2021 Economic Study: Future Grid Reliability Study Phase 1

Overview of Assumptions – Part 3

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Introduction

- On March 12, 2021, NEPOOL submitted the Future Grid Reliability Study (FGRS) Phase 1 as a 2021 Economic Study Request
- On April 1, 2021, ISO New England accepted the request and will perform the FGRS as the 2021 Economic Study
- Part one of study assumptions were presented by the ISO at the April 2021 PAC meeting; part two at the May 2021 PAC meeting
- Today's presentation will cover remaining outstanding assumptions for the production cost analysis

2021 Economic Study Past Presentations & Materials

Presentation & Materials	Date (Link)
High-level draft scope of work and assumptions (Part 2)	May 14, 2021
High-level draft scope of work and assumptions (Part 1)	April 14, 2021
FGRS Assumptions Table Submitted to ISO-NE	March 31, 2021
FGRS Framework Document Submitted to ISO-NE	March 31, 2021
ISO-NE Feedback on FGRS	March 31, 2021
Modeling of Electric Vehicles	February 22, 2021
ISO-NE Revised Schedule and Feedback on FGRS	February 22, 2021

Scenario Overview

Scenario	Proponent	Alternate Scenario Name or Notes
1	National Grid	Based on the 2020 Economic Study
2	Eversource	London Economics
3	NESCOE	Energy Pathways Study
A	National Grid	Bi-Directional Transmission & HQ Storage
B	Synapse (Multi Sector Group B)	Vehicle to Grid
C	NextEra/Dominion	Nuclear Retirement
D	Anbaric	100% Clean Electricity
E	Anbaric	Onshore/Offshore Grids

REMAINING ASSUMPTIONS

Production Cost and Ancillary Services Simulations

Wind and Solar PV Resources

- For Alternatives D & E, additional wind, solar, and storage resources will be distributed proportional to the parent case as much as possible. As needed, resources will be redistributed based on interface flow exceedances in the initial runs.
  - ISO will note in its future results presentations if resources were relocated
- For ancillary services simulations, historical 2019 solar PV data from the ISO's operations support vendor will be used instead of using DNV data. DNV's data is in one-hour increments, whereas the vendor data is in five minute increments. Utilizing this data means that less processing of the existing data will need to occur.

Change to EV distribution in Alternative B

- The ISO recommends that for modeling EVs in Alternative B, distribute the EVs' load and injections proportionally based on the summer peak load similar to the other scenarios (instead of distributing EVs based on Census data):
  - Distributing EVs in Alterative B may have impacted ISO's ability to meet the ambitious timeline of the FGRS study sought by NEPOOL
  - Because of an unconstrained transmission system, it is unclear how meaningful the impact of using census data versus proportional to the summer peak load
    - Dominant effect would be localized internally within the unconstrained RSP areas
    - Conceptual logic for a rational dispatching of injections across the grid vs. local support may distort transmission flows
    - Ability of the distribution system to accommodate significant injections is a key parameter in which locations can support injections
    - Developing insightful metrics reflecting the effect of load / injections on the distribution system are a subject of ongoing discussions in other venues

36 Hour Batteries Modeling

- Alternative scenarios D & E requested holding back 36-hour batteries for energy reserves during wind and solar droughts
- ISO-NE has performed some reconnaissance simulations
  - VOM can be used to change priority usage of battery
  - May result in “churning” of energy among batteries
    - Some batteries charge while others simultaneously discharge
    - Increased losses
  - GridView may have difficulties with a non-traditional battery dominated scenario

BESS Duration	BESS Capacity (MW)	BESS Energy (MWh)	Operational Role	VOM ($/MWh)
4 hour	7,000	28,000	Use previous assumptions	3.00
8 hour	10,000	80,000	Use previous assumptions	3.00
36 hour	60,700	2,185,000	“Held” in reserve for droughts	4.00

SCENARIO 1 LOAD & RESOURCE PROFILES

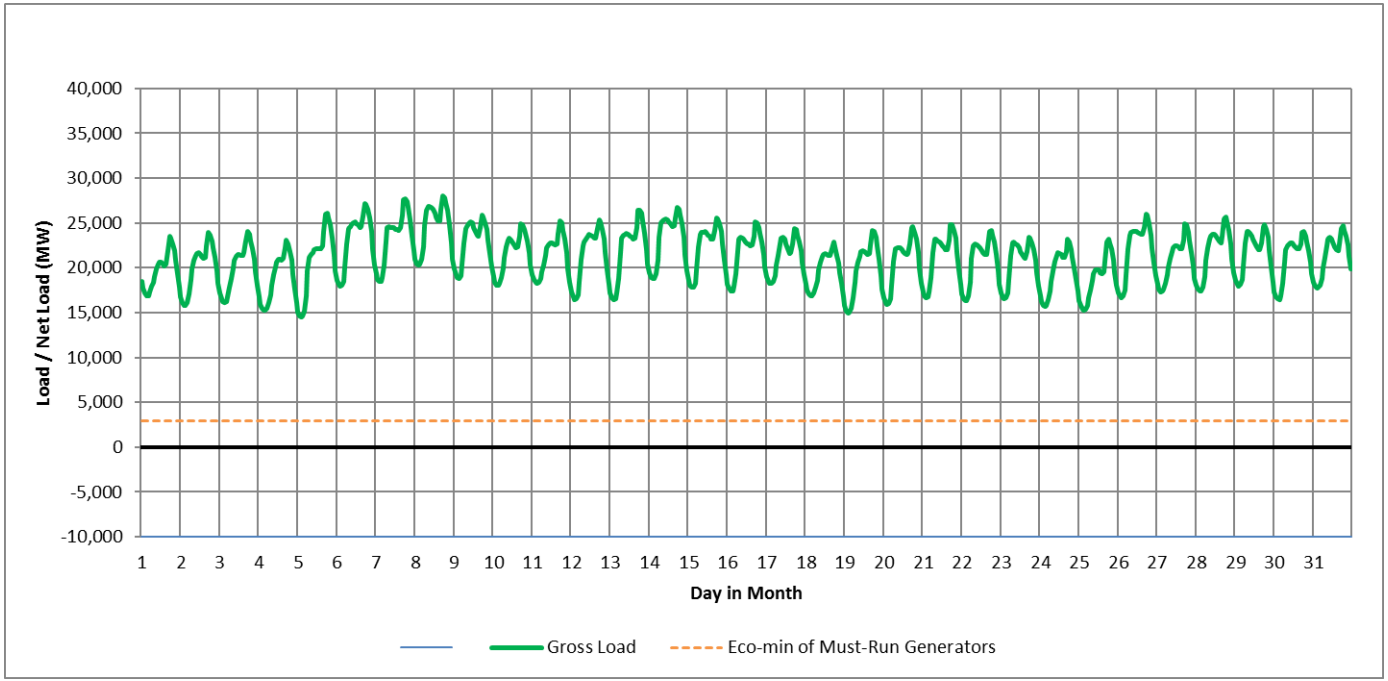
January 2040

Scenario 1 Load and Resource Profiles

- The following slides for January and May illustrate:
  - how much capacity needs to be served by dispatchable generation
  - how much capacity needs to be transmitted across the system
  - the impact of curtailment
  - the impact of energy storage
- This provides insight into what the assumed winter and spring/fall load and gen profiles look like in 2040 to demonstrate what load is left for dispatchable generation to serve after accounting for profiled resources
- Note the titles on the following slides describe the change in net load as additional elements are added going from the previous blue line to a new green line with latest element

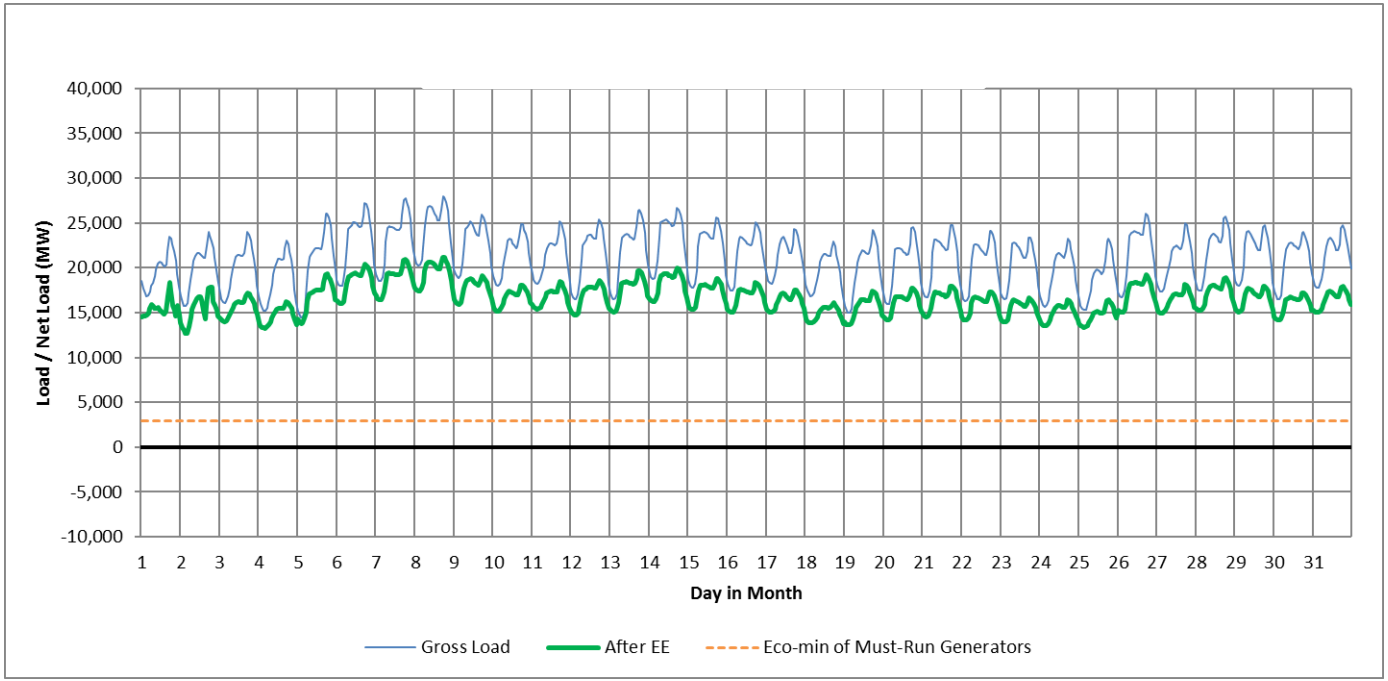
Scenario 1 – January 2040

Gross Load



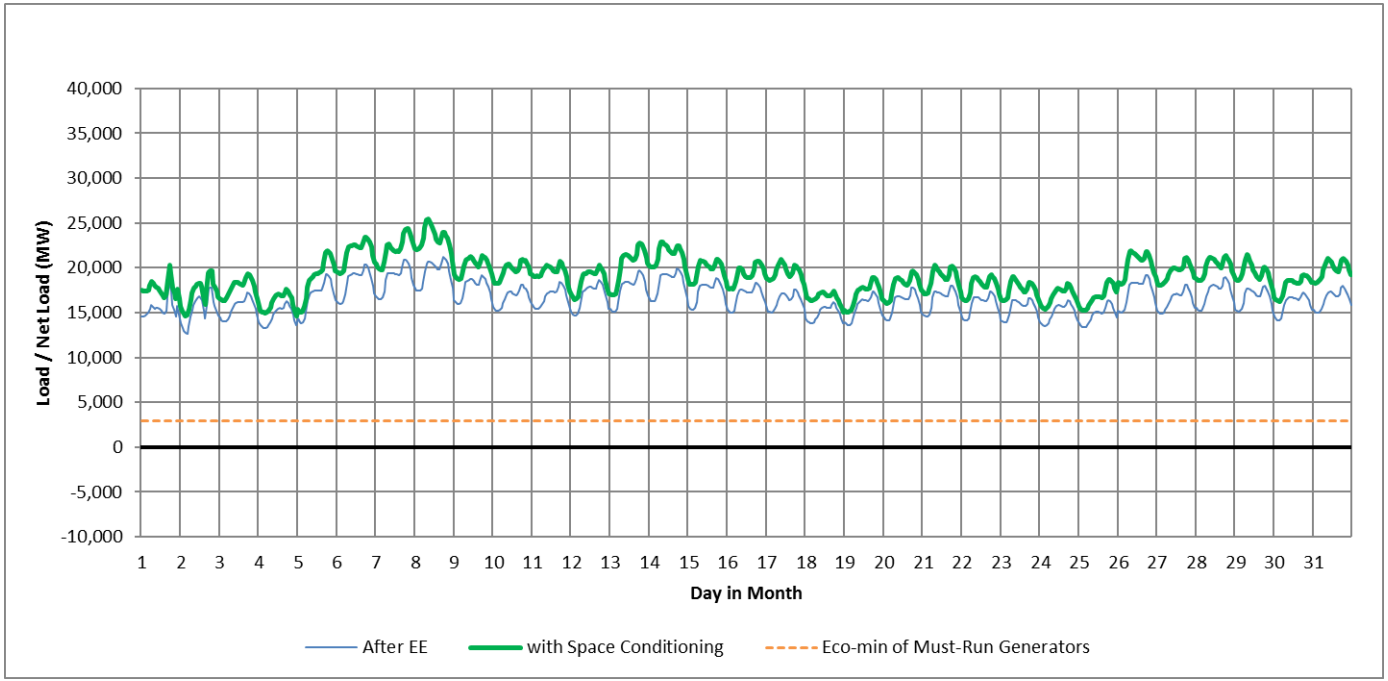
Scenario 1 – January 2040 (cont.)

Gross Load to After Energy Efficiency (EE)



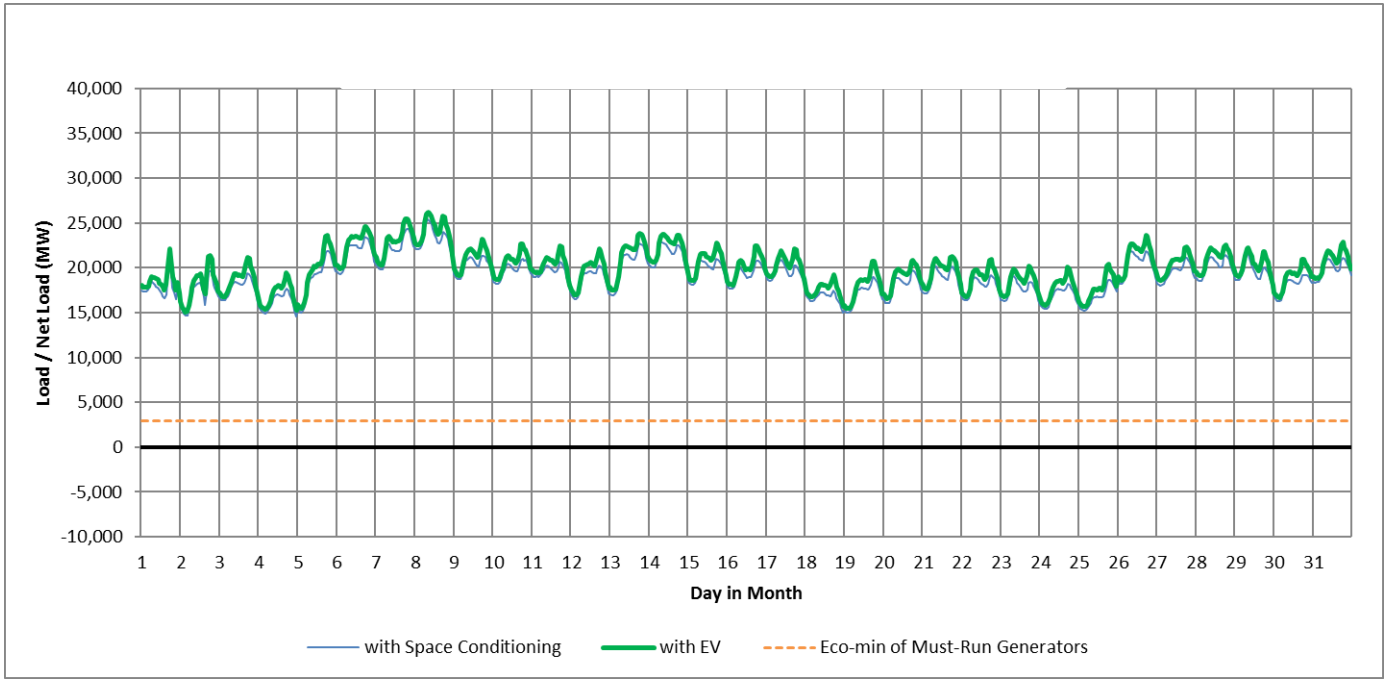
Scenario 1 – January 2040 (cont.)

After Energy Efficiency (EE) to After Space Conditioning Electrification



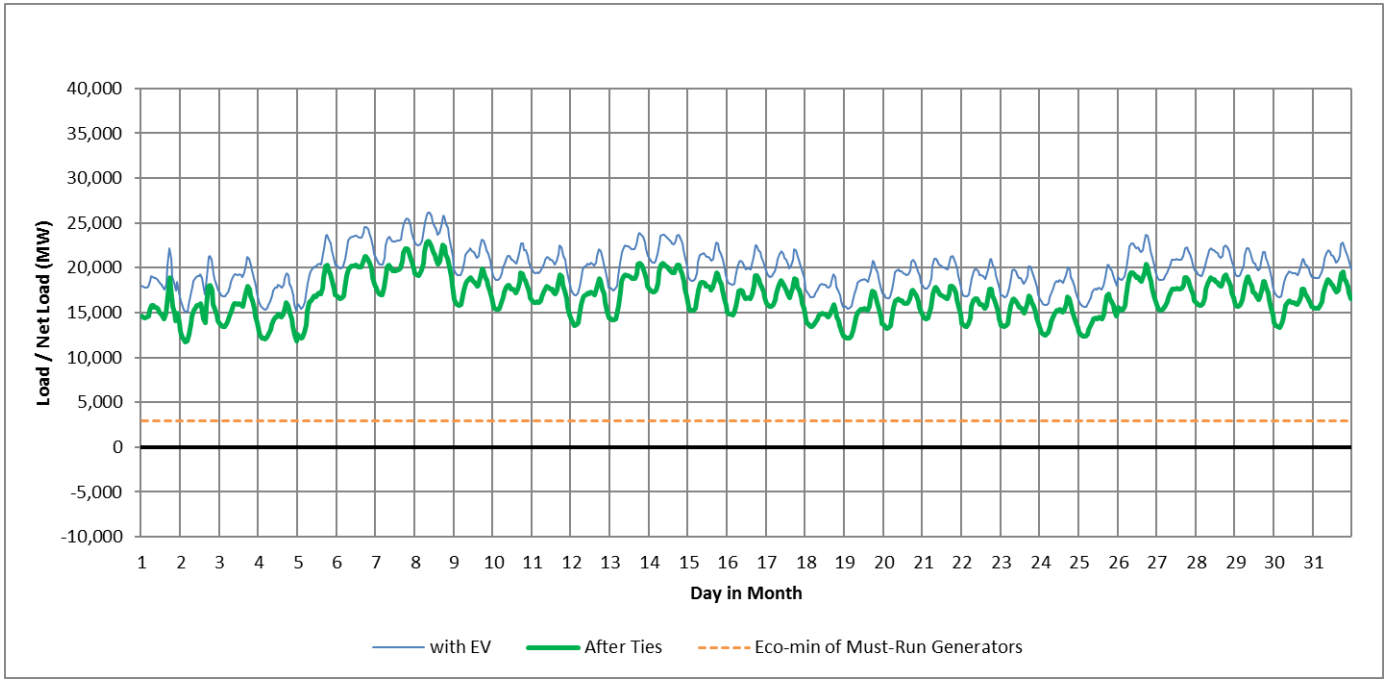
Scenario 1 – January 2040 (cont.)

After Space Conditioning Electrification to After Electric Vehicles (EVs)



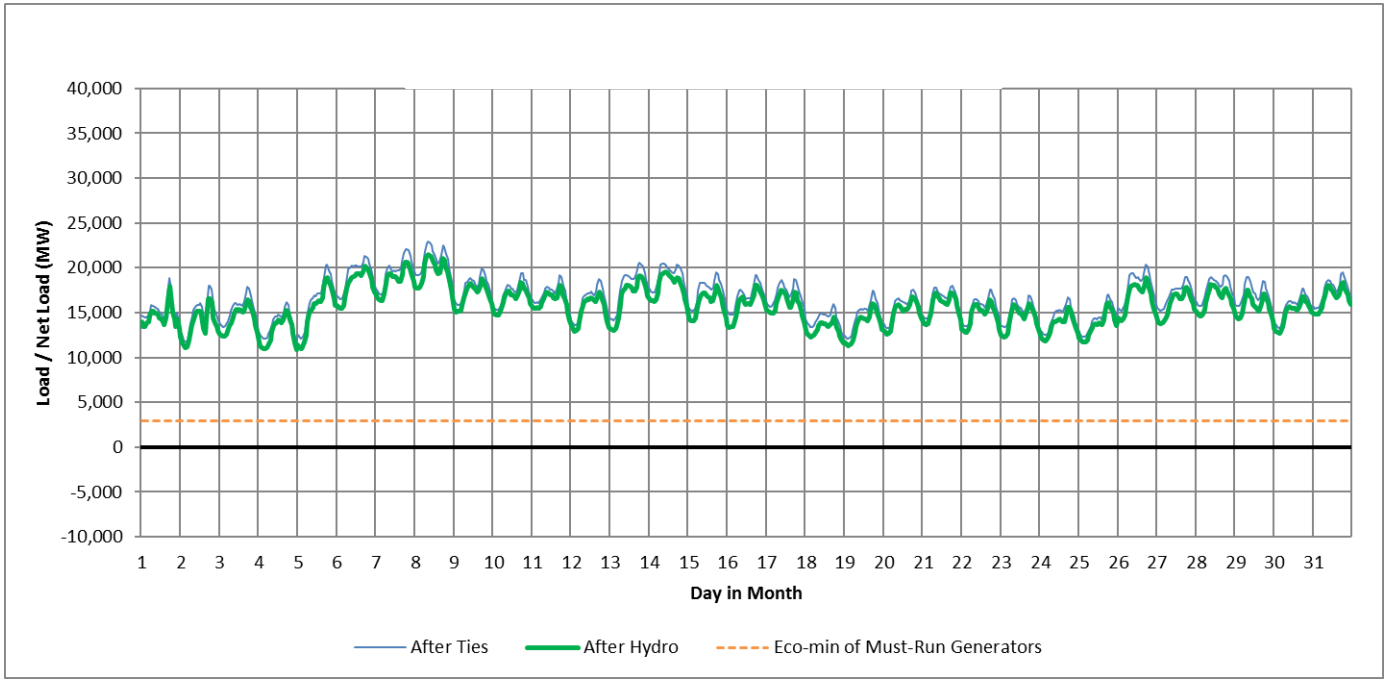
Scenario 1 – January 2040 (cont.)

After Electric Vehicles (EVs) to After All Imports



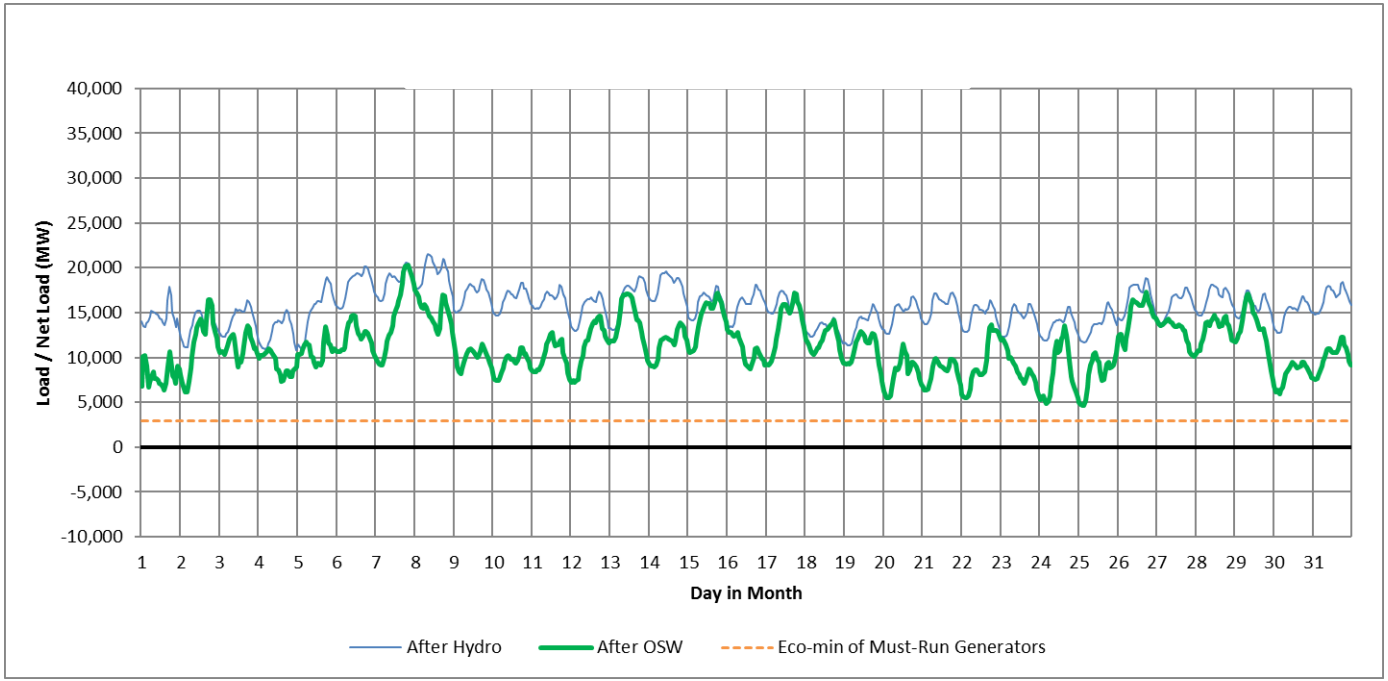
Scenario 1 – January 2040 (cont.)

After All Imports to After Hydro



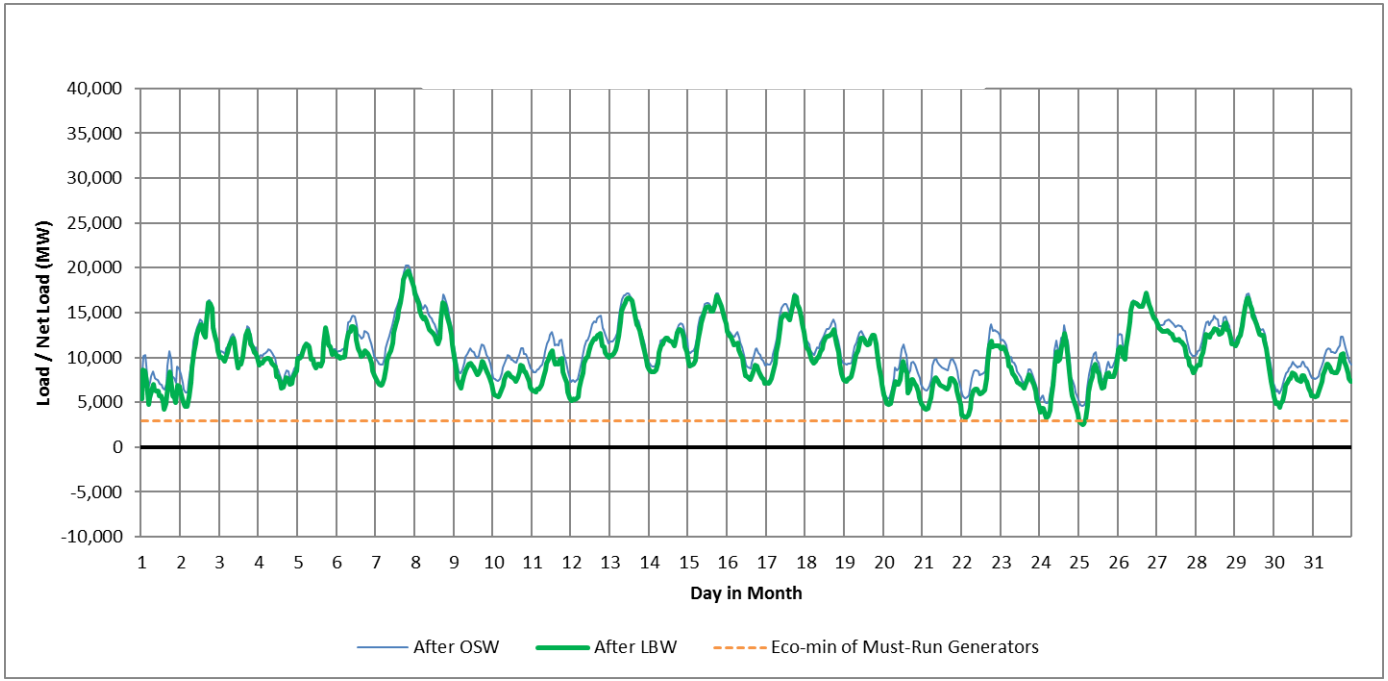
Scenario 1 – January 2040 (cont.)

After All Imports to After Offshore Wind (OSW)



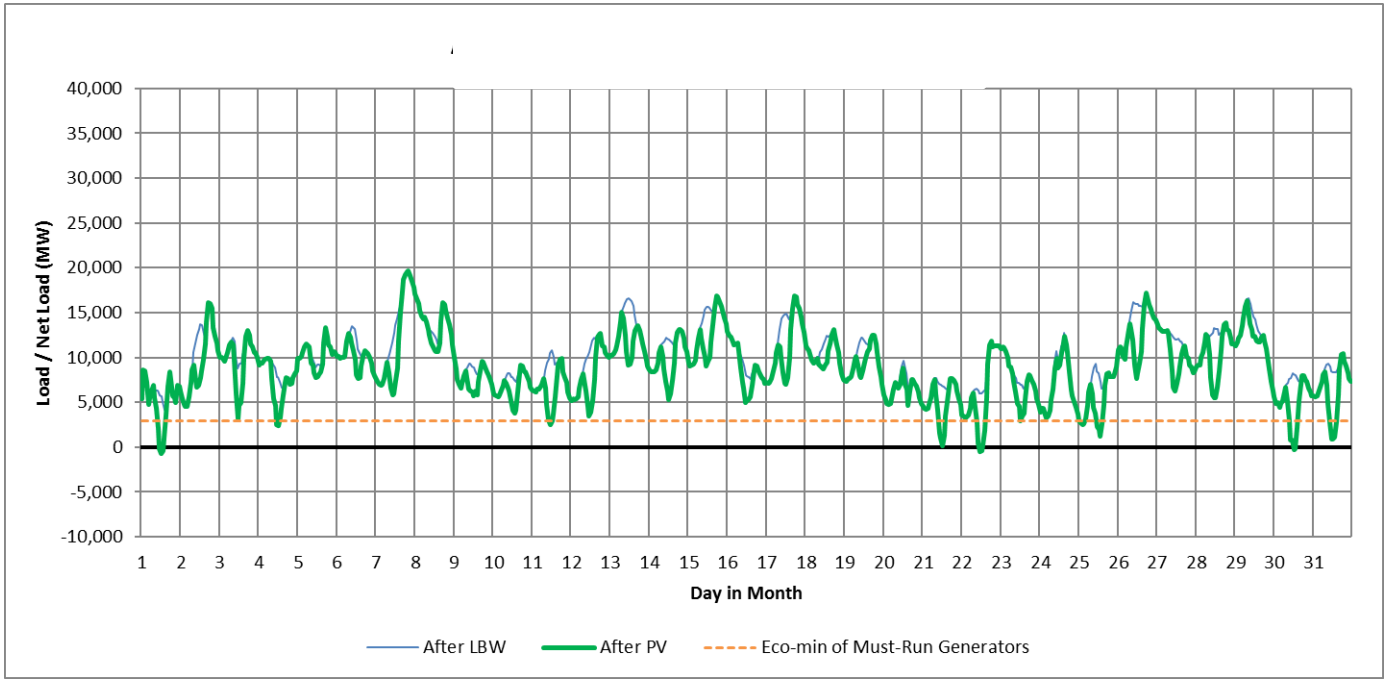
Scenario 1 – January 2040 (cont.)

After Offshore Wind (OSW) to After Land Based Wind (LBW)



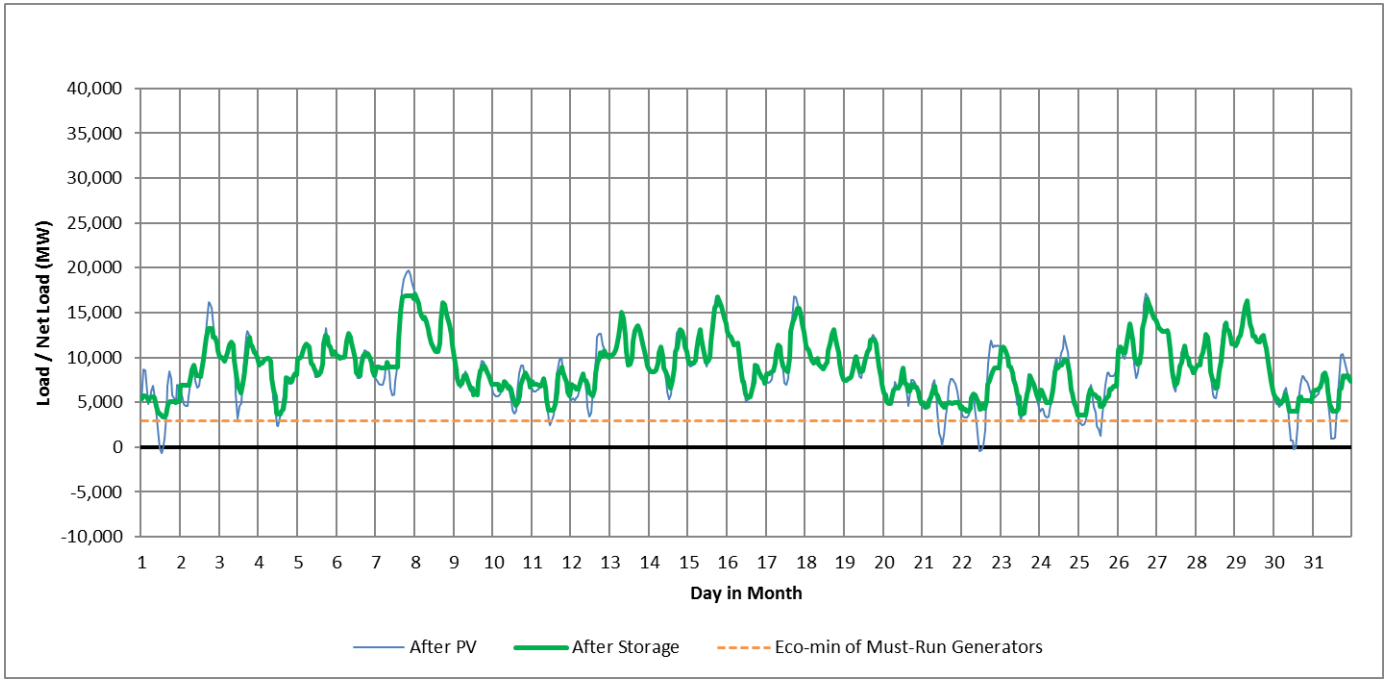
Scenario 1 – January 2040 (cont.)

After Land Based Wind (LBW) to After Solar Photovoltaics (PV)



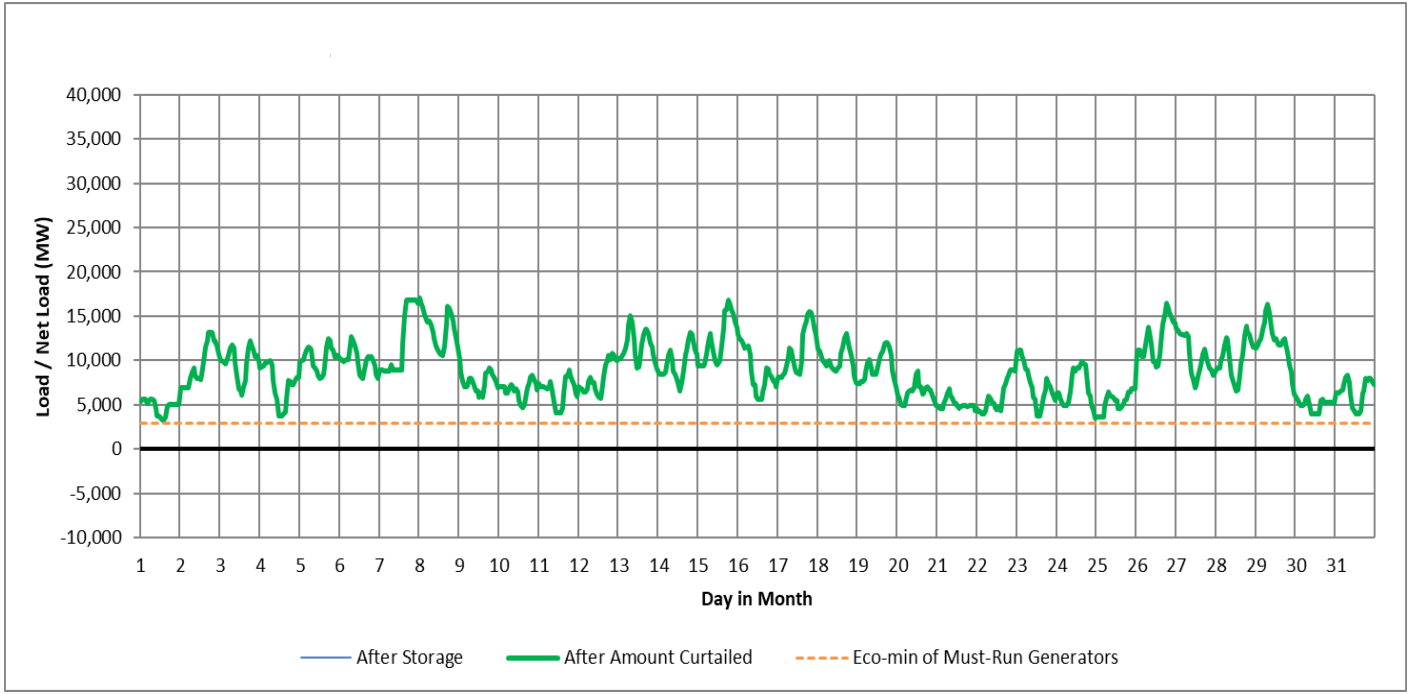
Scenario 1 – January 2040 (cont.)

After Solar Photovoltaics (PV) to After Energy Storage



Scenario 1 – January 2040 (cont.)

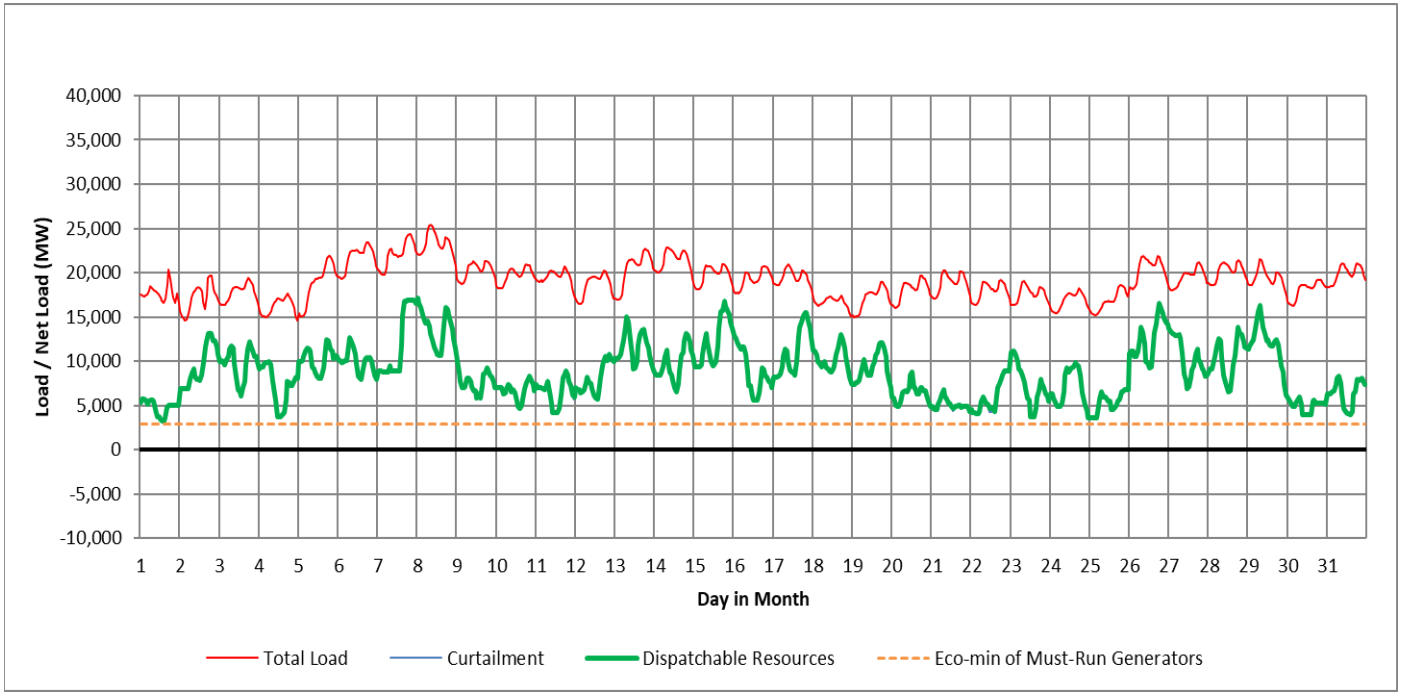
After Energy Storage to After Curtailments



Replaced "After Amount Spilled" with "After Amount Curtailed"

Scenario 1 – January 2040 (cont.)

Total Load, Dispatchable Resources, Curtailments, and Must-Run



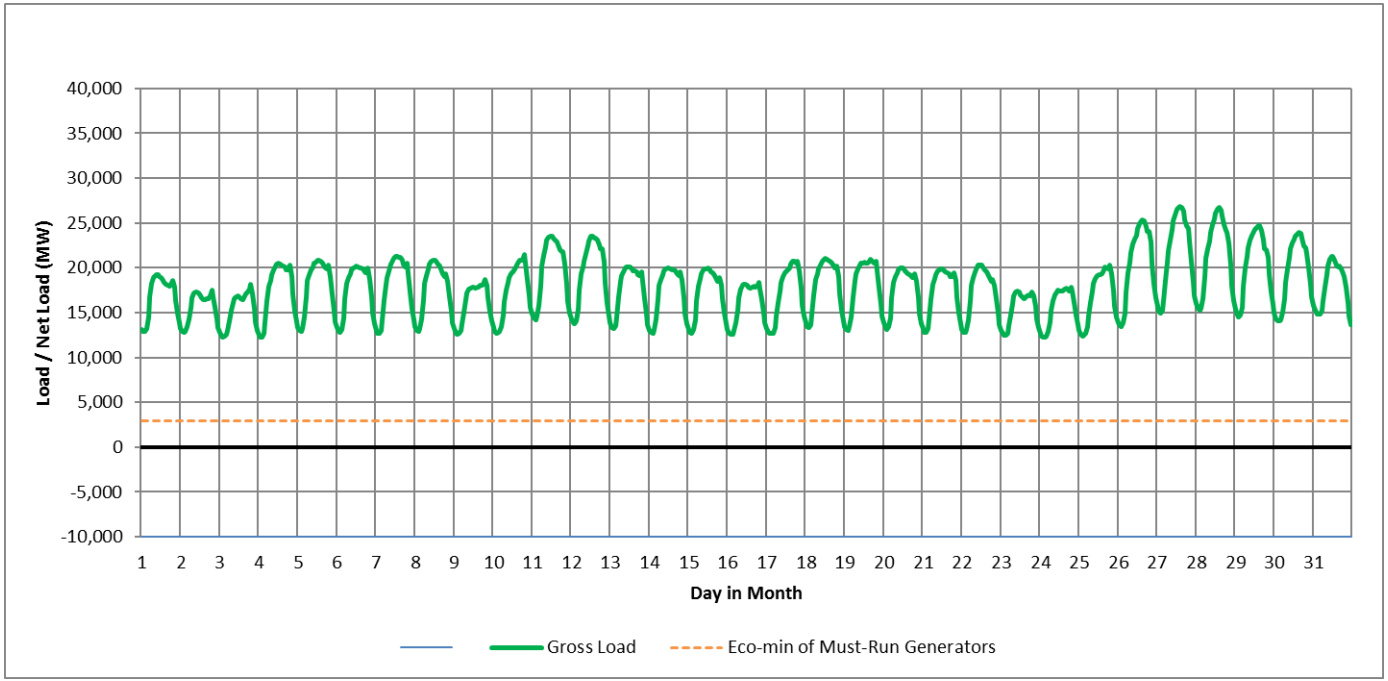
Replaced "Spillage" with "Curtailment"

SCENARIO 1 LOAD & RESOURCE PROFILES

May 2040

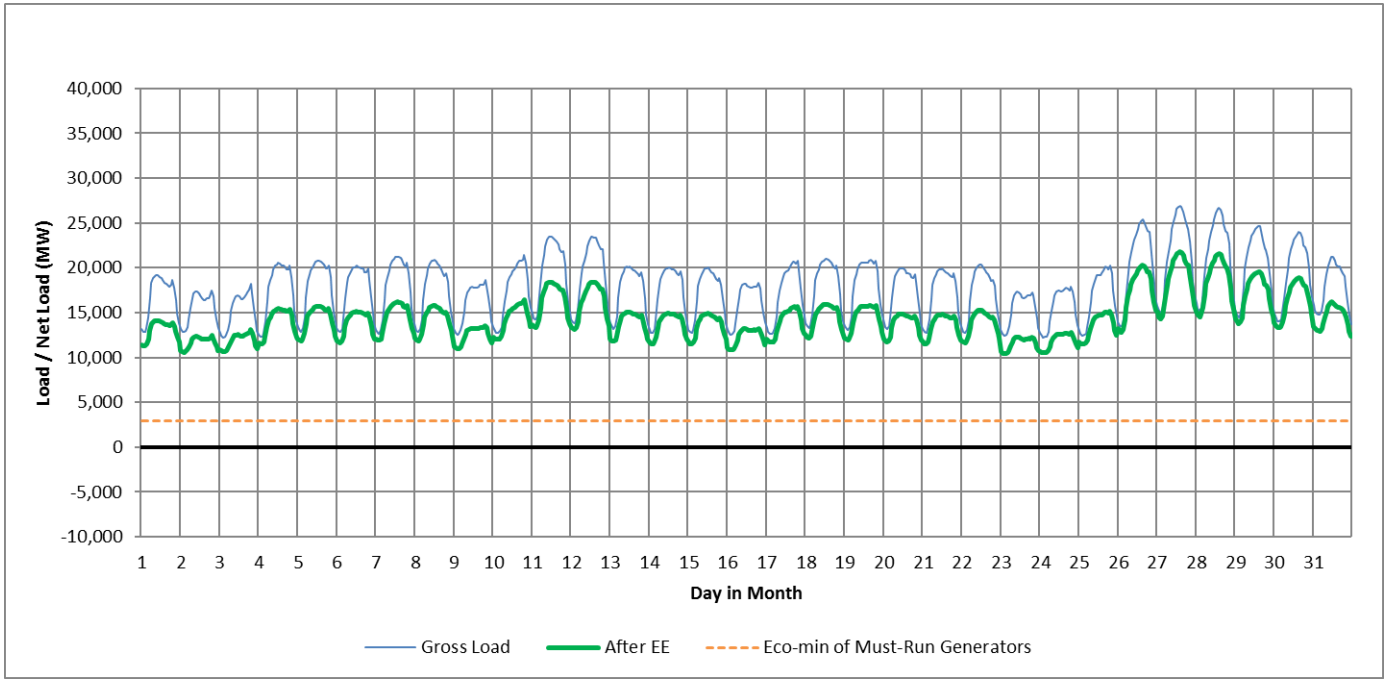
Scenario 1 – May 2040

Gross Load



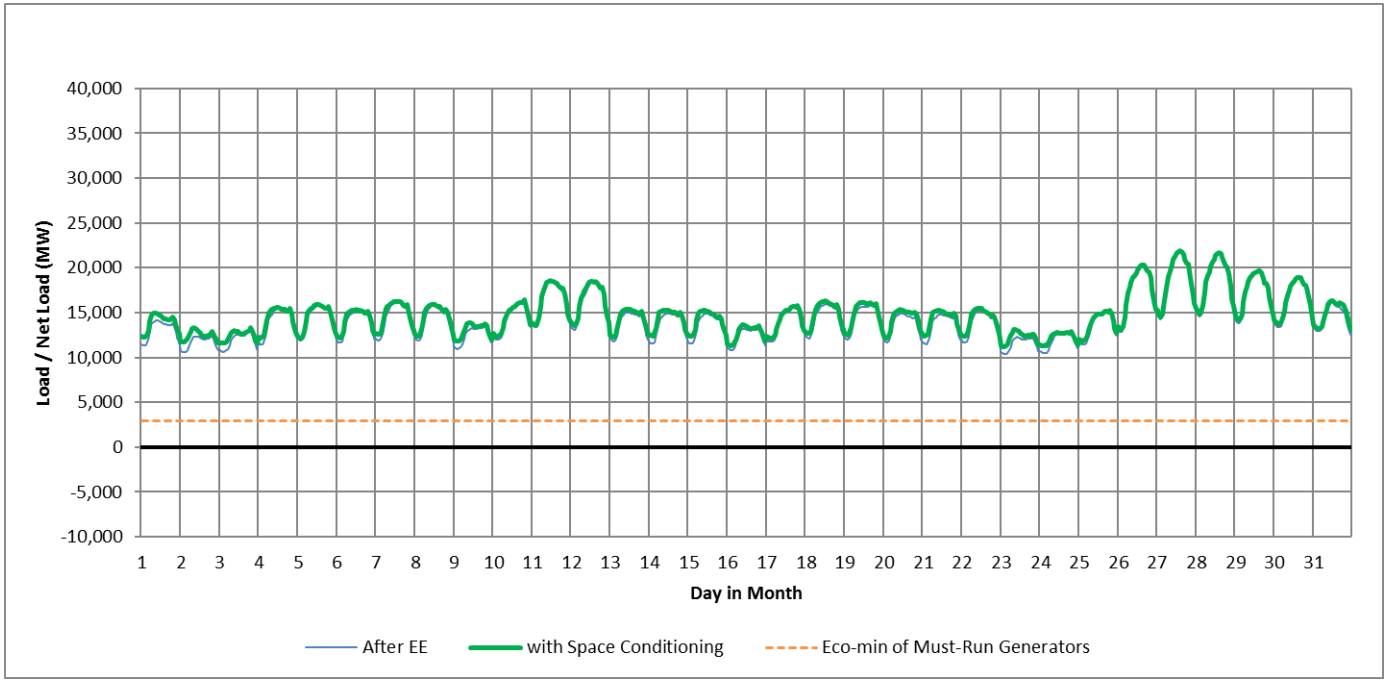
Scenario 1 – May 2040 (cont.)

Gross Load to After Energy Efficiency (EE)



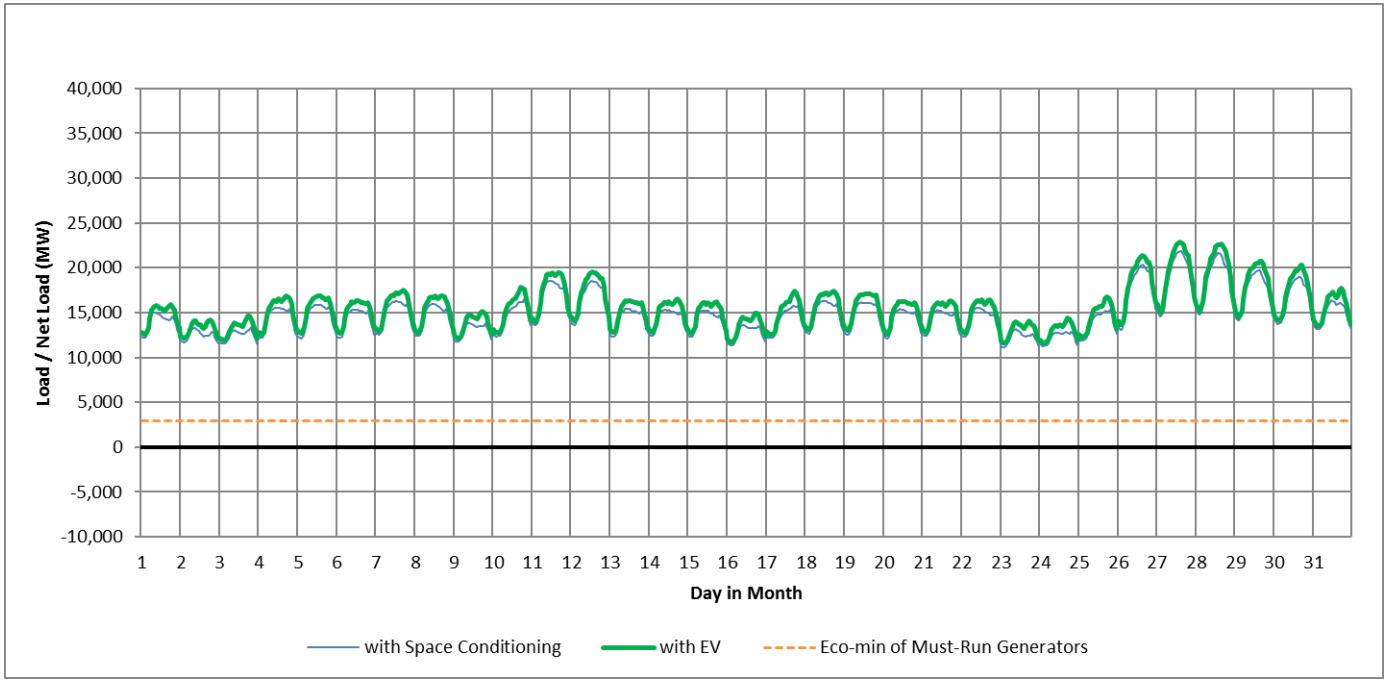
Scenario 1 – May 2040 (cont.)

After Energy Efficiency (EE) to After Space Conditioning Electrification



Scenario 1 – May 2040 (cont.)

After Space Conditioning Electrification to After Electric Vehicles (EVs)



Scenario 1 – May 2040 (cont.)

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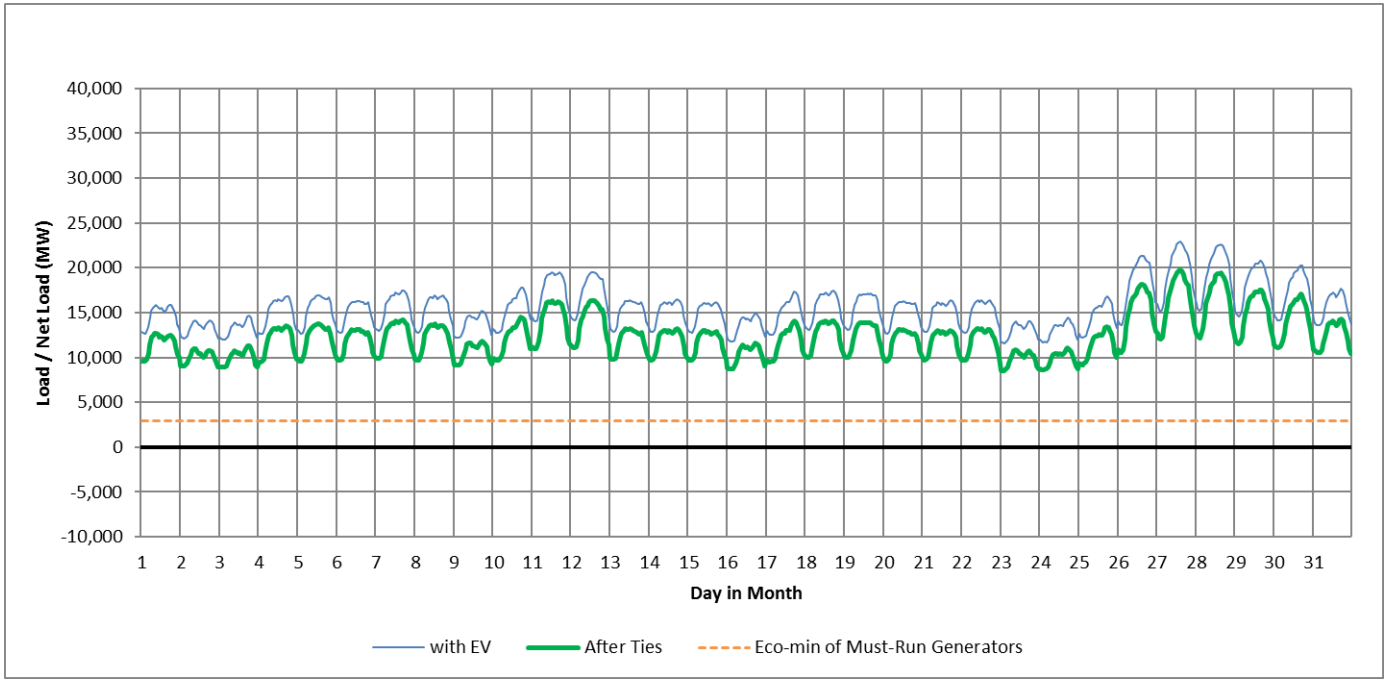
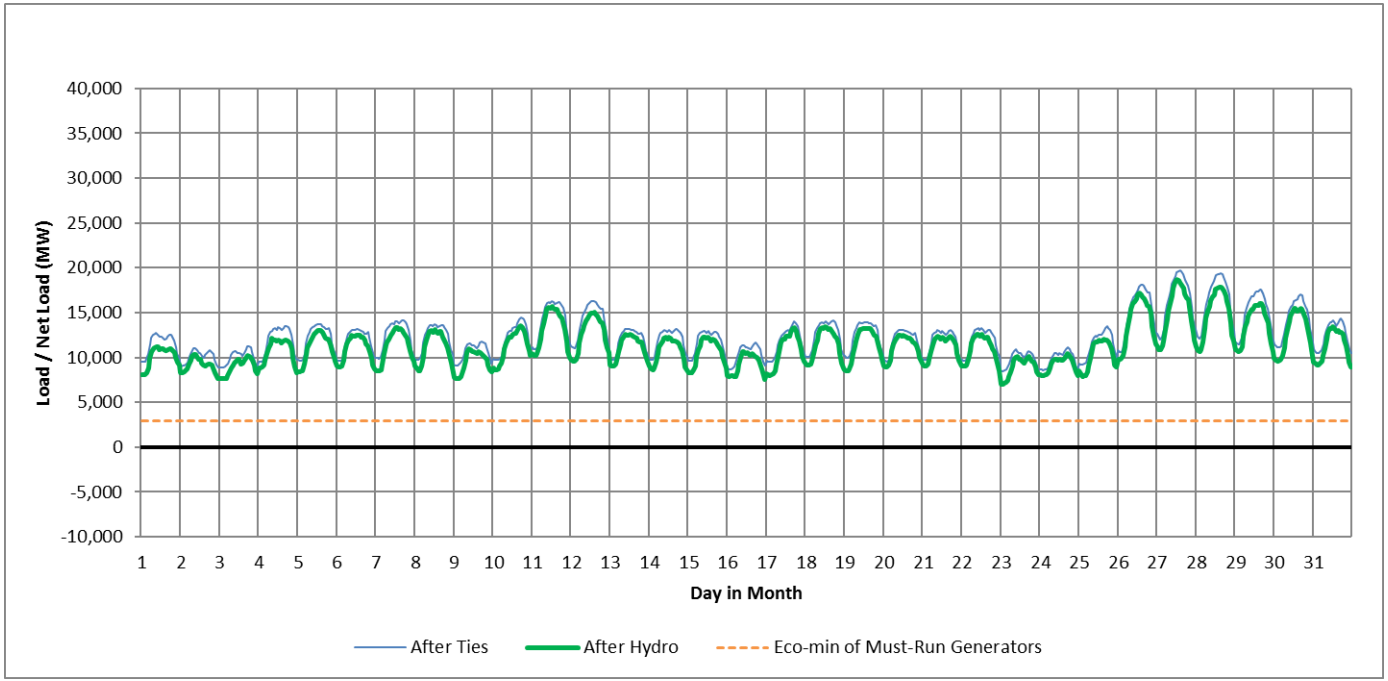


Scenario 1 – May 2040 (cont.)

After All Imports to After Hydro



Scenario 1 – May 2040 (cont.)

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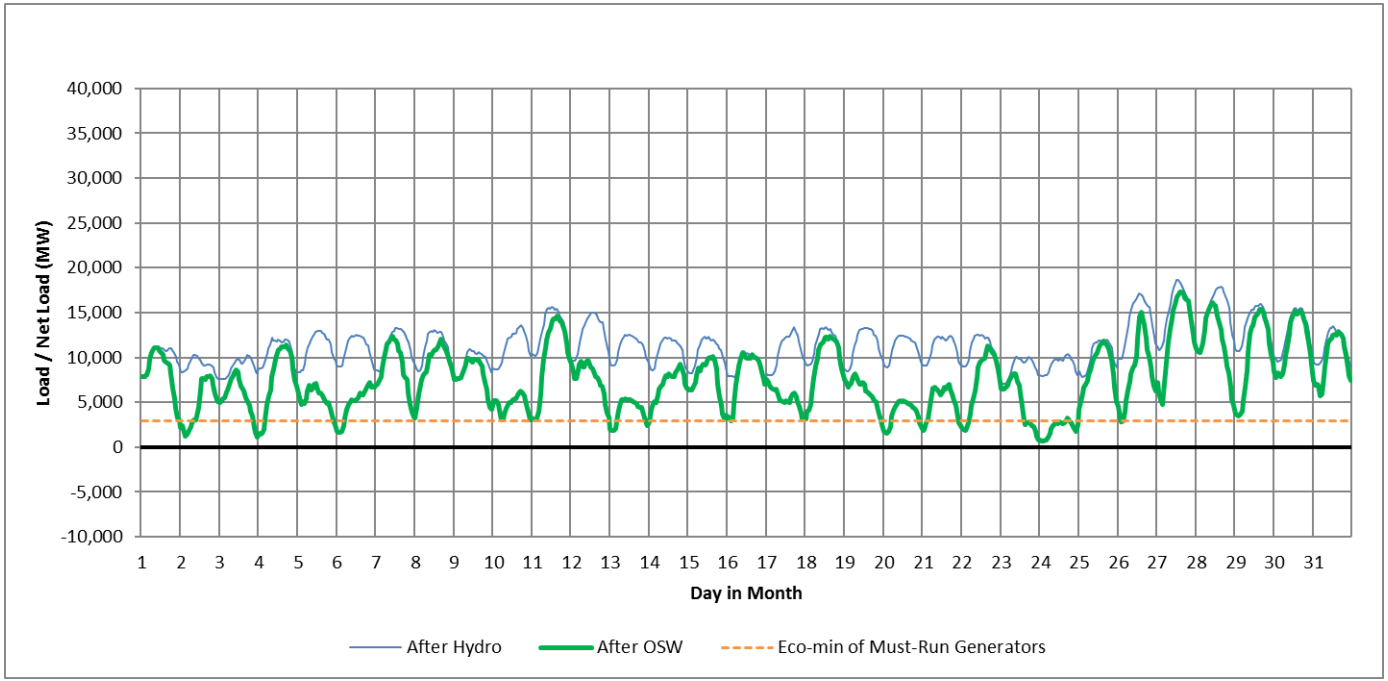

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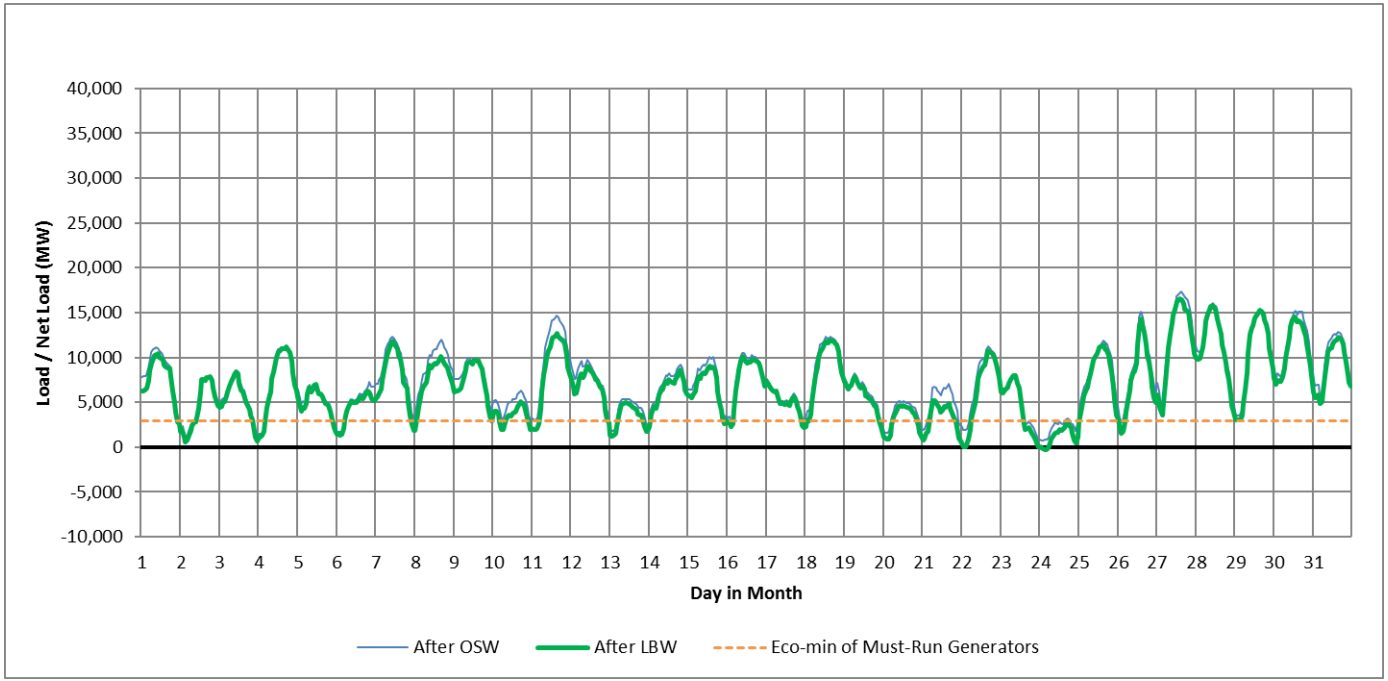

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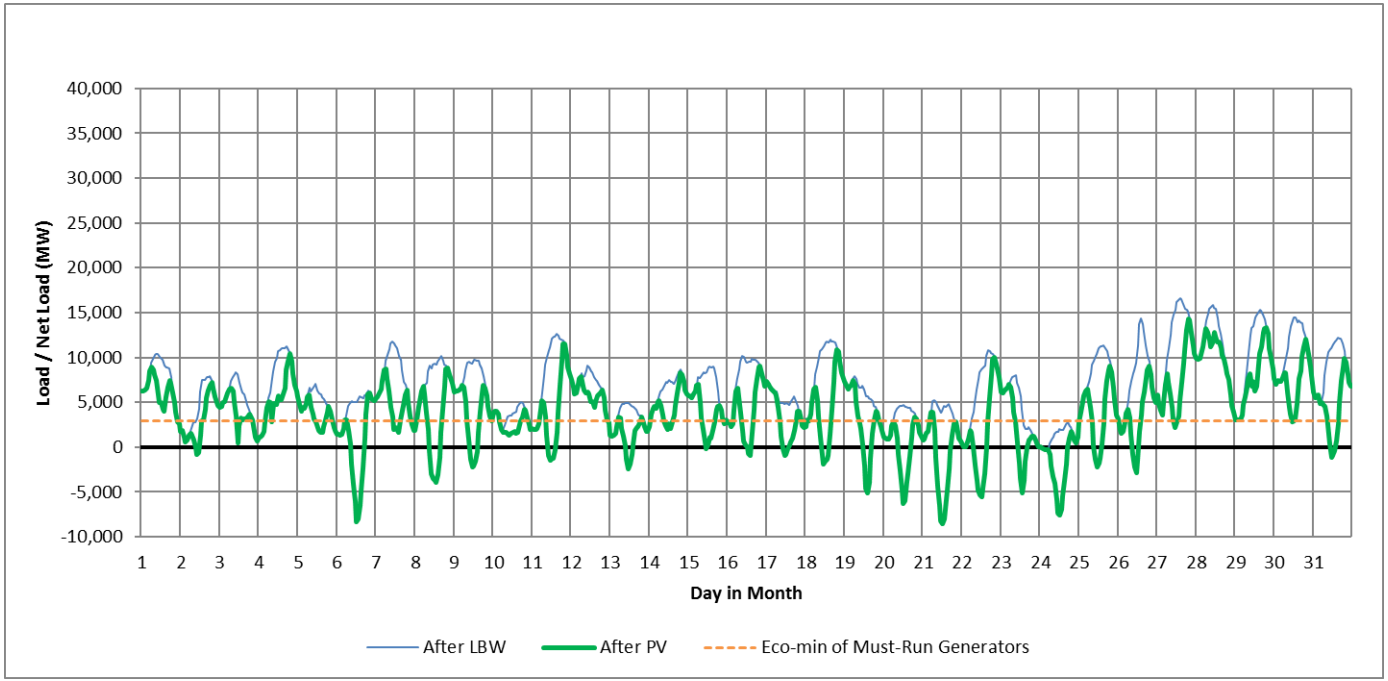
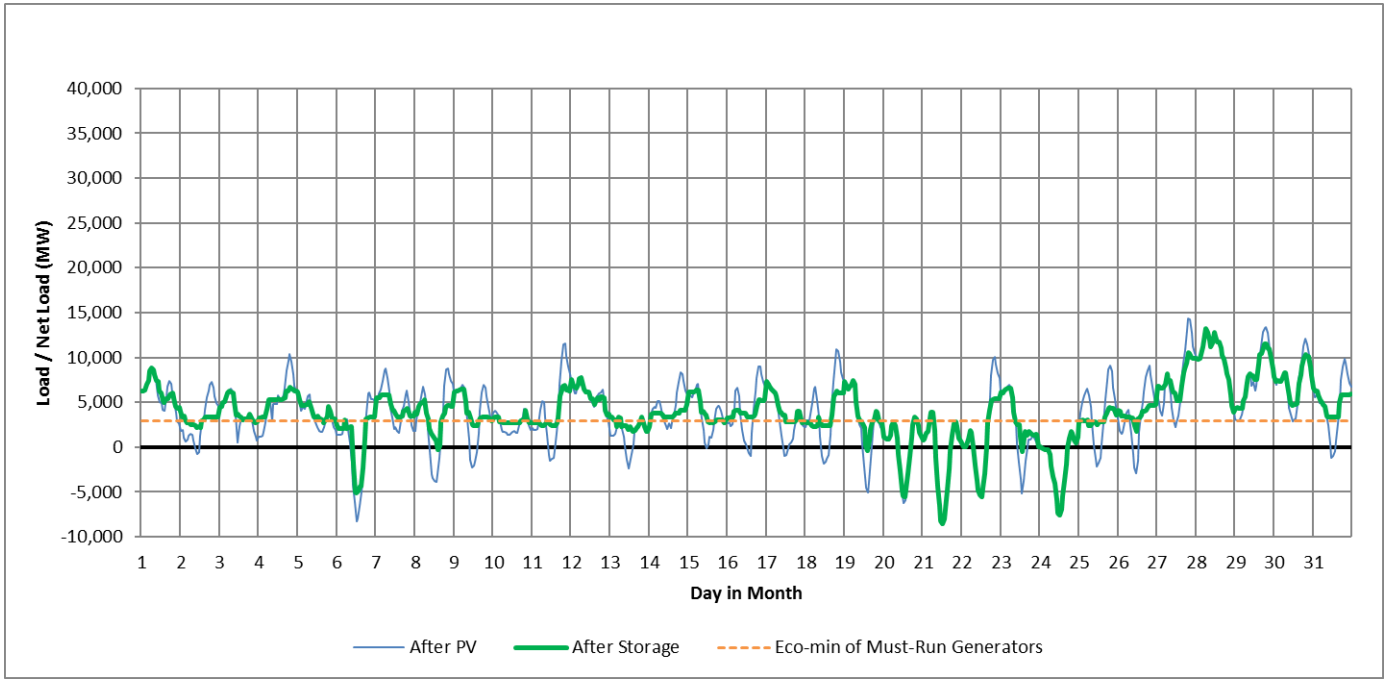


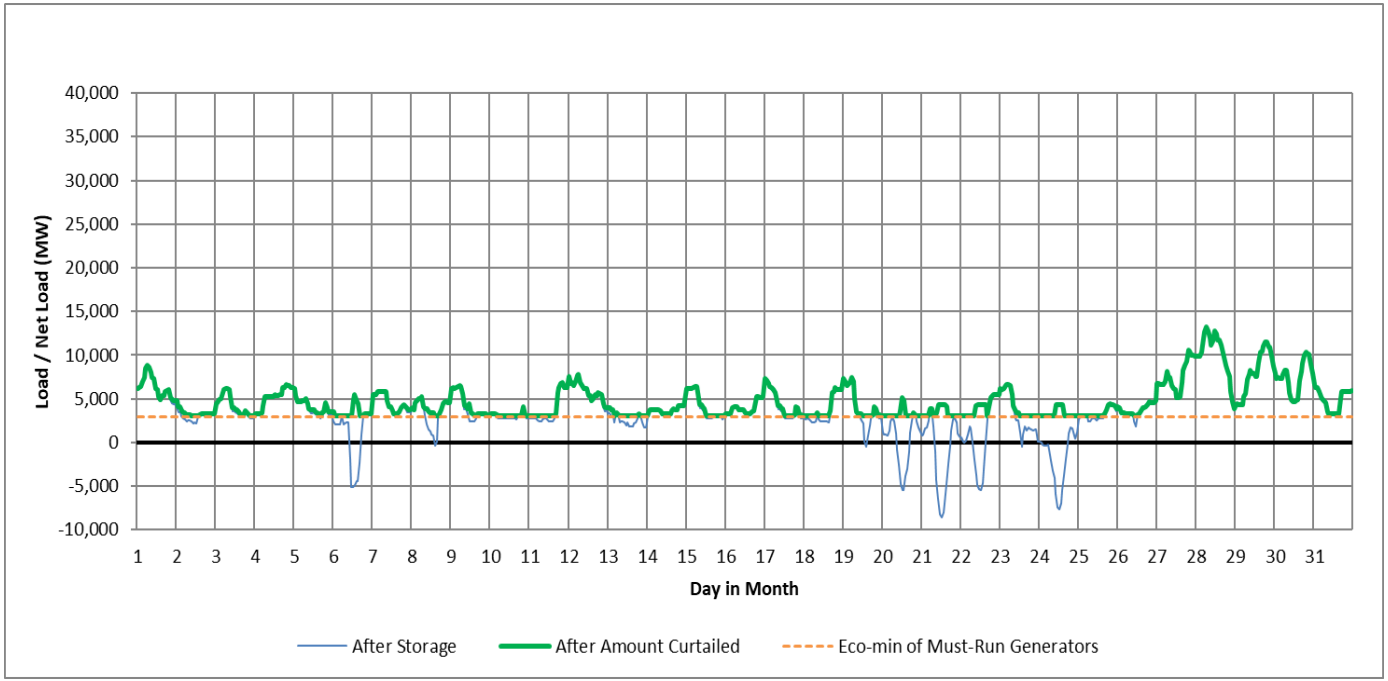
Scenario 1 – May 2040 (cont.)

After Solar Photovoltaics (PV) to After Energy Storage



Scenario 1 – May 2040 (cont.)

After Energy Storage to After Curtailments



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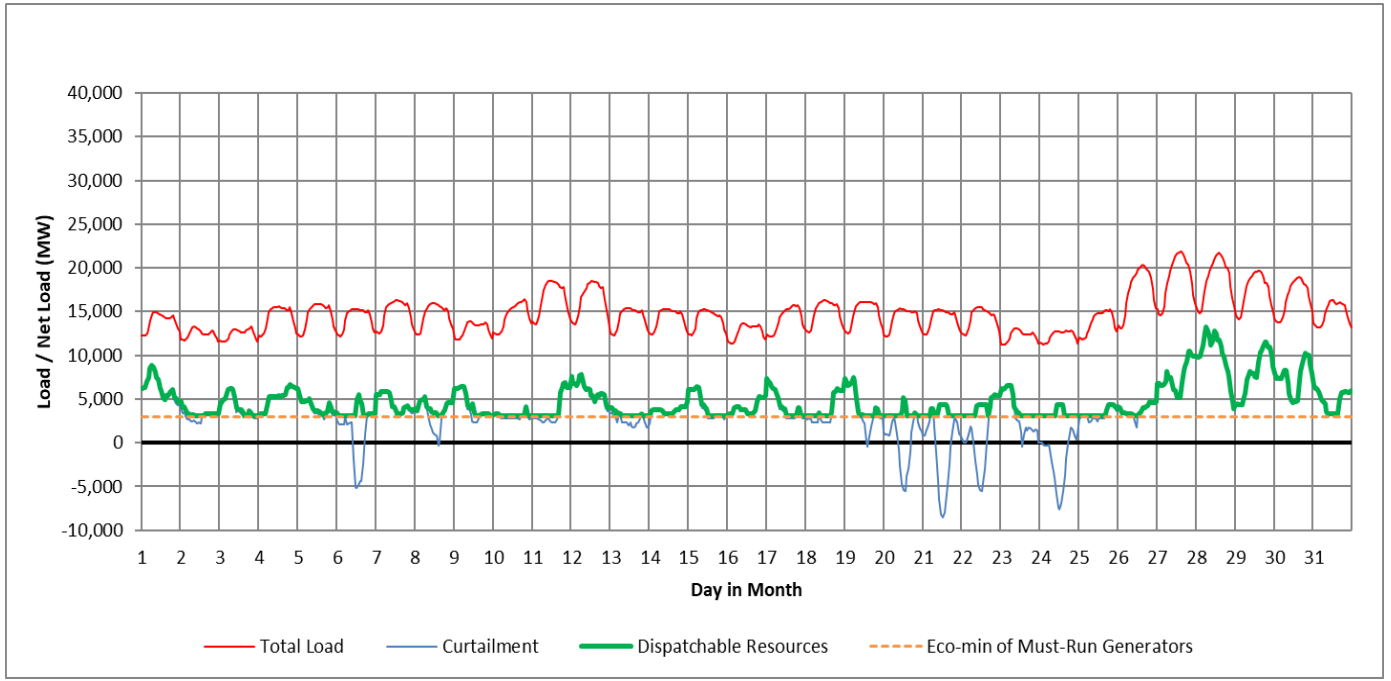


Replaced "Spillage" with "Curtailment"

SCENARIO 3 INPUT DATA RECASTING

Recasting the 2012 input data for the 2019 weather year

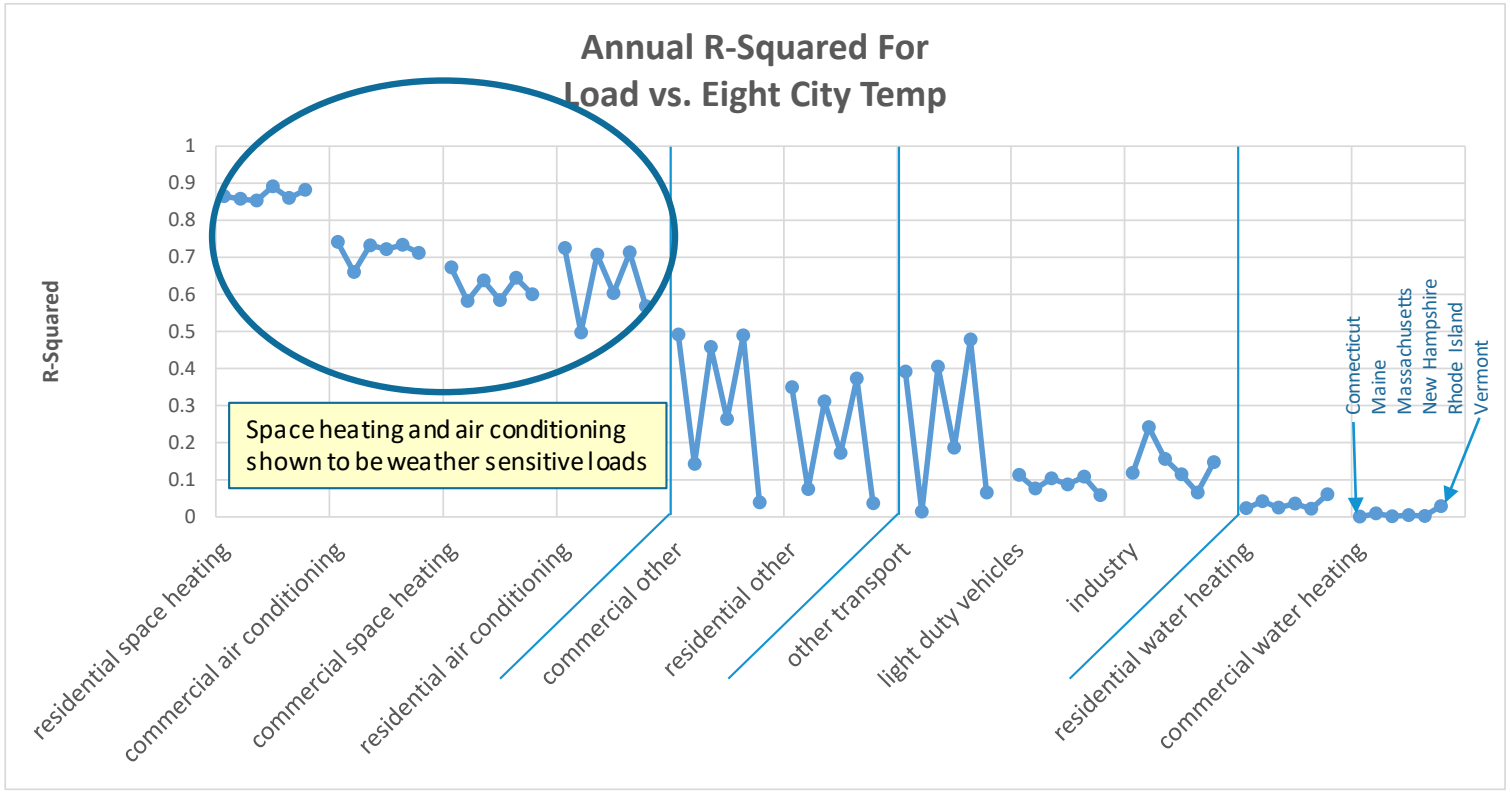
Input Data Recasting Overview

- 2040 EnergyPATHWAYS profiles were proposed as the basis for “Matrix Scenario 3” of the 2021 Economic Study
  - Based on a 2012 weather year
- Data requirements for 2021 Economic Study
  - Ancillary services simulations require one-minute resolution data
  - One-minute data not available for 2012, but is available for 2019
    - Readily available data on the PI data system, ISO’s historical operations database, only goes back three years
  - For consistency, production cost simulations require recasting 2012 hourly profiles into 2019 weather year profiles
- Goal: Recast profiles with minimum distortion

Results of the Recasting Effort

- Observed that some of the profiles are weather sensitive and others are much less sensitive
- For determining weather sensitivity
  - Developed 2nd order polynomial regression equations
  - Energy PATHWAYS profiles vs. New England average temperatures
  - R^2 statistic used to identify weather sensitive profiles
    - Space heating
    - Air conditioning
  - Some profiles had causal temperature sensitivity caused by summer winter level changes
    - Residential other / water heating
    - Industry
    - Transportation

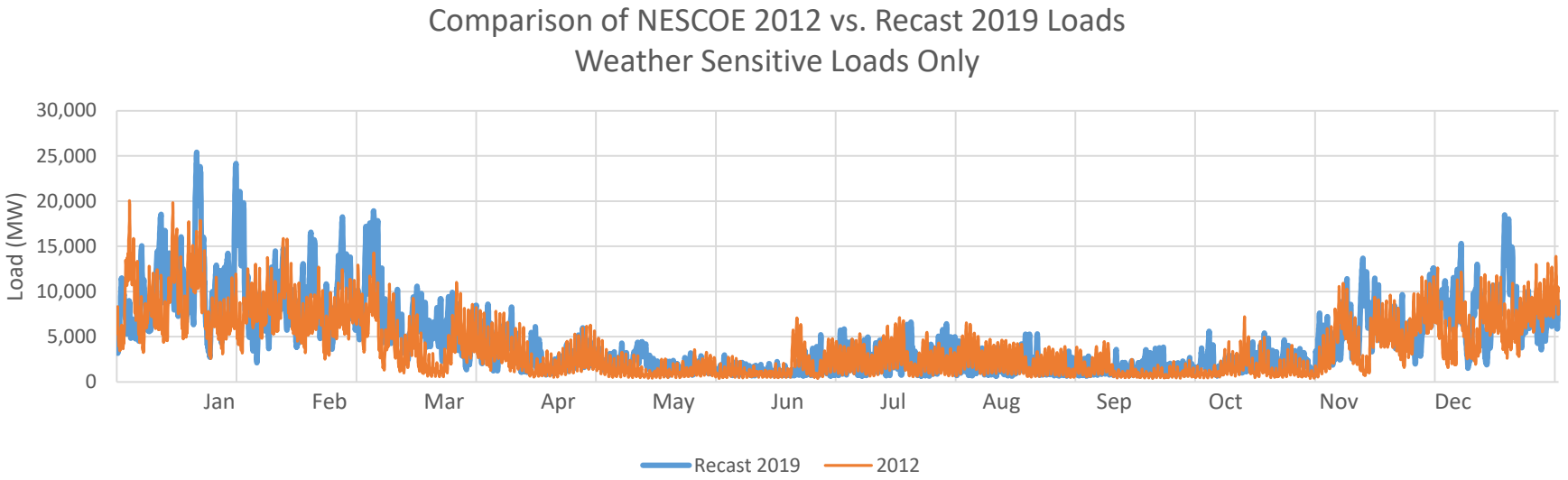
R^2 Used to Identify Temperature Sensitivity



Recasting Process

- Developed temperature functions for heating and cooling
  - Used state temperatures instead of New England Eight City Average
    - Separate weekend / weekday functions
    - Separate on-peak / off-peak functions
  - Air conditioning equation was only applied to temperatures above 55 degrees F
- Non-weather sensitivity loads
  - Used directly
  - Time-shifted to align weekend / weekdays
    - Align 2012 weekends to 2019 calendar weekends
      - Delete 2012's initial Sunday and Monday to start on Tuesday
      - For day 365, add January 1, 2020 weather to represent December 31
    - Time-shifting keeps summer loads and winter loads in correct season

Chronological Loads Suggest Colder Winter Weather



NOTE: Weather sensitive loads only

NEXT STEPS

Next Steps

- Preliminary production cost results for Scenario 1 will be presented today, remaining Scenario 1 runs and other scenarios will be presented in July and August 2021 beginning with Scenario 3
- Preliminary ancillary services analysis results for Scenario 1 are expected in September 2021
- Results for other scenarios are expected in Q3/Q4 2021

Questions

APPENDIX I

Acronyms

Acronyms

ACDR	Active Demand Capacity Resource	EE	Energy Efficiency
ACP	Alternative Compliance Payments	EFORd	Equivalent Forced Outage Rate demand
AGC	Automatic Generator Control	EIA	U.S. Energy Information Administration
BESS	Battery Energy Storage Systems	EPECS	Electric Power Enterprise Control System
BTM PV	Behind the Meter Photovoltaic	EV	Electric Vehicle
BOEM	Bureau of Ocean Energy Management	FCA	Forward Capacity Auction
CCP	Capacity Commitment Period	FCM	Forward Capacity Market
CELT	Capacity, Energy, Load, and Transmission Report	FGRS	Future Grid Reliability Study
CSO	Capacity Supply Obligation	FOM	Fixed Operation and Maintenance Costs
Cstr.	Constrained	HDR	Hydro Daily, Run of River
DER	Distributed Energy Resource	HDP	Hydro Daily, Pondage
DR	Demand-Response	HQ	Hydro-Québec

Acronyms, cont.

HY	Hydro Weekly Cycle	OSW	Offshore Wind
LBW	Land Based Wind	O&M	Operation and Maintenance
LFG	Landfill Gas	PHII	Phase II line between Radisson and Sandy Pond
LFR	Load Following Reserve	PV	Photovoltaic
LMP	Locational Marginal Price	RECs	Renewable Energy Credits
LSE	Load-Serving Entity	RFP	Request for Proposals
MSW	Municipal Solid Waste	RGGI	Regional Greenhouse Gas Initiative
NECEC	New England Clean Energy Connect	RPS	Renewables Portfolio Standards
NESCOE	New England States Committee on Electricity	SCC	Seasonal Claimed Capability
NG	Natural Gas	Uncstr.	Unconstrained
NICR	Net Installed Capacity Requirement	VER	Variable Energy Resource
NREL	National Renewable Energy Laboratory		