Thoughts on RCA: Unit Specific Fuel

Ben Griffiths | Markets Committee | March 2024

About LS Power

LS Power is a development, investment and operating company focused on the North American power and energy infrastructure sector

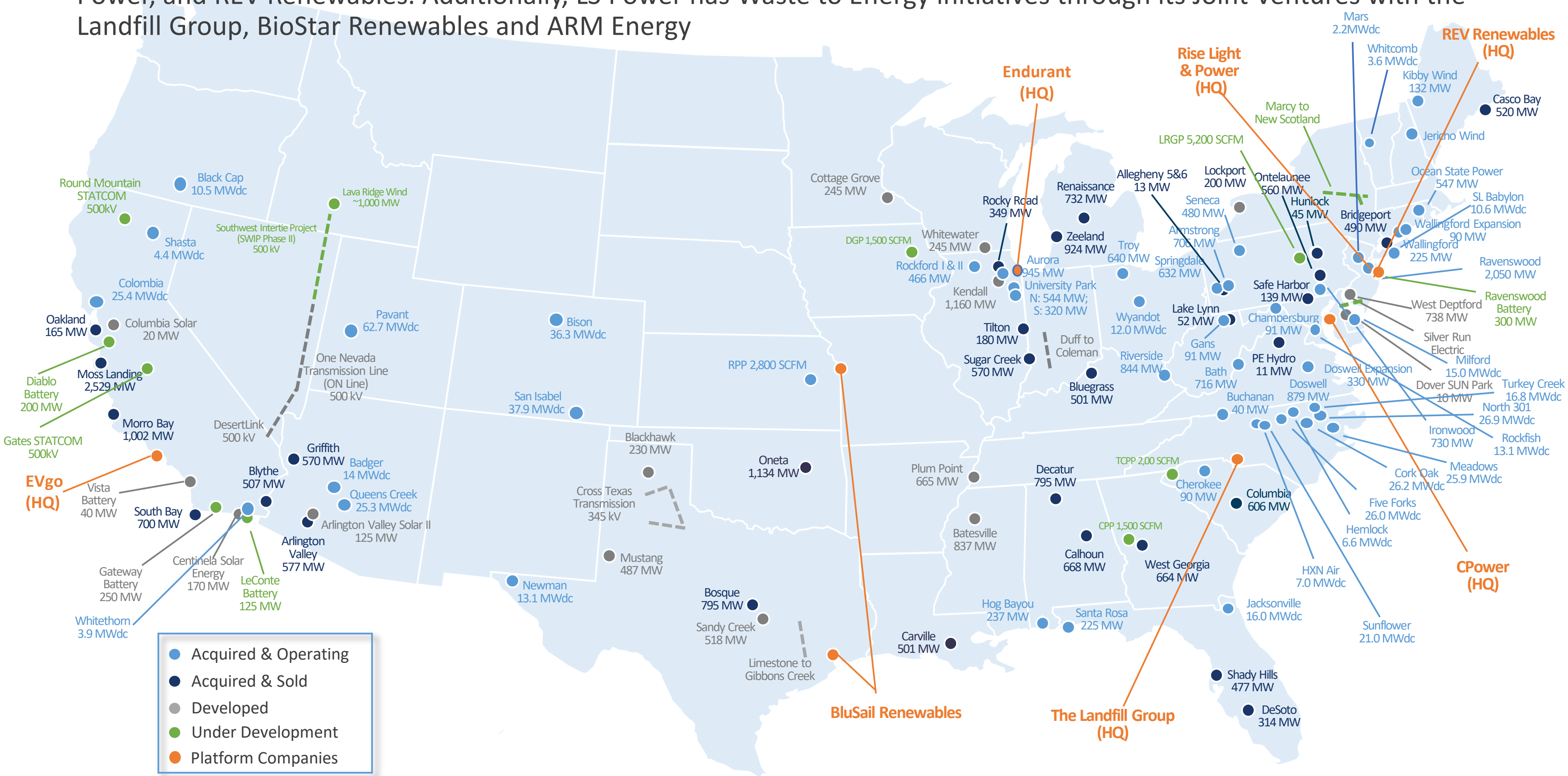
- Founded in 1990, LS Power has 280 employees across its principal and affiliate offices in New York, New Jersey, Missouri, Texas and California
- LS Power is at the leading edge of the industry's transition to low-carbon energy by commercializing new technologies and developing new markets.
  - **Utility-scale power projects across multiple fuel and technology types**, such as pumped storage hydro, wind, solar and natural gas-fired generation
  - **Battery energy storage**, market-leading utility-scale solutions that complement weather dependent renewables like wind and solar energy
  - **High voltage electric transmission infrastructure**, which is key to increasing grid reliability and efficiency, as well as carrying renewable energy from remote locations to population centers
  - **EVgo, the nation's largest public fast charging platform for electric vehicles** and first platform to be 100% powered by renewable energy
  - **CPower Energy Management**, the largest demand response provider in the country that is dedicated solely to the commercial and industrial sector
- Since inception, LS Power has developed, constructed, managed and acquired competitive power generation and transmission infrastructure, for which **we have raised over $47 billion in debt and equity financing.**
  - **Developed over 11,000 MW of power generation** (both conventional and renewable) across the United States
  - **Acquired over 34,000 MW of power generation assets** (both conventional and renewable)
  - **Developed over 660 miles of high voltage transmission**, with ~400 miles of additional transmission under development

Utilize deep industry expertise as owner/operator

LS Power Project Portfolio

Extensive development/operating experience across multiple markets and technologies

- With over $47 billion in equity and debt raised, LS Power has developed and acquired 120 Power Generation projects (renewable and conventional generation), 7 Transmission projects, and 5 Battery Energy Storage projects
- LS Power's Energy Transition Platforms includes CPower Energy Management, Endurant Energy, EVgo, Rise Light & Power, and REV Renewables. Additionally, LS Power has Waste to Energy initiatives through its Joint Ventures with the Landfill Group, BioStar Renewables and ARM Energy



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Presentation Summary

- LS has shown that gas availability is *not* uniform in New England using a variety of techniques (economics, physical flows, pipeline entitlements)
  - Even though the ISO has not refuted that work, it is proposing to accredit gas resources by assuming that gas is uniformly available
- Capacity accreditation *should* reflect the fact that gas resources are not substitutable
  - This basic concern applies just as much to a prompt/seasonal market as the current forward/annual one
  - A market-based constraint approach to gas accreditation that does not reflect locational attributes will be just as fundamentally flawed as the current allocation-based proposal
- A failure to reflect locational attributes will lead to inaccurate pricing for gas generators, worse reliability, potential premature retirement
- This presentation:
  - Reviews prior work on the locational nature of fuel availability in New England
  - Provides two approaches to reflect locational availability in RCA
  - Provides an approach for integrating locational aspects into a gas market constraint

Location, Location, Location

Prior Work on Gas Supply Heterogeneity

Economic evidence suggests profound locational variability

- In February 2023, LS provided a presentation (and methodological memo) offering a quantitative approach to assess unit-specific fuel availability and results from that same approach
  - LS inferred the presence of gas constraints through power market data
  - Analysis compared observed cold-weather performance of gas only generators with expected generation at those same units using imputed economic offers. Controls for fuel costs and unit operational characteristics
- LS results indicate that gas availability is locational and fact specific
  - At cold temperatures, some units have no observed unavailability while others are almost totally unavailable
  - Results suggest that certain resources would have difficulty obtaining gas before others and that location appears to be the dominant factor. More specifically:
    - Resources interconnected to Iroquois or AGT upstream of Burrillville appear to have the least risk
    - Facilities in Maine or on the AGT –G and AGT –I laterals have the most pronounced risk
    - The remaining facilities fall somewhere in between
- This analysis offers two key insight into how ISO-NE should consider fuel constraints in its RCA project
  - **First**, it is not reasonable to assume that all resources have equal access to pipeline gas
  - **Second**, Individual units have observable differences in fuel availability and these attributes should be integrated into RCA

Results from Economic Analysis

- On a region-wide basis, expected unavailability reaches 27% at the coldest temperatures
  - The assessed units have aggregate winter capacity of 9,080 MW so a 27% MW-weighted derate is equivalent to about 6,625 MW of available gas capacity at very cold temperatures
- On a state level,
  - **Connecticut** produces energy at a higher level than we would expect across a range of temperatures and there is no appreciable temperature-dependent output deviation
    - This suggests that the gas system is not constrained in Connecticut at any observed temperature
  - Two of the three **Maine** units exhibit significant degradation at cold temps (in excess of 65%) but the third fares better, perhaps due to contracting
  - **MA** is highly variable with several units exhibiting decreasing output as temperatures fall; others show persistent issues across range of colder temps
- On a unit level,
  - Derates range from 0% to 97% at very cold temperatures

	T < 10	10 ≤ T < 20	20 ≤ T < 30	30 ≤ T < 40	40 ≤ T < 50	50 ≤ T
ISO-Wide Results						
Total	-27%	-19%	-16%	-15%	-11%	-1%
State-Wide Results						
MA	-52%	-38%	-27%	-25%	-20%	-1%
ME	-41%	-32%	-29%	-33%	-19%	-1%
RI	-28%	-12%	-9%	0%	-1%	0%
NH	0%	-1%	-18%	-22%	-17%	0%
CT	0%	0%	0%	0%	0%	0%
Facility Specific Results						
[UNIT A]	-97%	-92%	-85%	-62%	-29%	-1%
[UNIT B]	-94%	-95%	-84%	-73%	-51%	0%
[UNIT C]	-89%	-75%	-73%	-49%	-23%	0%
[UNIT D]	-75%	-67%	-62%	-65%	-33%	0%
[UNIT E]	-65%	-46%	-42%	-49%	-32%	-3%
[UNIT F]	-51%	-37%	-44%	-34%	-23%	0%
[UNIT G]	-48%	-47%	-21%	-7%	-8%	-2%
[UNIT H]	-47%	-36%	-27%	0%	0%	-1%
[UNIT I]	-47%	-24%	0%	-9%	-20%	0%
[UNIT J]	-43%	-20%	-10%	-20%	-19%	-2%
[UNIT K]	-24%	-9%	-2%	-9%	-7%	0%
[UNIT L]	-18%	1%	0%	0%	-1%	0%
[UNIT M]	0%	-1%	-18%	-22%	-17%	0%
[UNIT N]	0%	0%	0%	0%	0%	0%
[UNIT O]	0%	0%	0%	0%	0%	0%
[UNIT P]	0	0%	0%	0%	0%	0%
[UNIT Q]	0%	0%	0%	0%	0%	0%
[UNIT R]	0%	0%	0%	0%	0%	-1%
[UNIT S]	0%	-4%	0%	0%	0%	-2%

Review of Gas Pipeline Flows/Contracts show Locational Attributes

- In April 2023, LS supplemented its economic analysis with new work focusing on gas molecules: both firm entitlements on pipelines and historical observed flows into Connecticut
- During the stressed days (i.e., those with OFOs), pipelines will operate such that FT entitlements are respected
  - So, a conservative estimate of the magnitude of pipeline gas deliverable to Connecticut assumes that pipeline will deliver gas to Connecticut commensurate with entitlements, but no more
  - Just because you can get gas into Connecticut does *not* mean you can get gas to points north. Compressors reduce in size at downstream points
- A detailed review of all contracted capacity on the three interstate pipelines *into* Connecticut on contracts originating *outside* of New England indicates
  - **1,386 BBtu** of FT entitlements overall
  - **933 BBtu/d** of demand by CT LDCs at design day conditions
  - **453 Bbtu/d** of "residual" gas entitlements that can be used *only in Connecticut*, (after for LDC demand)
- Looking at observed flows on cold days (HDD>55), same basic trend exists with ~239 BBtu stranded in Connecticut
  - It is unsurprising that observed flows are about 4% lower than contractual ones – needs may change within operational day; economics may not support use of marginal supply; scheduling issues; etc.
- Results confirm that pipelines in Connecticut are export constrained. **Connecticut has enough residual gas to allow gas generators to run at 1.5-3x of their pro-rata "share" of generation during cold conditions**

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Implications of Locational Gas Availability

- **The ISO has provided no evidence that the gas system has homogenous gas availability**
  - To the contrary, observational data, economic modeling, and physical analysis all indicate that gas availability is location and fact specific. Certain resources would have difficulty obtaining gas before others
  - At minimum, all available evidence indicates that resources in Connecticut are significantly more valuable, from a fuel-availability standpoint, than resources located outside of Connecticut
- Any ISO approach to gas modeling will need to reflect locational attributes
  - This basic concern applies just as much to a prompt/seasonal market as the current forward/annual one
- Similarly, a market-based constraint approach to gas accreditation that does not reflect locational attributes will be just as fundamentally flawed as the current pro-rata allocation approach embedded in the current design
  - There is gas that is effectively "stranded" in Connecticut and only available to generation in that state. This means that a unit in Connecticut is not substitutable with a unit located outside of it, just as a unit located in the Northern New England capacity zone is not (always) substitutable with one in Rest of Pool
- Assuming gas is uniform will result in flawed capacity accreditation and inaccurate market outcomes
  - High quality non-firm gas resources will be paid less than their "fair share" while lower quality ones will be over-compensated. This will result in inaccurate price signals and lessened reliability
- The next module provides two suggestions on locational enhancements that the ISO could adopt

Integrating Locational Attributes into RCA

Option 1: Integrate Locational Aspects of Gas Availability through performance-based Allocation of Gas Fleet QMRIC

- Locational features can be integrated into RCA, in the context of the ISO's current forward/annual market design *without* a market-based gas constraint
- LS Proposal *would* change allocation of gas capacity to reflect individual unit contributions to reliability during periods of stress (same size pie, different sized slices)
  - The proposed approach aligns the modeling+empiricism approach used by PJM for allocation of class-based ELCCs to individual resources
- LS proposal *would not* make changes to:
  - The ISO's risk assessment approach (no new MARS runs)
  - Assessment of firm-fuel arrangements (either firm-gas or dual-fuel)
  - treatment of gas resources in summer

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Other markets already have developed reasonable methods to allocate class-based values to unit-specific ones

- MISO adjusts unit ELCC's based on historic performance during stressed hours
- PJM uses *class*es to estimate ELCCs (today *average*, in future, *marginal*) but needs to then allocate class ELCC MWs to individual resources
- In PJM, a specific unit would be allocated a share of its class's total ELCC in proportion to:
  1. Its average output during the relevant windows over the 10 years of actual (and/or backcast data, if applicable), relative to
  2. The average output of the fleet during the same windows
- Two changes must be made to adapt the PJM approach to New England gas units
  1. Need a method that reflects that the ISO counts on gas generation not only for energy (output) but also for reserves
  2. Need a method to identify the relevant windows for historical review

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LS understands that the ISO's approach allocates QMRIC to gas resources based on EFOR

- Like PJM, ISO is doing an allocation of class capacity values to specific units
- For winter season, ISO is proposing a two-part method for calculating capacity contributions
  - **Step One:** Compute Gas Fleet-wide QMRIC / Fuel-Derate
  - **Step Two:** Allocate Fleet-wide QMRIC to individual units, based on unit/fleet EFORs
- Roughly speaking, for winter season:

$$\boldsymbol{QMRIC_{Unit} = QMRIC_{Gas\ Fleet}\left(\frac{QC_{Unit}}{QC_{Gas\ Fleet}}\right)\left(\frac{1 - EFOR_{Unit}}{1 - EFOR_{Gas\ Fleet}}\right)}$$

The first term reflects the fleet's QMRIC, accounting for fuel-related limitations

The second term reflects the unit's size in relation to the fleet's size

The third term allocates QRMIC to an individual unit based on its EFOR rate relative to the fleet's average EFOR

(N.b., ISO's examples are numerically equivalent but terms are presented differently)

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EFORs are less precise than other possible methods

- EFOR is calculated as the percentage of total *demand* time that a unit was unavailable due to forced outages or deratings
- EFOR rates are typically computed over a relatively long duration, one or more years
- EFOR does *not* measure value in stressed periods in particular
  - A failed start or forced outage on a mild April day counts just the same as one on the summer peak or during a PfP event
- EFOR rates do not account for parameter constrained (non-)dispatch
  - In recent PfP events, slow start resources were not dispatched because the duration of the event was shorter than their start-up time. Non-performance in these events would not adversely affect EFOR, because unit was never "demanded"
- EFOR rates do not reflect temperature-dependent performance
  - A poorly weatherized plant might struggle more in very cold weather than on average

Gas should be allocated based on observed contributions to reliability during periods of elevated system stress

- While keeping the ISO's basic framework intact, LS proposes a more precise allocator: observed unit contribution to reliability during periods of elevated system stress
  - This approach values resources that *actually provide value* during stress, rather than those that *could potentially provide value*
- Mathematically, QMRIC should be allocated based on something like:

$$QMRIC_{Unit} = QMRIC_{Fleet} \times \frac{\sum(Energy_{Unit}+Reserves_{Unit})}{\sum(Energy_{Fleet} + Reserves_{Fleet})}$$

- As with the IPR resources, use of observed generation to calculate allocator *intrinsically* includes forced outrages, unit economics, and unit (in)flexibility
  - A non-firm, but base-load gas resource running 24x7 will rightly show as being more valuable than a "typical" non-firm resource
  - A very expensive, high outage, or slow-starting combined cycle will rarely be running during stressed periods (e.g. 12/24/2022 PfP event), providing less value to system
- Reflects fact that ISO may rely on both online and off-line gas resources to meet reserve requirements during system stress

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An example

- Consider an example where 10 GW of gas have winter *fleet* QMRIC of 4 GW
  - In a general sense, ISO approach would derate all units basically 60%
  - This alternative approach would derate proportional to value during stress
- ***N*** total gas generators and ***3*** *historic* periods where performance is assessed
  - *Unit 1: 800 MW baseload generator (running at full output in all hours)*
  - *Unit 2: 100 MW baseload generator (running at full output in all hours)*
  - *Unit 3: 100 MW generator (on long term outage or fuel constrained)*
  - *Unit 4: 100 MW generator (with derates and outages)*

	Capacity	Energy + Reserves Stress Period 1	Stress Period 2	Stress Period 3	Total	Unit Gen as % of Fleet Gen in	Unit QMRIC	ISO QMRIC
Unit 1	800	800	800	800	2,400	20%	800	320
Unit 2	100	100	100	100	300	3%	100	40
Unit 3	100	-	-	-	-	0%	-	40
Unit 4	100	50	-	50	100	1%	33	40
Other Units	8,900	2,550	3,100	3,550	9,200	77%	3,067	3,560
Total	**10,000**	**3,500**	**4,000**	**4,500**	**12,000**	**100%**	**4,000**	**4,000**

Implementation

- Many possible methodologies for estimating unit-specific contributions that are all transparent, based on available data, and do not require modifications to MARS
- LS proposes two different approaches for discussion:
  1. Calculate each unit's combined energy output + reserve designations, compared with the gas fleet's average energy output + reserve designations on *days where HDDs are greater than or equal to 40*
  2. Calculate each unit's combined energy output + reserve designations, compared with the gas fleet's average energy output + reserve designations *in intervals where the region has less than or equal to 300 MW of surplus 10- or 30-minute reserves (review of historic data suggests ~77 hours/year would be flagged with this approach)*
- Would likely want to align lookback period with either the:
  – 3 years of data used to generate profiles for ADCR
  – 5 years of data for profiling IPRs
- While implementation is different, conceptually similar to use of ISO's proposal to use historic offers/performance to generate QMRICs for IPRs and ADCR

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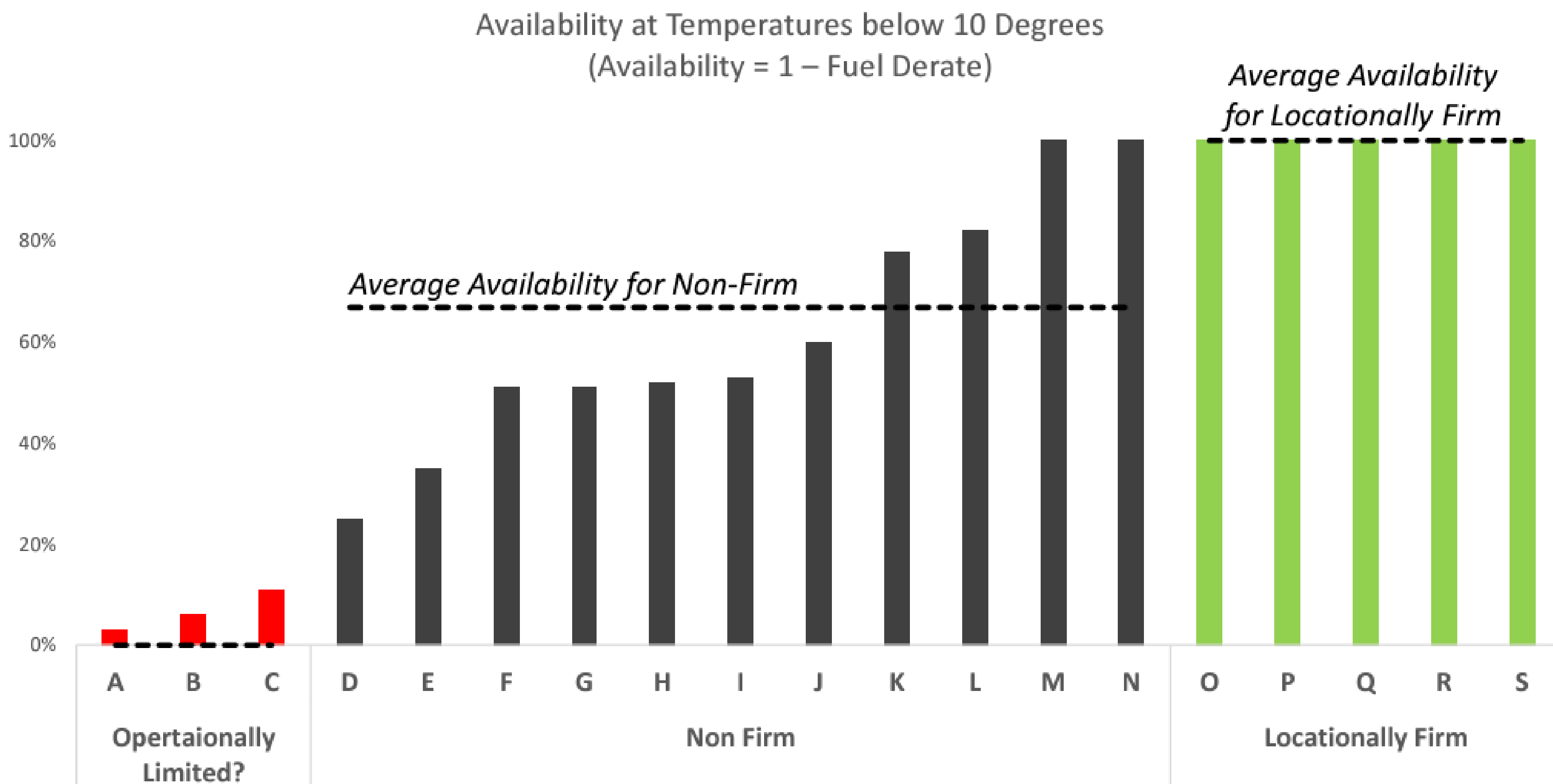
Option 2: "Locationally Firm" resources

- The ISO's proposal includes three levels of fuel availability: (a) Operationally Limited, (b) non-firm, and (c) firm
  - As contemplated, ISO's use of "firm" relates to resources with contractual arrangements
- The ISO already recognizes that some units are unable to provide reliability in the winter *because of their location*, those deemed "operationally limited"
- But the reverse is also true: some units *because of their location* that are disproportionally reliable.
  - Units in Connecticut, for example, can make use of "stranded" gas that can not be sent down-stream. These units also benefit from better economics (negative basis to Citygate) which result in higher runtimes in practice
- LS suggests that the firm categorization could be extended to include a new sub-category
  - **Contractually Firm**: resources with firm supply and/or firm transport arrangements (ISO's current concept)
  - **Locationally Firm**: resources interconnected to Iroquois or AGT upstream of Burrillville which do not have apparent difficulties obtaining gas
- In a market-constraint type approach, this same general concept could be employed by creating a nested zone for Connecticut which has higher levels of fuel availability and is, in effect, unconstrained
- The Locationally Firm concept was first presented at the MC in March 2023

Creation of “Locationally Firm” Resource Category



1. https://www.iso-ne.com/static-assets/documents/2023/03/a02c_mc_2023_03_07-09_ls_power_unit_specific_gas_modeling_presentation.pdf

Performance adjustments and/or locationally firm designation would better align QMRICs with a unit's value to the system

- **Better reflects locational features of gas system:** Units with inferior locations on interstate pipelines should tend to have lesser performance during stressed conditions, either because they can't get gas or because its prohibitively expensive, which will be reflected in the performance adjustment
- **Better compensates flexible generators:** Gas generators providing reserves that the ISO relies on will also be compensated for those contributions to reliability
- **Better incentives for firming:** resources that firm up should be able to run more during stressed conditions, increasing their unit-adjustment and resultant QMRIC
- **Does not change overall reliability estimate of gas fleet**: the MWs of gas capacity identified by the risk assessment model is not affected by this approach
- **Approach should be implementable**: Does not require additional MARS runs; is simply a different *ex post* allocator to distribute fleet QMRIC to individual resources

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Questions?

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