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RAA Model and Capacity Requirements under RCA

Review of proposed Resource Adequacy Assessment (RAA) Load Modeling and Capacity Requirement changes for the Resource Capacity Accreditation (RCA) project

Revision 1

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Resource Capacity Accreditation in the Forward Capacity Market | WMPP ID: 157

Proposed Effective Date: FCA 19 (with one year delay)

- The Resource Capacity Accreditation (RCA) project proposes improvements to the accreditation processes used for the Forward Capacity Market (FCM) by implementing methodologies that will more appropriately accredit resource contributions to resource adequacy as the resource mix transforms supporting a reliable transition to clean energy technologies
  - See the Key Project page for links to prior presentations
- Improvements are required to the Resource Adequacy Assessment (RAA) used currently to calculate capacity requirements (demand) and develop resource-specific accreditation values
- Focus of today is on changes being proposed to load modeling and Installed Capacity Requirement (ICR) and capacity transfer limit (CTL) calculations

Proposed Effective Date: FCA 19 (with a one-year delay)

Outline of today's discussion:

- RCA RAA Background (Slides 4-8)
- Proposed load modeling (Slides 9 -37)
- ICR and CTL calculations (Slides 36 -39)
- Stakeholder feedback (Slides 40-41)
- Appendix - Definitions and Acronyms (Slides 42-46)

RCA RAA BACKGROUND

Review of motivation for changes to the RAA under the RCA project

RAA is used to establish capacity requirements and demand curves and, under RCA, resource accreditation

- RAA is currently used as the basis for determining the system and local capacity requirements and demand curves
  - Determines the system's ability to meet the one-in-ten ("1-in-10") loss-of-load expectation (LOLE) reliability criterion
- Under RCA, the RAA is also being used as the basis for the development of resource-specific accreditation
  - Much more focus on individual resource's seasonal performance than the aggregate impacts to reliability of load and resource performance

Improvements to RAA modeling are required for more accurate MRI-based accreditation

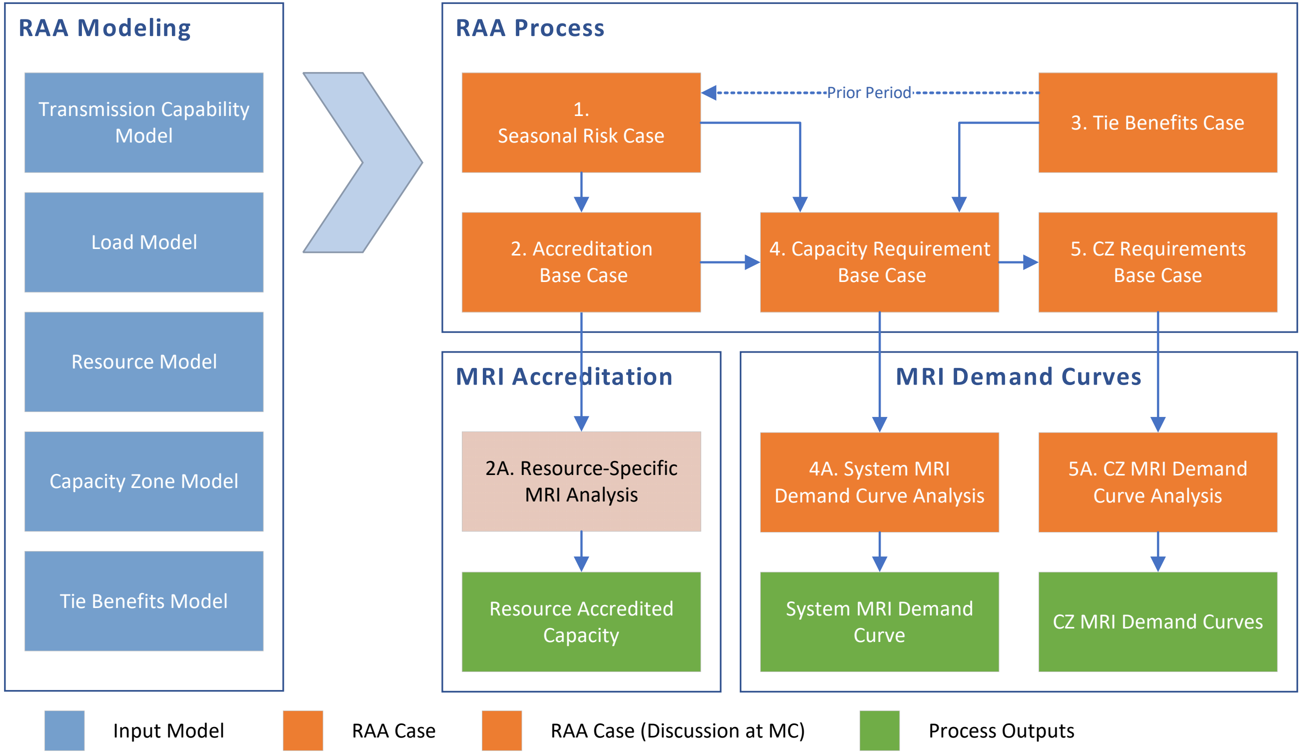
- A marginal approach to accreditation is conceptually a measure of the expected performance of resources during hours of reliability risk (*e.g.*, system is experiencing loss of load)
- Improvements to the RAA will better identify when loss-of-load (LOL) events occur and their duration, and will improve how individual resource performance is reflected during these events
- There are four broad drivers of changes being considered in the RAA:
  - Model system conditions with greater accuracy and granularity
  - Better capture resources' performance and interactions among different resources
  - Better reflect the correlation between resources' performance and system loading conditions and weather
  - Improve modeling consistency among different types of resources

All aspects of the RAA are impacted by the proposed RCA improvements

- **RAA Process.** Defines the modeling approach and input assumptions for each RAA case:
  - Seasonal Risk Case
  - Accreditation Base Case
  - FCA System Capacity Requirement Base Case
  - FCA Zonal Capacity Requirement Base Cases*
  - ARA-related cases*
- **Load Model.** Defines how the expected load is represented in the RAA cases:
  - Seasonal Load Shape and Peak Uncertainty Factors
  - Energy Uncertainty Factors
  - Passive Demand Resource Treatment
  - Behind-the-Meter Solar and other Load Modifiers
- **Resource Model.** Defines the modeling approach and input assumptions associated with each resource type:
  - Generation Capacity Resource
  - Demand Capacity Resource
  - Import Capacity Resource
  - Distributed Energy Capacity Resource
- **Tie Benefits Model.** Defines how the seasonal tie benefits are established
- **Transmission Interface Model.** Defines expected capacity transfer capability (CTC) for the external and internal interfaces*

* Items that will be discussed in RCA Phase II for FCA19

Conceptual RAA Process Flow



PROPOSED LOAD MODELING

Review of proposed modeling improvements for how load is represented in the RAA

Current load modeling process in the RAA

- A base hourly gross load profile is first developed by scaling the 2002 hourly load shape to reflect the forecasted seasonal "gross" peaks, which reflect the passive demand resource (PDR) reconstitution, but do not account for the impacts from BTM solar and transportation electrification load
  - BTM solar is modeled separately as a load modifier using hourly profiles to reduce the hourly gross load
  - Transportation electrification load is modeled separately as a load modifier using hourly profiles to increase the hourly gross load
  - Existing qualified PDRs are modeled as a supply resource
    - The amount could be different from the PDR reconstitution
- The base hourly load profile is further scaled to different levels (higher or lower) reflect the daily peak load forecast uncertainty due to weather
  - Each load level has different probability of occurring based on the daily peak load forecast uncertainty distributions
- Reference Section 5.4 of ICR Reference Guide for more details

Current load modeling process largely remains unchanged with four targeted changes

- 2002 hourly load shape will be replaced with a composite seasonal load shape that is based on the 2021 annual net load characteristics and reflecting 2021 hourly weather for the Solar Summer Period and the 2013/14 hourly weather for the Solar Winter Period
- PDR reconstitution will be removed from the gross load forecast, and existing qualified PDRs will be removed from the supply side
  - Difference between PDR reconstitution and existing qualified PDRs is reflected in the RAA as a load modifier using profiles to either increase or decrease the load
- Different energy scaling factors will be applied when the base hourly load profile is scaled to different levels to reflect daily peak load forecast uncertainty due to weather
- BTM solar will be modeled consistently with supply-side solar resources

SEASONAL LOAD SHAPE

Review of changes to the seasonal load shape used in the RAA under RCA

Composite load shape is developed to reflect the hourly load characteristics under the historical weather

- Use historical hourly weather conditions of 2021 for the Solar Summer Period, and the 2013/14 for the Solar Winter Period
  - For the summer will be based on the 2021 actual net hourly load during the summer
  - For the winter will be developed based on the 2021 winter load response functions and the historical hourly weather from 2013/14
- 2021 summer and 2013/2014 winter weather conditions are considered representative for resource adequacy studies by NPCC and are used for its seasonal assessments
  - Heat waves in 2021 summer and cold snaps in 2013/2014 winter and exposure to seasonal peaks for multiple days
  - Close correlation across NPCC regions
  - Additional information from NPCC on 2021 load shape and 2013/14 load shape

2021 load characteristics reflect more up-to-date load characteristics

- As technologies have evolved over years, the 2021 hourly load characteristics have inherently captured their impacts more accurately, e.g.
  - Large amounts of PDR and BTM solar have been installed in the system, which are not captured by 2002 load shape

PASSIVE DEMAND RESOURCE MODELING

Review of changes to how the Passive Demand Resources are reflected in the RAA under RCA

PDR are currently modeled as supply resources with adjustments reflected in the gross loads

- Currently, PDRs are modeled in the RAA as a supply resource
  - On the supply side, PDRs (including both on-peak and seasonal-peak demand resources) are assumed to be 100% available at their summer QC for all hours during the year
- To avoid the double counting, they are also reconstituted into the gross load forecast
  - On the demand side, PDRs are reconstituted into the gross load forecast using a forecasted amount based on CSOs from recent FCA and estimated hourly reduction impact profiles, also subject to the adjustments to the load (e.g., ALCC)
- Ideally PDRs' impact on the supply side should offset their impact on the demand side, but there is some differences exist because of the adjustments on the load modeling side and use of different values

PDR will be modeled as load modifier under RCA with an associated profile

- PDR reconstitution will be removed from the gross load forecast, and existing qualified PDRs will be also removed from the supply side
  - Eliminates load adjustments causing differences between supply and demand side assumptions
- Difference between PDR forecast and existing qualified PDRs will be reflected in the RAA as a load modifier using hourly profiles to either increase or decrease the load
  - Profiles will be developed based on the profiles used for PDR reconstitution in the gross load forecast
- For accreditation:
  - Seasonal MRI will be calculated for all PDR using a proxy profiled RAA Resource based on the hourly profiles used in the RAA
  - Additional detail planned for March NEPOOL Markets Committee

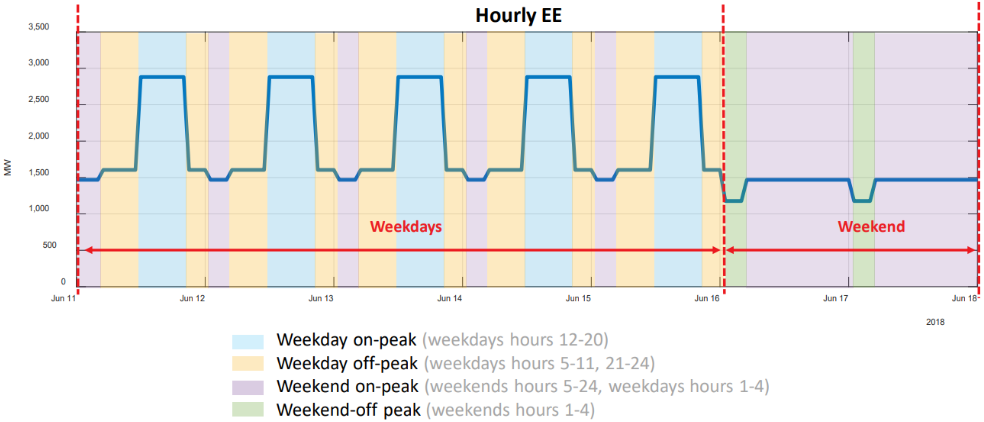
DEVELOPMENT OF HOURLY PROFILES FOR PDR

Review how the hourly profiles for load adjustment associated with PDR is established

PDR reconstitution in load forecast

- Hourly profiles are used to estimate the hourly demand deduction impact of PDR in the gross load forecast
  - Different hourly profiles for weekday and weekend
  - Different profiles for each month
- Reference [Long-Term Load Forecast Methodology Overview] for detailed information on PDR reconstitution methodology

Illustrative PDR hourly profile

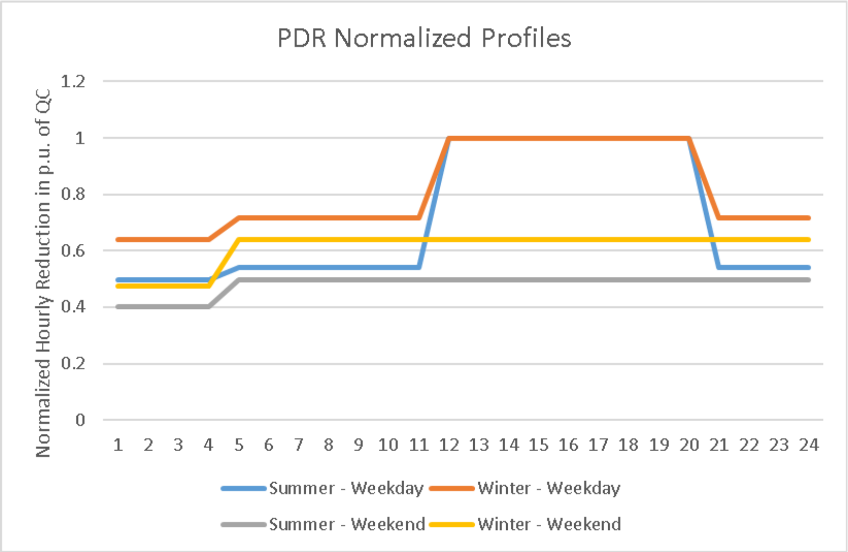


Two representative daily profiles will be used for each month; weekday and weekend

- Monthly profiles will be developed based on the profiles used in the PDR reconstitution in the most recent load forecast cycles
  - Data for each month and year are normalized to load adjustment for the day type (weekend and weekday)
  - Values are then averaged across to create a five-year average

Example: Hourly Profiles for PDR

- Graph shows the average monthly normalized profiles for
  - Weekday and weekend of summer months from June to September
  - Weekday and weekend of winter months from December to February



Example: Hourly PDR Load Modifier

- Assumptions:
  - PDR reconstitution: 8 MW
  - Existing PDR QC: 10 MW
- A net of 2 MW to adjust the load down using a hourly profile
  - This same profile forms the basis for the accreditation

HE	Demand: Forecasted w/QC Adjustment					
	Forecasted Capacity (MW)	Qualified Capacity (MW)	Hourly Profile (%)	Hourly Load Adjustmemt (MWh)	Net Load (MWh)	Adjusted Net Load (MWh)
13	8	10	70%	-1.4	100	98.6
14	8	10	90%	-1.8	110	108.2
15	8	10	90%	-1.8	115	113.2
16	8	10	90%	-1.8	120	118.2
17	8	10	90%	-1.8	118	116.2
18	8	10	70%	-1.4	114	112.6

ENERGY SCALING FACTORS

Review of how energy scaling is applied when the base hourly load profile is scaled to the different levels to reflect daily peak load forecast uncertainty due to weather

Implied energy scaling in current load model

- Currently the base hourly load profile is scaled to different levels (higher or lower) reflect how would the daily peaks may vary due to weather
- Loads in other hours during the day are also scaled up and down using the same scaling factors that are developed for the daily peaks
  - This essentially means the total energy would also change at the same rate, which may not be the case

Inverse relationship between energy and peak

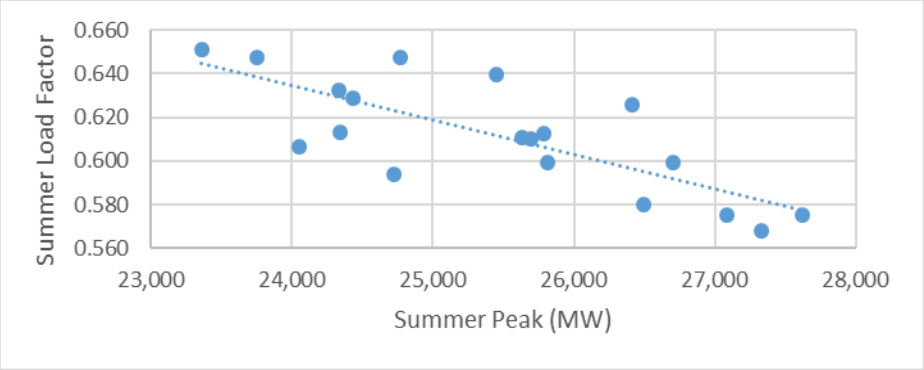
- Load factor, which is the ratio of average demand (load) to maximum demand (load) during a period of time, is a good metric to establish a linkage between the energy consumption and the peak load

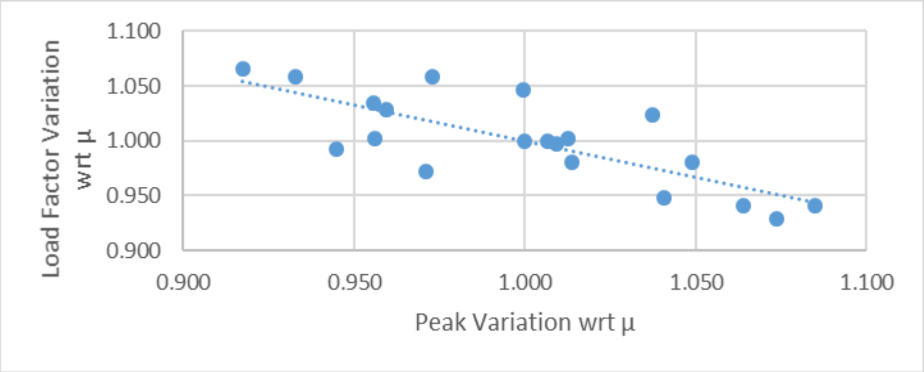
$$Load\ Factor = {}^{Average\ Load}/_{Peak\ Load}$$

- New England's energy and peak values tend to have an inverse relationship, meaning that higher peaks tend to correspond to lower load factors (refer to plots on the next slide)
- Therefore, historical seasonal peaks and energy can be used to establish a mathematical relationship between the peak and load factor through curve fitting
  - The resulting curve fitting will then be used to calculate the energy scaling factor for any given peak scaling factor

Historical load factors

- Top graph shows an inverse relationship between summer load factor and summer peak based on the last 20 years of historical data
- Bottom graph shows that change relative to mean value is not one-to-one between load factor and peak loads
  - Downward slopping linear curve can be used to describe how the load factor would vary when the peak deviates from its mean value

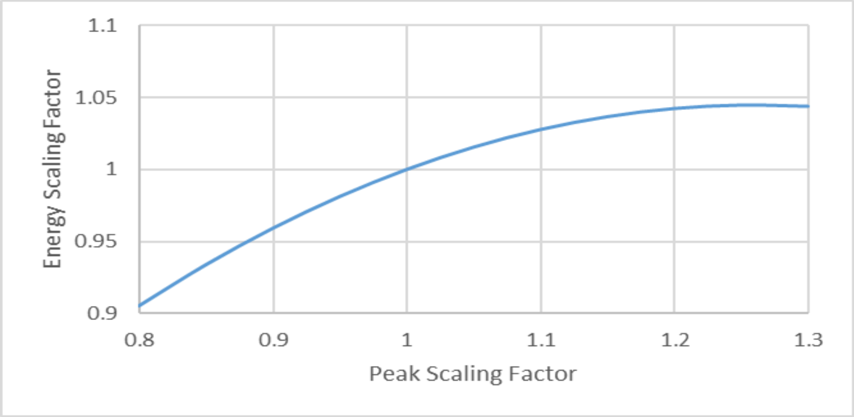




Proposed using different energy scaling factor

- Energy variation corresponding to a given peak load variation will be calculated as the product of load factor variation and peak load variation
  - The graph shows the corresponding energy scaling factor for a given peak scaling factor
- Energy and peak load scaling factors will be developed for three periods
  - Summer Season: June – September
  - Peak Winter Period: December – February
  - Non-Peak Winter Period: March – May, October – November

	Scaling Factor wrt Mean					
Summer Peak Scaling	0.8	0.9	1	1.1	1.2	1.3
Estimated Load Factor Scaling	1.131	1.066	1	0.934	0.869	0.803
Resulting Energy Scaling	0.905	0.959	1	1.028	1.042	1.044



BTM SOLAR PROFILES

Review of changes to how the BTM Solar magnitude and profiles are used in the RAA under RCA

BTM solar forecast level modeled in RAA

- Composite hourly shape is based on 2021 actual net load characteristics, which have inherently reflected the impact of the BTM solar already installed in the system
  - The winter hourly loads are developed based on the 2021 winter actual net load response to 2013/14 weather such that they have also implicitly reflected the impact of BTM solar already installed in the system
- Only the incremental BTM solar beyond 2021 actual installation will be modeled in the RAA as a load modifier using the profiles to reduce the gross load

BTM solar will be treated consistent with the modeling for the supply-side solar resources in RAA

- Continue to use a single hourly profile to model BTM solar in the Solar Summer Period to capture the correlation between solar output and load
  - Hourly profile will be now based on the 2021 hourly weather
  - Continue to incorporate output uncertainties by randomly selecting a daily profile within a 7-day window (+/-3 days) for the day under study
- Use multiple profiles based on the most recent five full calendar years' weather for the Solar Winter Period
  - Not a strong correlation between load level and solar performance in the winter
  - One of these composite hourly profiles will be randomly selected with equal probability for each replication during the simulation

REVISED LOAD MODELING PROCESS

Base hourly gross load profile is developed using the same process as today

- Base hourly gross load profile is first developed by scaling the composite load shape to reflect the forecasted seasonal "gross" peaks
  - Forecasted seasonal "gross" peaks do not reflect the PDR reconstitution or the impacts from incremental BTM solar beyond 2021 installation level and transportation electrification load
- The base hourly gross load profile will be further adjusted to an energy target based on historical average load factor for different periods
- The base hourly gross load continues to be scaled to different levels (higher or lower) reflect the daily peak load forecast uncertainty due to weather, and will be further adjusted using the corresponding energy scaling factors

Hourly gross load profile is further adjusted for load modifiers for use in the RAA

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- Incremental BTM solar beyond 2021 installation level will be modeled separately as a load modifier using hourly profiles to reduce the hourly gross load
- Transportation electrification load continues to be modeled separately as a load modifier using hourly profiles to increase the hourly gross load
- Difference between PDR forecast and existing qualified PDRs will be reflected in the RAA as a load modifier using hourly PDR profiles to either increase or decrease the hourly gross load

KEY TAKEAWAYS

Summary of load modeling enhancements

- A composite seasonal load shape is used to reflect more up-to-date load characteristics and reasonably stressed weather conditions for both summer and winter seasons
- Different peak and energy scaling factors are used to better capture peak load and energy uncertainty due to weather
- BTM solar will be modeled consistently with the supply-side solar resources
- PDR reconstitution is removed from the gross load forecast, and existing qualified PDR resources are removed from the supply side. The difference between PDR reconstitution and existing qualified PDRs is reflected in the RAA model as a load modifier using profiles to either increase or decrease the hourly gross load

CAPACITY REQUIREMENTS

Review implications and changes required to the installed capacity requirement (ICR) and capacity transfer limit (CTL) calculations under RCA

Capacity requirements calculations are conceptually unchanged from what is done today

- Net ICR and ICR will continue to be calculated in the context of summer qualified capacity (QC)
  - MRI system demand curves are also calculated using the same process as today
- CTL calculation for each external interface will continue be calculated in terms of QC, but now be calculated for the Summer and Winter Season separately
- How these are transformed into QMRIC terms will be discussed at an upcoming NEPOOL Markets Committee meeting

ICR calculations are conceptually unchanged from today and remain based upon summer capability

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$$ICR = \frac{Capacity_{Summer} - TB_{Summer} - OP4_{Summer}}{1 + \frac{ALCC}{50/50\ Peak\ Load_{Summer}}} + HQICC_{Summer}$$

$$Net\ ICR = ICR - HQICC_{Summer}$$

- Capacity is the summer QC of all of the capacity resources modeled in the Capacity Requirements Base Case plus the tie benefits and OP4 action values
  - Capacity includes the total amount of Import Resource capacity modeled in the RAA
- Tie Benefit (TB) is the summer tie benefits value
- OP4 actions are the summer load relief associated with the voltage reduction
- Adjusted load carrying capability (ALCC) is the additional load that can be met in the RAA without violating the 0.1 days/year LOLE
- HQICC is the is the summer tie benefit capacity value associated with the HQ Phase II interconnection

CTL calculations for each external interface are now calculated seasonally

- For each non-elective transmission upgrade (ETU) interface:

$$CTL_{Interface,Season} = CTC_{Interface,Season} - Tie\ Benefit_{Interface,season}$$

  - CTC is the capacity transfer capability (CTC) for the interface in each season
  - Tie benefit is the tie benefit value associated with the interface in each season

- For each ETU interface:

$$CTL_{Interface,Season} = Proposed\ CNIC_{Interface,Season} + Realized\ CNIC_{Interface,Season}$$

  - Proposed CNIC is any new capacity network interconnection capability (CNIC) proposed for interface that has not cleared
  - Realized CNIC is any CNIC that has previously been cleared and not retired

STAKEHOLDER FEEDBACK

Review stakeholder feedback received on Resource Modeling discussion

Stakeholders have raised questions on the resource modeling which the ISO are evaluating

- General
  - Process to challenge various input values used in the RAA
  - Using an at-criteria system for the RAA base cases
- Intermittent Power Resources
  - Development of profiles for new intermittent resources
  - Adjustments to profiles for historical curtailments
- Import Resources
  - Establishment of the quantity of Import capacity to include in the RAA
  - Use of outage rates for pool-backed Import capacity
- Active Demand Resources
  - Development of profiles for new active demand resources
- Tie Benefits
  - Assumed performance of tie benefit being near perfect capacity
  - Monthly assumptions associated with tie benefits values
  - Use of approximated values in the winter period
- Fuel Requirements
  - Application of a linear approach for establishing the daily operating hours requirement (DOHR)
  - Discussion of the proxy energy storage and its relation to how DOHR is established

RAA MODEL DESIGN RECAP

Review what aspects of the RAA Model design have been discussed with stakeholders and what remains to review

All aspects of the RAA are impacted by the proposed RCA improvements

- **RAA Process.** Defines the modeling approach and input assumptions for each RAA case:
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- **Load Model.** Defines how the expected load is represented in the RAA cases:
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* Items that will be discussed in RCA Phase II for FCA19

Questions

APPENDIX 1: DEFINITIONS AND ACRONYMS

Summary of new "defined" terms and acronyms used within this material

Time Period Definitions

Period	Start	End
Capacity Commitment Period (CCP)	June (Year)	May (Year+1)
Calendar Year (CY)	January	December
Summer Season (default)	June	September
Winter Season (default)	October (Year)	May (Year+1)
Demand Resource Summer Period	April	November
Demand Resource Winter Period	December (Year)	March (Year+1)
Solar Summer Period	April	September
Solar Winter Period	October (Year)	March (Year+1)
Gas/Oil Peak Winter Period	December (Year)	February (Year+1)
Gas/Oil Non-Peak Winter Period	October (Year) March (Year+1)	November (Year) May (Year+1)

Acronyms

ADCR	Active Demand Capacity Resource
ARA	Annual Reconfiguration Auction
CY	Calendar Year
CCP	Capacity Commitment Period
CNRC	Capacity Network Resource Capability
CTC	Capacity Transfer Capability
CTL	Capacity Transfer Limit
DR	Demand Resource
DFO	Distillate Fuel Oil

DECR	Distributed Energy Capacity Resources
DRR	Demand Response Resource
ENC	Effective Nameplate Capacity
ETU	Elective Transmission Upgrade
ESR	Energy Storage Resource
xEFORd	Equivalent forced outage rate on demand excluding events out of management control
FCA	Forward Capacity Auction

Acronyms

FCM	Forward Capacity Market
IPR	Intermittent Power Resource
HDD	Heating Degree Day
LOL	Loss of Load
LOLE	Loss of Load Expectation
MRI	Marginal Reliability Impact
MC	NEPOOL Markets Committee
MW	Megawatt
MWh	Megawatt-hour

NC	Nameplate Capacity
NEPOOL	New England Power Pool
NRC	Network Resource Capability
NERC	North American Reliability Council
NPCC	Northeast Power Coordinating Council
PDR	Passive Demand Resources
PC	Perfect Capacity
POI	Point of Interconnection

Acronyms

PSH	Pumped-Storage Hydro
QC	Qualified Capacity
QMRIC	Qualified MRI Capacity
RC	NEPOOL Reliability Committee
RCA	Resource Capacity Accreditation
RAA	Resource Adequacy Assessment
RFO	Residual Fuel Oil

SCC	Seasonal Claimed Capability
TB	Tie Benefits
WTHI	Weighted Temperature Humidity Index