NEBRASKA WIND AND SOLAR CONFERENCE

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SYSTEM PLANNING

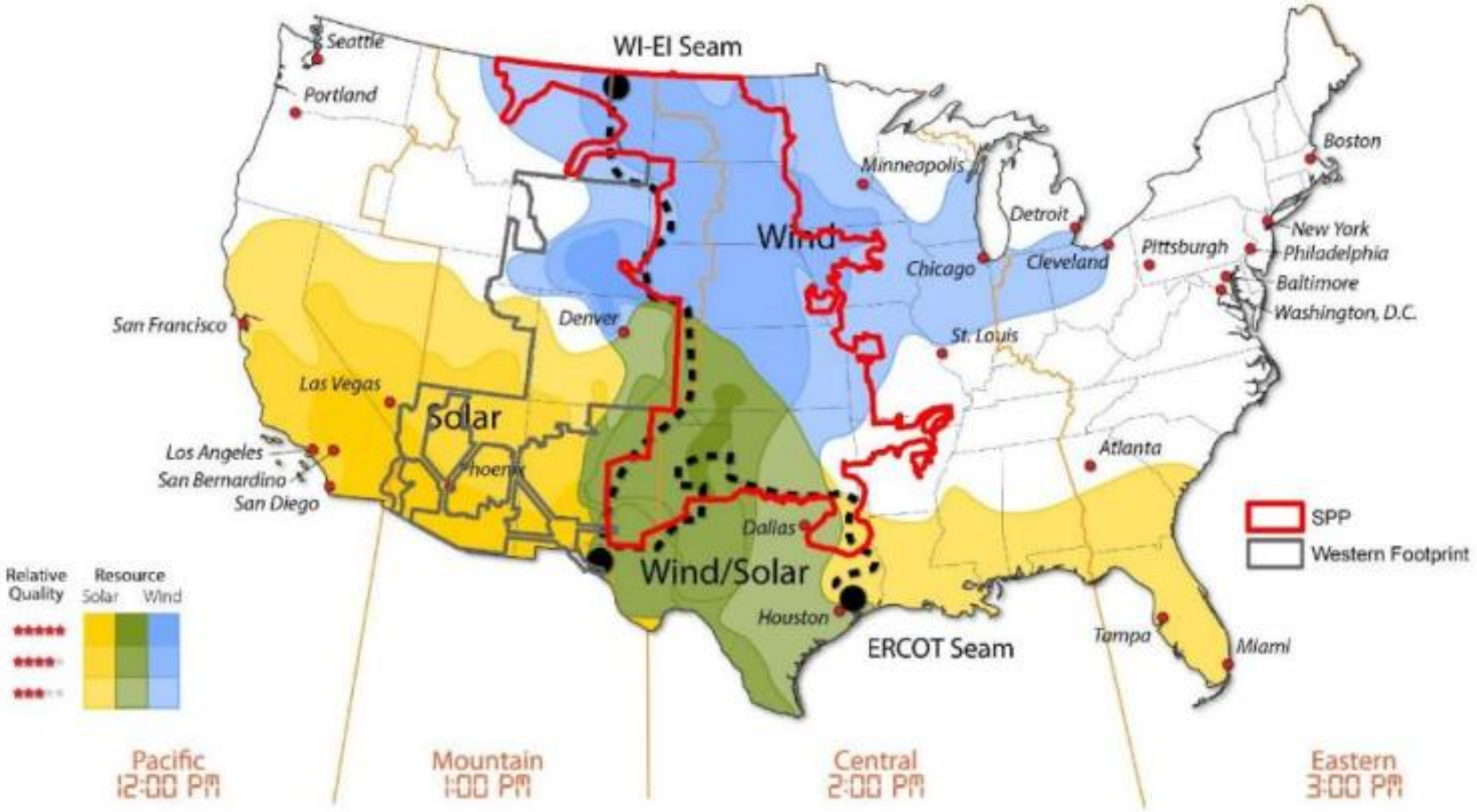
FEBRUARY 11, 2021

OVERVIEW

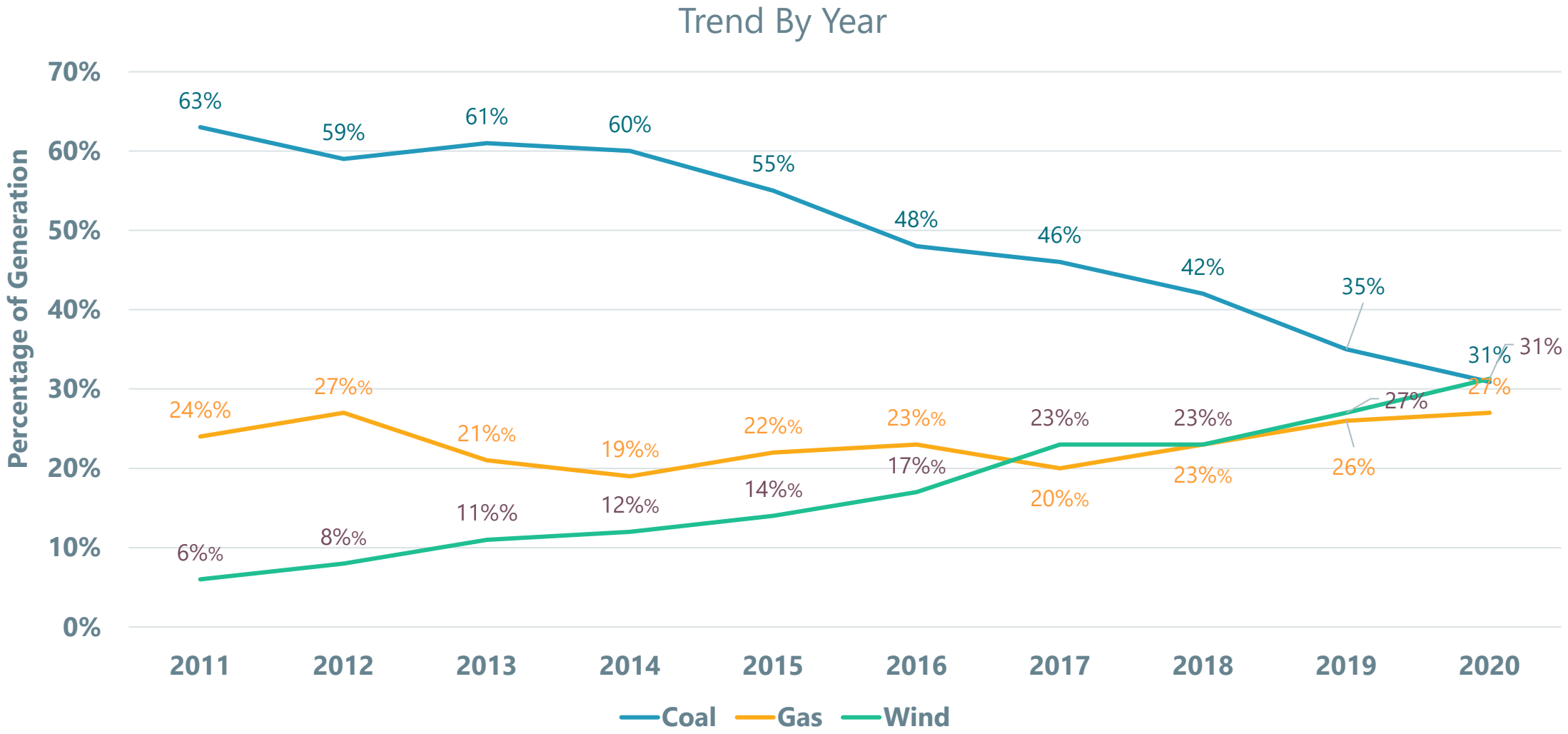
- Continuing change in generation mix
- State-level data
- State of the Generation Interconnection (GI) queue
- What does the future hold?
- Strategic and creative re-engineering of integrated planning team (SCRIPT)

CONTINUING CHANGE IN GENERATION MIX

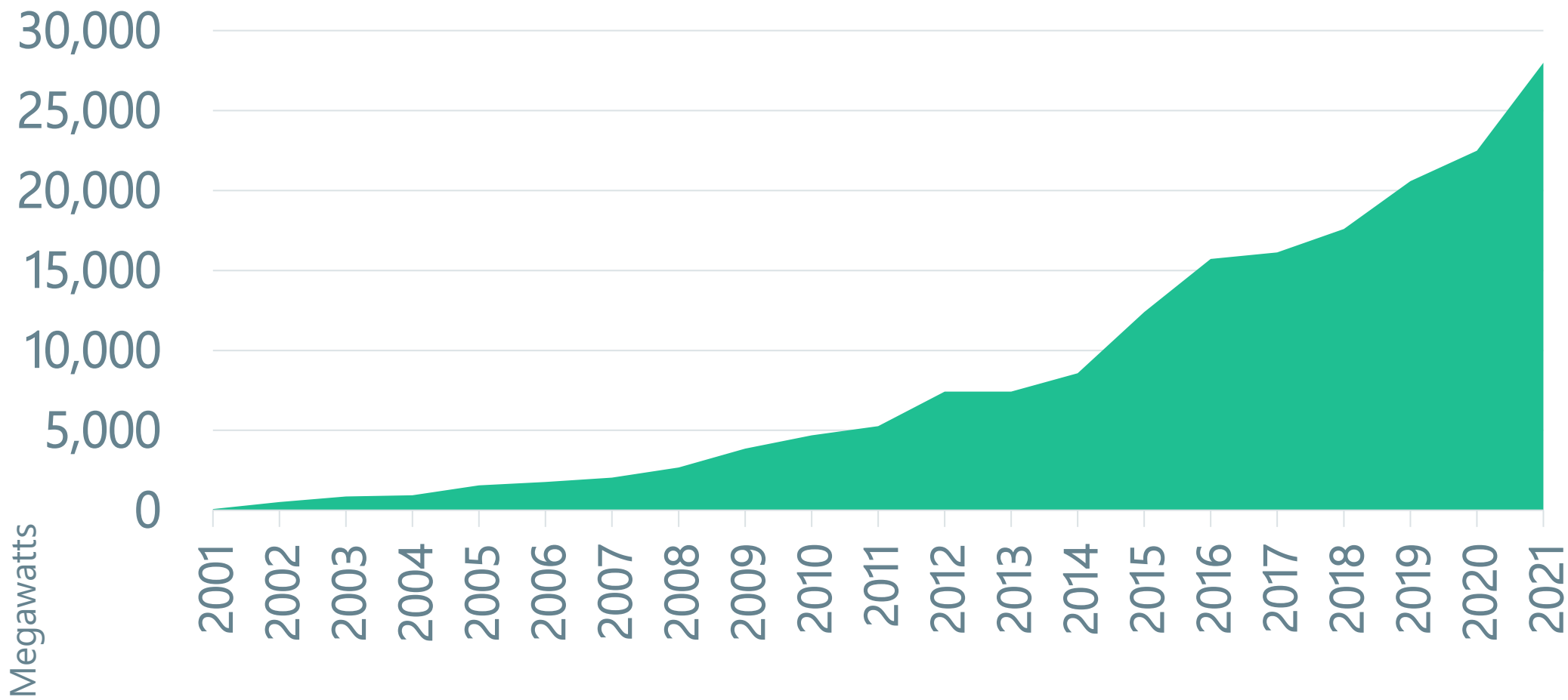
WIND AND SOLAR IN SPP



OUR EVOLVING ENERGY MIX

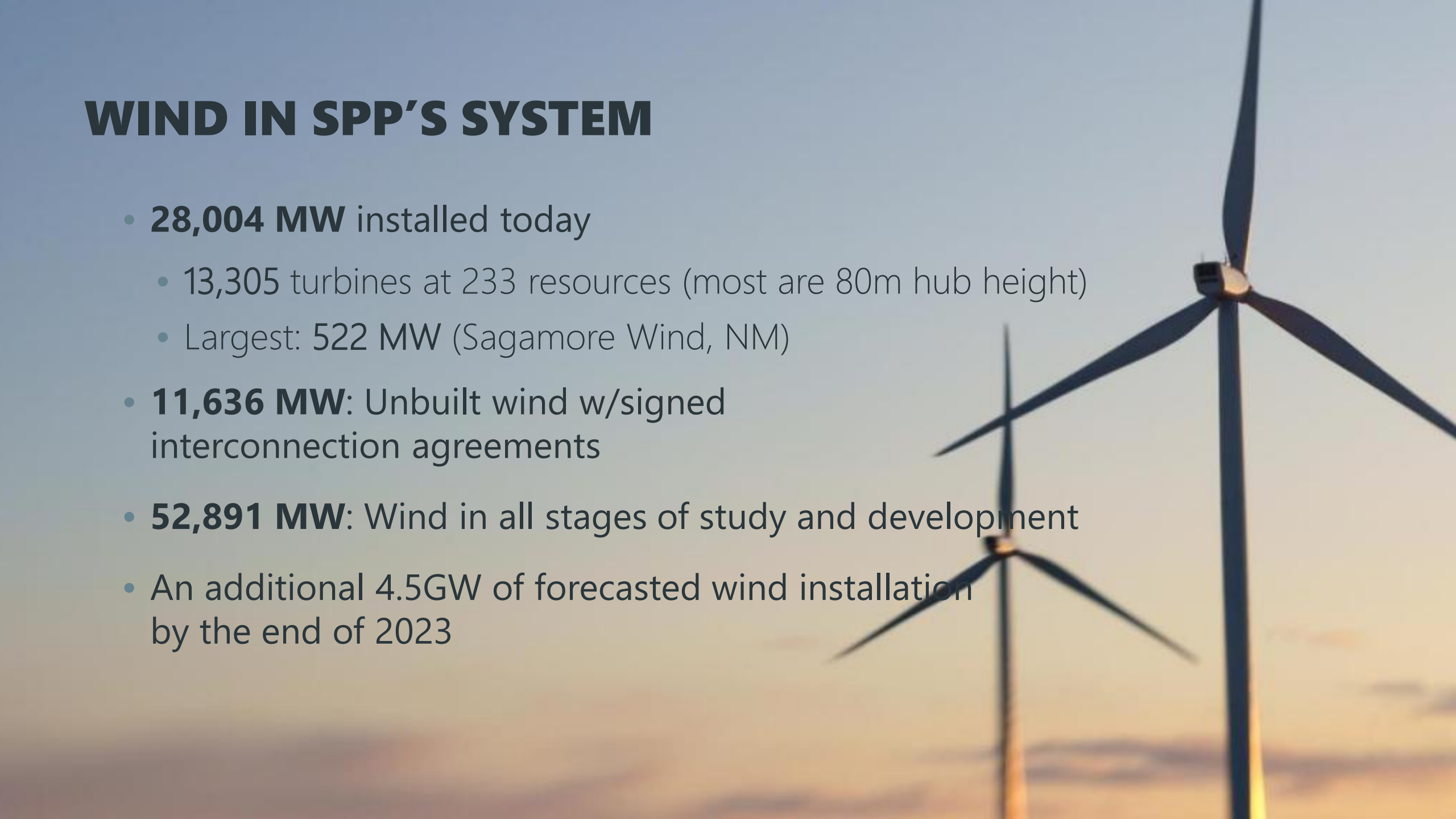


INSTALLED WIND CAPACITY BY YEAR



WIND IN SPP'S SYSTEM

- **28,004 MW** installed today
  - 13,305 turbines at 233 resources (most are 80m hub height)
  - Largest: 522 MW (Sagamore Wind, NM)
- **11,636 MW**: Unbuilt wind w/signed interconnection agreements
- **52,891 MW**: Wind in all stages of study and development
- An additional 4.5GW of forecasted wind installation by the end of 2023



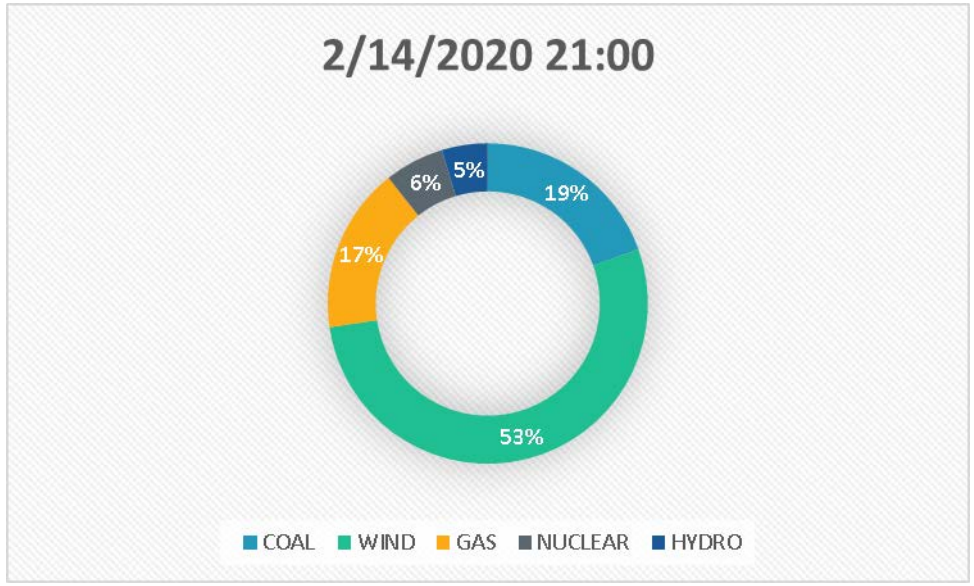
WIND PENETRATION IN SPP

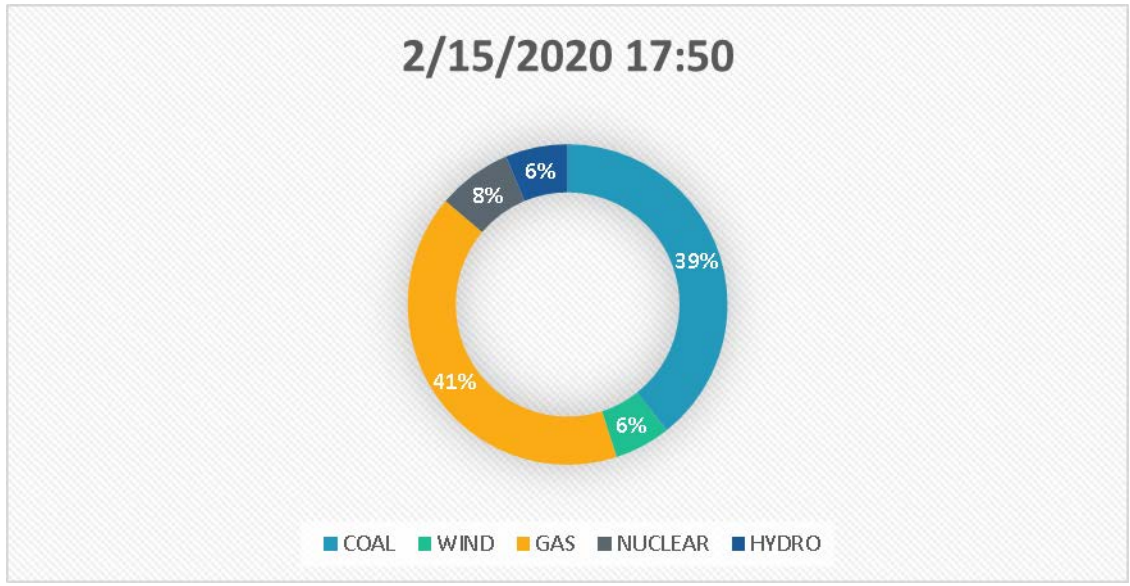
- Maximum wind output: **20,108 MW** (2/4/2021)
- Minimum wind output (last 12 mos.):
  252.3 MW (1/9/21 @ 10:06)
- Maximum wind penetration: **73.2%** (4/27/20)
- Average wind penetration (2020): **32.6%**
- Max wind swing in one day: >16 GW on Dec. 11-12, 2019
  (17.9 GW to 1.7 GW in 21 hours)
- Max 1-hour ramp: **3,700 MW**

DIFFERENCE A DAY MAKES

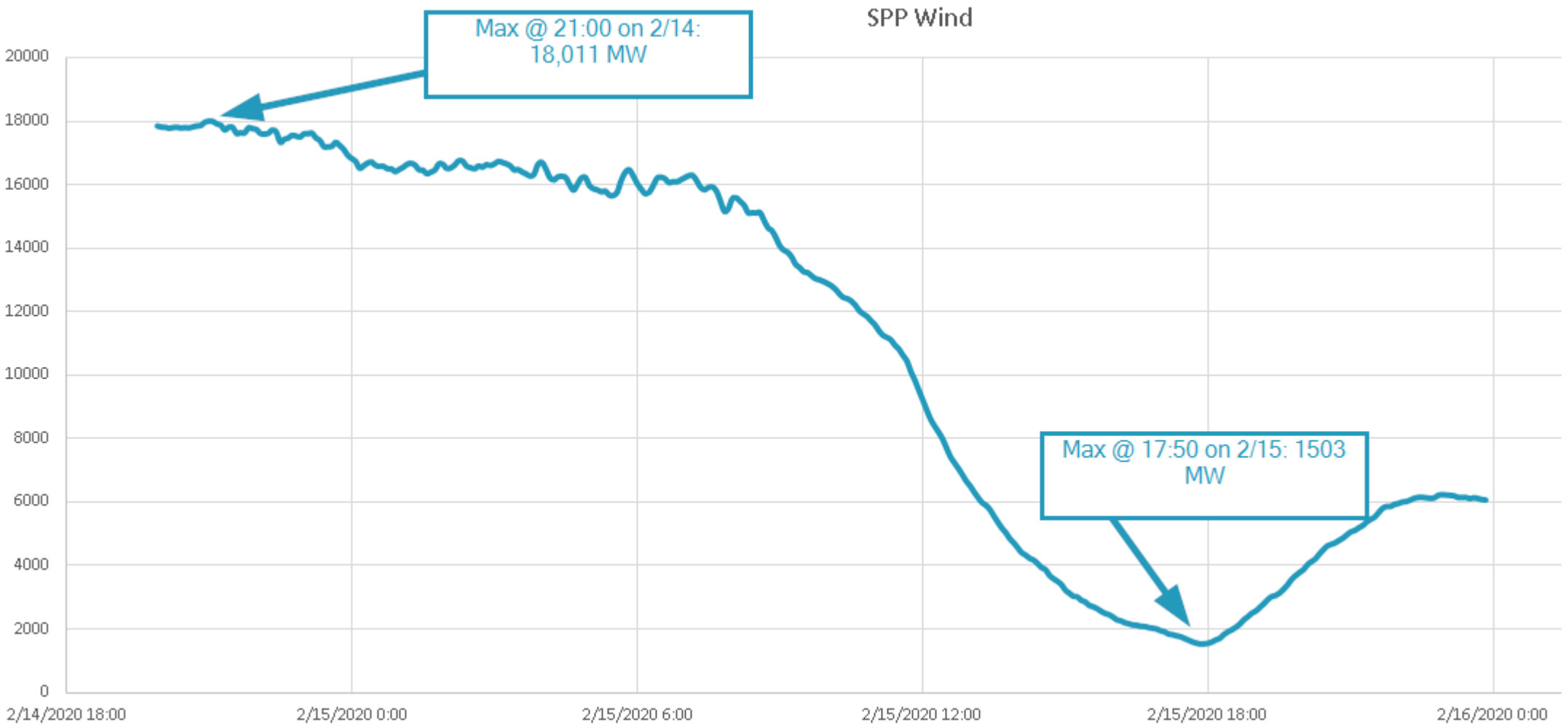
- 02/14/20 21:00, 17955 MW of wind served 53% of load
- Next day, wind shrank to 6% and other sources ramped up
- We need diverse fuel mix to accommodate all circumstances

Approx.
21 hours later

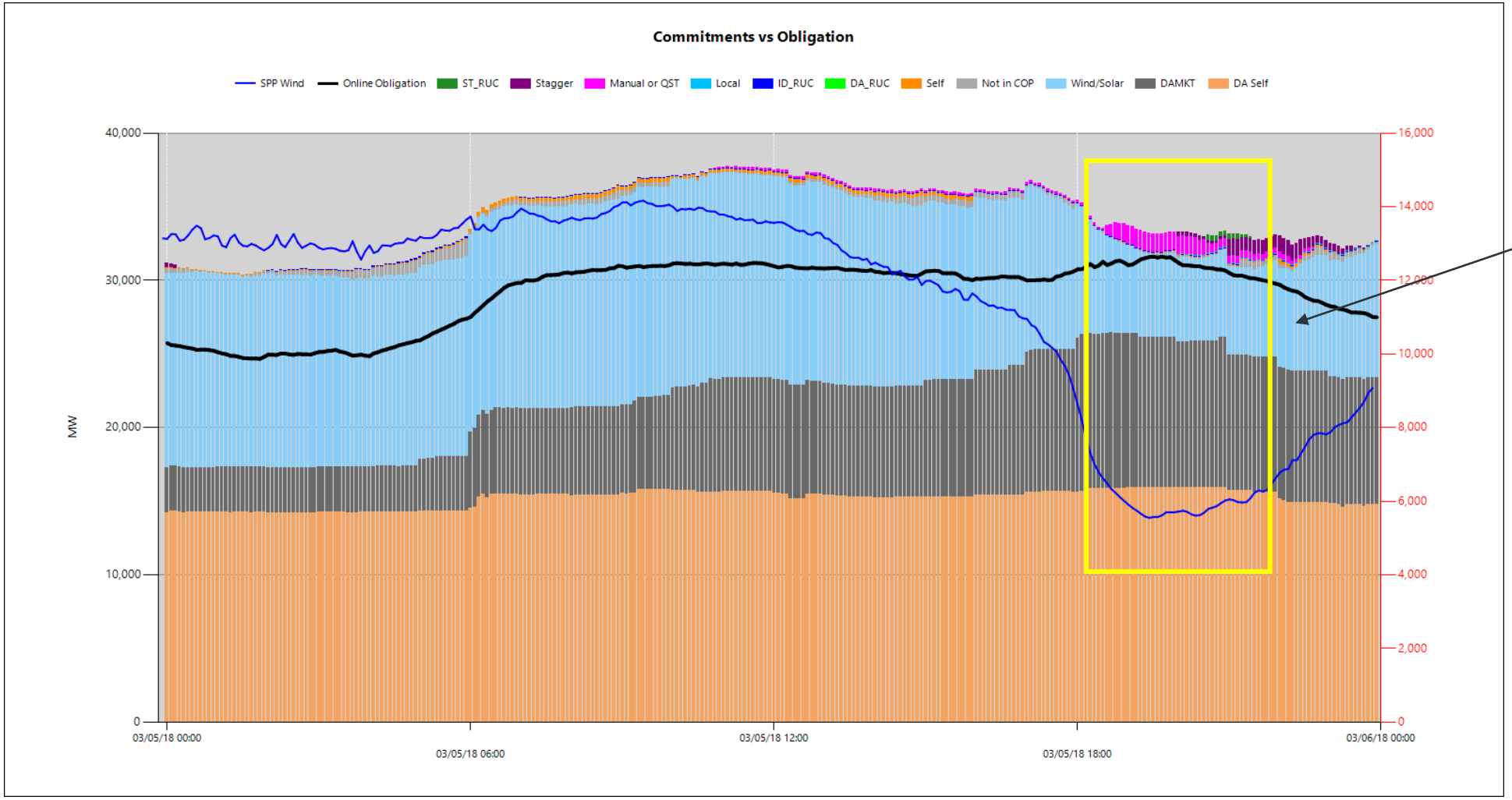




WHY FUEL DIVERSITY MATTERS: SPP'S RECORD WIND SWING (16.5 GW IN 21 HOURS)

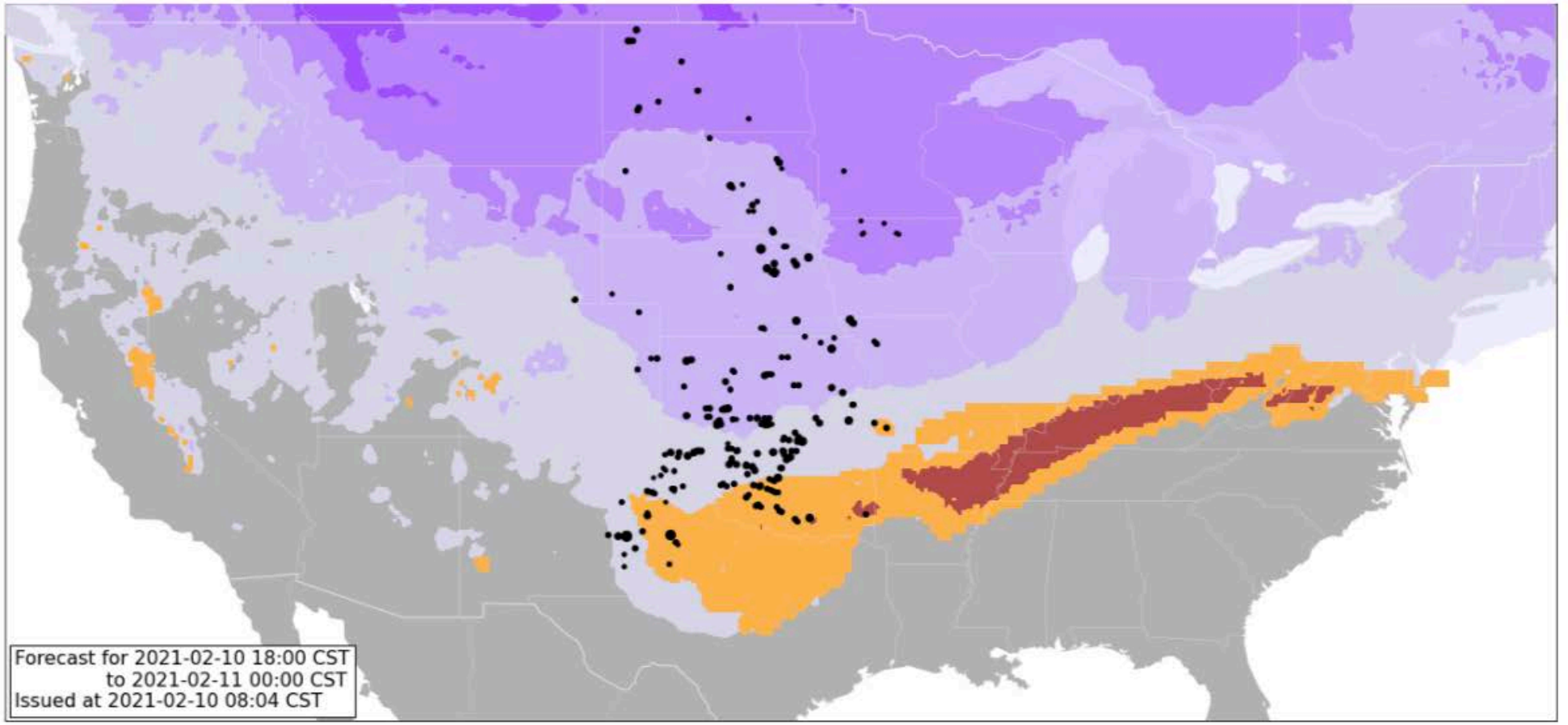


EXAMPLE SCENARIO: LARGE 1-HOUR WIND DROP

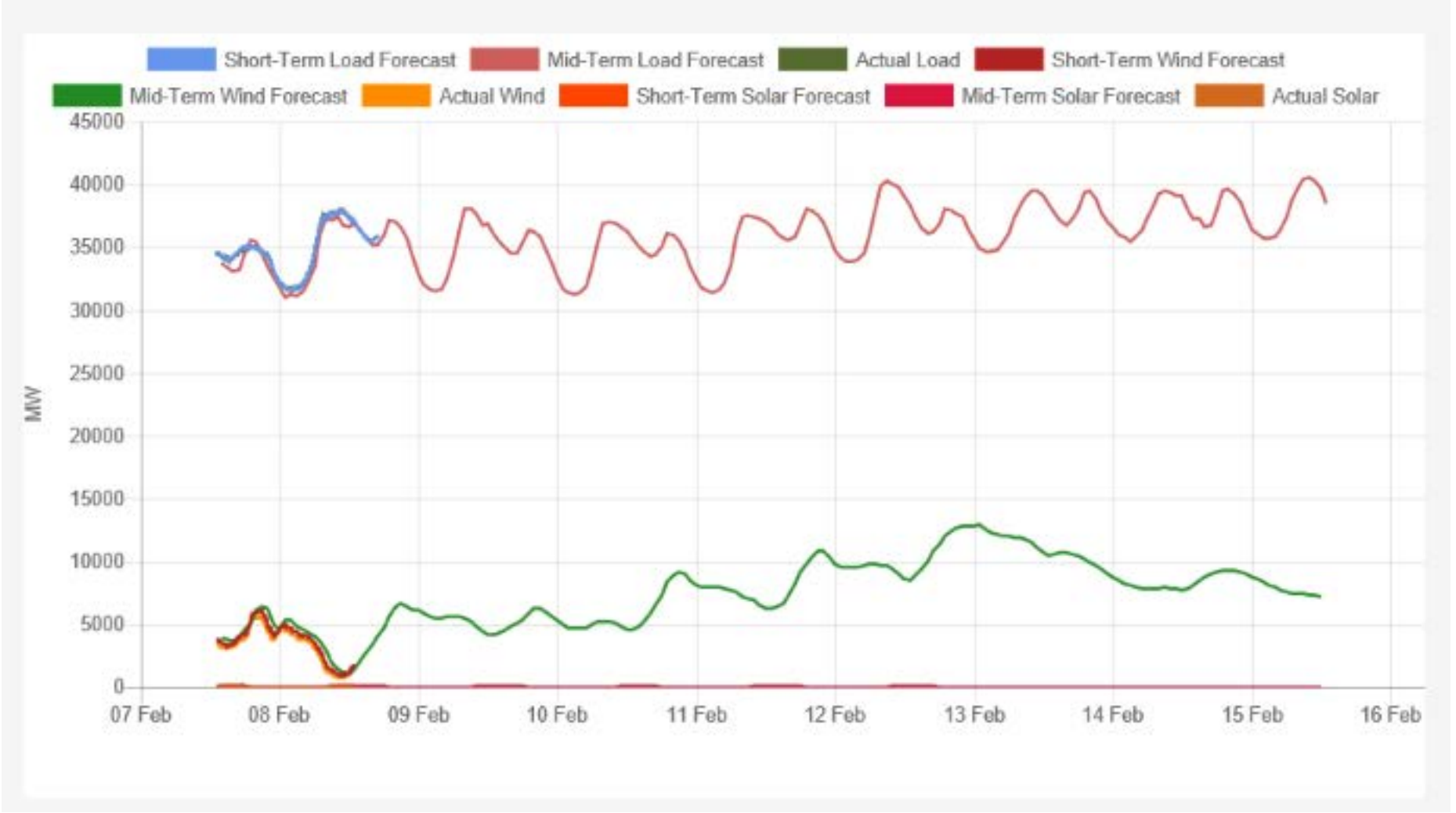


Danger Zone

ICING LAST NIGHT



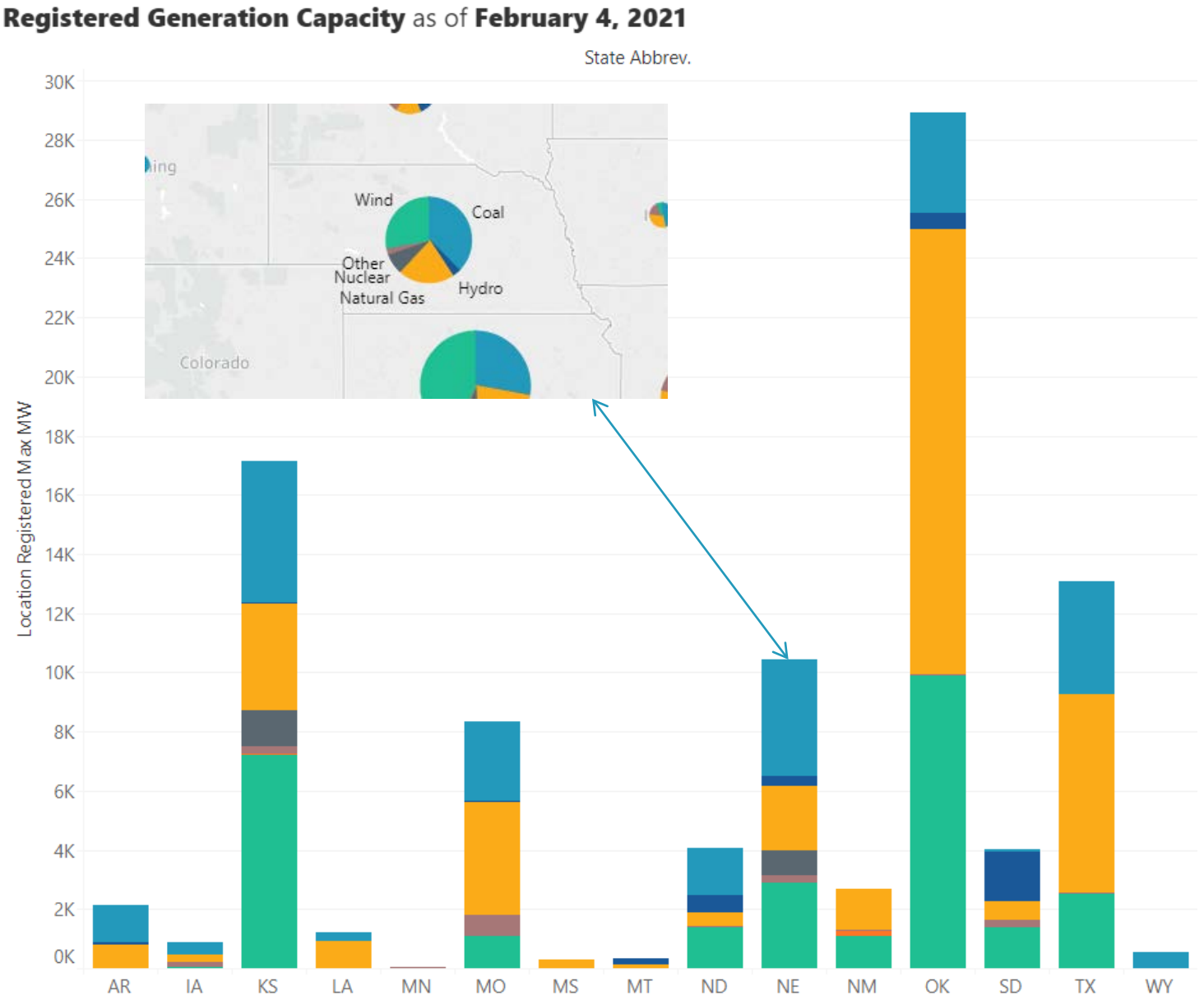
LOW WIND OCCURRENCE



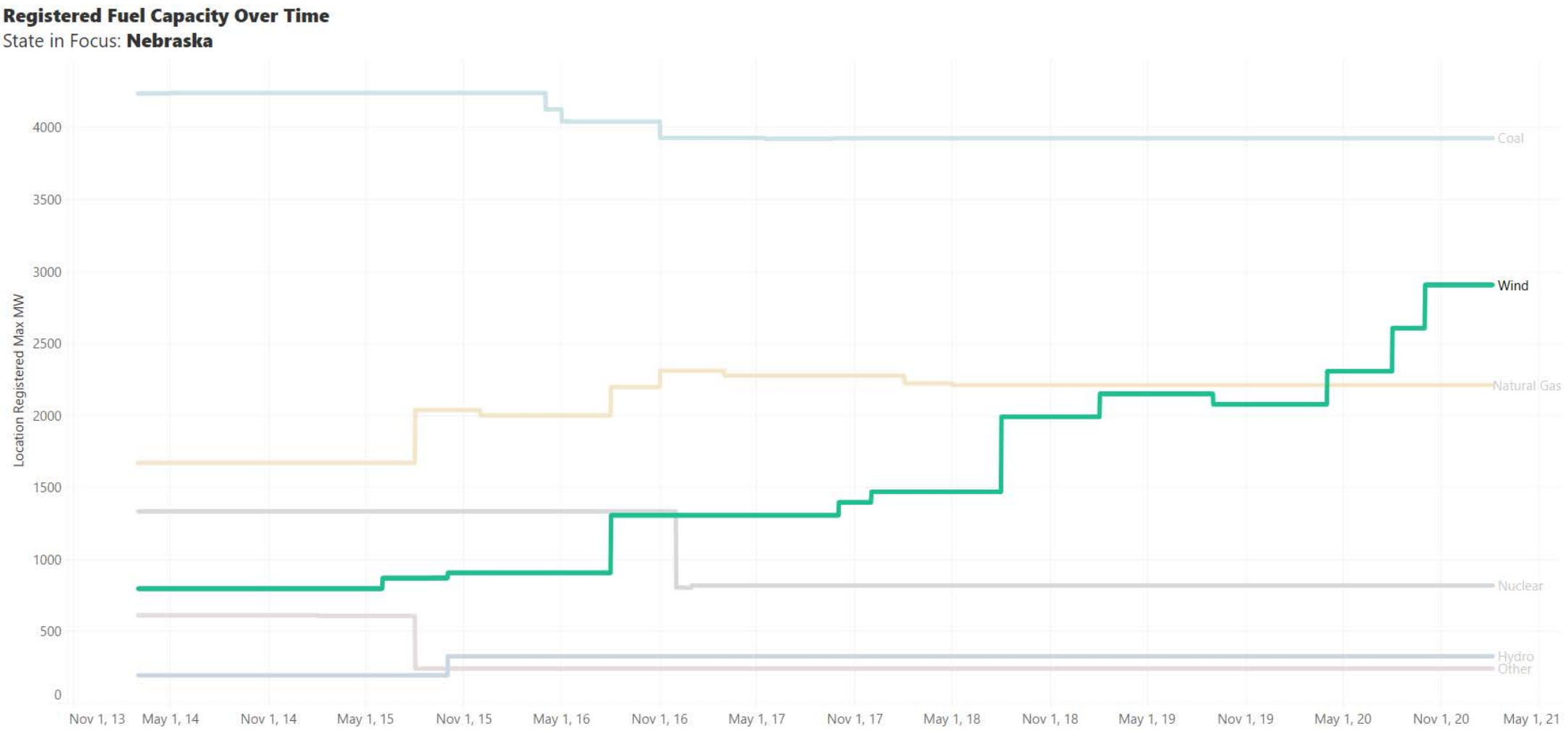
STATE-LEVEL DATA

NEBRASKA

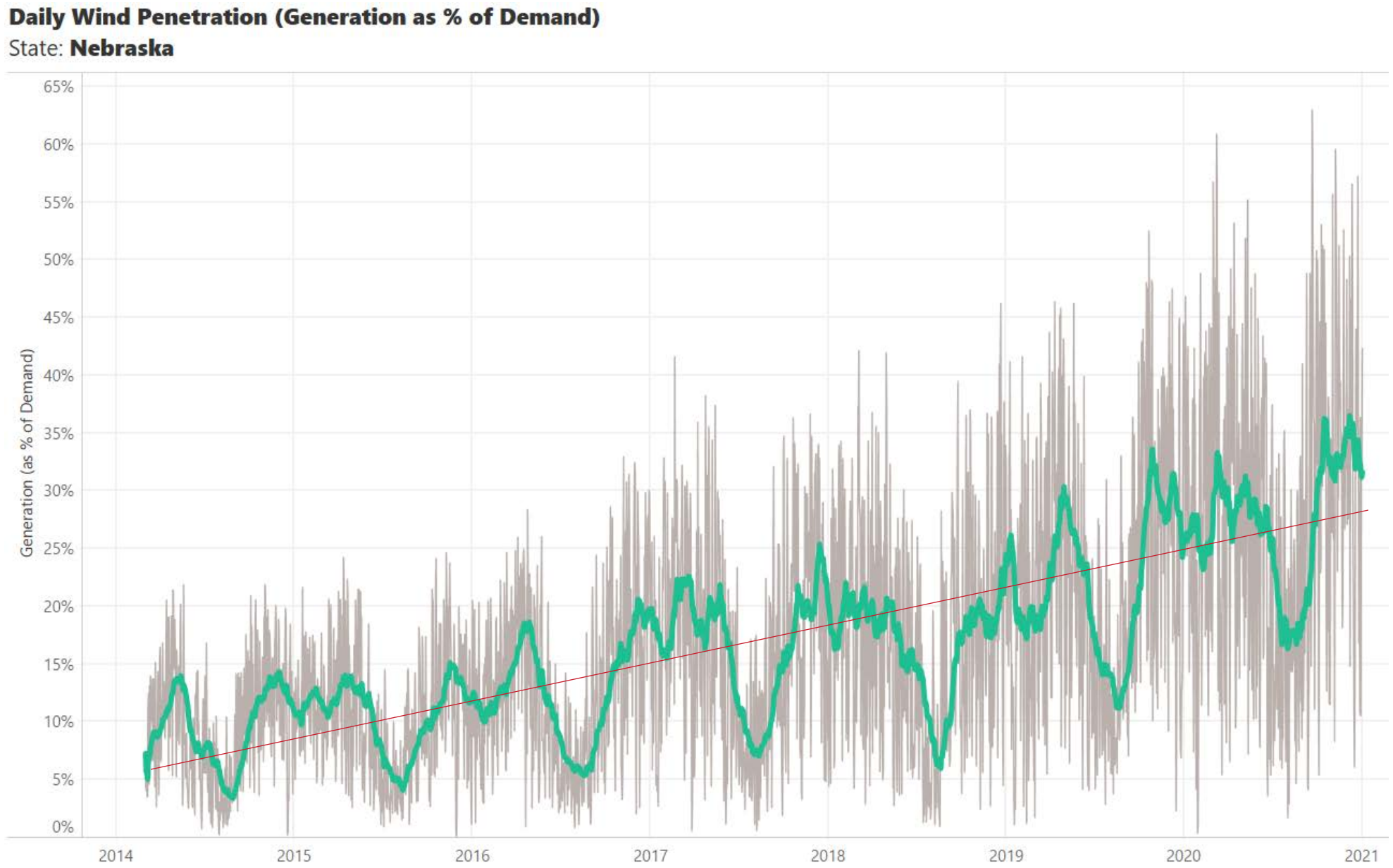
REGISTERED CAPACITY



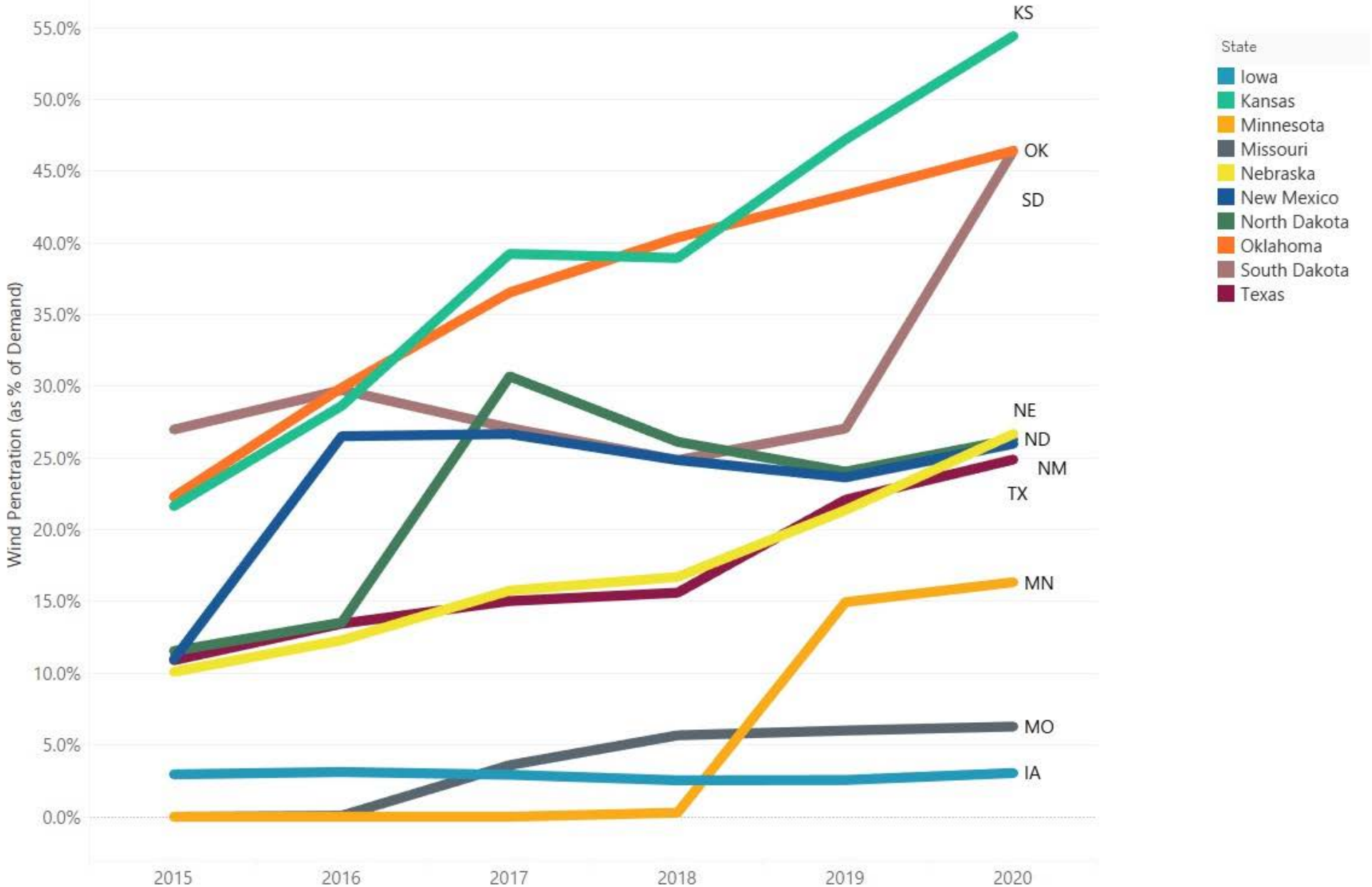
REGISTERED CAPACITY



DAILY WIND PENETRATION LEVELS



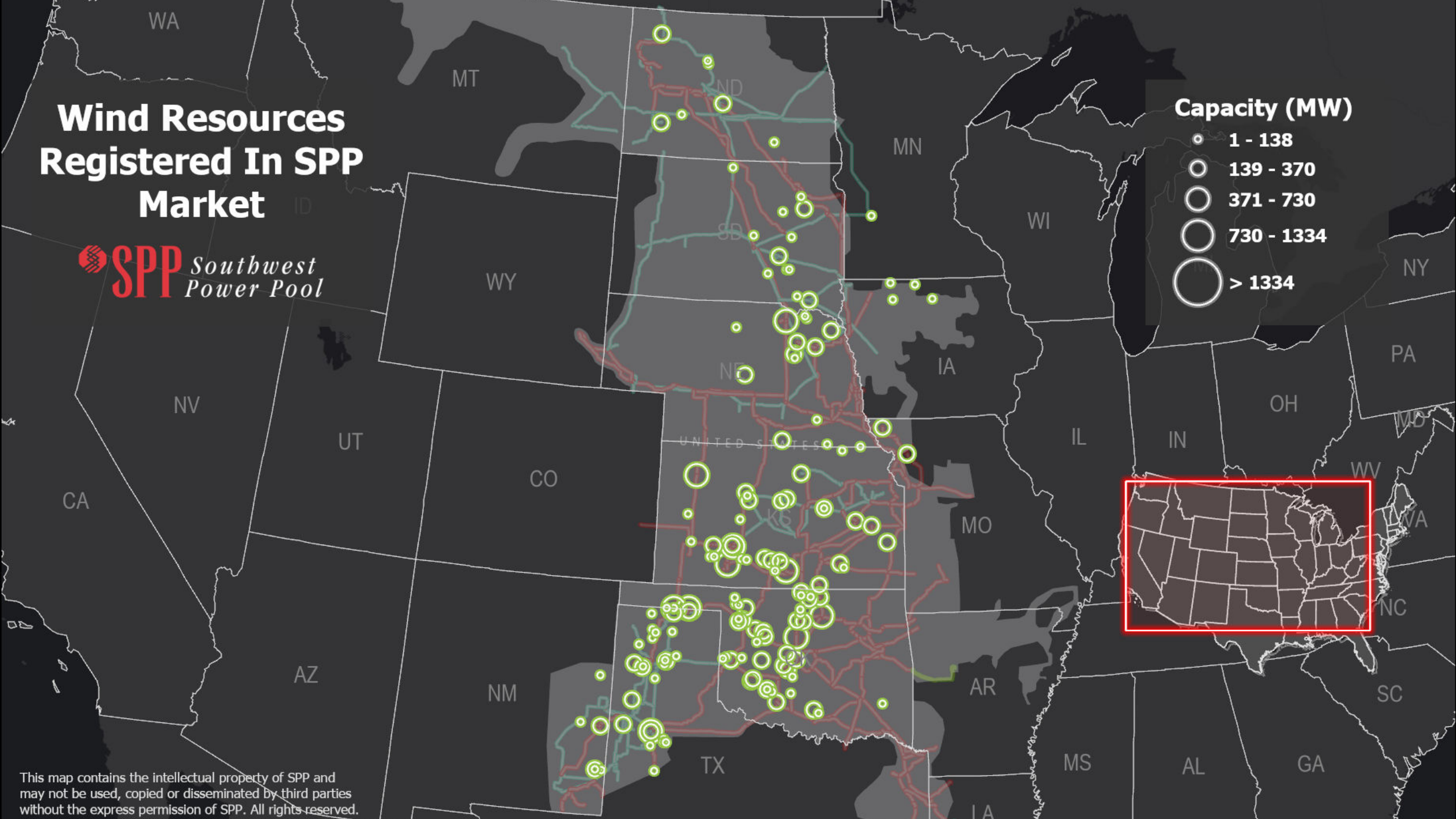
Annual Wind Penetration (of Demand) by State
SPP Market/BA Only



STATE OF THE QUEUE

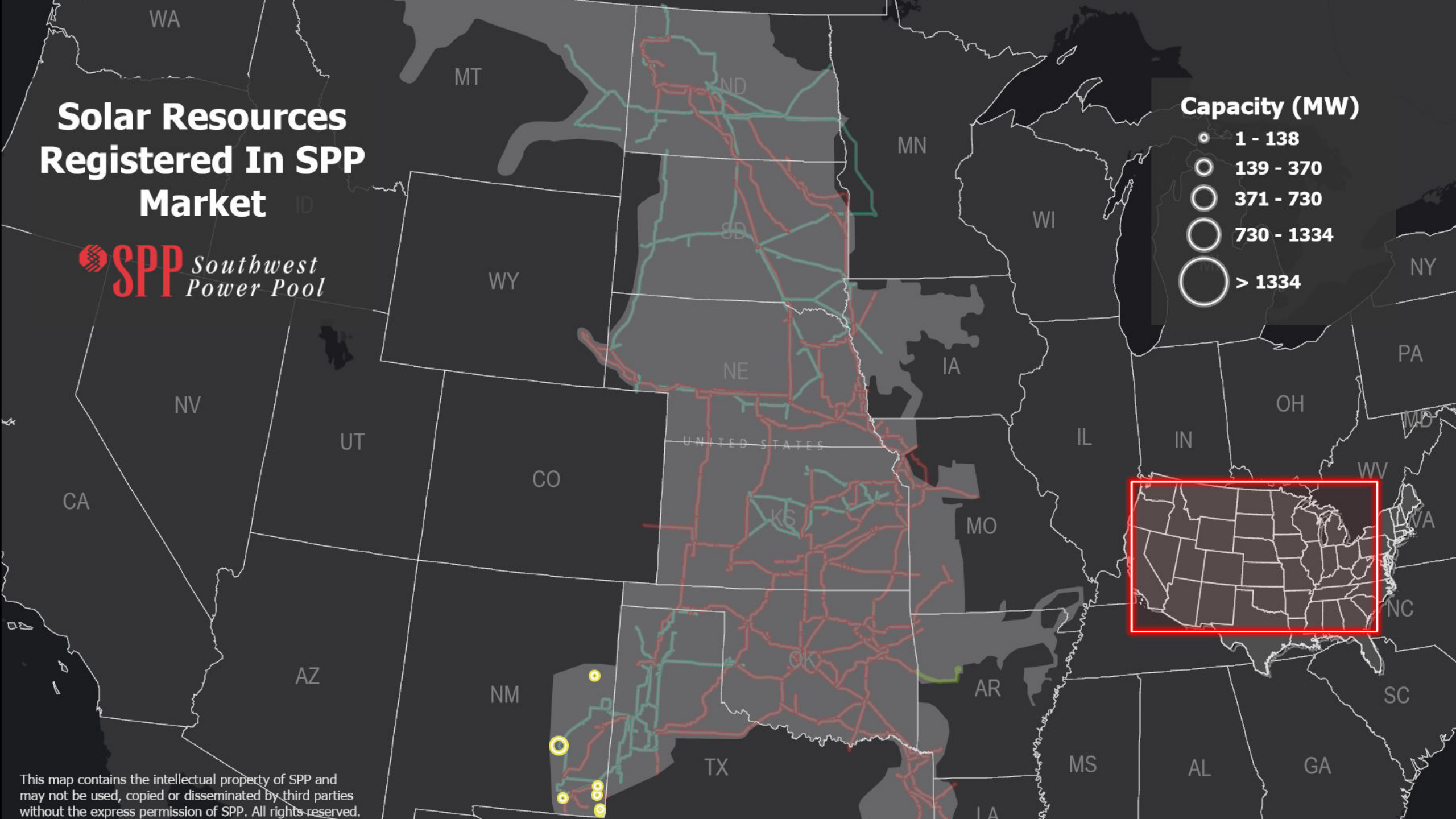
Wind Resources Registered In SPP Market

SPP Southwest Power Pool

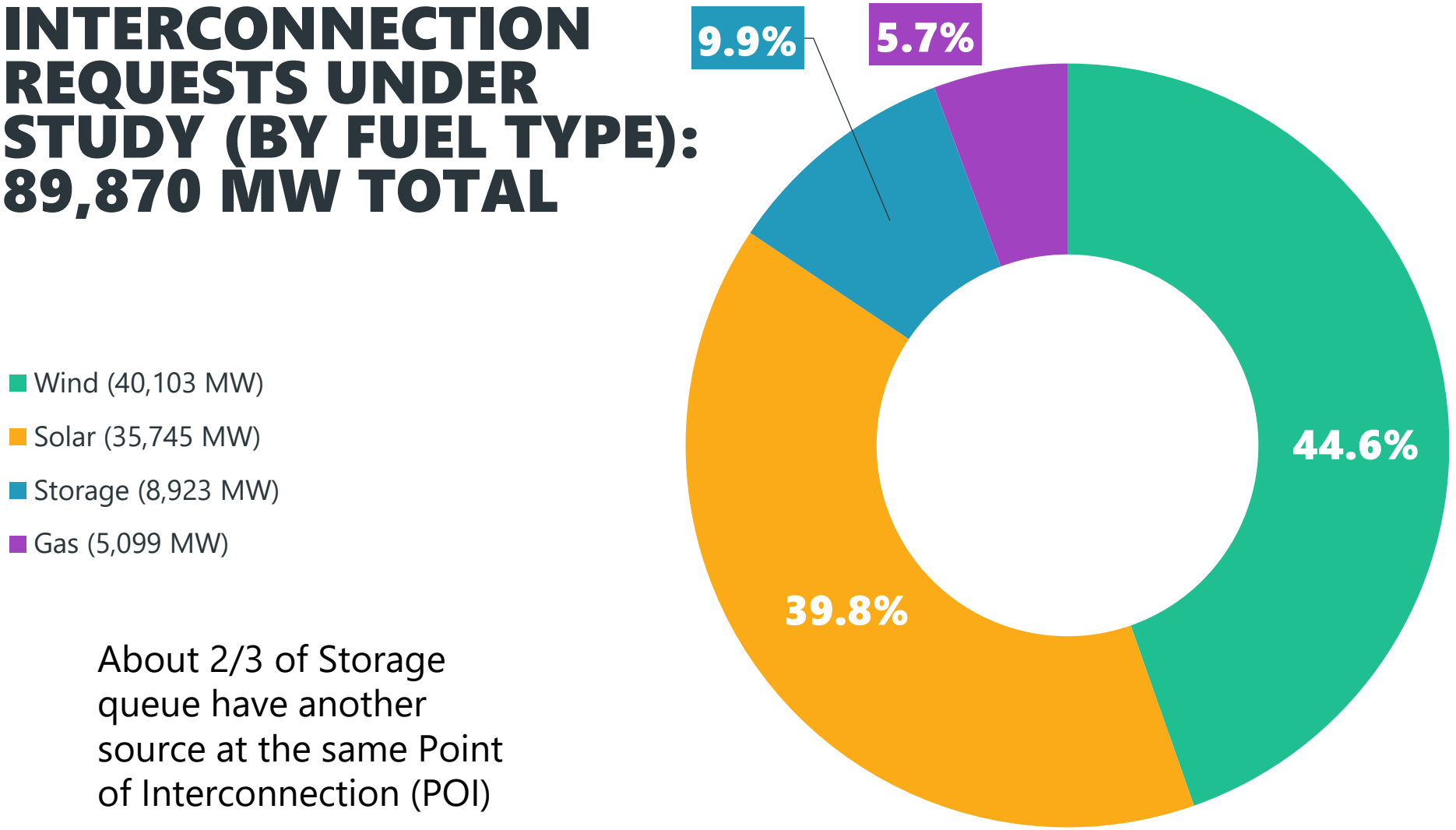


Solar Resources Registered In SPP Market

SPP Southwest Power Pool

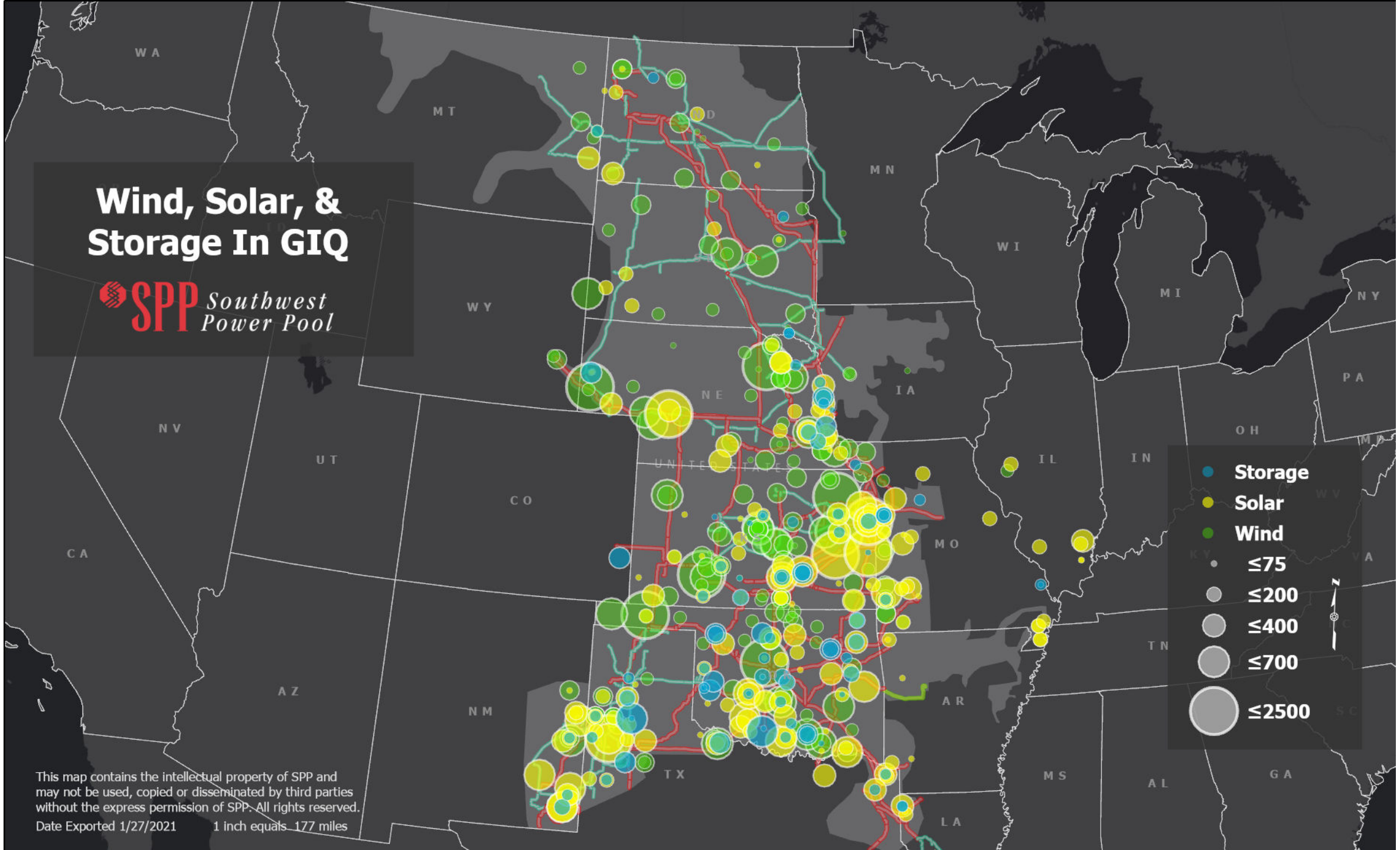


GENERATOR INTERCONNECTION REQUESTS UNDER STUDY (BY FUEL TYPE): 89,870 MW TOTAL



About 2/3 of Storage queue have another source at the same Point of Interconnection (POI)

Jan. 13, 2021


Wind, Solar, & Storage In GIQ
SPP Southwest Power Pool
Storage
Solar
Wind
≤75
≤200
≤400
≤700
≤2500
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Date Exported 1/27/2021
1 inch equals 177 miles

BACKLOG PROBLEM DESCRIPTION

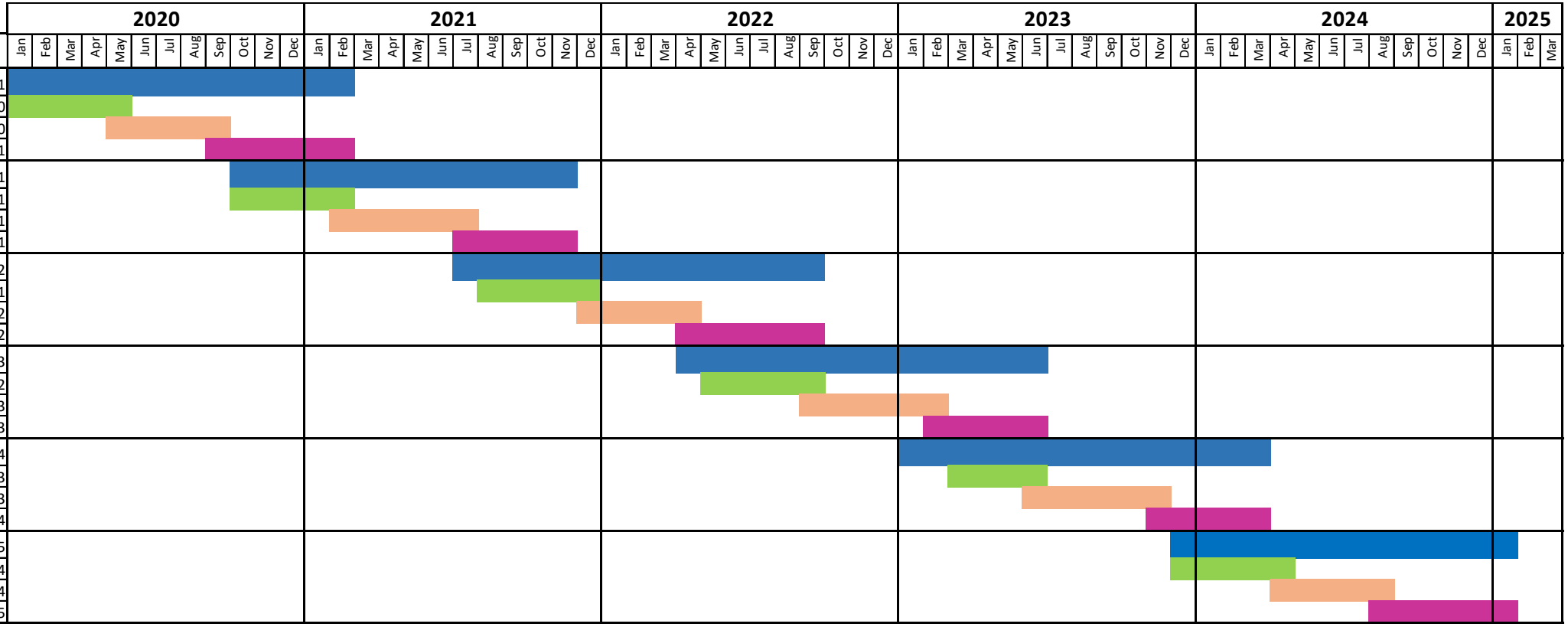
- SPP's GI queue has a four year backlog that is affecting the ability of GI customers to interconnect their generation on the requested time
- The fundamental causes of this massive backlog are:
  - The queue is formed by interconnection customers with different business purposes (some are ready to execute the project, some are more speculative)
  - This uncertainty triggers multiple re-studies
  - Low financial commitment that keep the speculative customers on the queue
  - High number of models to be evaluated
- **The current process will not eliminate the backlog**
- **GOAL: Develop an agile process to evaluate the GI requests reducing the amount of re-studies that delay the process**

BACKLOG MITIGATION PLAN STRATEGY

1. **How can the process accommodate different business purposes?**
   - Expand our single lane road to more than one lane
2. **How can the process be changed to reduce re-studies?**
   - Modify "queue priority" from being solely based on application date to be more readiness-based
3. **Can we increase financial commitment and other readiness requirements in order for customers to stay in the queue?**
   - Define increasingly stringent financial and readiness metrics for customers to progress through study queue
4. **What can be done to reduce the length of time to perform studies?**
   - Simplify study processes and methodologies, enhance 3-phase process, evaluate need for staffing increases, and evaluate tools and technologies

TIMELINE OF QUEUES COMPLETING STUDY PROCESS WITHOUT A MITIGATION PLAN

DISIS Study Queue	START	STOP
DISIS-2017-001	1/15/2020	2/5/2021
Phase 1	1/15/2020	5/5/2020
Phase 2	5/5/2020	9/23/2020
Phase 3	9/23/2020	2/5/2021
DISIS-2017-002	10/30/2020	11/21/2021
Phase 1	10/30/2020	2/18/2021
Phase 2	2/18/2021	7/9/2021
Phase 3	7/9/2021	11/21/2021
DISIS-2018-001	8/15/2021	9/4/2022
Phase 1	8/15/2021	12/3/2021
Phase 2	12/3/2021	4/22/2022
Phase 3	4/22/2022	9/4/2022
DISIS-2018-002	5/29/2022	6/18/2023
Phase 1	5/29/2022	9/16/2022
Phase 2	9/16/2022	2/3/2023
Phase 3	2/3/2023	6/18/2023
DISIS-2019-001	3/12/2023	3/31/2024
Phase 1	3/12/2023	6/30/2023
Phase 2	6/30/2023	11/17/2023
Phase 3	11/17/2023	3/31/2024
DISIS-2020	12/24/2023	1/12/2025
Phase 1	12/24/2023	4/12/2024
Phase 2	4/12/2024	8/30/2024
Phase 3	8/30/2024	1/12/2025



<u>This timeline assumes no restudies throughout the DISIS</u>

Combined Cluster With Restudy Backlog Mitigated: 10/2024

DISIS-2017-002 P1 (90)	DP1 (20)	DISIS-2017-002 P2 (120)	DP2 (20)	Restudy (60)	DP3 (20)	DISIS 2017-002 P3 (135)	GIA (60)
9/23/2021	10/13/2021	2/10/2022	3/2/2022	5/1/2022	5/21/2022	0/3/2022	12/2/2022

DISIS-2018 P1 (110)	DP1 (20)	DISIS-2018 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
8/19/2022	9/8/2022	1/6/2023	1/26/2023	3/27/2023	7/25/2023

DISIS-2019 P1 (110)	DP1 (20)	DISIS-2019 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
12/27/2022	1/16/2023	5/16/2023	6/5/2023	8/4/2023	12/2/2023

DISIS-2020 P1 (110)	DP1 (20)	DISIS-2020 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
5/6/2023	5/26/2023	9/23/2023	10/13/2023	12/12/2023	4/10/2024

DISIS-2021 P1 (110)	DP1 (20)	DISIS-2021 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
9/13/2023	10/3/2023	1/31/2024	2/20/2024	4/20/2024	8/18/2024

DISIS-2022 P1 (110)	DP1 (20)	DISIS-2022 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
1/21/2024	2/10/2024	6/9/2024	6/29/2024	8/28/2024	12/26/2024

DISIS-2023 P1 (110)	DP1 (20)	DISIS-2023 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
5/30/2024	6/19/2024	10/17/2024	11/6/2024	1/5/2025	5/5/2025

DISIS-2024 P1 (110)	DP1 (20)	DISIS-2024 P2 (120)	DP2 (20)	Restudy (60)	GIA (120)
10/7/2024	10/27/2024	2/24/2025	3/16/2025	5/15/2025	6/4/2025

Catch Up

Note: The process assumes **one** restudy for each cluster to include a restudy at DISIS-2017-001 and DISIS-2017-002 clusters.

SPP would mitigate the backlog in 10/2024 and would wait for the closing of the next cluster window and review period before commencing the next DISIS.

WHAT DOES THE FUTURE HOLD?

MOPC APPROVED 2022 ITP – FUTURES

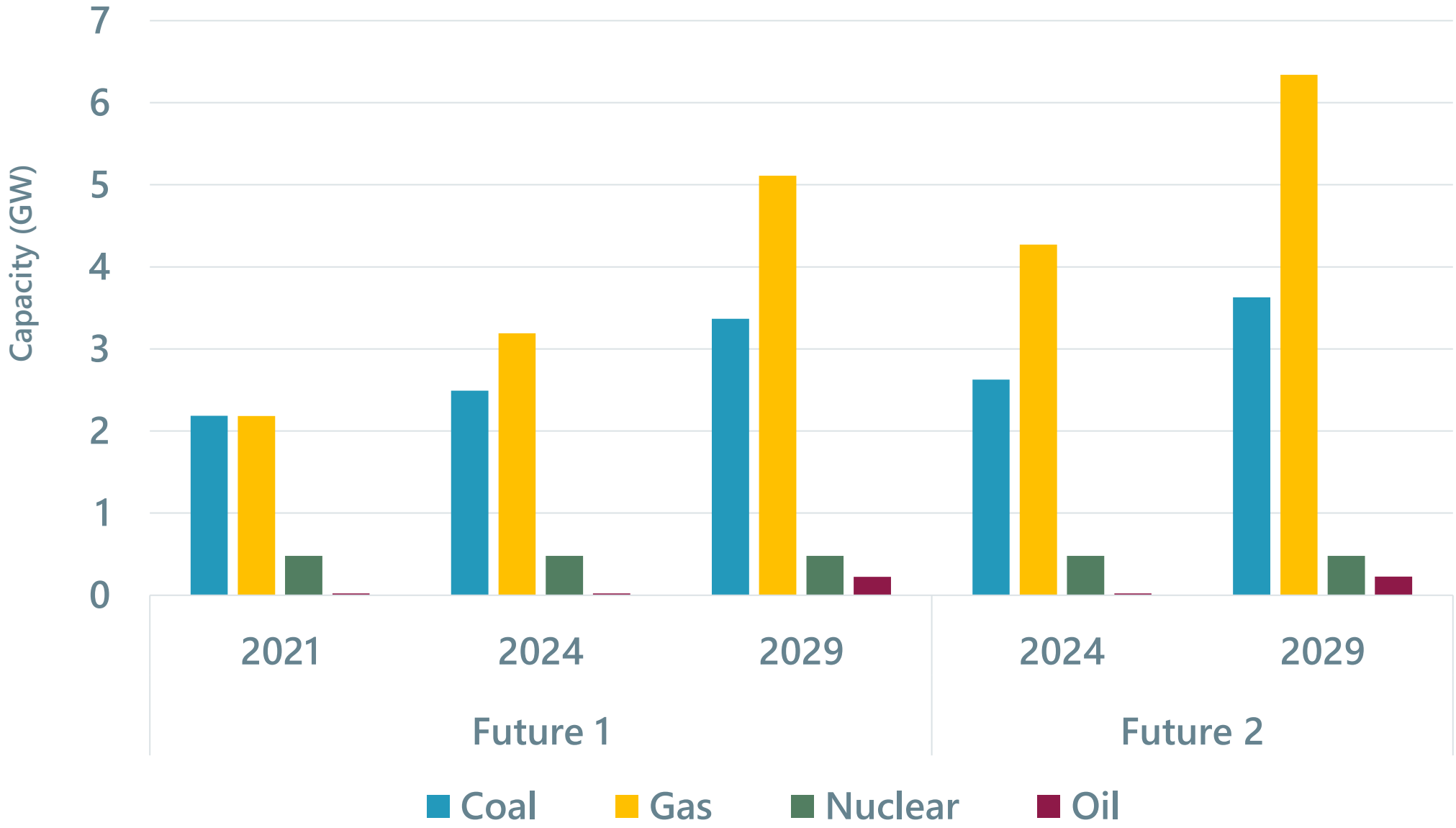
KEY ASSUMPTIONS	DRIVERS				
	Year 2	Future 1 – Reference Case		Future 2 – Emerging Technologies	
	2	5	10	5	10
Peak Demand Growth Rates	As submitted in load forecast	As submitted in load forecast		As submitted in load forecast	
Energy Demand Growth Rates	As submitted in load forecast	As submitted in load forecast		Increase due to electric vehicle growth	
Natural Gas Prices	Current industry forecast	Current industry forecast		Current industry forecast	
Coal Prices	Current industry forecast	Current industry forecast		Current industry forecast	
Emissions Prices	Current industry forecast	Current industry forecast		Current industry forecast	
Fossil Fuel Retirements	Current forecast	Coal age-based 56+, Gas/Oil age-based 50+, subject to generator owner (GO) review		Coal age-based 52+, Gas/Oil age-based 48+, subject to GO review and ESWG approval	
Environmental Regulations	Current regulations	Current regulations		Current regulations	
Demand Response[1]	As submitted in load forecast	As submitted in load forecast		As submitted in load forecast	
Distributed Generation (Solar)	As submitted in load forecast	As submitted in load forecast		+300 MW	+500 MW
Energy Efficiency	As submitted in load forecast	As submitted in load forecast		As submitted in load forecast	
Storage	Existing + RARs	20% of projected solar (1.4 GW / 2.2 GW)		35% of projected solar (3.7 GW / 5.2 GW)	
Total Renewable Capacity					
Solar (GW)	Existing + RARs	7	11	9	15
Wind (GW)	Existing + RARs	33	36	38	42

MOPC APPROVED 20-YEAR – FUTURES

	Drivers			
	Future 1 (F1)	Future 2 (F2)	Future 3 (F3)	Future 4 (F4)
Key Assumptions	2022 ITP Reference Case	2022 ITP Emerging Technologies	Accelerated Decarbonization (New administration and aggressive energy/ environmental policy change)	Based on SPP F3 with hurdle rate of zero between MISO and SPP
Year	20	20	20	20
Peak Demand Growth Rates	As submitted in load forecast	As submitted in load forecast	Moderate increase due to switching to electric home heating and increased electric transportation, potential shift to a winter peaking SPP	Moderate increase due to switching to electric home heating and increased electric transportation, potential shift to a winter peaking SPP
Energy Demand Growth Rates	As submitted in load forecast	Increase due to electrification growth	Higher demand due to electrification compared to F2 due to aggressive policy	Higher demand due to electrification compared to F2 due to aggressive policy
Natural Gas Prices	Current industry forecast	Current industry forecast	Increase prices incluenced by emissions pricing policy	Increase prices incluenced by emissions pricing policy
Coal Prices	Current industry forecast	Current industry forecast	Increase prices influenced by emissions pricing policy	Increase prices influenced by emissions pricing policy
Emissions Prices	Current industry forecast	Current industry forecast	Emission prices based on new policy	Emission prices based on new policy
Fossil Fuel Retirements	Coal age-based 56+, Gas/Oil age-based 50+, subject to generator owner (GO) review	Coal age-based 52+, Gas/Oil age-based 48+, subject to GO review and ESWG approval	All Coal and Oil retired. More Gas retirements, driven by higher emission reduction levels relative to F2 driven by new policy	All Coal and Oil retired. More Gas retirements, driven by higher emission reduction levels relative to F2 driven by new policy
Environmental Regulations	Current regulations	Current regulations	Federal Policy, mandated carbon cuts, carbon tax	Federal Policy, mandated carbon cuts, carbon tax
Demand Response[1]	As submitted in load forecast	As submitted in load forecast	Increase from F2	Increase from F2
Distributed Generation (Solar)	As submitted in load forecast	900MW	Increase from F2 due to policy shift and significant incentives to behind-the-meter installation	Increase from F2 due to policy shift and significant incentives to behind-the-meter installation
Energy Efficiency	As submitted in load forecast	As submitted in load forecast	Increase in F2	Increase in F2
Storage	20% of projected solar	35% of projected solar	Increase from F2	Increase from F2
Total Renewable Capacity				
Solar (GW)	19	27	48	48
Wind (GW)	41	50	65	65
Additional Assumptions				
Emissions Reduction Target	N/A	N/A	93% to 95% Emissions Reductions Target in 2042 from 2017 Levels	93% to 95% Emissions Reductions Target in 2042 from 2017 Levels
Hurdle Rate	N/A	N/A	N/A	SPP-MISO and MISO-SPP Hurdle Rate set to $0

[1] As defined in the MDWG Model Development Procedure Manual: MDWG Manual

CONVENTIONAL GENERATION RETIREMENTS



STRATEGIC AND CREATIVE RE-ENGINEERING OF INTEGRATED PLANNING TEAM

STAKEHOLDER-DRIVEN REVAMP OF PLANNING PROCESSES

SPP'S PLANNING STUDIES & COST ALLOCATION

Stakeholder-driven, member-funded

- Integrated Transmission Planning (ITP)
- High Priority
- Balanced Portfolio
- Interregional Projects

Customer-Initiated, customer-funded

- Transmission Service (TS)
- Generation Interconnection (GI) Service
- Sponsored Upgrades

Cost Allocation

- Highway/Byway
- Highway
- Highway/Byway, subject to Safe Harbor Limit
- Direct Assigned

WHAT COMES FROM THESE PLANNING PROCESSES?

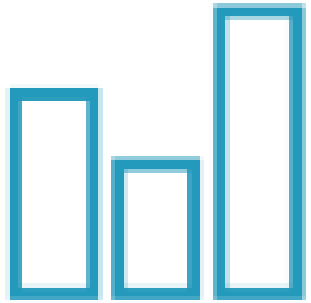
Reliability projects +

Economic projects =

Optimal grid performance

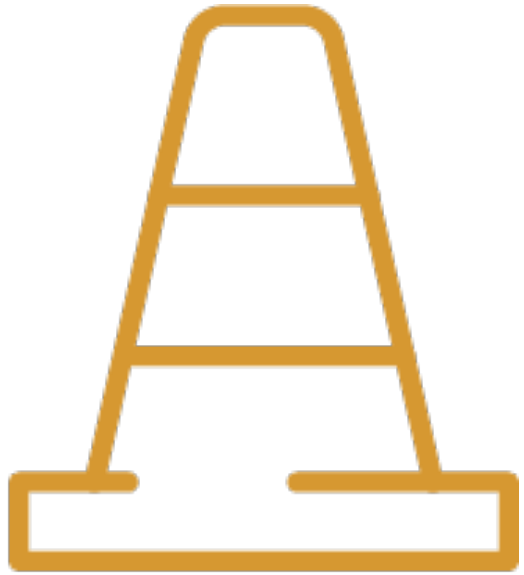
INDUSTRY CHANGES

- Integrated Marketplace
- Growth of wind and other renewables
- Excess energy
- GI request volume
- Regional investment
- Parallel studies



SPP'S PLANNING CHALLENGES

- Unprecedented GI queue volumes
- Lack of export capability or incentives for excess energy
- Lack of consensus on planning assumptions, results and funding
- Lack of certainty about future transmission investment decisions
- Parallel studies with different cost allocation
- Concerns about inequitable cost allocation



WHAT IS THE SCRIPT?

- **S**trategic and **C**reative **R**e-engineering of **I**ntegrated **P**lanning **T**eam
- Group of stakeholder representatives from board, Members Committee, SPC and RSC
- Reports to the Board and Members Committee
- Expected to complete its work by October 2021

THE SCRIPT WILL PROPOSE POLICIES TO…

- Consolidate planning processes
- Improve responsiveness and certainty
- Reduce dependence on queue-driven analyses
- Improve decision quality
- Facilitate beneficial exports and imports
- Improve cost-sharing

THIS ISN'T OUR PARENTS' ELECTRIC GRID

Advanced technologies

Smart meters

Environmental constraints

Generator retirements

Cybersecurity

Prosumers

Microgrids

Wind

Energy efficiency

Evolving grid

Fuel prices

Electric vehicles

Battery storage

Solar

Demand response

Distributed generation

Consumer demand

PLANNING FOR AN UNCERTAIN FUTURE