Energy Duration Limited Resource Modeling Whitepaper

Prepared for the New York State Reliability Council – Installed Capacity Subcommittee

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Introduction

As the grid evolves, resources that have daily energy duration limitations, such as Energy Storage Resources (ESRs), will take up a greater and greater share of the supply mix required to maintain a reliable and cost effective grid. These duration limited resources may include batteries, compressed air and pumped hydroelectric generators, flywheels, which can supply electricity to the grid to meet demand, but will also withdraw electricity from the grid, which can be utilized to alleviate excess supply. Duration limited resources can promote more reliable and efficient operation of the electric grid, particularly when situated to balanced intermittent renewable generation. Duration limited resources participate in the New York Independent System Operator, Inc. (NYISO)-administered energy, ancillary service, and capacity markets in certain limited participation models (e.g., Limited Energy Storage Resources (LESR), Energy Limited Resource (ELR), and demand response programs), but these models are growing as the NYISO market design has been developing participation models for Distributed Energy Resources and Electric Storage Resources. As part of this evolution, the NYISO is working to ensure that tools to measure grid reliability are enhanced to appropriately account for the change in resource mix that is anticipated.

The New York State Reliability Council and the NYISO continue to look for better ways to integrate duration limited resources into New York's wholesale electricity markets and harness the value that these resources can bring to the grid, while ensuring reliability and resource adequacy for New York electric consumers.

At the same time, the characteristics of duration limited resources often differ from existing capacity resources (*e.g.*, limits on the number of hours the resource can operate in a day). As a result, the NYSRC and NYISO are exploring methods to incorporate duration limited resources into the IRM study and LCR study.[1]

This whitepaper investigates one method of modeling duration limited resources in the NYSRC IRM study and is motivated in part by both the need for both enhanced tools and methods to model the evolving supply mix and the existence of two 5MW, 40MWh (i.e., 8-hour duration) batteries that are expected to meeting the inclusion rules for the 2020 IRM study.

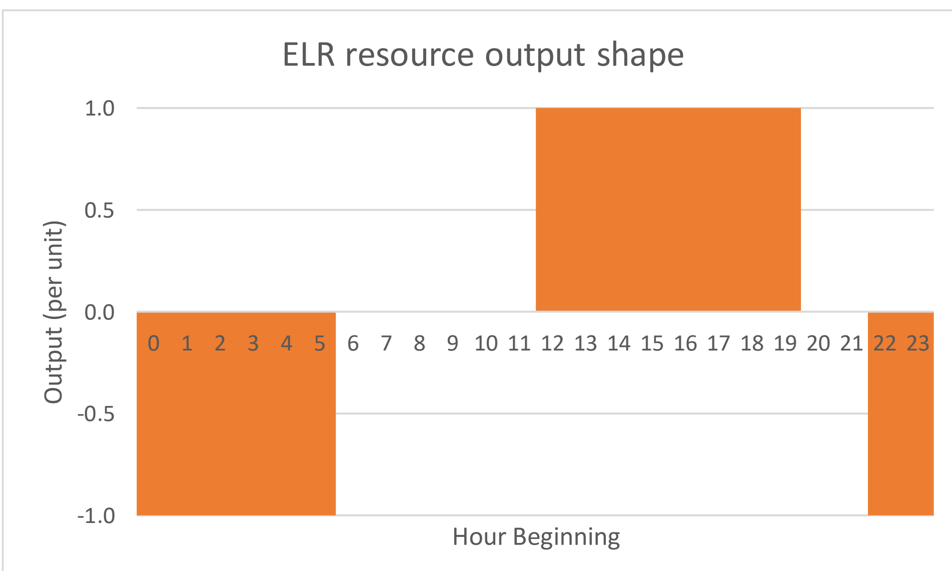
[1] The NYSRC and NYISO establish various reliability requirements applicable to the New York Control Area, wherein the grid is designed to meet annual projected peak load, plus a minimum reserve margin requirement to account for unanticipated generator or transmission outages. This margin, called the Installed Reserve Margin (IRM), secures generation capacity beyond the forecasted peak demand to meet a contingency. The IRM, determined by the New York State Reliability Council in conjunction with the NYISO, is 17.0% for 2019-2020.

The NYISO expects that if additional modeling tools become available in the future, they could be evaluated within the NYSRC ICS study/whitepaper framework.

Methodology

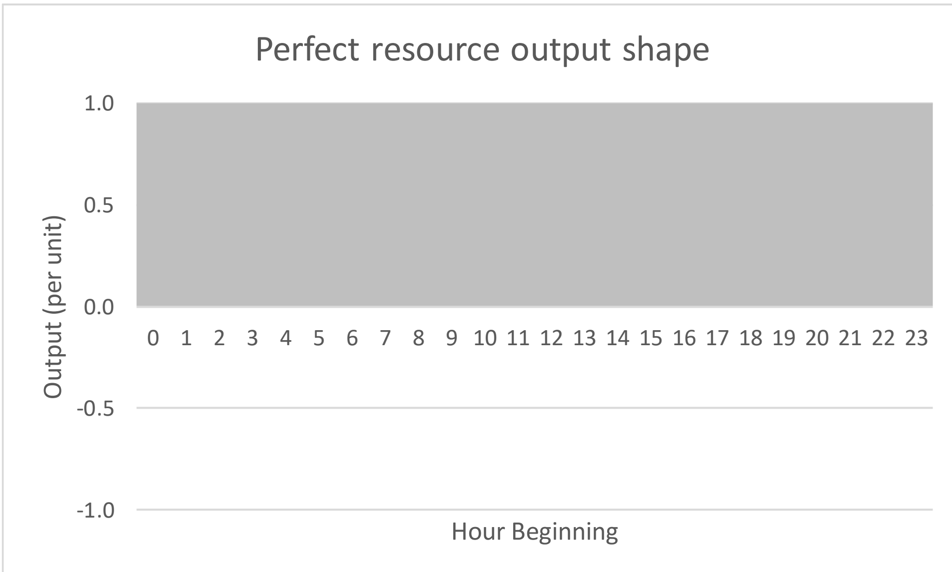
The NYISO began the evaluation using the 2019 IRM Technical Study Final Base Case, which has an LOLE of 0.100 and is discussed in the 2019-20 IRM report.[2]

For this study, we looked at energy storage resources and modeled them as "shapes" with predetermined charge and discharge periods. Using this set-up, the resources can be better controlled in order to study various aspects of the unit. We specify when the unit charges and discharges, as well as set limitations on total energy produced from the unit. The figure below shows the daily charge (10pm until 6am) and discharge (noon until 8pm) patterns for the two storage resources being modeled in the 2020 IRM (*e.g.*, 8-hour resources). Due to the nature of the GE MARS program, the actual hours where loss of load events occurs cannot be predicted. The hours for charging and injections were selected in the view that most events will occur during the period selected for injection. This simulates utilizing the storage resources to avoid an LOLE event. The magnitude and length for both charging and injections was modeled off of publicly available information. While there is an understanding that this may not be the case for all future units of this type, this approach is the most consistent with the units entering the system for the upcoming IRM cycle.[3]



[2] Available at: http://nysrc.org/pdf/Reports/2019%20IRM%20Study%20Body-Final%20Report[6815].pdf.
[3] The NYISO anticipates evaluating other duration limitations (*e.g.*, 4 hr, 6 hr) as part of the whitepaper that evaluates GE MARS enhancement for energy duration limited resources.

For a reference point we ran cases at the same MW values modeled in the shape approach, represented as perfect capacity. This a worthwhile comparison because it will represent the value of the storage unit when put up against a constant resource of equal maximum value. The figure below shows the daily discharge pattern for the perfect resource, i.e., discharging all hours of the day.



The MW values tested were 10 MWs, 20 MWs, 50 MWs and 100 MWs to each of the listed zones. Each scenario was applied to different zones and are listed with the results. Only the statewide LOLE changes are listed, as representing these cases from an IRM sensitivity perspective could be misleading since some were strictly upstate or downstate updates.

When comparing an eight-hour resource to perfect capacity using this approach, the results are almost identical as most loss of load events were covered in the eight-hour period of the battery discharge that was tested.

Results

We first established a baseline to compare our resources against. Perfect capacity was tested at the named MW values and it produced the following results. For reference the LOLE of the case without any capacity additions was 0.100.

Perfect Capacity				
Zone	10 MWs	20 MWs	50 MWs	100 MWs
A	0.099	0.099	0.098	0.097
ACD*	0.098	0.097	0.094	0.088
G	0.099	0.099	0.097	0.095
GHI*	0.098	0.097	0.092	0.086
GHIJ*	0.097	0.095	0.087	0.077
J	0.099	0.098	0.094	0.090
JK*	0.097	0.094	0.087	0.077
K	0.098	0.096	0.092	0.087
All*	0.093	0.086	0.071	0.050
Impact on all 8760 hours - No charging				

**Note: the listed MWs were added to each of the associated zones individually (i.e. if ACD is listed, the corresponding total MW added would be 30, 60, 150 and 300)*

These results are generally intuitive as a lot of weight went on these perfect resources in the downstate zones.

After these cases were complete, the next scenario in line was the test case using the proposed interim model for an 8-hour resource. The units charged from 10pm to 6am and discharged at the same MW value from 12pm to 8pm.

Interim Model - Charge during off peak, discharge during peak				
Zone	10 MWs	20 MWs	50 MWs	100 MWs
A	0.099	0.099	0.098	0.097
ACD*	0.098	0.097	0.094	0.088
G	0.099	0.099	0.097	0.095
GHI*	0.098	0.097	0.092	0.087
GHIJ*	0.097	0.095	0.087	0.077
J	0.099	0.098	0.095	0.090
JK*	0.097	0.095	0.088	0.077
K	0.098	0.096	0.093	0.087
All*	0.093	0.087	0.072	0.051
Charging from 10 pm to 6 am. Discharging from 12 pm to 8 pm				

**Note: the listed MWs were added to each of the associated zones individually (i.e. if ACD is listed, the corresponding total MW added would be 30, 60, 150 and 300)*

In order to easily see the impacts of these results, we took the test case and put the LOLE results up against the that of the perfect capacity in order to create a capacity value comparison.

ELR Capacity Value in relation to perfect capacity				
Zone	10 MWs	20 MWs	50 MWs	100 MWs
A	100%	100%	100%	100%
ACD*	100%	100%	100%	100%
G	100%	100%	100%	100%
GHI*	100%	100%	100%	92.6%
GHIJ*	100%	100%	100%	100%
J	100%	100%	82.1%	100%
JK*	100%	82.1%	92.1%	100%
K	100%	100%	86.8%	100%
All*	100%	92.6%	96.5%	98.0%
Charging from 10 pm to 6 am. Discharging from 12 pm to 8 pm				

$$\text{Capacity Value} = \frac{LOLE_{Base} - LOLE_{Interim\ Model}}{LOLE_{Base} - LOLE_{Perfect\ Capacity}}$$

This table shows us that an 8-hour resource is almost directly comparable to that of perfect capacity in IRM studies. This makes sense because, in practice, the resources should only be used during an LOLE event. Which, in reliability studies, will theoretically make a resource of this type and duration appear to be perfect capacity in most situations. On average across the scenarios run, the capacity value of an 8-hour resource using this methodology is 98%. Using the 2019 IRM Study Final Base Case and at the penetrations modeled, 8 hour resources and resources without duration limitations have similar effects on LOLE. Under these conditions, 8 hour resources are expected to affect the IRM consistent with resources that do not have durations limits.

Recommendation

The NYISO recommends modeling the two 5 MW duration limited battery resources in the 2020 IRM study using the predetermined charge and discharge shapes discussed and validated above. The NYISO evaluated the relationship between LOLE and the installed capacity of 8-hour duration limited resources across many combinations of NYISO Load Zones. The results indicate that 8-hour duration limited resources affect LOLE intuitively. For example, the direction of the LOLE effect and the magnitude of the effect align with the NYISO's expectations and produce an LOLE nearly identical to the LOLE produced by the addition of perfect capacity. Further, the method used to model the duration limited resources, i.e., a predetermined charge and discharge profile, can be feasibly implemented for the 2020 IRM study and could likely be scaled to accommodate additional resources.

Additional modeling tools and methods that are on the horizon can be evaluated when such tools and methods become available. This includes both a duration limited resource modeling module within GE MARS and enhancements to the charge/discharge shape discussed within this whitepaper (e.g., accounting for EFORd). Such evaluations would ideally be identified and resourced within the NYSRC ICS study/whitepaper framework, possibly as early as December 2019.