Winter Storm Elliott

Southern Company

Winter Storm Elliott Event Summary

- Loads set all-time December highs, with the coldest December temperatures since 1989
- Forecasts were significantly below actual loads, expecting typical declines in demand over weekends and holidays
- Combination of higher demand and loss of generation early Christmas Eve morning led to an EEA1, progressing to an EEA2
- Actions taken with declarations of EEA1 and EEA2 both reducing demand and increasing supply mitigated risk of firm load shed
- Extreme cold weather design changes were tested and should continue to be implemented
- All generation types and fuels contributed to serving loads throughout the event
- Fuel assurance strategies and our diverse fuel mix proved critical to system operations
- Communications and collaboration across functions and neighboring utilities were critical to managing system reliability

Responding as Winter Storm Elliott enters our footprint

Winter Storm Elliott entered Southern Company's service territory with strong winds that gusted to 50+ mph and affected customers' electric service. Operating company crews responded throughout the Christmas weekend to safely restore power for some 390,000 customers affected by the high winds from Thursday night, Dec. 22, through Monday morning, Dec. 26.

Approximately **3,000** responders

2,000 company resources

&

1,000 native contractors

Service restored to **99%** of affected customers by **8 AM** CST on Christmas Day



Timeline



*Operating Reserves increase as loads ramping down, some generating capacity returns and solar ramps up

Winter Preparedness

- Establishment of winter target reserve margins
- Generating unit design changes for extreme cold temperatures
- Annual winter preparedness procedures
- Annual assessment of winter reliability risk
- Energy Emergency Alert drills conducted semi-annually
- Fuel assurance planning



Seasonal Planning

Winter Target Reserve Margins

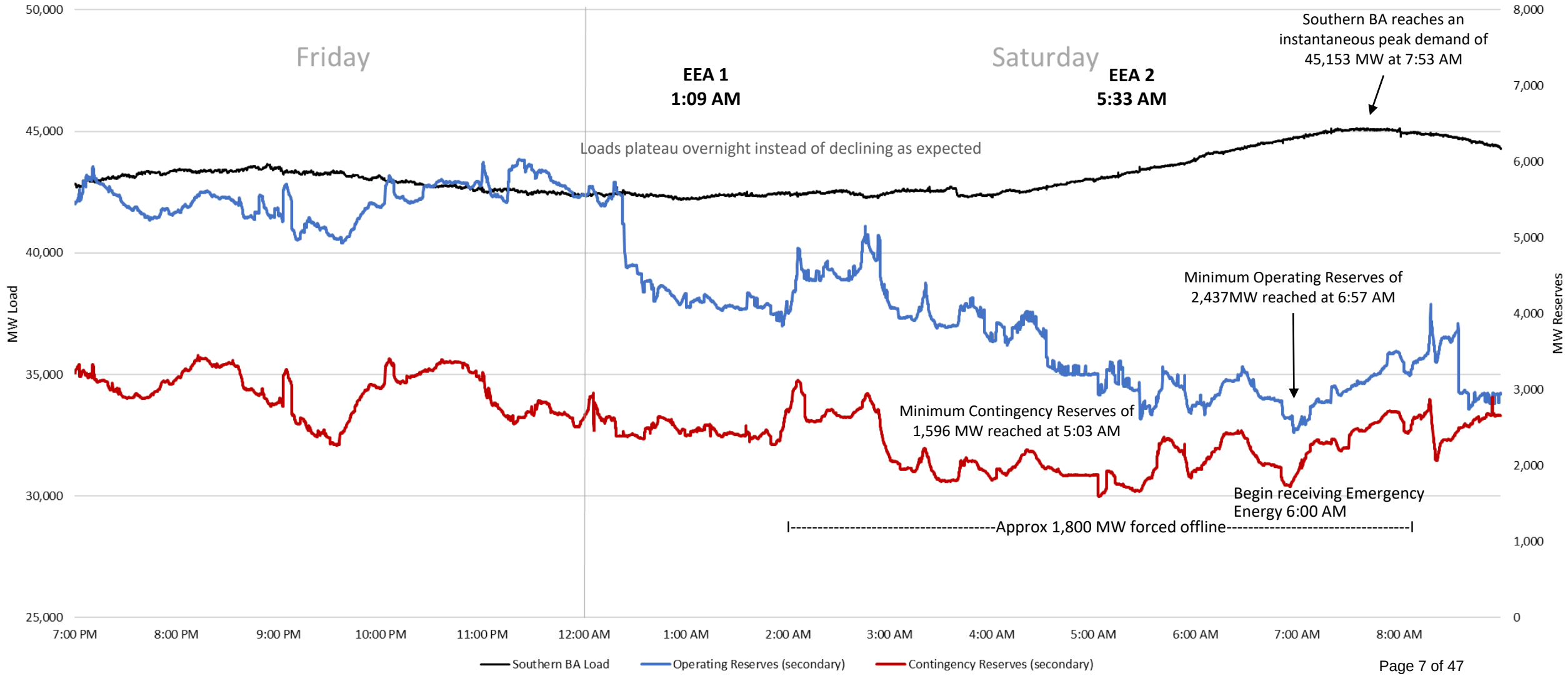
- Measures to improve winter reliability implemented after the 2014 Polar Vortex.
- Seasonal Planning and Winter Target Planning Reserve Margin implemented in 2019.
- Neighboring utilities have winter reserve margin targets ranging from 12.6% (OPC) to 25% (TVA).

Seasonal planning drivers

1. Narrowing of summer and winter peak loads
2. Distribution of peak loads relative to the norm
   (winter peaks more volatile than summer peaks)
3. Cold-weather-related unit outages
4. Solar resource penetration
   (solar is less aligned with winter peak demand than summer)
5. Increased natural gas reliance
   (subject to natural gas pipeline constraints at cold temperatures)
6. Market purchase availability
   (limited on cold days)

Utility	Winter Planning Reserve Target
TVA	25%
Santee Cooper	17%
Duke Energy Carolina	17%
Dominion	14% for resource planning + 7% for peak
Oglethorpe (OPC)	12.6%
ERCOT	13.75% minimum
MISO	16.5%
PJM	14.9% planning, 20% operations
PowerSouth	26% under CPO

Southern Balancing Area (SBA)



Regional view

TVA had its first ever rolling blackouts on 12/23 and 12/24, shedding 5-10% of system load.

- Load on 12/23 reached a winter record 33,425 MW.
- Forecasting errors reached at least 10%.*
- Two coal units representing 1,873 MW capacity went offline. TVA also acknowledged there were issues at another coal plant and some gas units.
- Net imports peaked at 7,179 MW, mostly from MISO.

Duke also instituted its first ever rolling blackouts, impacting about 500,000 customers in the Carolinas on 12/24.

- Duke Energy Carolinas load peaked at 20,879 MW on 12/24, 12% above forecast; load for Duke Energy Progress peaked at 14,083 MW, 5% above forecast.*
- About 2,500 MW were unavailable including 360 MW CC and 675 MW ST, as previously weatherized instrumentation lines froze, and at least 1,250 MW of firm purchases were cut.

Other South Carolina utilities struggled to meet load on 12/24.

- **Santee Cooper** employed one 15 minute rolling blackout, impacting 12,000 customers.
- **Dominion** announced it "implemented a controlled load shed" in South Carolina.

PowerSouth and **Oglethorpe** set record peaks.

- PowerSouth reached 2,674 MW, 9% above its previous peak (Jan 2018).
- Oglethorpe peaked at 11,034 MW, 15% above its previous winter peak and 8% above its previous all-time high (Jun 2022).

The **ERCOT**, **MISO**, and **PJM** systems were stressed but avoided rolling blackouts.

- The DOE waived some emissions standards to allow ERCOT and PJM to maximize generation.
- MISO and PJM declared maximum generation emergencies and took conservations actions.
- ERCOT set a new winter record with a demand of 74 GW and had forecasting errors of up to 10 GW.
- PJM's peak load forecast fell short by about 10% and their overnight valley was 40,000 MW higher than the next highest Christmas Eve.
- Up to 3,000 MW from PJM ended up flowing to the southeast via MISO.

Southern Company both gave and received emergency assistance during Elliot.

- On 12/23, SO provided TVA with 5,000 MWh.
- On 12/24, SO sent 3,700 MWh to Dominion, while receiving 6,375 MWh from FPL and 100 MWh from MISO.

*Day ahead forecasts and demand numbers from EIA.

Areas for Review & Lessons Learned

- Load forecasting in extreme cold weather
- Unit availability and winterization
- Planning assumptions and target reserve margins
- Demand response programs
- Oil and demineralized water needs for CT operations
- Availability of market energy purchases
- Processes and plans for communications with customers and other stakeholders


Southern
Company

FERC/NERC inquiry – Winter Storm Elliott

- A joint inquiry was announced on Dec. 28, 2022, by FERC, the North American Reliability Corporation (NERC) and NERC's regional entities.
- The inquiry will focus on bulk power system (BPS) operations during the extreme weather conditions that occurred during Winter Storm Elliott.
- FERC, NERC and the regional entities will work with other federal agencies, states, and utilities to identify BPS performance problems and recommend solutions for addressing those issues.

"The joint inquiry with NERC we are announcing today will allow us to dig deeper into exactly what happened so we can further protect the reliability of the grid."

- **Former FERC Chairman Rich Glick**

"This storm underscores the increasing frequency of significant extreme weather events (the fifth major winter event in the last 11 years) and underscores the need for the electric sector to change its planning scenarios and preparations for extreme events."

- **NERC President and CEO Jim Robb**

Continuous improvement focus

Nearly 40 action items and assessments underway to position Southern Company for even better performance during extreme winter weather/peak load events

Broad areas of action and assessments

Forecasting/Planning

System peaks, customer load shapes, weather dynamics, demand-side options, wholesale market assumptions

Resilience

Winterization enhancements (including transmission switchyards), peaking and secondary fuel operations, third-party/ PPA, potential environmental waivers, supplemental staffing

Fuel Assurance

Gas force majeure, oil inventory optimization

Process

Internal EEA awareness, external/customer communications before and during EEA, load-shed automation and restoration

Communications improvement focus

Internal and external communications can be improved to ensure clarity in processes and unity of message.

Review and improve systemwide Energy Emergency communications plan

- Address potential gaps to **improve alignment** and to ensure decisions and information are communicated accurately in a timely manner with appropriate stakeholders
- **Develop recommendations** to enhance systemwide communications coordination; ensure clear understanding of roles and responsibilities; and identify key system stakeholders and partners
- **Ensure clear understanding** of both internal and customer communications triggers and ownership

Prior and ongoing communications preparedness efforts highlights

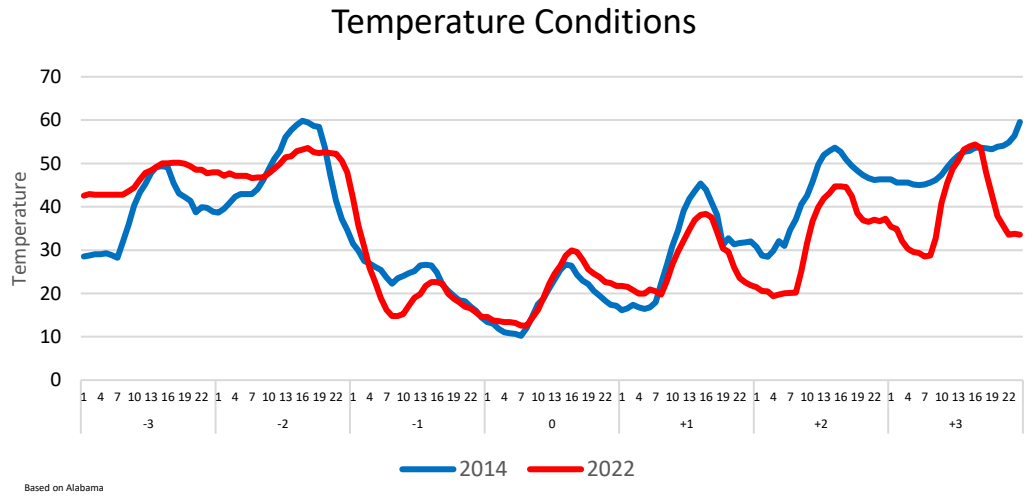
- Emergency Alert Procedure/Plan in place at PCC and each operating company TCC
- Commercial Operations & Bulk Power Operations leaders briefed System Public Relations Committee (Nov. 2021)
- Internal audit in 2022 of each operating company's respective Energy Emergency Alert/Load Shed Communication plan

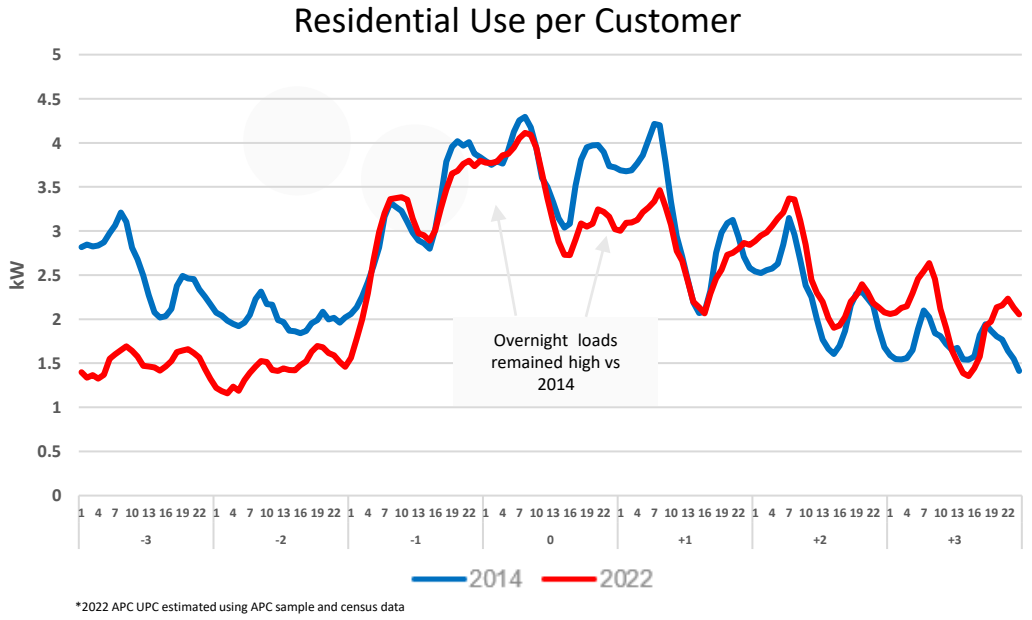
Feb. 22 System Customer Council with cross-functional stakeholders to review lessons learned & identify follow-up communications actions

What we know . . .

- Temperatures were similar to the 2014 event, but the underlying customer activities were very different.
  - 2014 – Post-holiday (January weekday) with businesses and residences ramping up to regular activity
  - 2022 – Holiday/Weekend (Christmas Eve) with business activity at low levels

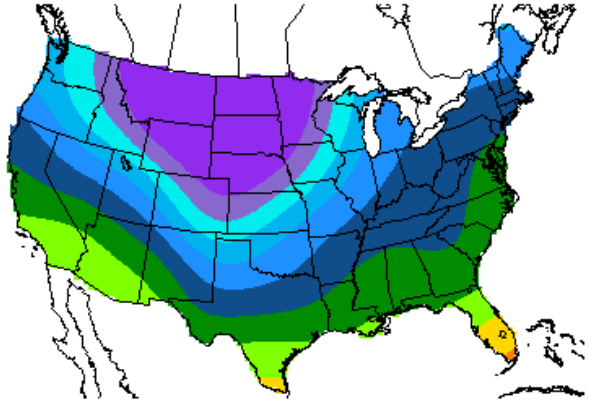
- Residential load was the primary driver of the shape and level of peak demands
  - Residential loads explain 94% of the movements in total peaks
    - » Stronger correlation than previous events
  - Unlike 2014, overnight residential loads and system loads did not decline



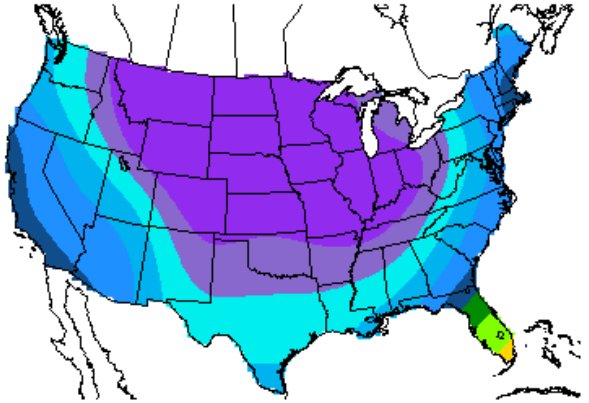


Note – Charts reflect Alabama data, but are representative of data from across the system

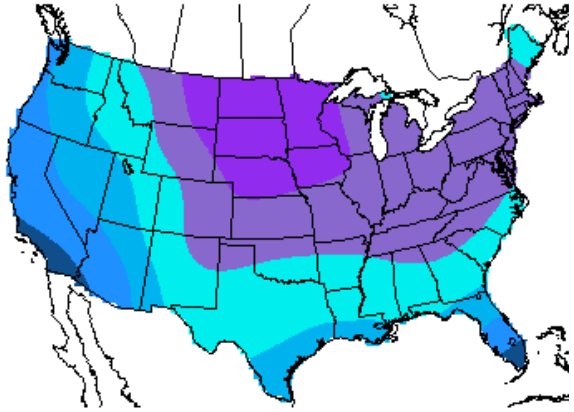
Weather event summary



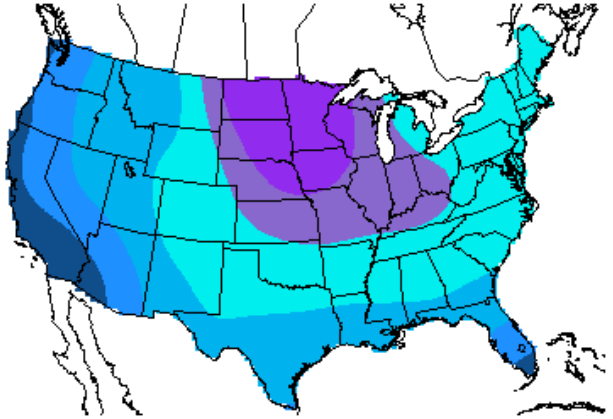
Thursday afternoon



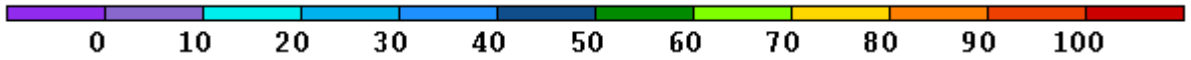
Friday morning



Saturday morning



Sunday morning



Serving reliably during Winter Storm Elliott

Winter Storm Elliott brought historic, extended frigid temperatures that drove electricity demand to the system's highest-ever December peak load. Teams across Southern Company Operations and the system worked tirelessly 24/7 to reliably serve customers, with strong coordination across the electric generating fleet, retail operating company transmission and distribution, Fleet Operations, Fuels and Energy Trading and Bulk Power Operations. The system retained sufficient reserves throughout the event.

Our reliability is supported by

- State-led IRPs that enable seasonal Target Planning Reserve Margin (25.5% winter) and associated resource plan and investments
- Year-round extreme-weather preparedness
- Design standards for winterization and hardening (e.g., for generation: 0°, 25-mph winds, 72 hours)
- Fuel supply assurance and diverse fuel mix
- Effective procedures, communication and training

As we addressed some system issues during Elliott, we benefited from

- Peaking generation from both steam units and dual-fuel resources not frequently operated
- Utilization of demand-side options and other system load-management resources
- Emergency Energy purchases across the peak demand hours (see timeline)
- Solar contribution

Extreme Christmas Eve cold
Atlanta, Birmingham and Gulfport
20-30°F below normal
(North Georgia low of 4°F)

Historic system hourly December peak load served
37,577 MW
Dec. 24, 7-8 a.m. CST
(All-time hourly integrated winter peak 39,130 MW Jan. 7, 2014)

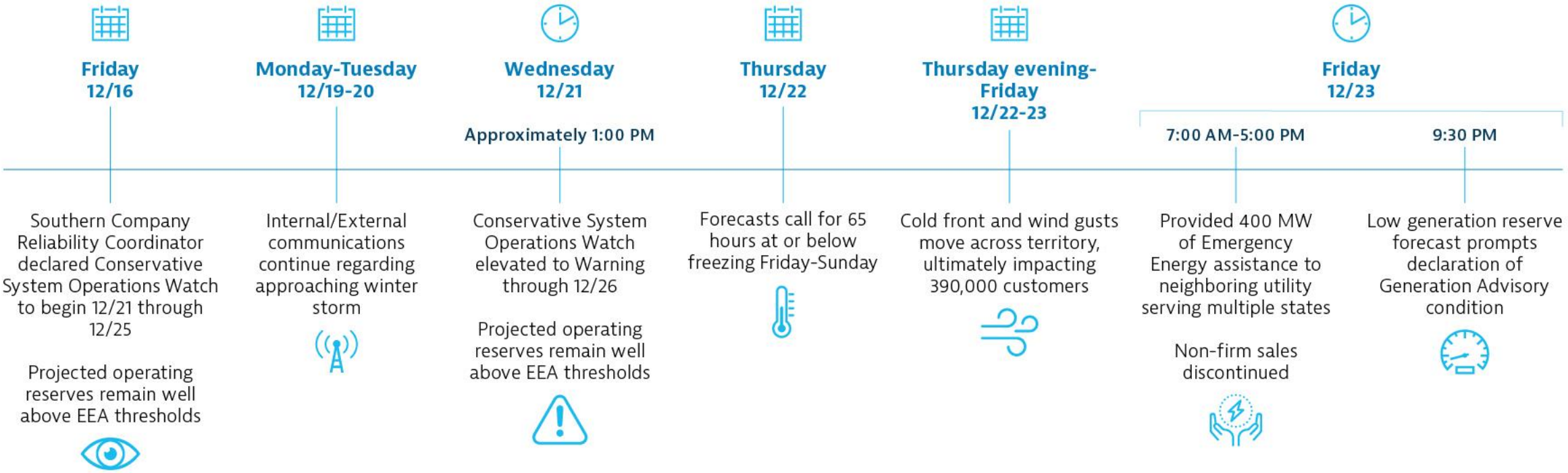
Average temperature on Dec. 24, 2022, coldest December since 1989
13°F for 5 consecutive hours

System weighted average temperature
≤30°F for 55 hours
≤20°F for 15 hours

Southern Company balancing area winter peak load
45,153 MW
Dec. 24, 7:53 a.m. CST
(All-time winter peak 45,887 MW Jan. 7, 2014)

Timeline

All times CST



Timeline

All times CST

Saturday, 12/24 (Christmas Eve)

Approximately 1:00 AM
EEA 1 declared by SBA due to increasing loads

1:10 AM-5:25 AM
EEA 1 actions included
Voltage reduction program
Additional system peaking capacity requested
Interruptible customer loads curtailed

5:25 AM
EEA 2 declared by SBA due to declining operating reserves and expected load increase
Emergency Energy assistance requested from neighbor utilities

6:00 AM-12:00 PM
Southern Company received 1000 MW of Emergency Energy assistance from Florida

7:00 AM-8:00 AM
Southern Company received 100 MW of Emergency Energy assistance from MISO
SBA Peak load 45,153 MW @ 7:53
Southern Company hits highest December peak on record – 37,577 MW

7:00 AM-12:00 PM
Southern Company provided 100 MW of Emergency Energy assistance to South Carolina

11:08 AM
Interruptible load restoration begins

12:00 PM - 7:00 PM
Southern Company provided 400 MW of Emergency Energy assistance to South Carolina

1:15 PM
EEA 2 downgraded to EEA 1 by SBA

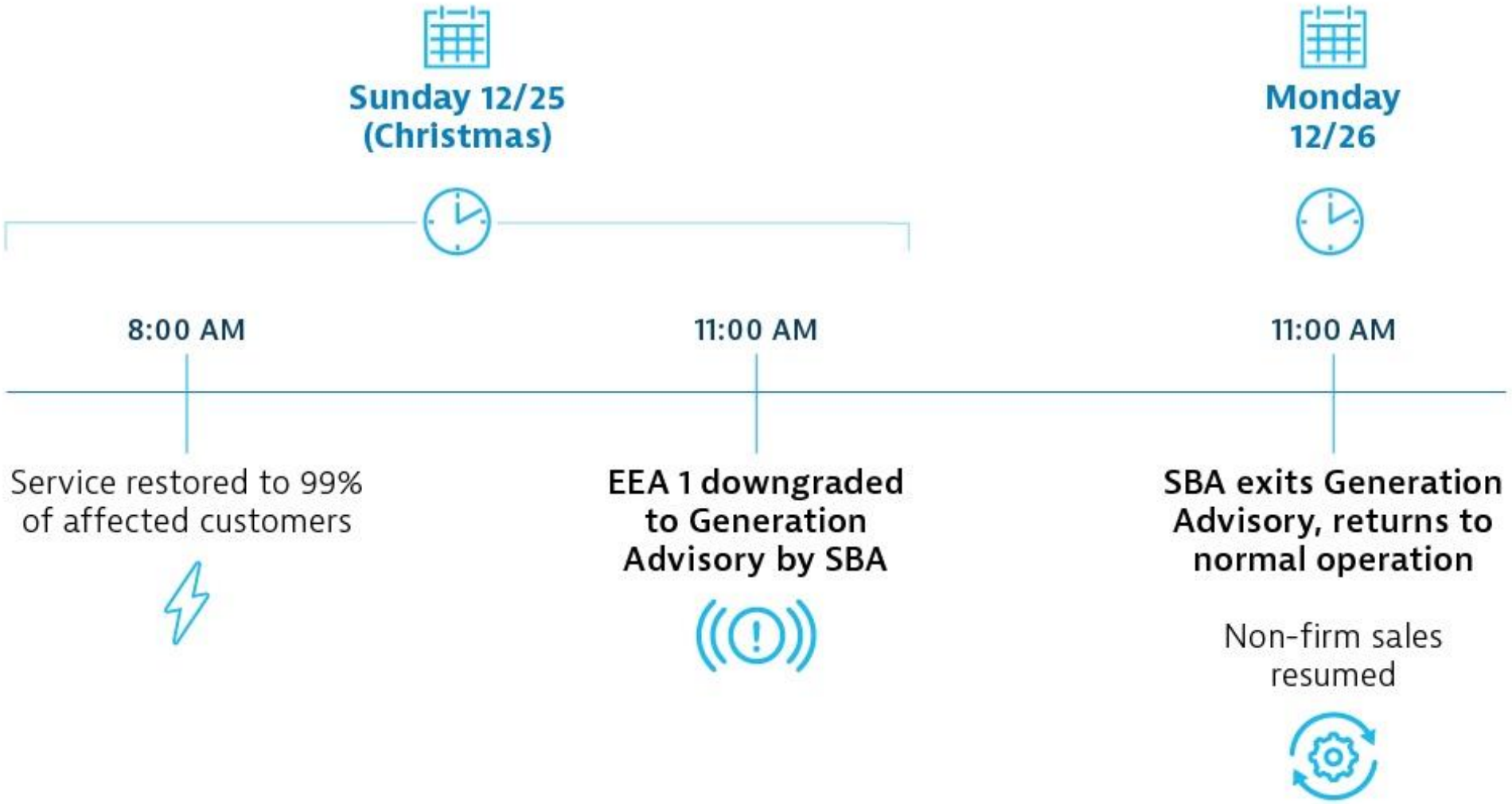
7:00 PM-9:00 PM
Southern Company provided 200 MW of Emergency Energy assistance to South Carolina

Starting at 8:00 AM
Reserve margin improves as loads begin to ease, some offline generating capacity is regained and solar ramps up

11:00 PM - 1:00 AM
~500 MW of gas/oil generating capacity forced offline

1:00 AM - 5:00 AM
Additional ~890 MW of gas/combined cycle generating capacity forced offline

Timeline


Sunday 12/25
(Christmas)
Monday
12/26
8:00 AM
11:00 AM
11:00 AM
Service restored to 99%
of affected customers
EEA 1 downgraded
to Generation
Advisory by SBA
SBA exits Generation
Advisory, returns to
normal operation
Non-firm sales
resumed

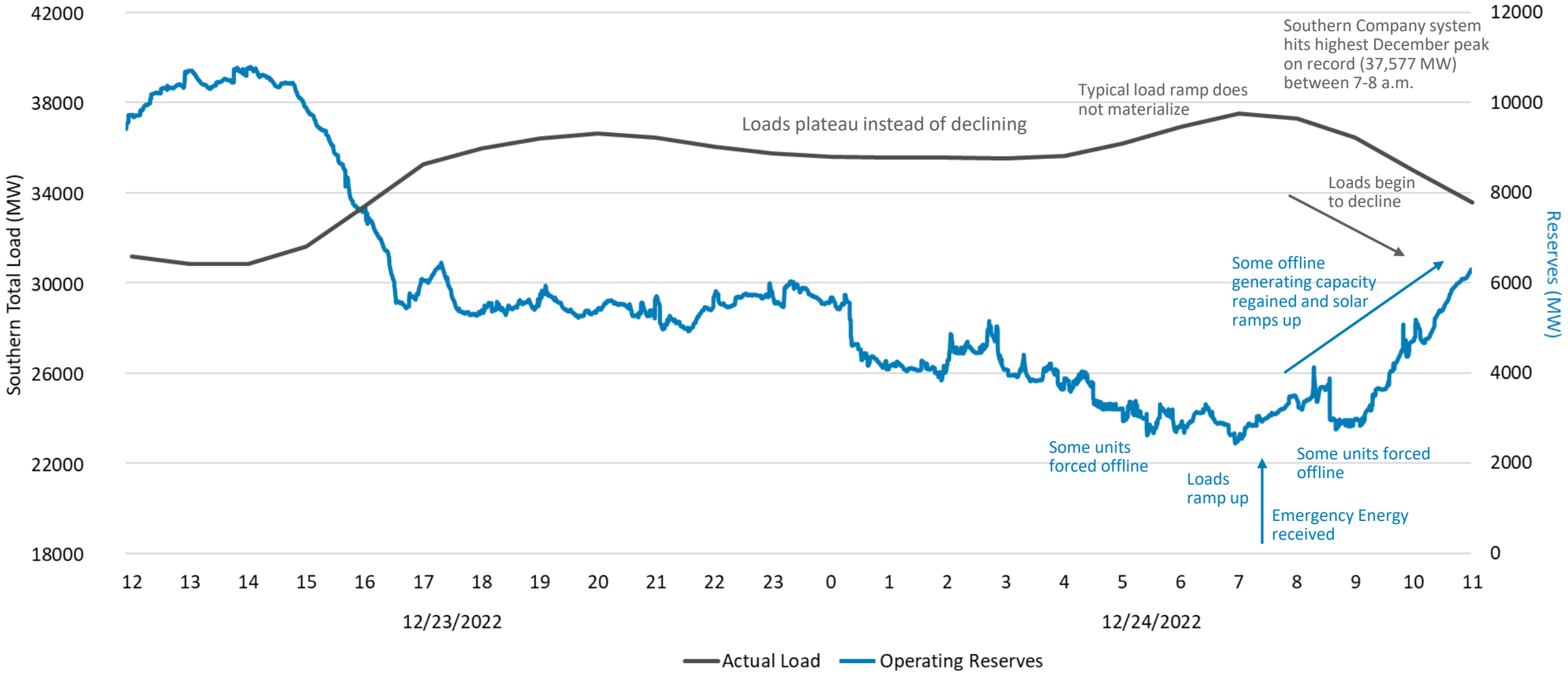
Winter Storm Elliott observations

- Establishment of a winter target planning reserve margin (25.5%) in 2019 supports reliability in extreme cold conditions.
- Loads during Elliott exceeded forecasts significantly; assessments of demand and load shapes are underway to improve forecasting during extreme cold weather events.
- Fuel assurance strategies and diverse fuel mix proved critical to reliable system operation.
- Extreme cold weather design changes adopted in 2020 were tested and should continue to be implemented.

- Generating fleet cold weather procedures were followed and proven effective.
- The Energy Emergency Alert process was appropriately executed by the Southern Balancing Authority.
- All generation resources and fuels contributed to serving peak demand hours and peak energy days.
- Collaboration across functional groups was pivotal to addressing real time issues.
- Internal and external communications can be improved to ensure clarity in processes and unity of message.

Learning continues in each of these areas to improve

Southern Company Load Served

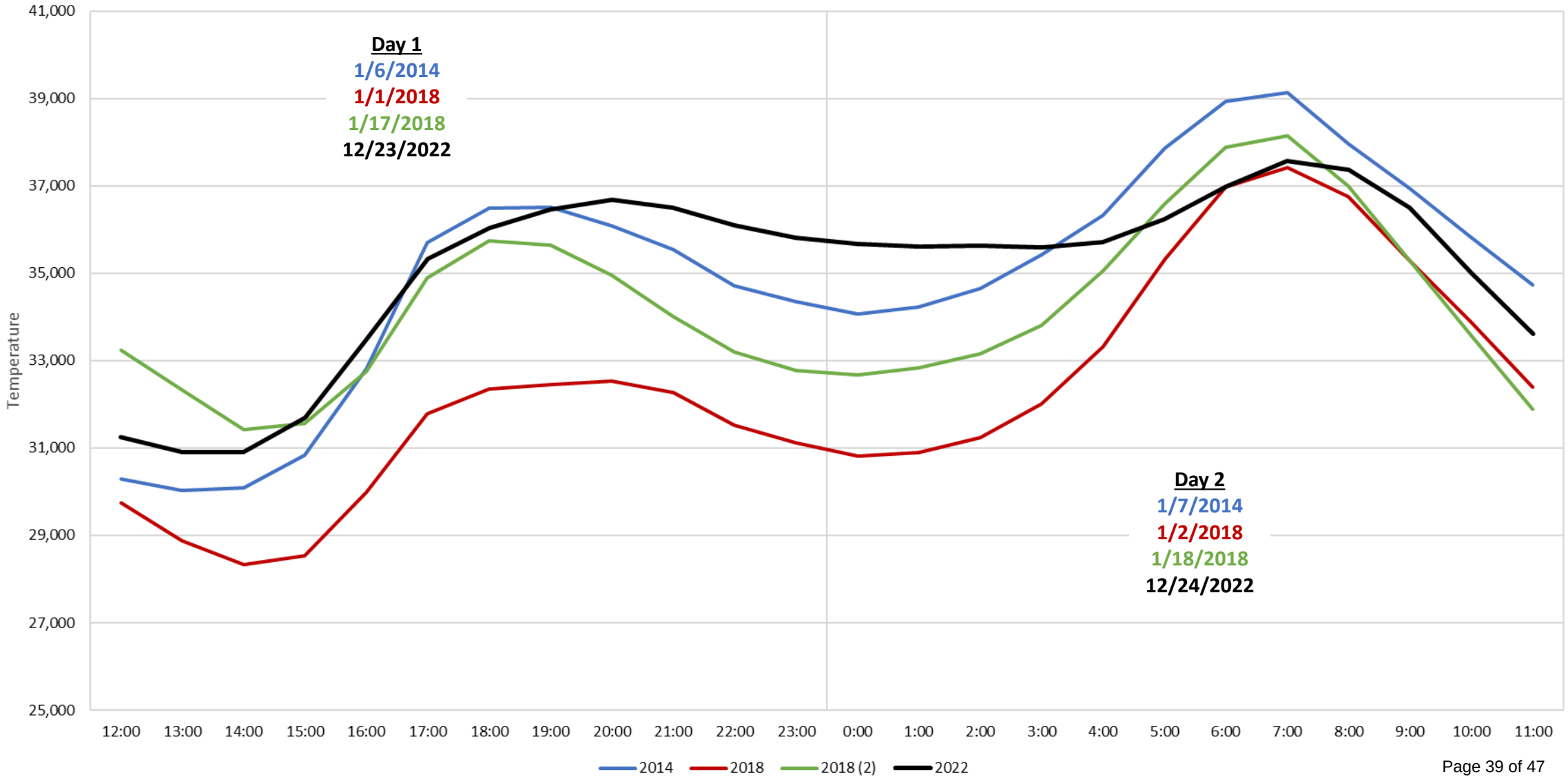


New Slides

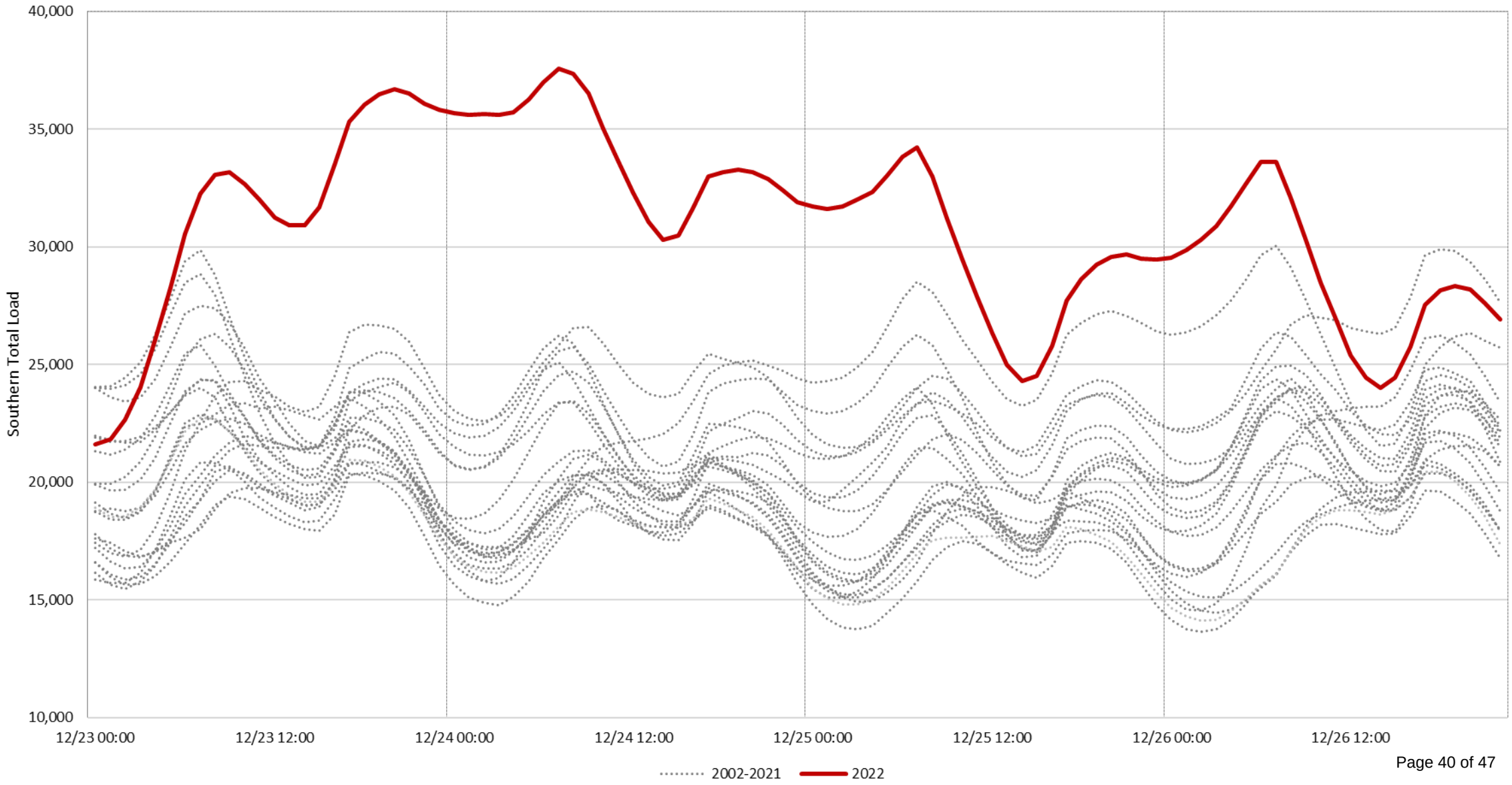


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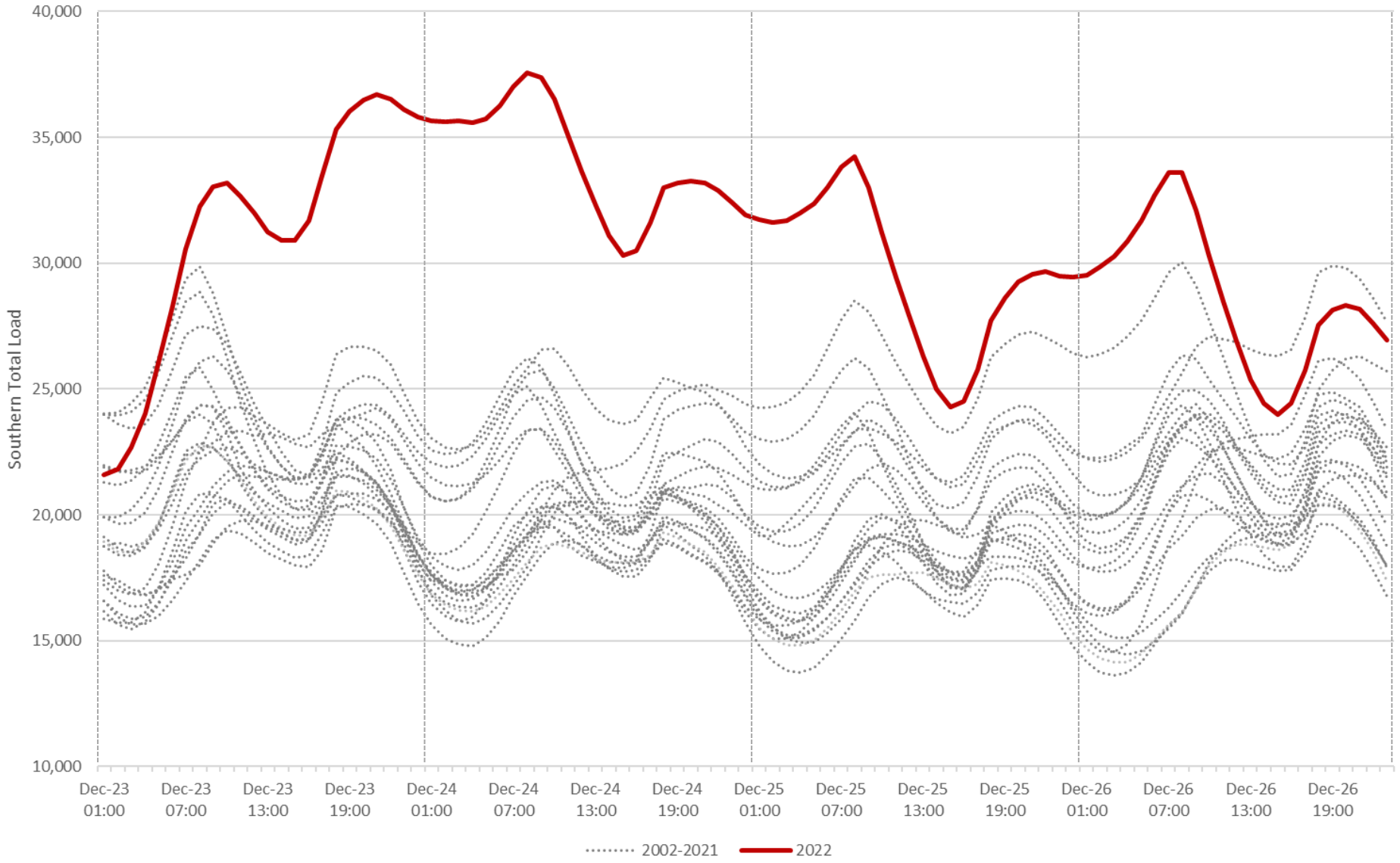
Comparable Winter Loads



Previous Christmas Loads



Highest Christmas Loads in the last 20 Years



Comparable Winter Loads

Overnight Plateau vs Valleys

