

SPP IBR Integration Challenges

Casey Cathey

Senior Director, Grid Asset Utilization

Southwest Power Pool

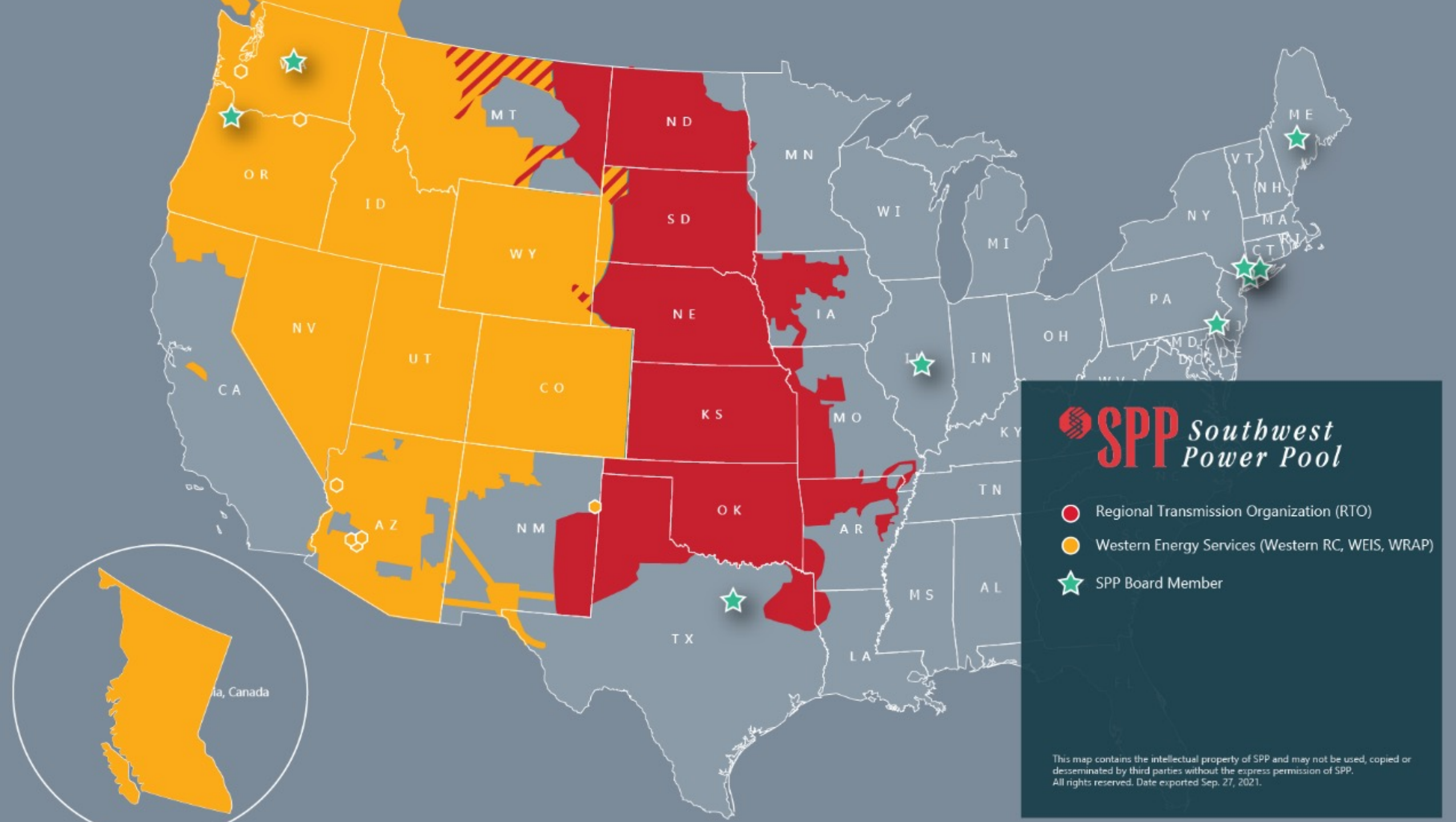
ccathey@spp.org

August 24-25, 2023

A nighttime photograph of a city skyline, featuring several illuminated skyscrapers. A semi-transparent dark grey rectangular box is overlaid on the image, containing white text. The text is centered and reads:

OUR MISSION: Working together to responsibly and economically keep the lights on today and in the future.

OUR VISION: Leading our industry to a brighter future while delivering the best energy value.



SPP *Southwest Power Pool*

- Regional Transmission Organization (RTO)
- Western Energy Services (Western RC, WEIS, WRAP)
- ★ SPP Board Member

This map contains the intellectual property of SPP and may not be used, copied or disseminated by third parties without the express permission of SPP. All rights reserved. Date exported Sep. 27, 2021.

Top grid priorities

ASSURE

adequate generation to maintain reliability under normal & extreme conditions

PROTECT

grid from cyber attacks

BUILD

transmission to connect new generation and customers to grid

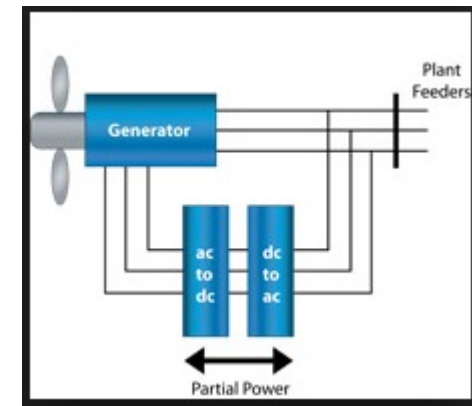
FACILITATE

robust wholesale markets that make low-cost energy widely available

REDUCE

Risks and costs associated with extreme events

Inverter-Based Resources



Solar

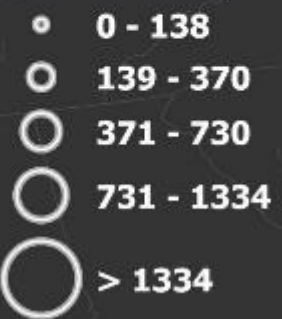
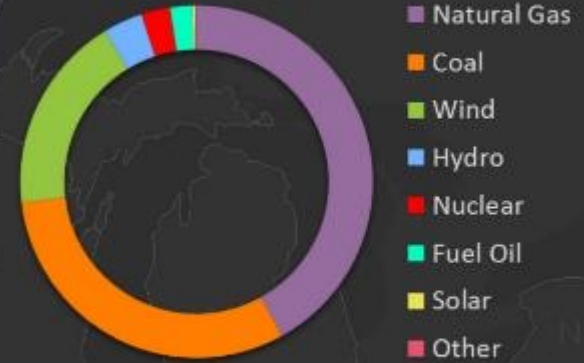
Wind

Battery



Distribution of Generation

Generation Mix



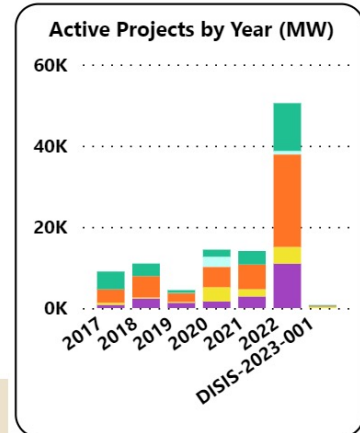
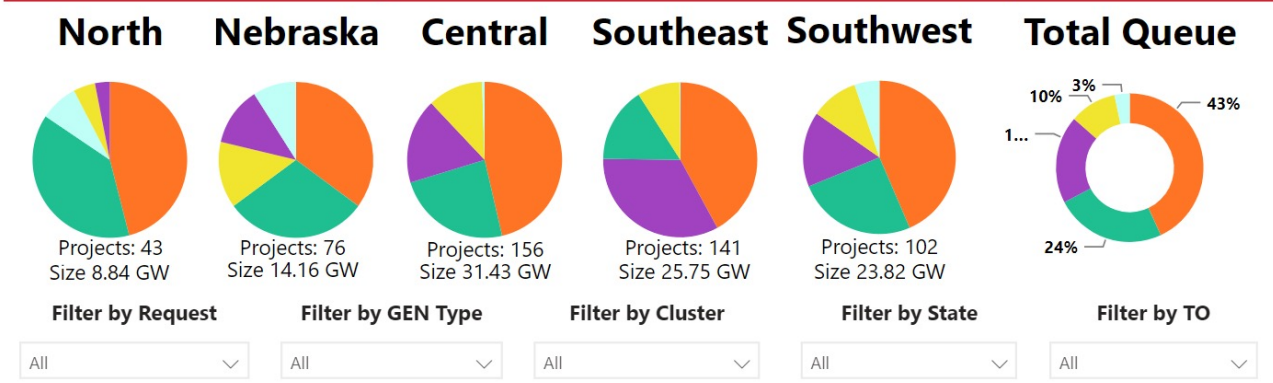
This map contains the intellectual property of SPP and may not be used, copied or disseminated by third parties without the express permission of SPP. All rights reserved.
Date Exported 2/7/2023 1 inch equals 182 miles

Generation interconnection dashboard (8/2/23)

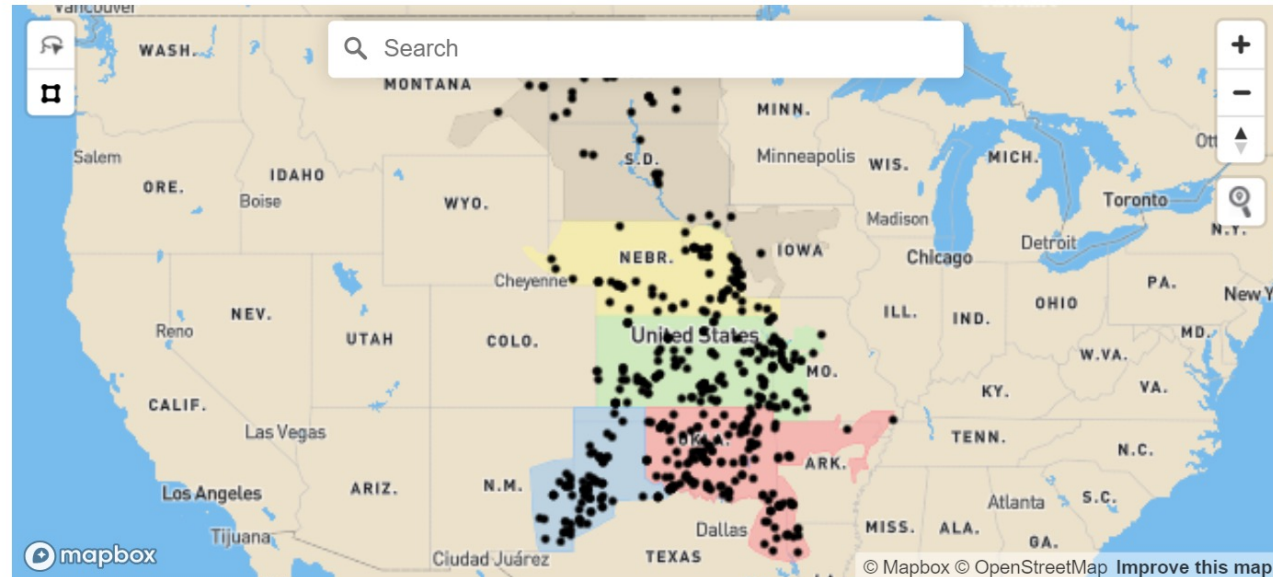
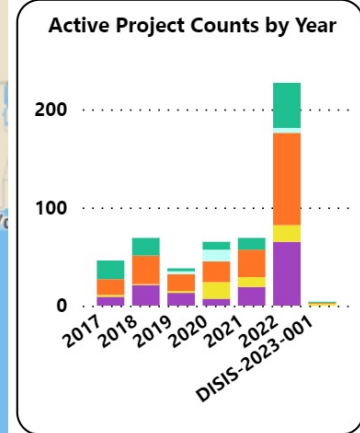
SPP.org/engineering/generator-interconnection/

Southwest Power Pool Generation Interconnection Queue Dashboard

The current generator interconnection active queue consists of 518 projects totaling 104 GW



Cluster	MW	Projects
01 NORTH	8,841.60	43
Battery/Storage	274.10	2
Hybrid	404.50	3
Solar	4,065.00	16
Thermal	700.65	5
Wind	3,397.35	17
02 NEBRASKA	14,164.60	76
Battery/Storage	1,730.00	12
Hybrid	1,952.00	11
Solar	4,969.47	27
Thermal	1,285.56	7
Wind	4,227.57	19
03 CENTRAL	31,428.35	156
Battery/Storage	5,538.39	40
Hybrid	3,630.00	14
Solar	14,572.98	68
Thermal	166.56	4
Wind	7,520.42	30
04 SOUTHEAST	25,749.93	141
Battery/Storage	8,538.99	57
Hybrid	2,294.60	13
Solar	10,825.10	53
Thermal	46.00	1
Wind	4,045.24	17
05 SOUTHWEST	23,817.56	102
Battery/Storage	3,770.00	23
Hybrid	2,394.00	10
Solar	10,366.27	42
Thermal	1,262.00	3
Wind	6,025.29	24
Total	104,002.04	518



Generation Type ● Battery/Storage ● Hybrid ● Solar ● Thermal ● Wind

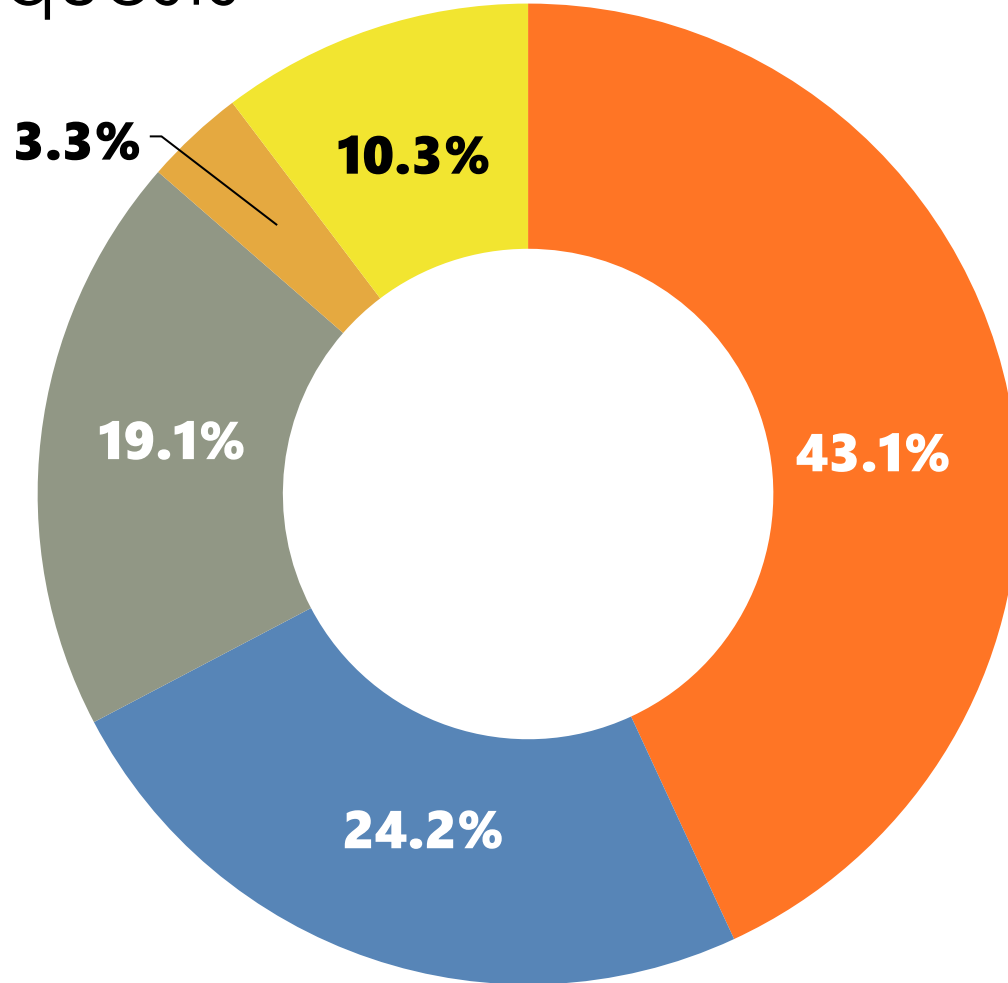
Disclaimer: The data provided is for information purposes only and is subject to change without notification. Questions? Email: gjstudies@spp.org. Click [HERE](#) for SPP GI Web Site. Click [HERE](#) for Study Region Map

104.0 GW

Generator Interconnection Requests under Study

As of July 26, 2023

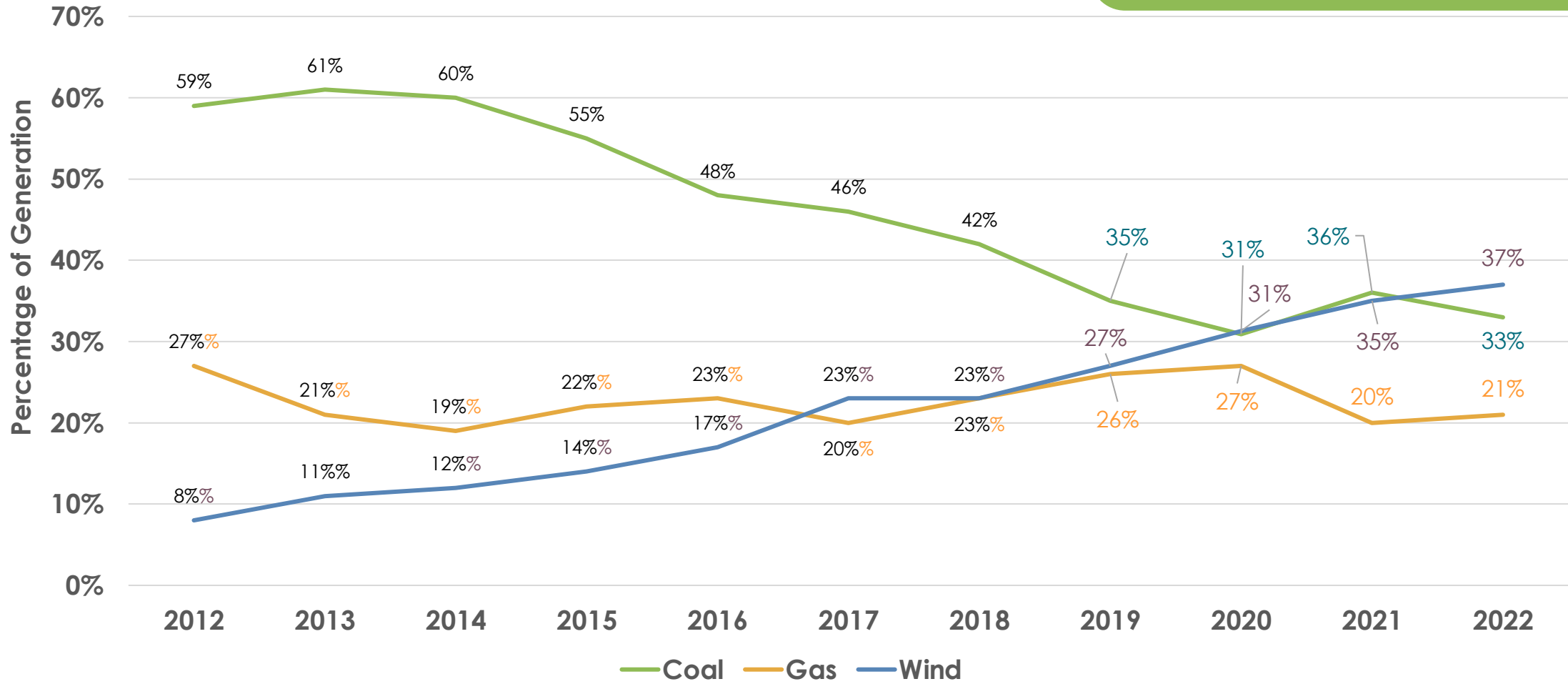
- Solar (44,798 MW)
- Wind (25,216 MW)
- Storage (19,852 MW)
- Gas/Thermal (3,461 MW)
- Hybrid: renewables + storage (10,675 MW)



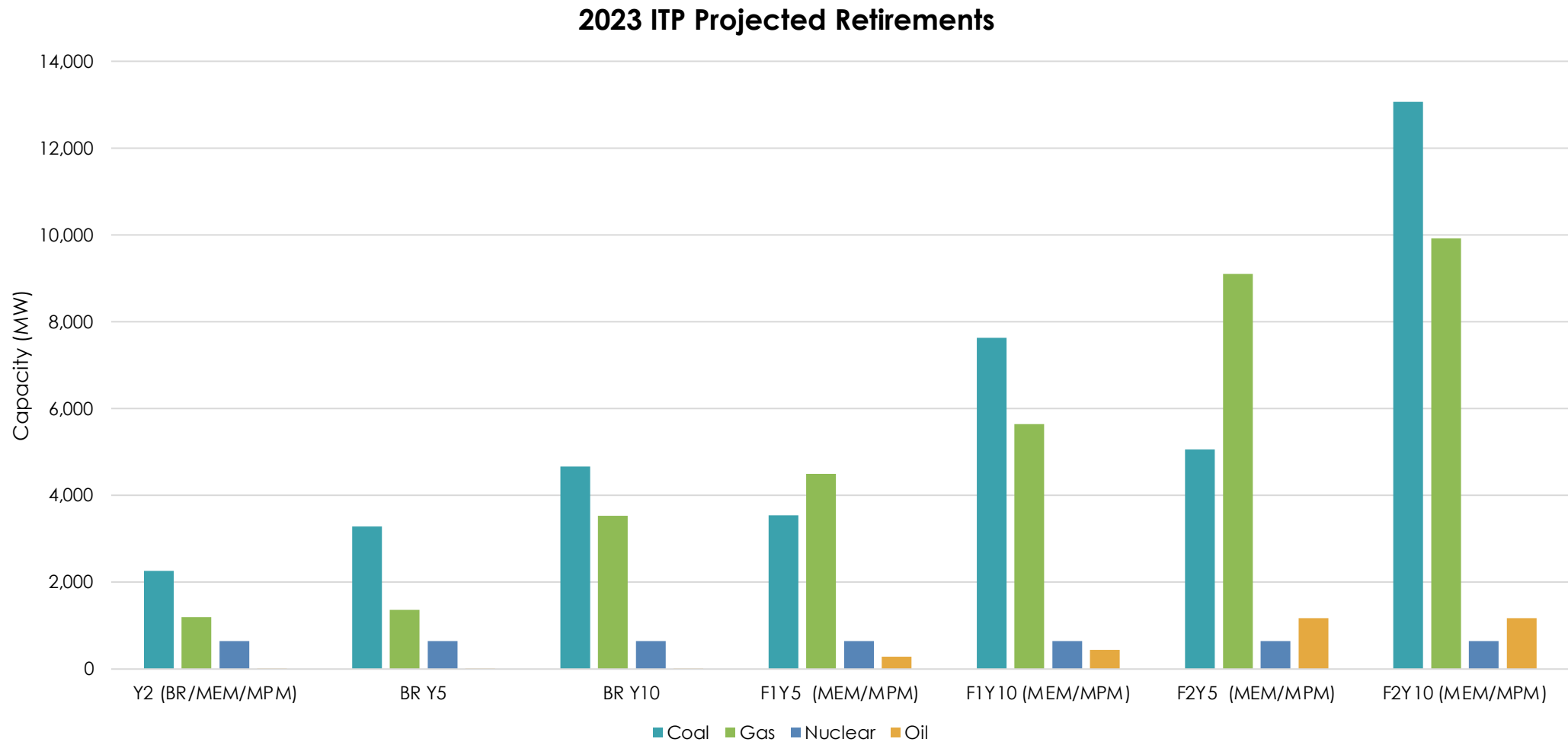
Our Evolving Energy Mix

Coal and gas use has decreased, while wind has increased

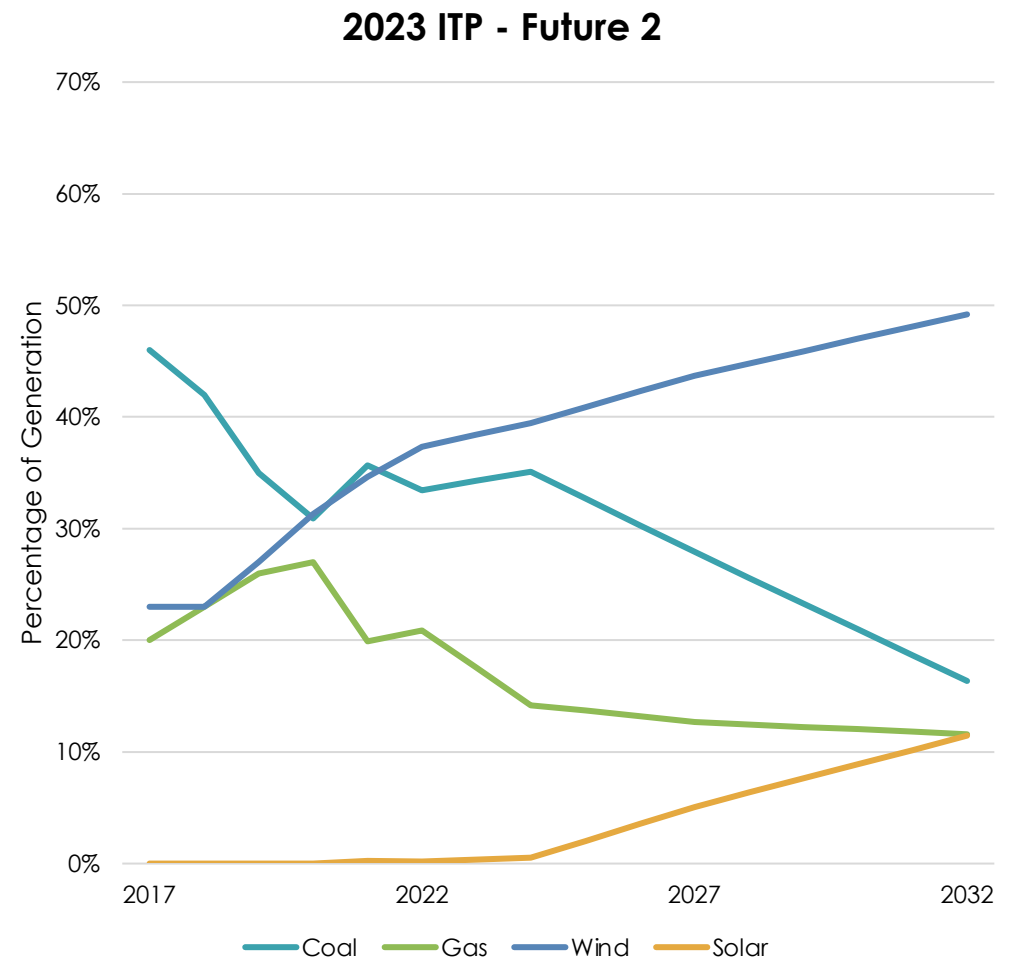
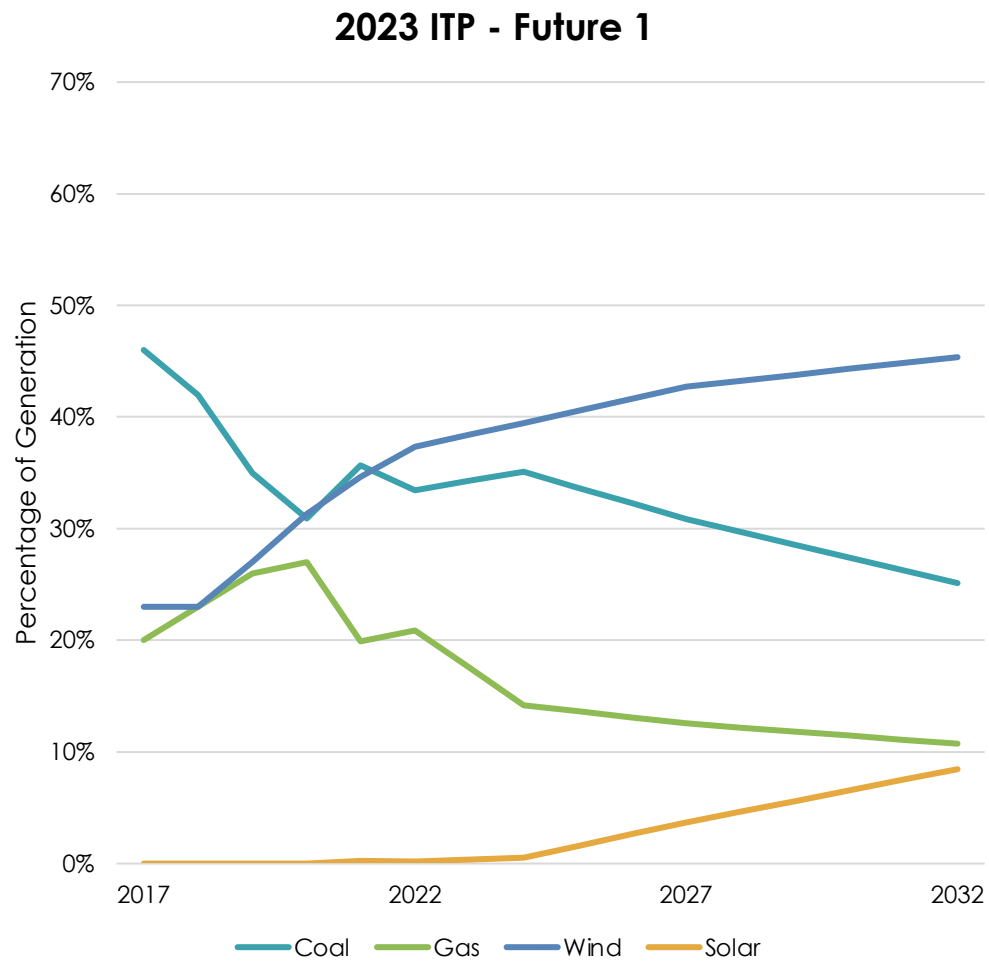
Trend By Year

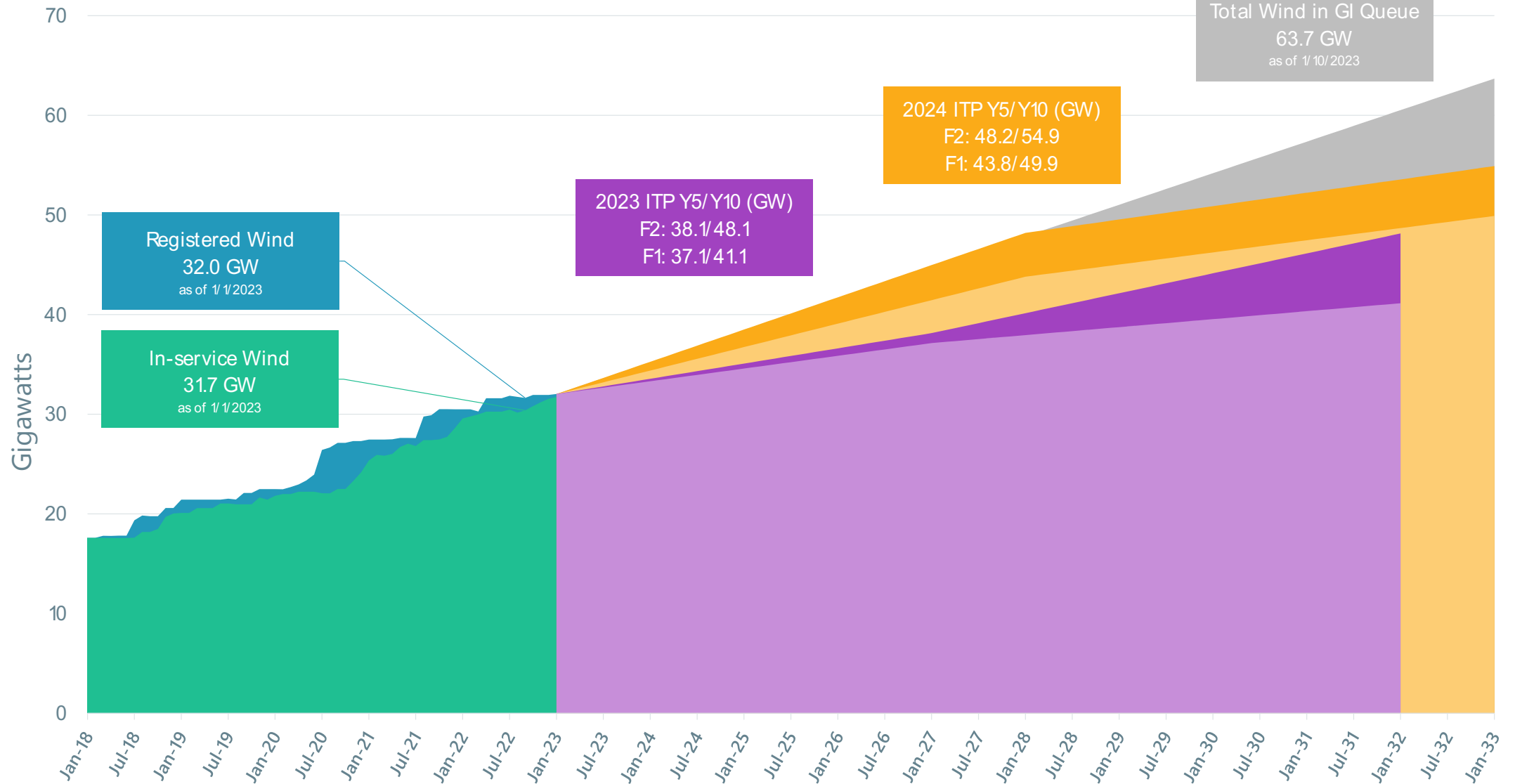


2023 ITP projected Retirements



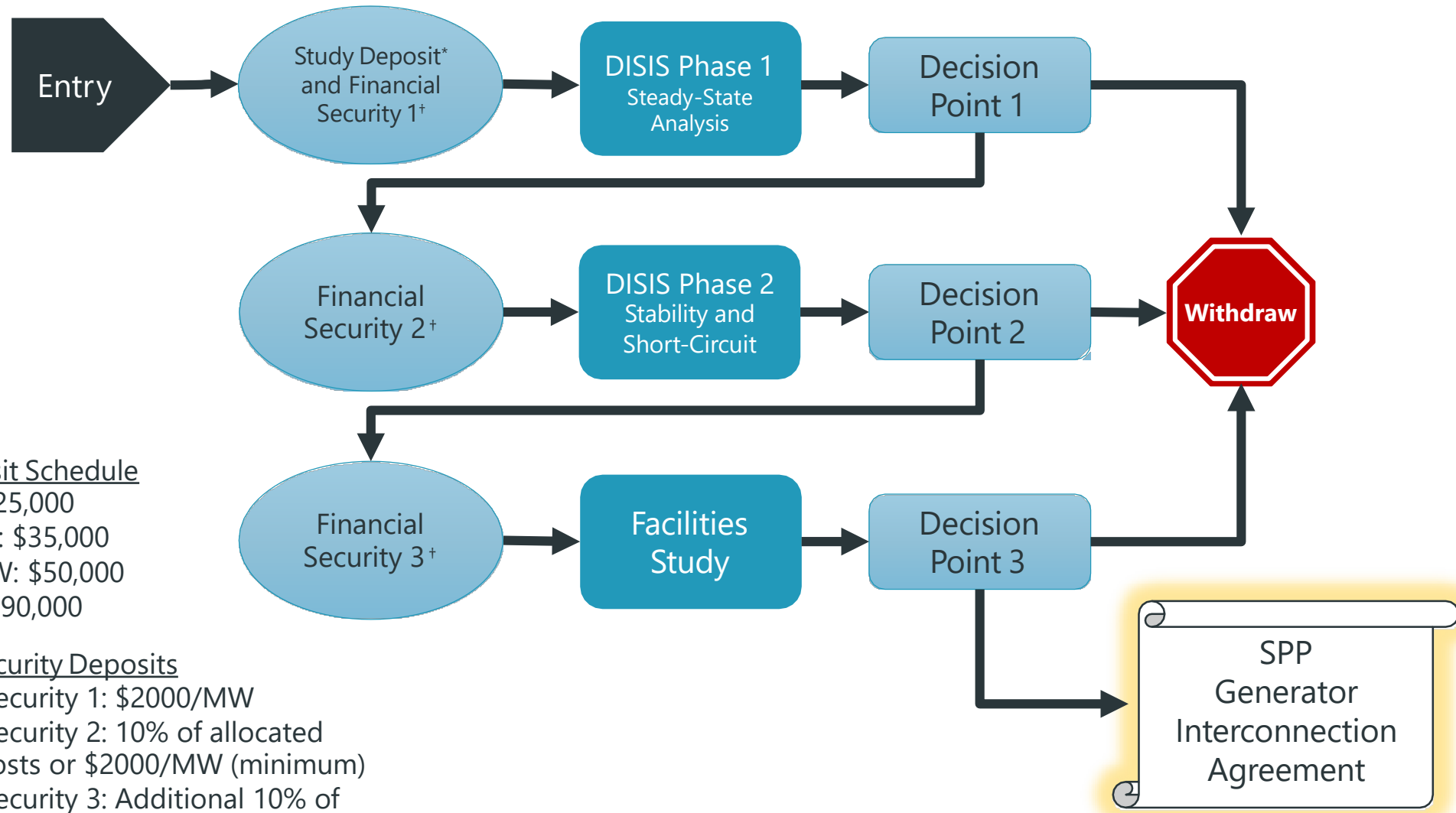
Evolving Gen Mix and ITP Projections





■ GI Queue
 ■ Registered Capacity
 ■ Generating Capacity
 ■ 2024 ITP F2
 ■ 2024 ITP F1
 ■ 2023 ITP F2
 ■ 2023 ITP F1

Current ERIS and NRIS Products



*Study Deposit Schedule

- 0-2 MW: \$25,000
- >2-20 MW: \$35,000
- >20-74 MW: \$50,000
- 75 MW+: \$90,000

† Financial Security Deposits

- Financial Security 1: \$2000/MW
- Financial Security 2: 10% of allocated upgrade costs or \$2000/MW (minimum)
- Financial Security 3: Additional 10% of allocated upgrade costs (total of 20%)

SPP Approach: IBR Screening & EMT Simulation for Planning Studies (continued)

Short Circuit Ratio:

$$SCR = \frac{S_{SC}}{MW}$$

Maximum Available Short Circuit Power (MVA) before connection of the resource

Power Rating (MW) of resource to be connected

- Measures the strength (voltage stiffness) at a point (bus) in the power system
- Measured at the POI of a resource to be connected
- Low SCR indicates weakness and additional analysis may be required

SPP Approach: IBR Screening & EMT Simulation for Planning Studies (continued)

Short Circuit Ratio:

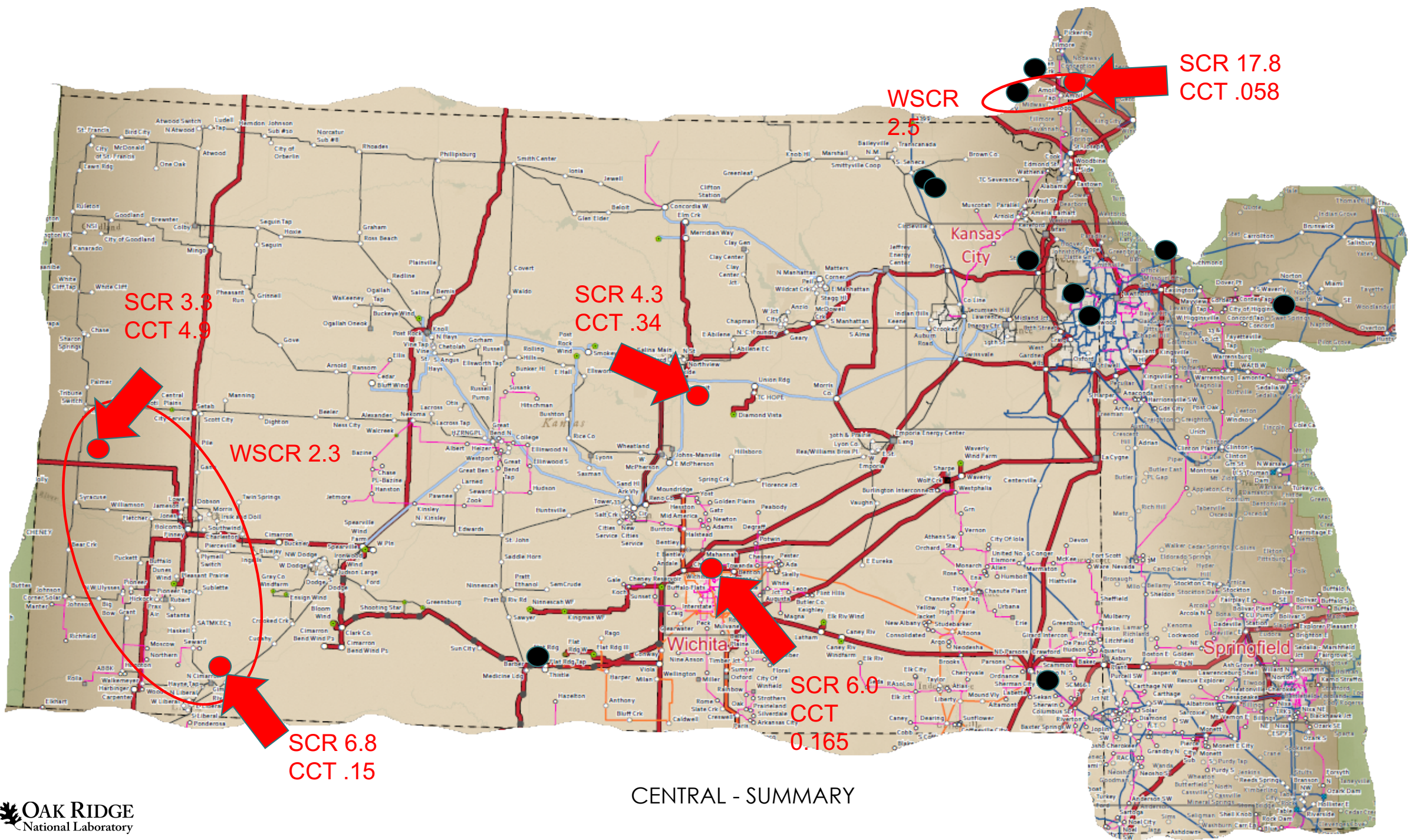
$$CSCR = \frac{CSCMVA}{MW_n}$$

Composite Short Circuit Ratio

$$WSCR = \frac{\sum_i^N SCMVA * MW_i}{\sum_i^N MW_i^2}$$

Weighted Short Circuit Ratio

- A large concentration of wind plants connected in the vicinity of a transmission node can result in low grid strength
- Ratio calculation becomes more complicated
- Composite and Weighted SCR better measure of Ratio



CENTRAL - SUMMARY

EPRI GSAT Tool

- Grid Strength Assessment Tool - Benefits
 - Fast screening of hundreds of buses based on short circuit current
 - Provides insights into possible interactions among electrically nearby generating plants
 - Provides insights into possible controller interactions and instabilities for converter resources interconnected at low short circuit locations
- Developed in 2018 under project P173.03
- Evaluates SCR, WSCR, and CSCR

An Additional Metric.....

- **Critical Clearing Time (CCT)** - the maximum time a fault near the POI of the inverter plant is allowed to remain on the system such that inverter plant remains stable
- GSAT CCT metric can help identify IBRs with **possible** oscillatory instability
- The possibility of inverter instability is governed by,
 - Short circuit current
 - Controller gains
 - MW power output
 - Fault clearing time