SECOND DRAFT 05/01/2019 EVALUATION OF EXTERNAL AREA MODELING IN NYCA IRM STUDIES

NEW YORK STATE
NYSRC
RELIABILITY COUNCIL

Contents

I) Background

The inclusion of emergency assistance (EA) benefits from external areas in IRM studies has been standard practice since the very beginning of these studies[1]. The inclusion of EA in IRM studies results in a reduction in required resources below that which would otherwise have been required without EA to meet reliability requirements.

In New York, tie benefits consist of two parts. The first is firm capacity contracts which assist in lowering the New York Control Area (NYCA)'s Loss of Load Expectation (LOLE), but do not generally affect the establishment of the New York IRM. The second piece is the EA, which is energy that a neighboring Control Area can provide when emergency resources are needed due to a sudden system disturbance. These do lower the IRM requirement.[2]

The modeling of EA in IRM studies can be challenging because the models utilized to calculate an Area's IRM have limitations. For instance, the modeling of the transmission system is usually limited to a transportation like network model and not a power flow-based model. This makes it more difficult to capture transmission constraints which could negatively impact the delivery of EA or prevent loop flow. Other issues include a need to be careful not to model excess capacity that might exists in an external area. The "as-found-system" for most Areas will have excess capacity above that required to meet its reliability criteria. In NY, these concerns have led to a set of requirements in NYSRC's Policy 5-13 which are designed to avoid overdependence on the external Areas for emergency capacity support. These requirements can be found in Policy 5-13 in section 3.5.6 entitled: "External Control Area Load and Capacity Models" on pages 16-17.

Table I below shows the IRM base case for the last 10 years. It also presents the result for the isolated case – i.e., what the NYCA IRM would be without emergency assistance. The difference between the base and the isolated cases serves as proxy,

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[1] See "early evolution of LOLP *evaluating generating capacity requirements," Roy Billinton and Kelvin Chu, IEEE Power & Energy Magazine, July/August 2015, pages 88-98*

[2] It is interesting to note that the NYSRC, concerned with setting the IRM, determines the amount of EA established in the model. The NYISO, concerned with operating its markets, honors that EA by only allowing external capacity contracts to the extent that the NYSRC established EA is not affected. Solving issues related to the establishment of EA will also assist the NYISO in the determination of external capacity contracts (external rights)

albeit an imperfect one, for the level of EA that NYCA benefited from in establishing its IRM.

Table 1

Comparison of Emergency Assistance/Tie Benefits Impact on the IRM
As Measured by the Difference between the Isolated Case and the Base Case
2010 to 2019

Year	**2010**	**2011**	**2012**	**2013**	**2014**
Base Case IRM %	17.9	15.5	16.1	17.1	17.0
NY Isolated %	25.2	25.6	24.7	24.8	25.9
Difference	7.3	10.1	8.6	7.7	8.9
Peak Load MW	32,976	32,872	33,335	33,278	33,655
EA Equivalent in MW	2,407.2	3,320.1	2,866.8	2,562.4	2,995.3
Year	**2015**	**2016**	**2017**	**2018**	**2019**
Base Case IRM %	17.3	17.4	18.1	18.2	16.8
NY Isolated %	26.0	25.9	26.4	26.2	25.0
Difference	8.7	8.5	8.3	8.0	8.4
Peak Load MW	33,587	33,387	33,273	32,868	32,488
EA Equivalent in MW	2,922.1	2,838.0	2,761.7	2,629.4	2,729.0
Ten Year Average of the Differences & σ	8.5% +- 0.8%				

Table I implies that over the last 10 years[3] EA has, on average, reduced the required IRM by approximately 8.5%. For the 2019 IRM study, the updating of the external Areas resulted in an even larger EA benefit than presented here even after accounting for the required Policy 5 adjustments. The implied benefit would have been more than 1% greater than presented and could have been as high as 9.5%, a number that would be on the higher end of observed historical values.

Concerned about a significant increase in EA that wasn't fully understood, NYISO staff brought its concern to ICS. After further review conducted by NYISO staff and NYSRC consultant Adams, it was decided not to update the external Areas from the 2018 IRM model and study the issue further for the 2020 IRM study. This was consistent with prior changes to the external Areas that have been deferred to allow for more time to study the issue further.

[3] In the five years prior to 2010 the average difference 5.2%.

II) Study Scope and Approach

At its September 5th, 2018, the ICS directed the NYISO to evaluate alternative adjustments to external control areas as a result of the EA concerns raised by NYISO staff regarding the observed increase in EA VS. the 2018 IRM study after the externals were updated. The alternative adjustments were developed in conjunction with NYSRC consultant Adams. The adjustments result from NYSRC Policy 5-13 requirements which are designed to avoid overdependence on the external Control Areas for emergency capacity support. These requirements are: 1) an external Control Area's LOLE assumed in the IRM study cannot be lower than its own LOLE criterion and 2) its reserve margin can be no higher than the external Control Area's minimum requirement. Also, Policy 5 states that emergency operating procedures (EOP) are not to be represented in external Areas.

To evaluate alternative adjustments approaches the following set of five study cases were developed by NYISO Staff and the NYSRC Consultant:

- Case 1 - Load scaled proportional to existing load to meet the LOLE criterion and adjust reserve margins if needed to be no higher than the published minimum requirement.
- Case 2 - Same approach as the above case. However, this analysis uses the mod-mdmw table to add loads. The mod-mdmw table is necessary to adjust multiple load shapes; which will be needed for the cases 3-5.
- Case 3 - Change the order of adjustment steps. Load scaled proportional to existing load to meet the LOLE criterion first, then remove EOPS, lastly adjust reserve margins if needed to be no higher than the published minimum requirement.
- Case 4 - Load scaled proportional to excess capacity in each zone to the meet the LOLE criterion and adjust reserve margins, if needed, to be no higher than the published minimum requirement.
- Case 5 - Change the order of adjustment steps and use excess capacity to scale. Load scaled proportional to excess capacity in each zone to meet the LOLE criterion first, then remove EOPs, lastly adjust reserve margins if needed to be no higher than the published minimum requirement.

Case 1 is the current process for adjusting or scaling load in external areas and is for comparison purposes with the other cases. Case 2 is the same as case one except in uses the mod-mdmw to adjust loads to facilitate the timely completion of cases 3-5. Case 3 an alternative way to remove EOPs from external Areas and uses the uses the existing scaling approach. Case 4 is the alternative scaling approach where load is scaled proportional to the capacity in a zone or locality to meet Policy 5 requirements. Case 5 is the same as Case 3 except it uses the alternative scaling approach.

After the initial set of Cases were completed and evaluated the scope was expanded to further explore Case 4 and address alternative ways to model external Areas such as individual EA limits for external Areas and explore whether it possible to develop a more simplified approach to modeling external Areas. These additional scope items or next steps were as follows:

- Validate Option/Case 4 by repeating prior 2 years IRM results using this scaling approach.
- Run most recent IRM study by not removing EOPs in neighboring Areas.
- Begin review of individual control Area EA limits.
- Explore development of a simplified models of external Areas and topology if feasible.
- Investigate running the isolated case for NYCA much earlier in the study process in order to get an indication of the direction of the EA benefit accruing to the NYCA much earlier in the study process.
- Make changes to Policy 5 as required.

III) Case Results

The tables 2&3 below present the results of Cases 1-5.

Table 2

Results of Cases 1, 2, and 4

LOLEs and Margins of External Control Areas

External Control Area LOLEs and Margin Levels										
Year:	2018 FBC		2019 PBC							
Case:	2018 FBC (18.2%)		Starting Case* (15.0%)		Finish Existing - Case 1 (15.6%)		Use Mod-MDMW Case 2 (15.4%)		Proportional to Excess Cap Case 4 (16.4%)	
Area	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level
_PJM_MA_	0.146	**116.0%**	0.017	**124.6%**	0.467	**115.9%**	0.398	**115.9%**	0.145	**115.2%**
ISONE	0.108	**113.8%**	0.000	**145.4%**	0.135	**117.6%**	0.108	**117.0%**	0.109	**116.5%**
IESO	0.104	**134.0%**	0.000	**143.5%**	0.639	**117.7%**	0.560	**117.7%**	0.551	**117.7%**
_HQ_	0.110	**144.1%**	0.000	**148.0%**	0.103	**138.3%**	0.103	**131.7%**	0.103	**131.7%**
_HQ_(winter)	-	**99.9%**	-	**107.9%**	-	**100.9%**	-	**100.5%**	-	**100.5%**

Table 3

Results of Cases 3 and 5

LOLEs and Margins of External Control Areas

External Control Area LOLEs and Margin Levels						
Year:	2019 PBC					
Case:	Starting Case* (15.0%)		EOPs 2nd, α to load - Case 3 (19.5%)		EOPs 2nd, α to Excess Cap - Case 5 (21.7%)	
Area	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level	Annual LOLE	Reserve Level
_PJM_MA_	0.017	**124.6%**	1.712	**111.5%**	1.102	**109.6%**
ISONE	0.000	**145.4%**	0.260	**113.9%**	0.349	**110.7%**
IESO	0.000	**143.5%**	2.821	**110.5%**	1.111	**114.7%**
_HQ_	0.000	**148.0%**	1.118	**134.0%**	1.132	**125.0%**
_HQ_(winter)	-	**107.9%**	-	**97.7%**	-	**97.3%**

Cases 3, 4, & 5 are the cases of interest while Cases 1&2 are for comparison purposes. Cases 3 & 5 are the cases where the external Area are brought to its LOLE criterion as required by Policy 5 and then EOPs are removed. Case 3 utilizes scaling of load proportional to load by zone while Case 5 utilizes scaling of load proportional to zonal excess capacity. Policy 5 requires that EOPs not be modeled in external Areas. The concept behind this approach is to reflect the reduced external Area reliability that would result without the availability of their EOPS. As can be seen in Table 3, this approach has a significant impact on the resulting IRM when compared with Cases 1 or 2. Depending on the load scaling utilized, the IRM is increased by 4% to 6% compared to Cases 1 & 2. This significant impact is the result of EOPs representing a significant amount of equivalent capacity.

Case 4 is the case where scaling of zonal loads is done proportional to zonal excess capacity to accomplish the adjustment required by Policy 5. This approach results in an increase in the IRM of about 1%. The focus on zonal excess capacity to adjust load is more consistent with the objective to avoid overdependence on the external Areas for emergency capacity support. It reduces reserve margins or excess capacity proportionally more in the external Area zones with greater excess capacity. Therefore, depending on the juxtaposition of the zone relative to NYCA, reducing the excess reserves proportionally more in external areas zones closer to NYCA will result in less EA being available to NYCA. It also appears to result in the external Areas meeting their LOLE criterion with lower reserves.

IV) Additional Scope Items or Next Steps

Case 4 Validation

Case 4 is the approach whereby adjustments to the external Areas to satisfy Policy 5 requirements, which are designed to avoid NYCA overdependence on external capacity for EA, are implemented proportional to the excess capacity in the external zone or locality. The purpose of this review is to validate the approach 4 by repeating prior 2 years of IRM results. This will demonstrate how this approach impacts year-to-year changes in IRM and whether there any issues which could produce adverse impacts.

Initial Case 4 analysis conducted by NYISO staff found the Case 4 approach eliminated the need to make additional reserve adjustments in two of the external

Areas (ISO-NE and PJM) after LOLE Policy 5 criteria were satisfied and reduced the magnitude of IRM adjustments in the other external Areas. This suggest that scaling zonal load proportional to zonal excess capacity versus scaling load proportional to existing load appears to offer the following advantages:

1. Given detailed topology models in external Areas, scaling load proportional to excess capacity to meet Policy 5 LOLE requirements helps to avoid localized LOLE violations while reducing excess reserves in external Areas available to provide NYCA with EA.
2. Lower overall excess reserves in external Areas is more consistent with the Policy 5 objective of avoiding overdependence on the external Areas for emergency capacity support.

Case with EOPs in External Areas

Cases 3 & 5 clearly demonstrated that bringing the external Areas to their LOLE criterion and then removing the EOPs as required by has a significant impact on external Areas LOLE and the NYCA IRM. This is because Area EOP steps can account for a significant amount of equivalent capacity. Adopting this approach in the manner performed for these cases would represent a significant change and should not be pursued further.

Current practice is to remove the EOP steps in the external Ares and then bring the Area to its LOLE criterion. In NYSRC consultants view, this approach effectively replaces the EOP steps capacity equivalent with some of the excess capacity in the external Area. This raises the question as to why even go through the process of removing the EOP steps. The purpose of this next step was to explore the impact on the NYCA IRM if the EOP steps in the external Area were not removed to start with. If this approach were adopted it would require Policy 5 to be updated.

Review of Individual EA Limits

Currently, each MARS Monte Carlo draw limits the total amount of EA available to NYCA from the external Areas to 3500 MW. This limit was developed from the analysis of excess operating reserves that is available in the external Areas. The amount of EA that can come from any one external Area is subject to the transfer capability between the external Area and the NYCA. However, concerns were raised that the majority of the 3500 MW could come from a single external Control

Area. Large injections of EA from a single Area may be unrealistic and could result in NYCA being over dependent on a single external Area for EA. As part of the evaluation of EA issue, examination of individual Control Area limits was included in the next steps.

Explore simplified models of external Areas and topology

During the review of EA, a suggestion was put forth by NYISO staff that alternative ways be explored to model the external Areas that would result in less complex models of those Areas. This would speed up both the updating process for the external Areas and the run time of the simulations. Three test cases or alternative approaches were proposed by NYISO staff. They are as follows:

1. Test #1: Using the individual Area EA limits developed above, model each external control area as a single Area with the tie capability entering New York set to the individual EA values and isolate the ties leaving New York in order to eliminate loop flow.
2. Test #2: Same as test #1 but with a single perfect generator modeled in each external Area equal to the individual Area EA limit.
3. Test #3: Same as Test #2 but remove the tie limits from the interfaces

Timing of NYCA Isolated Case

The isolated IRM case where NYCA is modeled without the availability EA from the external Areas is a proxy for how much benefit or reduction in the IRM that results from having access to EA. This result provides guidance as to how much the level of assistance has changed from the previous year's study to the current year's IRM study. Significant changes in level can indicate that a more in-depth review of the updates to the external Areas should be under taken. The isolated case is run as part of the sensitivity cases. These cases are run close to the end of the IRM study. This can result in limited time for review if an issue arises. NYISO staff has been asked if it would be possible to run the isolated case earlier in the process.

V) Findings of Next Steps

Case 4 Validation

Table 4 presents the results of scaling loads in external Area proportional to excess capacity in the zones for 2017 and 2018 as well as 2019.

Table 4
Results of Scaling Load Proportional to Excess Capacity
2017, 2018 and 2019

	2017			**2018**			**2019**		
	Before Pol 5	Final	New Final	Before Pol 5	Final	New Final	Before Pol 5	Final*	New Final**
LOLE									
NYCA	0.100	0.100	0.099	0.100	0.100	0.100		0.100	0.100
PJM_MA	0.008	0.141	0.142	0.000	0.146	0.146	0.017	0.467	0.145
ISONE	0.107	0.134	0.132	0.092	0.108	0.110	0.000	0.135	0.109
IESO	0.001	0.109	0.103	0.040	0.104	0.100	0.000	0.639	0.551
Quebec	0.000	0.113	0.101	0.000	0.110	0.105	0.000	0.103	0.103
Load Added		Previous Method	New Method		Previous Method	New Method		Previous Method	New Method
PJM_MA		10,115	10,750		14,014	15,850		14,851	12,501
ISONE					150	200		6,080	6,309
IESO		2,760	2,675		950	1,450		1,765	4,822
Quebec		2,350	2,375		2,550	2,650		1,952	2,856
Total		15,225	15,800		17,664	20,150		24,648	26,488
IRM Sensitivity		18.10%	18.20%		18.20%	18.76%	15.00%	15.60%	16.40%

* If the replacement of the externals had occurred and the old method retained.
**If the replacement of the external had occurred and the new method utilized.

The results for 2017 and 2018 are consistent with the initial Case 4 result as they all result in a slightly higher IRM for NYCA and overall net lower reserves in the external areas which reduces the amount of EA available to NYCA. When one looks below the total Area to the zonal level there is consistent pattern as well. In PJM there is a shift of reserves between PJM east and central with PJM east reserves increasing and PJM Central reserves decreasing across all three years. In general, the total reserves in PJM East and Central remain at approximately the same level in 2019 but there was net loss in 2018 and 2019 with a noticeable shift of reserves within the PJM Area to zones further from NYCA. In ISONE you see a similar pattern with a shift in reserves from the zones closest to NYCA to zones further away as well as an overall reduction in reserves.

In summary, depending on the starting point and the amount of adjustment required, the scaling of loads in external Areas proportional to excess capacity in the zones has an impact on the location of reserves in the external Areas and results in an overall reduction in the net reserves in the external Areas.

Case with EOPs in External Areas

There are no additional results to report for the case with EOPs modeled in the external Area. The primary reason is that the NPCC data obtained through the CP-8 process contains data for EOPs in the external Areas that is provided in 6 steps. NY models 10 steps. For the initial analysis, NY was collapsed to 6 steps. NYISO staff has indicated that to do this correctly the external Areas should be mapped to 10 steps. Completing this analysis should be an objective for the 2021 IRM study.

The current practice of not including external EOPs in the IRM analysis and bringing the external areas to criteria should viewed as an interim solution. Modeling EOPs in external Areas can have a twofold affect. The first is that the external Areas will start with more resources requiring more load to be added to achieve criteria; and the second is it could have potentially locational impacts especially if scaling loads in external Area proportional to excess capacity is adopted.

Review of Individual EA Limits

There is mounting evidence to suggest that a single NYCA import limit can bring about an overreliance on an external control area in supplying EA. The ICS inherently recognized this need years ago when setting the limits from Ontario to 1,750 MW, the limit from New England to 1,400 MW and the imports into southeast New York to 2,000 MW. In addition, Quebec has been limited by allowing 1,110 MWs of grandfathered capacity to utilize the existing tie (leaving 390 MW available). Although the overall NYCA import limit is set at 3,500 MW, one can see that the total of the above imports, 5,540 MW, can allow flooding from one external Control Area. Flooding from one Area can impose both higher IRMs and LCRs. Blocking external Control Areas in a systematic fashion may show the effects of this flooding, especially if conducted using tan 45 analysis which can reveal locational effects. This time consuming testing could not be performed if we waited for the completion of the 2020 IRM study. This testing should begin now using the 2019 IRM study, which would allow completion in the 2020 spring timeframe.

Explore simplified models of external Areas and topology

It is suggested in the footnote (#2) above that a more repeatable EA determination could also assist the NYISO in setting import rights. A simplified model could be constructed using the above established external control area limits which would allow the NYISO to fix the import rights and allow consistency of both the EA limits and the import rights from year to year. The testing of such a model could be performed in parallel with the above external area limit testing and results also provided in the spring of 2020.

Timing of NYCA Isolated Case

The NYISO, when conduction the parametric analysis, waits until most of the other changes have occurred in the model build up before replacing the external control areas. This allows the policy 5 changes to be performed only once. Performing the policy 5 adjustments early could nullify those adjustments as other changes are made to the NYCA system. This is because the neighboring LOLEs are tied to the NYCA system.

It is still desirable to have an early indication of the impacts of the external areas. Although those impacts may become more stable under the adoption of the above limits and rights, knowing early impacts could allow better coordination of the parametric cases resulting in clearer testing results.

The NYISO will attempt to provide an early indication of the external area impacts. A comparison of the early policy adjustments and later adjustments could prove useful in an understanding of the interrelationships of the various input changes.

The results will be conducted and reported on during the preliminary and final base case build up for the 2020 IRM study.

VI) Conclusion and Recommendations

Based on the work and analysis completed to date the following conclusions and recommendations are provided.

1. Scaling loads in external Area proportional to excess capacity in the Area zones has a twofold impact on the EA available to NYCA. First, the overall level of reserves in the external Areas to support EA are reduced. Secondly, the external zones with excess capacity are generally positioned closer to the NYCA load zones and thus reduce the EA level further. This methodology is more consistent with the NYSRC 5-13 policy objective which is to avoid overdependence on the external Areas for emergency capacity support to NYCA. NYISO Staff and the NYSRC consultant recommends that scaling loads in this manner be adopted for the 2020 IRM study.
2. Not modeling EOPs in external Areas should only continue as an interim process until the impact of modeling EOPs in external Areas on the amount of EA available to NYCA is better understood especially the potential impact of their locational aspects.
3. Continue with the efforts regarding individual EA limits, simplified models of external Areas and timing of NYCA isolated case as described above.