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# RESOURCE ADEQUACY METRICS AND THEIR APPLICATIONS

***A Progress Report***

***Draft Report 3/2/21***


**Prepared by**

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## 1.0 Introduction

This report continues the NYSRC Resource Adequacy Working Group's (RAWG) consideration of the value of evaluating reliability metrics for measuring reliability risks in NYSRC probabilistic studies, recognizing the many emerging issues that will potentially impact NYCA reliability. RAWG's initial report, *Resource Adequacy Metrics and their Applications*[1], presented definitions of various resource adequacy metrics, a survey of metrics presently in use, and an initial review of potential NYSRC applications.

The RAWG's initial report identified three reliability risk metrics (RRMs) for possible application:

- Loss of Load Expectation (LOLE)
- Loss of Load Hours (LOLH)
- Expected Unserved Energy (EUE)

This second report compares reliability risk measurements calculated for above RRMs, on an annual and monthly basis, from three recent ICS studies: the 2020 IRM Study, 2021 IRM Study, and High Intermittent Renewable Resource Study. The report then provides the RAWG's observations concerning these results. Finally, the RAWG provides recommendations and thoughts about future RRM applications by the NYSRC for the Executive Committee's consideration.

## 2.0 Reliability Risk Metric Measures

Three important measures of reliability risk -- frequency, duration, and magnitude or severity of loss of load events -- are described by the LOLE, LOLH, and EUE metrics.[2] Each RRM measures one or more of these system reliability aspects. As shown in Table 1 below, EUE is the only metric that considers all three risk measures, and the only one that provides the load curtailment severity. In addition, both LOLH and EUE can provide insight as to the impact of intermittent resources on system reliability because of their ability to measure loss of load duration and magnitude. As more intermittent resources are added EUE appears to have significant value for resource adequacy evaluations[3]. EUE would also be helpful in quantifying the reliability risk impacts of extreme weather or other natural events.

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[1] *Resource Adequacy Metrics and their Applications*, April 2020, see http://www.nysrc.org/reports3.html.

[2] Brief definitions of these metrics are as follows:
**LOLE**: The number of events in which system load is not served in a given time period. This metric serves as NYSRC's resource adequacy criterion: "one expected loss of load event every 10 years."
**LOLH**: The expected number of hours in a given time period (often one year) when a system's hourly demand is projected to exceed the generating capacity.
**EUE**: The expected amount of energy (MWh) that will not be served in a given year.

[3] See page 15 of the NERC report, *Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning*, March 2011, at https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/IVGTF1-2.pdf

**Table 1**
**Risk Measures Considered by Reliability Risk Metrics**

| RRM | Frequency[4] | Duration[5] | Magnitude |
|---|---|---|---|
| LOLE | ✓ | | |
| LOLH | | ✓ | |
| EUE | ✓ | ✓ | ✓ |

## 3.0 RRM Results from Recent NYSRC IRM Studies and Observations

Table 2 below compares the annual RRMs calculated from three recent IRM studies, the 2020 IRM Study, the 2021 IRM Study,[6] and the High Intermittent Renewable Resource Study (High Renewable Study)[7]. The target LOLE was 0.1 days/year for all three studies.

**Table 2**
**Reliability Risk Metrics from Recent NYSRC Studies**

| | 2020 IRM Study Base Case | 2021 IRM Study Base Case | High Renewable Base Case |
|---|---|---|---|
| Base Case IRM | 18.9% | 20.7% | 42.9% |
| | | | |
| LOLE | 0.1 days/yr. | 0.1 days/yr. | 0.1 days/yr. |
| LOLH | 0.341 hr./yr. | 0.365 hr./yr. | 0.326 hr./yr. |
| EUE<br>Normalized[8] | 235.2 MWhr/yr.<br>0.000151% | 243.7 MWhr/yr.<br>0.000162% | 207.7 hr./yr.<br>0.000133% |

Table 2 shows that when the system is maintained at the LOLE criterion, the loss of load duration increased by 7%, while the magnitude or size of loss of load events increased by 4%, for the 2021 IRM Study base case compared to the 2020 IRM Study base case. There were a number of parametric parameter updates in the 2021 base case that in combination caused the LOLH and EUE risk values to increase.

[4] Frequency is the count of the number of loss of load events over a particular period of time or in a given sample.
[5] Duration is the length of time of a loss of load event.
[6] See http://www.nysrc.org/reports3.html
[7] The High Renewable Study added 4,000 MW each of onshore wind, offshore wind, and solar resources to the preliminary 2020 IRM Study's base case.
[8] "Normalized EUE" is the total expected firm load shed due to supply shortages (MWhr) as a percent (%) of the forecast annual system energy. The NYISO Gold Book energy forecasts for 2020 and 2021 were assumed for the Normalized EUE calculation. By way of comparison, Australia has a normalized EUE target of 0.002%.

Table 2 also shows that when the system is maintained at the LOLE criterion, the loss of load duration decreased by 5%, while the magnitude or size of loss of load events decreased by 13%, for the high renewable resource scenario compared to the 2020 base case. Although this preliminary result suggests that the renewable scenario provides a better reliability risk benefit, it should be recognized that the required IRM for the renewable scenario has increased to over 40%. Additional analysis is required to validate this conclusion.

Tables 3A, 3B, and 3C below depict monthly distributions for each of the LOLE, LOLH, and EUE RRMs for both of the IRM studies and the High Renewable Study.

**Table 3A**
**Monthly LOLE (days) Distribution**

| Case | July | August | Other Months |
|---|---|---|---|
| 2020 IRM Study | 0.051 | 0.048 | Negligible |
| 2021 IRM Study | 0.050 | 0.048 | Negligible |
| High Renewable Study | 0.041 | 0.057 | Negligible |

**Table 3B**
**Monthly LOLH (hours) Distribution**

| Case | July | August | Other Months |
|---|---|---|---|
| 2020 IRM Study | 0.197 | 0.048 | Negligible |
| 2021 IRM Study | 0.219 | 0.144 | Negligible |
| High Renewable Study | 0.158 | 0.166 | Negligible |

**Table 3C**
**Monthly EUE (MWhr.) Distribution**

| Case | July | August | Other Months |
|---|---|---|---|
| 2020 IRM Study | 168.9 | 66.0 | Negligible |
| 2021 IRM Study | 183.2 | 60.4 | Negligible |
| High Renewable Study | 128.1 | 79.2 | Negligible |

Tables 3A, 3B, and 3C show that, although essentially all of the annual risk of all three metrics occurs in July and August for all three cases, there is considerable shifting of risk within these two months between the three cases.

From the two IRM cases, the average duration of a loss of load event during the 2020 - 2021 period ranges between 3 hours 25 minutes and 3 hours 39 minutes. This compares to an average loss of load event duration of 3 hours 16 minutes for the High Renewable Case.

The above observations illustrate the benefits of considering RRMs in IRM and resource adequacy studies. **Additional analysis is required to further explore the above conclusions and to better understand the relationships between the three RRMs.**

## 4.0 Current RRM Applications by Other Entities

Many other entities in North America have been utilizing RRM in their planning and assessment programs, as follows:

NERC: NERC has been incorporating all three RRMs for a number of years as part of its annual long term reliability assessment (LTRA) program, and is currently planning to expand its applications.

NPCC: NPCC presently includes LOLE, LOLH, and EUE in its NPCC Area reviews and in its summer and winter assessments.

Other Entities: Although virtually all entities in North America use LOLE as their resource adequacy target or criterion, over 20 entities supplement their LOLE target metric with EUE for assessing reliability.

## 5.0 Recommendations

The NYCA is presently undergoing significant and rapid change, motivating the need to improve the assessment of risks to reliability. To this end, based on the analysis in this report, the RAWG recommends that the LOLH and EUE RRMs be used alongside the LOLE RRM when evaluating IRM and resource adequacy, especially those regarding the impact of intermittent resources. Accordingly, the RAWG recommends that these metrics be incorporated in all MARS studies including the 2022 IRM Study and future IRM studies, the planned High Renewable Phase II Study, extreme weather studies, and all other NYSRC resource adequacy studies. The RAWG will review the metric results in these studies to further improve our understanding of their relationships.

The RAWG further recommends the following activities:

- Continue to monitor the work NPCC and NERC is doing regarding RRMs.
- Encourage the NYISO to use the LOLH and EUE RRMs in RNA and other planning studies and reports.
- Continue our dialogue with NYISO Staff on the metric reviews.

Although this report shows the additional quantitative benefits that the LOLH and EUE RRMs provide; especially when evaluating a system with high intermittent resource penetration, the RAWG recommends that more examination of the future modeling results and relationships between RRM metrics is necessary before any change from the present LOLE criterion is considered. In addition, the level of NYISO and NYSRC commitment and MARS revisions must also be fully understood.