Resource Capacity Accreditation in the Forward Capacity Market

FCA 18/19 Base Case Accreditation

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

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

- The Resource Capacity Accreditation (RCA) project proposes improvements to ISO-NE's accreditation processes in the Forward Capacity Market (FCM) to further support a reliable, clean-energy transition by implementing methodologies that will more appropriately accredit resource contributions to resource adequacy as the resource mix transforms
- At the January 2024 Markets Committee (MC) meeting, the ISO provided an overview of how the impact analysis would be updated from April 2023
- This presentation summarizes FCA 18/19 base case assumptions, provides directional insights into marginal reliability impacts (MRIs), and details capacity accreditation for the FCA 18/19 base case

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Outline of today's discussion:

REVIEW OF IMPACT ANALYSIS PLAN

Impact Analysis Phases

- The impact analysis has three phases
  - Phase 1: Base Case Resource Accreditation (today)
  - Phase 2: Resource Accreditation Sensitivities (March 2024)
  - Phase 3: Base Case Capacity Market Impact (April 2024)
- This presentation summarizes resource accreditation results for the FCA 18/19 base case (Phase 1)

Responses to January 2024 MC Questions

- Can the base case use FCA 18 load instead of FCA 19 load?
  - FCA 18 load could be used *given adequate time*, but the results would not be comparable to production FCA 18. RAA modeling changes affect demand curves. In addition, applying FCA 18 load would not provide a meaningful projection of the seasonal risk split for FCA 19; the accreditation results would not be the best estimate of FCA 19 accreditation under the RCA design.
- Can market clearing be performed for sensitivity scenarios?
  - Market clearing may be possible for Scenario 4 *given adequate time* because no new resources would be introduced. Other scenarios would require the creation of new resources and offers in the ISO's FCM databases, a complex and assumption-driven undertaking.
- Will onshore wind be distinguished from offshore wind?
  - No, there are not enough offshore wind resources to prevent revealing private performance information.

Phase 1 Results

- Today's presentation includes:
  - Class-level results
    - Relative MRI (rMRI) (FCA Qualified Capacity (FCA QC)-weighted average)
    - Seasonal MRI (seasonal QC-weighted average)
    - Total qualified MRI capacity (QMRIC)
  - Other results
    - Seasonal risk split
    - Loss of Load Hour (LOLH) information
    - Uniform derating factor for gas resources
    - Net Installed Capacity Requirement (Net ICR)
- Most slides are adaptations of April 2023 slides

FCA 18/19 BASE CASE DETAILS

FCA 18 ICR Case as Starting Point

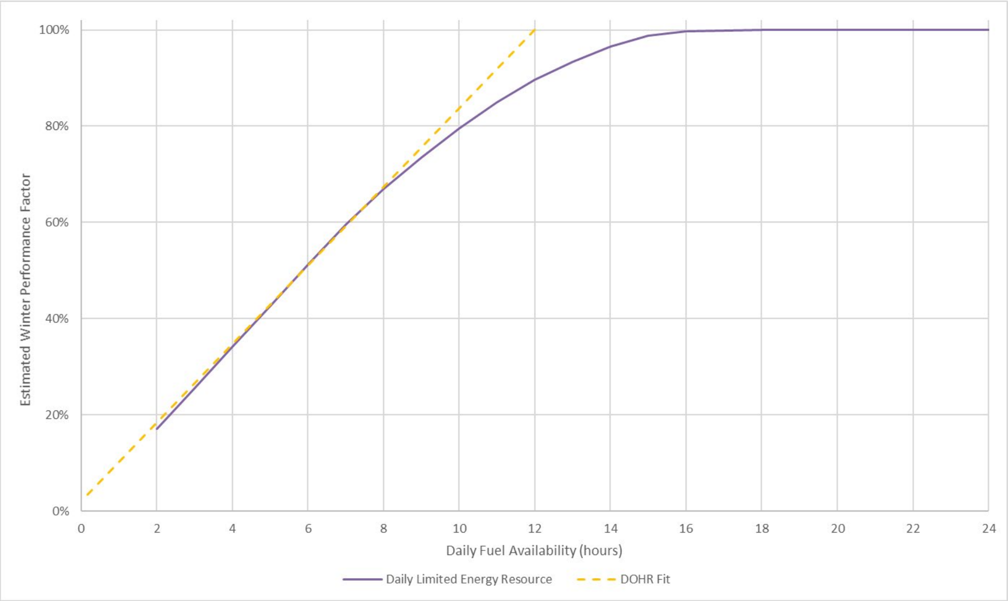
- Load model based on 2023 CELT load forecast for Capacity Commitment Period 2028-2029 (FCA 19)
- Resource mix from FCA 18 ICR case
  - Model FCA 13-cleared imports instead of existing imports (84MW) in the FCA 18 ICR case
- Updated resource adequacy assessment (RAA) resource models that reflect proposed modeling enhancements
  - Note: 100% round trip efficiency for storage will be assumed for the entirety of the impact analysis due to ambiguities in GE MARS charging logic under efficiency losses that need to be further investigated (material impacts appear unlikely at this time)

Season Definitions

- As described at the December 2023 Reliability Committee (RC) Meeting, months are grouped into the following seasons
  - **Summer**: June – September
  - Winter: October – May
    - **Peak winter period**: December – February
    - Non-peak winter period: March – May, October – November

Daily Operating Hours Requirement (DOHR)

- Based on the methodology presented at the January 2024 RC Meeting, the DOHR is 12 hours



Seasonal Operating Hours Requirement (SOHR) and Fuel Storage Hours Requirement (FSHR)

- SOHR = 11 x DOHR = 132 hours
- FSHR = 4 x DOHR = 48 hours
- Only existing fuel arrangements (oil storage and firm gas transport) prior to FCA 18 were considered in the FCA 18/19 base case
  - For resources with shared fuel storage, fuel was allocated so each resource had the same fuel storage hours
  - The topic of oil replenishment contracts is scheduled for discussion at the March 2024 MC meeting

RESULT INTERPRETATION

Impact Analysis Resource Classes

- Results are provided for aggregate resource classes
- Resource classes have been formulated to closely align with qualified fuel type consistent with how RAA modeling changes have been presented at the RC
- High-level classes in this presentation
  - Dual Fuel, Gas-only, Other Non-IPR, Passive DR, Oil-only, Energy Storage, Import, Other IPR, ADCR, IPR Wind, IPR PV, Hybrid, Fuel Cell, Non-IPR Hydro, IPR Hydro
  - Class assignment information is provided in Appendix A

Properties Generally Associated with Higher MRIs

- Resources modeled as thermal resources
  - Smaller capacity
    - Reason: Forced outage of a small resource is less likely to cause loss of load
  - Lower Equivalent Demand Forced Outage Rate (xEFORd)
    - Reason: Resource is less likely to be on forced outage during RAA MRI hours
- Resources modeled as storage resources
  - Longer storage duration
    - Reason: More stored energy is available during RAA MRI hours
- Resources modeled using output profiles
  - Temporal correspondence between output and RAA MRI hours

Properties Generally Associated with Lower MRIs

- Resources modeled as thermal resources
  - Larger capacity
    - Reason: Forced outage of a large resource is more likely to cause loss of load
  - Higher xEFORd
    - Reason: Resource is more likely to be on forced outage during RAA MRI hours
- Resources modeled as storage resources
  - Shorter storage duration
    - Reason: Less stored energy is available during RAA MRI hours
- Resources modeled using output profiles
  - Lack of temporal correspondence between output and RAA MRI hours

Refresher: Annual MRI, rMRI, and QMRIC

Units

$$Annual\ MRI = -\frac{\Delta EUE_{Annual}}{\Delta FCA\ QC}$$ hour/year

$$= \frac{Change\ in\ expected\ net\ energy\ output\ during\ RAA\ MRI\ hours\ per\ year}{Change\ in\ FCA\ QC}$$

$$= Expected\ net\ number\ of\ hours\ available\ at\ FCA\ QC\ during\ RAA\ MRI\ hours\ per\ year$$

$$Annual\ MRI_{perfect} = Expected\ number\ of\ RAA\ MRI\ hours\ per\ year$$ hour/year

$$rMRI = \frac{Expected\ net\ number\ of\ hours\ available\ at\ FCA\ QC\ during\ RAA\ MRI\ hours\ per\ year}{Expected\ number\ of\ RAA\ MRI\ hours\ per\ year}$$ unitless

$$QMRIC = FCA\ QC \times rMRI = Expected\ net\ energy\ output\ in\ each\ RAA\ MRI\ hour$$ MW

Refresher: Seasonal MRI and QMRIC

Units

$$Seasonal\ MRI = -\frac{\Delta EUE_{Annual}}{\Delta Seasonal\ QC} = -\frac{\Delta EUE_{Seasonal}}{\Delta Seasonal\ QC}$$ hour/year

$$= \frac{Change\ in\ expected\ net\ energy\ output\ during\ seasonal\ RAA\ MRI\ hours\ per\ year}{Change\ in\ Seasonal\ QC}$$

$$= Expected\ net\ number\ of\ hours\ available\ at\ seasonal\ QC\ during\ seasonal\ RAA\ MRI\ hours\ per\ year$$

$$Seasonal\ MRI_{perfect} = Expected\ number\ of\ seasonal\ RAA\ MRI\ hours\ per\ year$$ hour/year

$$Seasonal\ QMRIC = Seasonal\ QC \times \frac{Seasonal\ MRI}{Annual\ MRI_{perfect}}$$ MW

$$= Seasonal\ QC \times \frac{Seasonal\ MRI}{Seasonal\ MRI_{perfect}} \times \frac{Seasonal\ MRI_{perfect}}{Annual\ MRI_{perfect}}$$

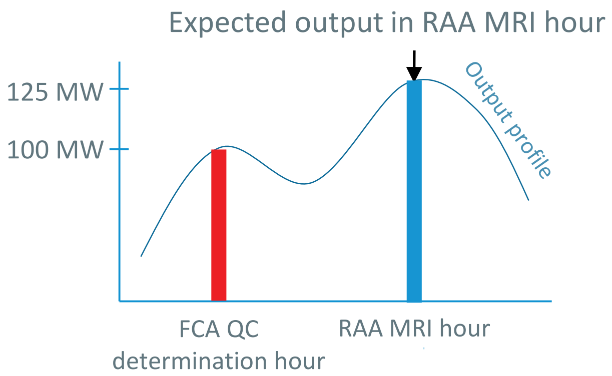
$$= Expected\ net\ energy\ output\ in\ each\ seasonal\ RAA\ MRI\ hour \times \frac{Expected\ number\ of\ seasonal\ RAA\ MRI\ hours\ per\ year}{Expected\ number\ of\ RAA\ MRI\ hours\ per\ year}$$

rMRI > 1 due to Different Seasonal QCs

- Assume 2 RAA MRI hours per year (1 hour summer, 1 hour winter) so $Annual\ MRI_{perfect} = 2\ hours$
- Consider a thermal resource with EFORd = 0, FCA QC = Summer QC = 100 MW, and Winter QC = 150 MW
- Changing the thermal resource’s FCA QC by 1 MW (1%) changes its expected energy output during RAA MRI hours by 2.5 MWh per year: 1 MWh summer + 1.5 MWh winter)
  - $Annual\ MRI = \frac{1\ MWh + 1.5\ MWh}{1\ MW} = 2.5\ hours$
  - $rMRI = \frac{2.5\ hours}{2\ hours} = 1.25$
- Because of the thermal resource’s seasonal QC difference, 1 MW of its FCA QC contributes 25% more to reliability than 1 MW of perfect capacity FCA QC

rMRI > 1 due to Profiled Output

- Consider a 200 MW nameplate resource with profiled output
  - FCA QC = 100 MW
  - 1 RAA MRI hour
- Based on the output profile,
  - $Annual\ MRI = \frac{1.25\ MWh}{1\ MW} = 1.25\ hours$
  - $rMRI = \frac{1.25\ hours}{1\ hour} = 1.25$



- Because the resource's output profile is not limited by FCA QC, 1 MW of its FCA QC contributes 25% more to reliability than 1 MW of perfect capacity FCA QC

rMRI > 1 Does Not Imply an Inflated QMRIC

- Even when $rMRI > 1$, QMRIC is correct
- For both rMRI > 1 examples,
  - $QMRIC = FCA\ QC \times rMRI = 100\ MW \times 1.25 = 125\ MW$
  - Interpretation: From a reliability contribution perspective, the resource is equivalent to 125 MW of perfect capacity. This outcome is sensible because the resource is not subject to outages and has an expected output of 125MW during the RAA MRI hours.

Importance of the Seasonal Risk Split

- The seasonal MRI split for perfect capacity has a significant impact on accreditation for resources with different seasonal capabilities
- From Slide 18, $Seasonal\ QMRIC = Seasonal\ QC \times \frac{Seasonal\ MRI}{Seasonal\ MRI_{perfect}} \times \frac{Seasonal\ MRI_{perfect}}{Annual\ MRI_{perfect}}$
- For simplicity, consider a thermal resource with Summer QC = 100MW, Winter QC = 40MW, and xEFORd = 0
  - xEFORd = 0 implies $\frac{Seasonal\ MRI}{Seasonal\ MRI_{perfect}} = 1$
- Accreditation outcomes under different perfect capacity MRI splits are below

	Summer/Winter MRI Split for Perfect Capacity				
	100/0	**75/25**	**50/50**	**25/75**	**0/100**
Summer QMRIC	100	75	50	25	0
Winter QMRIC	0	10	20	30	40
Annual QMRIC	100	85	70	55	40

RESULTS

Disclaimer

- These results represent the ISO’s best efforts to reflect the proposed design; however, they do not reflect a full production-level implementation
- The results should be understood as representative for FCA 19 based on the ISO’s most recent forecasts and assumptions

Key Findings

- Risk Assessment Case
  - Loss of Load Expectation (LOLE) split: 80% summer, 20% winter
- Accreditation Case
  - Perfect capacity MRI split: 72% summer, 28% winter
  - QMRIC share decreased for gas-only, oil-only, energy storage, ADCR, hybrid, and IPR PV classes (relative to FCA QC share)
  - Gas derating factor = 62.34%
    - Gas resources with 10,302MW Winter QC are expected to produce 4,014 MW during winter RAA MRI hours
  - QC-based Net ICR = 31,607 MW; QMRIC-based Net ICR = 26,139 MW

Achieving LOLE = 0.1 day/year

- Risk assessment case had a probability-weighted LOLE split of ~80% Summer, ~20% Winter
  - Gas and oil modeling/assumptions are based on the proposal from the January 2024 RC Meeting
  - Annual ALCC = 2,044 MW
- In the accreditation case, winter load scaling was used to reproduce the 80-20 LOLE split
  - Summer LOLE = 80.3%, Winter LOLE = 19.7%
  - Summer LOLH = 79.9%, Winter LOLH = 20.1%
  - Summer EUE = 83.0%, Winter EUE = 17.0%
- All following results are for the accreditation case

LOLH Heat Map

- LOLHs occurred in
  - June through September
    - Low July LOLH frequency due to mild 2021 July weather
  - December through February
- January had at least one Loss of Load (LOL) observation in each hourly bin
  - Implies rare LOL events crossing daily boundaries
- Substantial number of peak winter period LOLHs in evening/night

LOLH Distribution

Hour of Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0.01%	<0.005%	-	-	-	-	-	-	-	-	-	-	0.01%
2	<0.005%	-	-	-	-	-	-	-	-	-	-	-	<0.005%
3	<0.005%	-	-	-	-	-	-	-	-	-	-	-	<0.005%
4	<0.005%	-	-	-	-	-	-	-	-	-	-	-	<0.005%
5	<0.005%	-	-	-	-	-	-	-	-	-	-	-	<0.005%
6	<0.005%	-	-	-	-	-	-	-	-	-	-	-	<0.005%
7	0.01%	<0.005%	-	-	-	-	-	-	-	-	-	-	0.01%
8	0.09%	<0.005%	-	-	-	-	-	-	-	-	-	<0.005%	0.09%
9	0.16%	<0.005%	-	-	-	-	-	-	-	-	-	<0.005%	0.16%
10	0.21%	<0.005%	-	-	-	-	-	-	-	-	-	0.01%	0.21%
11	0.18%	<0.005%	-	-	-	-	-	-	-	-	-	0.01%	0.20%
12	0.16%	-	-	-	-	0.01%	-	<0.005%	-	-	-	0.02%	0.19%
13	0.11%	-	-	-	-	0.16%	<0.005%	<0.005%	-	-	-	0.03%	0.30%
14	0.12%	-	-	-	-	0.91%	<0.005%	0.07%	-	-	-	0.05%	1.16%
15	0.14%	-	-	-	-	2.09%	<0.005%	0.67%	-	-	-	0.10%	3.00%
16	0.17%	-	-	-	-	3.25%	0.02%	2.08%	-	-	-	0.24%	5.76%
17	0.26%	-	-	-	-	4.72%	0.06%	4.44%	<0.005%	-	-	0.75%	10.24%
18	1.14%	<0.005%	-	-	-	7.19%	0.17%	8.65%	<0.005%	-	-	2.39%	19.54%
19	1.07%	<0.005%	-	-	-	7.67%	0.17%	8.48%	<0.005%	-	-	2.42%	19.81%
20	1.51%	<0.005%	-	-	-	7.18%	0.08%	8.27%	<0.005%	-	-	2.77%	19.82%
21	1.13%	<0.005%	-	-	-	5.14%	0.02%	4.78%	<0.005%	-	-	2.03%	13.09%
22	0.65%	<0.005%	-	-	-	2.46%	<0.005%	1.16%	-	-	-	1.43%	5.70%
23	0.27%	<0.005%	-	-	-	0.01%	-	<0.005%	-	-	-	0.31%	0.59%
24	0.11%	<0.005%	-	-	-	-	-	-	-	-	-	0.01%	0.11%
Monthly	7.49%	<0.005%	-	-	-	40.79%	0.53%	38.60%	0.01%	-	-	12.58%	100.00%

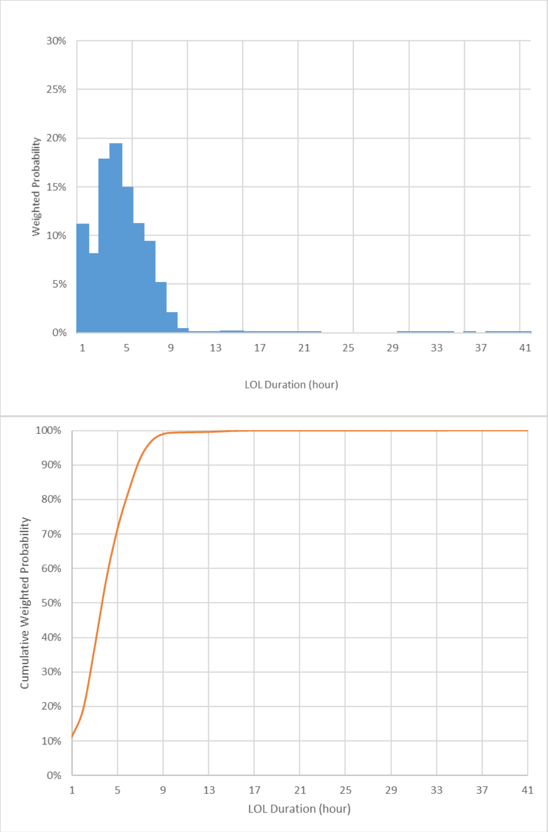
Annual LOL Durations

- MRI is a function of EUE, which depends on load level probabilities

  EUE =

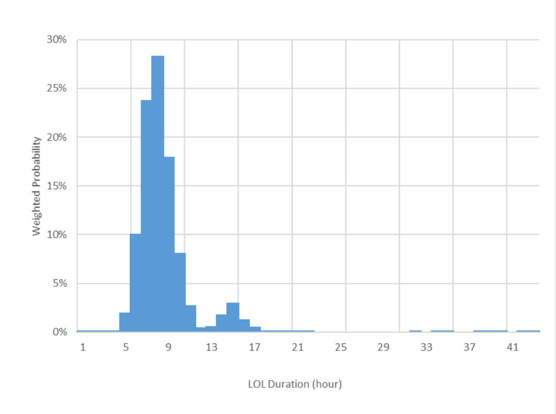
  ∑(Load level probability x Unserved energy for load level) / 5000

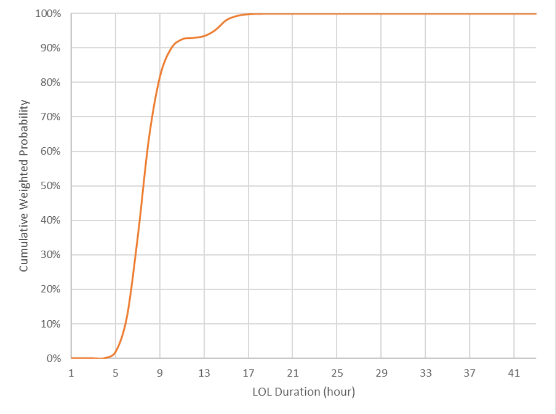
- It is useful to summarize LOL durations using the same weighting
- LOL events lasting over 8 hours were infrequent (3.0% frequency)



Estimated Annual RAA MRI Event Durations

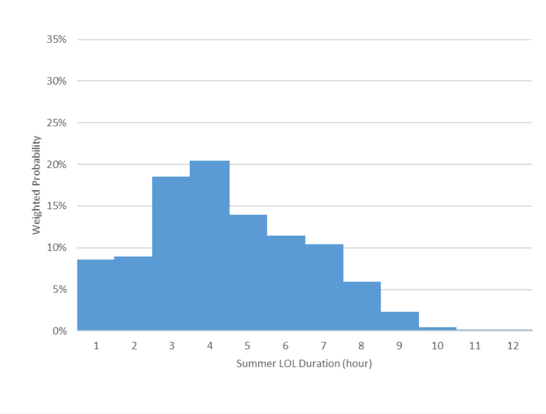
- Accreditation is driven by performance during RAA MRI events
- To estimate RAA MRI event durations, storage was removed and the durations of Slide 28 LOL events were recalculated
- RAA MRI event durations were longer than annual LOL events, showing how storage dispatch helped shorten LOL events
- A substantial percentage (36.1%) of RAA MRI events lasted more than 8 hours

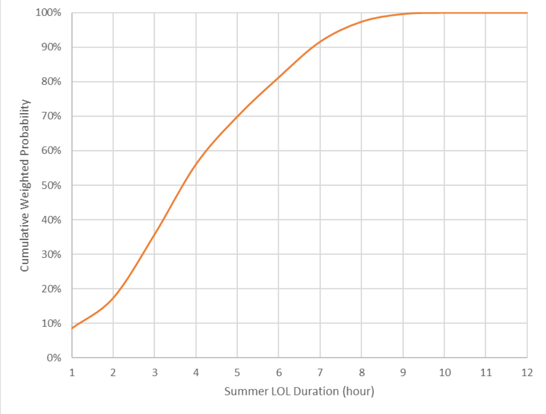




Summer LOL Durations

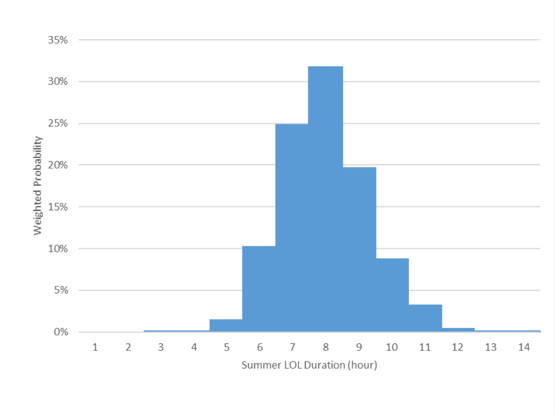
- Summer LOL events were generally shorter in duration
  - 2.6% of LOL events lasted more than 8 hours
  - Longest duration = 12 hours

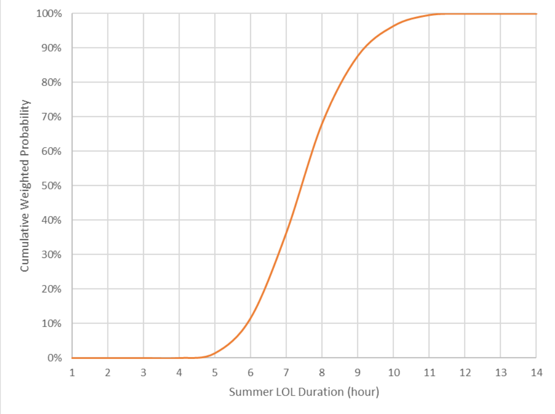




Estimated Summer RAA MRI Event Durations

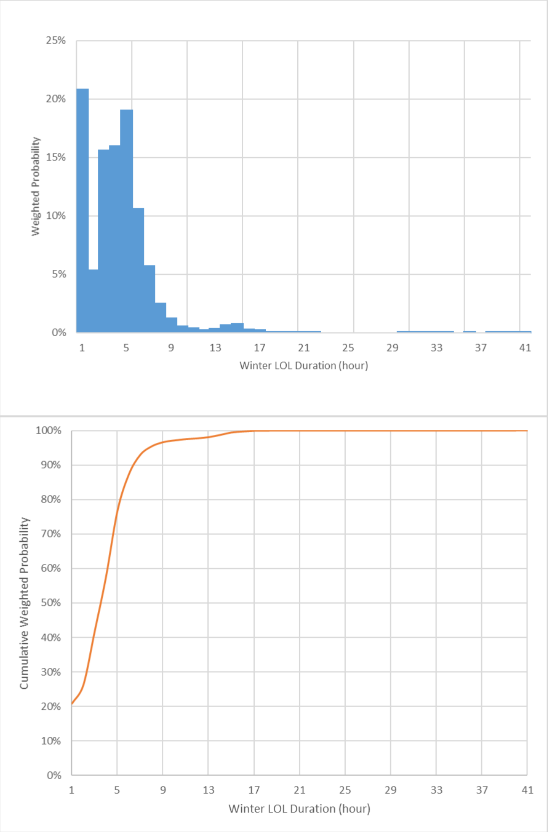
- LOL events that existed with storage became longer and more concentrated around 8 hours when storage was removed
  - No LOL events observed with less than 3-hour duration
  - Longest duration = 14 hours





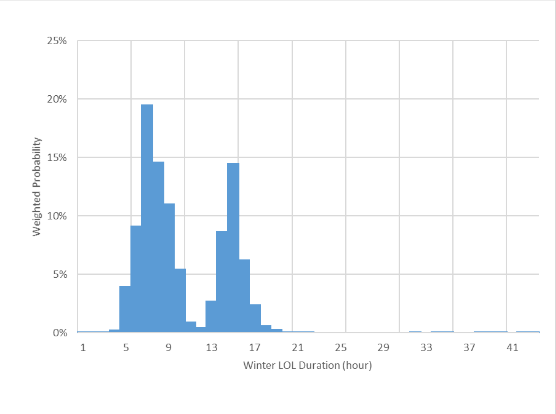
Winter LOL Durations

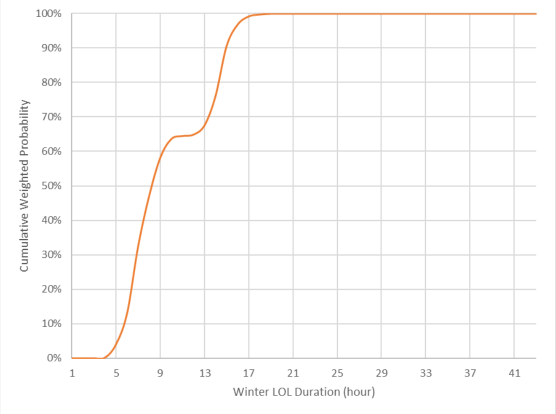
- Winter LOL events had a bi-modal distribution
  - 2013-14 winter had 2 cold snaps
    - Early January: Very cold but shorter
    - Late January: Not quite as cold but longer
- LOL events lasting over 8 hours were infrequent (4.5% frequency)
- Longest duration = 41 hours



Estimated Winter RAA MRI Event Durations

- Bimodal distribution of LOL events was clear when storage was removed
- 52.7% of winter RAA MRI events lasted longer than 8 hours
  - Longest duration = 43 hours





rMRI Results

$$QMRIC = FCA\ QC \times rMRI$$

Class	rMRI	Existing FCA QC	Existing QMRIC	Δ Accreditation
Dual Fuel	0.879	9,044.110	7,948.912	-12.11%
Gas-only	0.808	7,868.280	6,356.522	-19.21%
Other Non-IPR	0.918	4,263.950	3,913.591	-8.22%
Passive DR	1.025	1,986.419	2,036.339	2.51%
Oil-only	0.705	2,783.860	1,961.735	-29.53%
Energy Storage	0.547	3,004.261	1,643.061	-45.31%
Import	0.968	1,187.690	1,149.244	-3.24%
Other IPR	0.931	225.150	209.577	-6.92%
ADCR	0.538	731.800	393.624	-46.21%
IPR Wind	1.260	367.140	462.768	26.05%
IPR PV	0.395	457.800	180.930	-60.48%
Hybrid	0.418	216.436	90.387	-58.24%
Fuel Cell	0.891	21.640	19.274	-10.94%
Non-IPR Hydro	0.958	1,215.180	1,163.720	-4.23%
IPR Hydro	1.509	126.780	191.374	50.95%
Resource mix	0.827	33,500.496	27,721.058	-17.25%
Perfect capacity reference	1 (MRI = 0.75)			

Note: "Existing" means modeled in RAA process.

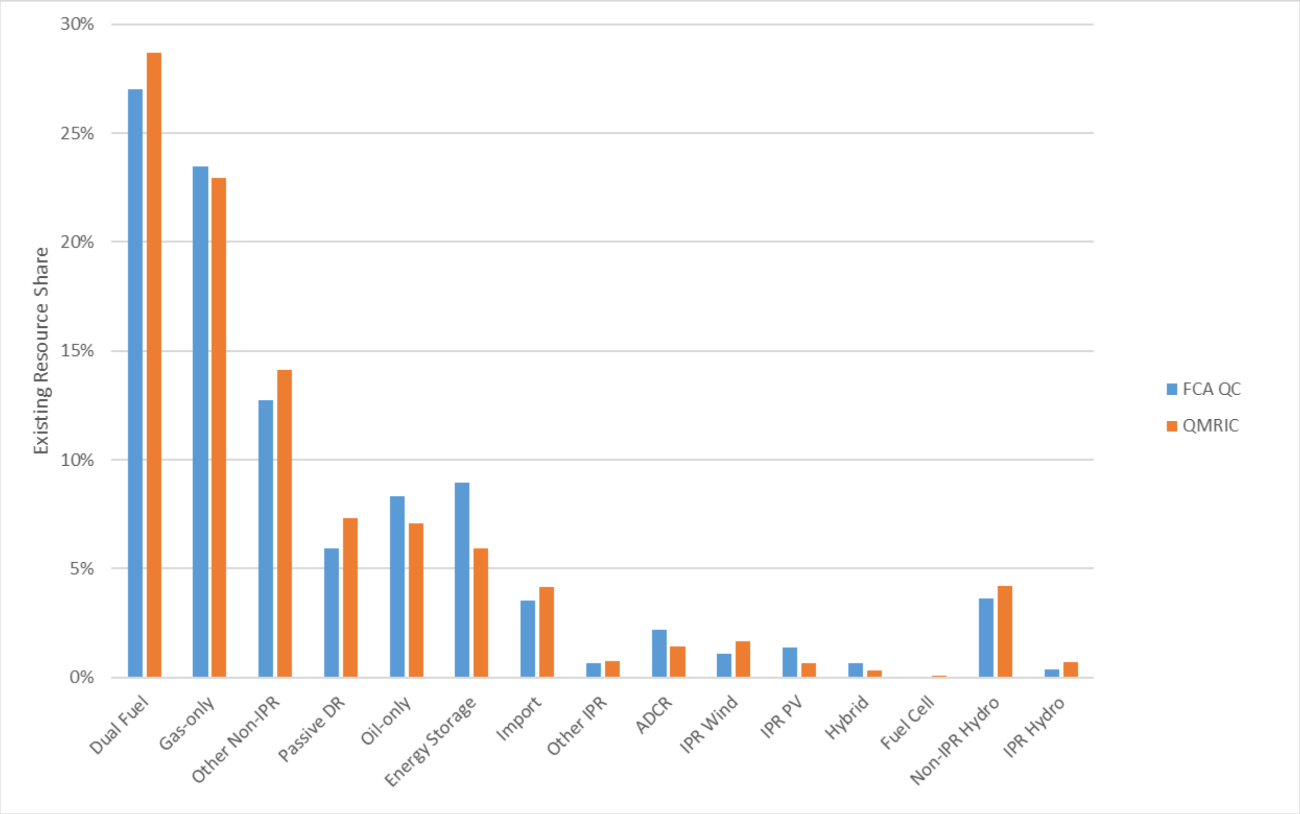
Note: "Hybrid" reflects co-located facilities that elected single-resource participation in the FCM; QMRIC calculation described at the April 2023 RC Meeting.

rMRI Drivers

- For thermal resources, we expect accreditation to decrease by at least xEFORd
- For profiled resources, accreditation depends on how closely the profile and RAA MRI hours coincide
- For storage resources, accreditation depends on the duration of RAA MRI events

Class	xEFORd	Δ Accreditation	RAA Model	Key Driver of Difference
Dual Fuel	7.05%	-12.11%	Thermal	Winter derating (mostly Energy Capability QC)
Gas-only	3.12%	-19.21%	Thermal	Winter derating (mostly not Energy Capability QC)
Other Non-IPR	5.38%	-8.22%	Thermal	RAA MRI hours are more likely during large generator outages
Passive DR	0.00%	2.51%	Profile	Profiled output in RAA MRI hours slightly higher than FCA QC on average
Oil-only	21.56%	-29.53%	Thermal	Winter derating (mostly Energy Capability QC); RAA MRI hours are more likely during large generator outages
Energy Storage	0.00%	-45.31%	Storage	Long-duration RAA MRI events
Import	2.48%	-3.24%	Thermal	
Other IPR	0.00%	-6.92%	Profile	Profiled output in RAA MRI hours slightly lower than FCA QC on average
ADCR	16.47%	-46.21%	Profile	Output profile maxes out at ~70% seasonal QC
IPR Wind	0.00%	26.05%	Profile	FCA QC determined by summer performance between 2PM - 6PM, but majority of LOLHs happen after 6PM when wind output is higher
IPR PV	0.00%	-60.48%	Profile	FCA QC determined by summer performance between 2PM - 6PM, but majority of LOLHs happen after 6PM when PV output is lower
Hybrid	0.00%	-58.24%	Perfect	Part of resource is accredited as storage, remainder is accredited as IPR PV
Fuel Cell	11.57%	-10.94%	Thermal	
Non-IPR Hydro	3.29%	-4.23%	Thermal	
IPR Hydro	0.00%	50.95%	Profile	Profiled output in RAA MRI hours significantly higher than FCA QC on average

Annual Resource Mix Share



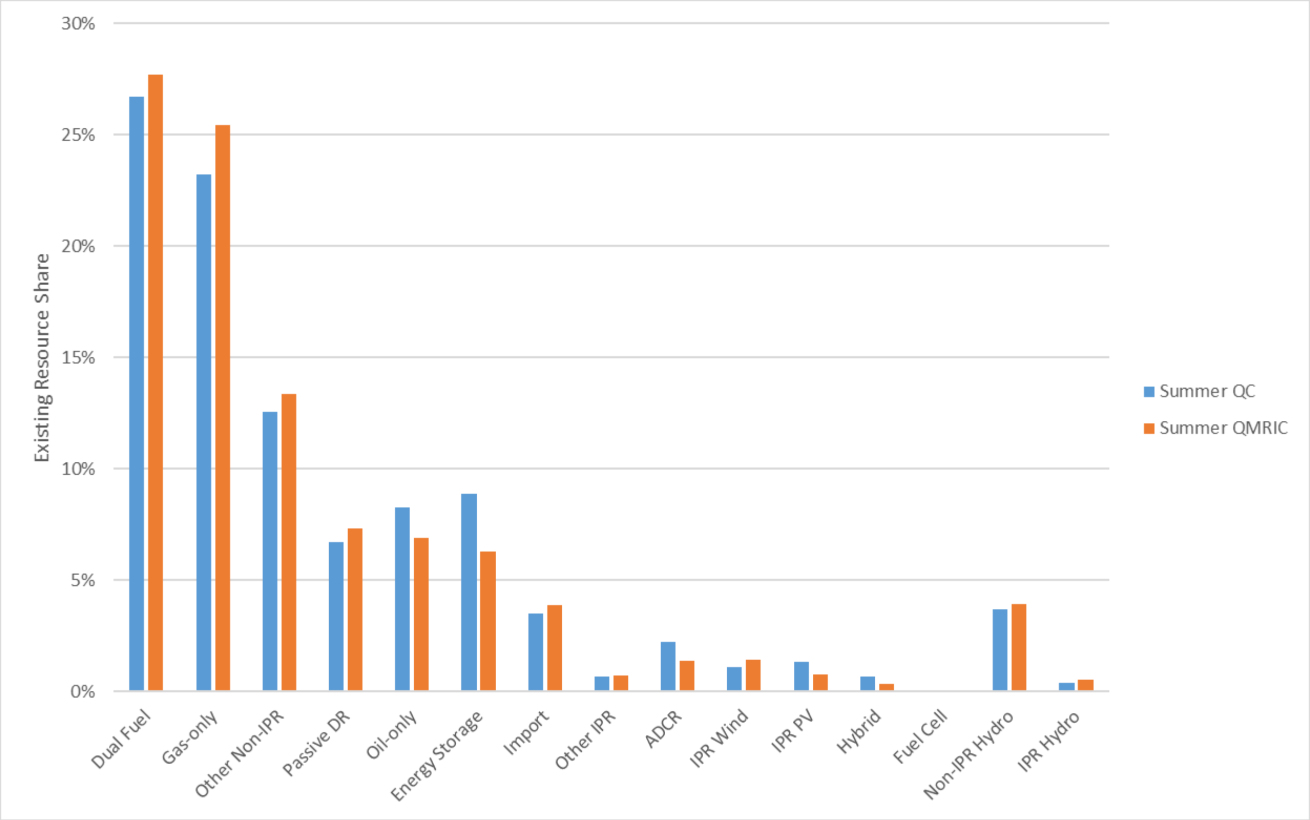
Summer MRI Results

$$Summer\ QMRIC = Summer\ QC \times \frac{Summer\ MRI}{Annual\ MRI_{perfect}}$$

← 0.75 (Slide 34)

Class	Summer MRI	Existing Summer QC	Existing Summer QMRIC
Dual Fuel	0.484	9,064.350	5,851.450
Gas-only	0.512	7,868.280	5,374.474
Other Non-IPR	0.495	4,265.760	2,817.679
Passive DR	0.510	2,277.948	1,549.005
Oil-only	0.391	2,802.830	1,460.867
Energy Storage	0.331	3,004.261	1,327.528
Import	0.520	1,187.690	822.829
Other IPR	0.495	225.150	148.670
ADCR	0.291	746.940	290.138
IPR Wind	0.611	367.140	299.190
IPR PV	0.262	457.800	159.641
Hybrid	0.240	231.706	74.089
Fuel Cell	0.471	21.740	13.645
Non-IPR Hydro	0.493	1,254.160	824.815
IPR Hydro	0.629	126.780	106.282
Resource mix	0.467	33,902.535	21,120.300
Perfect capacity reference	0.538		

Summer Resource Mix Share



Winter QMRIC Equation

- Winter QMRIC was previously expressed as

$$Winter\ QMRIC = Winter\ Capacity \times \frac{Winter\ MRI}{Annual\ MRI_{perfect}}$$

- Just as QMRIC can be decomposed into summer QMRIC and winter QMRIC, winter QMRIC can be decomposed into non-peak winter period QMRIC and peak winter period QMRIC

$$Non-Peak\ Winter\ Period\ QMRIC = Non-Peak\ Winter\ Period\ Capacity \times \frac{Non-Peak\ Winter\ Period\ MRI}{Annual\ MRI_{perfect}}$$

$$Peak\ Winter\ Period\ QMRIC = Peak\ Winter\ Period\ Capacity \times \frac{Peak\ Winter\ Period\ MRI}{Annual\ MRI_{perfect}}$$

- Because no RAA MRI hours were observed in non-peak winter period,

$$Winter\ QMRIC = Peak\ Winter\ Period\ Capacity \times \frac{Peak\ Winter\ Period\ MRI}{Annual\ MRI_{perfect}}$$

Winter MRI Results

$$Winter\ QMRIC = Peak\ Winter\ Period\ Capacity \times \frac{Peak\ Winter\ Period\ MRI}{Annual\ MRI_{perfect}}$$

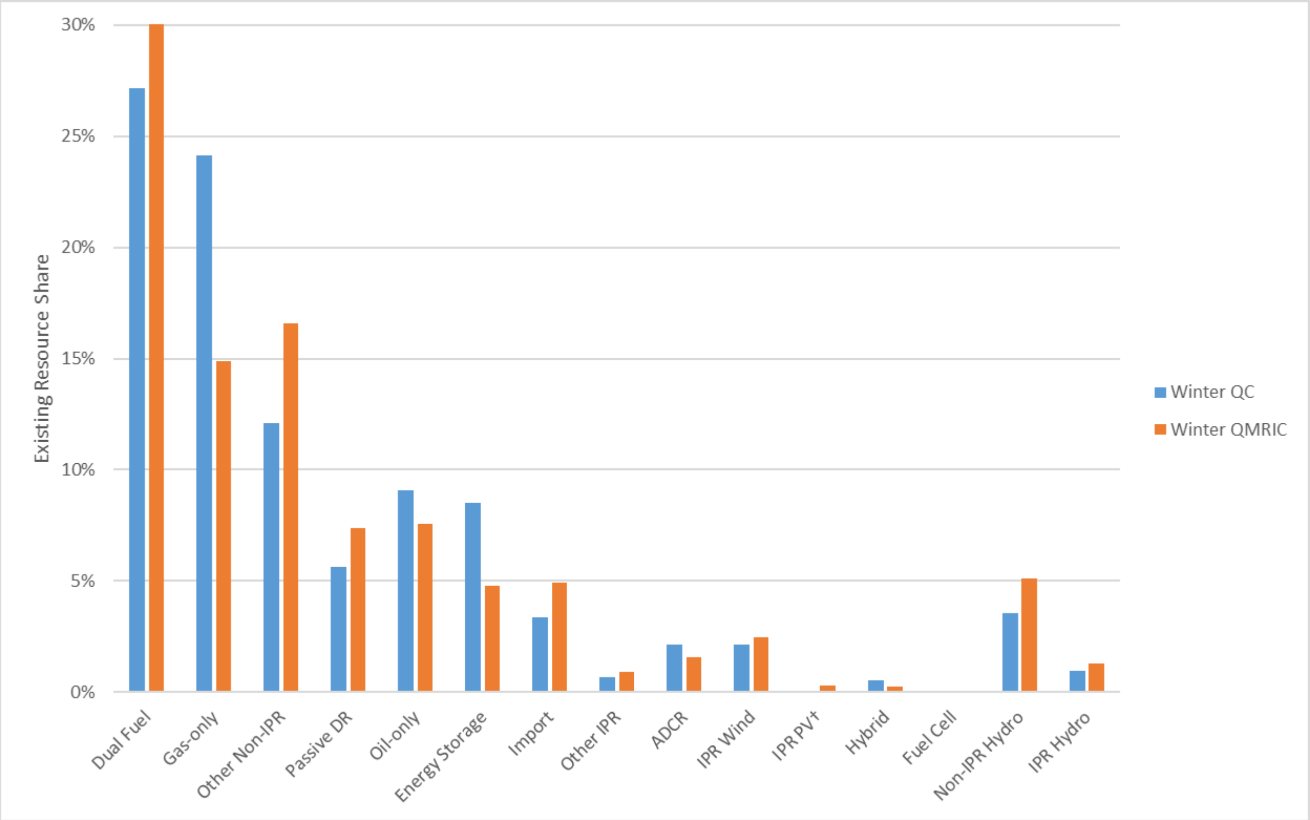
Winter QC or Winter Derated Qualified Capacity (DQC)

0.75 (Slide 34)

Class	Peak Winter Period MRI	Existing Winter QC	Existing Winter DQC	Existing Winter QMRIC
Dual Fuel	0.186	9,603.610	8,442.829	2,097.462
Gas-only	0.208	8,542.150	3,544.800	982.048
Other Non-IPR	0.192	4,279.560		1,095.911
Passive DR	0.184	1,986.419		487.335
Oil-only	0.134	3,208.780	2,802.650	500.868
Energy Storage	0.079	3,004.261		315.533
Import	0.206	1,187.690		326.415
Other IPR	0.191	239.290		60.907
ADCR	0.102	760.110		103.486
IPR Wind	0.163	753.990		163.578
IPR PV*	0.035	0.000		21.289
Hybrid	0.066	184.266		16.298
Fuel Cell	0.188	22.440		5.629
Non-IPR Hydro	0.203	1,250.540		338.905
IPR Hydro	0.187	340.980		85.092
Perfect capacity reference	0.214		Total	6,600.758

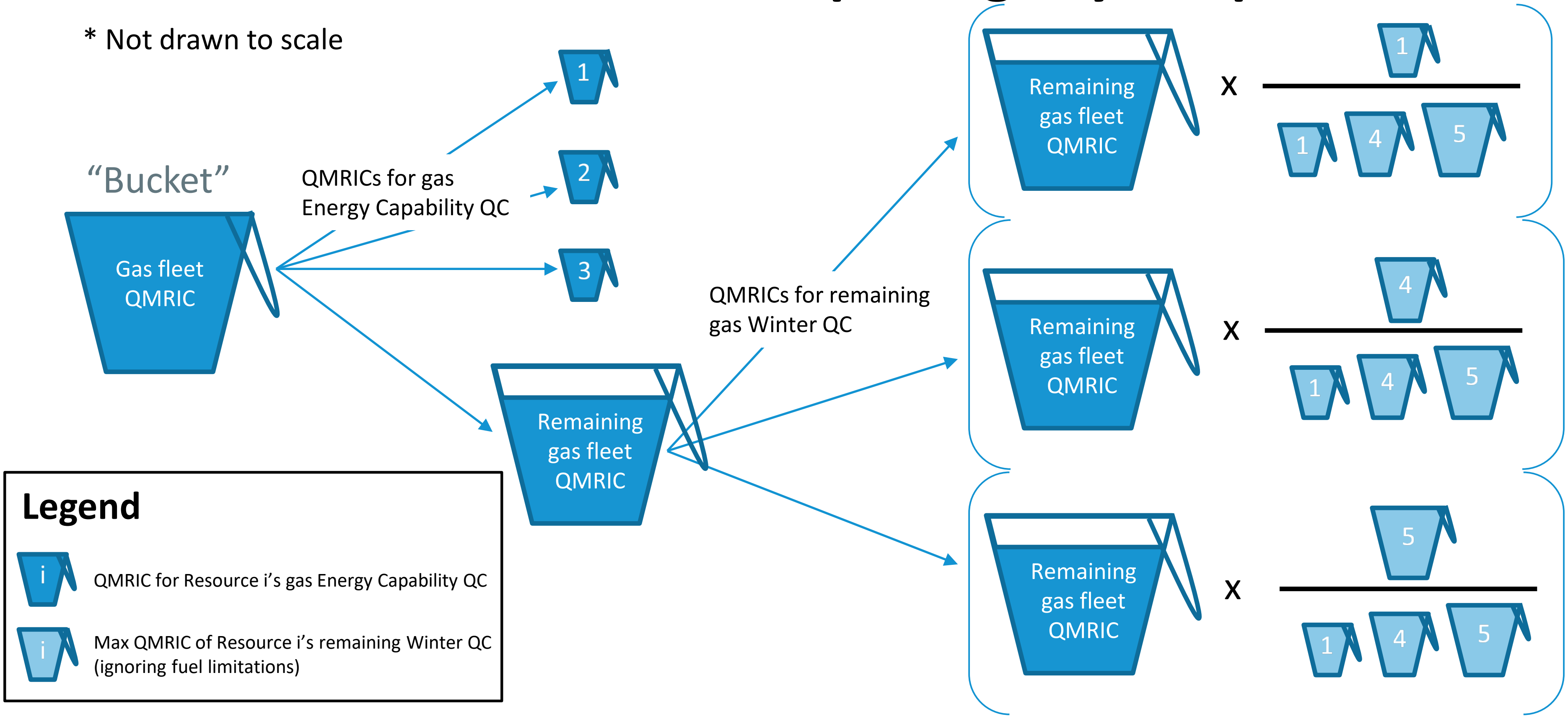
* $Winter\ QMRIC = Summer\ Capacity \times \frac{Winter\ MRI}{Annual\ MRI_{perfect}}$; Summer QC is used for weighting.

Winter Resource Mix Share



Visual Gas Accreditation Steps, Slightly Simplified

* Not drawn to scale



Gas Accreditation Steps, Slightly Simplified

1. Calculate gas fleet QMRIC
2. Assign gas fleet QMRIC to gas Energy Capability QC

$$Gas\ pipeline\ Energy\ Capability\ QC = \frac{\frac{Max\ Daily\ Quantity}{Heat\ Rate\ \times Winter\ QC}}{DOHR} \times Winter\ QC$$

$$Gas\ sales\ contract\ Energy\ Capability\ QC = min\left(\frac{\frac{Max\ Daily\ Quantity}{Heat\ Rate\ \times Winter\ QC}}{DOHR}, \frac{\frac{Total\ Contract\ Quantity}{Heat\ Rate\ \times Winter\ QC}}{SOHR}\right) \times Winter\ QC$$

$$Assigned\ QMRIC\ for\ gas\ Energy\ Capability\ QC_i = Gas\ Energy\ Capability\ QC_i \times (1 - xEFORd_i) \times \frac{Winter\ MRI_{perfect}}{Annual\ MRI_{perfect}}$$

3. Calculate maximum accreditation of remaining gas capacity

$$Max\ QMRIC\ of\ remaining\ gas\ Winter\ QC_i = Remaining\ gas\ Winter\ QC_i \times (1 - xEFORd_i) \times \frac{Winter\ MRI_{perfect}}{Annual\ MRI_{perfect}}$$

4. Proportionally allocate remaining gas fleet QMRIC to remaining gas capacity

1 – Derating factor

$$Assigned\ QMRIC\ for\ remaining\ gas\ Winter\ QC_i = Max\ QMRIC\ of\ remaining\ gas\ Winter\ QC_i \times \frac{Remaining\ gas\ fleet\ QMRIC}{\sum Max\ QMRIC\ of\ remaining\ gas\ Winter\ QC_i}$$

Gas Performance and Derating

- Winter gas performance can be expressed as QMRIC (i.e., equivalent annual perfect capacity) or expected output during Winter RAA MRI hours (i.e., equivalent winter perfect capacity)

$$Expected\ output\ during\ Winter\ RAA\ MRI\ hours = Winter\ QMRIC \times \frac{Annual\ MRI_{perfect}}{Winter\ MRI_{perfect}}$$

Annual $MRI_{perfect}$ ← 0.75 (Slide 34)

Winter $MRI_{perfect}$ ← 0.214 (Slide 40)

	Expected output during Winter RAA MRI hours	Winter QMRIC
Gas fleet total	4,014.018	1,145.333
Assignment to gas Energy Capability QC	909.803	259.597
Gas fleet remainder	3,104.215	885.736
Calculated maximum for gas capacity other than gas Energy Capability QC	8,241.883	2,351.684
Gas fleet remainder / Calculated maximum	37.66%	37.66%
Derate factor	62.34%	62.34%

Winter DQC Calculation

$$Winter\ DQC = Energy\ Capability\ QC + (1 - Derating\ Factor) \times Remaining\ Winter\ QC$$

Class	Gas operationally limited?	Existing Winter QC	Energy Capability QC	Remaining Winter QC	Derating Factor	Existing Winter DQC
Dual fuel	**No**	7,269.732	5,678.924 (Oil)	1590.8 (Gas)	62.34%	6,278.085
	Yes	2,333.863	2,164.744 (Oil)	169.1 (No fuel)	100%	2,164.744
Gas-only	**No**	7,873.325	929.471 (Gas)	6943.854 (Gas)	62.34%	3,544.800
	Yes	668.823	0	668.823 (No fuel)	100%	0
Oil-only		3,208.780	2,802.650 (Oil)	406.13 (No fuel)	100%	2,802.650

- Peak Winter Period MRIs for dual fuel and gas-only resources were calculated using Winter DQC

$$Peak\ Winter\ Period\ MRI = Winter\ QMRIC \times \frac{Annual\ MRI_{perfect}}{Winter\ DQC}$$

Seasonal Performance Factors

$$Seasonal\ QMRIC = Seasonal\ Capacity \times \frac{Seasonal\ MRI}{Seasonal\ MRI_{perfect}} \times \frac{Seasonal\ MRI_{perfect}}{Annual\ MRI_{perfect}}$$

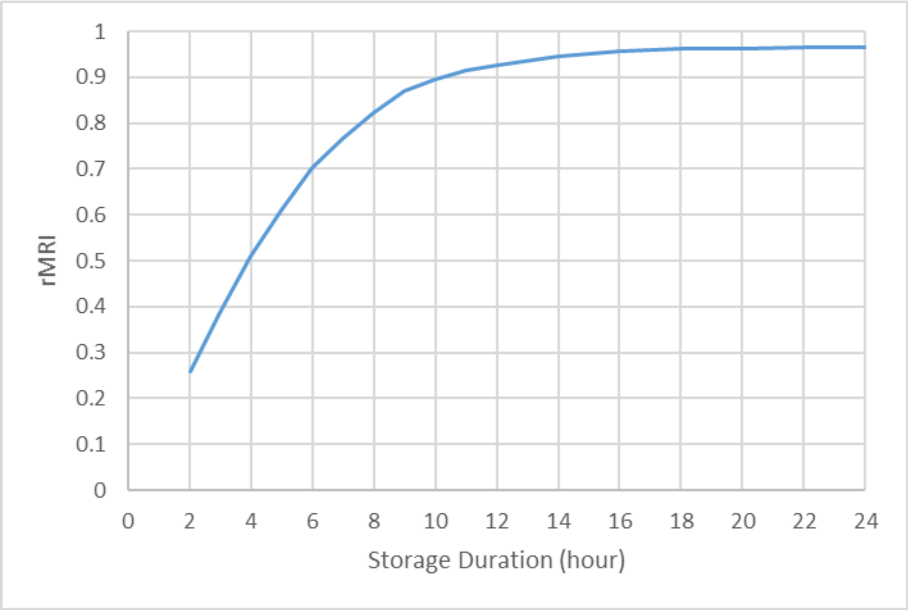
- These values express how well a resource performs seasonally relative to seasonal perfect capacity
  - Evening/overnight winter RAA MRI events impacted IPRs
  - Long winter RAA MRI events impacted energy storage
- Multiplying by seasonal capacity gives expected output during seasonal RAA MRI hours (see Slide 44)

Class	Summer Performance Factor	Winter Performance Factor
Dual Fuel†	89.99%	87.07%
Gas-only†	95.22%	97.09%
Other Non-IPR	92.08%	89.75%
Passive DR	94.80%	85.98%
Oil-only†	72.66%	62.63%
Energy Storage	61.60%	36.81%
Import	96.58%	96.32%
Other IPR	92.05%	89.20%
ADCR	54.15%	47.71%
IPR Wind	113.60%	76.03%
IPR PV*	48.61%	16.30%
Hybrid	44.58%	31.00%
Fuel Cell	87.50%	87.91%
Non-IPR Hydro	91.68%	94.98%
IPR Hydro	116.87%	87.46%
	Summer Share of Total EUE Change from Perfect Capacity Perturbation	**Winter Share of Total EUE Change from Perfect Capacity Perturbation**
	71.73%	28.27%

* $Winter\ QMRIC = Summer\ Capacity \times \frac{Winter\ MRI}{Annual\ MRI_{perfect}}$

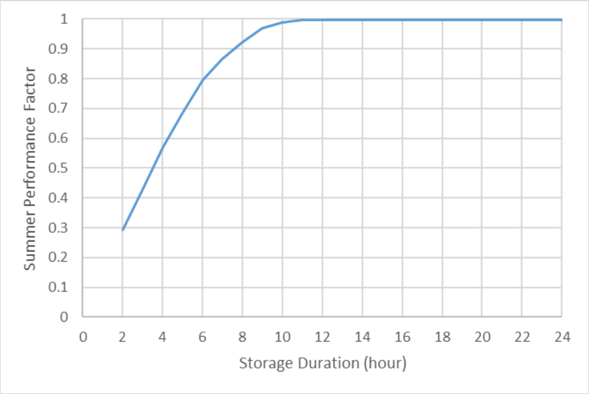
† Winter Performance Factor expressed relative to Winter DQC

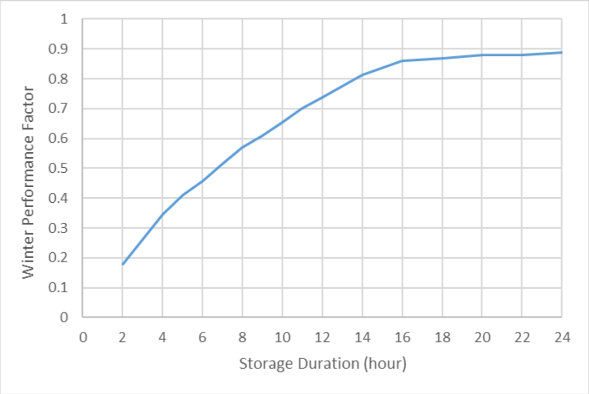
Indicative Storage rMRIs



- This curve shows the rMRIs of hypothetical storage resources with different durations
- rMRI increases with duration but is always less than 1
  - Reason 1: Storage does not recharge storage
  - Reason 2: Storage charging between LOL events may be limited by time and/or available energy

Seasonal Storage Analysis

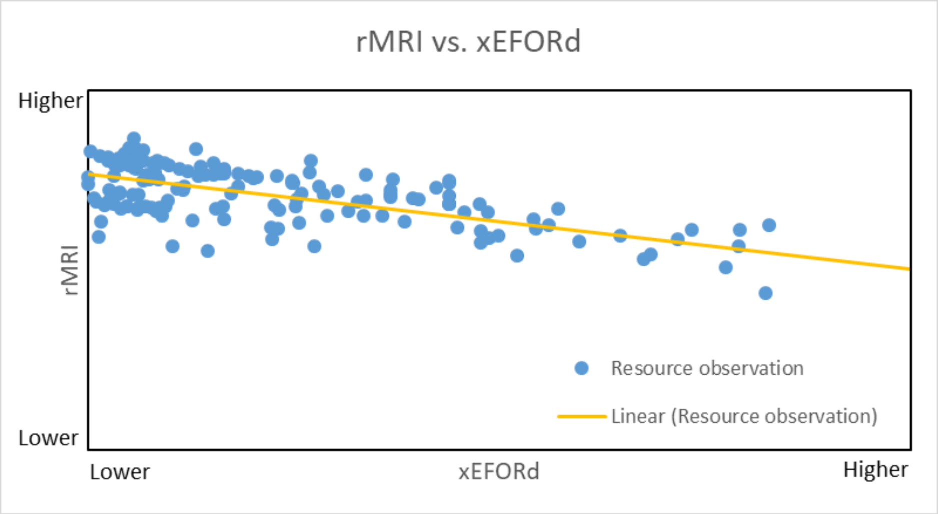




- The summer performance factor is over 95% by 9-hour duration
- The winter performance factor is ~60% for 9-hour storage
  - There were a significant number of long duration winter RAA MRI events (see Slide 33)

Relationship between xEFORd and rMRI

- Higher xEFORd values are generally associated with lower rMRIs
  - Gridlines have been removed to avoid revealing resource-specific rMRIs



Net ICR

- QC-based Net ICR = 31,607 MW
  - FCA 18 Net ICR = 30,550 MW
    - ~300 MW of increase due to summer LOLE decreasing from 0.1 to 0.08
    - 400-500 MW from more resources being modeled as energy storage
    - Remainder from ADCRs and IPRs being modeled with profiles
- QMRIC-based Net Capacity Requirement = 26,139 MW
  - Conversion factor = 0.827 (FCA QC-weighted rMRI of existing resources)

Net ICR Calculation

Total MW Breakdown	FCA18/19 Base Case (Summer QC MW)	Historical FCA18 (Summer QC MW)
Generating Capacity Resources	29,690	29,619
Demand Resources	3,058	3,058
Import Capacity Resources	1,188	84
Tie Benefits	2,115	2,115
OP-4 Actions 6 & 8 (Voltage Reduction)	262	262
Minimum System Reserve	(700)	(700)
Total MW	35,613	34,438
Other Details		
Annual Peak (50/50)	27,748	27,440
ALCC	2,044	1,985
Net ICR	31,607	30,550

CONCLUSION

Conclusion

- This presentation described
  - Assumptions in the FCA 18/19 Base Case
  - Directional insights for MRIs
  - Accreditation results for the FCA 18/19 Base Case

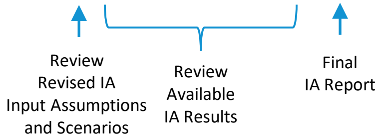
STAKEHOLDER SCHEDULE

Stakeholder Process - Overview

- There are several broad phases laid out in the stakeholder process:
  - RCA Refresher: October 2023
  - Conceptual & Detailed Design: November 2023 – March 2024
  - Finalize Design, Review Tariff Language, and Stakeholder Amendments: April 2024 – June 2024
  - Voting: July 2024 (Technical Committees) and August 2024 (Participants Committee)

- In addition, there are several key dates for the revised impact analysis projected in the process:
  - January 2024: Review revised input assumptions and scenarios
  - February 2024 – May 2024: Review available results
  - June 2024: Final report

	2023			2024											
	Q4			Q1			Q2			Q3			Q4		
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Current Schedule	Refresher	Conceptual and Detail Design					Final Design, Review Tariff, and Amendments			MC/RC Vote	PC Vote File			Eff. Date	



Parallel Stakeholder Processes

- The ISO is proposing to take additional time to prepare for CCP 19 to develop a prompt and seasonal capacity market
- While the ISO recommends developing a prompt and seasonal capacity market for CCP 19 and beyond, it is continuing to develop and prepare to implement RCA in a forward, annual construct with the auction delayed to 2026 while it awaits a FERC order on the further delay
- Below are the parallel stakeholder processes associated with these CCP 19-related efforts

	2023			2024											
	Q4			Q1			Q2			Q3			Q4		
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
RCA Forward, Annual (for FCA 19 with One-Year Delay)	Refresher	Conceptual and Detail Design					Final Design, Review Tariff, and Amendments			MC/RC Vote	PC Vote; File			Eff. Date	
FCA 19 One-Year Delay	Review Tariff; MC Vote	PC Vote; File		Eff. Date											
Alternative FCM Commitment Horizons	Analysis - Scope & Methodology		Analysis Findings & Stakeholder Feedback		Introduce proposal to incorporate additional time to develop a prompt and seasonal capacity for CCP 19	MC Vote on additional FCA 19 delay	PC Vote on additional FCA 19 delay; File		Eff. Date						

Questions

APPENDIX A

Class Assignment Information

Resource Class Assignment

- Data used for class assignment
  - ISO CELT report
    - Tab 2.1 (Generator List)
    - Tab 4.3 (Qualified & Cleared Capacity)
  - FCA qualification details

Resource Class Assignment, continued

- Dual-fuel
  - Has Prim Fuel Type and Alt Fuel Type, one of which is NG
- Gas-only
  - Prim Fuel Type = NG AND No Alt Fuel Type AND Gen Type ≠ FC
- Other Non-IPR
  - Intermittent = No AND Prim Fuel Type = LFG/WDS/MSW/NUC/BIT
- Passive DR
  - DR Type = ON_PEAK/SEASONAL_PEAK

Resource Class Assignment, continued

- Oil-only
  - Prim Fuel Type = DFO/RFO/KER/JF AND No Alt Fuel Type
- Energy Storage
  - Resource participating as storage OR Gen Type = PS
- Import
  - Type = Import
- Other IPR
  - Intermittent = Yes AND Prim Fuel Type = LFG/WDS/MSQ/OBG
- ADCR
  - DR Type = REAL_TIME

Resource Class Assignment, continued

- IPR Wind
  - Generating Fuel Type = Wind
- IPR PV
  - Intermittent = Yes AND Generating Fuel Type = Solar
- Hybrid
  - Co-located facility participating as single FCM resource
- Fuel Cell
  - Gen Type = FC

Resource Class Assignment, continued

- Non-IPR Hydro
  - Intermittent = No AND Prim Fuel Type = WAT AND Gen Type ≠ PS
- IPR Hydro
  - Intermittent = Yes AND Prim Fuel Type = WAT

APPENDIX B

More MRI Details

MRI Ranges

Class	Min rMRI	Max rMRI	Min Summer MRI	Max Summer MRI	Min Peak Winter Period MRI	Max Peak Winter Period MRI
Dual Fuel	0.694	1.008	0.382	0.534	0.129	0.222
Gas-only	0.664	0.950	0.454	0.534	0.195	0.213
Other Non-IPR	0.243	1.314	0.128	0.528	0.054	0.234
Passive DR	1.025	1.025	0.510	0.510	0.184	0.184
Oil-only	0.525	1.040	0.302	0.538	0.036	0.256
Energy Storage	0.261	0.795	0.078	0.482	0.020	0.114
Import	0.920	0.995	0.494	0.534	0.196	0.212
Other IPR	0.446	5.016	0.248	2.736	0.082	0.520
ADCR	0.016	0.973	0.000	0.526	0.004	0.214
IPR Wind	1.081	2.438	0.527	1.229	0.116	0.230
IPR PV*	0.234	0.694	0.152	0.442	0.018	0.079
Hybrid	0.261	0.962	0.158	0.536	0.038	0.185
Fuel Cell	0.845	0.917	0.450	0.484	0.174	0.204
Non-IPR Hydro	0.296	1.075	0.080	0.536	0.054	0.390
IPR Hydro	0.987	5.776	0.383	1.936	0.133	0.220

$* \; Winter\ QMRIC = Summer\ Capacity \times \frac{Winter\ MRI}{Annual\ MRI_{perfect}}$

More Granular MRI Results

Class	Average rMRI	Min rMRI	Max rMRI	Average Summer MRI	Min Summer MRI	Max Summer MRI	Average Peak Winter Period MRI	Min Peak Winter Period MRI	Max Peak Winter Period MRI
ADCR - Northern NE	0.536	0.016	0.923	0.287	0.008	0.496	0.098	0.004	0.196
ADCR - Southern NE	0.539	0.027	0.973	0.293	0.000	0.526	0.104	0.006	0.214
IPR Hydro - Northern NE	1.458	0.987	5.776	0.618	0.383	1.936	0.189	0.133	0.220
IPR Hydro - Southern NE	1.637	1.325	3.895	0.656	0.555	1.006	0.183	0.162	0.208
IPR Wind - Northern NE	1.552	1.193	2.250	0.804	0.614	1.125	0.160	0.122	0.203
IPR Wind - Southern NE	1.160	1.081	2.438	0.545	0.527	1.229	0.164	0.116	0.230
Other IPR - Northern NE	0.991	0.573	2.151	0.524	0.306	1.148	0.201	0.124	0.520
Other IPR - Southern NE	0.913	0.446	5.016	0.487	0.248	2.736	0.188	0.082	0.480
IPR PV - Northern NE	0.384	0.234	0.588	0.259	0.152	0.391	0.028	0.019	0.050
IPR PV - Southern NE	0.400	0.245	0.694	0.262	0.161	0.442	0.037	0.018	0.079

Estimation of Gas-only rMRI

- Assume that gas-only seasonal performance factors are close to (1 – xEFORd) = 96.88%

$$rMRI = \frac{MRI}{Annual\ MRI_{perfect}} = \frac{Summer\ MRI}{Summer\ MRI_{perfect}} \times \frac{Summer\ MRI_{perfect}}{Annual\ MRI_{perfect}} \times \frac{Summer\ QC}{FCA\ QC} + \frac{Winter\ MRI}{Winter\ MRI_{perfect}} \times \frac{Winter\ MRI_{perfect}}{Annual\ MRI_{perfect}} \times \frac{Winter\ DQC}{FCA\ QC}$$

$$rMRI \approx 0.9688 \times \frac{0.538}{0.75} \times \frac{7868.28}{7868.28} + 0.9688 \times \frac{0.214}{0.75} \times \frac{3544.80}{7868.28}$$

$$rMRI \approx 81.95\%$$

- Observed rMRI = 80.79%
- Similar logic does not hold for dual fuel and oil-only due to wide range of xEFORds