



Eastern Interconnection Planning Collaborative

Gas-Electric System Interface Study

Target 2

Capability of the Natural Gas Systems to Satisfy the Needs of the Electric Systems

February 12, 2015

(Version 2 with corrections Feb 18, 2015)

LEVITAN & ASSOCIATES, INC.
MARKET DESIGN, ECONOMICS AND POWER SYSTEMS

Acknowledgement and Disclaimer

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Acknowledgement:

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Agenda

- ◆ Introduction
- ◆ Research goals
- ◆ Method
- ◆ Highlights
 - Study Region
 - Individual PPAs
- ◆ Milestone Schedule

Target 2 Primary Research Objective

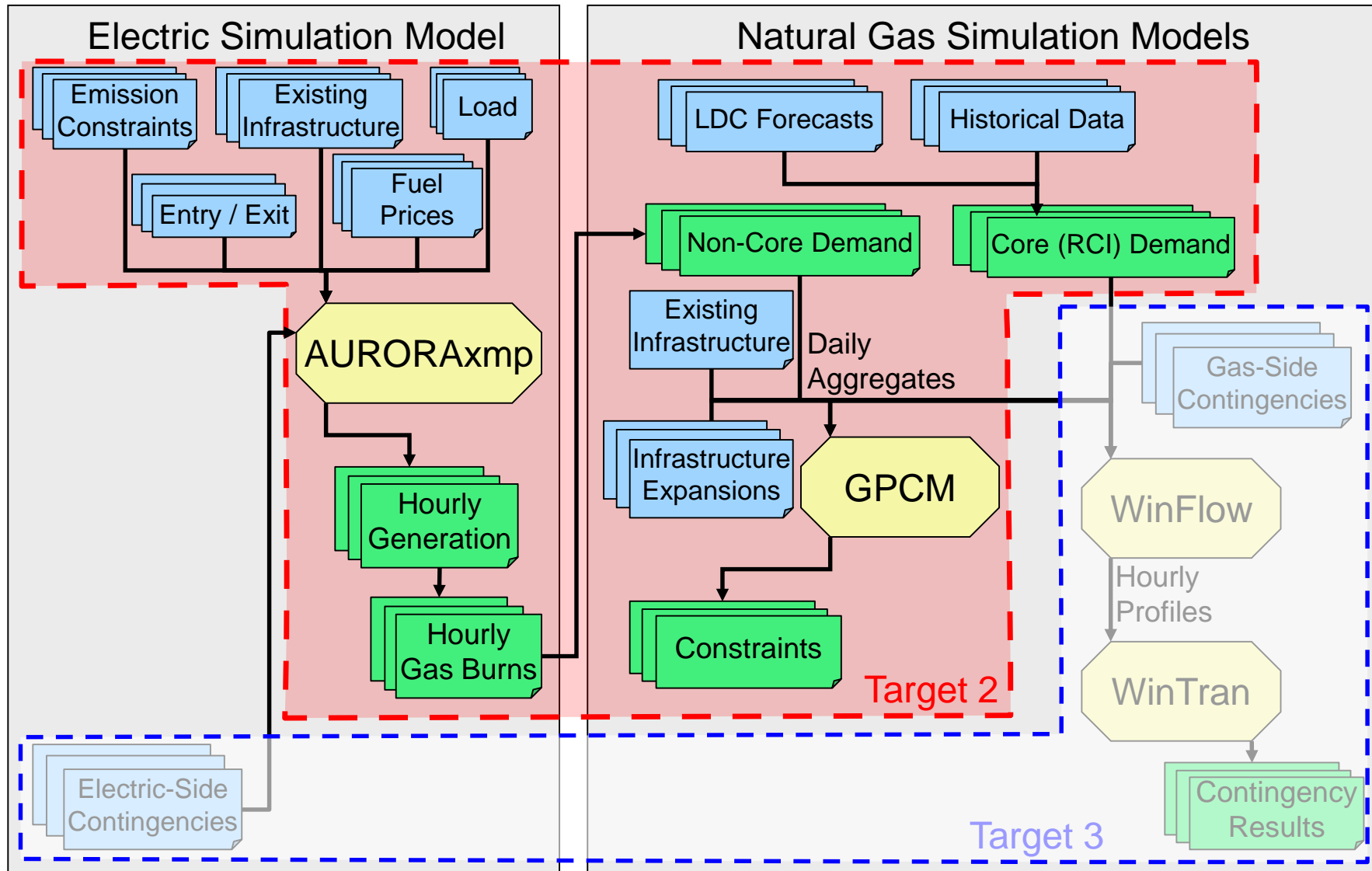
- ◆ Evaluate the adequacy of the interstate and interprovincial natural gas pipeline network to meet the coincident peak demands of LDCs serving residential, commercial and industrial (RCI) customers, as well as gas-capable electric generators across the Study Region

Target 2 Approach

- ◆ Derive hourly gas demands of electric generation
- ◆ Combine electric generator and RCI gas demands
- ◆ Quantify unserved gas demand for the peak hour on the summer and winter peak days, 2018 and 2023
- ◆ Identify gas transportation constraints affecting generation during the peak hour under the assumptions of the three Scenarios and numerous Case Sensitivities
- ◆ Analyze the frequency and duration (F-D) of the transportation constraints affecting gas-fired generators
- ◆ Identify potential mitigation measures

Target 2 Model Components

Target 2 Results



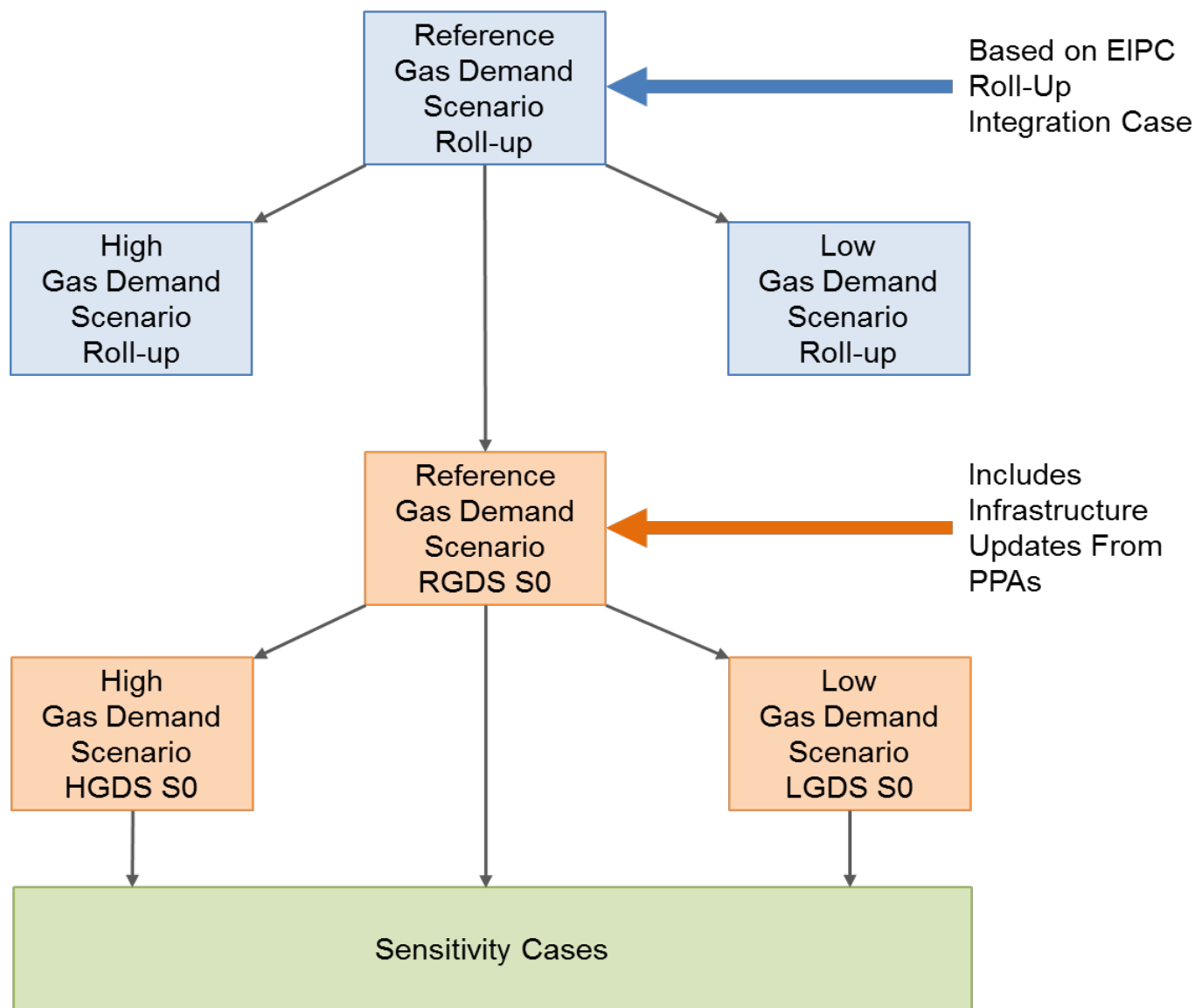
Terminology

- ◆ RGDS or R – Reference Gas Demand Scenario
- ◆ HGDS or H – High Gas Demand Scenario
- ◆ LGDS or L – Low Gas Demand Scenario
- ◆ Roll-Up – Model based on G&T resources incorporated within the Roll-Up Integration Cases prepared by the EIPC Steady State Modeling and Load Flow Working Group
- ◆ S0 – “Sensitivity 0” incorporates updates to Roll-Up based on existing and planned system resources known by early 2014
- ◆ S1 through S37 – Sensitivity Cases
- ◆ S1 – Peak winter day spot market gas prices
- ◆ Affected Generation – Generation served by constrained pipeline segments

Sensitivity Cases

- ◆ Sensitivity Cases tested alternative forecasts or assumptions for a selected scenario, *e.g.*
 - Fuel prices (includes Polar Vortex pricing)
 - Electric loads
 - Retirements
 - New G&T resources
 - LNG imports/exports
- ◆ Based on input from both the PPAs and SSC
- ◆ 23 different sensitivities run under multiple years and seasons
 - Not all sensitivities run for all years and seasons
- ◆ Results presented for groups of similar sensitivities

Scenarios and Sensitivities

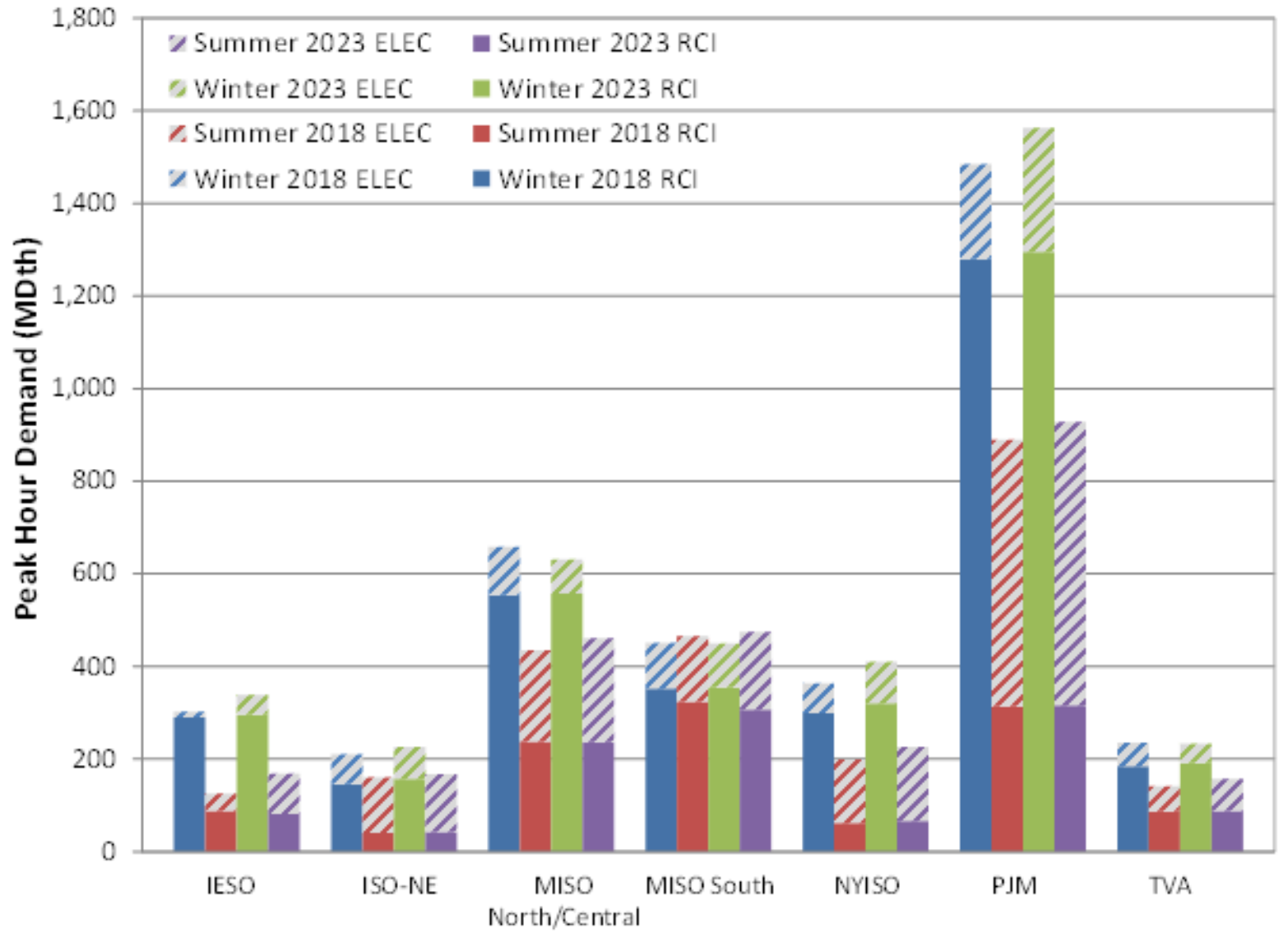


Structure of the Target 2 Report

- ◆ Report
 - Model description and assumptions
 - Results of the 3 Scenarios and array of Sensitivities
 - Mitigation measures to alleviate transportation constraints
- ◆ Exhibits
 - Input data tables
 - Peak hour gas demand results
 - Pipeline utilization maps
- ◆ Appendices
 - Frequency and duration results
 - Gas infrastructure expansion projects
 - Model documentation

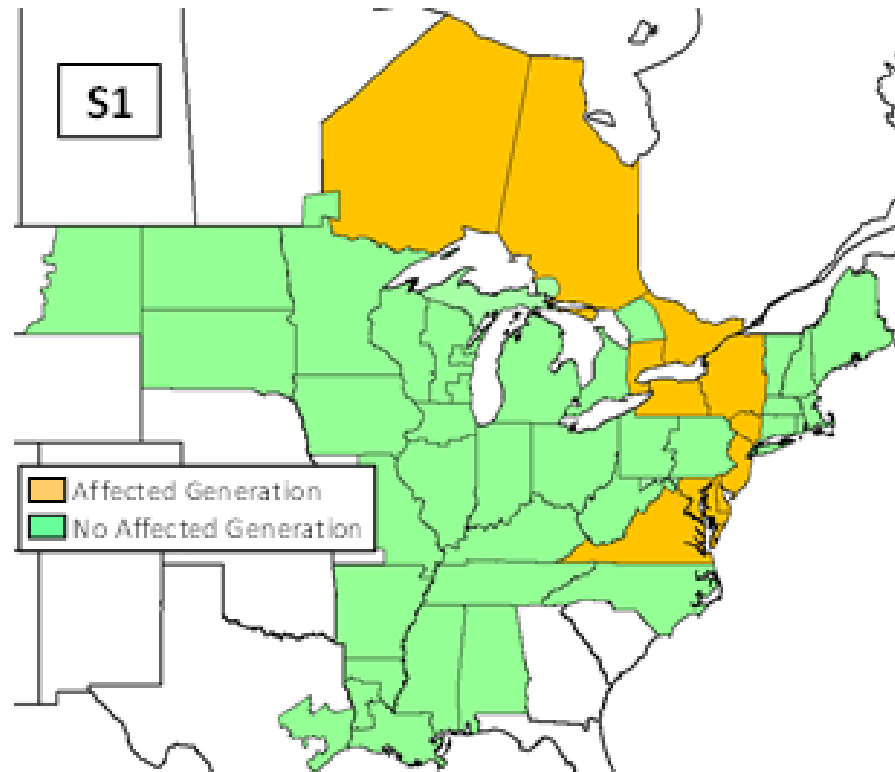
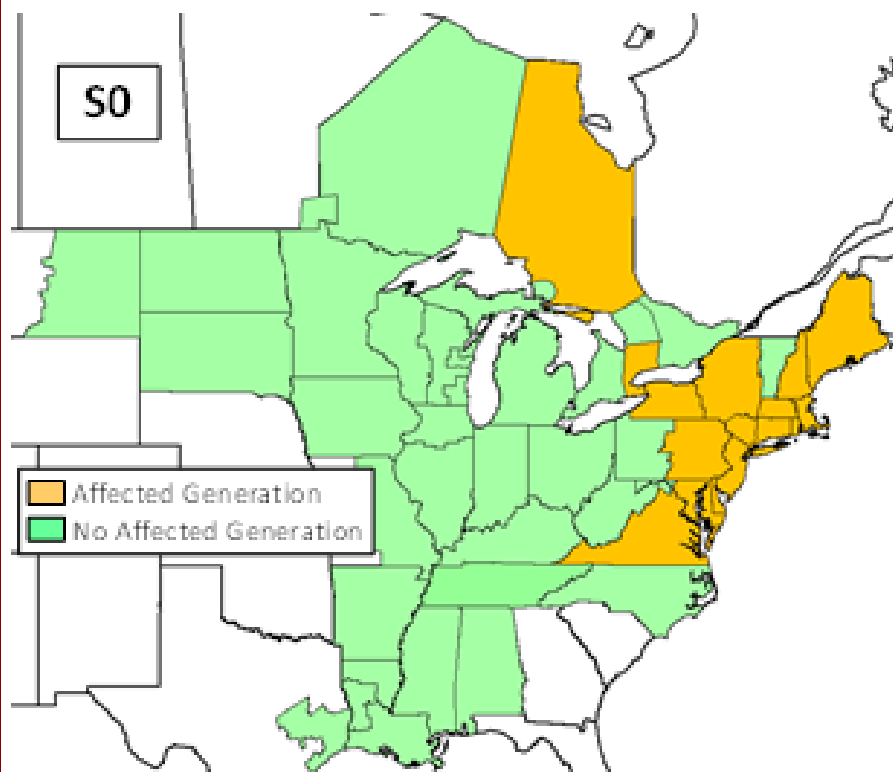
Target 2 Highlights

RGDS S0 Peak Hour Gas Demands

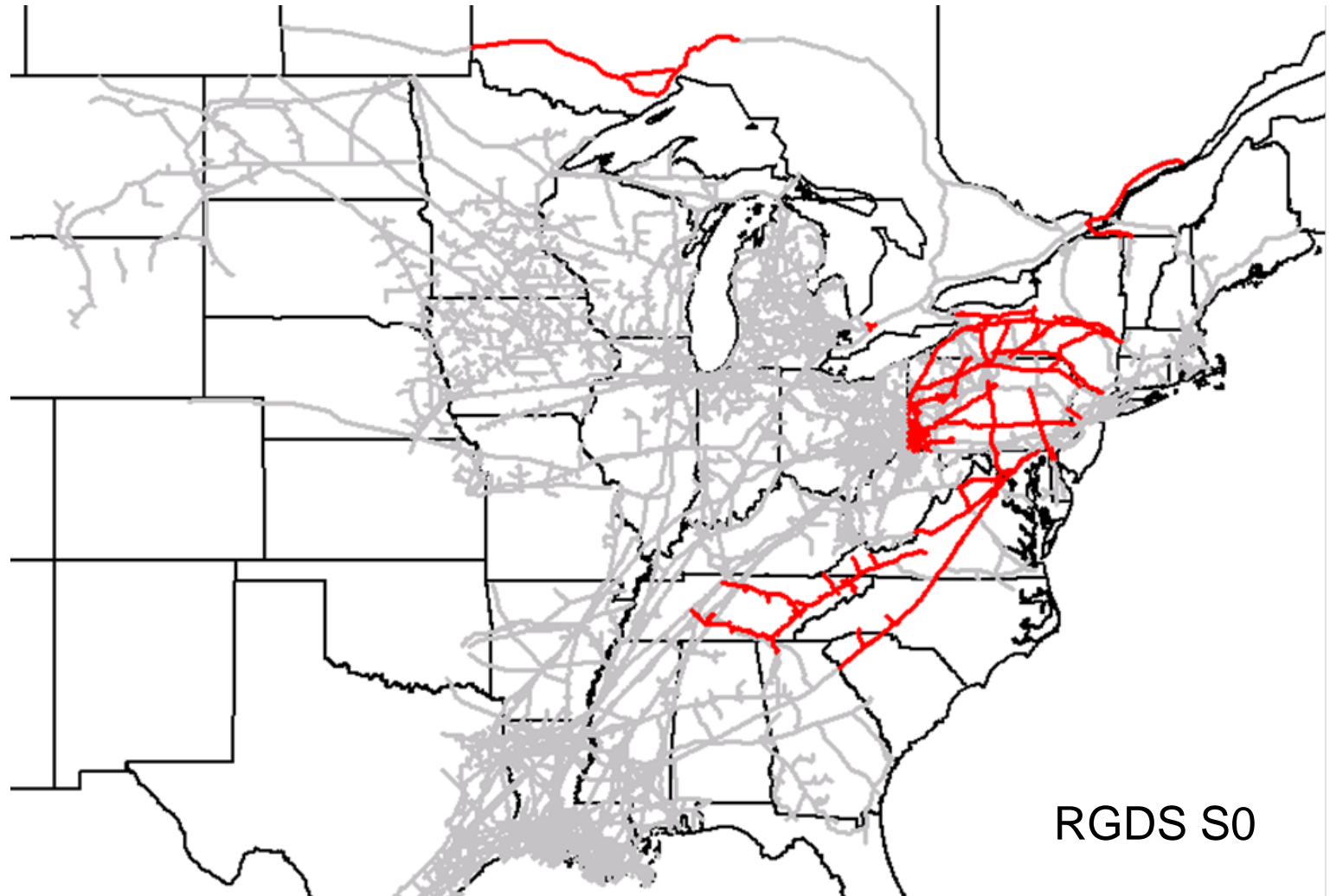


RGDS S1 v. S0 Affected Generation, Winter 2018

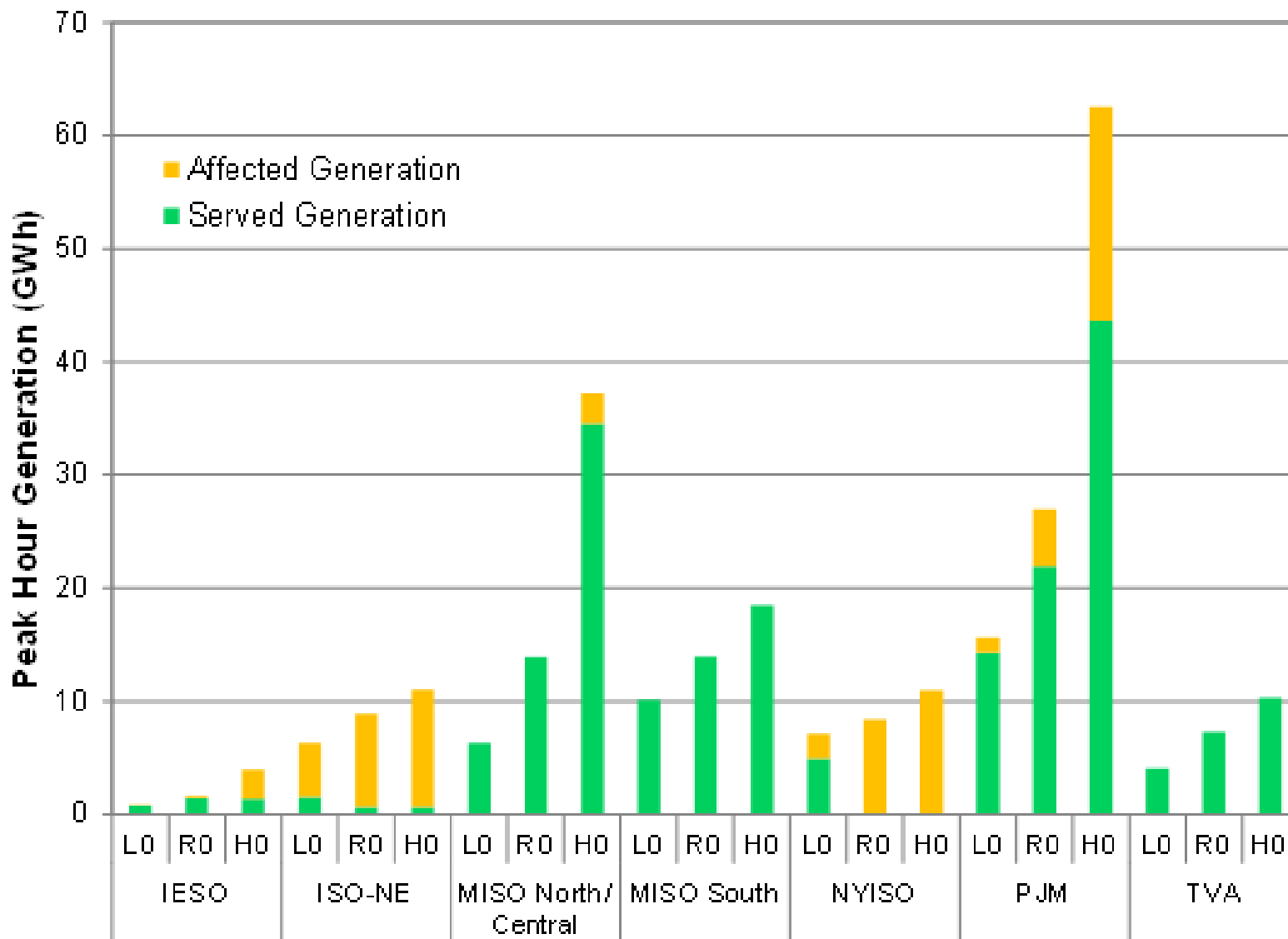
Target 2 Results



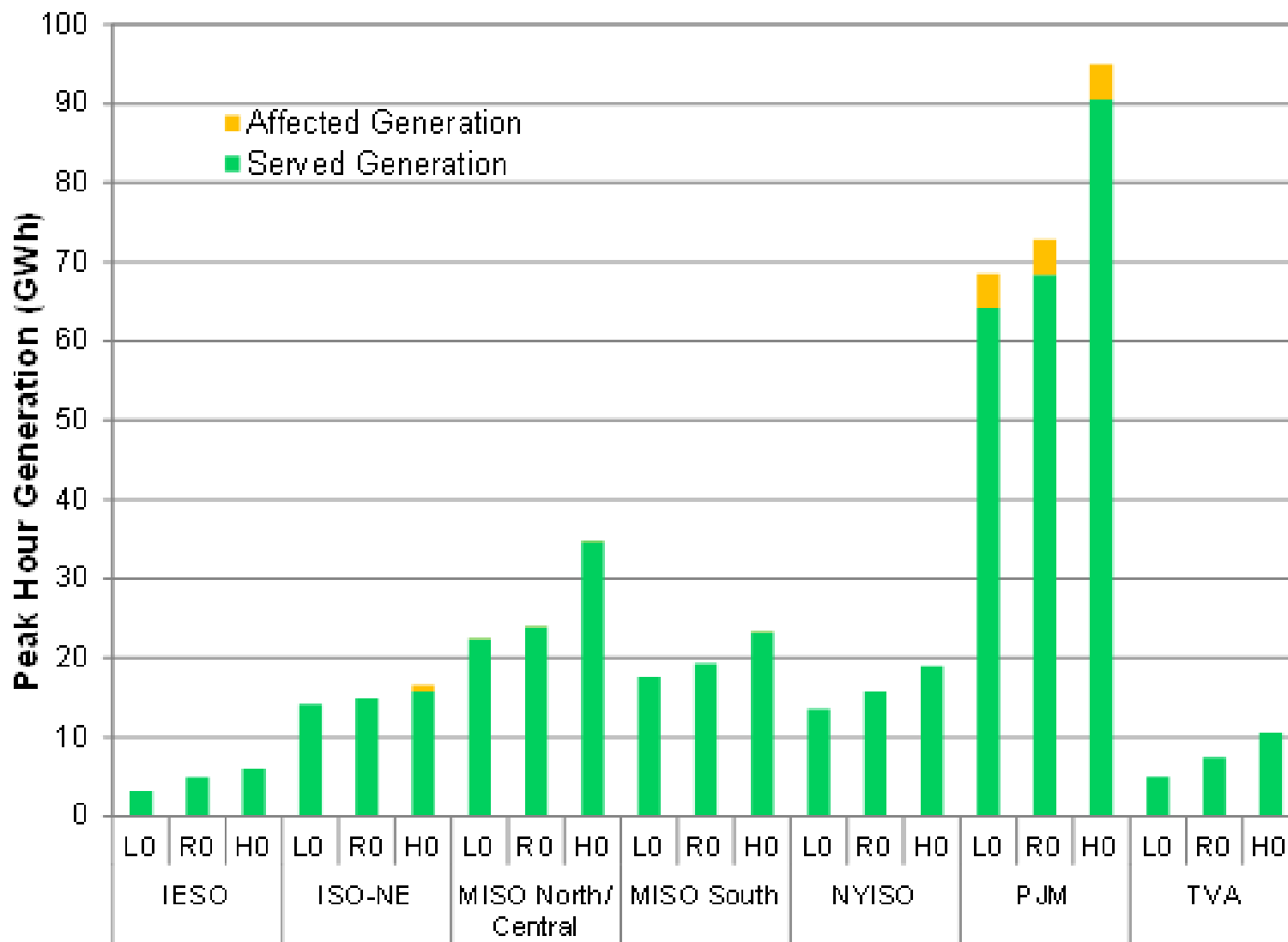
Peak Hour Winter 2018 Pipeline Constraints



Affected Generation by Scenario, Winter 2018



Affected Generation by Scenario, Summer 2018



Constrained Pipeline Segments

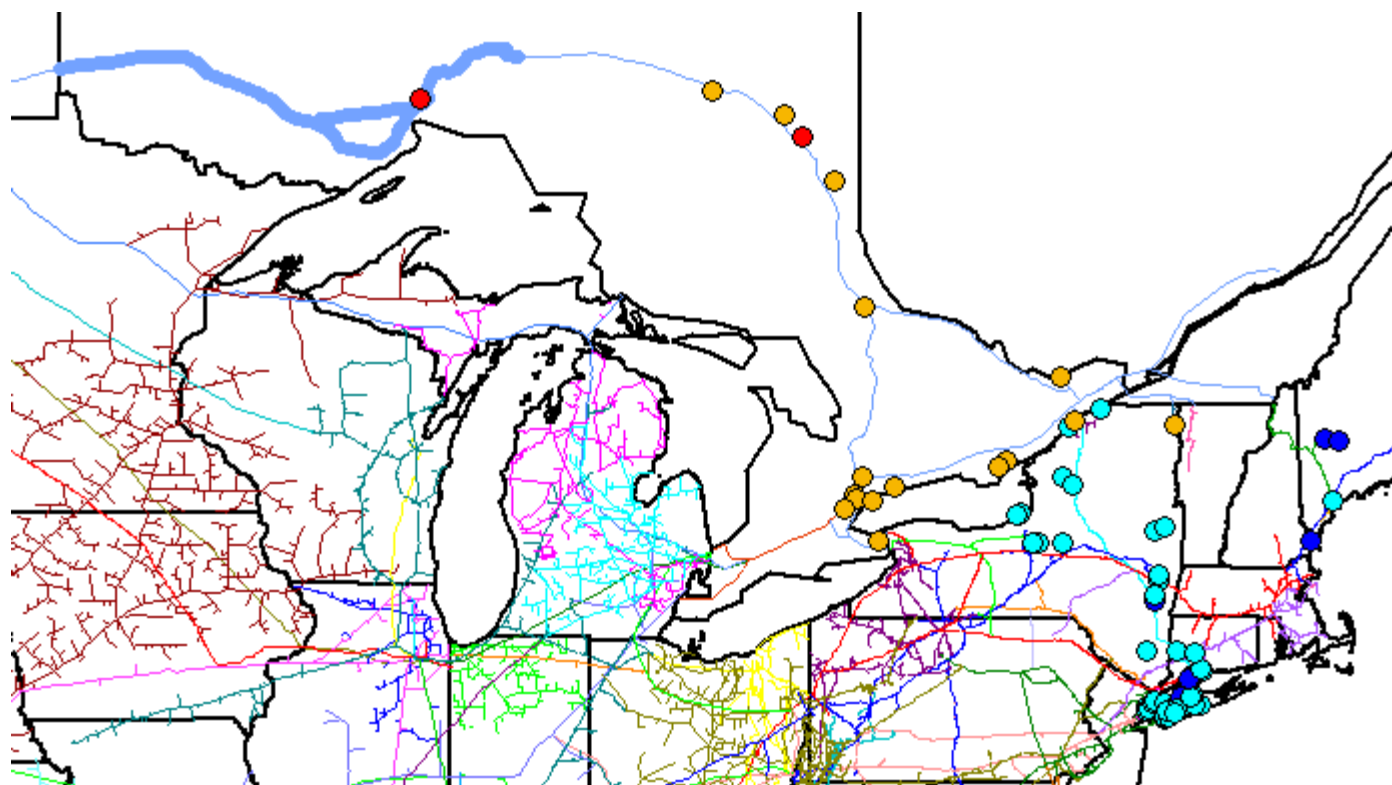
Constrained Segment	RGDS S0 Winter 2018				RGDS S0 Summer 2018				HGDS S0 2018		Characterization		
	Events	Min Duration (Days)	Max Duration (Days)	Total Days	Events	Min Duration (Days)	Max Duration (Days)	Total Days	Winter Days	Summer Days	Persistence	Severity	Depth
Columbia Gas VA/MD	12	1	5	23	1	1	1	1	57	21	Mod	Mod	Mod
Columbia Gas W PA/NY	11	1	5	21					17		Mod	High	Low
Constitution	5	1	12	25					90		Mod	Mod	High
Dominion Eastern NY	6	1	6	15					21		Mod	High	Low
Dominion Western NY	1	4	4	4					34		Low	High	Low
Dominion Southeast	7	1	12	22	3	1	2	5	22	37	Mod	High	Mod
East Tennessee Mainline	7	1	2	9					26		Low	Low	High
Eastern Shore	11	1	10	51	7	1	6	19	20	45	High	High	Mod
Empire Mainline	5	1	12	21					60		Mod	High	Low
Millennium	4	1	59	83					27		High	High	Mod
NB/NS Supply	13	1	20	58					56	28	High	High	Mod
TransCanada Ontario West	5	1	5	12					8		Mod	High	Low
TransCanada Quebec	9	1	14	30					29		Mod	High	Mod
Tennessee Z4 PA	10	1	7	30					76		High	High	Mod
Tennessee Z5 NY	2	31	59	90					90		High	High	High
Transco Leidy Atlantic	8	2	23	59					90		High	High	Mod
Transco Z5	3	1	7	9	7	2	6	18	21	16	Low	High	Low
Transco Z6 Leidy to 210	5	1	3	8					90		Low	Low	Mod
Texas Eastern ETX					4	1	6	12		24	Mod	High	Mod
Texas Eastern M2 PA South	10	1	15	50					90		High	High	Mod
Texas Eastern M3 North	10	2	7	39					82		High	High	Mod
Union Gas Dawn	2	1	3	4					6		Low	High	High

IESO

IESO – PPA Highlights

- ◆ Gas infrastructure is adequate
- ◆ Affected generation is negligible in winter 2018
- ◆ Small increase in affected generation in winter 2023
- ◆ Winter pipeline constraints located on TransCanada's Western Delivery Area and on Union Gas at the Dawn storage hub

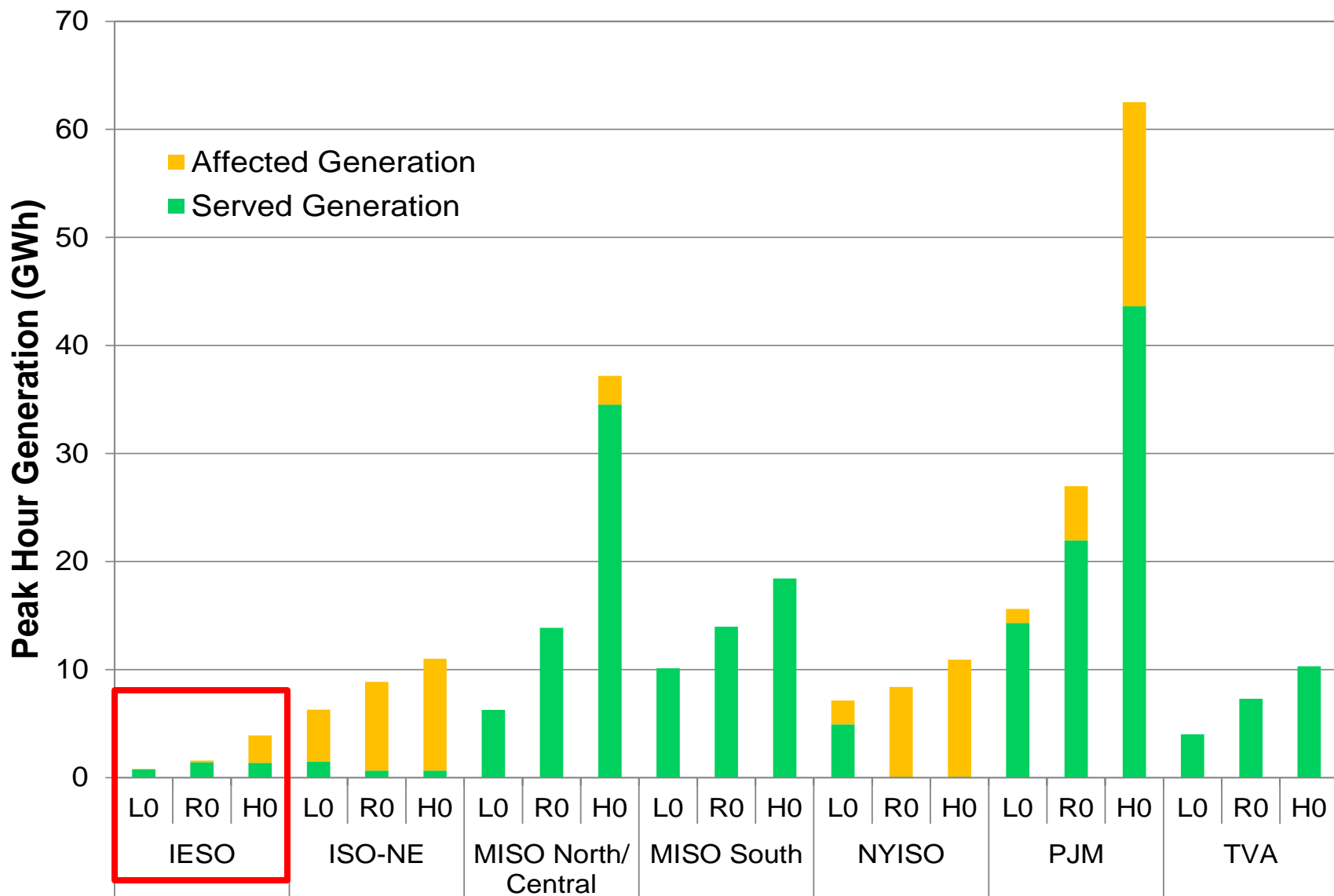
Generators Affected by TransCanada Western Ontario Constraint



- TransCanada Ontario West
- Direct-Connect Generator
- LDC-Served Generator
- Downstream Pipeline-Served Generator
- Downstream Pipeline → LDC-Served Generator

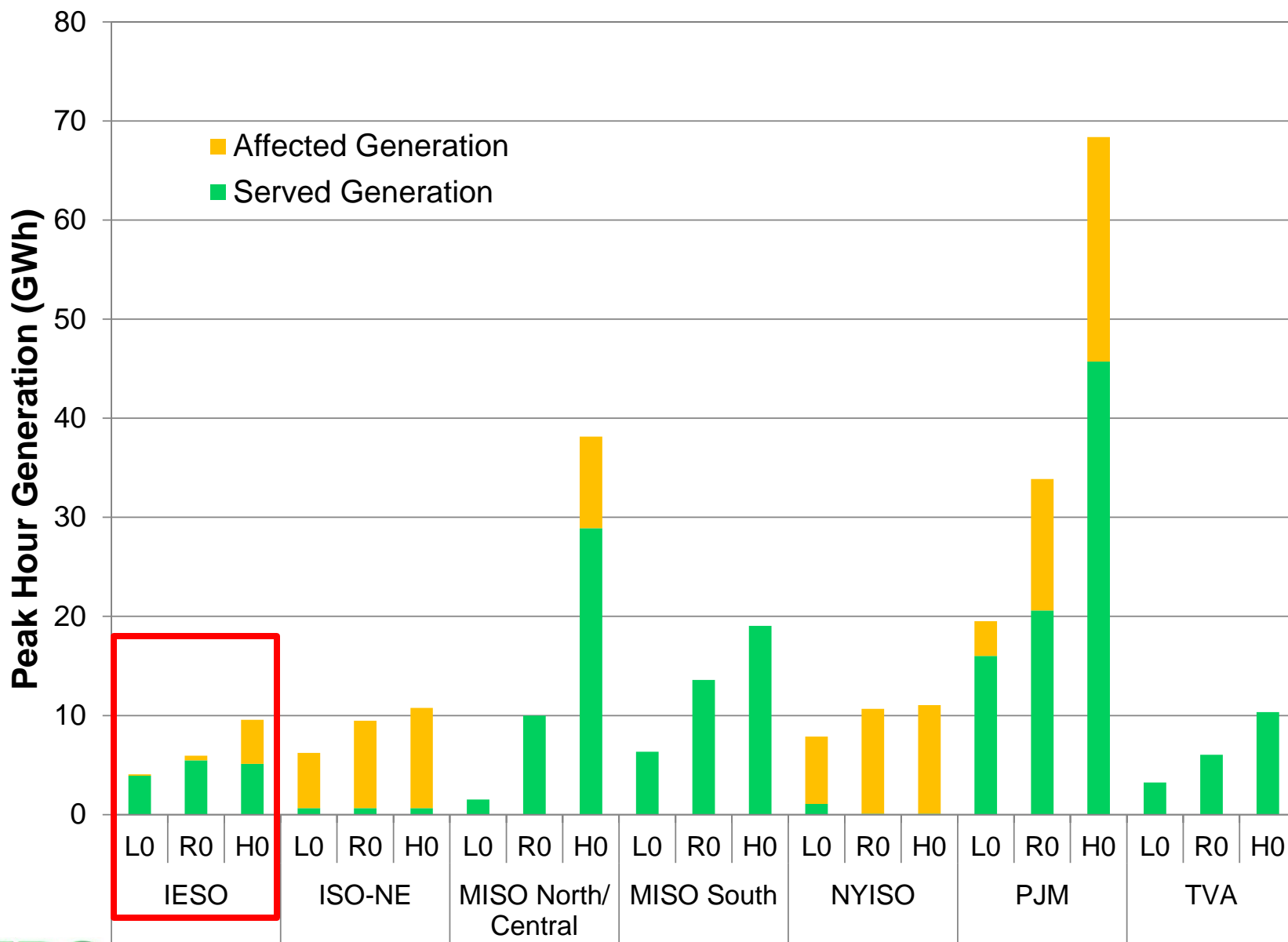
RGDS Winter 2018

Affected Generation in Winter 2018



Affected Generation in Winter 2023

Target 2 Results



ISO-NE

ISO-NE – PPA Highlights

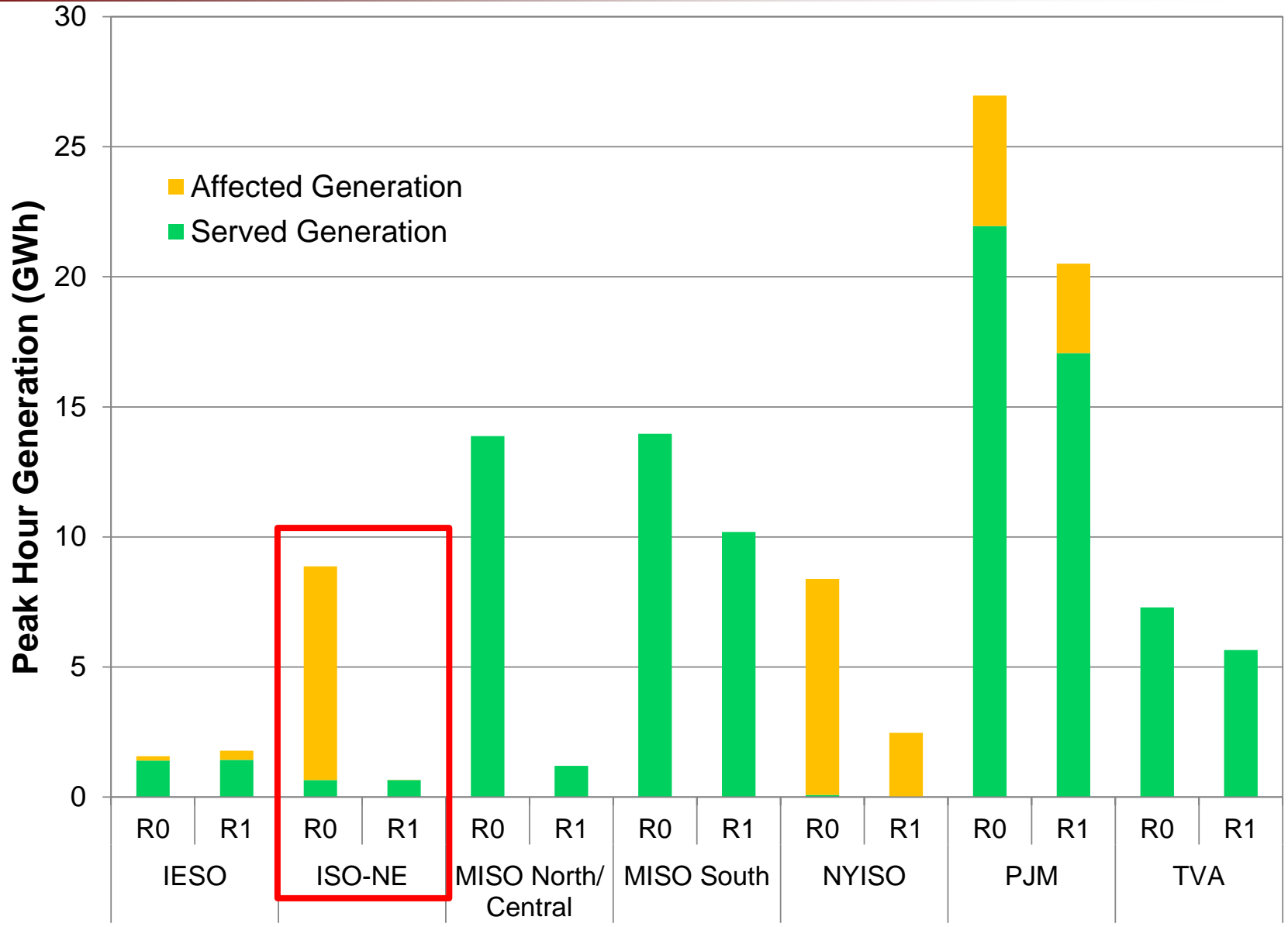
- ◆ Gas infrastructure is constrained during the winter under nearly all tested market conditions and resource mixes
- ◆ Deliverability shortfall due to material decline in region's portfolio diversity:
 - Upstream bottlenecks into New England from Marcellus
 - Continued decline of imports from Western and Atlantic Canada
 - Anticipated underutilization of LNG import facilities

ISO-NE – PPA Highlights (cont'd)

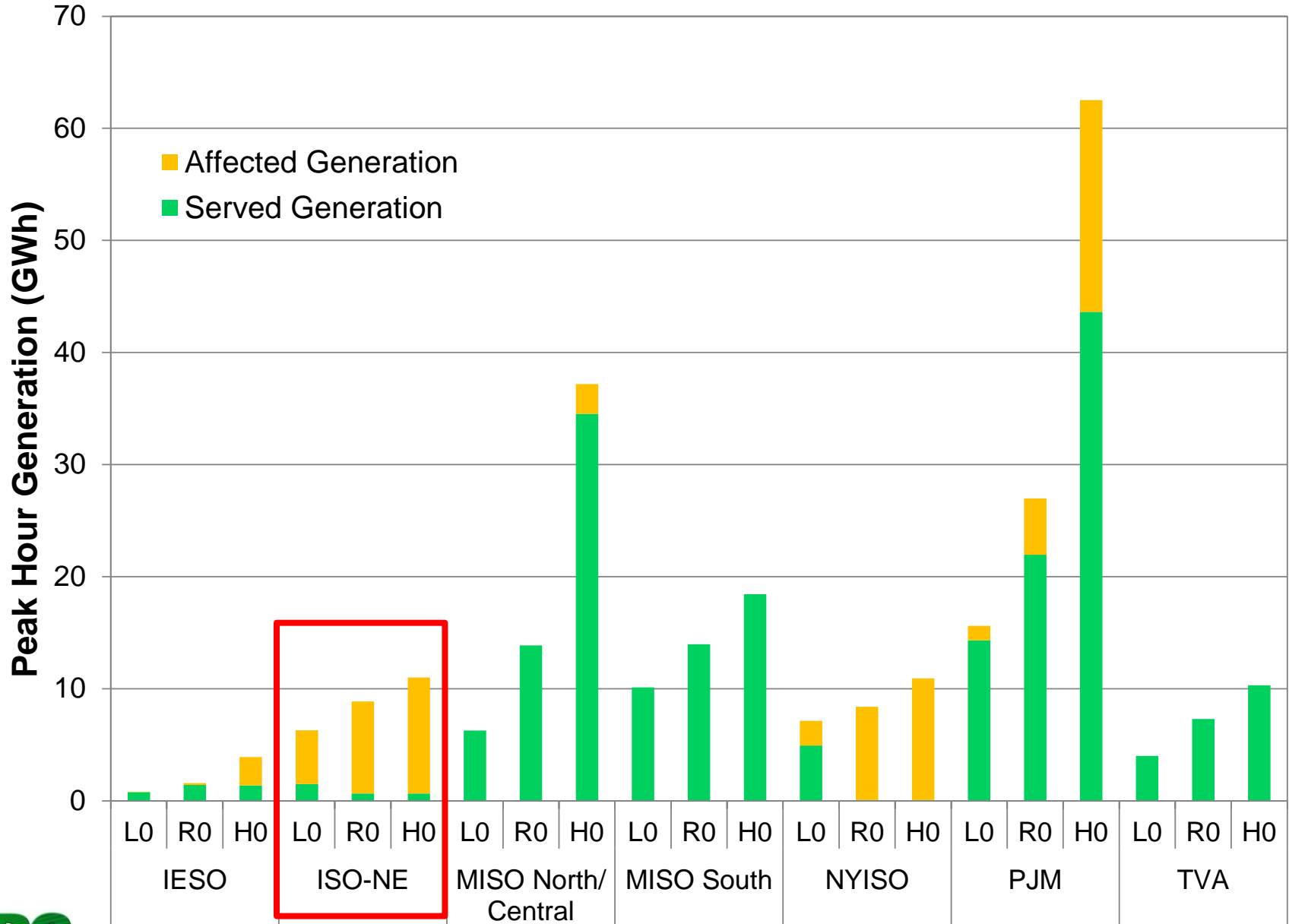
- ◆ Affected generation is mitigated fully in 2018 and 2023 in sensitivity S1 with high daily spot prices on cold days
- ◆ Increased imports at Canaport and Distrigas LNG terminals materially decrease affected generation
- ◆ Summer 2023 constraints materialize (low impact)

RGDS S1 (R1) v. RGDS S0 (R0), Winter 2018

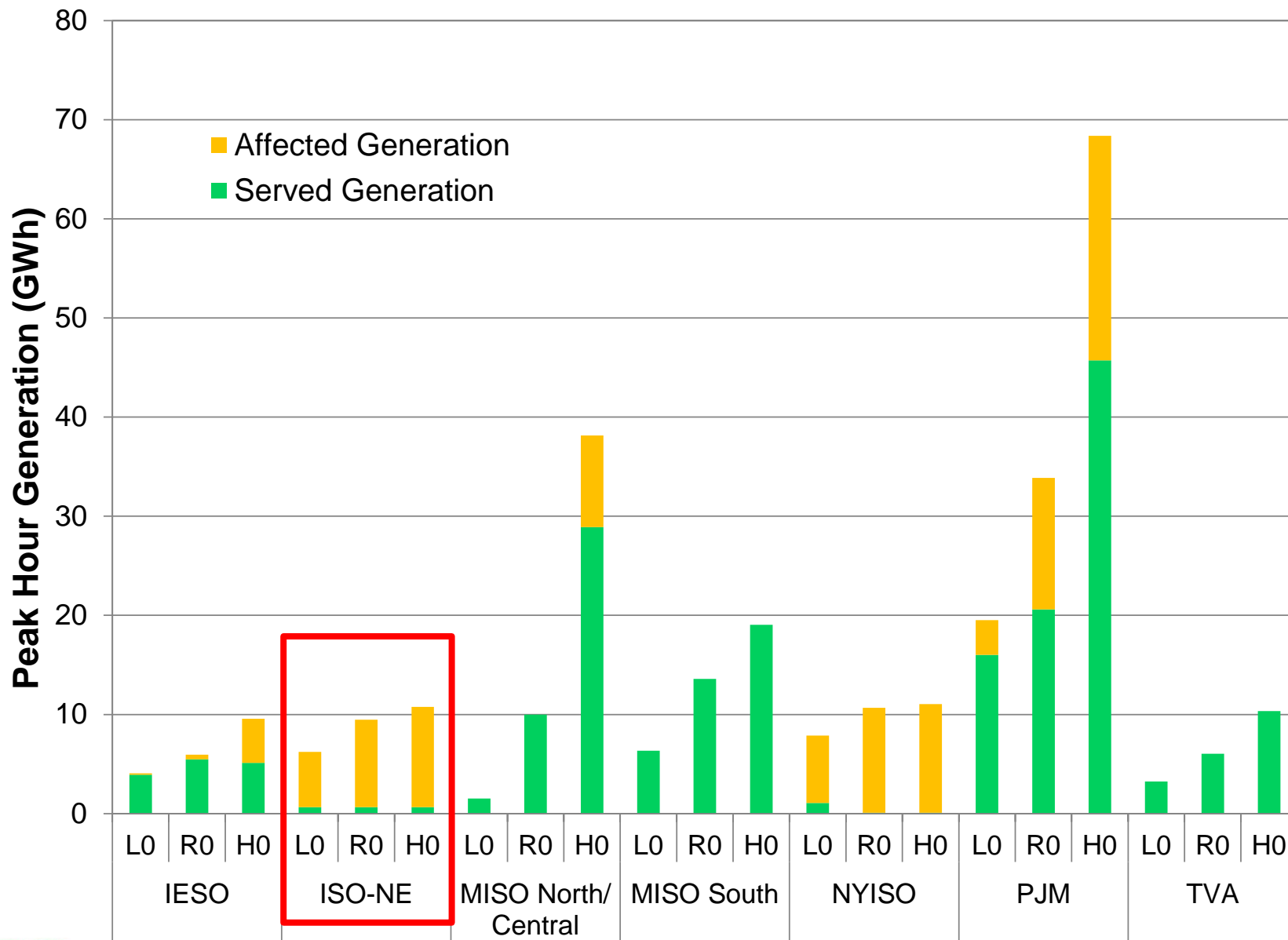
Target 2 Results



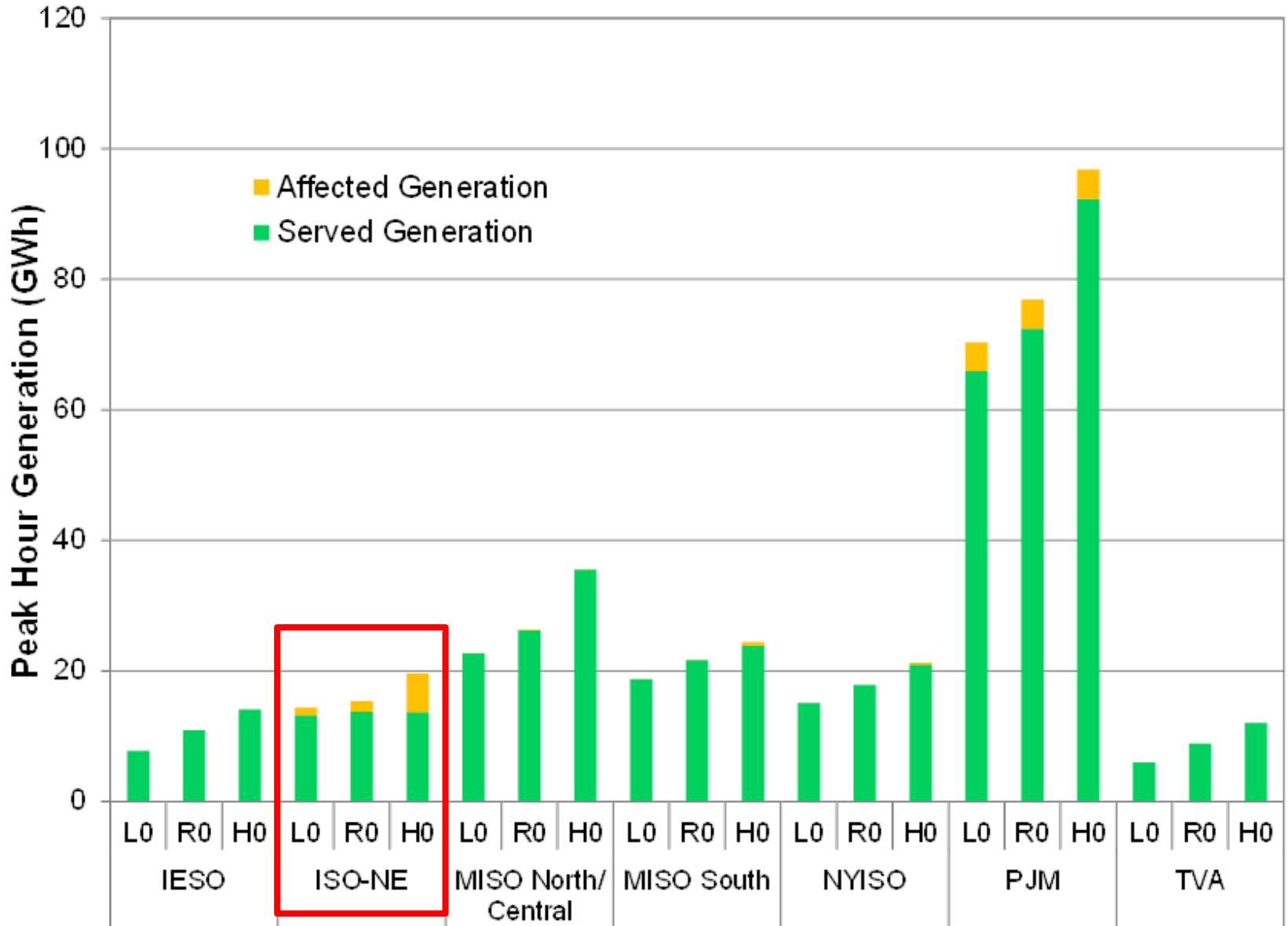
Affected Generation in Winter 2018



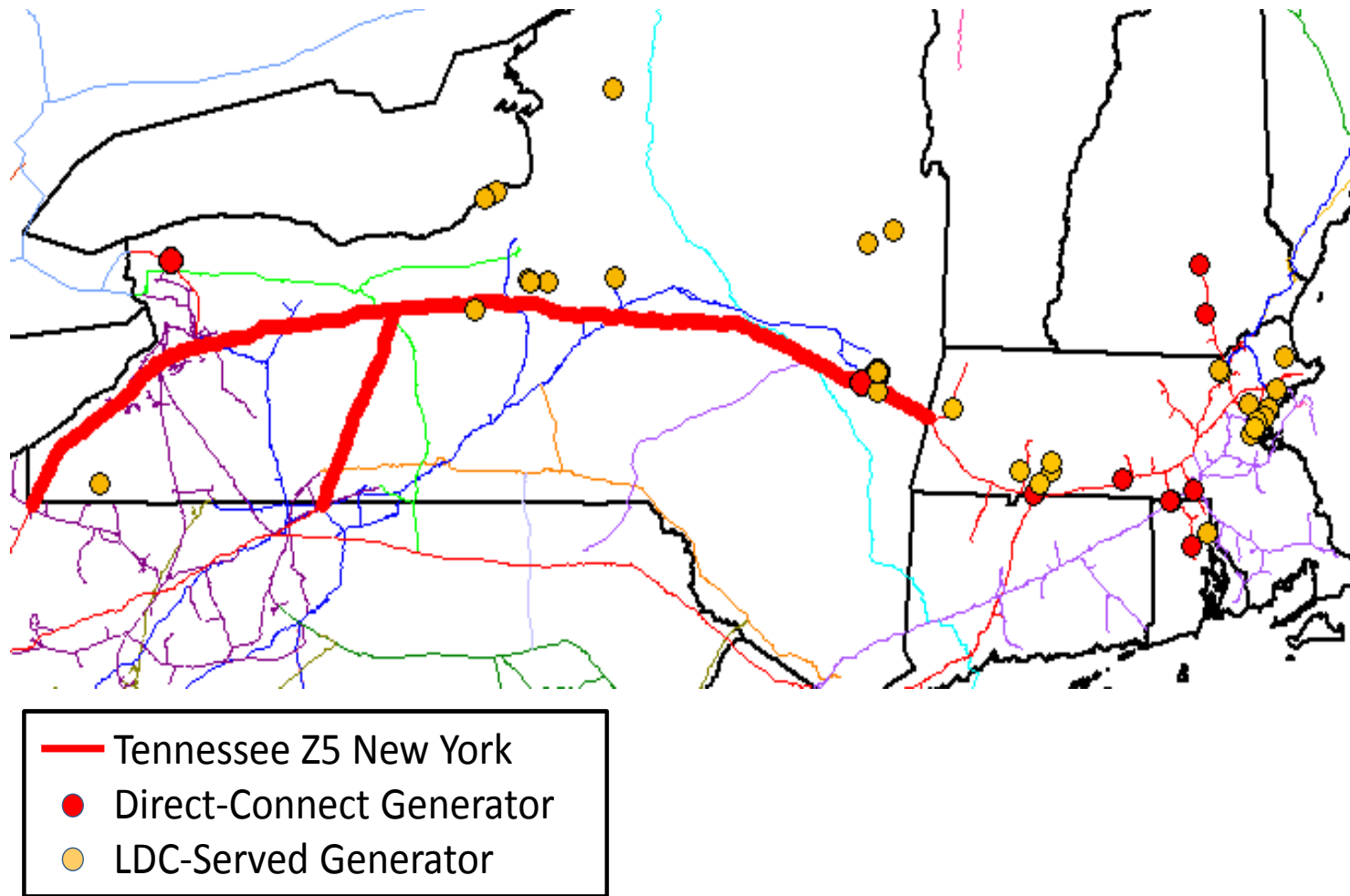
Affected Generation in Winter 2023



Affected Generation in Summer 2023



Generators Affected by Tennessee Z5 NY Constraint



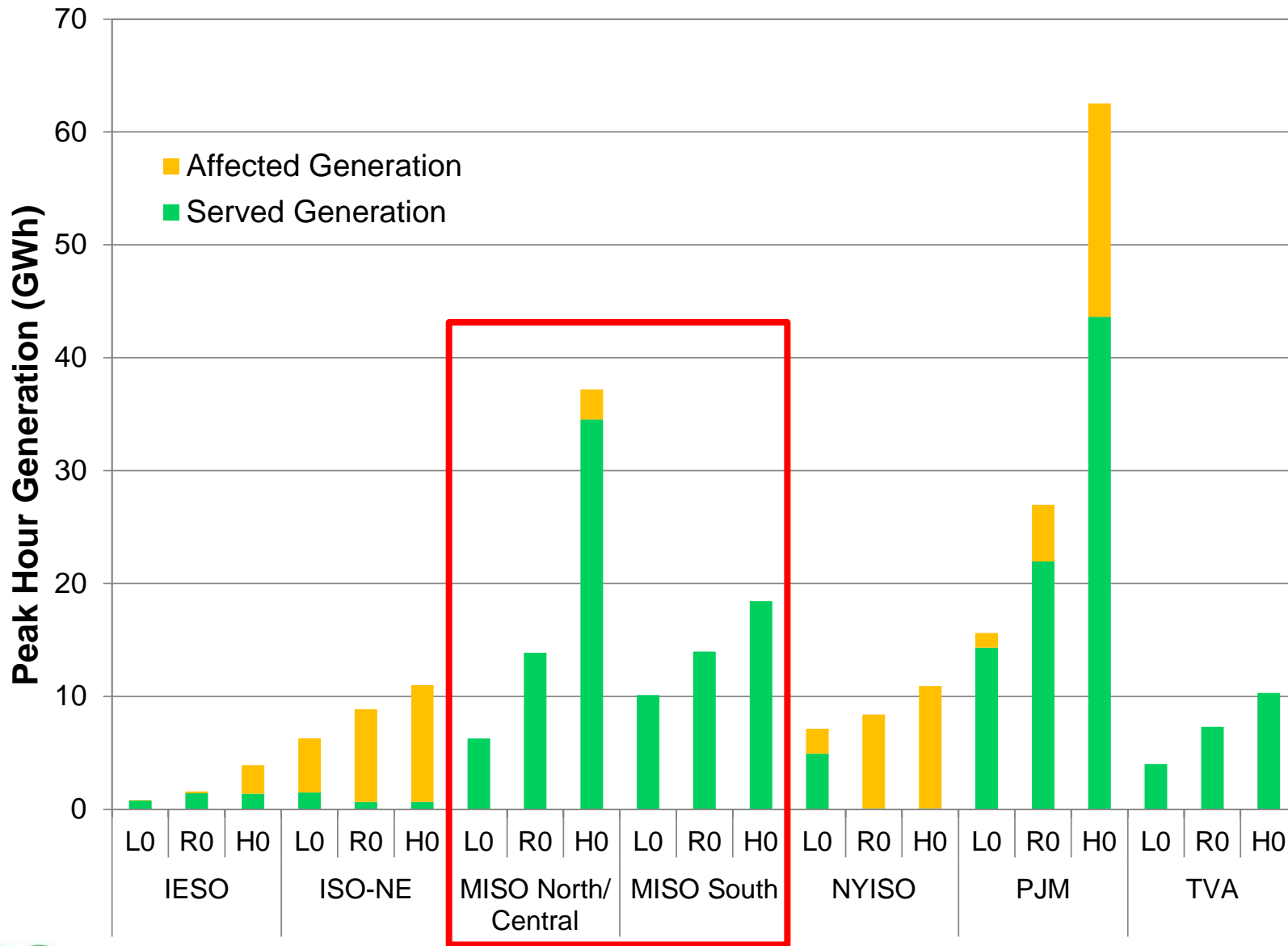
RGDS Winter 2018

MISO

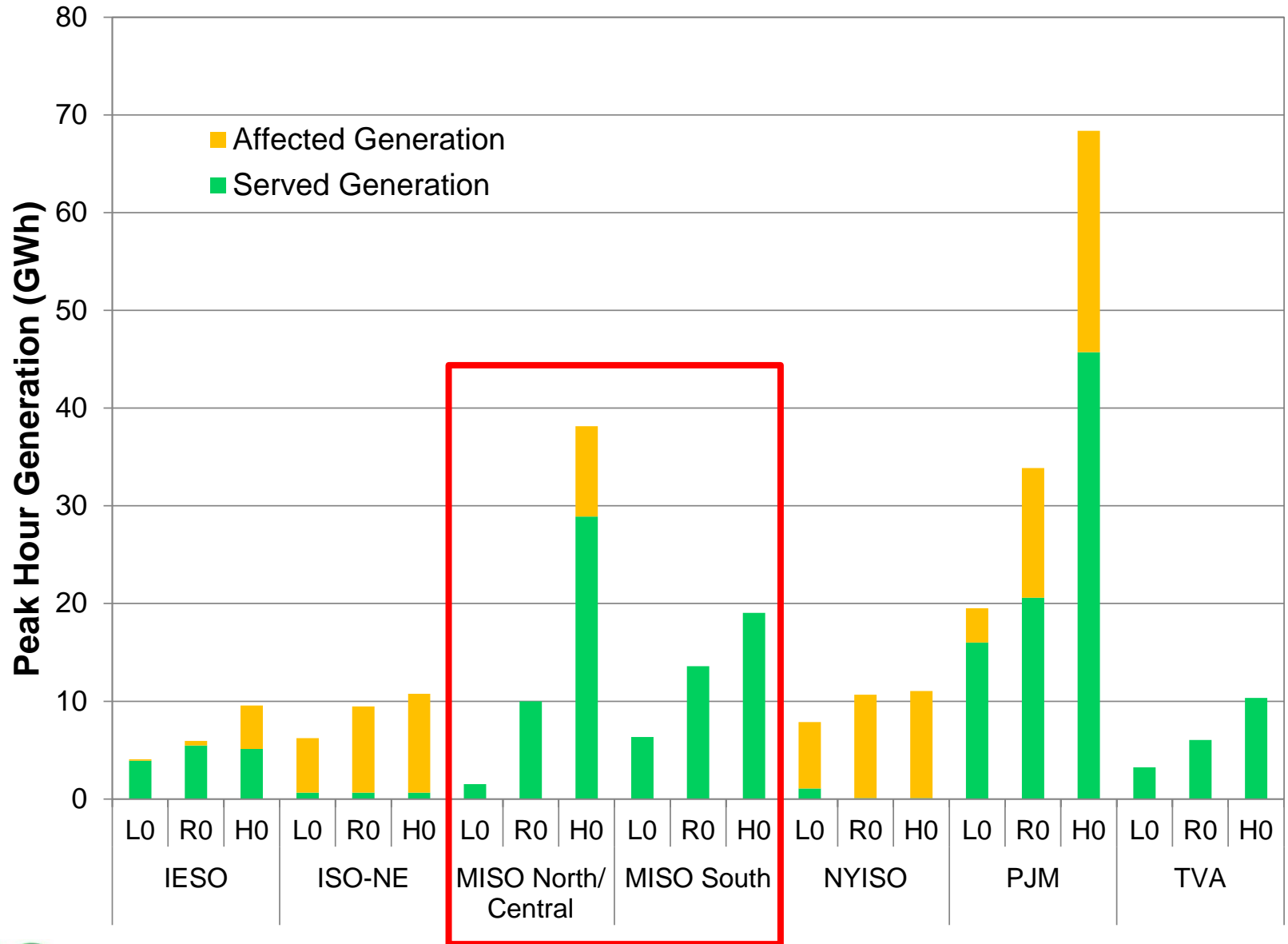
MISO – PPA Highlights

- ◆ Extensive pipeline and storage deliverability result in gas infrastructure adequacy under almost all market conditions and resource mixes
- ◆ Small transportation deficit in North/Central in winter 2018 and 2023 when additional attrition of coal-fired capacity is replaced by gas-fired capacity (HGDS)
- ◆ Anticipated commercialization of LNG export facilities in Gulf of Mexico does not increase F-D of transport constraints

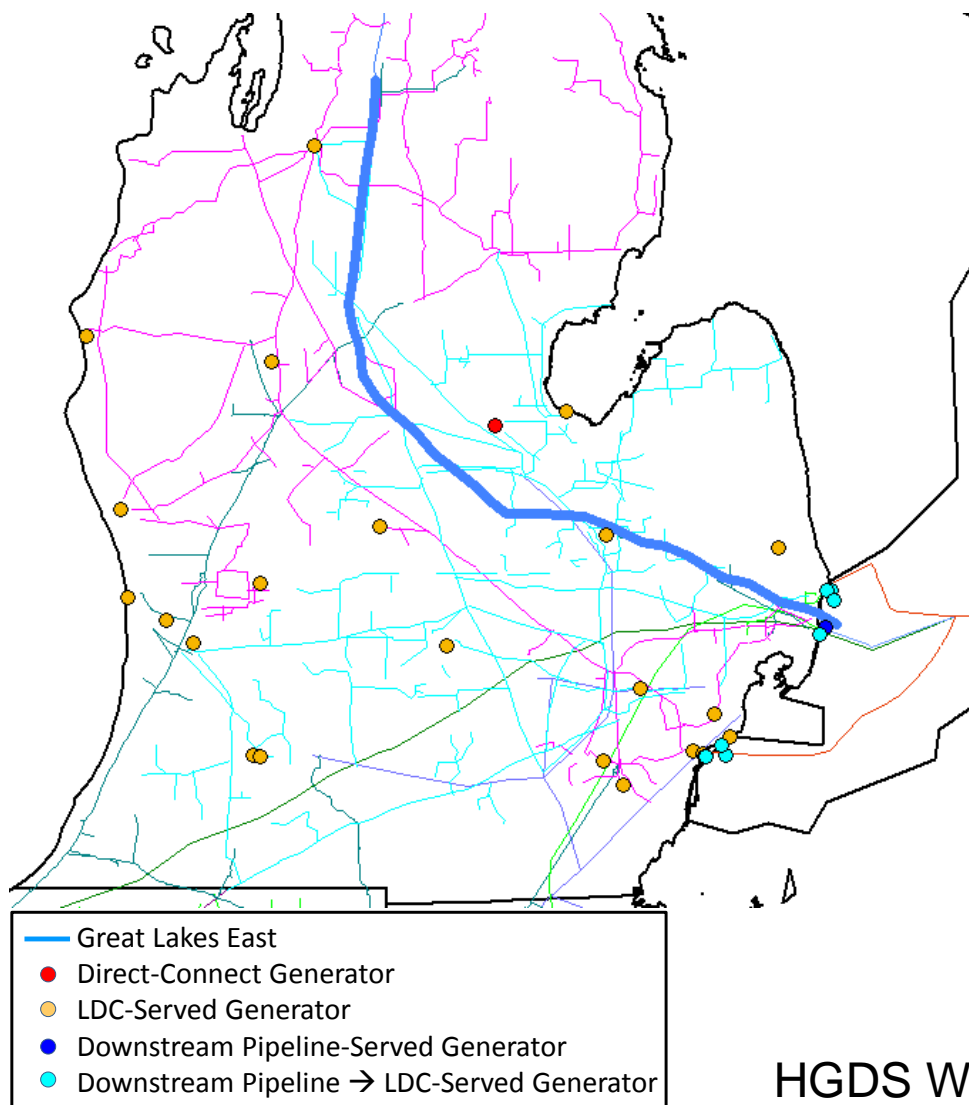
Affected Generation in Winter 2018



Affected Generation in Winter 2023



Generators Affected by Great Lakes East Constraint



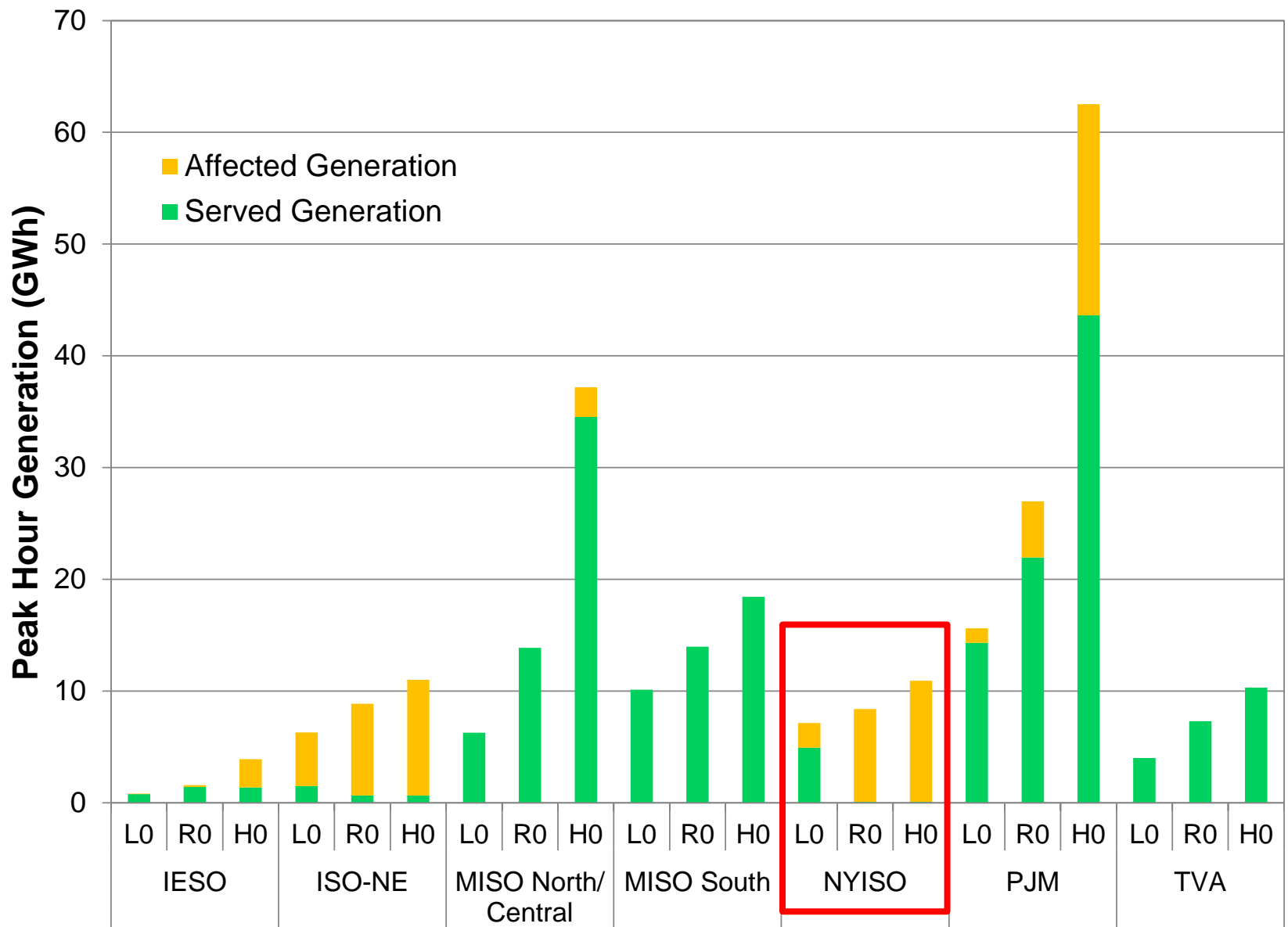
HGDS Winter 2018

NYISO

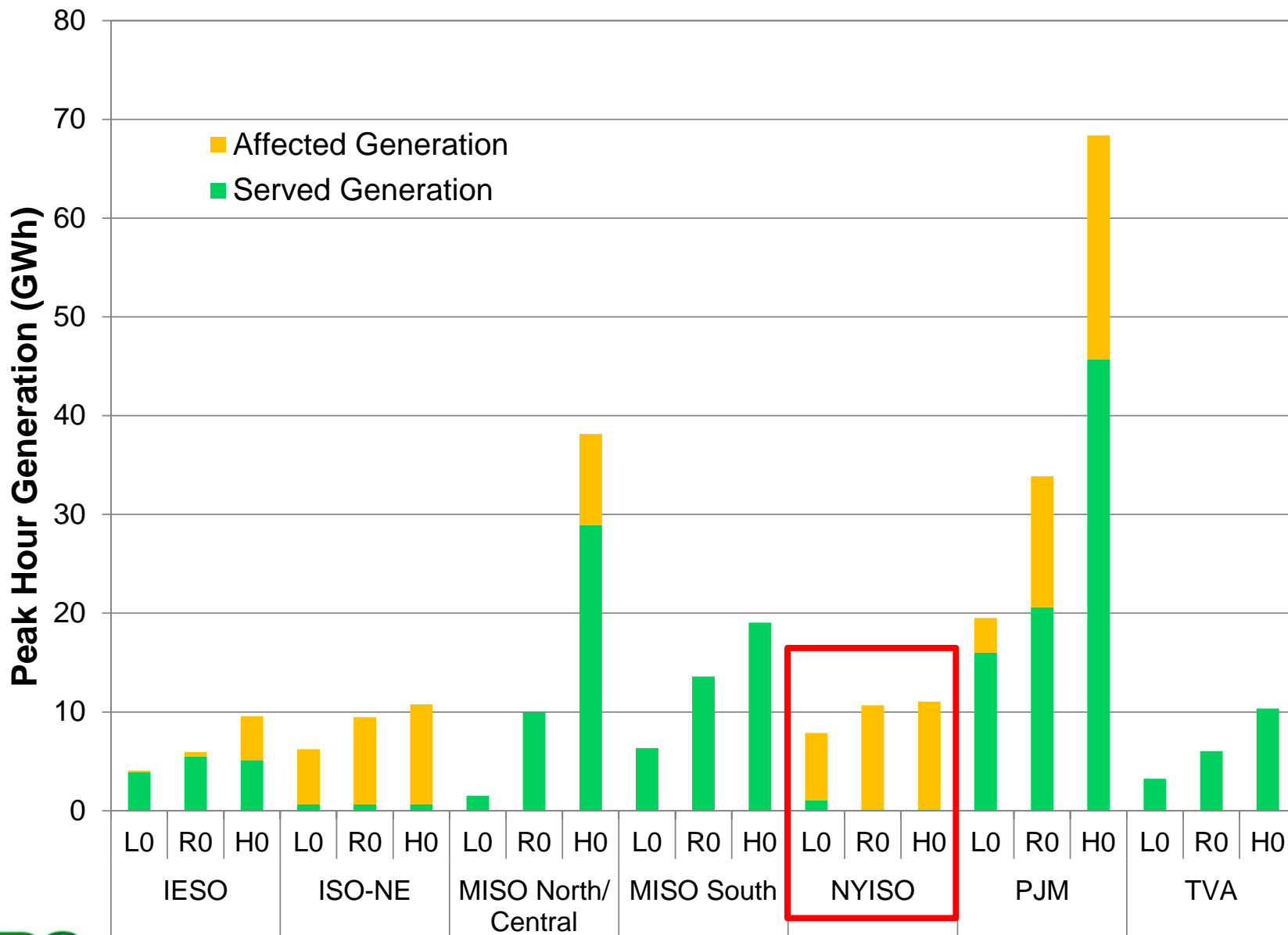
NYISO – PPA Highlights

- ◆ Gas infrastructure is constrained in winter 2018 and 2023 under nearly all market conditions and resource mixes
- ◆ Despite large pipeline buildout in New York, nearly all pipelines are fully utilized at the winter peak hour
- ◆ Constrained Transco segments in PJM also affect downstream generators located on the NYFS
- ◆ Significant dual-fuel capacity mitigates constraints under high daily gas prices (Polar Vortex pricing)
- ◆ Expanded pipeline capacity to accommodate Marcellus production materially decreases affected generation

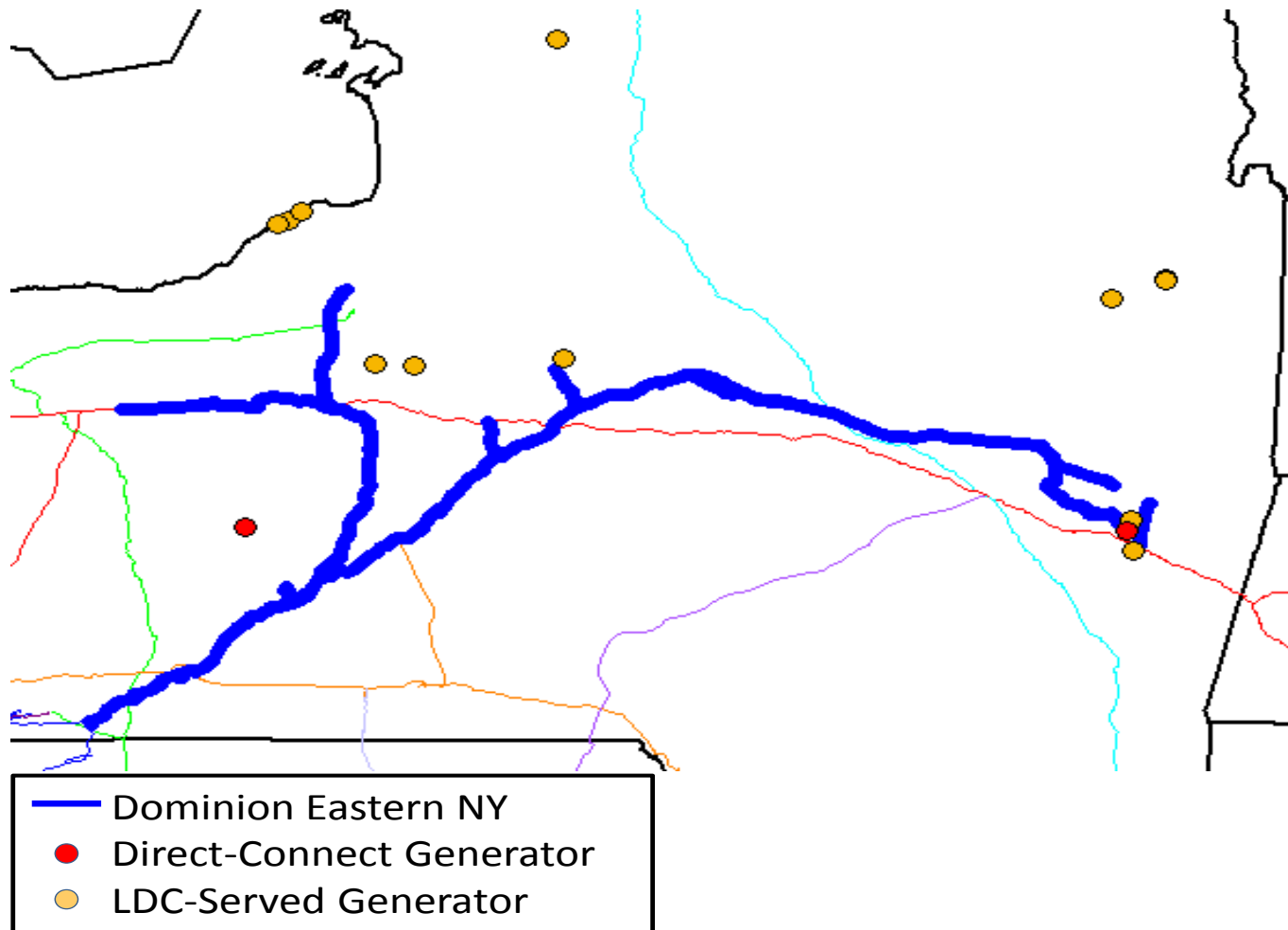
Affected Generation in Winter 2018



Affected Generation in Winter 2023

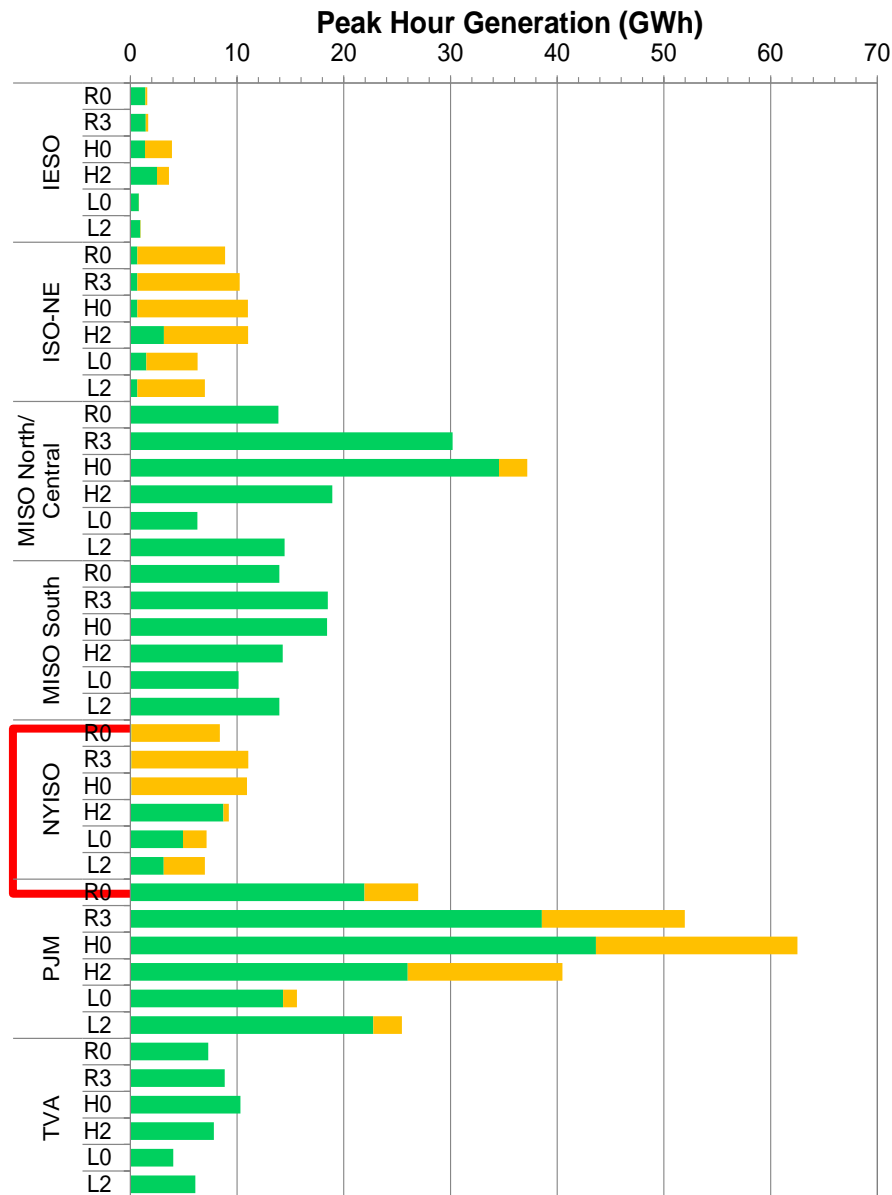


Generators Affected by Dominion Eastern NY Constraint



RGDS Winter 2018

Sensitivity Cases - Winter 2018



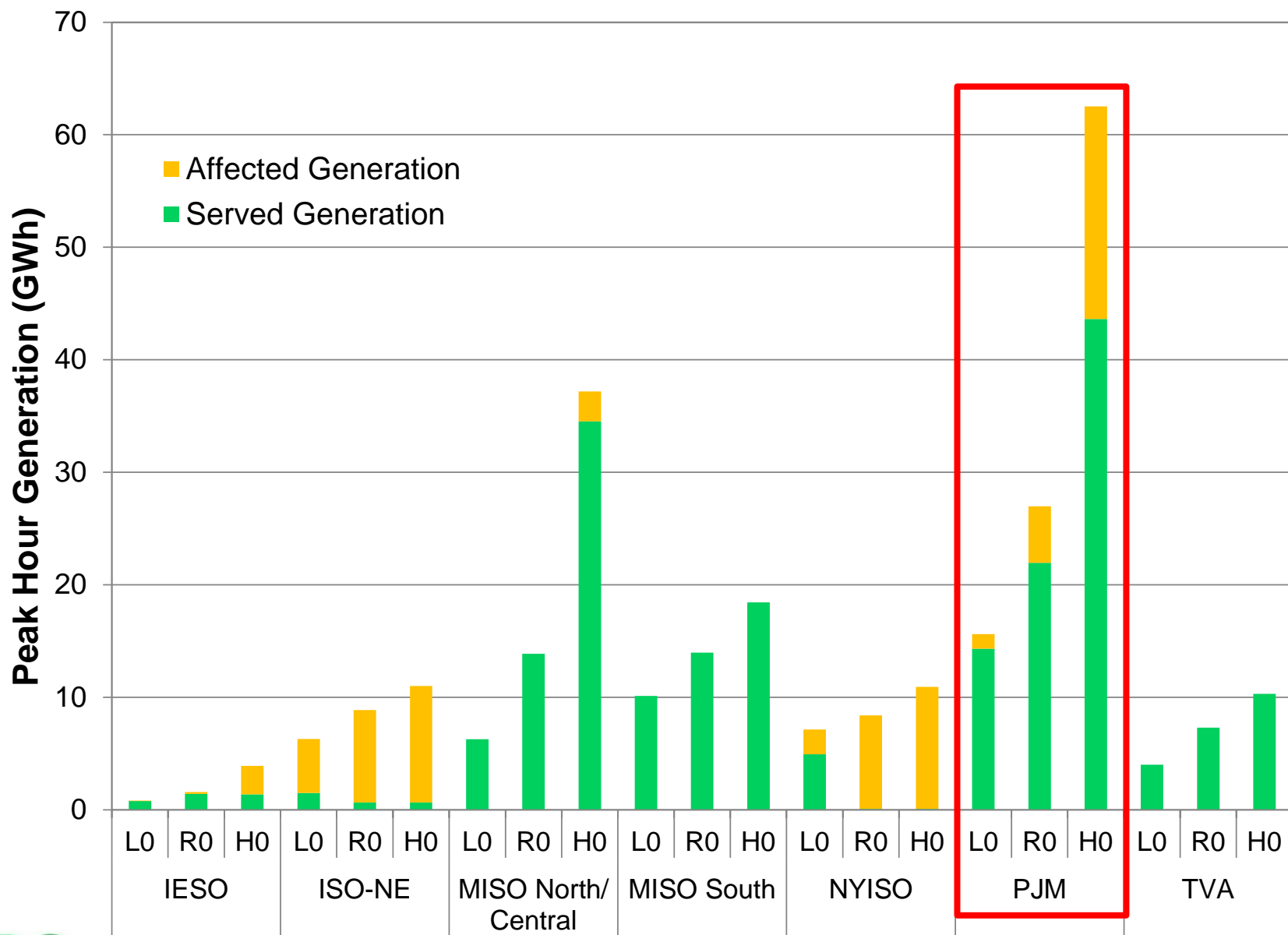
- ◆ Lower gas prices (R3) and higher gas demand (H0) increase affected generation relative to RGDS (R0)
- ◆ Higher gas prices and lower gas demand in LGDS (L0) decrease affected generation relative to R0
- ◆ Lower gas prices (L2) relative to L0 increase affected generation
- ◆ Dual fuel capacity in SE New York mitigates impact of gas constraints

PJM

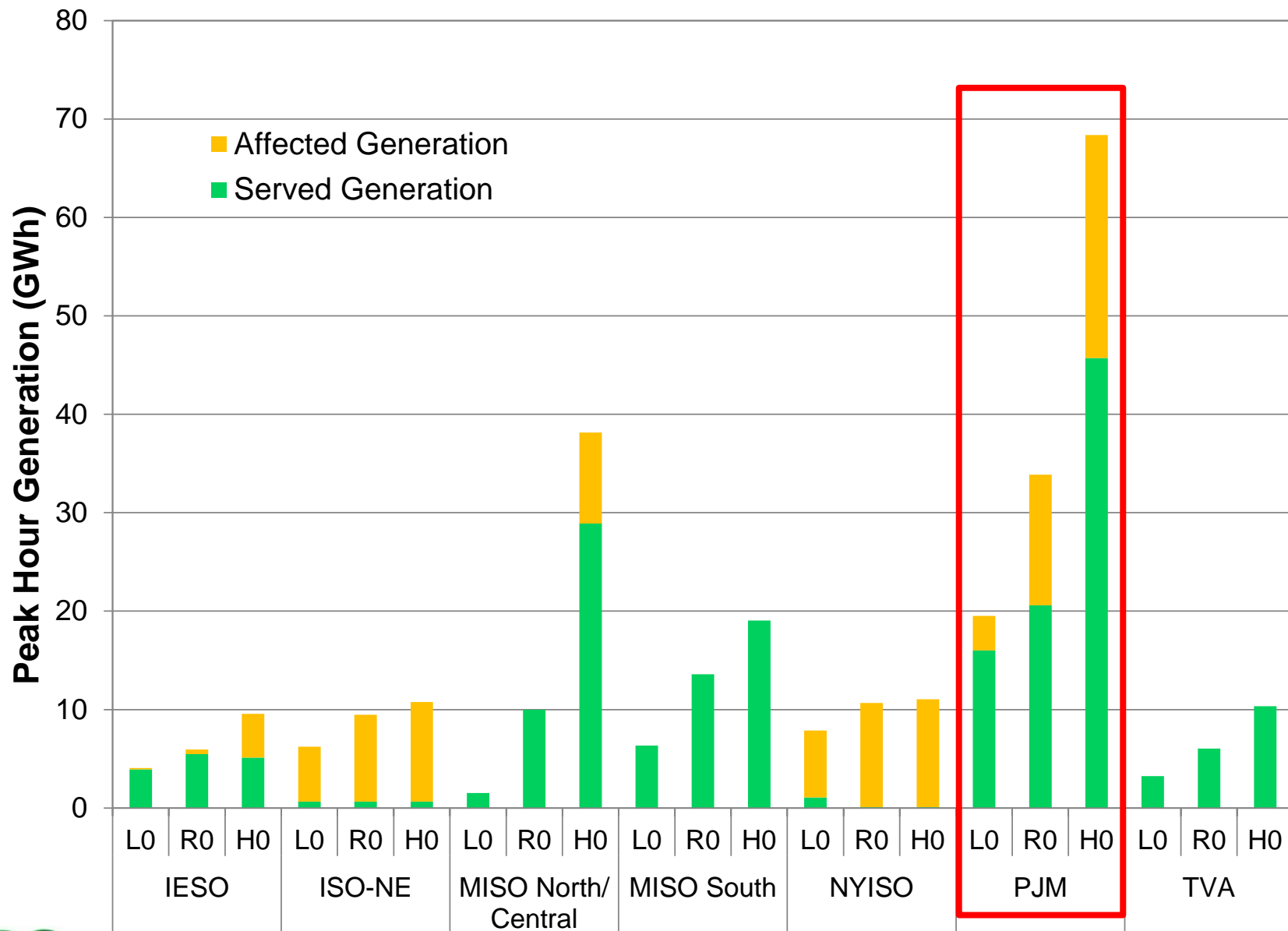
PJM – PPA Highlights

- ◆ Gas infrastructure is adequate or constrained in winter, depending on location
 - Most affected generation in MD, VA, Eastern PA, NJ, DE
 - Adequate deliverability elsewhere, including Chicago
 - Amount of affected generation reduced when high spot gas prices put more coal- and oil-fired generation in merit
 - Heightened attrition of coal-fired capacity and high load increases affected generation in 2018 and 2023
 - Incremental pipeline additions to accommodate increased Marcellus production decreases affected generation
- ◆ Moderate affected generation in summer 2018 and 2023 in DE, MD, VA

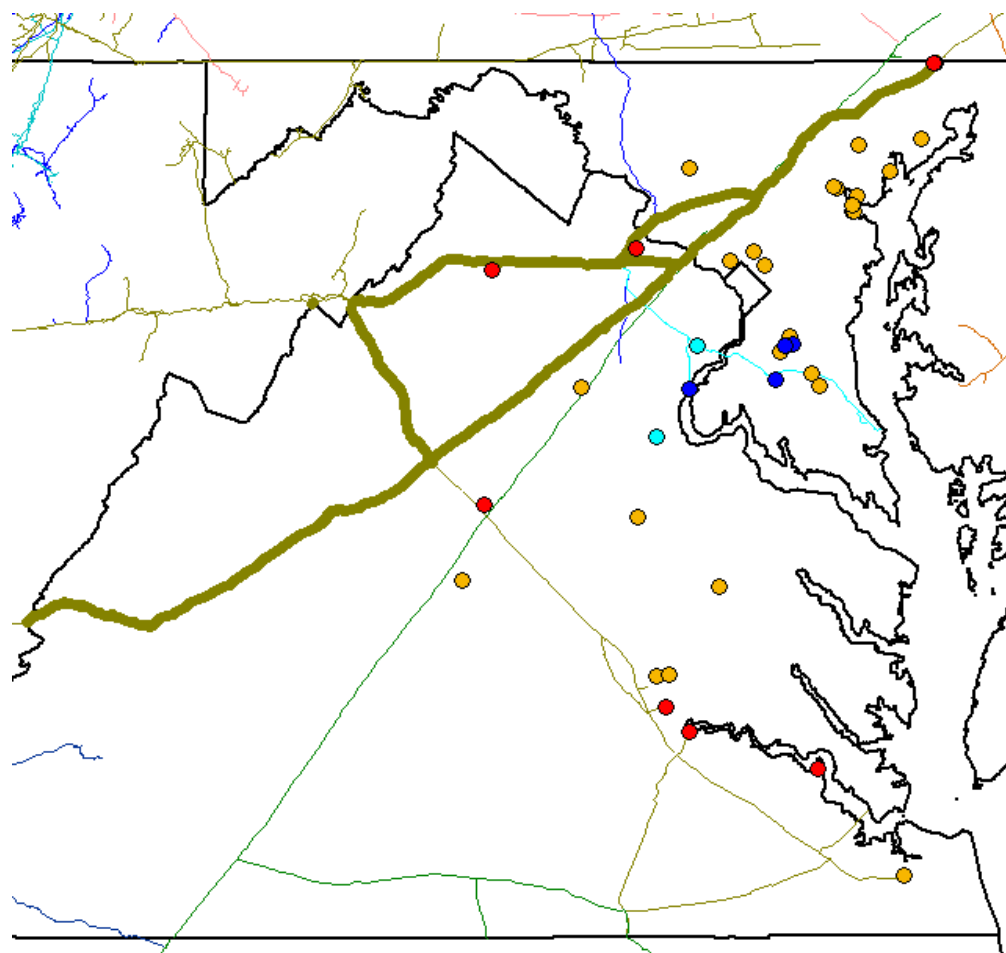
Affected Generation in Winter 2018



Affected Generation in Winter 2023



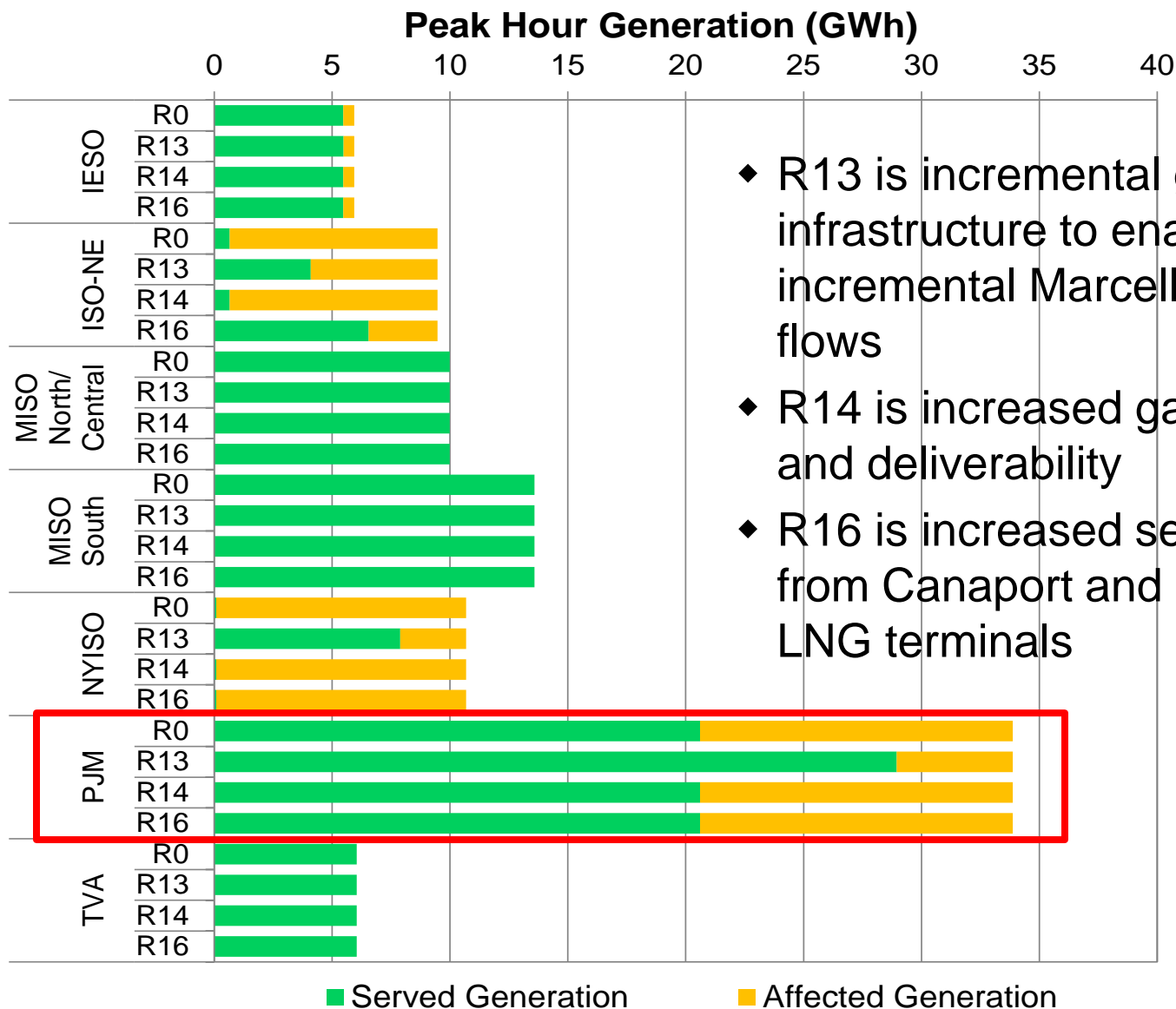
Generators Downstream of Columbia Gas VA/MD Constraint



- Columbia Gas VA/MD
- Direct-Connect Generator
- LDC-Served Generator
- Downstream Pipeline-Served Generator
- Downstream Pipeline → LDC-Served Generator

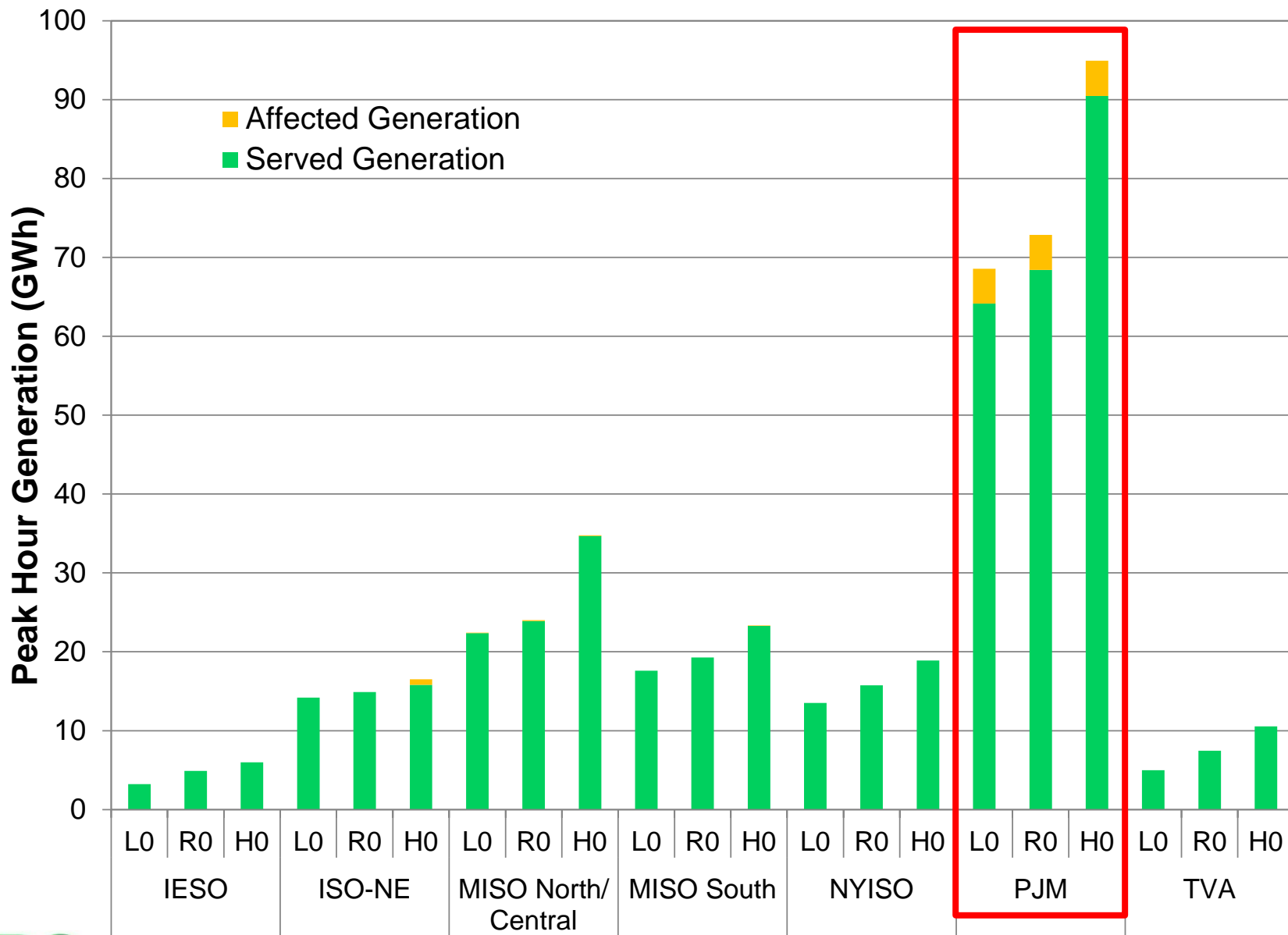
RGDS Winter 2018

Reduced Affected Generation in Winter 2023



- ◆ R13 is incremental gas infrastructure to enable incremental Marcellus/Utica flows
- ◆ R14 is increased gas storage and deliverability
- ◆ R16 is increased sendout from Canaport and Distrigas LNG terminals

Affected Generation in Summer 2018



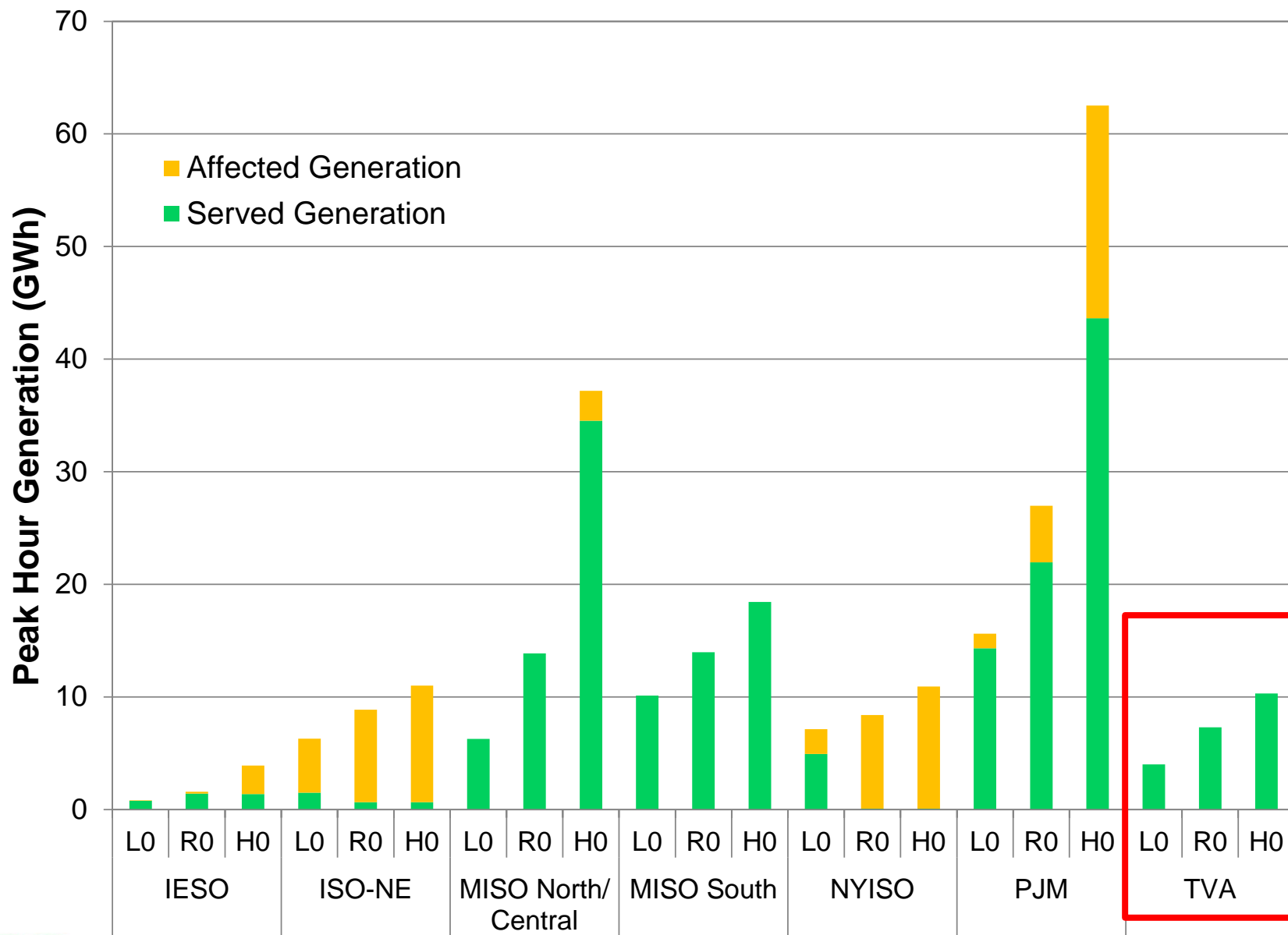
TVA

TVA – PPA Highlights

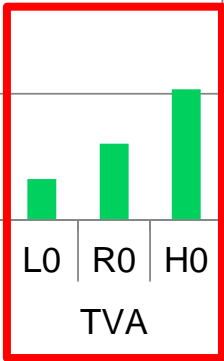
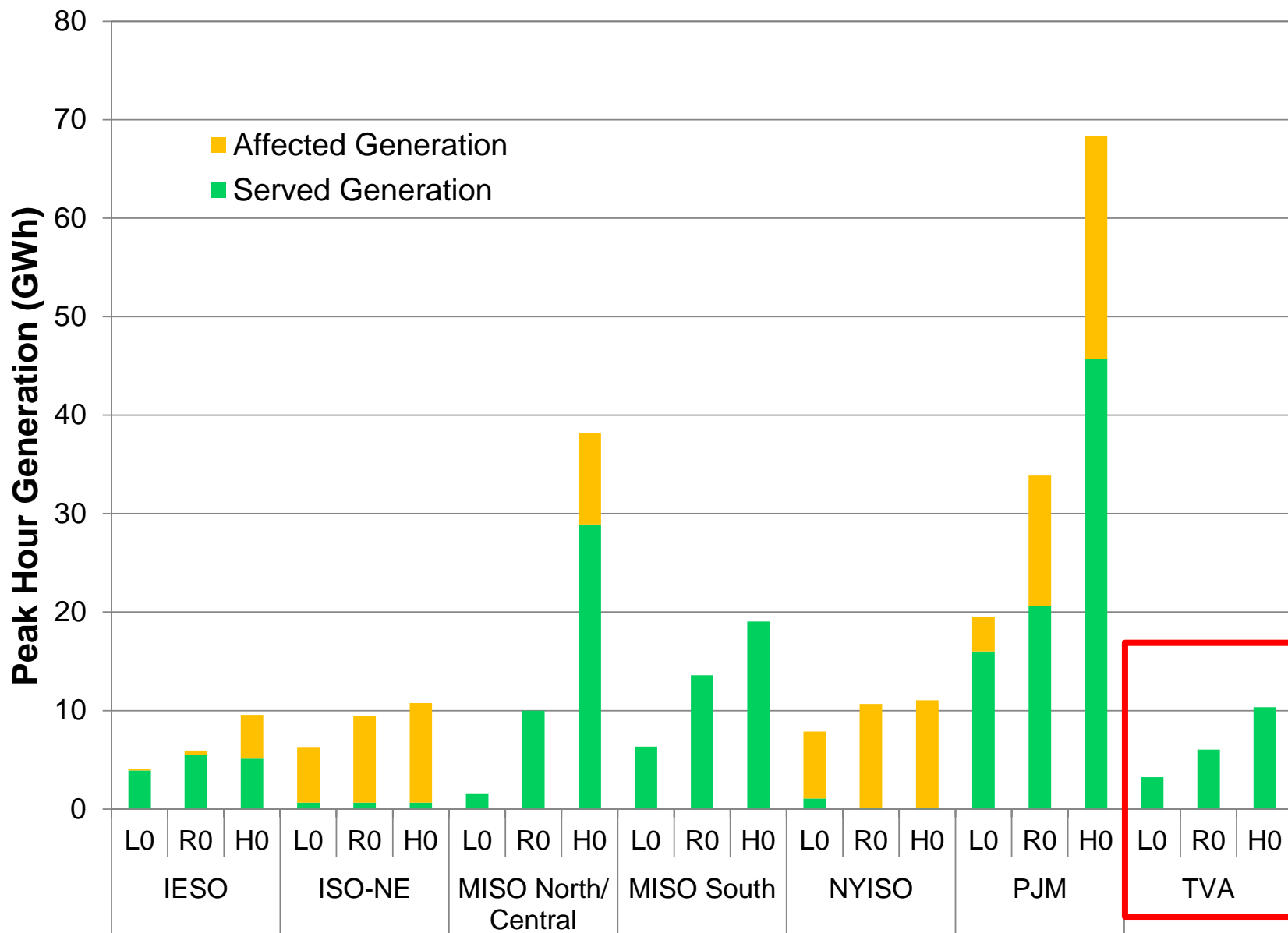
- ◆ Gas infrastructure is adequate under all market conditions and resource mixes tested
- ◆ Extensive network of pipelines serves TVA
- ◆ TVA holds firm transportation entitlements to meet most of its daily gas demands and has significant dual-fuel capability

Affected Generation in Winter 2018

Target 2 Results



Affected Generation in Winter 2023



Constraint Mitigation

High Frequency
or Duration

- Incremental compressor horsepower
- Loop line
- New pipeline

Low Frequency
or Duration

- Liquid fuel backup
- LNG arrangements
- Demand response

Market Dynamic and/or Risk Factor, Winter 2018

- ◆ Impact on affected generation varies widely by PPA
 - Green – negligible, Yellow – low/moderate, Red – high

Market Dynamic and/or Risk Factor	IESO	ISO-NE	MISO		NYISO	PJM	TVA
			North/ Central	South			
Transport Deficits	Green	Red	Green	Green	Red	Red	Green
New Pipeline Additions	Yellow	Red	Green	Yellow	Yellow	Green	Green
Proximity to Shale Gas	Yellow	Red	Green	Yellow	Yellow	Green	Yellow
Reversal-of-Flow	Green	Red	Green	Yellow	Green	Green	Green
Available Coal Output	Green	Yellow	Red	Yellow	Yellow	Red	Yellow
Nuclear Retirements/delay	Red	Green	Green	Green	Yellow	Yellow	Green
LNG Import Constraints	Green	Red	Green	Green	Green	Yellow	Green
LNG Export Constraints	Green	Green	Green	Yellow	Green	Yellow	Green
Transmission Transfer Limits (Electric)	Green	Green	Green	Green	Green	Green	Green
Generator FT Entitlements	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green
Generator Reliance on Non-Firm Arrangements	Green	Red	Green	Green	Red	Red	Green
Dual Fuel Capability	Yellow	Green	Yellow	Yellow	Green	Yellow	Green
Renewables Penetration	Green	Yellow	Yellow	Green	Yellow	Yellow	Green

Target 2 Production Schedule

◆ Proposed key milestones

- Stakeholder comments due: 2/27/2015
- Final draft report to DOE: 3/13/2015