ANALYSIS GROUP

NYISO Climate Change Phase II Study

Discussion of Draft Report Observations

September 10, 2020

Today:

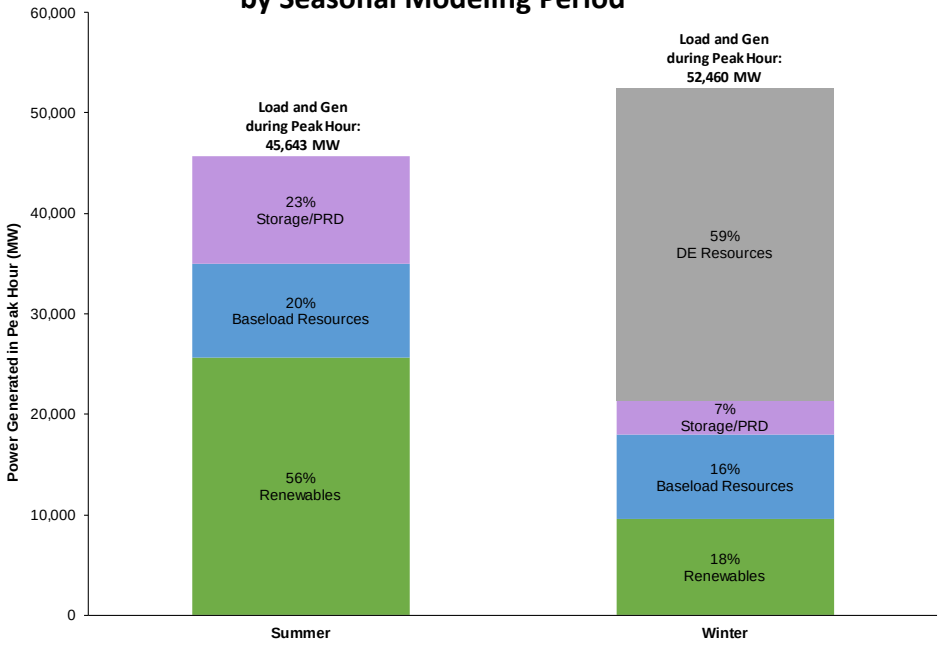
- Overview of Draft Report Observations
  - Attributes of Generic Resource Required for Grid Reliability
    - *Generic resource included in the resource sets – called Dispatchable & Emissions-Free Resource, or "DE Resource"*
  - Required Pace of Resource Development
  - Cross-Seasonal Differences in Load/Generation Balance
- Appendix: Updated Climate Case Results

Attributes of Generic Resource Required for Grid Reliability

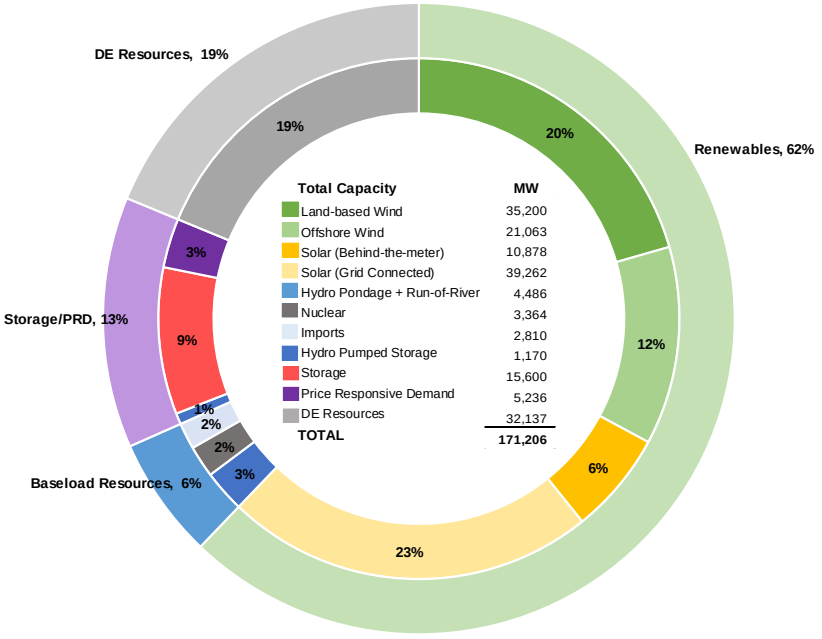
Backstop Resource

- The “DE Resource” category is included in the model to achieve reliable solutions
  - AG does not presume to know what resource or what fuel will fill this gap twenty years hence
  - The purpose of modeling it is to *understand the attributes* of the resource need
- The DE Resources are included to maintain reliability during the highest load hours of each modeling period. DE Resources provide the majority of energy on the peak winter hour during the CLCPA load scenario (Hour 2 of January 12, 2040)
- As a result, DE Resources make up a substantial portion of nameplate capacity: 19% of nameplate capacity in the Climate Change Phase II (CCP2) resource set for the CLCPA load scenario

Resource Mix during Peak Hour by Seasonal Modeling Period



Nameplate Capacity by Resource Type CLCPA Load Scenario, CC Resource Set

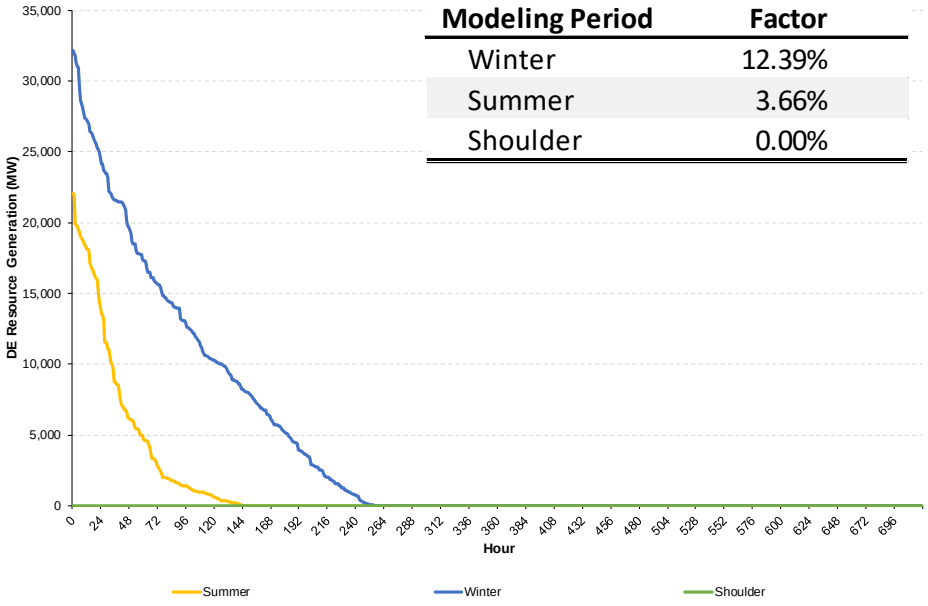


DE Resource Use by Seasonal Modeling Period

- Large quantity of DE Resource generation needed in a small number of hours
- DE Resource has low capacity factor (~12%) during the most stressed seasonal modeling period (winter)
- DE Resource has only a 3.7% capacity factor in the summer seasonal modeling period
- DE Resource is not needed at all during shoulder season modeling period
- Thus, while a substantial quantity of capacity is needed, the energy need is minimal

Duration Curve of DE Resource Generation by Modeling Period – CLCPA Load Scenario, Baseline Case

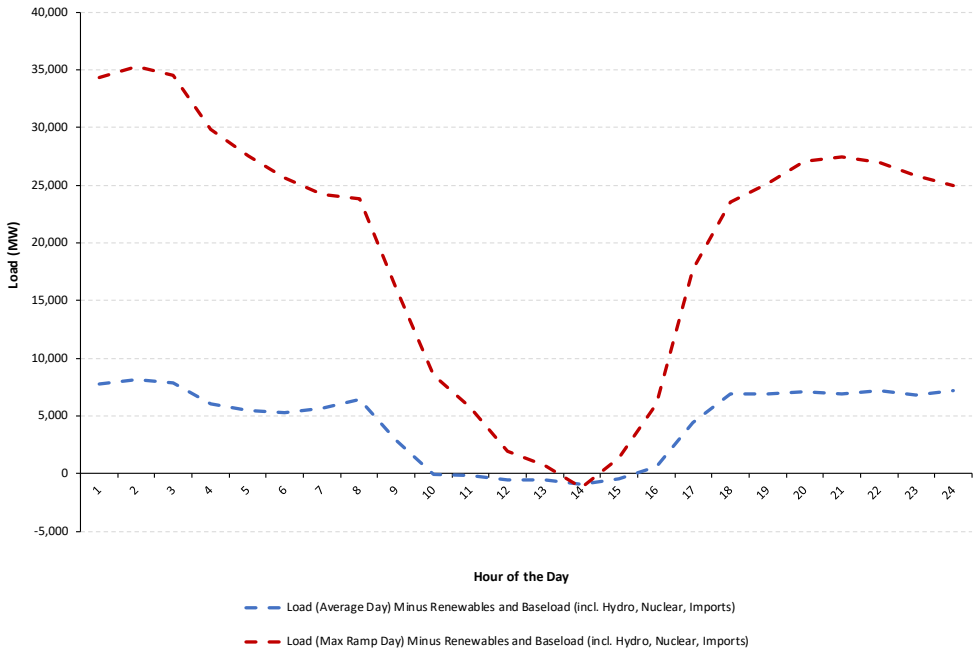
Seasonal Modeling Period	Average Capacity Factor
Winter	12.39%
Summer	3.66%
Shoulder	0.00%



DE Resource Ramping Capability Attribute

- The DE Resource must be able to come on line quickly, and be flexible enough to meet rapid, steep ramping needs
- On an average day, storage can meet evening peaks, but the DE Resource must generate if storage is depleted and renewable generation is low
- In the Winter CLCPA scenario, the DE Resource output across the state must increase from 362 MW (1.1% of DE Resource nameplate capacity) to 27,434 MW (85.4% of nameplate capacity) in 6 hours of the most stressed day

Maximum Hourly Ramping Requirement
Winter CLCPA Load Scenario, Baseline Case

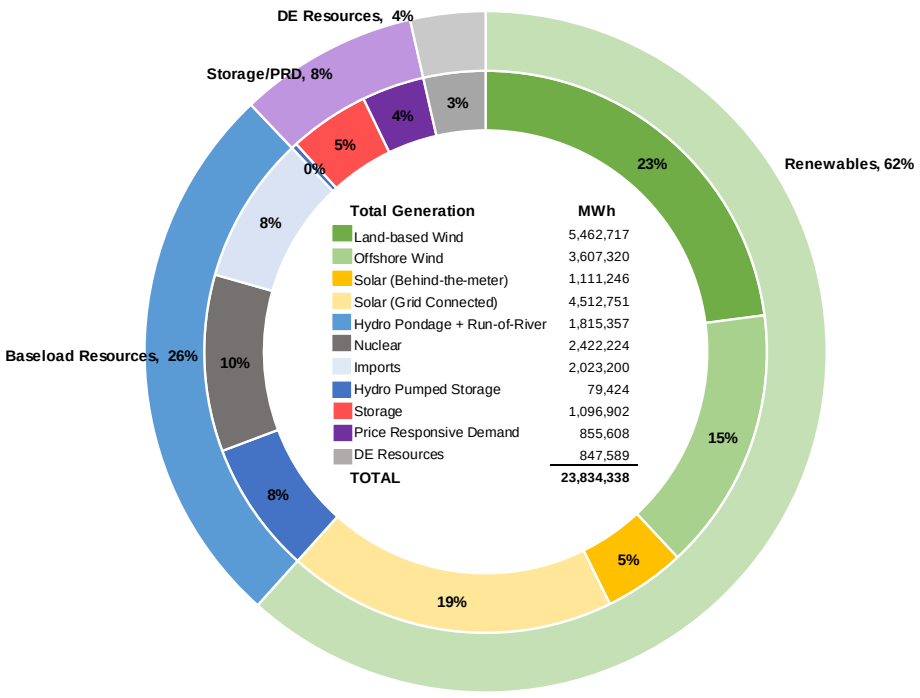


Note:
[1] Renewable generation quantities offset from load do not include curtailed renewable generation.

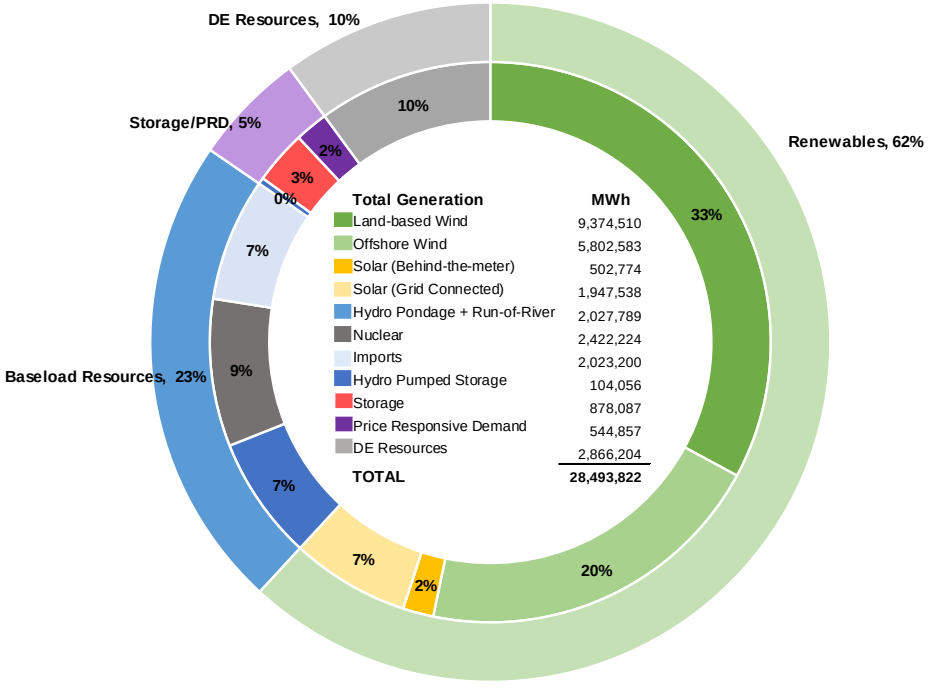
Resource Mix by Seasonal Modeling Period

- Overall, the DE Resource provides a small proportion of system energy; only 4% of summer modeling period load and 10% of winter modeling period load are met by DE Resources in the CLCPA load scenario under the CCP2 resource set
- Majority of load is served by baseload and renewable resources in each modeling period

Generation by Resource Type – Summer 2040
CLCPA Load Scenario, Baseline Case



Generation by Resource Type – Winter 2040
CLCPA Load Scenario, Baseline Case



Pace of Resource Development

Pace of Resource Development Required

- Overall, the impact on reliability associated with how the resource mix evolves between now and 2040 overshadows the reliability risks associated with the modeled climate disruption events
- The current system is heavily dependent on existing fossil-fueled resources, and eliminating these resources from the mix will require a substantial level of investment in new and replacement infrastructure, and/or the emergence of a zero-carbon fuel source for thermal generating resources

Pace of Renewable Resource Development Required

- For either the Climate Change Phase II or Grid in Transition resource sets, the required pace of development of wind and grid-connected solar nameplate capacity is thousands of MW per year from 2020 through 2040
- There is no historical precedent for this pace of renewable generation development and integration

Required Rate of New Resource Development in the CC and GIT resource sets, 2020-2040

	Nameplate Capacity (MW)		Required 2020-2040 Capacity Growth Rate (MW/yr)	
	Wind (Land-based and Offshore)	Grid-Connected Solar	Wind (Land-based and Offshore)	Grid-Connected Solar
Existing Resources (2020)	1,985	57		
Climate Phase II Reference Case Resource Set (2040)	39,962	34,354	1,899	1,715
Climate Phase II CLCPA Scenario Resource Set (2040)	56,263	39,262	2,714	1,960
Grid in Transition Reference Case Resource Set (2040)	23,522	30,043	1,077	1,499
Grid in Transition CLCPA Scenario Resource Set (2040)	48,357	31,669	2,319	1,581
Historical Capacity Growth Rate (2012-2020, MW/yr)			**71.4**	**3.1**

Source:
[1] 2012 NYISO Gold Book, 2020 NYISO Gold Book.

Cross-Seasonal Differences in Load/Generation Balance

Cross-Seasonal Differences in Load/Generation Balance

- Cross-seasonal differences in load and renewable generation would provide opportunities for renewable fuel production, provided it will be technically and economically feasible to create, transport, and store the fuel or to develop other forms of long-term storage
- The CCP2 resource set is constructed to meet peak demand in the winter and summer seasons based primarily on production from renewable resources, so there is a substantial amount of renewable generation that is excess, or “spilled,” in off-peak seasons and hours
- The energy/fuel production potential of the excess renewable generation is large relative to the energy needs of the backstop resources during the summer and winter

Opportunity for Use of Shoulder Month Excess Renewables

- In the average hour in the shoulder season modeling, ~76% of renewable generation is excess to load and storage demand in NY State in the model
- In the CLCPA load scenario, there are 2,866 GWh of generation from backstop resources in the winter month, and 23,204 GWh of excess renewable generation in the shoulder month
- This means a seasonal storage technology with a round trip efficiency on the order of 10%-20% would be able to meet backstop generation energy needs with excess off-season renewables

Excess Renewable Generation
CLCPA Load Scenario, CCP2 resource set

Season	Aggregate Excess Renewable Generation (GWh)	Average Hourly Excess Renewable Generation (MW)	Average Hourly Percentage of Excess Renewable Generation (%)
Winter	4,401	6,112	13.66%
Summer	3,926	5,453	13.95%
Shoulder	23,204	32,227	75.80%

Seasonal Storage Opportunity
CLCPA Load Scenario, CCP2 resource set

		Shoulder	Summer	Winter
	Dates	4/1/2040 -4/30/2040	7/1/2040 -7/30/2040	1/1/2040 -1/30/2040
CLCPA Case	Total DE Resource Energy Used (GWh)	0 GWh	848 GWh	2,866 GWh
	Total Renewable Energy Curtailed (GWh)	23,204 GWh	3,926 GWh	4,401 GWh
	Seasonal Storage Efficiency Needed to Meet DE Resource Energy Need with Shoulder Season Curtailed Energy	-	3.65%	12.35%

Appendix: Updated Case Results

CLCPA Load Scenario Results (CCP2 Resource Set)

	Loss of Load		DE Resource Generation				
	Total Hours with LOLO in at least one Load Zone	Aggregate LOLO (MWh)	Max Consecutive Hours with DE Resource Gen.	Total Hours with DE Resource Gen.	Aggregate DE Resource Gen. (MWh)	Max DE Resource Gen. (MW)	Max 1-hr. DE Resource Gen. Ramp (MW)
CLCPA Summer Scenario - Climate Impact Phase II Resource Set							
Baseline Summer	0	0	36	145	847,589	22,081	9,170
Heat Wave	0	0	36	147	964,668	22,081	8,642
Wind Lull - Upstate	0	0	37	179	1,171,656	23,361	9,447
Wind Lull - Off-Shore	0	0	40	196	1,116,165	23,170	9,170
Wind Lull - State-Wide	0	0	40	235	1,697,161	24,440	11,605
Hurricane/Coastal Wind Storm	26	20,168	171	322	1,892,046	22,081	8,642
Severe Wind Storm – Upstate	8	1,620	87	283	2,002,682	22,081	8,642
Severe Wind Storm – Offshore	0	0	36	167	1,079,462	22,163	10,015
Drought	0	0	36	166	1,148,649	23,595	10,610

	Loss of Load		DE Resource Generation				
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CLCPA Winter Scenario - Climate Impact Phase II Resource Set							
Baseline Winter	0	0	62	255	2,866,203	32,135	11,716
Cold Wave	0	0	62	259	2,879,947	32,135	11,716
Wind Lull - Upstate	5	2,373	62	259	3,076,530	32,135	12,707
Wind Lull - Off-Shore	10	7,184	104	274	3,350,666	32,135	11,715
Wind Lull - State-Wide	13	14,404	105	278	3,653,404	32,135	12,403
Severe Wind Storm – Upstate	45	22,146	81	369	3,822,059	31,419	12,850
Severe Wind Storm – Offshore	9	4,203	103	304	3,609,785	32,135	11,715
Icing Event	2	88	62	273	2,909,437	32,135	11,716

Reference Case Load Scenario Results (CCP2 Resource Set)

	Loss of Load		DE Resource Generation				
	Total Hours with LOLO in at least one Load Zone	Aggregate LOLO (MWh)	Max Consecutive Hours with DE Resource Gen.	Total Hours with DE Resource Gen.	Aggregate DE Resource Gen. (MWh)	Max DE Resource Gen. (MW)	Max 1-hr. DE Resource Gen. Ramp (MW)
Reference Summer Scenario - Climate Impact Phase II Resource Set							
Baseline Summer	0	0	36	183	972,444	17,059	6,520
Heat Wave	0	0	36	199	1,067,892	17,059	6,520
Wind Lull - Upstate	2	729	38	209	1,175,961	17,059	5,655
Wind Lull - Off-Shore	2	1,797	41	243	1,307,211	17,059	6,380
Wind Lull - State-Wide	4	3,149	42	283	1,697,728	17,059	10,929
Hurricane/Coastal Wind Storm	76	96,295	173	349	1,637,221	17,059	6,520
Severe Wind Storm – Upstate	18	4,470	106	330	1,975,003	17,059	6,520
Severe Wind Storm – Offshore	0	0	36	241	1,249,958	17,059	7,489
Drought	11	6,383	38	209	1,305,698	17,059	5,755

	Loss of Load		DE Resource Generation				
	Total Hours with LOLO in at least one Load Zone	Aggregate LOLO (MWh)	Max Consecutive Hours with DE Resource Gen.	Total Hours with DE Resource Gen.	Aggregate DE Resource Gen. (MWh)	Max DE Resource Gen. (MW)	Max 1-hr. DE Resource Gen. Ramp (MW)
Reference Winter Scenario - Climate Impact Phase II Resource Set							
Baseline Winter	0	0	4	6	9,316	3,762	2,479
Cold Wave	0	0	4	6	9,316	3,762	2,479
Wind Lull - Upstate	0	0	4	6	10,646	4,213	2,400
Wind Lull - Off-Shore	0	0	9	15	48,055	6,386	3,819
Wind Lull - State-Wide	0	0	13	32	90,238	8,219	4,127
Severe Wind Storm – Upstate	10	1,146	14	56	119,192	5,809	2,283
Severe Wind Storm – Offshore	0	0	8	20	31,311	4,677	3,809
Icing Event	3	157	6	14	9,886	3,762	2,479

CLCPA Load Scenario Results (Grid-in-Transition Resource Set)

	Loss of Load		DE Resource Generation				
	Total Hours with LOLO in at least one Load Zone	Aggregate LOLO (MWh)	Max Consecutive Hours with DE Resource Gen.	Total Hours with DE Resource Gen.	Aggregate DE Resource Gen. (MWh)	Max DE Resource Gen. (MW)	Max 1-hr. DE Resource Gen. Ramp (MW)
CLCPA Summer Scenario - Grid in Transition Resource Set							
Baseline Summer	0	0	98	512	4,181,951	27,075	6,382
Heat Wave	0	0	98	523	4,404,209	27,075	6,382
Wind Lull - Upstate	0	0	98	516	4,501,251	28,807	7,643
Wind Lull - Off-Shore	0	0	226	543	4,983,818	28,360	6,450
Wind Lull - State-Wide	0	0	226	543	5,322,997	30,794	7,172
Hurricane/Coastal Wind Storm	25	20,488	240	559	4,832,633	27,075	6,380
Severe Wind Storm – Upstate	24	18,963	172	549	4,998,149	27,075	6,382
Severe Wind Storm – Offshore	0	0	171	556	5,126,163	27,460	6,380
Drought	0	0	102	520	4,616,646	28,720	8,162

	Loss of Load		DE Resource Generation				
	Total Hours with LOLO in at least one Load Zone	Aggregate LOLO (MWh)	Max Consecutive Hours with DE Resource Gen.	Total Hours with DE Resource Gen.	Aggregate DE Resource Gen. (MWh)	Max DE Resource Gen. (MW)	Max 1-hr. DE Resource Gen. Ramp (MW)
CLCPA Winter Scenario - Grid in Transition Resource Set							
Baseline Winter	0	0	104	460	6,155,321	39,539	11,992
Cold Wave	0	0	104	466	6,272,961	39,539	11,992
Wind Lull - Upstate	8	7,090	110	469	6,309,711	39,539	12,408
Wind Lull - Off-Shore	6	1,378	168	487	6,836,558	39,539	11,627
Wind Lull - State-Wide	9	10,757	124	486	6,988,838	39,539	12,041
Severe Wind Storm – Upstate	51	57,457	110	551	6,707,765	38,284	11,461
Severe Wind Storm – Offshore	2	327	120	561	7,916,575	39,539	11,763
Icing Event	24	11,242	104	480	6,145,568	39,539	11,992

Next Steps

NYISO Climate Change Phase 2 Study – Final Report

- Final Report draft version posted along with the September 10th ESPWG meeting materials
- Requesting that all Stakeholder comments on the Final Report draft be sent via email to Lbullock@nyiso.com. Deadline for Stakeholder comments is **Thursday, September 17th**
- October: TPAS/ESPWG Stakeholder presentation of the Final Report by Analysis Group.
- Final Report posted to the NYISO public website

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