WECC

Year 10—Extreme Cold Weather Event Assessment

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Contributors

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- Year 10 Extreme Cold Weather Event Advisory Group
- E3
- Others

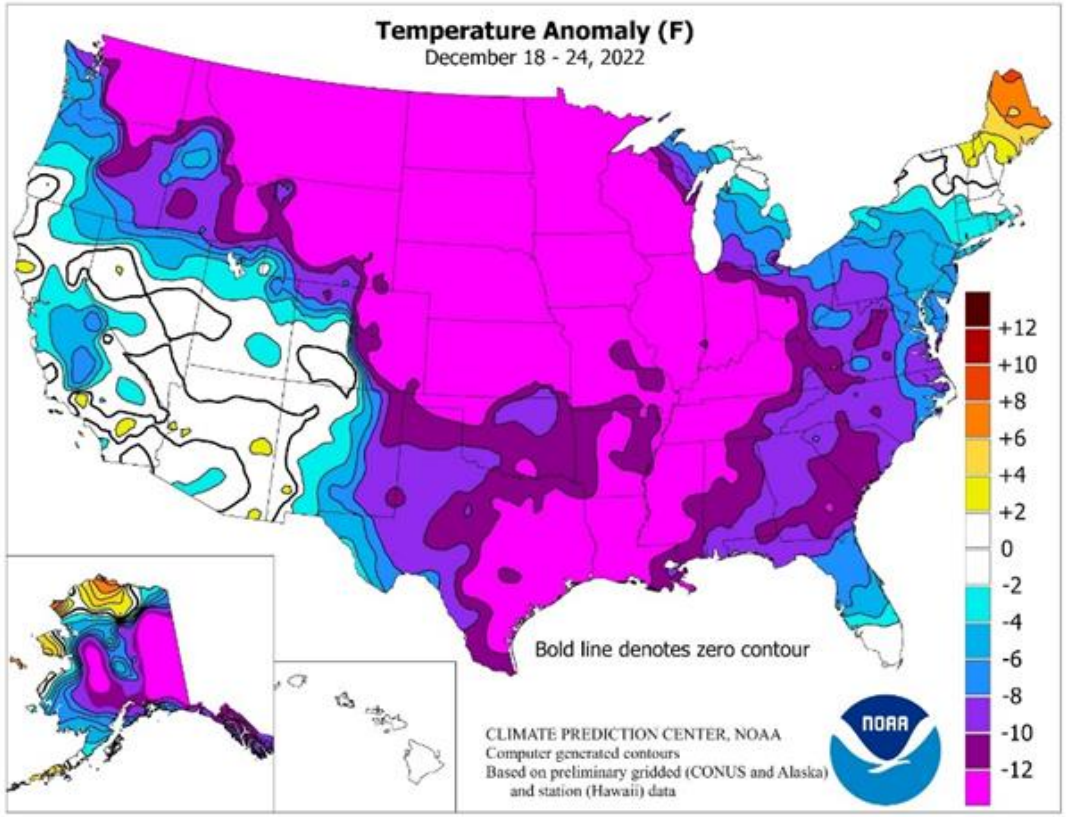
Scope

- Identify vulnerabilities during an extreme cold weather event and recommend mitigation techniques.
- Key reliability questions.
  - At what levels of extreme cold temperature, duration, and load level, does the model show reliability concerns such as unserved energy?
  - Which Western Interconnection regions are most sensitive or susceptible to an extreme cold event?
  - How does cold weather affect generator availability?
- Challenges.
  - What does a “realistic” extreme cold weather look like to the system?

Goal

Mimic Winter Storm Elliot (Dec 2022) and make more extreme until signs of unserved load.

City	Temperature
Butte, Montana	-38° F
Casper, Wyoming	-42° F
Denver, Colorado	-18° F
Edmonton, Alberta	-40° F
Pullman, Washington	-20° F



Assumptions

- Built on 2032 ADS PCM
- December 2022 load shape grown to 2032 load levels for entire interconnection
- 10% load increase for event duration, December 19–23
- December 2018 actual wind and solar shapes to replicate a low wind and solar period
- Behind the meter was unmodified
- Transmission was unmodified
- Forced outage rate for thermal generation was doubled in Alberta, Northwest, Rocky Mountain, and Basin regions
- Reduced NG generation capacity in three steps; 15%, 25%, and 35%

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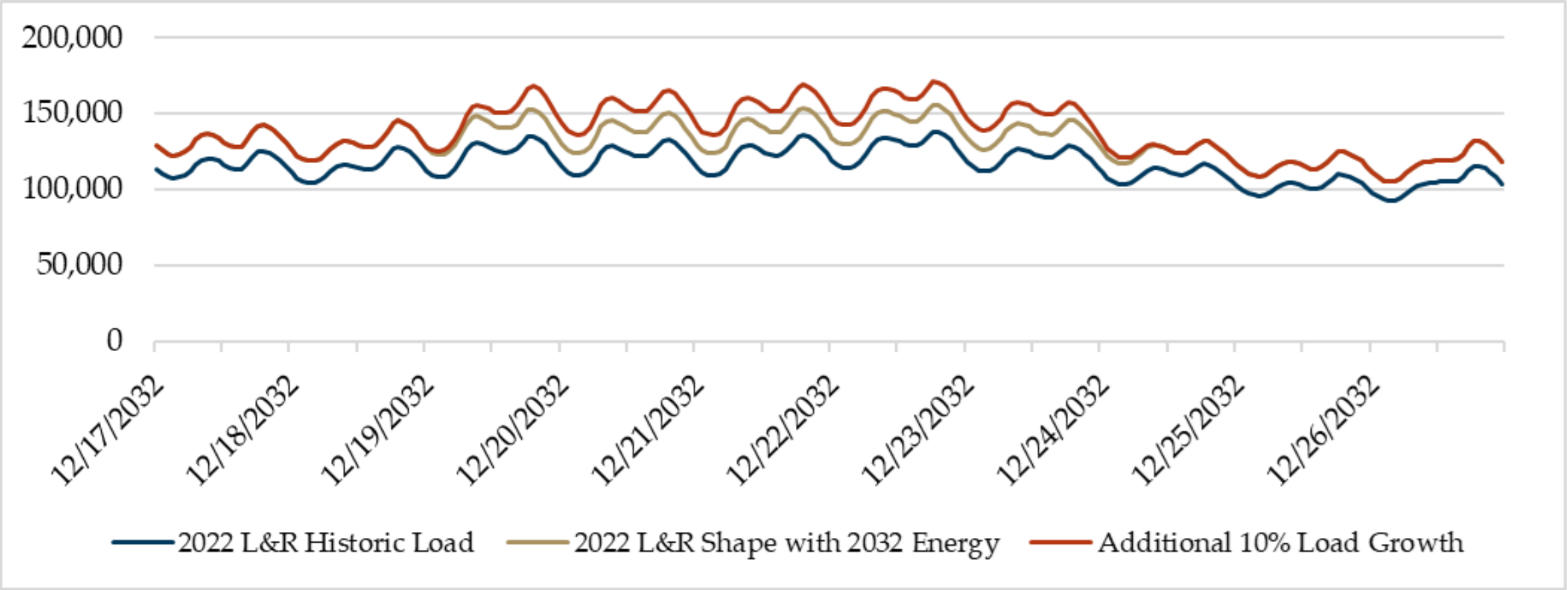
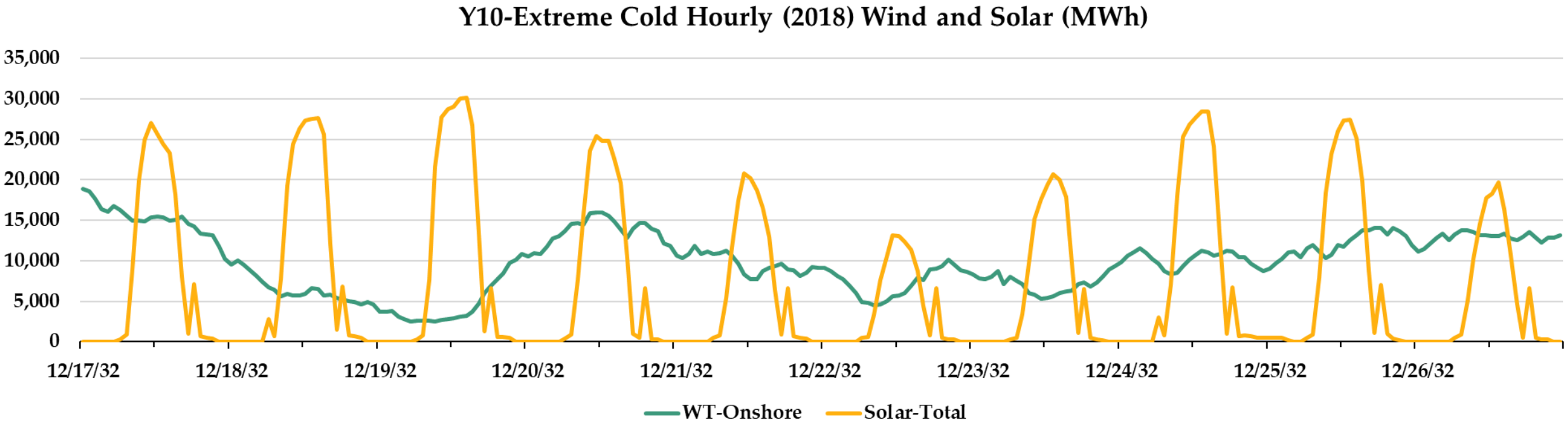
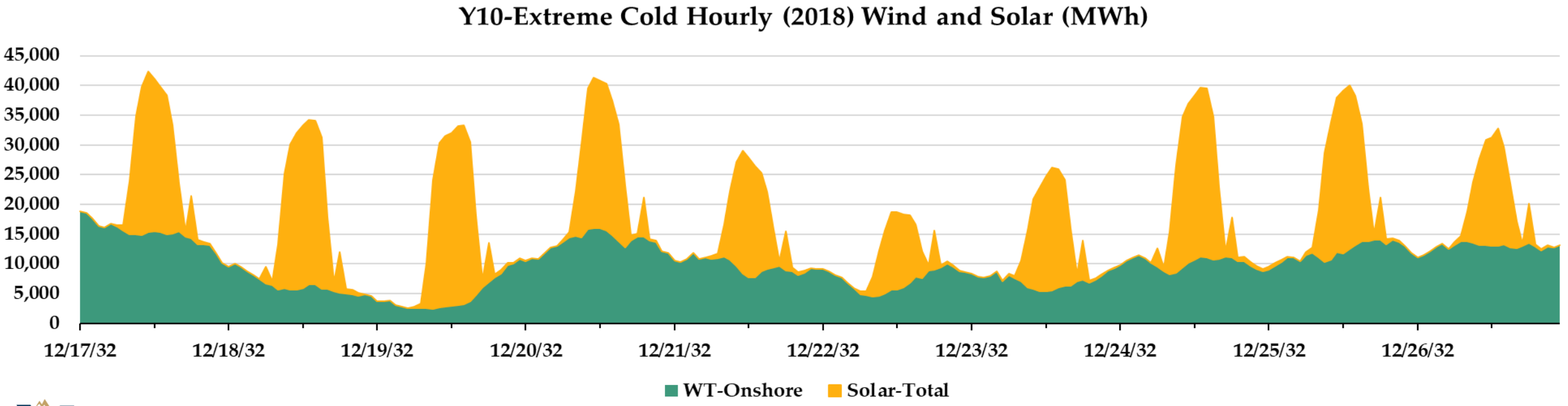
Western Interconnection Loads




Y10-Extreme Cold Hourly (2018) Wind and Solar (MWh)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
12/17/32
12/18/32
12/19/32
12/20/32
12/21/32
12/22/32
12/23/32
12/24/32
12/25/32
12/26/32
WT-Onshore
Solar-Total


Y10-Extreme Cold Hourly (2018) Wind and Solar (MWh)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
12/17/32
12/18/32
12/19/32
12/20/32
12/21/32
12/22/32
12/23/32
12/24/32
12/25/32
12/26/32
WT-Onshore
Solar-Total

Forced Outage Rate

- Forced outage rate—doubled
  - The highest forced outage rate in Texas during Winter Storm Uri in 2021 was three times greater than normal
  - More winterizing in the Western Interconnection

Natural Gas Generation Derate

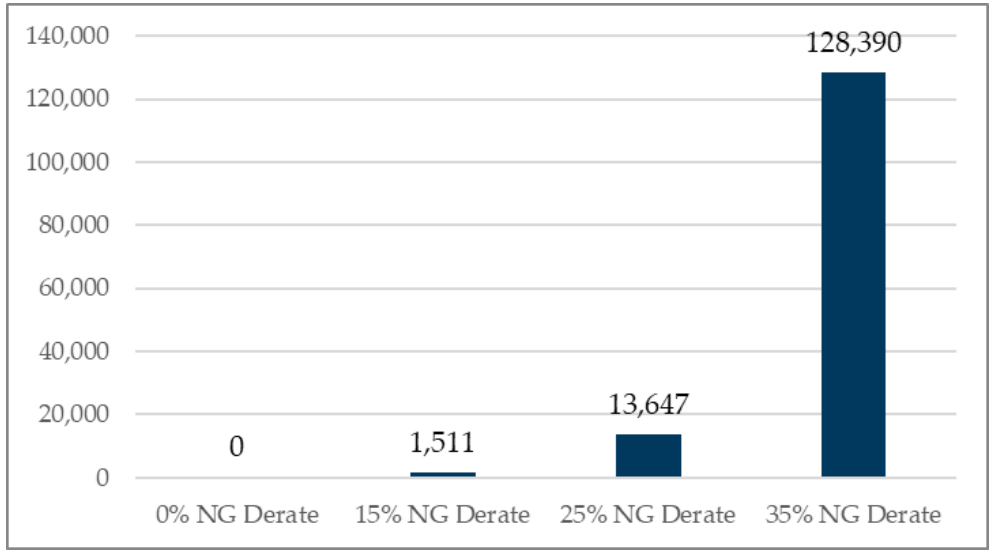
- Derates start on Dec 19, hour 5, and end on Dec 23, hour 10
- Northern California is generally warmer than the northwest WI; however, it uses the same natural gas pipelines and infrastructure, so it may be affected, but to a lesser degree

NG Derate Level Case	Canada, Northwest, Rocky Mountain, and Basin Regions	Northern California Region
15% Derate Case	15% Derate	7.5% Derate
25% Derate Case	25% Derate	10% Derate
35% Derate Case	35% Derate	17.5% Derate

Results

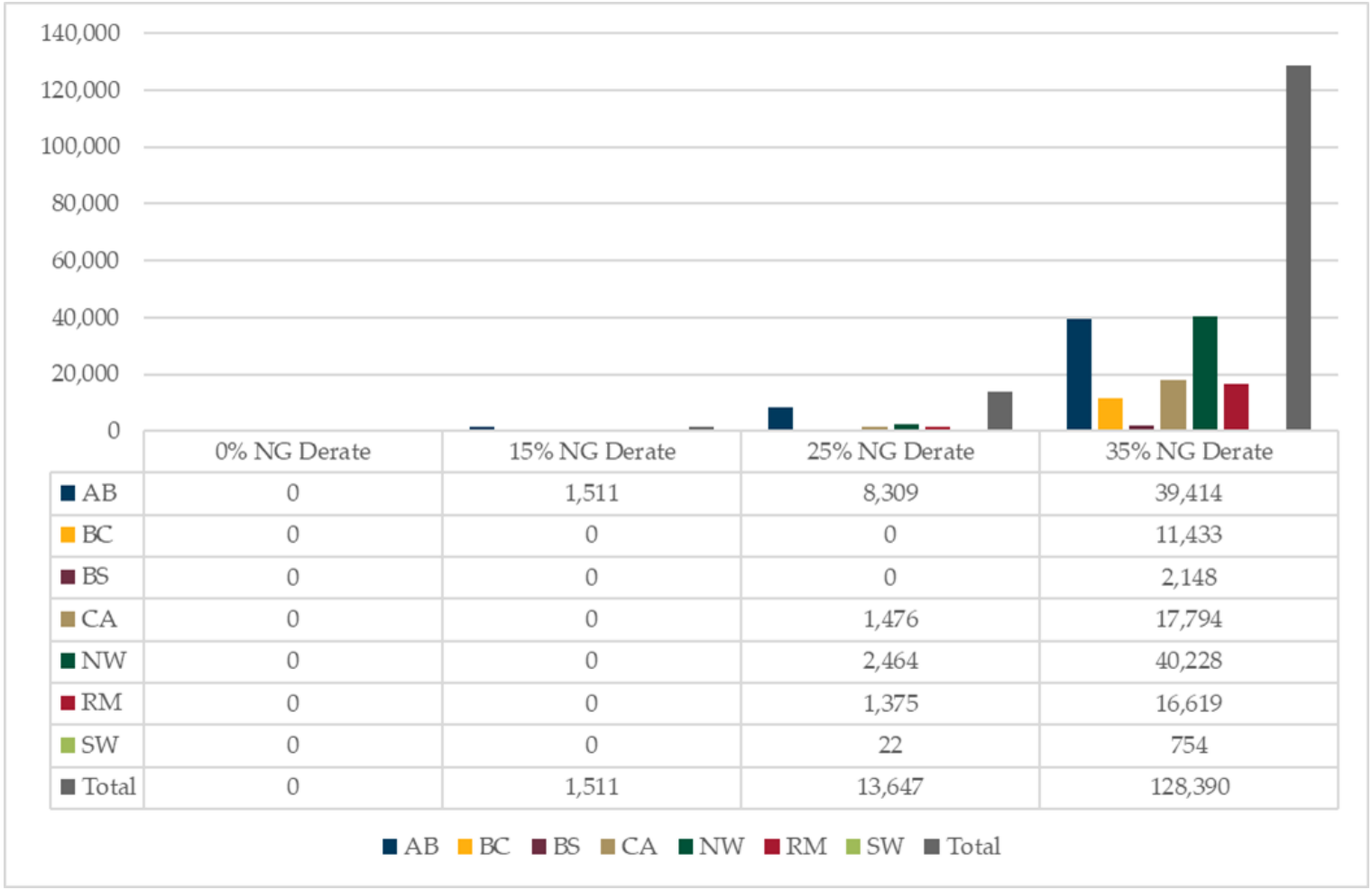
Unserved Load (MWh)

- Stacked impacts/assumptions:
  - Modified increased loads
  - 10% load increase
  - Modified decreased wind/solar shapes
  - 2x forced outage rate
  - NG derates shown in table



Region	15% NG Derate	25% NG Derate	35% NG Derate
Alberta	1,511	8,309	39,414
British Columbia	0	0	11,433
Basin	0	0	2,148
Californinia	0	1,476	17,794
Northwest	0	2,464	40,228
Rocky Mountain	0	1,375	16,619
Southwest	0	22	754
Total	**1,511**	**13,647**	**128,390**

Unserved Load (MWh)

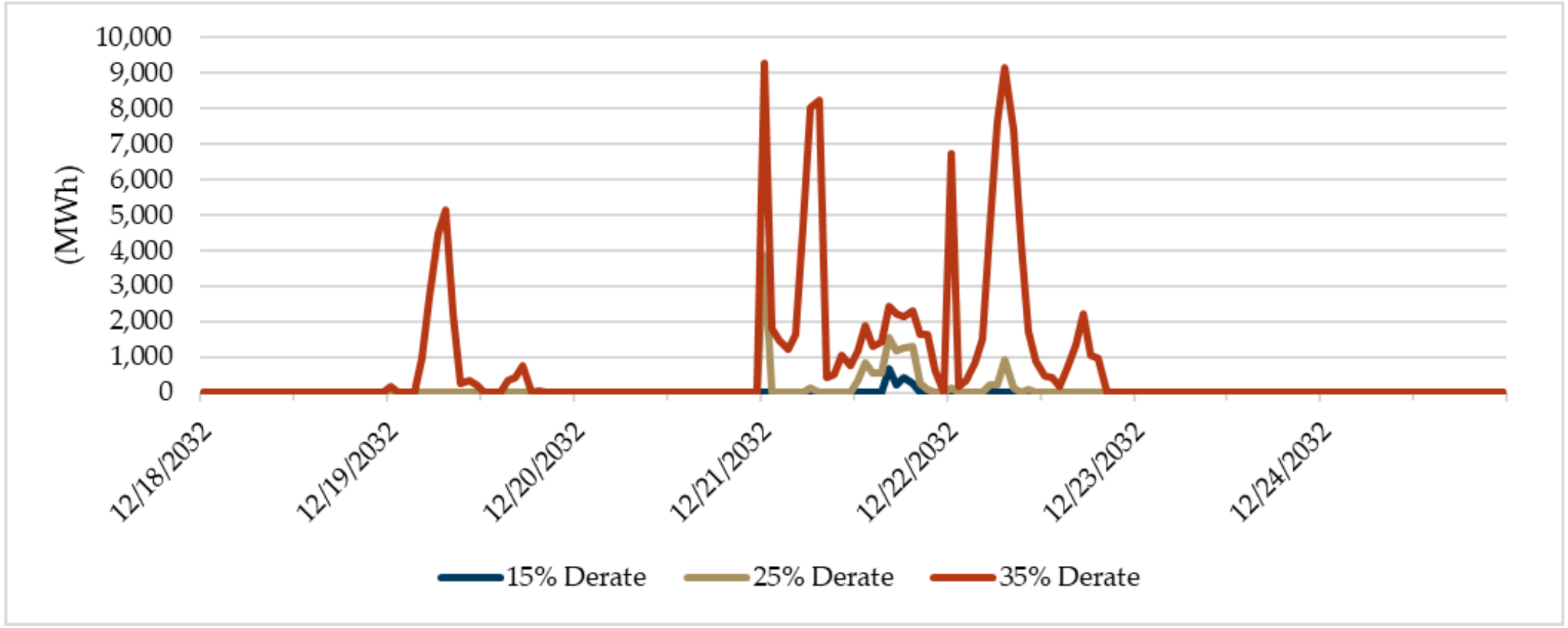


	0% NG Derate	15% NG Derate	25% NG Derate	35% NG Derate
AB	0	1,511	8,309	39,414
BC	0	0	0	11,433
BS	0	0	0	2,148
CA	0	0	1,476	17,794
NW	0	0	2,464	40,228
RM	0	0	1,375	16,619
SW	0	0	22	754
Total	0	1,511	13,647	128,390

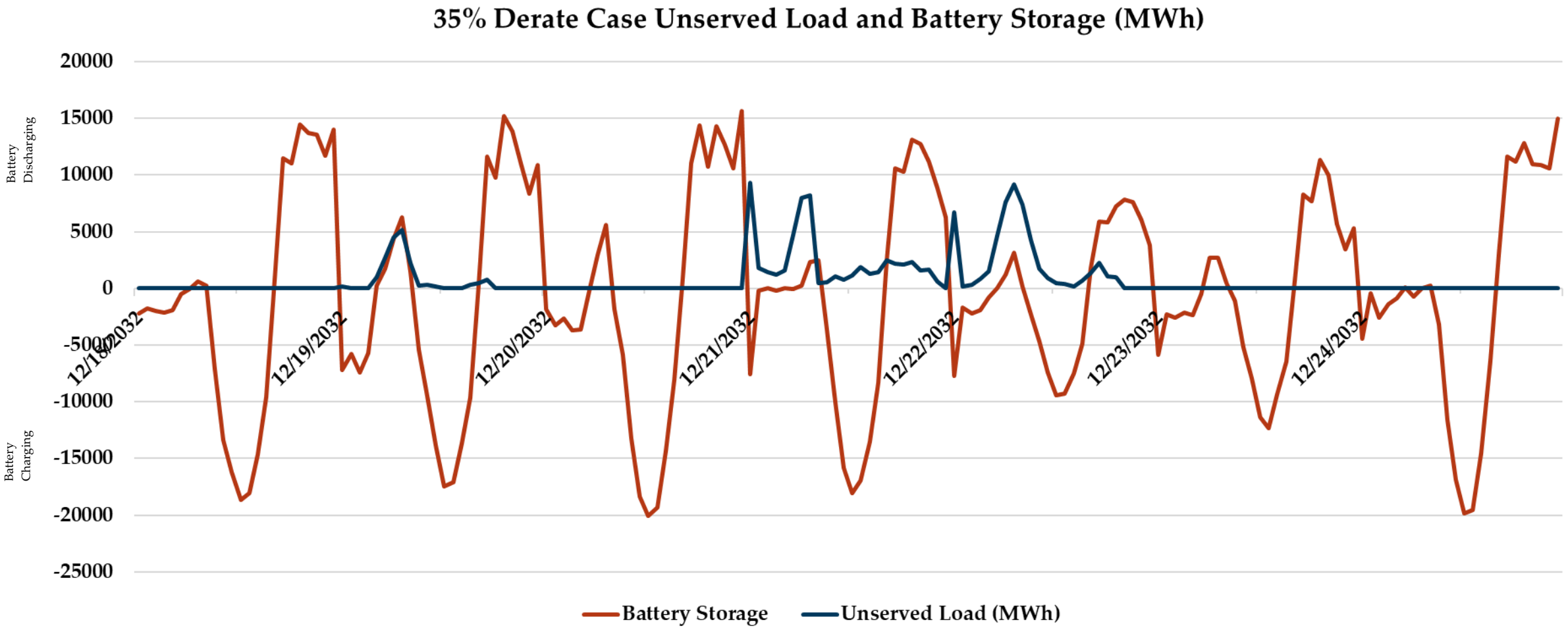
Peak Unserved Load 35% NG Derate Case

Region	Max (MW)	Date	Hour
Alberta	2,440	Dec 21	17
British Columbia	1,450	Dec 19	8
Basin	512	Dec 22	10
California	3,606	Dec 21	1
Northwest	4,446	Dec 22	8
Rocky Mountain	1,522	Dec 22	8
Southwest	509	Dec 21	1
Interconnection	**9,286**	**Dec 21**	**1**

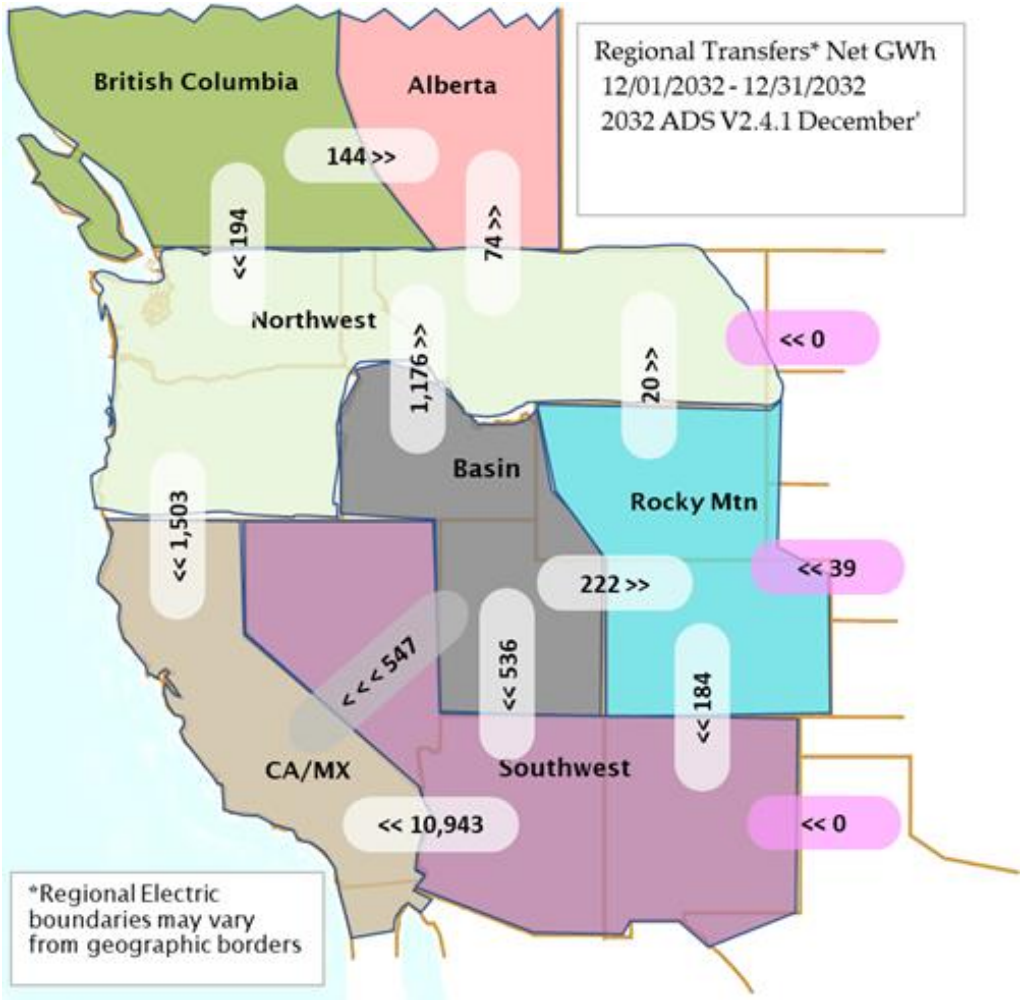
Unserved Load (MWh)

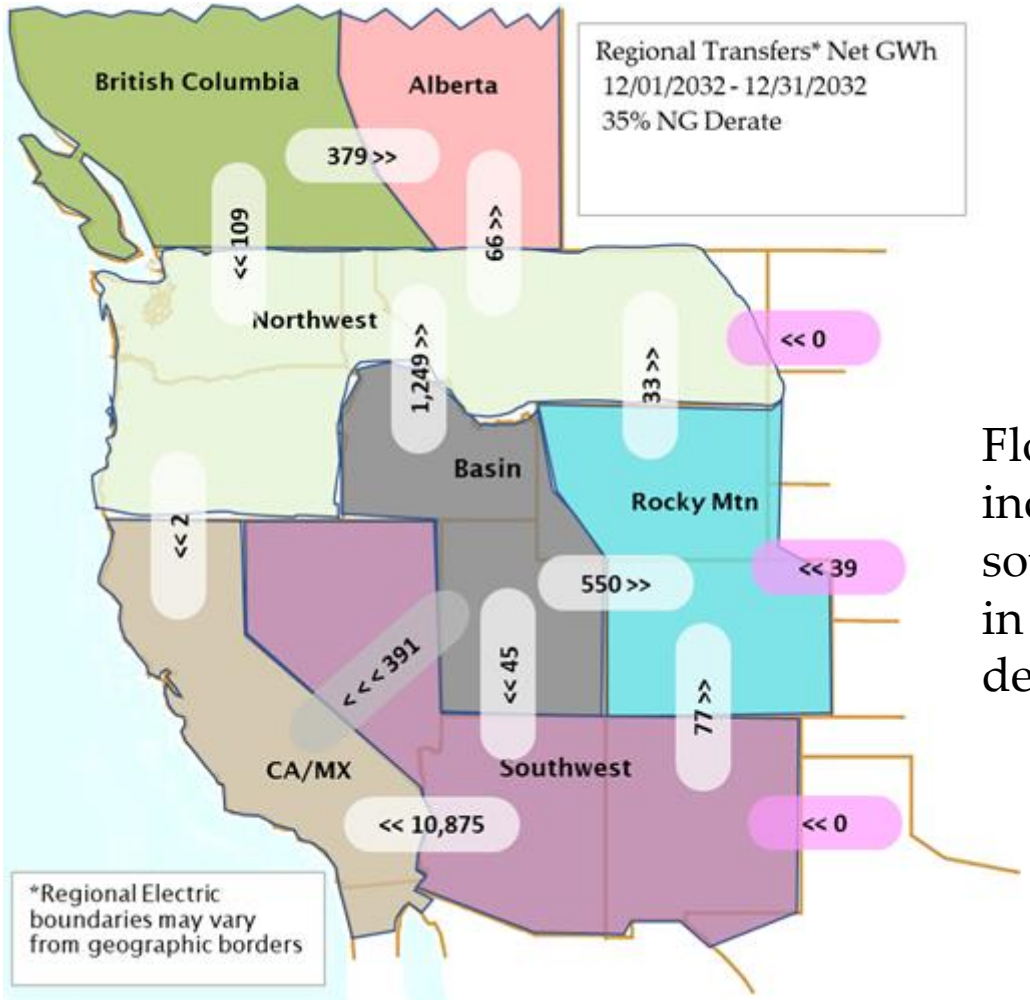


35% NG Derate Case



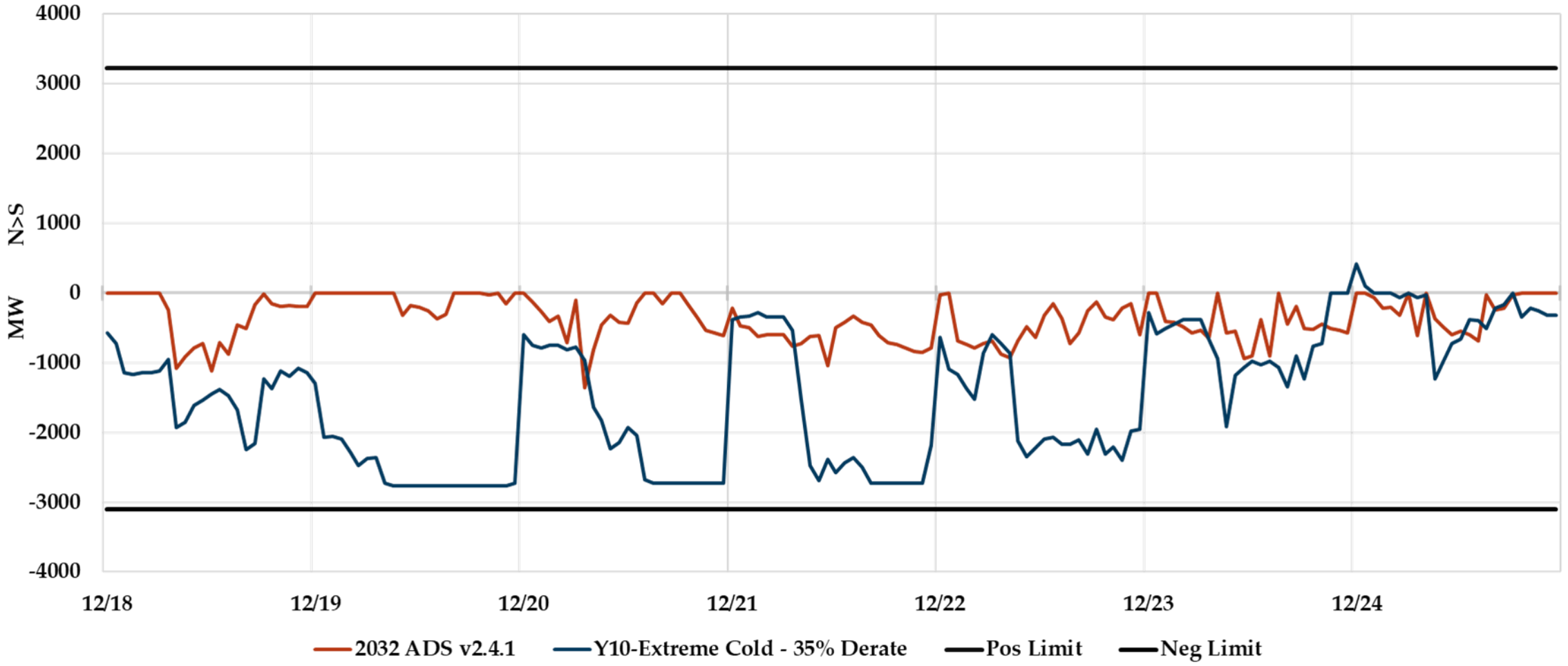
Regional Transfers



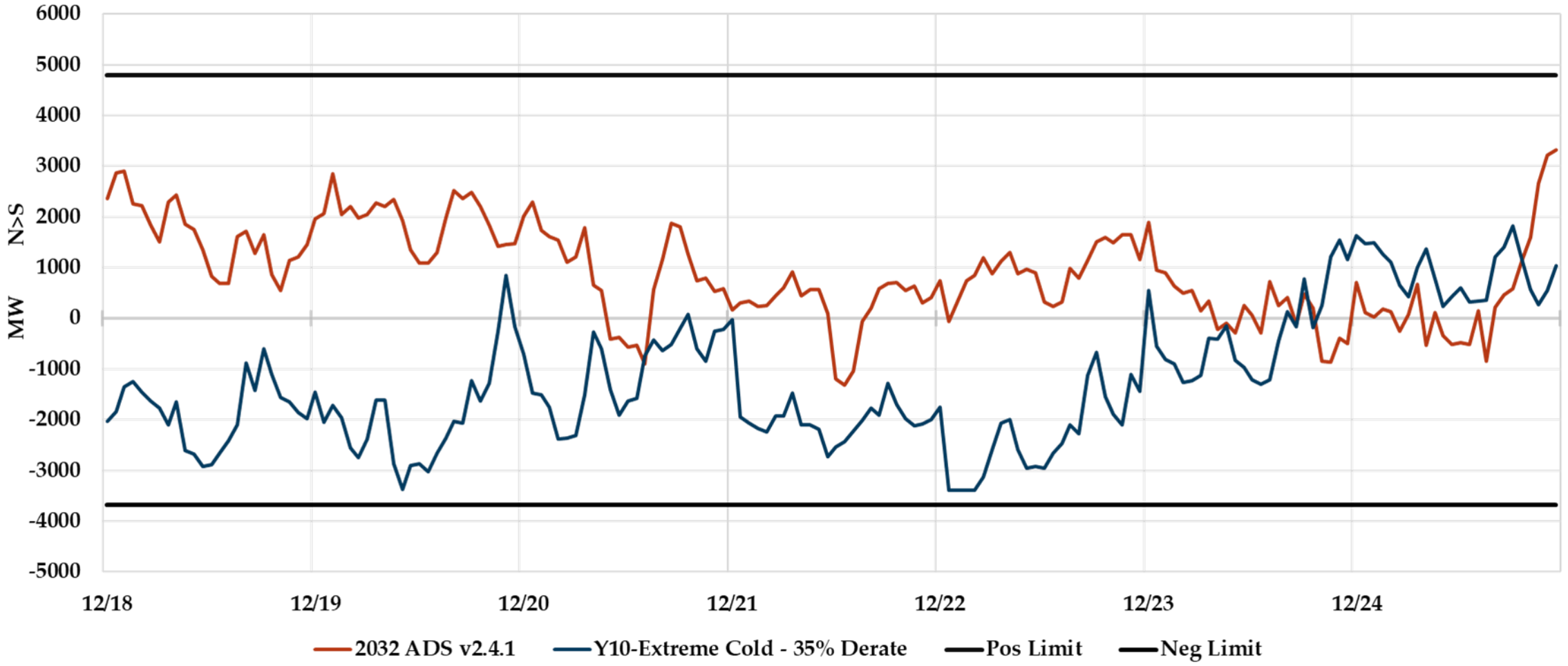


Flows increase south–north in 35% NG derate case

Path 65 PDCI


4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
MW
N>S
12/18
12/19
12/20
12/21
12/22
12/23
12/24
2032 ADS v2.4.1
Y10-Extreme Cold - 35% Derate
Pos Limit
Neg Limit

Path 66 COI


6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
MW
N>S
12/18
12/19
12/20
12/21
12/22
12/23
12/24
2032 ADS v2.4.1
Y10-Extreme Cold - 35% Derate
Pos Limit
Neg Limit

Recommendations

- Recommendation 1: Industry should—
  - Explore mitigation strategies for extreme weather conditions such as high demand and low generation availability. Also, closely monitor natural gas availability under extreme cold conditions;
  - Continually maintain datasets for studying extreme weather scenarios and include potential impacts to the natural gas system; and
  - Correlate detailed weather data with electric system data, such as generation and load data, to facilitate weather event studies.
- Recommendation 2:
  - WECC should implement software enhancements to enable multi-day storage cycling to more realistically analyze storage operation, dispatch, and commitment during extreme cold weather.
- Recommendation 3:
  - WECC and industry should model new transmission projects under various system conditions (scenarios) to evaluate the effect on transmission use and flows. They should also explore and understand the reliability implications of reverse of flows on major WECC paths.

Report

- Year 10 Extreme Cold Weather Event Report:
  - https://www.wecc.org/Administrative/Year-10%20Extreme%20Cold%20Weather%20Event%20Report%202023.pdf

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