarification

- The IESO will typically declare an Energy Emergency Alert Level 1 (EEA-1) prior to activating HDR resources out-of-market; however, this is not a requirement, and circumstances may require out-of-market activation without an EEA-1 declaration (e.g. to address a localized section of the grid approaching an emergency operating state)
- Market participants should be prepared to respond to an activation notice whenever placed on standby, either economically or manually

HDR Activation Process Clarification (2)

- An updated *Activation of Hourly Demand Response Resources FAQ for Market Participants* document will be circulated following this meeting to reflect this clarification

Improving Awareness of System Operating Conditions

- More broadly, the IESO is currently working with stakeholders to revise the advisory notice framework to provide better situation awareness to market participants, particularly when actions by market participants may be needed
  - Stakeholders are encouraged to stay informed and participate in the Improving Awareness of System Operating Conditions engagement

Draft, high-level 2021 stakeholder engagement plan for Capacity Auction enhancements

Ryan King, Supervisor, Capacity Development & Integration

Draft Agenda for Upcoming Meetings

- May
  - Begin discussion on UCAP transition including focus on principles and considerations for a range of existing resources
  - Present initial thoughts on establishing a minimum target capacity and seek stakeholder input on considerations

Draft Agenda for Upcoming Meetings

- June
  - Plan to introduce the Expanding Participation design category with a focus on resource-backed imports for the 2022 auction
  - Further updates as required on DR-baseline methodology analysis, and administrative enhancements to the 2021 auction

Draft High-Level Stakeholder Plan 2021

Internal Design
Stakeholder

Work Items	Q1	Q2	Q3	Q4
Enhance Auction Administrative Processes	Identify enhancements and process improvements	Discuss 2021 admin changes		
Expand Participation in the CA (Enable Resource-backed imports)		Design: identify challenges and propose solutions		
			Design proposals and participation frameworks	
Increase Certainty in the CA (Establish minimum-target Capacity)		Design: identify challenges and propose solutions		
		Discussion on min. target		
Establish QC Methodologies for Enabled Resources (Transition to UCAP)		Design: identify challenges and propose solutions	Develop QC Methodologies for Enabled Resources Including Imports	
		QC design principles and considerations		Stakeholder developed QC methodologies
Review Performance Obligations and Assessment (Incl. charges, HDR baseline)		Review current obligations	Update current Performance Obligations & Assessment framework	
		Stakeholder and solicit input on proposals		Stakeholder (as required)

Recap and Next Steps

Recap: Stakeholder Feedback Requests

- Capacity Auction process and administrative enhancements planned for the 2021 auction
  - Feedback on draft market rule and manual amendments
- Draft scope for HDR baseline methodology review
  - Feedback on draft scope. See questions on slide 41 and in feedback form
- All stakeholder feedback is requested by **May 13, 2021**

Next Steps

- May Resource Adequacy engagement meeting
  - Capacity Auction
    - Begin discussion on UCAP transition including focus on principles and considerations for a range of existing resources
    - Present initial thoughts on establishing a minimum target capacity and seek stakeholder input on considerations
  - Updates on the 2021 AAR and framework mechanisms, if available

Appendix – Relevant information from DR baseline assessment studies in other ISO/RTOs

Reference Studies/Whitepapers

- *PJM Empirical Analysis of Demand Response Baseline Methods,* KEMA, 2011
- *Proposed Changes to the Demand Response Baseline,* ISO New England, 2015
- *Estimating Demand Response Load Impacts: Evaluation of Baseline Load Models for Non-Residential Buildings in California*, Lawrence Berkeley National Laboratory, 2008
- *NYISO SCR Baseline Study*, KEMA, 2014
- *Assessment of Settlement Baseline Methods for Ontario Power Authority's Commercial & Industrial Event Based Demand Response Programs*, Freeman, Sullivan & Co, 2010
- *The Demand Response Baseline,* Enernoc Whitepaper, 2009
- *Measurement and Verification for Demand Response,* Prepared for the National Forum on the National Action Plan on Demand Response: Measurement and Verification Working Group, 2013

Summary of Key Design Elements in Reference Studies

Study	Data	Estimation Method	Baselines Assessed*	Performance Metrics
PJM	28 months	Simulated events during summer afternoon and winter morning periods	11 baselines, with 4 adjustments for each	Accuracy – RRSME Bias – median ARE Variability – median RER
ISO-NE	12 months	Simulated events for all hours across all assets and seasons	6 baselines for 3 day types (non-holiday weekdays, Saturdays, Sundays/holidays) [1]	Accuracy - RRSME Bias – mean ARE Variability – 95th percentile of RER
CAISO	6 months (May to Oct) over 2 years	12pm-6pm event period on *proxy event days*	7 baselines, with and without an in-day adjustment	Accuracy – mean absolute percentage error (MAPE) Bias – median ARE
NYISO	Two summer, two winter commitment periods	2pm – 7pm on *proxy event days*	11 baselines, with 4 adjustments for each[1]	Accuracy – RRSME Bias – median ARE Variability – median RER
Ontario	One year of pre-enrollment data from 95 customers	All event window hours on *proxy event days* (defined by supply cushion estimates)	8 baselines, with 2 adjustments each, and "hourly" vs. "daily" calculation[1]	Accuracy – RRSME Bias – mean ARE Variability – 80th and 90th percentile RER

[1]No regression-based baselines included in these studies

Example Customer Actual and Baseline Hourly Load

- For each baseline methodology, load will be estimated for all resources on each Suitable Business Day and assessed against actual load

Resource	Date	Baseline Hourly Loads (kW)						Actual Hourly Loads (kW)						Average Baseline (kW)	Average Actual (kW)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		1-2PM	2-3PM	3-4PM	4-5PM	5-6PM	6-7PM	1-2PM	2-3PM	3-4PM	4-5PM	5-6PM	6-7PM	=average (a:f)	= average (g:l)
1	26-Aug-19	508	520	517	506	488	461	492	494	500	502	502	481	500	495
2	26-Aug-19	83	82	72	53	47	35	64	59	38	47	5	5	62	36
3	26-Aug-19	349	342	287	267	237	196	326	322	313	301	294	222	280	296
4	26-Aug-19	3,482	3,468	3,843	3,606	3,556	3,445	3,771	3,761	3,730	4,023	3,487	3,361	3,567	3,689
5	26-Aug-19	439	445	446	416	425	404	383	382	383	381	387	391	429	385
6	26-Aug-19	386	397	394	370	229	194	353	386	375	312	235	178	328	307
7	26-Aug-19	92	92	92	93	92	92	82	85	83	85	84	86	92	84
8	26-Aug-19	3,204	3,229	3,257	3,208	3,185	3,115	2,964	2,964	2,961	2,386	2,833	2,770	3,200	2,813
9	26-Aug-19	660	625	568	532	493	482	613	583	566	551	535	499	560	558
10	26-Aug-19	6,397	6,377	6,322	6,308	6,411	6,343	7,165	7,098	7,047	6,918	6,799	6,820	6,360	6,975

Source: *PJM Empirical Analysis of Demand Response Baseline Methods,* KEMA, 2011

Example of Variability Metric (RER) Calculation

		Actual Hourly Error (kW)						Std Dev	Average Actual (kW)	Error Ratio
		(u)	(v)	(w)	(x)	(y)	(z)	(q)	(n)	(r)
Resource	Date	1-2PM	2-3PM	3-4PM	4-5PM	5-6PM	6-7PM	=stddev(u:z)	= average(g:l)	= q / n
1	26-Aug-19	(16)	(26)	(17)	(4)	14	20	18	495	0.04
2	26-Aug-19	(19)	(23)	(34)	(6)	(42)	(30)	13	36	0.35
3	26-Aug-19	(23)	(20)	26	34	57	26	32	296	0.11
4	26-Aug-19	289	293	(113)	417	(69)	(84)	236	3,689	0.06
5	26-Aug-19	(56)	(63)	(63)	(35)	(38)	(13)	20	385	0.05
6	26-Aug-19	(33)	(11)	(19)	(58)	6	(16)	22	307	0.07
7	26-Aug-19	(10)	(7)	(9)	(8)	(8)	(6)	1	84	0.02
8	26-Aug-19	(240)	(265)	(296)	(822)	(352)	(345)	218	2,813	0.08
9	26-Aug-19	(47)	(42)	(2)	19	42	17	36	558	0.06
10	26-Aug-19	768	721	725	610	388	477	153	6,975	0.02
									10th percentile	**3%**
									Median	**6%**
									Mean	**9%**
									90th percentile	**13%**

Source: *PJM Empirical Analysis of Demand Response Baseline Methods,* KEMA, 2011

Example of Bias Metric (ARE) Calculation

		Average Baseline (kW)	Average Actual (kW)	Average Error (kW)	Error (%)
		(m)	(n)	(o)	(p)
Resource	Date	= average(a:f)	= average(g:l)	= (n - m)	= o / n
1	26-Aug-19	500	495	(5)	-1%
2	26-Aug-19	62	36	(26)	-71%
3	26-Aug-19	280	296	17	6%
4	26-Aug-19	3,567	3,689	122	3%
5	26-Aug-19	429	385	(45)	-12%
6	26-Aug-19	328	307	(22)	-7%
7	26-Aug-19	92	84	(8)	-10%
8	26-Aug-19	3,200	2,813	(387)	-14%
9	26-Aug-19	560	558	(2)	0%
10	26-Aug-19	6,360	6,975	615	9%
				10th percentile	**-19%**
				Median	**-4%**
				Mean	**-10%**
				90th percentile	**6%**

Source: *PJM Empirical Analysis of Demand Response Baseline Methods,* KEMA, 2011

Relative Root Mean Square Error Calculation

- The root-mean-square error (RMSE) measures the differences between predicted values and observed (or known) values to assess the predictive power of an estimator
- RMSE is defined as: $RMSE = \sqrt{\frac{\sum_{i=1}^{n}(\hat{y}_i - y_i)^2}{n}}$, where, $\hat{y}_i$ is the predicted value, y_i is the observed value, and n is the number of data points in the sample
- The relative root-mean-square error (RRMSE) normalizes the RMSE to enable comparisons between resources with different consumption profiles (e.g. small vs. large)
- Though there is no consistent means of normalization in the literature, a common choice is the mean of the actual data, so mathetmatically $RRMSE = \frac{RMSE}{\bar{y}}$, where $\bar{y}$ is the mean of the observed data (this is what is used in the PJM and NYISO reports)

Example of Accuracy Metric (RRSME) Calculation

		Actual Hourly Error (kW)						MSE	Average Actual (kW)	Relative RMSE
		(u)	(v)	(w)	(x)	(y)	(z)	(s)	(n)	(t)
Resource	Date	1-2PM	2-3PM	3-4PM	4-5PM	5-6PM	6-7PM	$\sum e^2$/n (see note)	= average (g:l)	=SQRT(s)/(n)
1	26-Aug-19	(16)	(26)	(17)	(4)	14	20	306	495	0.04
2	26-Aug-19	(19)	(23)	(34)	(6)	(42)	(30)	791	36	0.77
3	26-Aug-19	(23)	(20)	26	34	57	26	1,114	296	0.11
4	26-Aug-19	289	293	(113)	417	(69)	(84)	61,308	3,689	0.07
5	26-Aug-19	(56)	(63)	(63)	(35)	(38)	(13)	2,319	385	0.13
6	26-Aug-19	(33)	(11)	(19)	(58)	6	(16)	871	307	0.10
7	26-Aug-19	(10)	(7)	(9)	(8)	(8)	(6)	66	84	0.10
8	26-Aug-19	(240)	(265)	(296)	(822)	(352)	(345)	189,009	2,813	0.15
9	26-Aug-19	(47)	(42)	(2)	19	42	17	1,065	558	0.06
10	26-Aug-19	768	721	725	610	388	477	397,577	6,975	0.09

Note: (s) = (u)^2 + (v)^2 + (w)^2 + (x)^2 + (y)^2 + (z)^2 / (count of hours)

10th percentile	**5%**
Median	**10%**
Mean	**16%**
90th percentile	**22%**

Source: *PJM Empirical Analysis of Demand Response Baseline Methods,* KEMA, 2011

Interpretation of Performance Metrics

Metric	Calculation Method	Interpretation
Accuracy	Root Mean Squared Error (RMSE)	- A baseline with a median RRMSE of 0.10 indicates that the baseline estimate falls within 10% of actual load most of the time - The smaller the RRMSE, the better the baseline performs as a predictor of actual hourly load
Bias	Average Relative Error (ARE)	- A median ARE value of zero indicates that the baseline does not systematically over- or under-estimate load - A positive (negative) value would indicate a tendency to over- (under-) estimate load - The closer ARE is to zero, the closer the baseline is to being unbiased
Variability	Relative Error Ratio (RER)	- Two baselines may have the same RRMSE, but one baseline may estimate the load shapes more closely than the other baseline (dispersion of errors much closer to actual load) - The smaller the median RER, the less variable a baseline's error is for the typical resource and therefore the better the baseline performs across a wide variety of circumstances

Thank You

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