FEBRUARY 2021 WINTER STORM EVENT

PRESENTATION TO OKLAHOMA CORPORATION COMMISSION
LANNY NICKELL
EXECUTIVE VICE PRESIDENT & COO
SOUTHWEST POWER POOL

Updated 3/8/21

Helping our members work together to keep the lights on... today and in the future.
WHO IS SPP?

501(c)(6) nonprofit corporation

One of 9 regional grid operators

104 member companies in 14 states

“Air traffic control” for high-voltage grid

Balances supply and demand across region

Maintains reliable grid operations

Operates wholesale energy market

Plans future transmission needs
Supply to Demand

1: Energy supplied to grid must equal energy demands

2: Transmission system must be operated within safe, reliable limits

WHOLESALE ENERGY AND TRANSMISSION

Power plant generates electricity
Transformer steps up voltage for transmission
Transmission lines carry electricity long distances

Supply

Demand

SPP’s Reliability Objectives

RETAIL ENERGY AND DISTRIBUTION

Neighborhood transformer steps down voltage
Distribution lines carry electricity to homes and businesses
Transformers on poles step down electricity before it enters houses
# AIR TRAFFIC CONTROL: AN ANALOGY

<table>
<thead>
<tr>
<th>Air Traffic Control</th>
<th>Southwest Power Pool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not own airplanes, airlines or airports</td>
<td>Does not own utilities, power generators or transmission lines</td>
</tr>
<tr>
<td>Does not own the airspace it monitors</td>
<td>Does not own the land electricity flows across</td>
</tr>
<tr>
<td>Directs air routes to ensure airplanes and passengers are safely transported</td>
<td>Monitors and directs regional bulk power grid to ensure electricity gets from where it’s made to where it’s needed</td>
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</tbody>
</table>
THREE ELECTRIC INTERCONNECTIONS

1,270 MW potential transfer capability from Western to Eastern Interconnection

800 MW potential transfer capability between SPP and ERCOT
**NAMEPLATE CAPACITY**

94,648 MW

- Natural Gas (36,783 MW)
- Wind (27,458 MW)
- Coal (22,992 MW)
- Hydro (3,428 MW)
- Nuclear (2,061 MW)
- Fuel Oil (1,570 MW)
- Solar (235 MW)
- Other (121 MW)

*As of 1/13/21

**ACREDITED CAPACITY**

62,281 MW

- Natural Gas (28,230 MW)
- Wind (3,490 MW)
- Coal (23,986 MW)
- Hydro (2,716 MW)
- Nuclear (1,944 MW)
- Fuel Oil (1,455 MW)
- Solar (162 MW)
- Other (298 MW)

*As of 6/15/20

**2020 ENERGY PRODUCTION**

262.730 TWH

- Natural Gas (69,903 GWh)
- Coal (81,131 GWh)
- Nuclear (16,823 GWh)
- Fuel Oil (11,701 GWh)
- Solar (568 GWh)
- Other (323 GWh)

*As of 6/15/20
SPP’S EMERGENCY RESPONSE FRAMEWORK
## FERC AND NERC JURISDICTIONAL

- SPP and utilities must comply with mandatory, enforceable NERC standards.
- Government enacted reliability standards after 2003 blackout.
- NERC regularly audits SPP.
- NERC directs how much energy SPP must keep for emergencies.
- FERC approves NERC standards.
- SPP must comply with FERC directives.
CONTINUAL EMERGENCY TRAINING

• Year-round planning for worst-case scenarios & cold weather events
• NERC certifies operators & approves SPP training program
• Operators receive 85-100 training hours per year
• In 2020, SPP provided 26,000 hours of training to 251 organizations
• In 2020, SPP drilled with MISO, CAISO & our joint operating companies
# BALANCING AUTHORITY (BA) OPERATING LEVELS

<table>
<thead>
<tr>
<th>Levels/alerts defined by SPP operating plans</th>
<th>Levels defined* by NERC EOP-011-1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal Operations</strong></td>
<td><strong>Energy Emergency Alert (EEA)</strong></td>
</tr>
<tr>
<td>SPP has enough generation to meet demand, has available reserves and does not foresee extreme or abnormal reliability threats</td>
<td><strong>Level 1</strong></td>
</tr>
<tr>
<td><strong>Weather alert</strong></td>
<td><strong>Load management procedures in effect</strong></td>
</tr>
<tr>
<td>SPP expects extreme weather in its reliability coordination service territory</td>
<td><strong>Level 2</strong></td>
</tr>
<tr>
<td><strong>Resource alert</strong></td>
<td><strong>Firm load interruption imminent or in progress</strong></td>
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<tr>
<td>SPP’s BA area expects severe weather conditions, significant outages, wind-forecast uncertainty and/or load-forecast uncertainty with potential to impact total capacity.</td>
<td><strong>Level 3</strong></td>
</tr>
<tr>
<td><strong>Conservative Operations</strong></td>
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<tr>
<td>SPP determines the need to operate system conservatively to avoid an emergency based on weather, environmental, operational, terrorist, cyber or other events</td>
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<tr>
<td><strong>Maximum emergency generation notification</strong></td>
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<tr>
<td>SPP foresees the need to use emergency ranges of resources for a certain hours.</td>
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2021 WINTER STORM GRID EMERGENCY
THE BIG PICTURE

Early prep helped
2/4: Issued cold weather alert
2/8: Issued resource alert
2/11: Committed long-lead generation

Public appeals reduced demand
Demand dropped below forecast, helping minimize interruptions

We used every MW we could get
We ran every available generator and imported energy from neighbors

Service interruptions required
2/15 ~1.5% of system demand for 57 min.
2/16 Up to ~6.5% of system demand for 3 hr. 23 min.

Collaboration reduced impact
Controlled, temporary interruptions prevented uncontrolled blackouts
HISTORIC WEATHER EVENT

• 73% of mainland U.S. covered in snow
• 3,000 daily and 79 all-time local low temperature records broken
• “Comparable to the historical cold snaps of Feb. 1899 & 1905.”

1 – National Operating Hydrologic Remote Sensing Center
2 – National Weather Service Weather Prediction Center
3 – National Weather Service Weather Prediction Center
SPP REGION IN COLDEST PART OF U.S.

Lower temperatures forecast for Feb 14-16, 2021
Sources: National Weather Service, Global Forecast System

- SPP service territory/balancing authority
- Temperatures below 0°F
- Between 0°F and 32°F
- Above 32°F

* Locations of ISOs/RTOs are approximate
DRIVERS OF TEMPORARY SERVICE INTERRUPTIONS

1. Generation unavailability
   • Lack of fuel supply
   • Icing and extreme cold weather-related outages

2. Rapid reduction of energy imports
   • Related to transmission congestion
   • Tightening supply conditions in neighboring areas

3. Record winter energy consumption
ADVANCE PREPARATIONS

- **Alerted** operators as conditions changed
- **Rescheduled** transmission & generation maintenance outages
- **Committed** generation that takes days to ramp up
- **Invited** members’ communications & government affairs staff to briefings
- **Issued** public appeals to conserve power
- **Updated** regulators
# SPP Balancing Authority Operations: Feb. 4-20, 2021

## Time Blocks are Not to Scale

<table>
<thead>
<tr>
<th>Thurs. 2/4 to Mon. 2/8</th>
<th>Tues 2/9 to Sat. 2/13</th>
<th>Sun. 2/14</th>
<th>Mon. 2/15</th>
<th>Tues. 2/16</th>
<th>Wed. 2/17</th>
<th>Thurs. 2/18</th>
<th>Fri. 2/19</th>
<th>Sat. 2/20</th>
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<tbody>
<tr>
<td>Normal Operations in Effect</td>
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<td>Normal Operations in Effect</td>
<td>EEA2 in Effect</td>
<td>EEA1 in Effect</td>
<td>EEA1 in Effect</td>
<td>Conservative Operations in Effect</td>
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<tr>
<td><strong>Thurs. 2/4:</strong> Issued cold weather alert to grid operators</td>
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<td></td>
<td>05:00 - Declared EEA1</td>
<td>06:15 - Declared EEA3</td>
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<td><strong>Thurs. 2/9:</strong> Declared conservative operations until further notice</td>
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<td>07:22 - Declared EEA2</td>
<td>06:44 - Demand interruption</td>
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<td><strong>Thurs. 2/11:</strong> Committed longer-lead time generating resources for Sat. 2/13 to Tues. 2/16</td>
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<td>10:08 - Declared EEA3 New record peak</td>
<td>10:07 – EEA3</td>
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<td><strong>Sat. 2/13:</strong> Reminded market participants of emergency cap &amp; offer processes</td>
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<td>12:04 - Demand interruption</td>
<td>11:30 - Declared EEA2</td>
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<td><strong>Mon. 2/15:</strong> Declared EEA1 to be effective 2/15 at 05:00</td>
<td>Requested member companies issue public appeals for conservation</td>
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<td>13:01 - EEA3</td>
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<td><strong>Mon. 2/16:</strong> EEA2 in effect</td>
<td>12:31 - Declared EEA2</td>
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<td>13:15 - Declared EEA1</td>
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<td>14:00 - Declared EEA2</td>
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<td>18:28 - Declared EEA2</td>
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<td>18:20 - Declared EEA2</td>
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<td>22:59 - Declared EEA1</td>
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<td>Conservaive Operations in Effect</td>
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AFTER THE STORM

• Collaborate with members and industry to ensure region is equipped to manage future crises effectively
• Comply with FERC and NERC inquiries
• Review processes for improvement areas
• Document lessons learned
ESSENTIAL POINTS

Our large, interconnected network minimized interruptions

- SPP’s transmission operators and neighboring regions all shared energy
- Helping each other in all directions minimized impacts to any one entity

Diverse generation mix gave flexibility during storm response

- Many types of generators provided power
- Because all fuel sources and generators are subject to problems in extreme weather, we needed many sources to call on

We avoided widespread, severe blackout by:

- Working closely with our neighbors
- Following NERC regulations and executing training scenarios
- Directing short curtailments to prevent grid from cascading out of control
OPERATIONS DATA
AVAILABLE GENERATION IN SPP MARKET

Extreme weather reduced available generation by ~20 GW below historical Feb. average
Appr. 42% of nameplate capacity and 65% of accredited capacity in SPP was available during EEA3 periods.
Appr. 26-28% of nameplate capacity in OK was available during EEA3 periods.
For wind generation in SPP, 3.5-4.6% of nameplate capacity and 95-123% of accredited capacity was available during EEA3 periods.
During the EEA3 events, wind in OK contributed nearly half of SPP's wind on the 15th but dropped to about 12% of SPP's wind on the 16th.
For coal generation in SPP, 71-75% of accredited capacity was available during EEA3 periods.
During the EEA3 events, coal gen. in OK supplied 8% of available coal gen in SPP on the 15th and 14% of available coal gen in SPP on the 16th.
For gas generation in SPP, 45-50% of accredited capacity was available during EEA3 periods.
During the EEA3 events, gas gen. in OK supplied 36% of available gas gen in SPP on both the 15th and 16th.
During peak conditions, gas generation contributed to ~60% of total unavailability.

Wind generation outages ~5x more than first week of Feb.

**GENERATING CAPACITY OUTAGES**

During peak conditions, gas generation contributed to ~60% of total unavailability.

Wind generation outages ~5x more than first week of Feb.
Up to 35,000 MW of generating capacity unavailable to meet demand

Nearly 2.5x more outages than first week of Feb.
GENERATION SUPPLY VS. DEMAND

SPP directed controlled service interruptions when imports were curtailed. Controlled service interruptions were effective.

Monday

Tuesday
2/15 LOAD & ONLINE GENERATION WITH NET ENERGY IMPORTS

SPP issued EEA3 when unable to maintain required reserves
Reduced imports created supply vs. demand imbalance

Online Generation & Scheduled
BA Load
BA Load & Contingency Reserves
Interchange

Morning outage & fail-to-start total 3,790 MW

10:08 EEA3

12:04 SPP directed 610 MW of firm load shed

Upcoming hour schedule curtailments begin (2,500 MW imports)

13:01 SPP instructed firm load restoration

14:00 EEA2
At times, SPP was importing significant amounts of energy.
2/16 LOAD & ONLINE GENERATION WITH NET ENERGY IMPORTS

SPP issued EEA3 when unable to maintain required reserves, caused by dwindling supply and higher demand.
**2/16 NET ENERGY IMPORTS**

At times, SPP was importing significant amounts of energy, although less than what had been available day prior.

Schedule mismatch caused units to ramp down

- **06:15** EEA3
- **06:44** SPP directed 1,359 MW of firm load shed
- **07:17** SPP directed 1,359 MW of additional firm load shed
- **11:30** EEA2
- **12:31** EEA1
- **09:32** instructed restoration of 1,359 MW
- **10:07** instructed restoration of remaining 1,359 MW
ENERGY THAT MET DEMAND IN REAL-TIME MARKET

SPP relied on energy from multiple sources, including imports from neighbors.
AVERAGE SUPPLY MIX
DURING FEBRUARY 15 CONTROLLED SERVICE INTERRUPTIONS

- Coal (16.8 GW) 39.2%
- Natural Gas (12.8 GW) 29.8%
- Imports (4.8 GW) 11.2%
- Wind (3.3 GW) 7.6%
- Hydro (2.1 GW) 4.8%
- Nuclear (2.0 GW) 4.8%
- Other (955 MW) 2.2%
- Solar (167 MW) 0.4%
AVERAGE SUPPLY MIX
DURING FEBRUARY 16 CONTROLLED SERVICE INTERRUPTIONS
SPP CAPACITY – BEGINNING OF DEMAND REDUCTION

Online Capacity by State/Zone
February 15, 2021 12:05 PM

Online Capacity by State/Zone
February 16, 2021 6:45 AM
AVERAGE SPP CAPACITY – DURING HOUR OF LOAD RESTORATION

Online Capacity by State/Zone
February 15, 2021 1 PM

Online Capacity by State/Zone
February 16, 2021 10 AM
# INTERRUPTIONS BY ENTITY

<table>
<thead>
<tr>
<th>Participating Entity</th>
<th>% of MW</th>
</tr>
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<tbody>
<tr>
<td>CSWS</td>
<td>16.8</td>
</tr>
<tr>
<td>WAPA</td>
<td>13.5</td>
</tr>
<tr>
<td>SPS</td>
<td>12.4</td>
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<td>OKGE</td>
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<td>KCPL</td>
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<td>WR</td>
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<td>NPPD</td>
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<td>SPA</td>
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<tr>
<td>TSGT</td>
<td>0.13</td>
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<tr>
<td><strong>SPP Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Notes: 1) Transmission operators with significant load in Oklahoma are highlighted. 2) CSWS includes PSO and SWEPCO. 3) Allocation percentages are predetermined based on pro-rata share of previous winter season’s energy consumption.

Graph:
- **Load Shed MW**
  - 2,718 MW (~6.5% of BA Load)
  - 1,359 MW (~3.2% of BA Load)
  - 610 MW (~1.5% of BA Load)

Directed interruptions allocated to transmission operators on pro-rata basis.
CONTACT SLIDE

Communications

Please feel free to contact us at communication@spp.org if you need help with the PPT, need modifications or would like to add a slide to the template.