Assessing Energy Efficiency Resource Performance in All Hours

Final Report of the Demand Resources Working Group to the NEPOOL Markets Committee

7/12/2019

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Executive Summary

This document is the report of the Demand Resources Working Group ("DRWG") on potential approaches to measuring or estimating energy efficiency resource ("EERs") performance in all hours for existing and new Energy Efficiency measures. This report is in response to a referral by the NEPOOL Markets Committee ("MC") dated March 5, 2019, which asked the DRWG to consider how EER[1] performance in all hours could be established and to report potential options back to the MC. The intent of this report is to better inform the MC in its deliberations concerning whether and how to assess the Actual Capacity Provided ("ACP") of EERs for Capacity Scarcity Conditions ("CSCs") that occur in off-peak hours.

As discussed in further detail in this report, the DRWG considered five options to estimating EER performance in all hours, which were initially developed by the ISO to facilitate discussion among DRWG participants. Among the options discussed, Shaping Option A – an option that estimates hourly EER performance as a function of established on-peak EER savings and system load levels – received the most support. Preliminary analysis indicated that the performance of EERs and load levels are correlated. All of the inputs needed to estimate the ACP of EERs using Shaping Option A are available immediately after a CSC occurs. Finally, Shaping Option A can be implemented at low cost, and could be implemented in reasonably short order after a FERC Order is issued and eliminate the settlement imbalance expeditiously. This is in contrast to all of the other options explored by the DRWG. Given what is known at this time, three of the five other options require retrieval of data not previously captured and/or reported, and/or require additional analysis that would involve additional costs and time for both Market Participants and the ISO to implement. The fourth option – the Modelling Option – will not be available until the 2021-2022 timeframe.

Some expressed concern with Shaping Option A believing that this method can overstate performance and give EERs an ACP exceeding their balancing ratio-adjusted Capacity Supply Obligation ("CSO") during off-peak hours. These participants argued that this result does not make sense given that most end-use facilities are closed during non-business, overnight, and/or weekend hours. Those familiar with the measurement, verification, and delivery of energy efficiency responded to this, explaining that many Energy Efficiency measures do produce savings during off-peak hours – e.g., street lighting, parking lot lighting, security lighting, HVAC, refrigeration – so that some extent of EER performance during all off-peak hours ought to be expected, and concluding that Shaping Option A would result in an accurate representation of the capacity delivered by EERs in any single interval. Another reason given for why the ACP of an EER may exceed its balancing ratio-adjusted CSO is that Market Participants with EERs tend to install more Energy Efficiency measures than the quantity needed to meet their CSO. Others stated that EERs can underperform pursuant to Shaping Option A if an insufficient number of Energy Efficiency measures are installed relative to the CSO taken on. Finally, several participants who supported Shaping Option A as a feasible option requiring the least amount of time and expense to develop and implement among the options discussed did not

[1] EER is used here as shorthand for the portion of On-Peak Demand Resources and Seasonal Peak Demand Resources consisting of Energy Efficiency measures.

necessarily support its use in establishing the ACP of EERs in off-peak hours; rather, their preferred approach would be to treat EERs neutrally during off-peak hours.

Because of differing positions taken by various DRWG participants, the DRWG could not establish a consensus. However, among the options reviewed by the DRWG, Shaping Option A was identified as the option requiring the least time and expense to develop and implement.[2] It is hoped that the information provided in this report is helpful to the MC in its deliberations concerning whether and how to assess the ACP of EERs for CSCs that occur in off-peak hours.

Background

This report is in response to a referral by the MC dated March 5, 2019 as described further below.

During the period November 2018 through March 2019, the MC was presented with different approaches[3] to address settlement imbalances associated with the treatment of EERs in connection with the calculation of Capacity Performance Payments during CSCs that occur in off-peak hours.[4] EERs are composed of a portfolio of passive, non-dispatchable Energy Efficiency measures whose current performance under the ISO Tariff is calculated only during on-peak hours.[5] One potential solution that was offered among others was to assess the ACP of EERs for CSCs that occur in off-peak hours, and to use the resulting values to calculate Capacity Performance Payments for EERs. This approach requires a method that estimates EER performance in all hours. At this time, however, there is no method in New England or elsewhere by which to estimate EER performance in all hours for existing and new Energy Efficiency measures.

To better inform stakeholder deliberations concerning whether and how to assess the ACP of EERs for CSCs that occur in off-peak hours, the MC referred the problem of estimating EER performance in all hours to the DRWG.[6] On March 5, 2019, the MC asked the DRWG to:

- Consider how EER performance in all hours for existing and new measures could be established and what, if any, additional methodological standards and reporting mechanisms would be required to accommodate such a change;

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[2] The MC's referral of this issue to the DRWG states that: "[i]n considering alternatives that assess the ACP of EERs in all hours, the DRWG will prioritize options that require the least time and expense to develop and implement." *See:* https://www.iso-ne.com/static-assets/documents/2019/02/a5_ee_problem_statement_and_referral.docx.

[3] Background materials concerning this issue are posted at: https://www.iso-ne.com/static-assets/documents/2019/01/a5_nepga_presentation_ee_settlement_shortfall.pdf ; https://www.iso-ne.com/static-assets/documents/2019/02/a5a_veic_presentation_ee_during_csc.pptx ; and https://www.iso-ne.com/static-assets/documents/2019/01/a3_iso_memo_re_pfp_ee_proposals.pdf .

[4] "Off-peak hours" are those hours *other than* Demand Resource On-Peak Hours for On-Peak Demand Resources, and those hours other than Demand Resource Seasonal Peak Hours for Seasonal Peak Demand Resources.

[5] "On-peak hours" are Demand Resource On-Peak Hours for On-Peak Demand Resources and Demand Resource Seasonal Peak Hours for Seasonal Peak Demand Resources.

[6] *See:* https://www.iso-ne.com/static-assets/documents/2019/02/a5_ee_problem_statement_and_referral.docx.

- Prioritize options that require the least time and expense to develop and implement;
- Allow sufficient opportunity for appropriate and representative stakeholder input and sufficient time for assessment of multiple options; and
- Report potential options back to the MC, which may include time and cost estimates associated with implementing each option.

The DRWG met five times with respect to this assignment: March 26, April 18, April 29, May 24, and July 1, 2019. On May 8, 2019, the Chair of the DRWG, Mr. Henry Yoshimura, reported on the DRWG's progress to the MC.[7] This document is the DRWG's final report on the potential approaches to estimating EER performance in all hours in response to the March 5th referral. Accordingly, the DRWG plans no additional work on this issue at this time.

The remainder of this document summarizes the potential options for establishing EER performance in all hours that were examined by the DRWG, which include a discussion of the pros and cons of each option. The document ends with a summary of concluding comments, which reviews the overall discussion among DRWG participants of the various options examined.

Potential Options for Estimating Energy Efficiency Resource Performance in All Hours

Introduction

The DRWG discussed five options for estimating EER performance in all hours. These options were initially developed by the ISO to facilitate discussion of alternative approaches among DRWG participants. The options discussed included:[8]

1. **Single Value Option:** calculate a single average hourly demand reduction value for all off-peak hours;
2. **Shaping Options**: shape currently known on-peak savings estimates to all hours based on the relationship between estimated performance under on-peak system conditions (reference load) and all other performance hour system conditions, including:
    a. **Shaping Option A:** estimate hourly EER performance as a function of established on-peak EER savings and system load levels; and
    b. **Shaping Option B:** distribute total seasonal off-peak energy savings using an average load shape for the season;

[7] *See:* https://www.iso-ne.com/static-assets/documents/2019/05/a6_presentation_assessing_ee_resource_performance_all_hours.pptx.
[8] *See the following for more details:* https://www.iso-ne.com/static-assets/documents/2019/03/ee_performance_evaluation_032619.pptx

3. **Modelling Option:** a measurement and verification ("M&V") method that estimates hourly EER performance for existing and new energy efficiency technologies using a calibrated simulation of building type specific performance data using open-source building stock end-use models that are currently being developed by the US Department of Energy; and
4. **Bottom-Up Option:** conduct M&V studies to develop and update characteristic 24x7 load shapes or profiles for all previously installed and new energy efficiency technologies to estimate savings across all hours and weather conditions.

DRWG participants were invited to provide other potential approaches for estimating EER performance in all hours to be considered by the group. However, none were provided.

Single Value Option

Under the current market rules, the performance of an EER is based on the sum of the average hourly demand reductions during on-peak hours of each installed Energy Efficiency measure comprising the EER. Using this concept, the Single Value Option estimates the off-peak demand-reduction performance of an EER based on the difference between the measured energy reduction over the entire year and the energy reduction during *on-peak hours* divided by off-peak performance hours. Equation (1) below generally summarizes the approach used by EER program administrators to estimate the total seasonal energy savings produced by a single Energy Efficiency measure *e*:

$$\text{kWh Savings}_e = (\text{kW}_b - \text{kW}_e) \text{ x OH x RR x PF x ISR} \qquad (1)$$

Where:

- kWh Savings_e = seasonal energy savings produced by Energy Efficiency measure *e*
- kW_b = kilowatt usage of baseline technology *b*
- kW_e = kilowatt usage of Energy Efficiency measure *e*
- OH = seasonal operating hours of the end-use application
- RR = savings realization rate based on impact evaluation studies
- PF = savings persistence factor over the life of the measure
- ISR = in-service rate, or portion of efficient units actually installed

kWh energy savings from equation (1) are transformed to kW capacity savings using a "coincidence factor study" that estimates the percentage of energy savings produced during on-peak hours. Coincidence factors are developed from hourly load profiles of the customer class or building type into which the Energy Efficiency measure is installed, or from 24-hour load logger profiles. The resulting coincidence factors are used to determine the average hourly demand reduction of the Energy Efficiency measure, which estimates the on-peak period performance of the installed Energy Efficiency measure for its remaining Measure Life [see equation (2)]:[9]

[9] This value is often referred to as the Energy Efficiency measure's "demand reduction value" or "DRV".

$$\text{On-Peak kW Savings}_e = \text{kWh Savings}_e \times \text{CF}_e / \text{ON} \qquad (2)$$ [10]

Where:

- On-Peak kW Savings_e = average hourly demand reduction of Energy Efficiency measure *e* during on-peak hours for the relevant season
- CF_e = Coincidence factor of Energy Efficiency measure *e* (i.e., the percentage of energy savings produced during on-peak hours) for the relevant season
- ON = Total Demand Resource On-Peak or Seasonal Peak Hours (as applicable) for the relevant season

Since On-Peak kW Savings_e = kWh Savings_e x CF_e / ON, it follows that the average hourly demand reduction of the same Energy Efficiency measure ***during off-peak hours*** is simply:

$$\text{Off-Peak kW Savings}_e = \text{kWh Savings}_e \times (1 - \text{CF}_e) / \text{OFF} \qquad (3)$$

Where:

- Off-Peak kW Savings_e = average hourly demand reduction of Energy Efficiency measure *e* during off-peak hours for the relevant season
- OFF = Total off-peak hours (hours other than Demand Resource On-Peak or Seasonal Peak Hours as applicable) for the relevant season

The Single Value Option represented in equation (3) is conceptually feasible. However, EER program administrators indicated that establishing Off-Peak kW Savings of each Energy Efficiency measure was much easier said than done. Because the only performance value presently reported to the ISO for each installed Energy Efficiency measure is the final On-Peak kW Savings_e, the other data needed to compute Off-Peak kW Savings_e – specifically, the total seasonal energy savings (kWh Savings_e) and the coincidence factor (CF_e) – are not presently reported and are not readily available. EER program administrators indicated that retrieving these data, ensuring that the retrieved data are consistent with the reported On-Peak kW Savings_e, and calculating and reporting Off-Peak kW Savings_e for hundreds of thousands of Energy Efficiency measures currently recorded in the ISO's energy efficiency management database ("EEM"), some of which were installed several years ago and are still functioning, would be very time-consuming, costly, and impractical[11].

Further, using a single value to represent the performance of an Energy Efficiency measure in all off-peak intervals, where off-peak intervals represent about 96 percent of total intervals in a year, will likely underestimate savings during off-peak intervals near the peak period, and overestimate savings during off-peak intervals far from the peak period. For example, assume an

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[10] Many studies apply CF_e directly to connected kW_e savings to establish On-Peak kW Savings_e.

[11] Some EER program administrators explained that obtaining information on coincidence in off-peak hours for energy efficiency installations whose performance was measured using customized and site specific conditions, as opposed to studies that generalize equipment and operating conditions, are impractical and may result in degradation of statistical precision and accuracy if such studies were not repeated in their entirety over the proposed longer performance hour duration.

EER participating as an On-Peak Demand Resource that produces on average 100 kW of savings in each interval between 1:00 to 5:00 p.m. on weekday afternoons in August. It is highly likely that this EER produces close to 100 kW of savings during the interval 5:00-5:05 p.m. weekday afternoons in August, and less savings during the interval 1:00-1:05 a.m. weekend mornings in April – yet the Single Value Option would assign the same off-peak savings value to both of these off-peak intervals.

EER program administrators indicate that implementing the Single Value Option would require data that is not currently available, would be time-consuming and costly, and would likely underestimate savings during off-peak intervals near the peak period and overestimate savings during off-peak intervals far from the peak period.

Shaping Options

Introduction

Studies conducted over decades on Energy Efficiency measures support the concept that savings produced by a portfolio of Energy Efficiency measures should be greater during high-load periods and lower during low-load periods, where a portfolio consists of a broad mix of end-use technologies. Where individual Energy Efficiency measures produce savings during the operating hours of the affected end-use application [as suggested by Equation (1)], EER program administrators believe a portfolio of Energy Efficiency measures affecting a cross-section of end-use applications have been demonstrated to produce savings that are a function of the end-use load shape – i.e., that the amount of savings produced by a portfolio of Energy Efficiency measures is directly proportional to the amount of energy consumption. The concept that EER performance and load levels are correlated is also reflected in the Commission's Order with respect to the Forward Capacity Market ("FCM"), Pay-for-Performance design:

> Energy efficiency resources are not similarly situated to other capacity resources because they do not actively perform in real-time—***they represent a pre-determined level of load reduction that is constant as a percentage of that resource's load***….[12]

Building on this concept, total energy savings for a period could be allocated or *"shaped"* among all hours in that period based on load levels. Some empirical evidence gathered by the ISO suggest that energy savings produced by lighting EERs (lighting EERs represent a significant (greater than 50%) portion of the current portfolio of measures) and energy consumption levels are correlated.[13] Some Market Participants looking at this issue indicated that "[t]o date, we have not found clear evidence that would contradict the [shaping] option's underlying assumption that EE performance generally correlates with total system load."[14] Others were

[12] *ISO New England Inc. and New England Power Pool*, Order on Tariff Filing and Instituting Section 206 Proceeding, 147 FERC ¶ 61,172 (2014) at P89 emphasis added.
[13] *See:* https://www.iso-ne.com/static-assets/documents/2019/04/ee_performance_evaluation_revised_option_a_4_23.pptx, slides 4-8.
[14] *See:* https://www.iso-ne.com/static-assets/documents/2019/04/42919_drwg_a04_eversource_preliminary_thoughts.pdf, slide 2.

concerned about making assumptions with the extent to which this is true or not in off-peak hours. Two shaping options were identified and discussed among DRWG participants: Shaping Option A, which allocates known on-peak demand savings to all hours based on system load levels; and Shaping Option B, which allocates total energy savings for a year or season to all hours based on estimated load shapes that were originally developed for wholesale energy allocation purposes.

Shaping Option A

Shaping Option A estimates hourly EER performance as a function of reported on-peak EER performance and system load levels. From an implementation standpoint this approach is simple and straightforward: use the ratio of actual system load to average peak-period load as the basis for shaping reported on-peak performance to all hours. The formulas that could be used to determine the ACP of an EER for On-Peak Demand Resources and Seasonal Peak Demand Resources are as follows:

Equation (4) estimates the ACP of an EER that is participating in the FCM as part of an On-Peak Demand Resource:

$$ACP_{ee} = Perf_{ee,\ On-Peak} * \frac{SL+PV}{ASL_{s,w}+APV_{s,w}} * 1.08 \qquad (4)$$

Where:

- ACP_{ee}= Actual Capacity Provided by the EER
- $Perf_{ee,\ On\text{-}Peak}$ = The EER's reported on-peak performance for the month
- SL = System load during CSC interval
- PV = Behind-the-meter photovoltaic ("BTM PV") generation output during CSC interval
- $ASL_{s,w}$ = Average System Load during on-peak hours of most recently completed 3 summer or 2 winter performance months
- $APV_{s,w}$ = Average BTM PV output during on-peak hours of most recently completed 3 summer or 2 winter performance months
- 1.08 = gross-up for avoided transmission & distribution ("T&D") losses

During the DRWG meeting held on April 29, some participants noted that the proposed Average System Load variable would use the most recently-complete 3 summer or 2 winter performance months. For the months of April and May, which are designated as summer months for demand resources, this value would be calculated from the prior year's June through August data, making it 7-9 months outdated. Because EERs are installed each month on consistent basis, Average System Load should decrease as a result. But if this value is outdated by 7-9 months, the value could be too high in the range of 200 MW based upon historical performance of EERs. This raises the denominator and thus reduces the overall value of the ratio. No alternative was suggested to the formula above, however.

Equation (5) estimates the ACP of an EER that is participating in the FCM as part of a Seasonal Peak Demand Resource. Note that the calibration point for Seasonal Peak Demand Resources is based on Demand Resource Seasonal Peak Hours, which are defined as any hour in which the system load is 90 percent or more of the 50/50 peak load forecast for the applicable summer or winter season:

$$ACP_{ee} = Perf_{ee,Seasonal\ Peak} * \frac{SL+PV}{SPL_{s,w}+SPV_{s,w}} * 1.08 \qquad (5)$$

Where:

- ACP_{ee} = Actual Capacity Provided by the EER
- $Perf_{ee,\ Seasonal\ Peak}$ = The EER's reported performance for the month
- SL = System load during CSC interval(s)
- PV = BTM PV generation during CSC interval(s)
- $SPL_{s,w}$ = 90% of the net 50/50 peak load forecast for the season[15]
- $SPV_{s,w}$ = Forecasted effect of BTM PV during peak load for the season
- 1.08 = gross-up for avoided T&D losses

There are several notable properties of Shaping Option A as summarized in equations (4) and (5). First, because the basis for assessing the ACP of an EER in all hours is the reported on-peak savings of each Energy Efficiency measure comprising EER, this approach avoids the retrieval of additional data associated with each Energy Efficiency measure (e.g., total time-dependent kWh savings and coincidence factors), and the need to conduct any additional analysis to assess off-peak EER performance.

Second, equations (4) and (5) assess the ACP of an EER in all hours, not just off-peak hours, based on the principle that EER performance is generally a function of load levels. The reported on-peak performance of an EER participating as an On-Peak Demand Resource is its *average* hourly demand reduction during Demand Resource On-Peak Hours – which implies that the actual demand reduction in any specific on-peak hour will be higher or lower than the average hourly demand reduction. Since EER performance is generally a function of load levels, the hourly on-peak performance of an EER should vary based on actual hourly on-peak period loads relative to average hourly on-peak period loads. Accordingly, equation (4) calibrates the ACP of EERs participating as an On-Peak Demand Resource to recent historical average hourly on-peak system loads during the relevant season. For EERs participating as a Seasonal Peak Demand Resource, equation (5) calibrates the ACP to the definition of Demand Resource Seasonal Peak Hours – i.e., 90 percent of the net 50/50 peak load forecast for relevant season.[16] Since the performance of an EER is generally a function of load levels, EER performance would be lower than its reported on-peak performance level when system loads lower than the relevant calibration points, and higher when system loads are higher than the relevant calibration points. Others were concerned that the general relationship between EER performance and load levels

[15] The 50/50 MW number comes from taking the Gross Summer Peak Forecast (1.1 on CELT report page 1.1) and subtracting the Passive DR Capacity (2.2.2 on CELT report page 1.1). The threshold for Seasonal Peak Hours is 90% of this value and is used in determining the Seasonal Peak Hours. The ISO publishes these values: https://www.iso-ne.com/isoexpress/web/reports/auctions/-/tree/season-peak-hour-data.

[16] For Seasonal Peak Demand Resources, Energy Efficiency measure performance is based on estimated average hourly demand reductions when system load is 90 percent or greater of the net 50/50 peak load forecast for relevant season. The Seasonal Peak Demand Resource category was designed for weather-sensitive measures, such as energy-efficient air conditioners, that produce greater savings during periods of extreme temperatures, which in turn are correlated with periods of higher overall energy consumption.

may be quite different in the off-peak versus on-peak periods. So rather than relying upon an assumption that EER performance is correlated with load levels, some thought that EER performance in off-peak periods ought to be specifically studied.

This approach also avoids any inexplicable discontinuities in the ACP of an EER at the border between on-peak and off-peak hours. For example, take a CSC occurring during the intervals 4:55 to 5:00 p.m. and 5:00 to 5:05 p.m.,[17] where system load in the second interval is lower than the first (prior) interval, but system loads in both intervals are significantly higher than average on-peak period loads. If the ACP of EERs for the on-peak period were based only on the reported on-peak savings values – i.e., $Perf_{ee,\ On\text{-}Peak\ or\ Seasonal\ Peak}$ – and equations (4) and (5) were used to assess the ACP of EERs for the off-peak period only, the ACP of EERs would be lower during the first interval, and higher during the second interval even though system load during the second interval was lower. By applying equations (4) and (5) to all hours, these inexplicable discontinuities in EER performance between on- and off-peak periods are avoided.

Finally, the shaping factor in Shaping Option A – i.e., ratio term in equations (4) and (5) – adjusts observed net system load to account for the impact of BTM PV generation. A significant amount of energy consumption that would otherwise appear in observed net system load data is masked by BTM generation that does not participate as Generator Assets in the ISO New England wholesale market. The output of these BTM generators appears to the ISO as a reduction in observed net system load. The largest component of BTM generation is PV. PV generation has a summer performance pattern that follows a specific and near coincident pattern with that of EERs,[18] and BTM PV continues to grow significantly over time. BTM-PV, however, should not be expected to produce performance in overnight hours.

Since hourly EER performance is correlated to actual total system load (i.e., overall energy consumption levels) and not to observed net system load – which is net of BTM PV production – observed net system load should be reconstituted[19] prior to calibrating EER performance levels. Such reconstitution would result in another favorable property – avoiding bias in EER performance calculations. Bias would occur if BTM PV output is different during a scarcity condition compared with its average output during Demand Resource On-Peak Hours or Seasonal Peak Hours. The ACP of an EER would be biased downwards during periods of higher BTM PV output, and upwards during periods with lower or no BTM PV output. The proposed methodology utilizes ISO System Planning values for installed BTM PV energy production during the reference periods used in the denominator of equations (4) and (5) and ISO System Operation's estimate of PV output in real-time used in the numerator of each equation.

[17] By definition, the first interval – 4:55 to 5:00 p.m. – is on-peak, and the second interval – 5:00 to 5:05 p.m. – is off-peak.

[18] Most non-PV BTM generation systems are combined heat-and-power plants that do not have as much output fluctuation as PV from hour to hour. Accordingly, we expect far less bias from ignoring the impact of these BTM generation systems compared to PV systems. Further, we do not have an estimate of hourly output of non-PV BTM generation.

[19] The ISO currently produces a daily operational estimate of BTM PV hourly output, which currently ranges from zero to about 2000 MW. The observed net system load would be reconstituted by adding in the hourly estimate of BTM PV output.

Shaping Option B

Shaping Option B distributes total seasonal off-peak energy savings using an average load shape for the season. In the wholesale energy market, real-time wholesale energy consumed by end-use customers is allocated among Profiled Load Assets using class-average load shapes developed from distribution company load research. Using the same distribution company load research data, a typical load shape of the population of end-use customers who receive Energy Efficiency measures can be derived and used to develop hour-specific percentages to allocate total seasonal off-peak period energy savings to specific hours in the year or season. Equation (6) describes, at a high level, how this could be done:

$$\text{Off-Peak kW Savings}_{e,h} = \Sigma[\text{kWh Savings}_e \text{ x } (1 - CF_e)] \text{ x } LSP_h \qquad (6)$$

Where:

- Off-Peak kW $\text{Savings}_{e,h}$ is the kW savings produced by Energy Efficiency measure *e* in hour *h*
- kWh Savings_e = seasonal energy savings produced by Energy Efficiency measure *e*
- CF_e = Coincidence factor of Energy Efficiency measure *e*
- LSP_h = load shape percentage for hour *h*, which is the amount of consumption in hour *h* as a percentage of total consumption based on an average load shape

This approach allocates off-peak energy savings developed from current M&V studies to each off-peak hour. But to implement this approach, many additional details would need to be defined, particularly how the LSP_h for each hour of the season would be determined. For example, would LSP_h be unique to each hour of the season, or would a "typical" LSP_h for different day-types – e.g., business days, Saturdays, Sundays, and holidays – in the season be determined? Would LSP_h be a fixed set of values based on historical data, or would it be dynamically adjusted for actual load levels in the day? If dynamically adjusted, how should dynamic load research data be calibrated to develop hourly LSP_h allocators? Which load shape should be used – e.g., class average, distribution company-wide, system-wide? Answering these questions, let alone implementing the answers, would be complex and would likely be costly.

Further, as discussed previously in the context of the Single Value Option, Shaping Option B requires the retrieval of data not currently reported to the ISO, specifically, the total seasonal energy savings (kWh Savings_e) and the coincidence factor (CF_e). As EER program administrators indicate, these values are not readily available, retrieving these data and ensuring their consistency with the reported On-Peak kW Savings_e would be time-consuming, costly and impractical as explained in the Single Value Option above. Given these challenges, this approach received no further consideration at the DRWG.

Modelling Option

The National Renewable Energy Laboratory ("NREL") and Lawrence Berkeley National Laboratory ("LBNL") recently kicked-off a three-year, Department of Energy funded project to estimate the "End-Use Load Profiles for the U.S. Building Stock."[20] The objective of the project

[20] *See:* https://www.nrel.gov/buildings/end-use-load-profiles.html.

is to use validated end-use load profiles for U.S. building stock to develop calibrated, open-source building stock end-use models that will estimate EER and demand response savings profiles for existing and emerging technologies. The resulting savings profiles could be used to establish hourly and sub-hourly performance of groupings of Energy Efficiency measures that affect a particular end-use energy application (e.g., lighting, HVAC, water heating, refrigeration) in a residential or commercial building,[21] which, in turn, could be used to establish interval-specific savings of EERs participating in the New England wholesale electricity markets.

Once the models are established and calibrated, the models should produce relatively accurate results, and the cost of using the models should be modest. But the results of this project will not be available until the 2021-2022 timeframe. Because the results on this project will not be available for a number of years, no further consideration was given to the approach at this time. However, it was recommended that market participants and administrators monitor the progress of the NREL/LBNL "End-Use Load Profiles for the U.S. Building Stock" project as results become available.

Bottom-Up Option

As previously discussed in the section describing the "Single Value Option," estimated kWh energy savings or connected kW demand savings are transformed to on-peak kW capacity savings using a "coincidence factor study." Coincidence factors are developed from hourly load profiles characteristic of the many customer classes, building types, and unique site-specific facilities into which Energy Efficiency measures are installed. The proposed approach is equivalent to current M&V practices used to develop on-peak savings, but would involve the estimation of hourly kW savings for all hours using existing and newly developed hourly load profiles. As under the shaping options previously discussed above, these savings profiles could consist of a single 24x7 savings profile for an entire season, or savings profiles for different day types or weather conditions in the season, each on a measure specific basis. This approach recreates the same bottom-up process that is currently used to develop on-peak kW capacity savings, but focuses on developing hourly savings for each and every hour or blocks of off-peak hours (which account for about 96 percent of total hours in a year).

While some considered this approach to be one that could produce the most accurate results, others argued that achieving accuracy using this approach would be very challenging and costly, at least using current methods. Some asserted that this approach would require re-study of load shape data for a large portion of the EER program administrators' existing portfolio involving custom measures already installed at commercial and industrial facilities, whose operations are unique and highly variable. For existing Energy Efficiency measures, EER program administrators indicated that establishing 24x7 savings profiles using a bottom-up approach would require the retrieval and reconciliation of a great deal of archived data that is currently not reported to the ISO, is dated (more than 5 years old), or may require new studies as savings that occur during off-peak periods may not have been analyzed in the past. This is because EER

[21] Industrial Energy Efficiency measures comprise nearly 40 percent of some EER portfolios. However, it is not clear that the models currently being developed could be used to estimate Energy Efficiency performance in industrial facilities.

program administrators typically conduct M&V studies to demonstrate and report performance of their Energy Efficiency measures only for Demand Resource On-Peak or Seasonal Peak Hours. EER program administrators assert that M&V is a significant expense in delivering energy efficiency programs and a time consuming process where numerous studies must be conducted over many years to produce demand reduction values that meet precision and confidence levels mandated in the ISO Tariff across a wide array of measures. They further assert that changing the hours over which EER performance must be determined and reported must be carefully considered given the potential increase in M&V effort and cost depending on the methods employed.

Similar to the comments on the Single Value Option above, EER program administrators indicated that retrieving and reconciling these existing data and producing new data, ensuring that the data are consistent with the reported On-Peak kW Savings, developing 24x7 savings profiles for each existing and new measure class, and adjusting (for weather and time) and applying these measure-specific profiles for purposes of determining and reporting their demand reduction values to the ISO for each Energy Efficiency measure type shortly after each CSC would be a daunting task – one that would take many years and at significant cost. In addition, there is a wide disparity among participants in terms of their ability to implement this approach given the differences in the amount and richness of their existing load shape data and resources available to perform additional M&V. Further, the ISO's EEM database would require significant modification to accept 24x7 savings profiles for each Energy Efficiency measure – currently, only a single on-peak kW savings value for each measure is reported.

For new Energy Efficiency measures, the process of estimating 24x7 savings profiles could be automated up-front, which would reduce some of the challenges associated with recreating 24x7 savings profiles for existing measures. However, some also commented that it would be very challenging and costly to estimate 24x7 savings profiles that meet the Tariff requirement that "the reported monthly demand reduction value shall achieve at least a ten percent relative precision and an eighty percent confidence interval."[22] This is because off-peak hours account for 96 percent of the hours in the year. Given that weather and load conditions and savings levels vary greatly from hour to hour during off-peak hours compared to on-peak hours, a much larger sample size and perhaps more sophisticated estimation techniques would be required to meet a given level of confidence and precision. This would impose much greater cost with no guarantee that the results continue to meet the confidence and precision requirements in the ISO Tariff. Other approaches such as the shaping options or modelling options would likely produce results at far lower cost.

Concluding Comments

Shaping Option A received the most support among all of the options discussed, though some expressed concern that this approach may overstate EER performance in certain off-peak hours. Preliminary analysis indicated that savings and load levels are generally correlated, a factor that Shaping Option A relies upon in estimating the ACP of EERs in all hours. All of the inputs

[22] *See* Tariff Section III.13.1.4.3.1.

needed to estimate the ACP of EERs using Shaping Option A are available immediately after a CSC occurs, and the method could be implemented at low cost and in reasonably short order after a FERC Order is issued and eliminate the settlement imbalance expeditiously. This is in contrast to all of the other options explored by the DRWG. Given what is known at this time, three of the five other options require retrieval of data not previously captured and/or reported, and/or additional analysis that would involve additional costs and require more time for both Market Participants and the ISO to implement; and the fourth option – the Modelling Option – will not be available until the 2021-2022 timeframe. Further, several DRWG participants noted that it would be very challenging for Market Participants to develop EER savings for all hours that meet current precision and confidence interval requirements using a bottom-up approach, and all other approaches (other than Shaping Option A) would be more complex for the ISO to implement.

With respect to Shaping Option A, some DRWG participants questioned the need to use equations (4) and (5) to estimate EER performance in all hours (on-peak hours as well as off-peak hours). These participants suggested an alternative approach in which EER performance is assessed only for the hours for which we currently do not have values (i.e., off-peak hours). However, these participants did not address whether or how to attend to the discontinuity in the resulting on- and off-peak ACP values as previously described above. Furthermore, those stakeholders that were supportive of Shaping Option A did not indicate any preference towards using shaping Option A in all hours versus off-peak hours only.

Additionally, a DRWG participant noted the difference between equations (4) and (5) of Shaping Option A, particularly that the denominator of the ratio term in equation (5)[23] may be overstated, resulting in the understatement of the ACP. However, others with such resources commented that the denominator was generally correct given that the on-peak hours of Seasonal Peak Demand Resources occur only during very high system loads, 90% of the 50/50 seasonal peak.

While Shaping Option A received the most support relative to the other options discussed, some expressed opposition to the approach on the basis that the option can overstate EER performance and give EERs an ACP exceeding their balancing ratio-adjusted CSO during off-peak hours. These participants argued that this result does not make sense given that most end-use facilities are closed during non-business, overnight, and/or weekend hours. Those familiar with the measurement, verification, and delivery of energy efficiency responded to this, explaining that many Energy Efficiency measures do produce savings during off-peak hours – e.g., street lighting, parking lot lighting, security lighting, HVAC, refrigeration – so that some extent of EER performance during all off-peak hours ought to be expected, and concluding that Shaping Option A would result in an accurate representation of the capacity delivered by EERs in any single interval. Another reason given for why the ACP of an EER may exceed its balancing ratio-adjusted CSO is that Market Participants with EERs tend to install more Energy Efficiency measures than the quantity needed to meet their CSO.[24] Others stated that EERs can

[23] Equation (5) establishes the ACP of an EER that is participating in the FCM as part of a Seasonal Peak Demand Resource.

[24] For example, as of June 1, 2019, the summer seasonal audited capability of On-Peak and Seasonal Peak Demand Resources, the vast majority of which consist of EERs, was 3,012 MW (2,789 MW multiplied by the avoided T&D

underperform pursuant to Shaping Option A if an insufficient number of Energy Efficiency measures are installed relative to the CSO taken on. Finally, several participants who supported Shaping Option A as a feasible option requiring the least amount of time and expense to develop and implement among the options discussed did not necessarily support its use in establishing the ACP of EERs in off-peak hours; rather, their preferred approach would be to treat EERs neutrally during off-peak hours.

Because of differing positions taken by various DRWG participants, the DRWG could not establish a consensus. However, among the options reviewed by the DRWG, Shaping Option A was identified as the option requiring the least time and expense to develop and implement. It is hoped that the information provided in this report is helpful to the MC in its deliberations concerning whether and how to assess the ACP of EERs for CSCs that occur in off-peak hours.

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loss factor of 1.08) while the CSO of these resources was 2,751 MW – *see* https://www.iso-ne.com/static-assets/documents/2019/06/dr_stats_2019_07_01.pptx, slides 2 and 4. As of January 1, 2019, the winter seasonal audited capability of On-Peak and Seasonal Peak Demand Resources was 2,944 MW (2,726 MW multiplied by the avoided T&D loss factor of 1.08) while the CSO of these resources was 2,631 MW – *see* https://www.iso-ne.com/static-assets/documents/2019/01/dr_stats_2019_01_30_final.pptx, slides 2 and 4.