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Independent System Operator

2019 CARIS 70x30 Scenario: Review of Assumptions and Resource Mix

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Agenda

- Background and Study Approach
- Scenario Assumptions
- Renewable Resource Mix
- Preliminary Relaxed Case Results

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Background and Study Approach

Background

- **Previously presented at ESPWG**
  - September 11
    - CARIS Preliminary 70 x 30 Scenario Development
  - October 4
    - CARIS Scenario Load Forecast Development
    - CARIS 1 70x30 Scenario ESR Modeling
  - October 23
    - CARIS 70x30 Scenario Assumptions and Calculation
  - November 18
    - Preliminary Scenario Results (High/Low Gas Prices and Loads)

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“70 by 30” Scenario

- The study will identify opportunities for transmission investment to un-bottle renewable energy to enable the state’s renewable energy production goals.
- The Climate Leadership and Community Protection Act (CLCPA) requires that a minimum of 70% of New York end-use electrical energy requirements shall be generated by renewable energy systems in 2030.

Scenario Study Approach

- **Develop assumptions for the major drivers that could impact transmission congestion patterns**
  - Develop 70x30 Scenario Load Forecast for comparison with the Base Case Forecast
  - Add renewable generation to approximate achievement of 70% renewable energy target for each load forecast, considering renewable energy "spillage" (*i.e.*, generation exceeds load)
- **Evaluate system production under "relaxed" conditions**
  - Model the resulting resource mix in GE-MAPS without internal NYCA transmission system constraints to establish a baseline of what the system "wants to do" when there are no transmission constraints
- **Evaluate the impact of transmission constraints on renewable energy production for the assumed renewable resource mix**
  - Identify transmission constraints that cause renewable curtailments (*i.e.*, renewable generation pockets)
  - Quantify the magnitude and frequency of the curtailments for each assumed resource mix
- **Sensitivity analysis to understand impact to system production and transmission constraints**
  - Sensitivity analysis of retirement of the entire nuclear fleet
  - Sensitivity analysis of 3,000 MW of Energy Storage Resources (ESR)

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Scenario Assumptions

Key Policy Drivers for Study Assumptions

- 70% of end-use energy shall be generated by renewable energy systems by 2030
- 6,000 MW of distributed solar by 2025
- 185 trillion Btu of end-use energy savings below the 2025 energy-use forecast
- 3,000 MW of energy storage resources (ESR) by 2030
- 9,000 MW of offshore wind (OSW) by 2035

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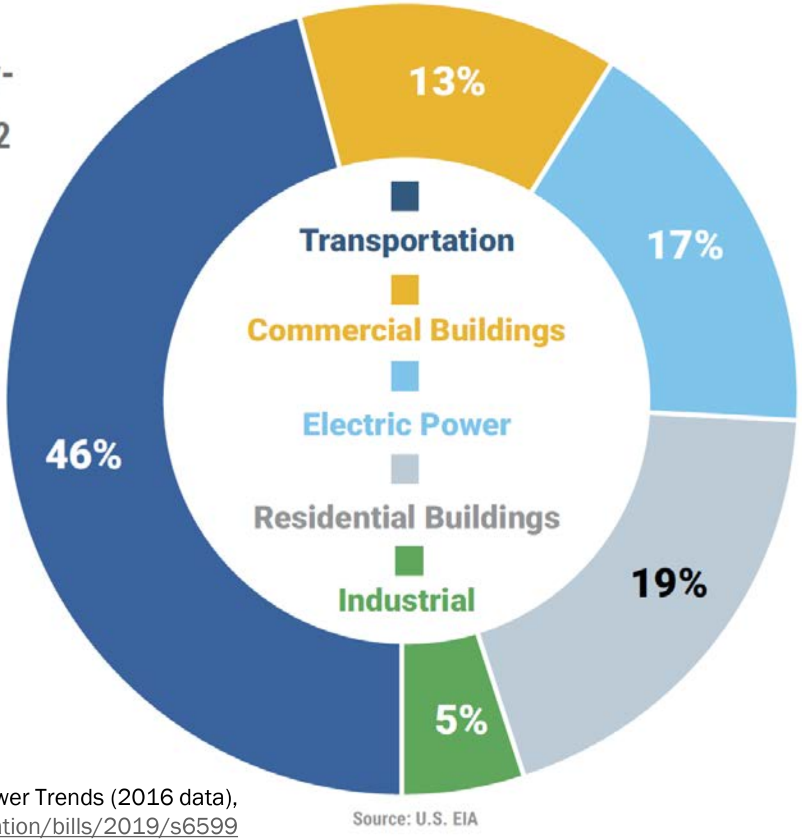
Emission Reductions Not Studied

- 2030 – 40% economy-wide GHG reduction
- 2040 – “zero emission” power sector
- 2050 – 85% economy-wide GHG reduction (and up to 15% additional as offsets)
  - “Sources in the electric generation sector shall not be eligible” to offset emissions

Figure 23: NYS Energy-Related CO_2 Emissions by Sector



2019 Power Trends (2016 data),
https://www.nysenate.gov/legislation/bills/2019/s6599

70x30 Scenario Adjustments

Started from the 2019 CARIS 1 base case 2028 model year

- **Load Forecast/Shape**
  - Scenario load includes zonal 8,760 hourly profiles with non-uniform distribution of energy efficiency (EE), electrification (electric vehicles and space heating), and behind-the-meter solar (BTM-PV)
  - Base (2019 Gold Book) load level studied for comparison to the 70x30 Scenario load forecast
- **Renewable Energy (RE) Modeling, Locations and Amounts**
  - Land-based wind generation based on NREL shapes instead of historic actual output
  - Zonal capacity distribution informed by NYSERDA RFP Awards and NYISO Interconnection Queue
  - Bus assignments for added RE based on Interconnection Queue project information
- **Neighboring system assumptions**
  - Hydro-Québec (HQ) imports counted as renewable
  - Additional HVDC connection included with HQ schedule to NYC
- **NY Fossil Fleet Operations**
  - All coal plants assumed retired; all GTs impacted by Peaker Rule assumed retired and replaced with new GTs consistent with 2019-2028 CRP Scenario findings

70x30 Scenario Load Forecast Assumptions

	Base Case Load Forecast	70x30 Scenario Load Forecast
EV	1.3 million Light-duty vehicles by 2030	2.2 million Light-duty vehicles by 2030
Space Heating Electrification	None	2015 estimate of 13,600 GWh in 2015 grows by 50% by 2030 for NYCA
PV	3,000 MWDC behind-the-meter by 2023	6,000 MWDC behind-the-meter by 2025
EE	23,500 GWh of incremental savings by 2030 beyond the 11 GWh achieved by 2014	Additional 30,000 GWh* of savings by 2025 beyond 2014 achievements plus around 2,000 GWh/year** for 2026-30
* This target is based on the retail sales of investor-owned utilities implied by the 2015 Gold Book forecast for the year 2025.		
** This is based on the targets expressed in the Clean Energy Fund documents.		

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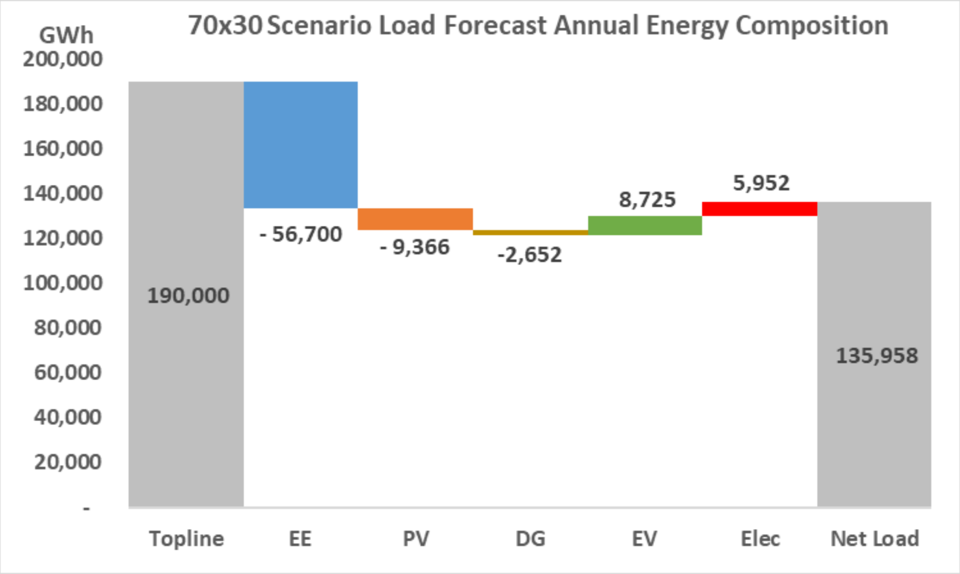
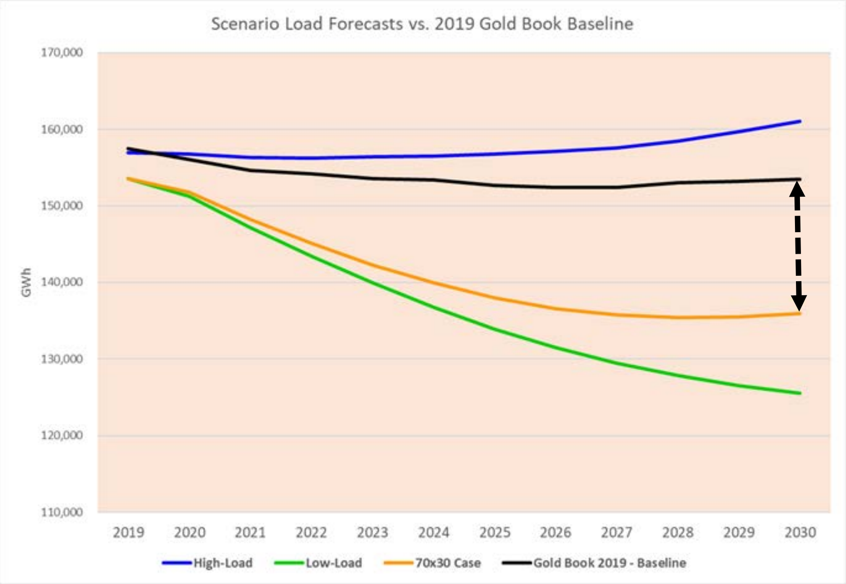
70x30 Scenario Load Forecast





The net load in 2030 is assumed to be approximately 136,000 GWh resulting from the cumulative impacts of EE (56.7 TWh), BTM-PV (9.4 TWh), DG (2.7 TWh) and EV (8.7 TWh) plus an incremental 6 TWh due to electrification of space heating (Elec).

Annual Load (GWh)	A	B	C	D	E	F	G	H	I	J	K	NYCA
Base Case Load	14,590	9,695	15,394	5,337	7,095	11,312	9,544	2,807	5,881	51,749	19,608	153,012
70x30 Scenario Load	13,034	7,757	12,626	5,101	5,694	9,654	7,911	2,848	5,952	46,354	19,026	135,958

Renewable Resource Mix

Renewable Additions

- Capacity additions of utility-scale solar (UPV) and land-based wind (LBW) are adjusted to achieve 70% RE
- Developed zonal capacity distribution based on UPV and LBW capacity shares by zone from the 2017 and 2018 CES REC solicitation awards and the NYISO Interconnection Queue

Nameplate Capacity Distribution		
	UPV	LBW
A	27%	30%
B	3%	5%
C	20%	30%
D	0%	15%
E	10%	20%
F	25%	0%
G	15%	0%
H	0%	0%
I	0%	0%
J	0%	0%
K	0%	0%
NYCA	100%	100%

Renewable Addition Locations

- **Injection points are assumed to be the closest existing substations based on interconnection points from the NYISO Interconnection Queue**
- **Study Assumptions:**
  - UPV: 73 sites, injecting at various voltage levels from 345 kV – 115 kV
  - LBW: 30 sites, injecting at various voltage levels from 345 kV – 115 kV
  - OSW: 7 sites, injecting at 345 kV in Zone J and 138 kV – 69 kV in Zone K
  - Hydro imports: 1 site, injecting at 345 kV in Zone J (generic 1310 MW HVDC)

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Initial Annual 70x30 Input Calculation

- RE = Wind + Solar + Hydro + Hydro Imports
- Assume, %RE = RE / Gross Load

	OSW	LBW	UPV	BTM-PV	Hydro	Hydro Imports	RE	Net Load	Gross Load	%RE
Base MW	0	2,212	77	4,011						
Additional MW	6,098	1,641	6,345	3,531						
2030 MW	6,098	3,853	6,422	7,542						
2030 Capacity Factor	44%	30%	18%	14%						
2030 Calculated GWh	23,344	10,126	10,126	9,366	28,832	19,941	101,735	135,970	145,335	70%

Net Load accounts for BTM-PV; Gross Load does not.

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70x30 Renewable Capacity Calculation

- **Initial input calculation of annual RE does not consider hourly coincidence between RE production and load levels**
- **Use hourly input production and NYCA load profiles to account for spillage and define 70x30 case RE capacity mix**
  - For each hour, compare projected nuclear and renewable generation to NYCA gross load.
  - “Spillage” occurs when generation exceeds NYCA gross load.
  - For the purposes of this scenario, spillage is not counted towards 70% RE attainment.
- **This method is used as a simple benchmark to establish RE capacity levels**

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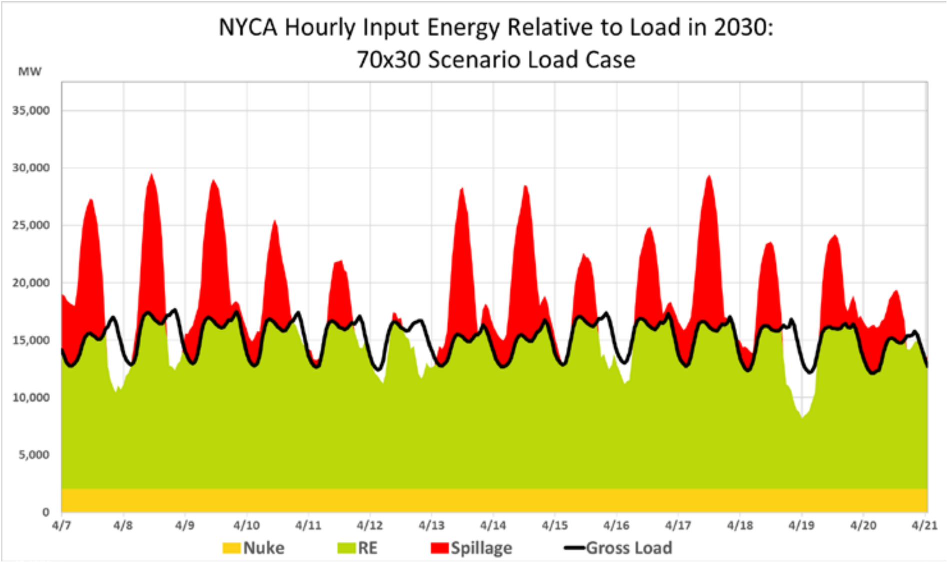
Hourly Input Profile Calculation Illustration



- Compare hourly gross load (black line) to nuclear (yellow) and renewable energy (green) input generation profiles
- Spillage (red) occurs when renewable generation exceeds load
- Renewable energy target assumed to be attained when total renewable generation (green) equals 70% of total gross load on an annual basis

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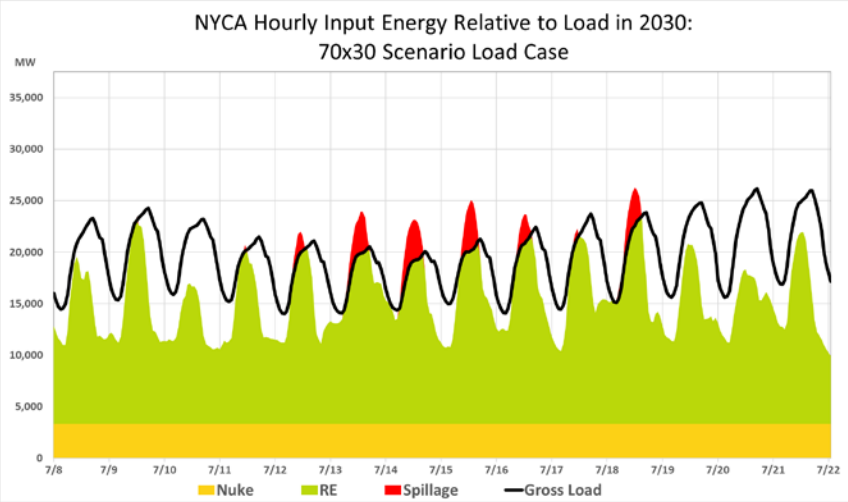
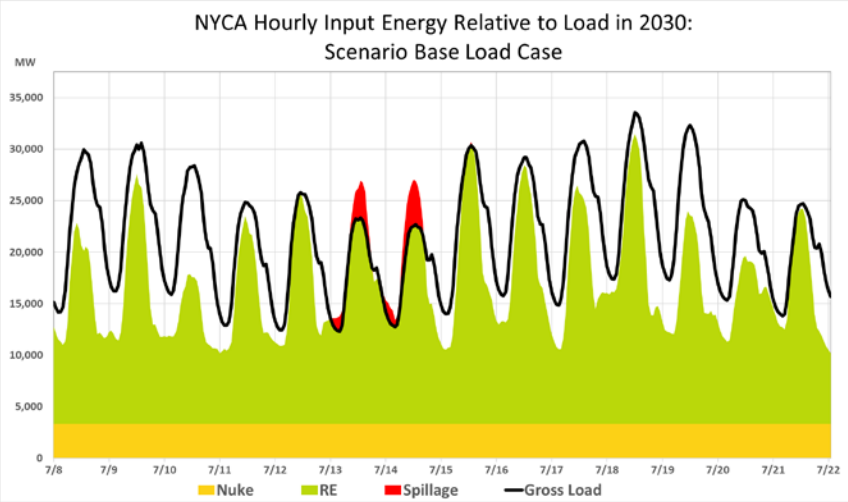
Hourly Input profiles: Peak loads





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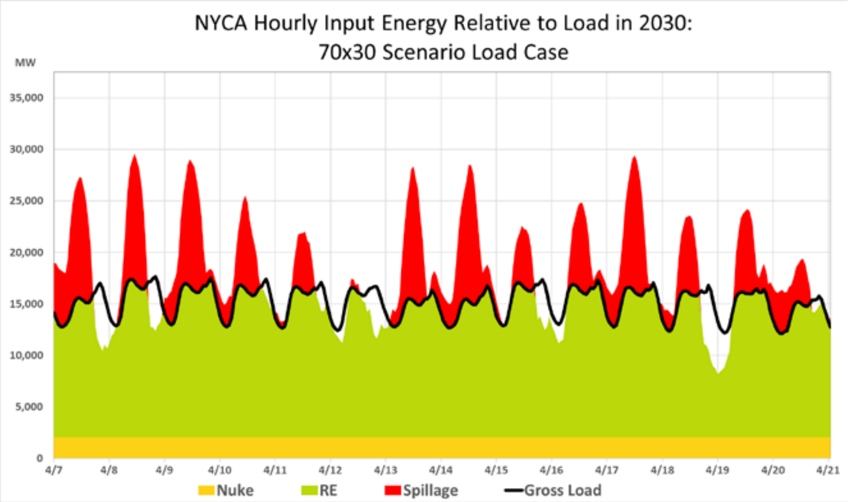
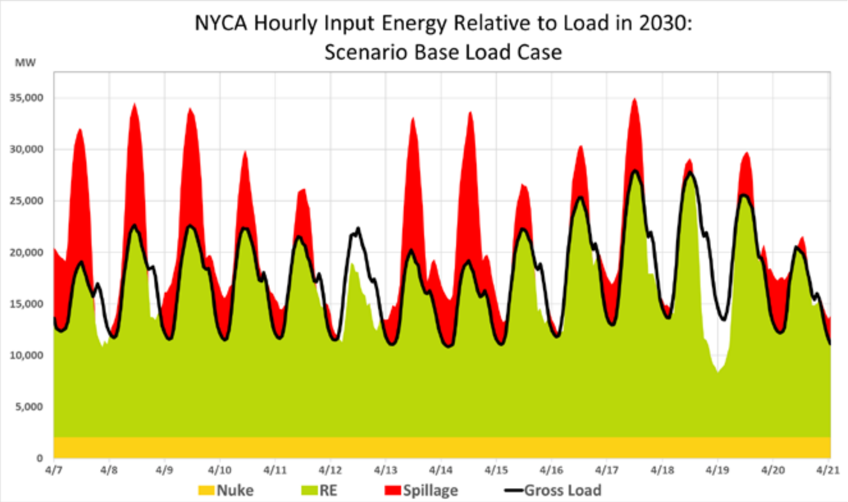
Hourly Input profiles: Minimum Load





70x30 Renewable Capacity Calculation

- For the purpose of determining how much renewable capacity to model for both load shapes/levels (70x30 Scenario load and base load forecasts), renewable energy is calculated as:

$$\%RE = (RE_{Input} - Spillage) / Gross\ Load$$

- The initial capacity mix results in approximately 4,800 GWh of spillage in the scenario load and 5,200 GWh of spillage in the base load
- Increased LBW and UPV capacity until 70% RE attained based on hourly input profiles

Input (GWh)	OSW	LBW	UPV	BTM-PV	Hydro	Hydro Imports	RE_{Input}	Spillage	Gross Load	%RE
Scenario Load	23,359	16,874	16,651	9,366	28,702	19,941	114,892	12,605	145,324	70%
Base Load	23,359	23,233	23,264	9,366	28,702	19,941	127,864	13,524	162,378	70%

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Resulting Zonal Wind and Solar MW Capacity

70x30 Scenario Load

2030 MW	OSW	LBW	UPV	BTM-PV
A		1,640	3,162	995
B		207	361	298
C		1,765	1,972	836
D		1,383		76
E		1,482	1,247	901
F			2,563	1,131
G			1,450	961
H				89
I				130
J	4,320			950
K	1,778		77	1,176
NYCA	6,098	6,476	10,831	7,542

Base Load

2030 MW	OSW	LBW	UPV	BTM-PV
A		2,286	4,432	995
B		314	505	298
C		2,411	2,765	836
D		1,762		76
E		2,000	1,747	901
F			3,592	1,131
G			2,032	961
H				89
I				130
J	4,320			950
K	1,778		77	1,176
NYCA	6,098	8,772	15,150	7,542

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Preliminary Relaxed Case Results

Preliminary Relaxed Case MAPS Output

- "Relaxed" case: no transmission constraints modeled inside NYCA
- Curtailments are due to (1) transmission constraints with neighboring regions, or (2) excess generation compared to system-wide load

Output (GWh)	OSW	LBW	UPV	BTM-PV	Hydro	Hydro Imports	RE	Nuclear	Fossil	Other	*Net Exports	Curtail ments	Gross Load
Scenario Load	22,775	13,960	14,764	9,269	28,082	19,803	108,653	27,435	26,390	2,164	18,821	6,239	144,948
Base Load	22,656	19,243	21,782	9,302	27,974	19,780	120,736	27,436	31,268	2,158	18,736	7,128	161,934

* Net Exports between NYISO and IESO, ISO-NE, and PJM

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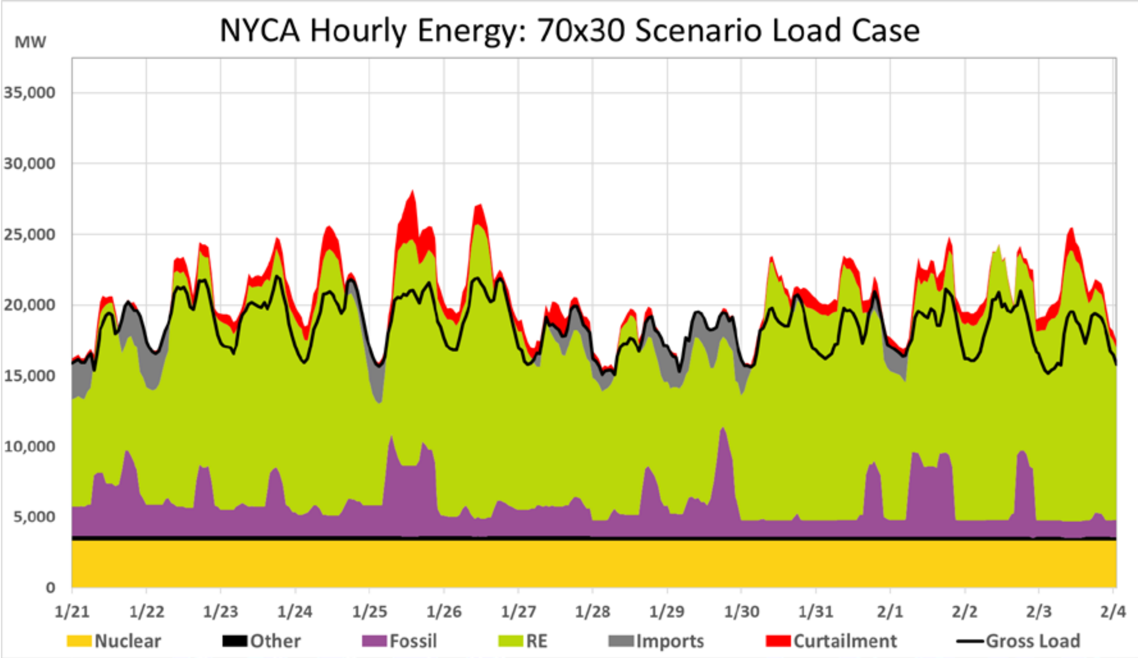
Hourly Output Profile Illustration



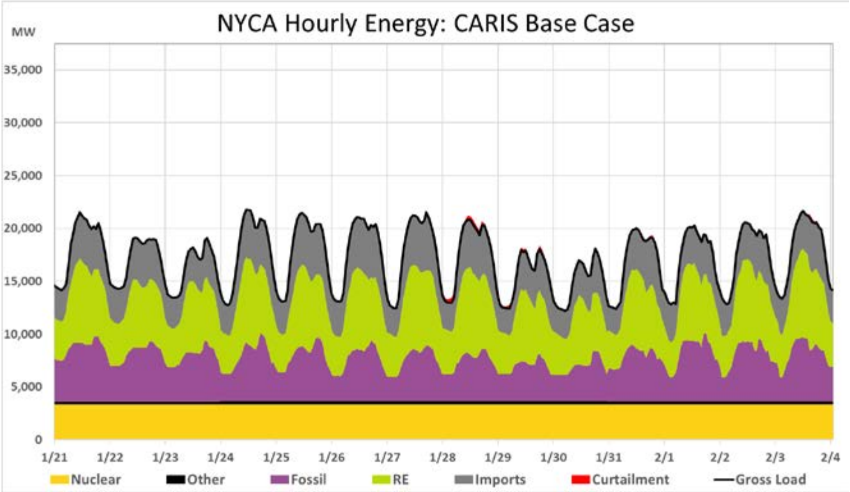
- Displays output energy production by type from MAPS simulations
- RE curtailments occur due to excess generation or external transmission constraints
- “Relaxed”: No transmission constraints are modeled inside NYCA

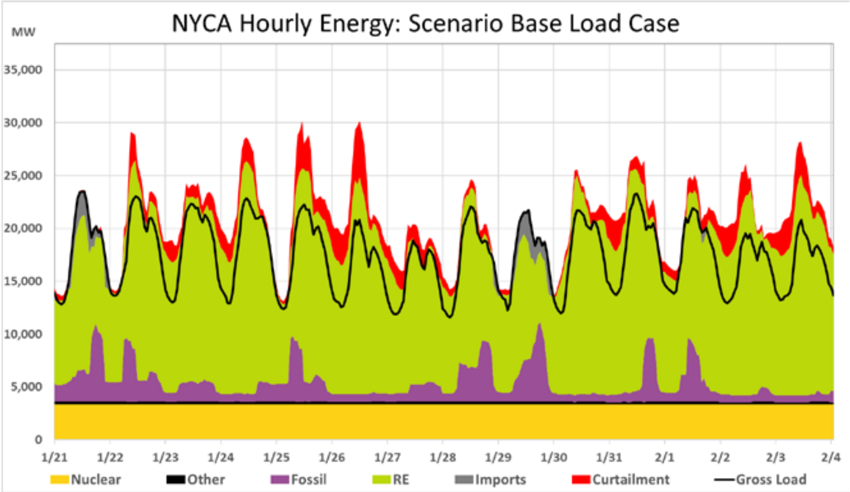
“Other” includes Methane (Biogas), Refuse (Solid Waste), and Wood fuel-fired generators
“Imports” includes imports from IESO, ISO-NE, and PJM

Modeling of Fossil Generation

- **Reasons why fossil generation runs in the model:**
  - Serve load in the absence of sufficient renewable resources
  - Meet locational reserve requirements
  - Meet Local Reliability Rules
  - Serve steam contracts
  - Operational limitations such as min. gen levels and min. runtime
- **Operational considerations not modeled in MAPS:**
  - Ramp rates and real-time sub-hourly variations
  - Energy and Ancillary Service co-optimization
  - Fuel availability or gas system constraints

Sample comparison of CARIS Base Case and Scenario Base Load Case





CARIS Base Case chart is for 2028 and Scenario Base Load Case chart is for 2030.
“Other” includes Methane (Biogas), Refuse (Solid Waste), and Wood fuel-fired generators
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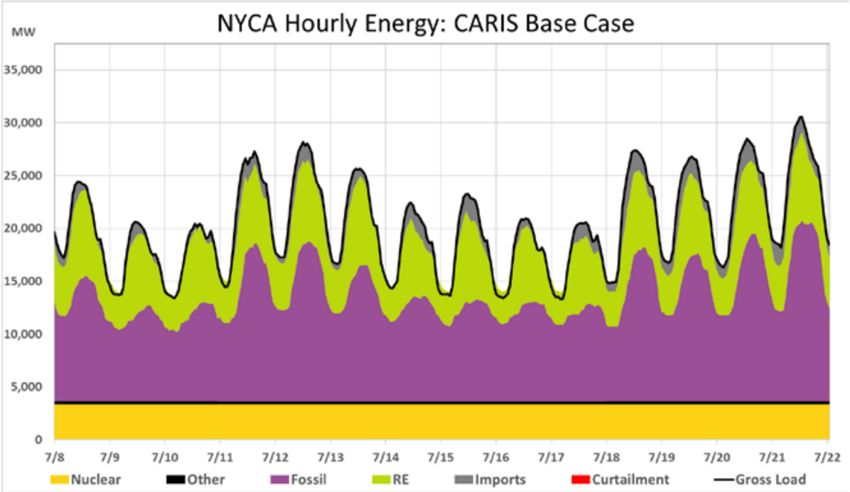
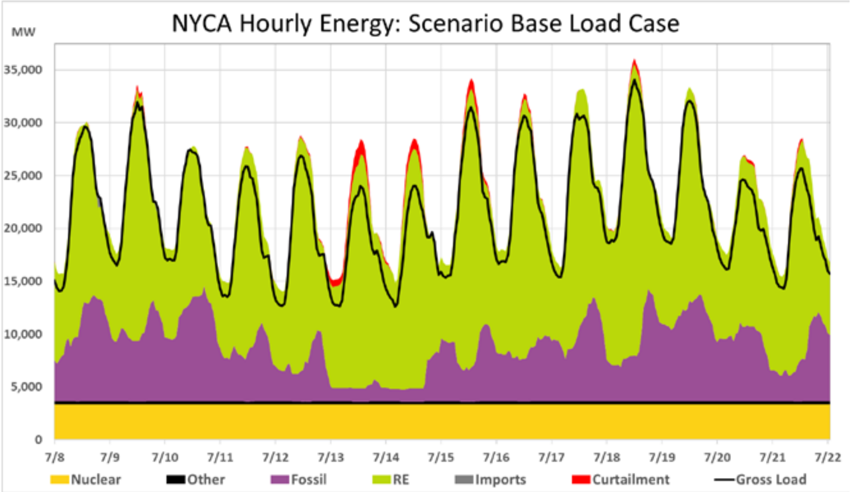
Sample comparison of CARIS Base Case and Scenario Base Load Case: Peak Loads





CARIS Base Case chart is for 2028 and Scenario Base Load Case chart is for 2030.
“Other” includes Methane (Biogas), Refuse (Solid Waste), and Wood fuel-fired generators
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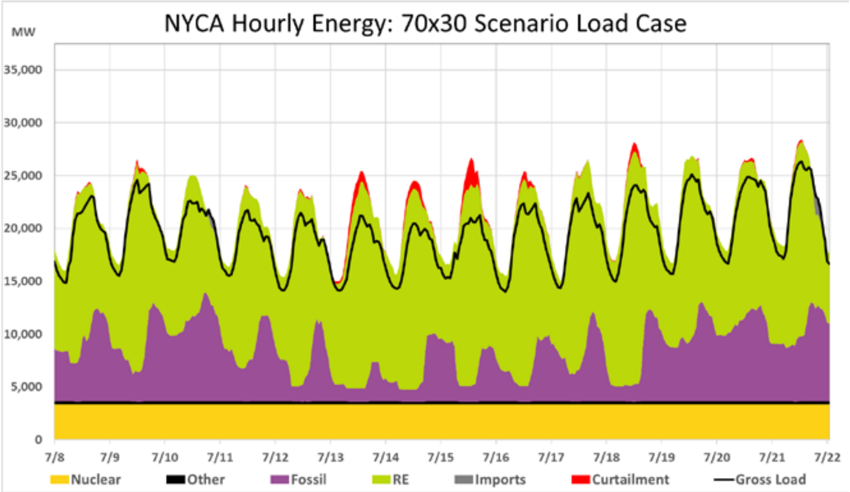
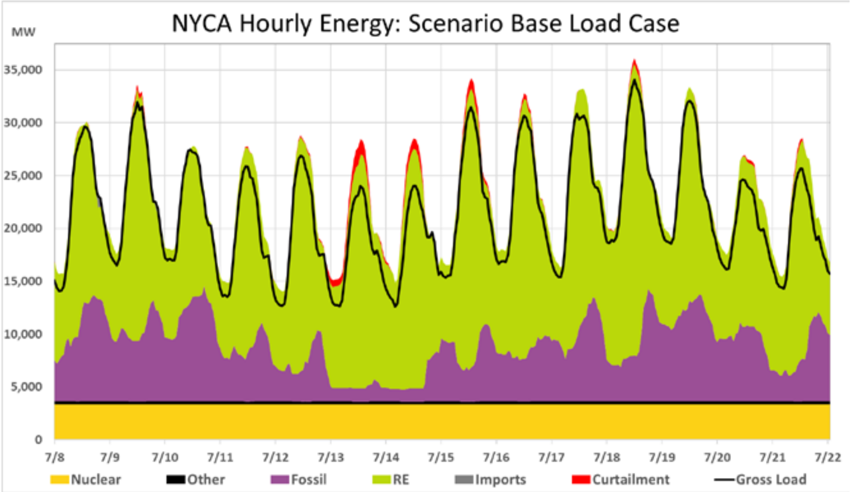
Sample Scenario Output Profiles: Peak Loads





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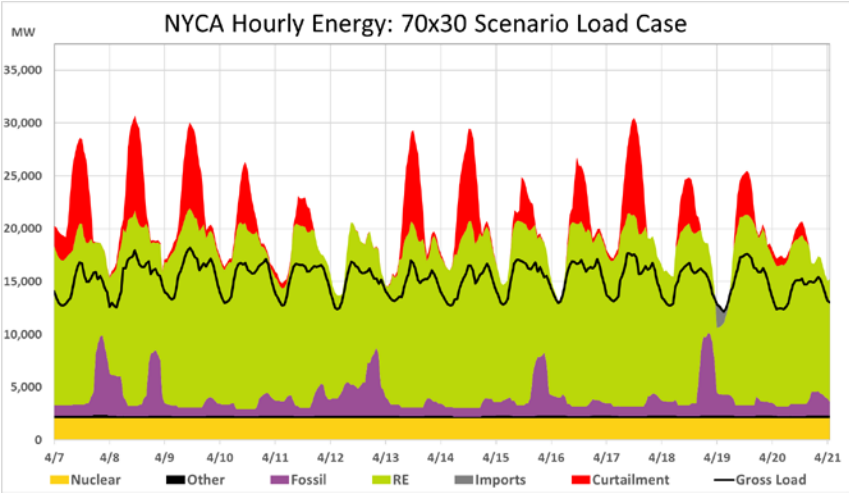
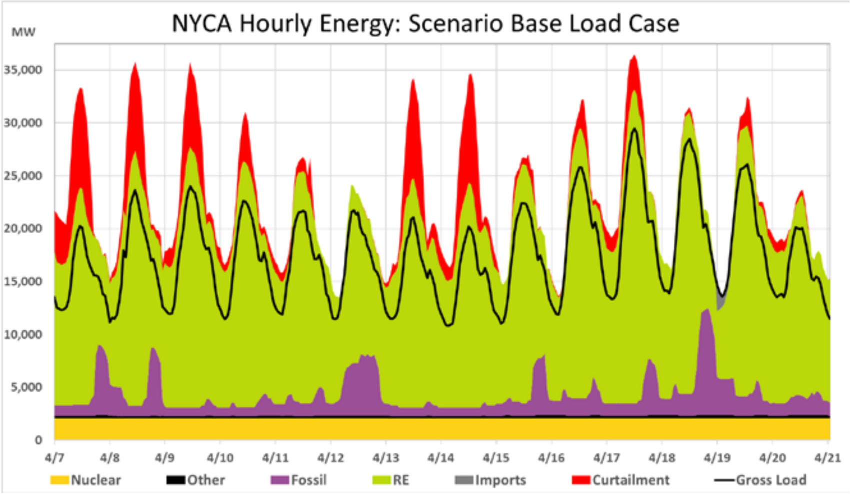
Sample Scenario Output Profiles: Minimum Load





“Other” includes Methane (Biogas), Refuse (Solid Waste), and Wood fuel-fired generators
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Next Steps

- Discuss transmission system constraint modeling and review production results reflecting NYCA transmission constraints
- Review sensitivity analysis of nuclear retirements and energy storage
- Review model results for fossil fuel-fired fleet
- Identify transmission constraints that cause renewable curtailments (*i.e.*, renewable generation pockets)
- For each pocket, quantify the magnitude and frequency of the curtailments for each assumed resource mix

Questions?

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- Maintaining and enhancing regional reliability
- Operating open, fair and competitive wholesale electricity markets
- Planning the power system for the future
- Providing factual information to policymakers, stakeholders and investors in the power system

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