



Indian Point Replacement Options

2017

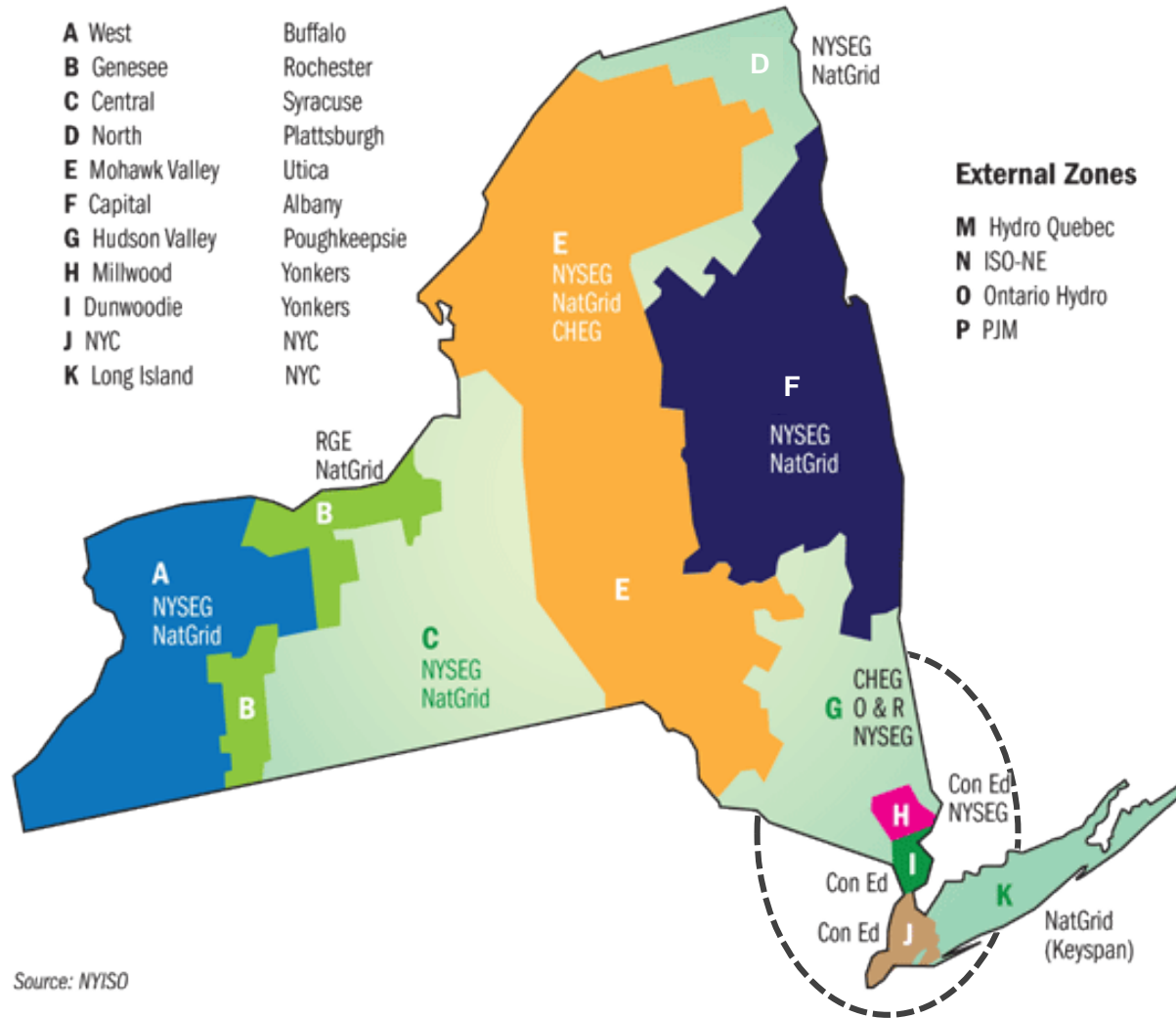
Summary

- Confluence of Indian Point shutdown, implementation of new ozone standards, and NYC #6 fuel oil phase out could result in a capacity shortfall of >1,000 MW in 2023.
- A portfolio of resources that includes 450MW of battery storage can fill the capacity gap while saving New Yorkers money. This analysis shows an estimated \$315m savings over a five year period for electricity customers when compared to more traditional resource replacement scenarios.
- In addition to saving New Yorkers money, energy storage also provides the following key benefits:
 - Short time to develop: storage facilities can be deployed in less than one year if a storage procurement target and process is in place. The emergency situation in California's Aliso Canyon provides a real-world example in which projects totaling over 200MWh were operational 4 months after receiving procurement contracts.
 - Zero local emissions: can achieve phase-out of local pollutants without threatening reliability.
 - Safeguard for customers: Mitigates risk of capacity shortfall and related price spikes in case new peaker projects are delayed or pipelines are constrained.
 - Enhances resiliency: Provides addition grid resiliency to provide backup power during future storms and protect against disruption of fuel supplies
 - Benefits to all regions: Can help to increase utilization of generators in upstate regions that are transmission constrained during peak hours.
 - Jobs: Deployment and installation of energy storage requires local construction, engineering, and electrical work
- To realize these benefits, policy intervention is required (see slide 23 for proposals). We recommend a “no regrets” energy storage procurement target of 450MW by 2020 to ensure cost-effective energy storage deployment and help overcome current market barriers.

NYISO G-J Locality

New York Control Area Load Zones

A West	Buffalo
B Genesee	Rochester
C Central	Syracuse
D North	Plattsburgh
E Mohawk Valley	Utica
F Capital	Albany
G Hudson Valley	Poughkeepsie
H Millwood	Yonkers
I Dunwoodie	Yonkers
J NYC	NYC
K Long Island	NYC

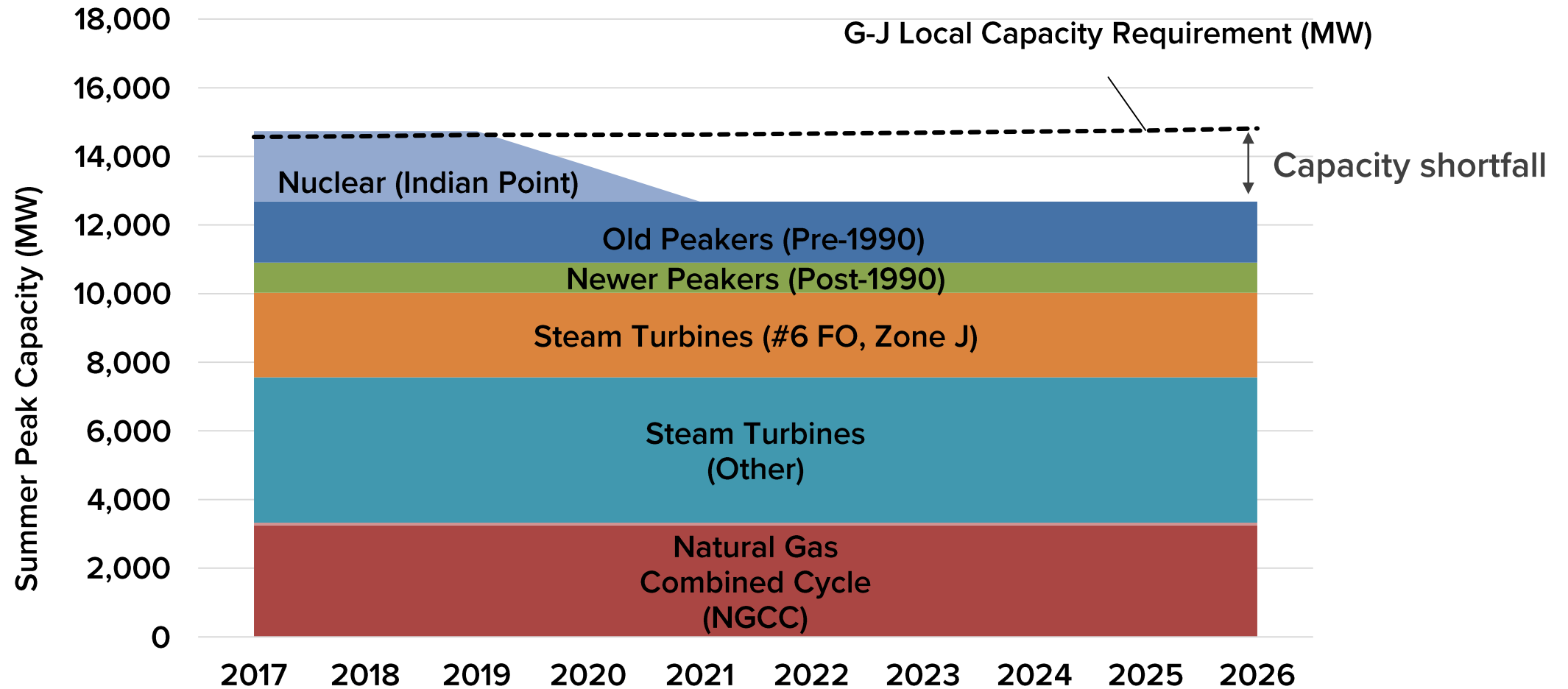


Source: NYISO

- ~16,000 MW Summer Peak Load.¹
 - <1% annual growth projected through 2026 (after EE and DG).
- 90% Local Capacity Requirement (~14,500 MW).²
- Indian Point Nuclear Plant Retirement
 - 2,060 MW reduction in Zone H by 2021
 - ~14% of G-J local capacity need

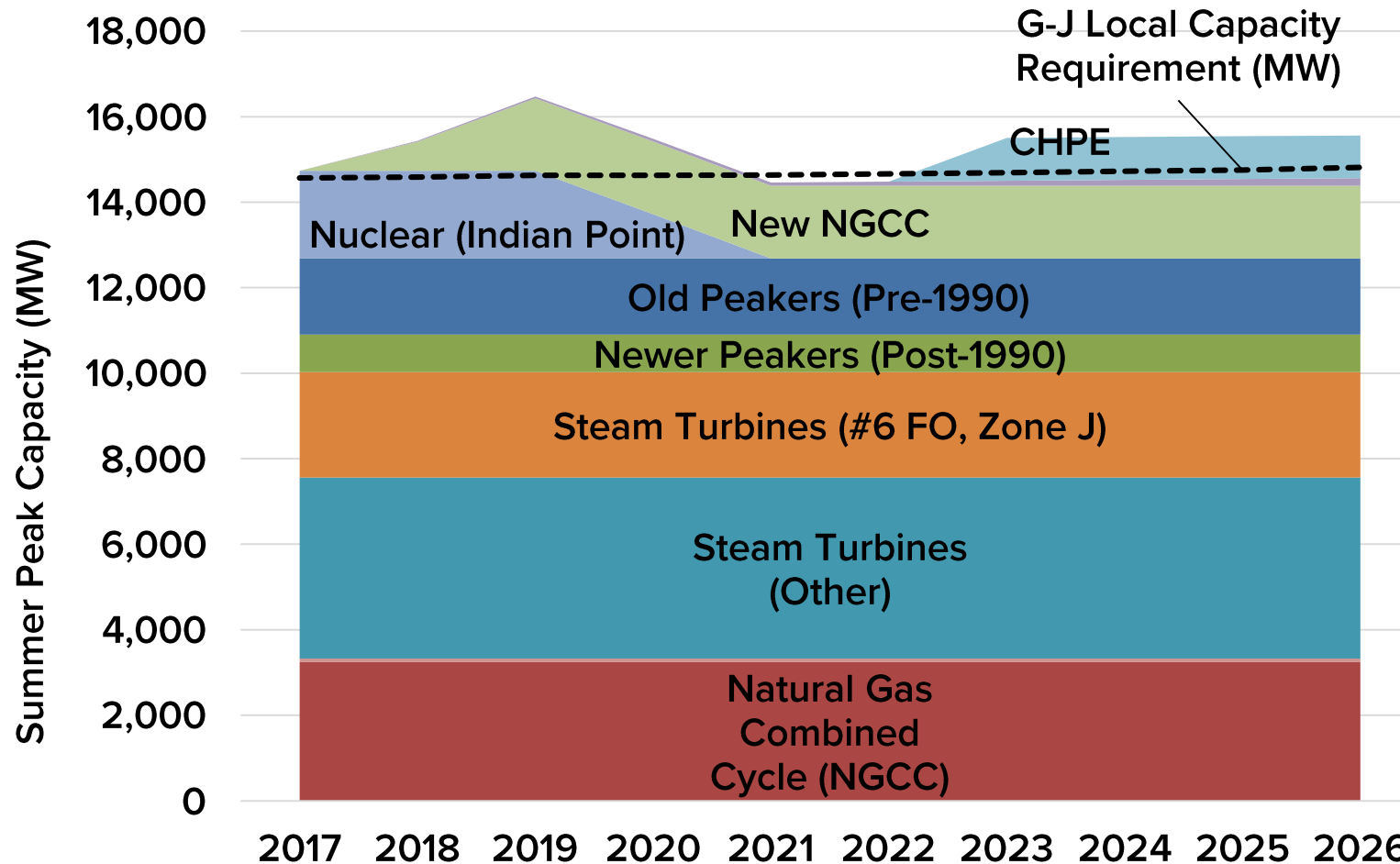
[1]: NYISO 2016 Reliability Needs Assessment, Table 4-8, (Oct 2016)
 [2]: NYISO Locational Minimum Installed Capacity Requirements Study - 2016-2017 Capability Year, (Jan 2016).

Existing Capacity Resources in Zone G-J



Source: 2017 resources based on NYISO 2016 Load & Capacity Data ("Gold Book")

Existing + Planned Resources in Zone G-J

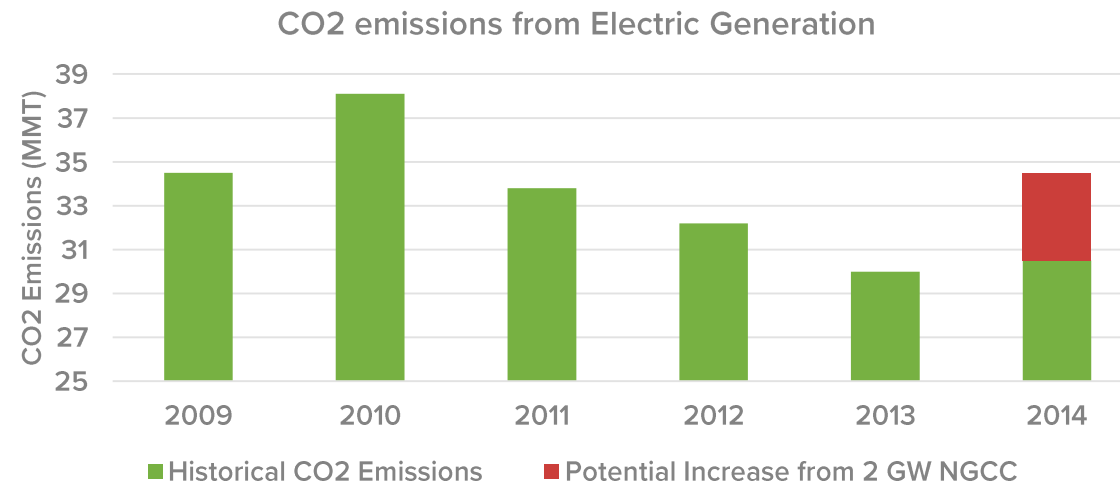


- **New NGCC**
 - CPV (+680 MW in 2018)
 - Cricket Valley (+ 1,020 MW in 2019)
- **New transmission**
 - Champlain Hudson Power Express (+1,000 MW DC line to Hydro Quebec, 2022-23 timeframe)
 - Others?

Source: 2017 resources based on NYISO 2016 Load & Capacity Data ("Gold Book")

Potential Risks for Planned G-J Resource Additions

- Planned additions could be delayed -- particularly transmission projects
 - e.g. CHPE recently delayed
- NGCC additions are counterproductive to NY State's GHG energy goals
 - 2,000 MW of NGCC would increase electric sector GHG emissions by ~13%, erasing 5 years worth of progress (see chart below)
- Renewables may face local siting hurdles or may be transmission constrained – particularly during peak times

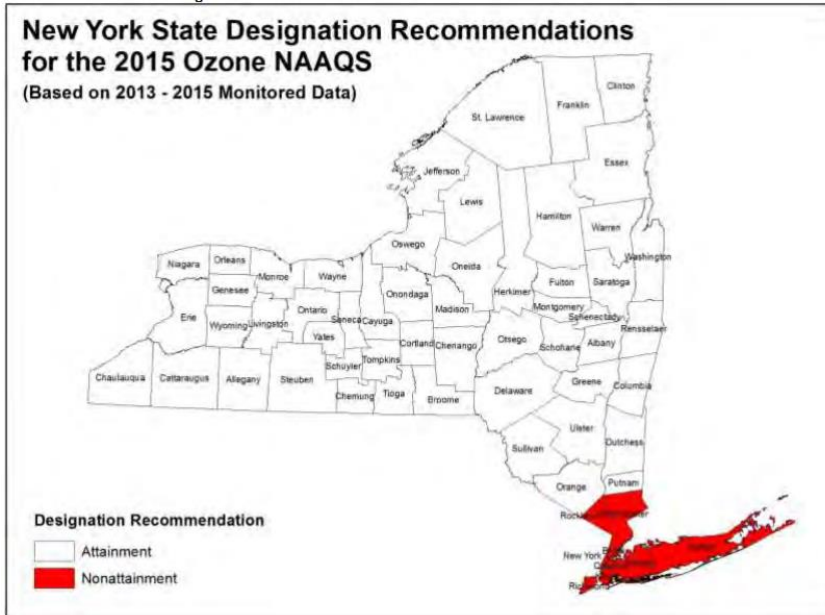


Assumptions: heat rate = 7,655 Btu/kWh; NG emissions factor = 53.07 kg/mmBtu; NYS 2014 GHG Inventory electric sector emissions = ~30 MMtCO₂e

Potential Risks for Existing G-J Resources

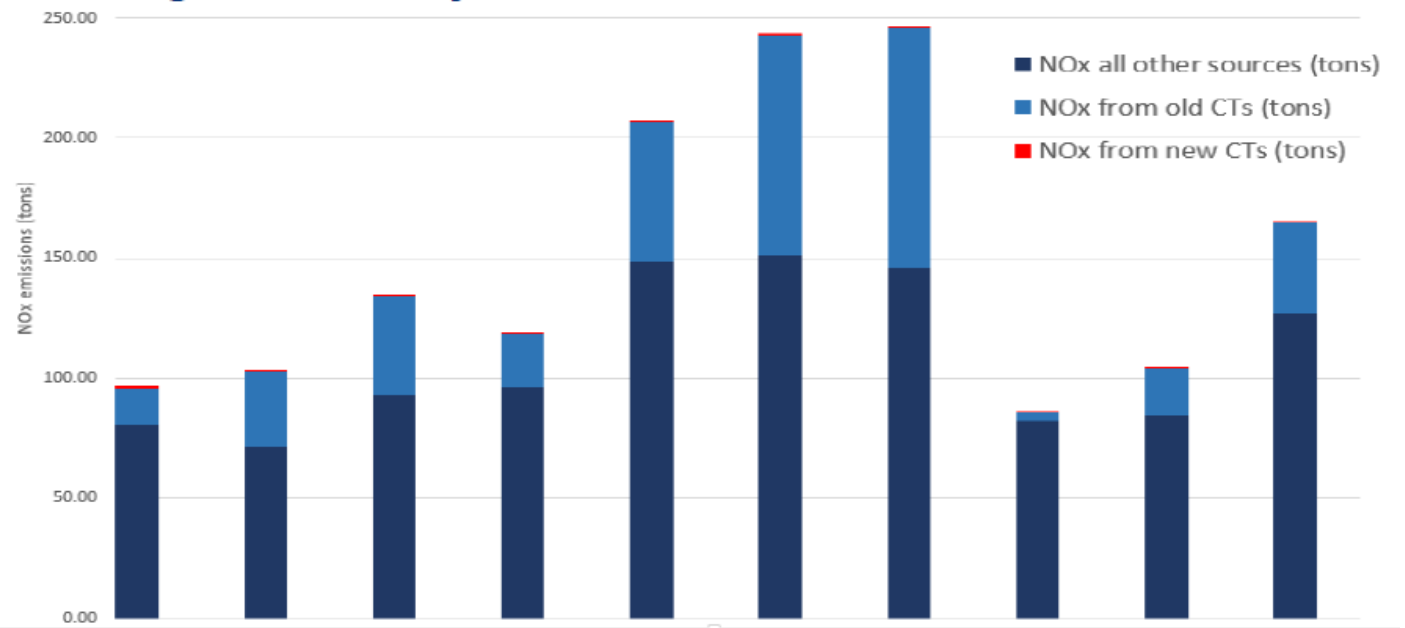
- New Ozone Rules
 - NY metro area is in non-attainment for federal ozone standards (2015 NAAQS 8-hr)
 - NY DEC modeling shows that peaking units contribute significantly to ozone non-attainment
 - DEC likely to implement new NOx limits affecting older peaker plants (pre-1990) in New York metro area
 - Could affect up to ~1,775 MW of generation in Zones G-J, with implementation in 2023 timeframe
- NYC Phase Out of #6 Fuel Oil
 - NYC has mandated phase out of #6 fuel oil by 2020, and #4 fuel oil by 2030 (Local Law 38 of 2015)
 - Proposed council resolution (Res. No. 320, Constantinides) could accelerate timeline for phase out of #4 to 2025
 - Dual-fuel capability required for reliability (some plants may be able to switch to #2 oil as backup fuel)
 - Could affect 2,460 MW of steam generation in Zone J that uses #6 oil as backup fuel

Old Peakers Contribute Significantly to Ozone Pollution



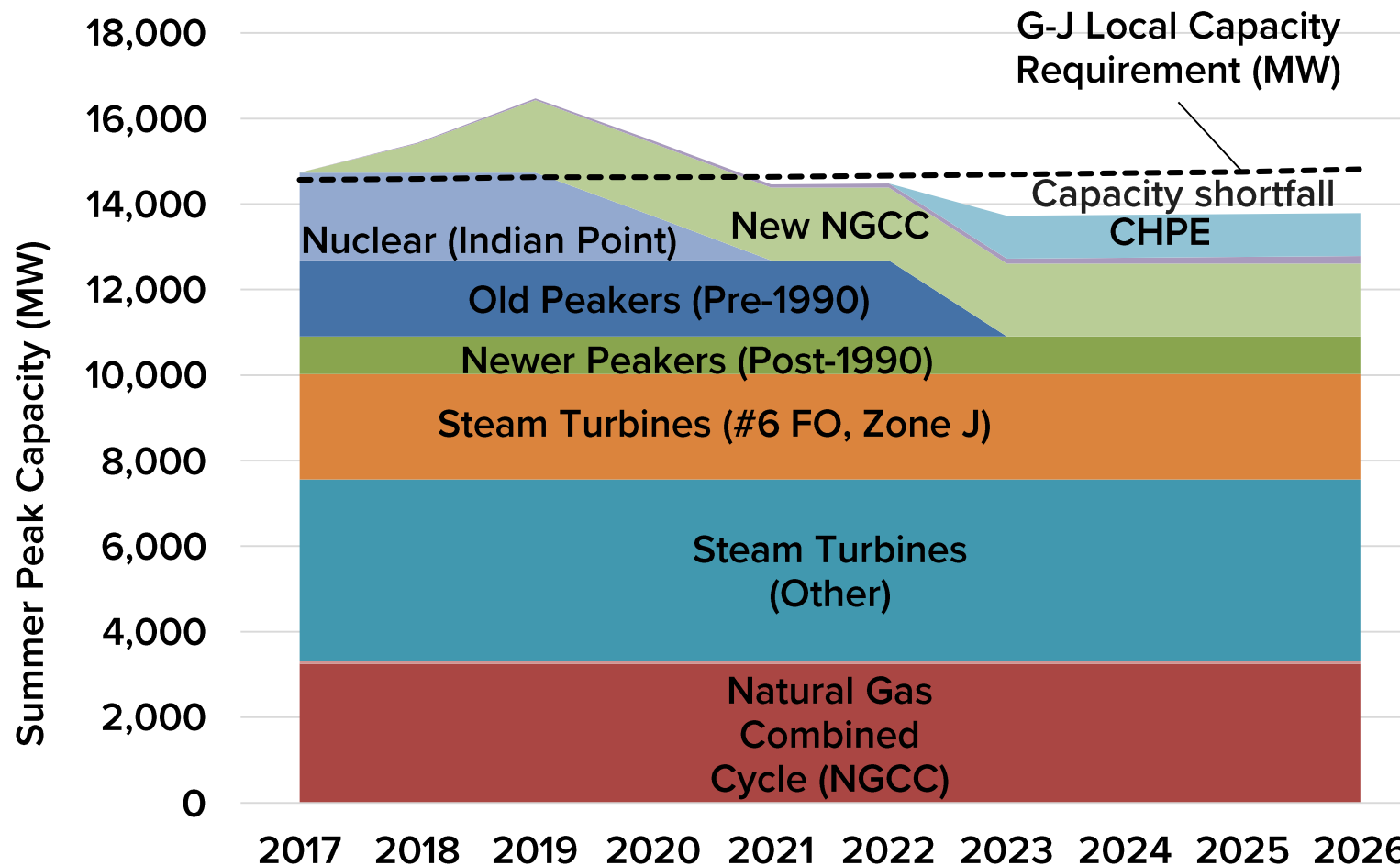
Source: New York State Designation Recommendations for the 2015 Ozone National Ambient Air Quality Standards, 2015

Emissions comparisons High ozone days in 2013 Statewide



Source: NY DEC Stakeholder Meeting, January 20, 2017

What if scenario: existing + planned resources, & old peakers removed (G-J)



- Removing 1,775 MW of old peakers by 2023 could lead to ~1,000 MW shortfall (equivalent to one Indian Point unit)
- Shortfall could be significantly larger if:
 - Planned resource additions are delayed or cancelled
 - #6 oil plants are unable to switch fuels

Source: 2017 resources based on NYISO 2016 Load & Capacity Data ("Gold Book")

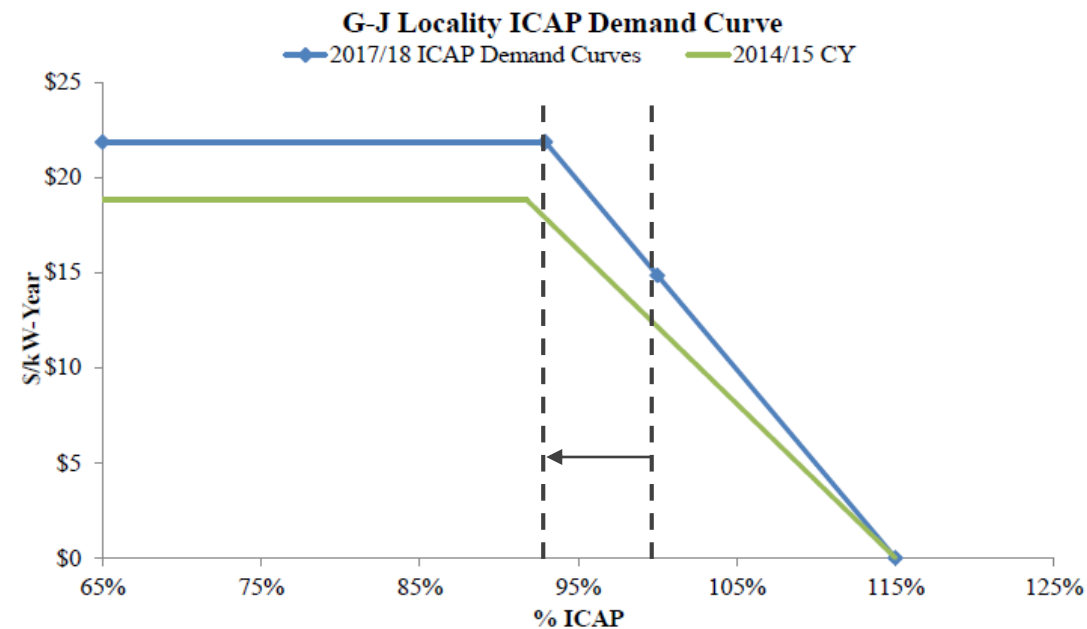
Potential Risks of Meeting Capacity Shortfall with New Gas Peakers

- New fossil units have not gone through new Article 10 siting process.
- May take 7 to 10 years to build new peaking capacity in densely populated non-attainment areas.
- Contributes pollution to local areas, even if lower emitting.
- Natural gas pipeline constraints could limit capability in winter months
 - Limited ability to bring new gas pipelines into the area
 - Based on one recent study, NYISO gas infrastructure was constrained in winter months through 2023 under nearly all market conditions and resource mixes tested.^[1]
- Inability to construct new peaker plants could lead to spike in capacity prices and/or reliability issues.

[1] EIPC: Interregional Transmission Development and Analysis for Three Stakeholder Selected Scenarios And Gas-Electric System Interface Study, 2015

Potential Costs to Customers

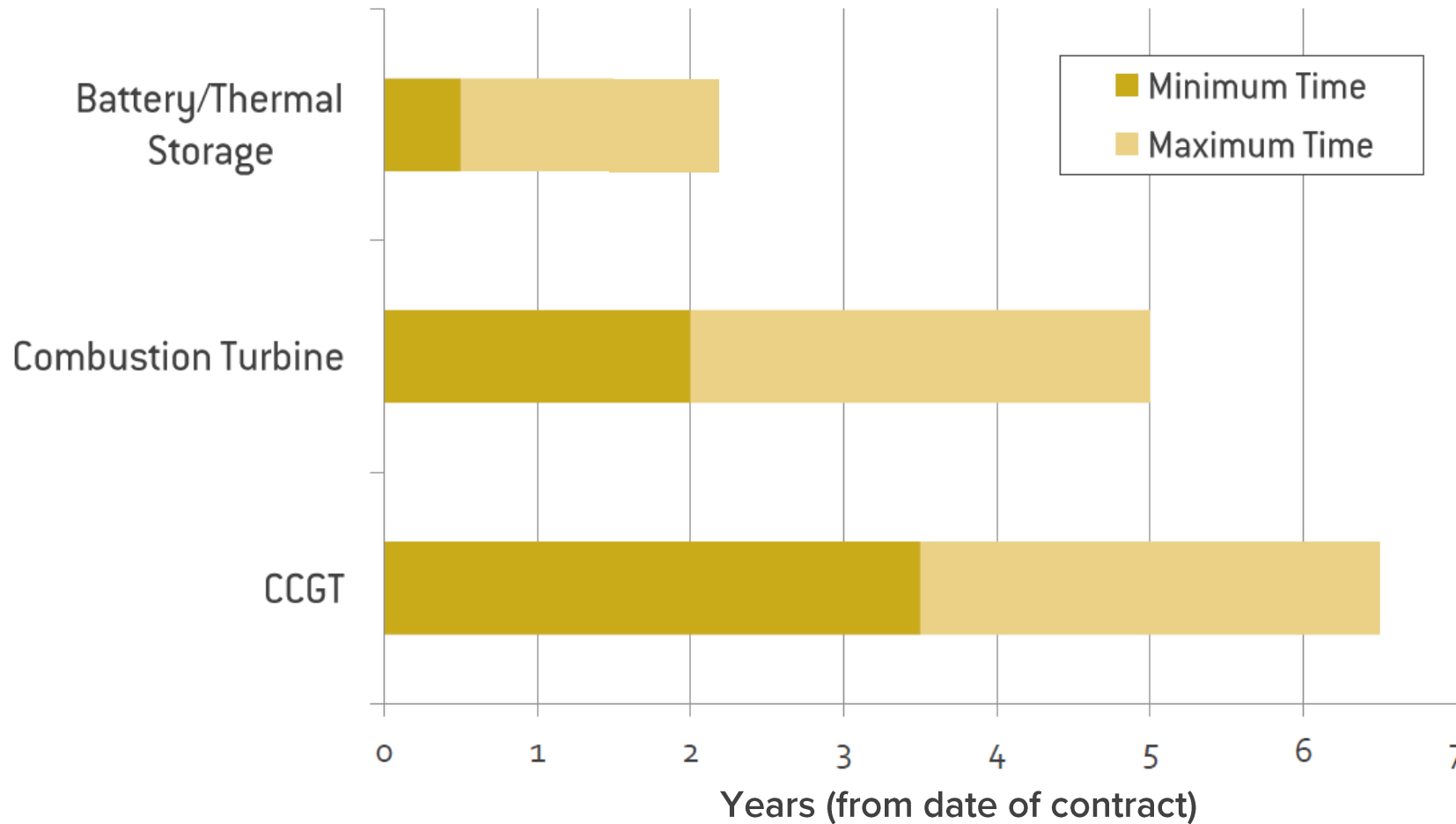
- A 1,000 MW shortfall due to closure of Indian Point and other resources represents installed capacity in G-J at 93% of the required 100% ICAP value
- This could cause capacity prices to reach the Maximum Clearing Price of \$21.85/kW-month for G-J (unless new resources are brought online quickly)
- 1,000 MW at this price equates to \$262 M annual cost to customers.



Note: 2017/18 ICAP Demand Curve for the G-J Locality is based on Load Zone G (Dutchess County).

Source: NYISO CONE FERC Filing (Nov 2016)
<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14402543>

Siting, Permitting, and Installation Time by Resource

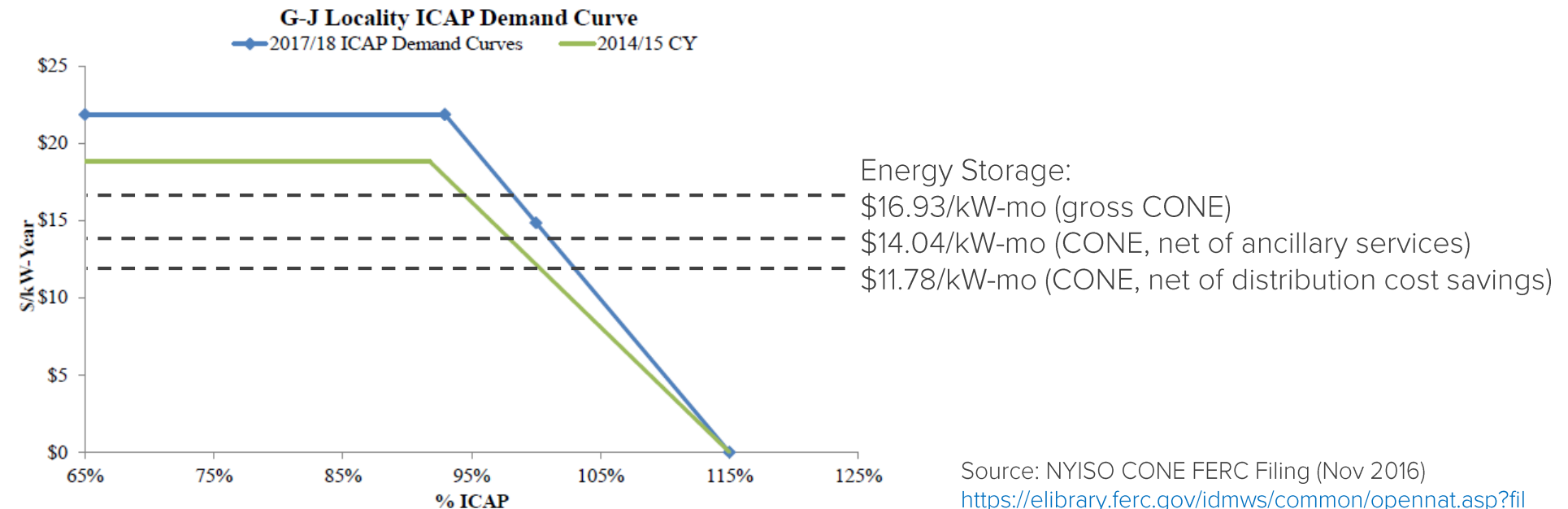


- Timeframes depicted are based on experience in California
- Estimated time for Battery/Thermal Storage adjusted upward to reflect New York-specific requirements
- Minimum timeframe depends on pre-screening of vendors and prior contracting experience

Source: California Energy Storage Alliance

Energy Storage as a Backstop Solution

- Energy storage can be implemented quickly to provide fully dispatchable local capacity.
- Can be procured for less than \$16.93/kW-mo (see appendix for details), but only through long-term contracting arrangements (e.g. 10-20 years).
- Provides a backstop for retail customers against sudden spikes in capacity prices after plant closures.
- Storage provide additional benefits that can increase savings to customers:
 - Low-cost ancillary services (zero startup costs)
 - Distribution system cost savings



Source: NYISO CONE FERC Filing (Nov 2016)
<https://elibrary.ferc.gov/idmws/common/opennat.asp?fileID=14402543>

Generation Options for Replacing Energy Output (GWh) from each ~1,000 MW Indian Point Unit

Scenarios**	New Generation Nameplate Capacity (MW)	Annual Net Energy (GWh) [1]	Renewable Energy (% of total 2016 retail sales) [2]	Increase in CO ₂ Emissions (electric sector) [3]	> 1,000 MW Capacity at Peak? [4]	Mitigates future RE curtailment?
Existing Indian Point Unit	1,000 MW	7,884	26%	0%	Yes	No
New NGCC & EE	1,605 MW	7,884	26%	+10%	Yes	No
New Wind, Solar, & EE	2,400 MW wind; 1,125 MW solar;	7,884	31%	0%	No	No
New Wind, Solar, EE & Storage	2,400 MW wind; 1,125 MW solar; 450 MW storage;	7,851	31%	0%	Yes	Yes

*****All scenarios include incremental energy efficiency (EE) deployment of 2,856 GWh by 2021 in the G-J locality (reducing ~449 MW of summer peak demand). This is consistent with NYISO Gold Book.***

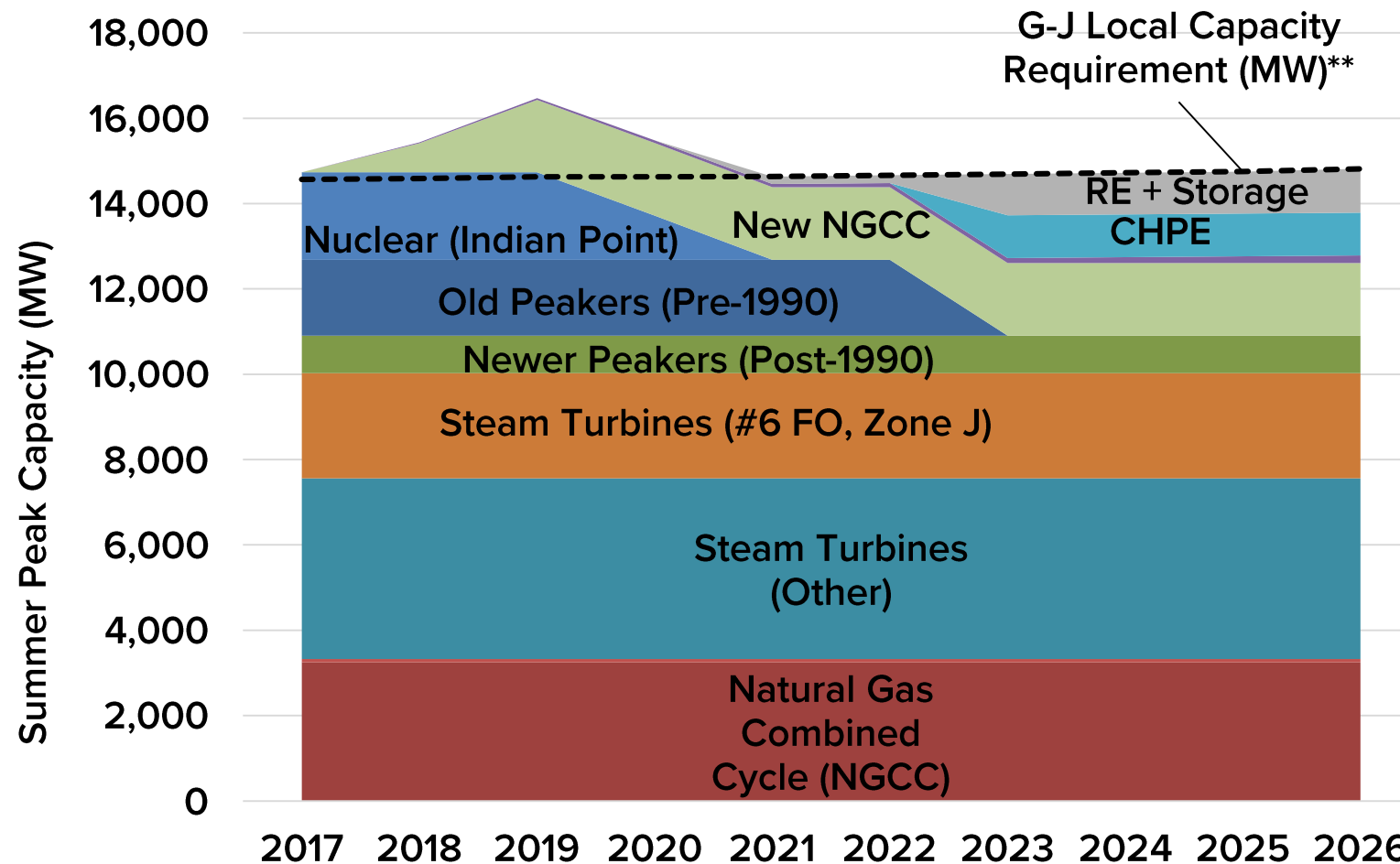
[1]: Assumes the following capacity factors: nuclear = 91%, NGCC = 56%, wind = 30%, solar = 16%; storage round trip efficiency = 85%, 4-hr duration cycled once daily during summer months. Annual net energy output is lower with the addition of storage due to round trip losses.

[2]: Based on projected 160 million MWh retail sales in 2020

[3]: Based on following assumptions: heat rate = 7,655 Btu/kWh; NG emissions factor = 53.07 kg/mmBtu; NYS 2014 GHG Inventory electric sector emissions = ~30 MMtCO₂e. Minor emissions increase may result from storage due to additional grid charging necessary to account for round trip losses.

[4]: Assumes the following capacity value at peak: wind & EE = 10%, solar = 40%. ~140 MW storage added to account integration of variable energy resources, colocation, plus additional unmet local need in Zone J.

What if scenario: existing + planned resources, old peakers removed, & renewables + storage added



- Assumes ~200 MW of Renewables + Storage in 2021 increasing to >1,000 MW in 2023
- Need will be higher if new NGCC or CHPE projects are delayed

** Local Capacity Requirement includes effects of energy efficiency (EE) and behind-the-meter generation.

Source: NYISO 2016 Load & Capacity Data ("Gold Book")

Potential Ratepayer Benefits from 450 MW Energy Storage

- A near term investment in storage can deliver multiple benefits. A 5-year snapshot is shown below, but benefits will extend beyond this timeframe.

Ratepayer Benefits	2020	2021	2022	2023	2024	5-year Total
Storage Costs	-\$ 91 M	-\$ 91 M	-\$ 91 M	-\$ 91 M	-\$ 91 M	-\$ 457 M
Avoided Capacity Costs	\$ 80 M	\$ 80 M	\$ 80 M	\$ 118 M	\$ 118 M	\$ 476 M
Avoided Ancillary Service Costs	\$ 16 M	\$ 17 M	\$ 18 M	\$ 19 M	\$ 20 M	\$ 90 M
Avoided Distribution System Cost	\$ 28 M	\$ 28 M	\$ 28 M	\$ 28 M	\$ 28 M	\$ 139 M
Avoided Peaker Startup Costs	\$ 13 M	\$ 13 M	\$ 13 M	\$ 13 M	\$ 13 M	\$ 67 M
Total Annual Benefit	\$ 46 M	\$ 47 M	\$ 48 M	\$ 87 M	\$ 88 M	\$ 315 M+

Assumptions for Ratepayer Benefits:

- Avoided capacity costs assumes storage avoids ~450 MW deficiency in G-J capacity auction each month. Clearing price equal to 2017/2018 ICAP Demand Curves reference point (\$14.51/kW-mo) through 2023, and increases to max clearing price (\$24.15/kW-mo) thereafter.
- See appendix for assumptions regarding avoided ancillary services and distribution system cost savings
- Assumes storage avoids starts from 450 MW of simple cycle combustion turbines (9 plants) with average cost per start of \$12,000 and 124 starts per year.

Additional Assumptions

Assumptions for Energy Storage Costs

Assumption	Value
Installed Cost (4-hrs)	\$1600/kW ¹
Economic Life	20 years
Fixed O&M Costs	\$16/kW-yr ¹
Fixed O&M Cost Escalation	2%/yr
Property Tax	0.75%
Insurance	0.60%
Income Tax – Federal	35%
Income Tax – State	7.1%
MACRS Term	7 years
Equity Share	45%
Cost of Debt	5.5%
Cost of Equity	8.5%

- Levelized Cost of Storage = \$203.17/kW-yr (\$16.93/kW-month)
- Does not include any revenues from Ancillary Services or Distribution Peak Reduction Benefits (see following slides for estimates of these)
- Does not include federal ITC which can apply to storage co-located with RE.
- Does not include sales tax

[1]: Represents Strategen's 2017 "snapshot" estimate of all-in system cost (including replacement costs, EPC, etc.) based on information collected from vendors and public sources (e.g. EPRI Energy Storage Cost Summary for Utility Planning: Executive Summary, 2016, <http://tdworld.com/site-files/tdworld.com/files/uploads/2016/04/energy-storage-epri-report.pdf>). Assumes land and siting costs for project in zone G-J (siting costs specific to Zone J may be higher). Storage cost ranges are highlighted in the EPRI report.

Ancillary Services Benefit Calculation

- Regulation reserves are the highest valued ancillary service product in NYISO (most advantageous to bid full capacity for regulation (vs. spin, non-spin, etc.).
- Regulation prices in recent years have ranged from \$9.23 - \$12.87 per MWh¹
- Operating Assumptions:
 - Regulation price = \$9/MWh
 - Storage offered as regulation 16 hours/day, 350 days per year
 - Round trip efficiency = 85%
 - Maximum hourly energy losses: 15% of nameplate capacity
 - Assumed hourly round trip energy losses: 7% of nameplate
 - Average energy price for charging and discharging = \$40/MWh
- Annual Revenue (net of energy losses) = \$34,720/MW installed
- Estimated benefit: 15-20% of storage CONE (\$2.50-\$3.40/kW-month)

Source: NYISO 2015 State of Market Report

Distribution System Peak Reduction Benefit

- Assumes distribution system peak reduction is concurrent with G-J peak demand
- O&R used as basis for calculating peak reduction benefit
- Estimated benefit: 30% of storage CONE (\$5.15/kW-month)

Simple “Value of D” Distribution System Benefits from CSRP MCOS

Utility	\$/kW-yr	\$/kW-mo
O&R	\$ 61.81	\$ 5.15
CHG&E	\$ 31.52	\$ 2.63
CON ED	\$ 162.72	\$ 13.56
NYSEG	\$ 30.84	\$ 2.57
RG&E	\$ 31.58	\$ 2.63
NGRID	\$ 66.48	\$ 5.54

Source: Staff Report and Recommendations in the Value of Distributed Energy Resources Proceeding Appendix C “VoD Estimate.xlsx,” October 27, 2016, Docket No. 15-E-0751,

Recommendations

Benefits of Energy Storage Solutions

- Short time to develop: storage facilities can be built in 1-2 years, even in heavily populated areas (e.g. recent examples in Los Angeles basin).
- Zero local emissions: can achieve phase-out of local pollutants without threatening reliability.
- Safeguard for customers: Mitigates risk of capacity shortfall and related price spikes in case new peaker projects are delayed or pipelines are constrained.
- Low cost: Levelized cost for storage on par or less than alternative capacity resources, but only if long-term contracts can be provided.
- Enhances resiliency: Provides additional grid resiliency to provide backup power during future storms and protect against disruption of fuel supplies
- Benefits to all regions: Can help to increase utilization of generators in upstate regions that are transmission constrained during peak hours.

Implementation Strategies to Deploy Storage

- Establish Target of 450 MW* of storage by 2020 for Zones G-J. Potential options include:
 - Require load serving entities to competitively procure storage through long-term contracts
 - Expand and reform demand reduction programs such as demand response and demand management program so energy storage can fully participate
- Ensure tariffs allow fair compensation and facilitate interconnection for energy storage
- Include storage as a component of the Clean Energy Standard procurement. Two pathways:
 - Use existing framework, with increased emphasis on Flexibility & Peak Coincidence criterion
 - Introduce supplemental Clean Peak target as a submarket of the clean energy standard
- Encourage procurement through state and local government agencies
- Develop new storage procurement programs to achieve better system efficiency through the Earnings Adjustment Mechanisms established by the NY PSC
- Require existing peaker plant owners to install storage as an environmental/resiliency measure (could be funded through PSC-approved retail rate rider)

*

In the recent Riverkeeper and Natural Resources Defense Council report on Indian Point replacement options, one scenario called for high energy efficiency deployment and 500 MW of new energy storage to meet New York's capacity shortfall. This is conservative, as the modeling conducted in the report did not account for the near-term plant closures expected from emission constraints.

Clean Energy Standard Procurement

RES 2017 Anticipated Procurement Timeline	
2017 Renewable Energy Credit RFP 1 Release	April 2017
RFP 1 Awards	August 2017
NYSERDA/DPS announcement on need for 2017 RFP 2 Procurement	September 2017
2017 Renewable Energy Credit RFP 2 Release (if needed)	October 2017
RFP 2 Awards	February 2018

Generation Facility Evaluation Criteria:

- Bid Price: 70 percent (70%)
- Economic Benefits: 10 percent (10%)
- Project Viability: 10 percent (10%)
- Operational Flexibility and Peak Coincidence: 10 percent (10%)



NYSERDA & NYDPS: 15-E-0302 CES Phase 1 Implementation Plan Proposal

Clean Energy Standard Order

- “if the various mechanisms that the Commission is pursuing to ensure storage takes its rightful place as a critical resource for the modern grid prove insufficient, this topic will be revisited.”

- NYPSC, Order Adopting A Clean Energy Standard, Case 15-E-0302, August 1, 2016

Appendix

Air Quality Issues

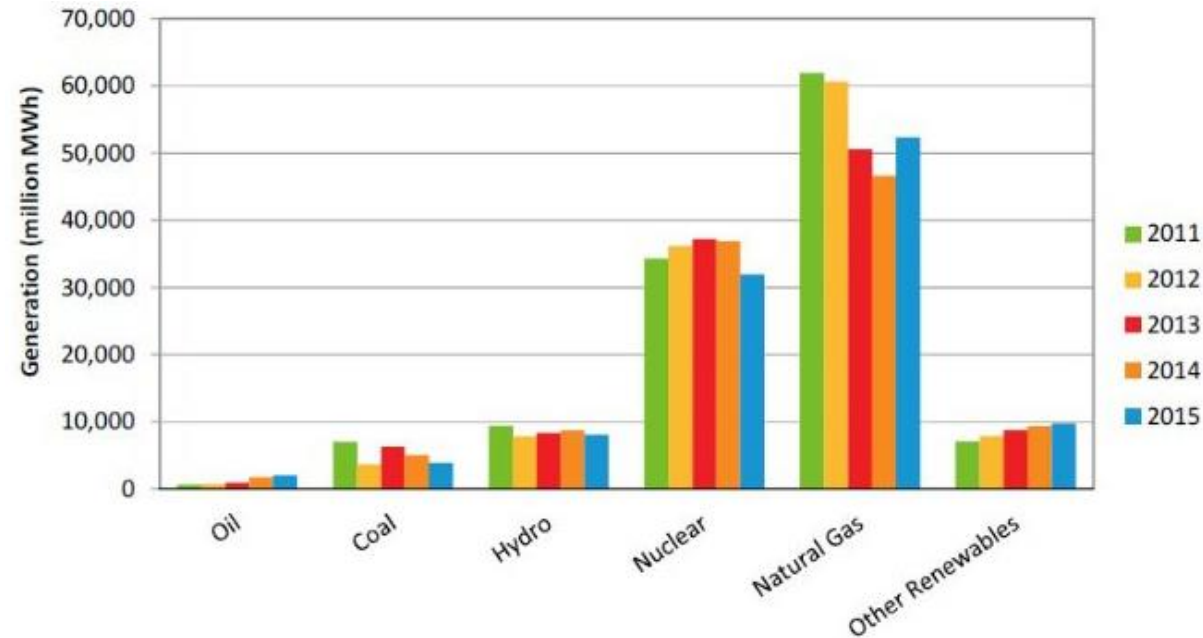
	NOx (tons)	Heat Input (mmBtu)	Gross Load (MWh)	Efficiency
Pre-1990 Peakers	1,486	6,533,605.78	465,897.93	25%
Post-1990 Peakers	50	5,727,075.45	634,782.93	39%
2011 - 2015 high ozone days				

	Pre-1990 (lb/mmBtu)	Post-1990 (lb/mmBtu)	Pre-1990 (lb/MWh)	Post-1990 (lb/MWh)
2011 NOx Rate*	0.457	0.026	6.406	0.231
2012 NOx Rate*	0.458	0.020	6.590	0.174
2013 NOx Rate*	0.460	0.011	6.012	0.102
2014 NOx Rate*	0.421	0.010	6.195	0.089
2015 NOx Rate*	0.431	0.011	6.890	0.110
*Rates are for high ozone days				

Source: NY DEC Stakeholder Meeting, January 20, 2017

- Emissions were analyzed for days between 2011-2015 with ozone levels above 75 ppb and it was found that Peakers built before 1990 wouldn't meet the Ozone Transport Committee's model rule of NOx emissions of less than 0.100 lb/mmBtu and 1.00 lb/MWh.
- One of the possible outcomes for Ozone reduction as discussed by the Dept. of Environmental Conservation was the removal of the averaging provision (Subpart 227-2.5(b)) which allows for system averaging by allowing owner/operators to employ a weighted average permissible emission rate.
- This outcome could possibly put several of the pre 1990 peakers at risk of decommissioning or major retrofits.

Retiring Nuclear Facilities lead to increase in CO2 emissions: ISO-NE



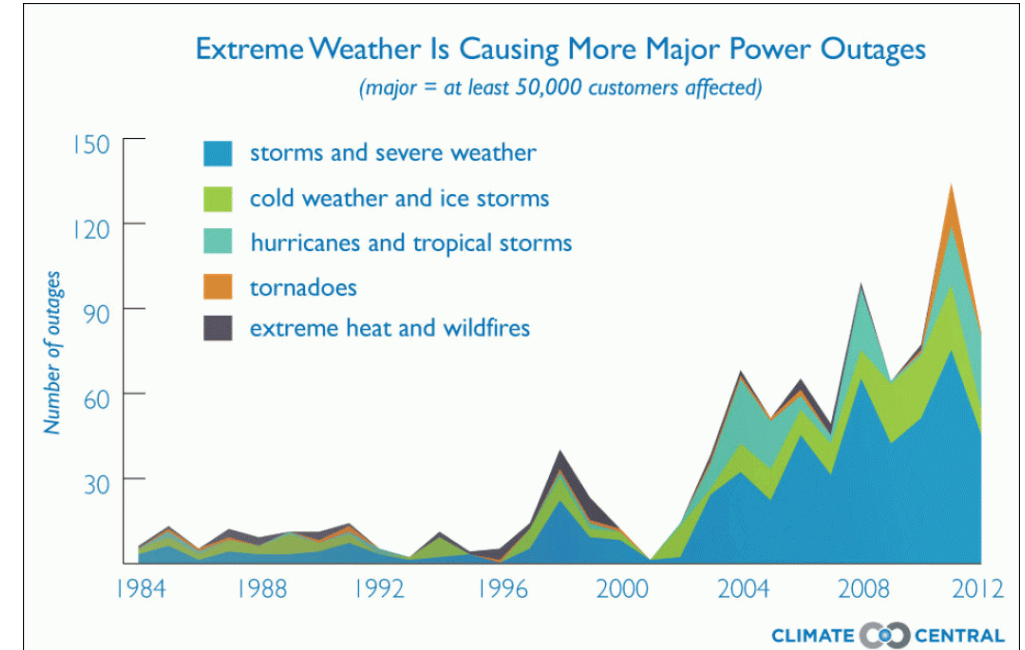
- The retirement of 600 MW Yankee nuclear plant resulted in an increase of 5750 GWh of natural gas fired generation in 2015 in ISO-NE.
- As a result, the replacement of non emitting resources with fossil fuel plants lead to an increase in CO2 emissions rates from 726 pounds/MWh in 2014 to 747 pounds/MWh in 2015.

Source: 2015 ISO New England Electric Generator Air Emissions Report

Energy storage can enhance resiliency of New York's grid

Financial Impact of Power Outages

- A 30-minute power cut results in an average loss of US\$15,709 for medium and large industrial clients
- An eight-hour interruption costs on average US\$94,000.
- 59% of Fortune 500 companies experience 1.6 hours downtime/week
 - The downtime loss in labor alone can come to \$896,000 per week —more than \$46 million annually.

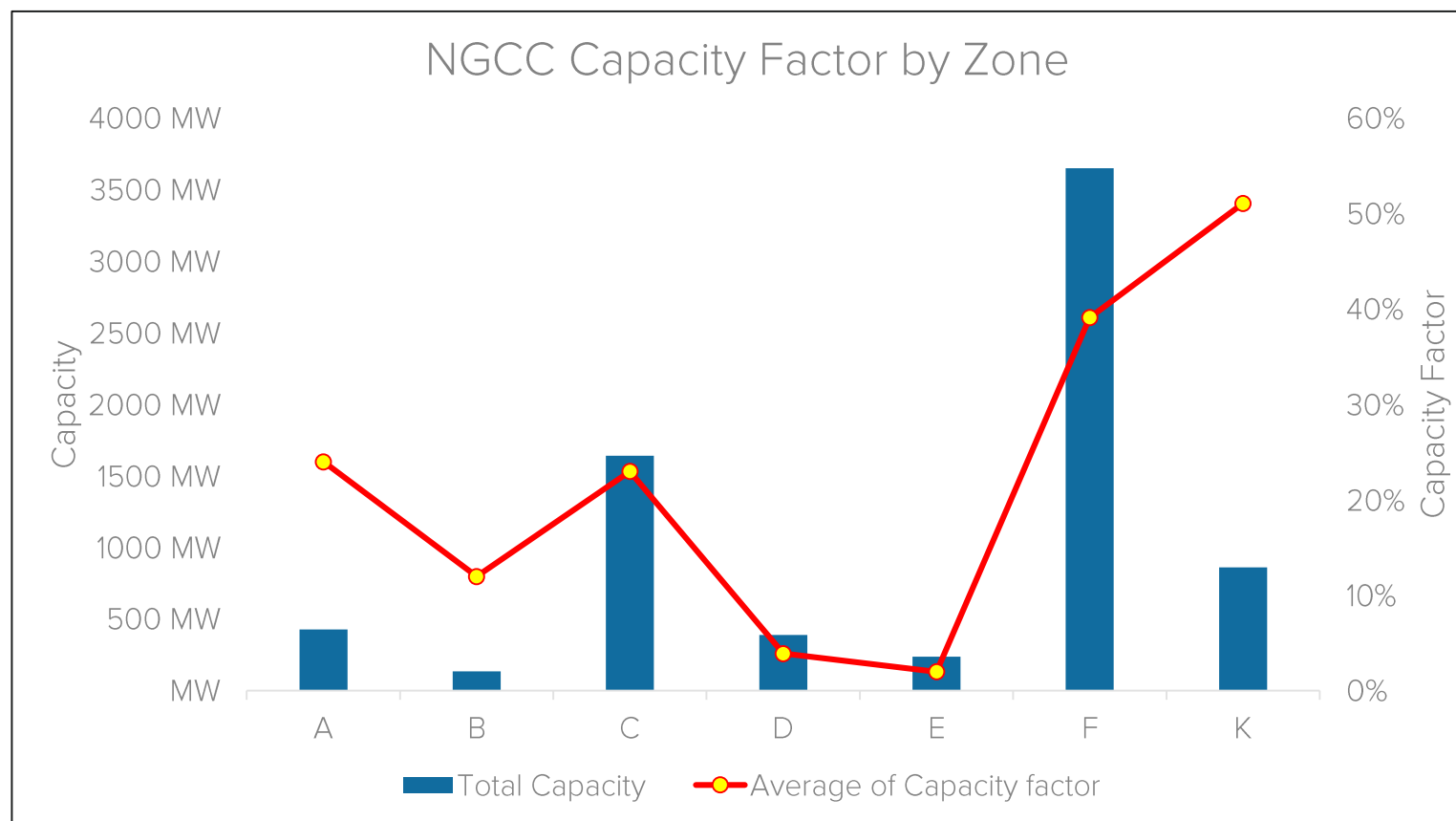


“In 2003, New York City experienced a 16-hour power failure. **One hundred twenty hospitals were impacted.** ...one hospital was forced into bankruptcy and ten experienced subsequent significant revenue losses. Based on our research, **1 in 20 hospitals in the U.S. are not fully prepared for this type of event** and an incident of this nature would result on average in **greater than \$1 million revenue loss and other costs**”

-Schneider Electric Report

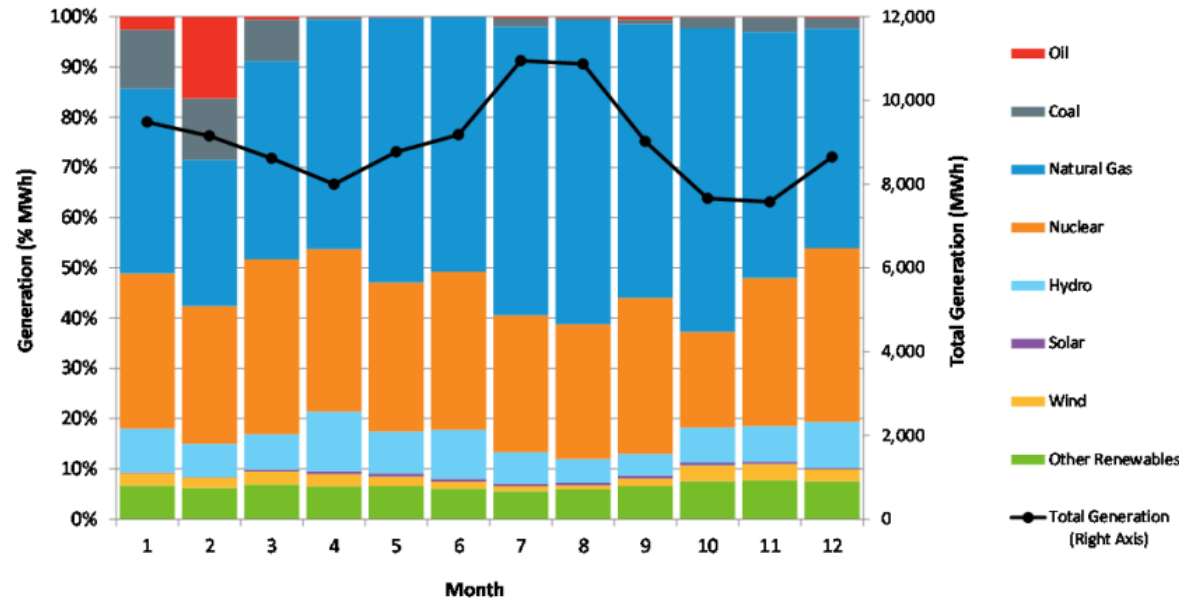
Enhancing output of upstate facilities

- Energy storage located in downstate region could help increase output of underutilized plants in upstate regions by charging during off-peak times when there is less congestion

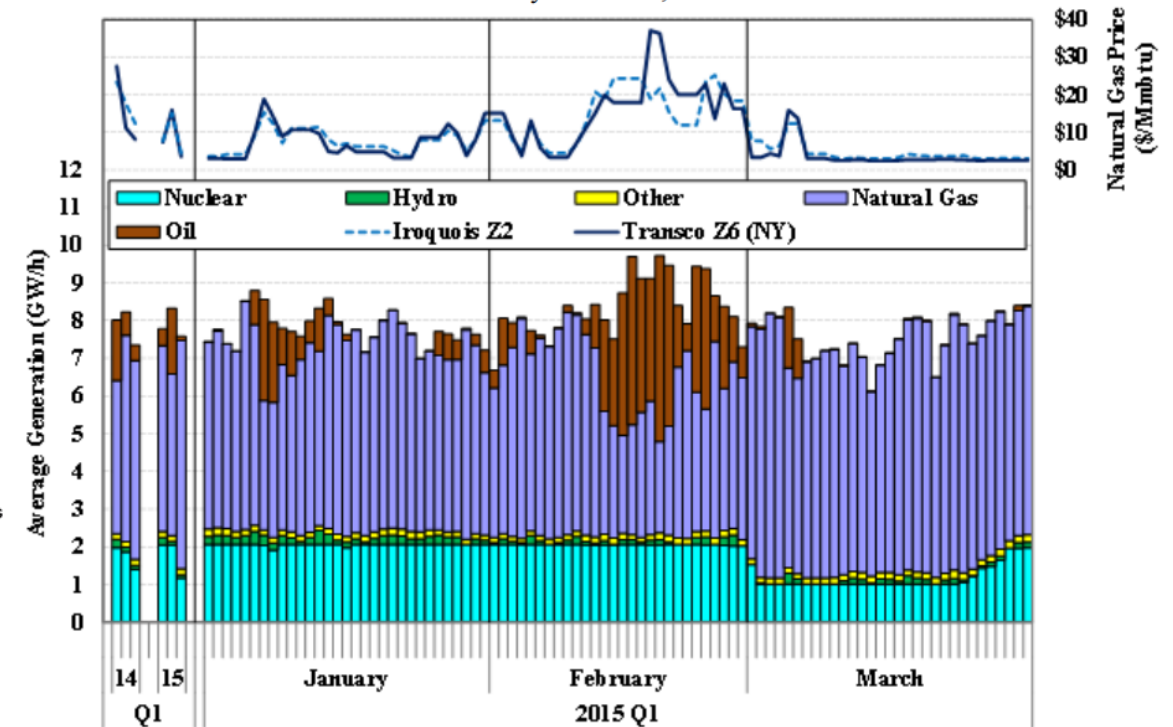


Source: NYISO 2016 Load & Capacity Data (“Gold Book”)

Retiring Supply Constraints and Capacity Shortfall



2015 ISO New England monthly generation by fuel type (% MWh, MWh).

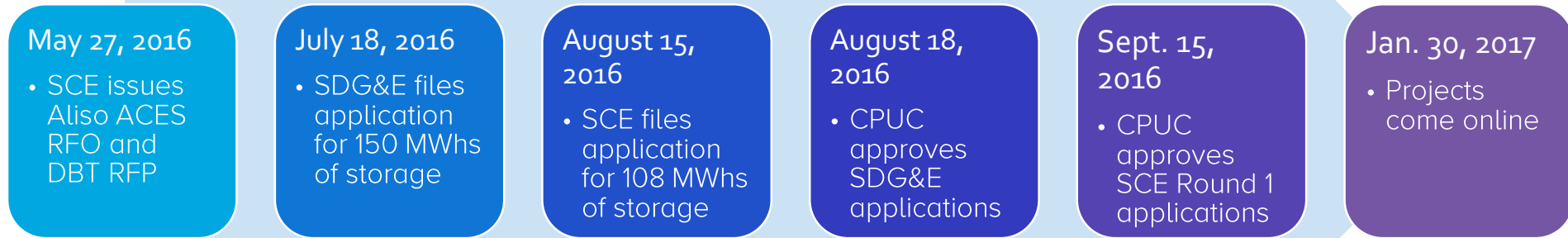


- Due to Natural Gas supply constraints during the winter months, the marginal contribution of oil and coal in the ISO-NE electricity mix was significantly high.
- As seen in figure on the right, during natural gas shortages, a large number of Oil Generation came online.
- Based on a study, In NYISO, the gas infrastructure is constrained in winter 2018 and 2023 under nearly all market conditions and resource mixes in the scenarios and sensitivities tested.

Source: 2015 ISO New England Electric Generator Air Emissions Report

EIPC: Interregional Transmission Development and Analysis for Three Stakeholder Selected Scenarios And Gas-Electric System Interface Study, 2015

Aliso Canyon Timeline: from RFP to online in 7 months



IOU	DEVELOPER	SIZE (MW)	SIZE (MWH)
SCE	WESTERN GRID	5	20
	ALTAGAS	20	80
	GRAND JOHANNA	2	8
	TESLA	20	80
	GE	10	4
SDG&E	AES	7.5	30
	AES	30	120

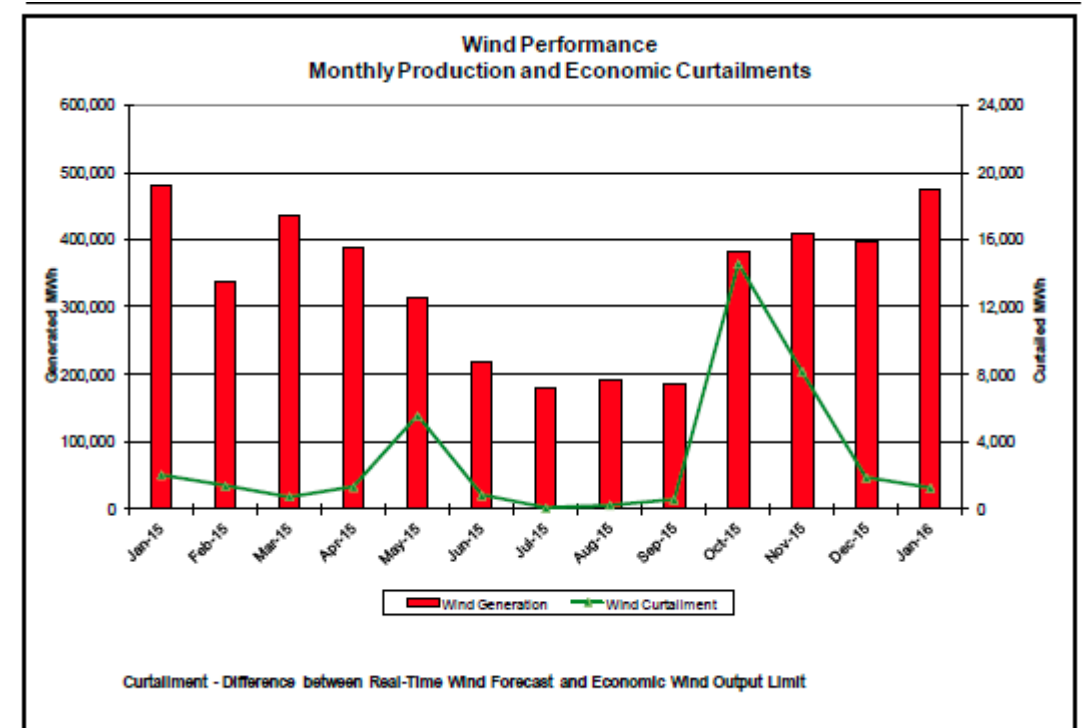
Total:
94.5 MW / 342 MWh

Marginal Generation Units and Curtailment in NYISO

**Table 2: Fuel Type of Real-Time Generation and Marginal Units in New York
2013-2015**

Fuel Type	Average Internal Generation						% of Intervals being Marginal		
	GW			% of Total					
	2013	2014	2015	2013	2014	2015	2013	2014	2015
Nuclear	5.1	4.9	5.1	33%	31%	32%	0%	0%	0%
Hydro	2.7	2.8	2.8	17%	18%	18%	44%	45%	49%
Coal	0.5	0.5	0.3	3%	3%	2%	11%	7%	2%
Natural Gas CC	4.9	5.0	5.2	32%	31%	33%	67%	60%	67%
Natural Gas Other	1.5	1.6	1.7	10%	10%	10%	42%	29%	28%
Fuel Oil	0.1	0.2	0.2	1%	1%	1%	5%	6%	5%
Wind	0.4	0.5	0.5	3%	3%	3%	7%	4%	5%
Other	0.3	0.3	0.3	2%	2%	2%	0%	0%	0%

Source: NYISO 2015 State of Market Report



Source: NYISO Operations Performance Metrics Monthly Report, January 2016