Reliability Analysis Update

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2025 RTEP:

2032 Scenario 5 & 6 Update

Overview

- Introduction to Scenario 5 and Scenario 6 of year 2032
- Key takeaways
- Scenario 5:
  - Capacity Expansion
  - Powerflow model and study resutls
- Scenario 6: Powerflow model and study results

Scenario 5 & 6: Background

At the May 2025 TEAC, PJM agreed to analyze the following 7-Year (2032) scenarios.

Scenarios 5 and 6
are the focus of this update.

Scenario 3	Existing generation, GIA/ISA generation, Suspended ISA generation, Fast Lane Queue, TC1 queue, TC2 queue (with RRI), 7500MW NJ OSW, (Remove) Q1 deactivations, (Remove) withdrawn queues
Scenario 4	2032 base case + remove NJ/DE OSW (assume delays beyond 2032)
Scenario 5	2032 base case + policy deactivations
Scenario 6	2032 base case with batteries dispatched

Scenario 5 & 6: Background

	Objectives	Compare

Scenario 5	▪ Assess reliability impact due to
	  ▪ Potential generation deactivation due to state and federal policies
	  ▪ State RPS
	  ▪ Economic capacity expansion needed to meet resource adequacy of 1 in 10
	▪ Informational GenDeliv study of SUM, WIN and LL
		▪ The reliability of 2032 base case (Scenario 3)

Scenario 6	▪ Assess reliability impact of battery dispatch in base case due to generation emergency ▪ Remainder of PJM Generation scaled down to keep power balance ▪ Informational GenDeliv study of SUM and WIN	▪ The reliability of 2032 base case (Scenario 3)

Key Takeaways

2032 Scenario 5

- Due to policy-driven generation changes, forecasted load growth, and to meet resource adequacy requirements:
  - Significant new generation is needed in the PJM footprint by 2032.
  - Most of the forecasted generation expansion is in the Western Region.
  - Most of the forecasted generation being added are of fuel types gas and solar.
- The forecasted generation results in higher West-East transfer than 2032 base case.
- The resulting generation mix has an impact on the PJM transmission system.
- The proposed 2025 RTEP will help address the higher West-East transfer of 2032 Scenario 5.
- However, additional West-East transmission reinforcements are likely required.

2032 Scenario 6

- Dispatching battery storage did not impact reliability significantly based on the currently low penetration level.

2032 Scenario 5: Capacity Expansion Study

2032 generation forecast based on a capacity expansion study	
Load assumption: 2025 PJM load forecast report	**Resource adequacy:** 1 in 10

Policy assumptions:

- State and federal policy deactivation (federal GHG polices excluded as subject to repeal)
- States' RPS
- Resource-specific targets – including 7,500 MW NJ OSW and 8,500 MW MD OSW by 2032

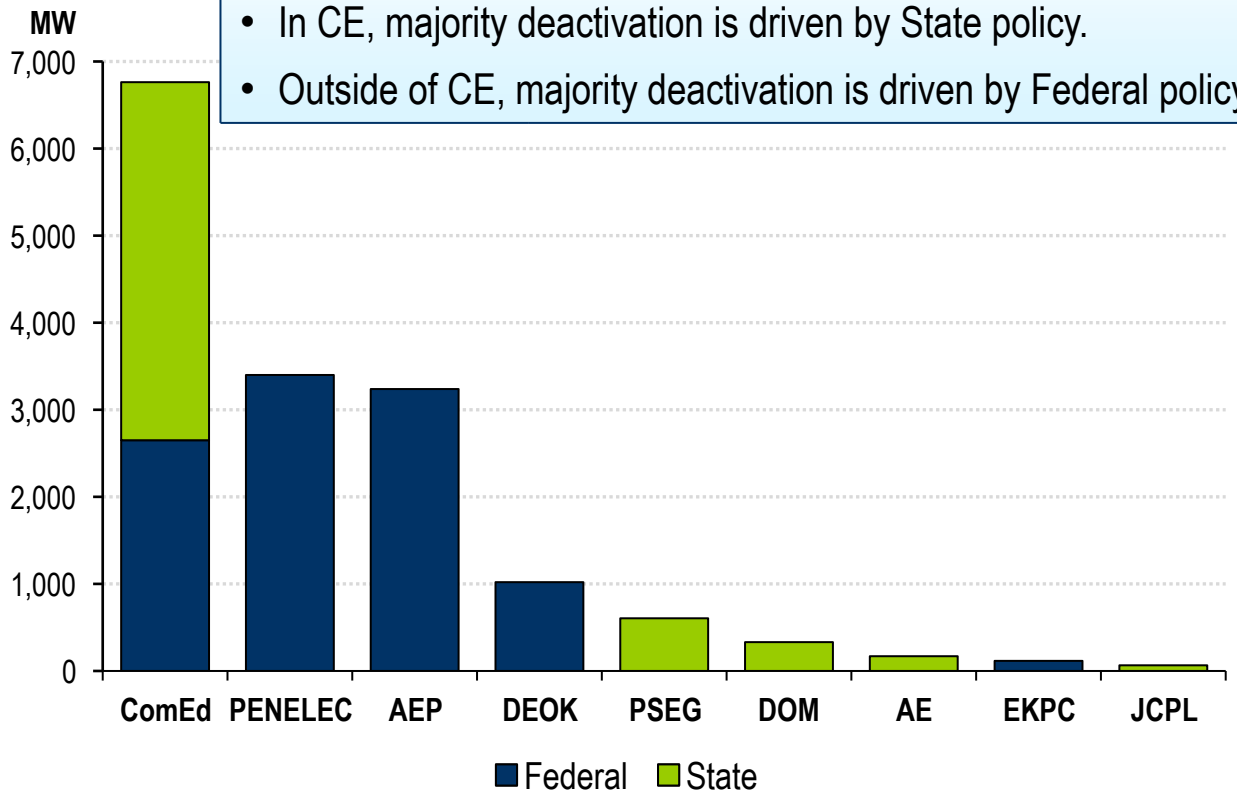
2032 Scenario 5: Policy Deactivation

Area	Federal	State	Grand Total
ComEd	2,650	4,112	6,762
PENELEC	3,400		3,400
AEP	3,238		3,238
DEOK	1,020		1,020
PSEG		605	605
DOM		331	331
AE		169	169
EKPC	116		116
JCPL		65	65
Grand Total	**10,424**	**5,283**	**15,706**

Type of Policy Driving Retirement	Policy Driving Retirement
Federal	EPA Coal Combustion Residuals (CCR)
	EPA Effluent Limitation Guidelines (ELG)
State	Illinois, CEJA
	Virginia, Clean Economy Act
	New Jersey, CO2 Emissions Rule

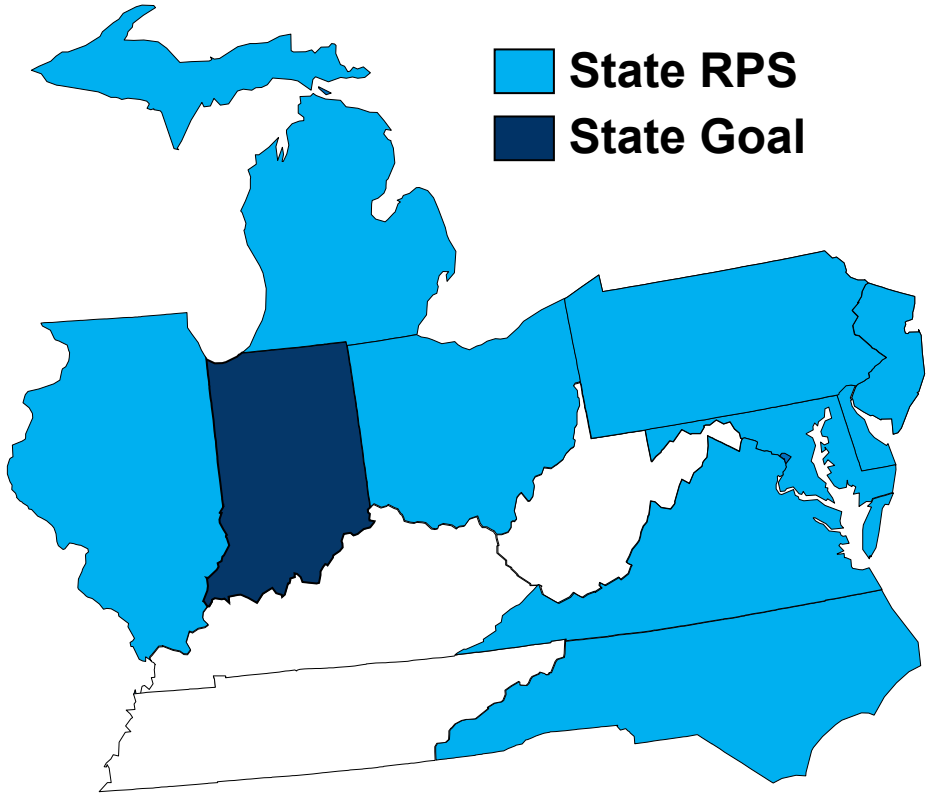
KEY TAKEAWAY

- ComEd, PENELEC and AEP accounts for 85% of the policy-driven potential deactivation.
- In CE, majority deactivation is driven by State policy.
- Outside of CE, majority deactivation is driven by Federal policy.



PJM State RPS Targets

State Renewable Portfolio Standards (RPS) require suppliers to utilize renewable resources to serve an increasing percentage of total demand.



State RPS Targets*

- ☼ **NJ:** 50% by 2030**
- ☼ **MD:** 50% by 2030**
- **DE:** 40% by 2035
- **DC:** 100% by 2032
- **PA:** 18% by 2021***
- ☼ **IL:** 50% by 2040
- ☼ **VA:** 100% by 2045/2050 (IOUs)
- ☼ **NC:** 12.5% by 2021 (IOUs)
- **OH:** 8.5% by 2026
- **MI:** 60% by 2035
- **IN:** 10% by 2025***

☼ Minimum solar requirement

* Targets may change over time; these are recent representative snapshot values.
** RPS also requires an additional 2.5% of Class II resources each year.
*** Includes nonrenewable "alternative" energy resources

Jan. 2024

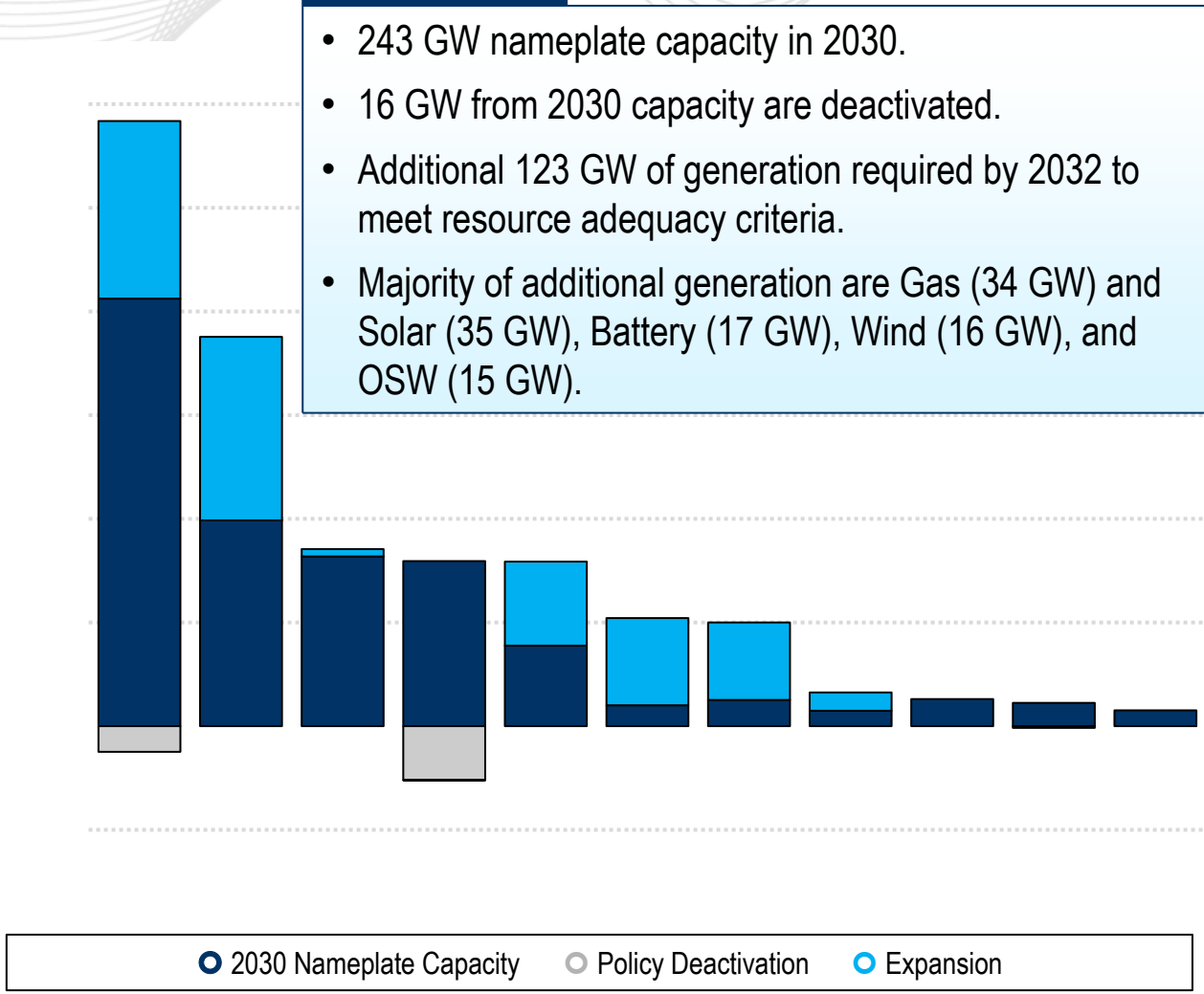
2032 Scenario 5: Capacity Expansion Summary

By Fuel Type

Resource Type	2030 Nameplate (MW)	Policy Deactivation (MW)	Capacity Expansion (MW)	Total
Gas	87,438	-4,952	34,250	116,736
Solar	39,699	0	35,410	75,108
Nuclear	32,742	0	1,423	34,165
Coal	42,265	-10,423	-6	31,836
Onshore	15,537	0	16,210	31,747
Battery	4,030	0	16,822	20,852
Offshore	5,054	0	14,952	20,006
Hybrid	2,976	0	3,528	6,504
Pumped-Hydro	5,225	0	0	5,225
Other	4,825	-331	153	4,647
Hydro	3,052	0	13	3,065
Total	**242,843**	**-15,706**	**122,754**	**349,890**

KEY TAKEAWAY

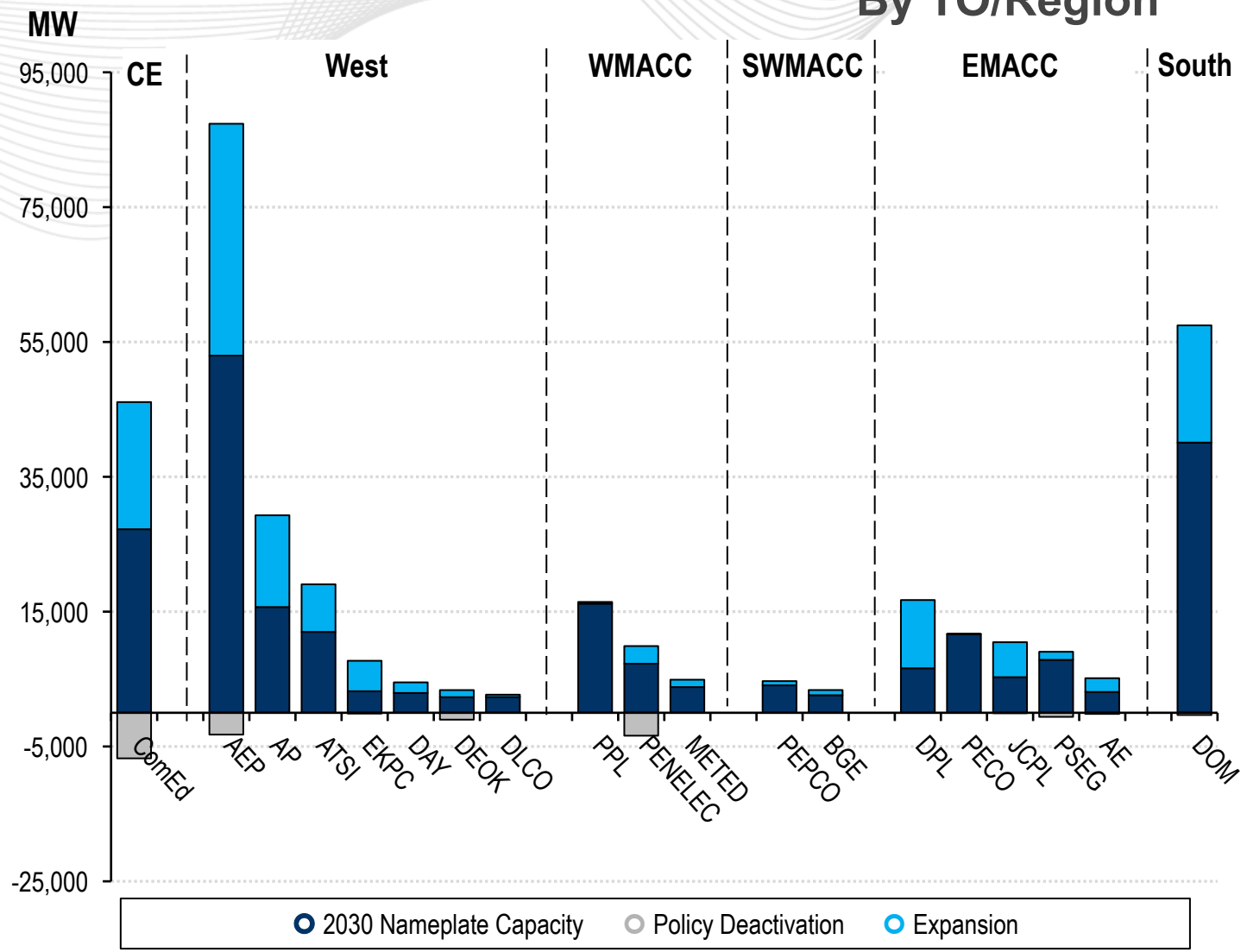
- 243 GW nameplate capacity in 2030.
- 16 GW from 2030 capacity are deactivated.
- Additional 123 GW of generation required by 2032 to meet resource adequacy criteria.
- Majority of additional generation are Gas (34 GW) and Solar (35 GW), Battery (17 GW), Wind (16 GW), and OSW (15 GW).



2032 Scenario 5: Capacity Expansion Summary

By TO/Region

Region	2030 Nameplate (MW)	Policy Deactivation (MW)	Capacity Expansion (MW)	Total
ComEd	33,986	-6,762	18,862	46,085
West (W/O CE)	95,799	-4,374	62,554	153,980
WMACC	30,667	-3,400	3,966	31,234
SWMACC	6,672	0	1,399	8,071
EMACC	35,313	-839	18,584	53,057
South	40,405	-331	17,389	57,463
Total	**242,843**	**-15,706**	**122,754**	**349,890**



KEY TAKEAWAY

- ComEd and West accounts for 66% (81 GW) of 123 GW of capacity expansion.
- Most of the expansion is forecasted in AEP (34 GW), CE (19 GW), DOM (17 GW), AP (14 GW) and DPL (10 GW).

Xfmr = Transformer

Overall: S3/S5 Unique Overloaded Facilities

2032 Base Scenario (S3)

Area	230–345 kV		500–765 kV		Total
	Line	Xfmr	Line	Xfmr	
AP	1				1
ATSI	9				9
AEP	35		6	1	42
OVEC	3				3
DAY	2				2
DEO&K	4				4
DLCO	1				1
ComEd	28			4	32
PENELEC	2				2
METED	2				2
JCPL	1		1		2
PPL	12			1	13
PECO	11		2		13
PSEG	7				7
BGE				1	1
PEPCO	2		1	1	3
AE	2				2
DP&L	3		1		4
EKPC	1				1
Dominion	95		13	10	118
Total	**217**	**0**	**22**	**18**	**257**

2032 Deactivation Scenario (S5)

Area	230–345 kV		500–765 kV		Total
	Line	Xfmr	Line	Xfmr	
AP	3		8	3	14
ATSI	13				13
AEP	54		20	3	77
OVEC	3				3
DAY	3				3
DEO&K	5				5
DLCO	2				2
ComEd	34		1	4	39
PENELEC	7		3	1	11
METED	3			1	4
JCPL	10	2	1		13
PPL	14		1	1	16
PECO	17		2		19
PSEG	14			1	15
BGE	3		2	2	7
PEPCO	8		4	2	13
AE	2				2
DP&L	22		3	2	26
EKPC	1				1
Dominion	102		19	12	133
Total	**318**	**2**	**61**	**31**	**412**

Scenario 5: Summary

Addition of 123 GW generation
forecasted between 2030 and 2032 under following consideration:

Potential generation deactivation due to state and federal policies	State RPS	Resource specific targes by states	Resource adequacy of 1 in 10

Based on the economical generation forecast:

Considerable:

- Generation nameplate capacity would be added in West.
- Gas and solar generation nameplate capacity would be added to PJM.

There will be significant reliability impact on BES due to change in regional capacity.

Overall: S3/S6 Unique Overloaded Facilities

	230–345 kV			500–765 kV						Total		
	Line			Line			Transformer					
Area	No Impact	Relieved	Aggravated	No Impact	Relieved	Aggravated	No Impact	Relieved	Aggravated	No Impact	Relieved	Aggravated
CE	20	6	0	0	0	0	3	1	0	23	7	0
APS	1	0	0	0	0	0	0	0	0	1	0	0
FE	1	0	10	0	0	0	0	0	0	1	0	10
AEP	23	3	8	3	1	3	1	0	0	27	4	11
OVEC	1	0	2	0	0	0	0	0	0	1	0	2
DAY	2	0	0	0	0	0	0	0	0	2	0	0
DEO&K	3	0	1	0	0	0	0	0	0	3	0	1
DLCO	1	0	0	0	0	0	0	0	0	1	0	0
EKPC	1	0	0	0	0	0	0	0	0	1	0	0
PENELEC	2	0	2	0	0	1	0	0	0	2	0	2
ME	2	0	0	0	0	0	0	0	0	2	0	0
PL	10	0	2	0	0	1	0	0	1	10	0	3
BGE	0	0	0	0	0	0	0	1	0	0	1	0
PEPCO	1	1	0	0	0	1	1	0	0	2	1	1
JCPL	1	0	0	1	0	0	0	0	0	2	0	0
PECO	10	0	2	1	1	0	0	0	0	11	1	2
PSEG	7	0	0	0	0	0	0	0	0	7	0	0
AE	2	0	0	0	0	0	0	0	0	2	0	0
DP&L	1	0	2	0	1	0	0	0	0	1	1	2
DVP	30	32	22	3	5	4	7	1	2	40	38	28
Total	**116**	**41**	**49**	**8**	**7**	**8**	**12**	**3**	**3**	**136**	**51**	**60**

KEY TAKEAWAY

- No new violations on BES were observed.
- Majority of the S3 violations were not impacted.
- Overload on some facilities in S3 were reduced in S6, and overload on comparable number of facilities were aggravated in S6.

No Impact: The difference in the facility's maximum loading between S3 and S6 is less than 2%.

Relieved: Facility's maximum loading in S6 is reduced more than 2% compared to S3.

Aggravated: Facility's maximum loading in S6 is increased more than 2% compared to S3.

Scenario 6: Summary

- Scenario 6 evaluated reliability impacts of dispatching battery storage in base case.
- Dispatching battery storage did not impact reliability significantly due to low battery storage penetration in 2032.
- The future impact on reliability due to battery storage would depend on location and size of new battery storage facilities.

Scenario 5 and Scenario 6: Concluding Remarks

SUMMARY

- PJM completed studies of Scenario 5 and Scenario 6.
- These are information studies, and PJM will not seek solutions to reliability violations found in the studies.
- Presently, no further activities are planned for Scenario 5 or Scenario 6.

Appendix

2032 Scenario 5: Capacity Expansion Study

Starting Resource Mix:

Consistent with 2025 RTEP model-year 2030:

Existing generation, GIA/ISA generation, Suspended ISA generation, Queue, Fast Lane, CVOW and Chesterfield plants.

Build limits:

- Minimum build limit: TC1 and TC2 (with RRI) by 2032 from Generation Interconnection Queue
- Maximum build limit: 2x (2030 ML* + Queue) for renewable, battery, hybrid and gas generation builds by 2032

Capacity Expansion horizon: 15 years (2031–2045)

Using the results of 2032 from the 15-year horizon

*Machine List

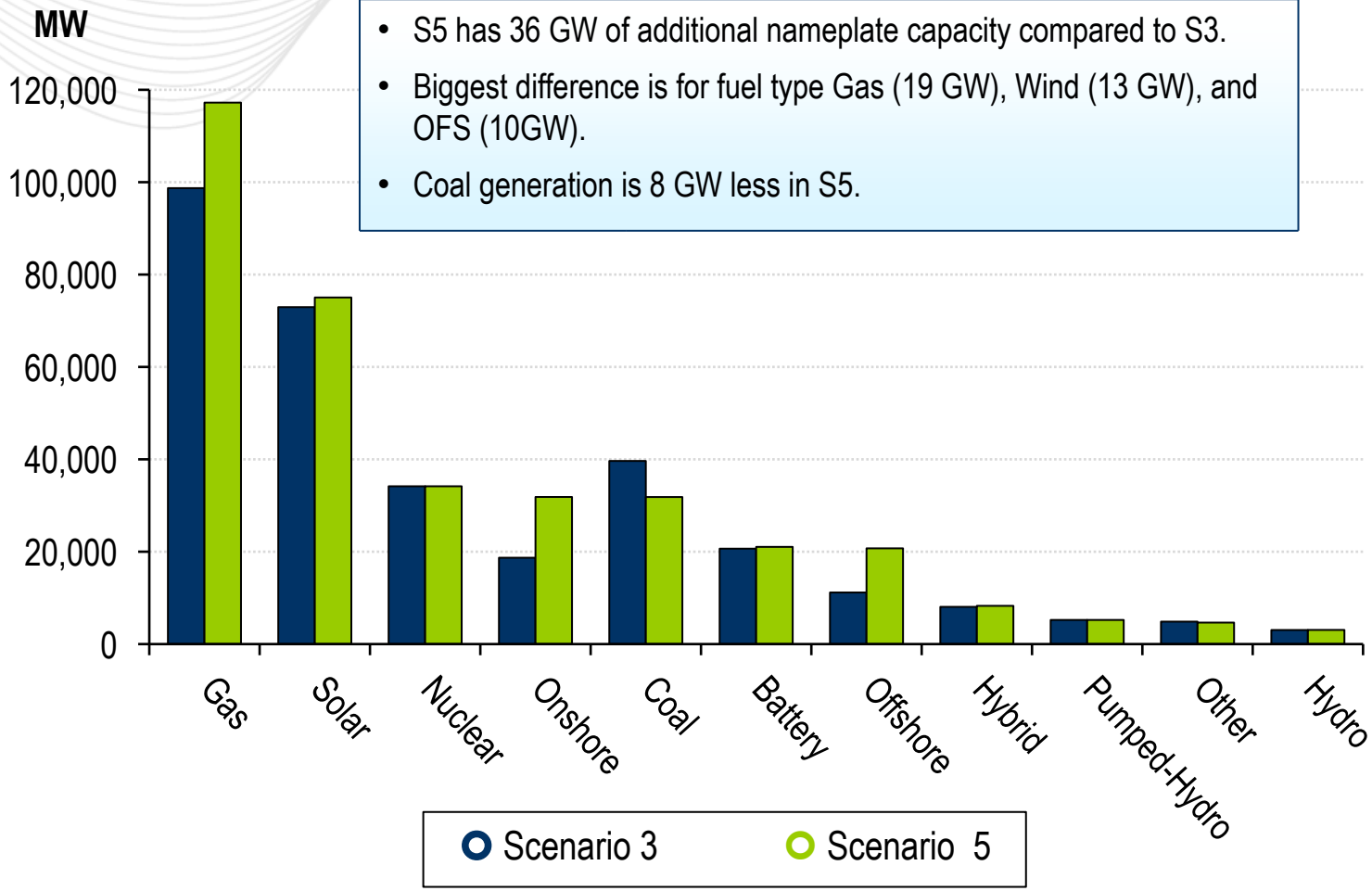
Nameplate Capacity: Scenario 3 vs. Scenario 5

By Fuel Type

MW Capacity by Fuel Type	Scenario 3	Scenario 5
Gas	98,713	117,226
Solar	72,952	75,037
Nuclear	34,165	34,165
Onshore	18,694	31,848
Coal	39,648	31,837
Battery	20,658	21,045
Offshore	11,170	20,728
Hybrid	8,059	8,279
Pumped-Hydro	5,225	5,225
Other	4,861	4,653
Hydro	3,045	3,066
Grand Total	**317,190**	**353,108**

KEY TAKEAWAY

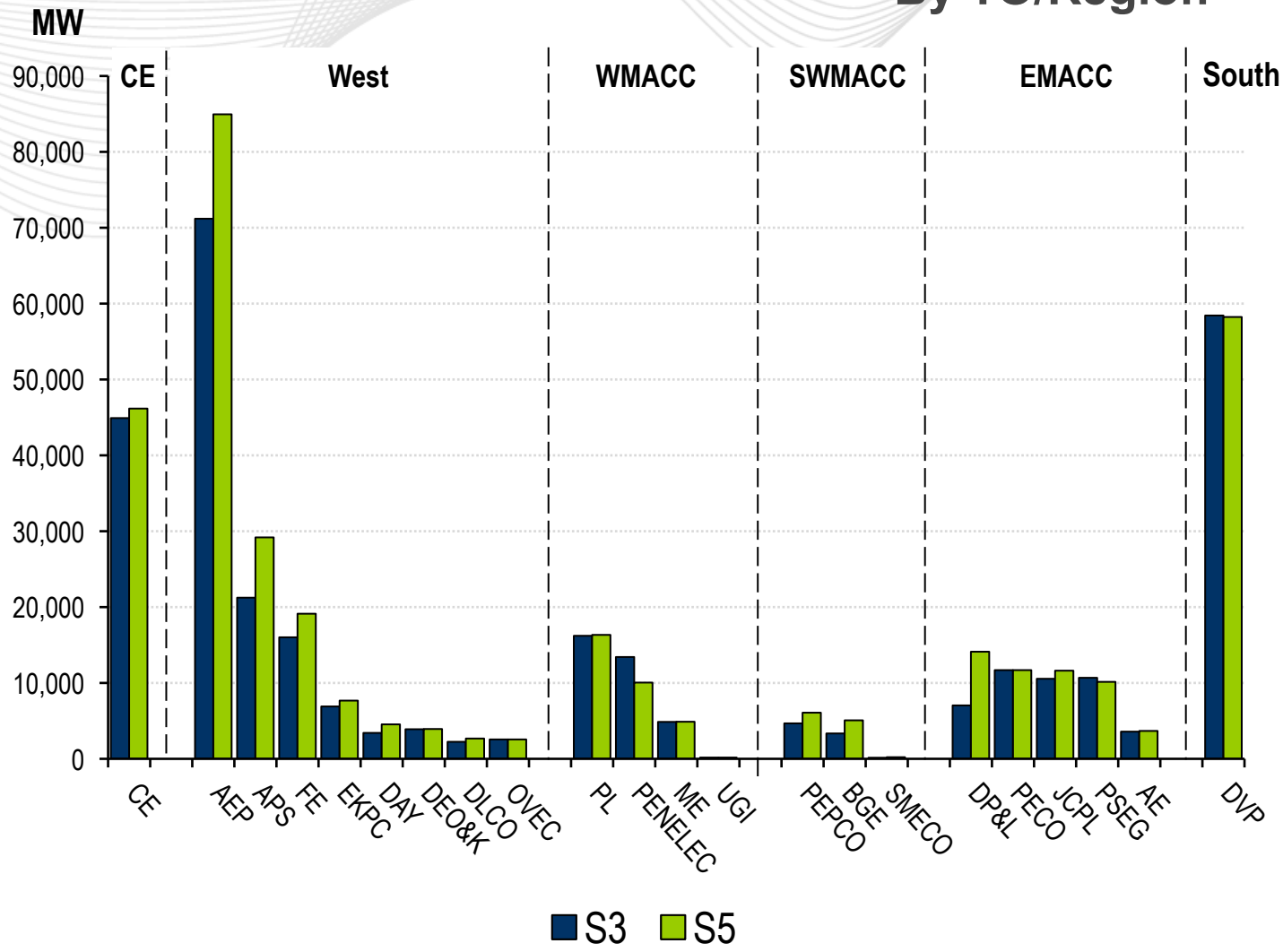
- S5 has 36 GW of additional nameplate capacity compared to S3.
- Biggest difference is for fuel type Gas (19 GW), Wind (13 GW), and OFS (10GW).
- Coal generation is 8 GW less in S5.



Nameplate Capacity: Scenario 3 vs. Scenario 5

By TO/Region

MW Capacity by region	Scenario 3	Scenario 5
CE	44,913	46,166
West	127,461	154,641
WMACC	34,673	31,443
SWMACC	8,166	11,372
EMACC	43,547	51,251
South	58,431	58,236
Grand Total	**317,190**	**353,108**



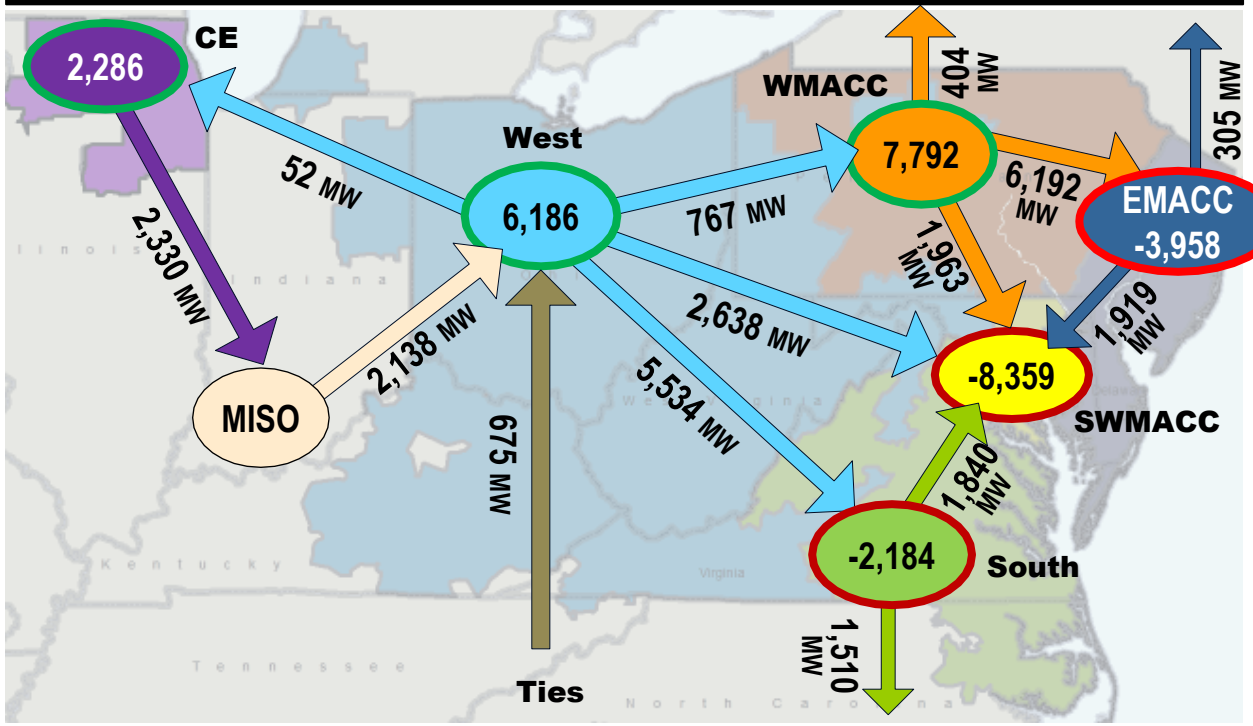
KEY TAKEAWAY

- In CE, despite policy-driven deactivation of 6.8 GW, net capacity in S5 is higher than S3 due to addition of forecasted generation in S5.
- In S5, capacity is mostly higher in West region (27 GW), EMACC (8 GW) and SWMACC (3 GW) regions.
- In West region capacity is mostly higher in AEP (14 GW), APS(8 GW) and FE (3 GW) in S5.
- In S5, installed capacity is less in WMACC region (by 3 GW) compared to S3 due to policy-driven deactivation.

Summer: Regional Gen/Flow in S3/S5

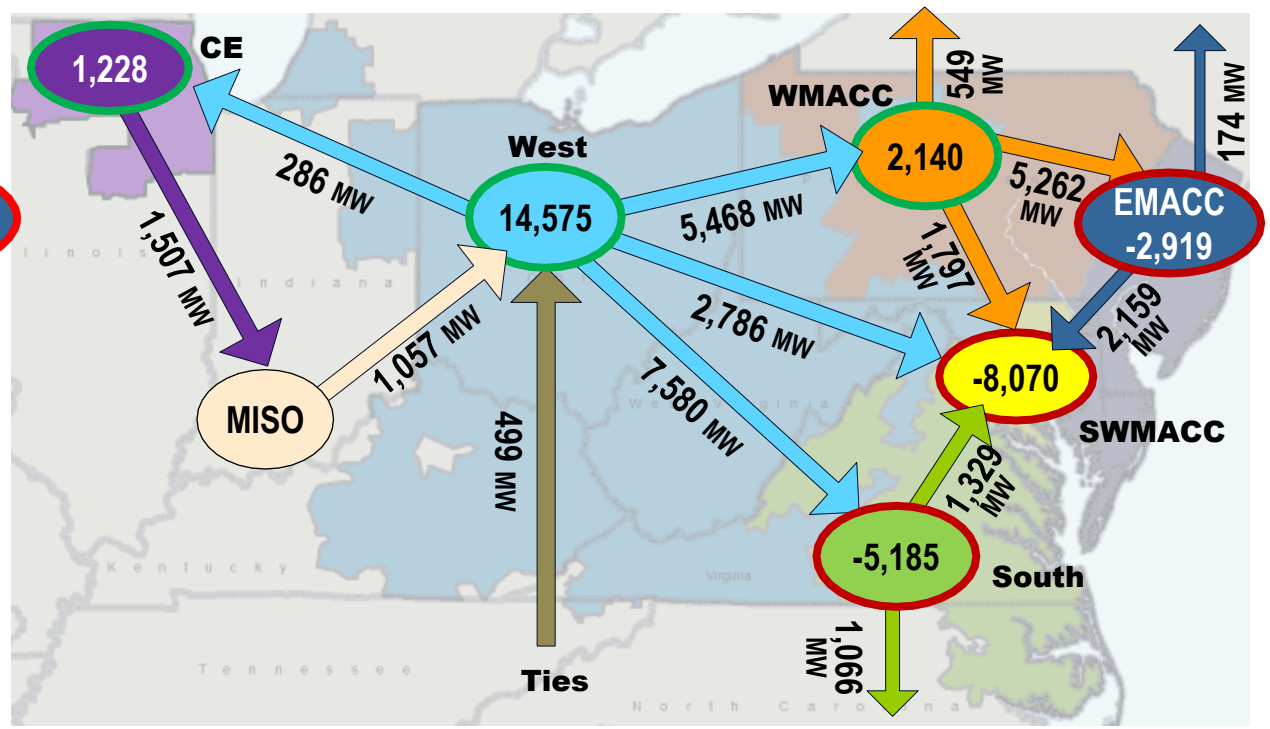
Net Import Net Export

2032 Scenario 3



In Scenario 5:	Net Generation
West	8.4 GW ↖
EMACC	1 GW ↖
WMACC	5.6 GW ↗
South	3 GW ↗
CE	1 GW ↗

2032 Scenario 5

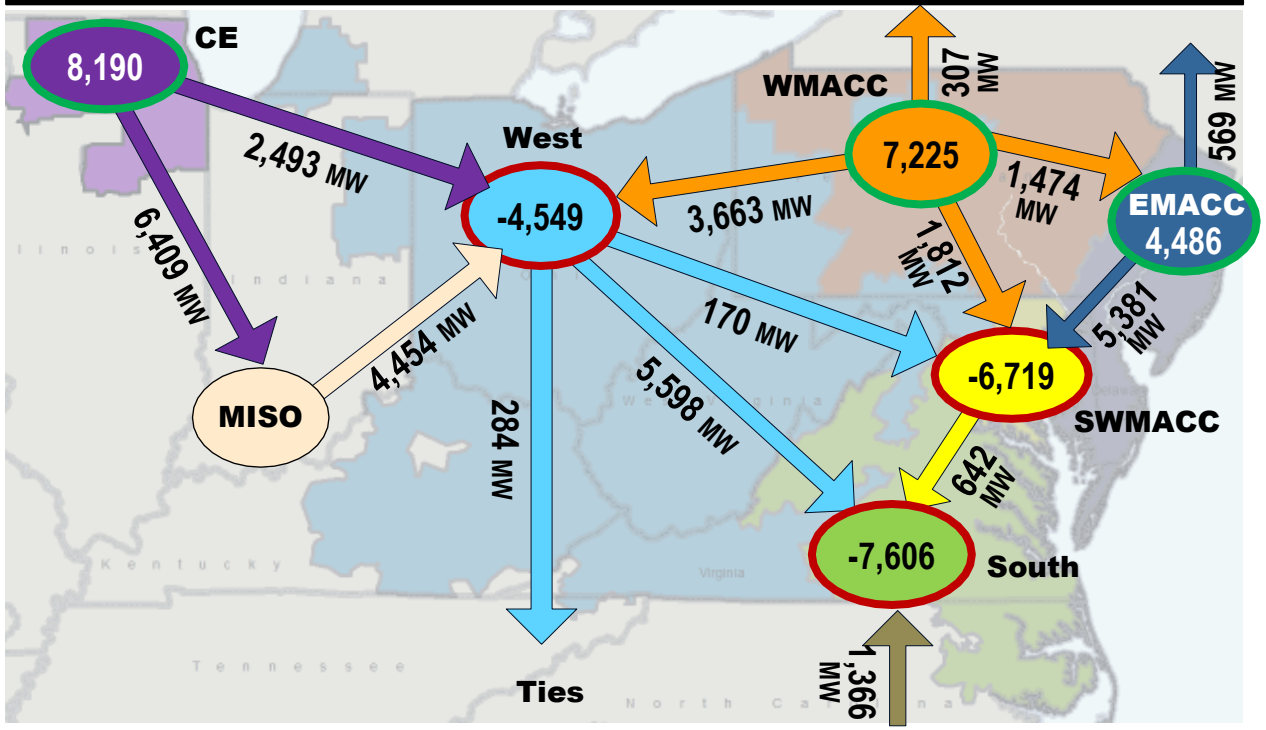


In Scenario 5:	Regional Transfer
West-WMACC	4.7 GW ↖
West-South	2 GW ↖
WMACC-EMACC	1 GW ↗

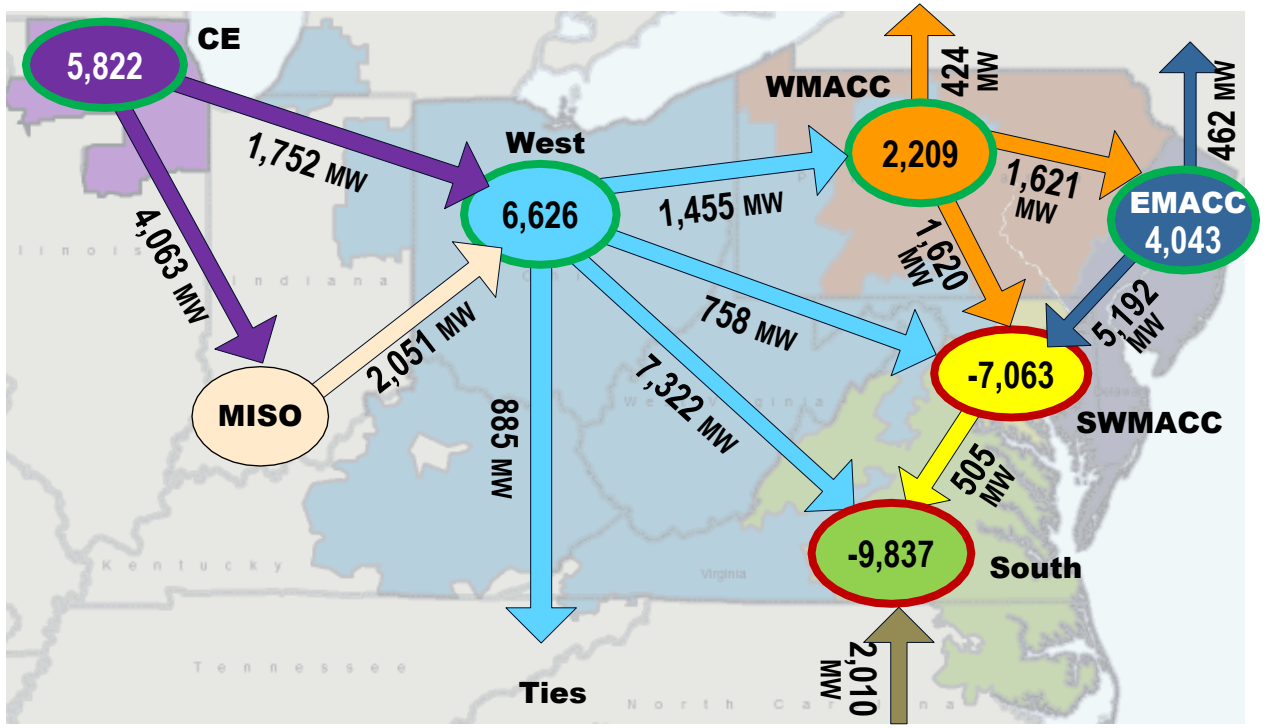
Winter: Regional Gen/Flow in S3/S5

Net Import Net Export

2032 Scenario 3



2032 Scenario 5



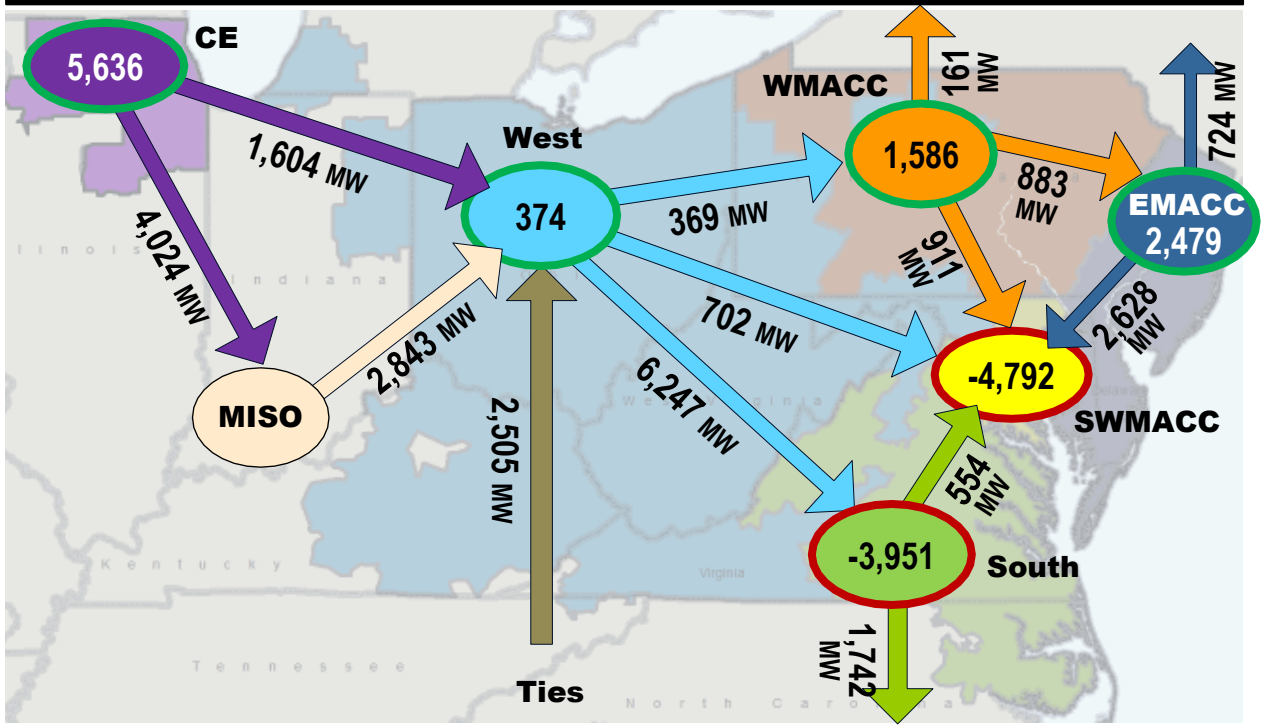
In Scenario 5:	Net Generation
West	11 GW ↖
WMACC	5.0 GW ↗
South	2.2 GW ↗
CE	3 GW ↗

In Scenario 5:	Regional Transfer
West-South	1.7 GW ↖
West-WMACC	5.1 GW ↖

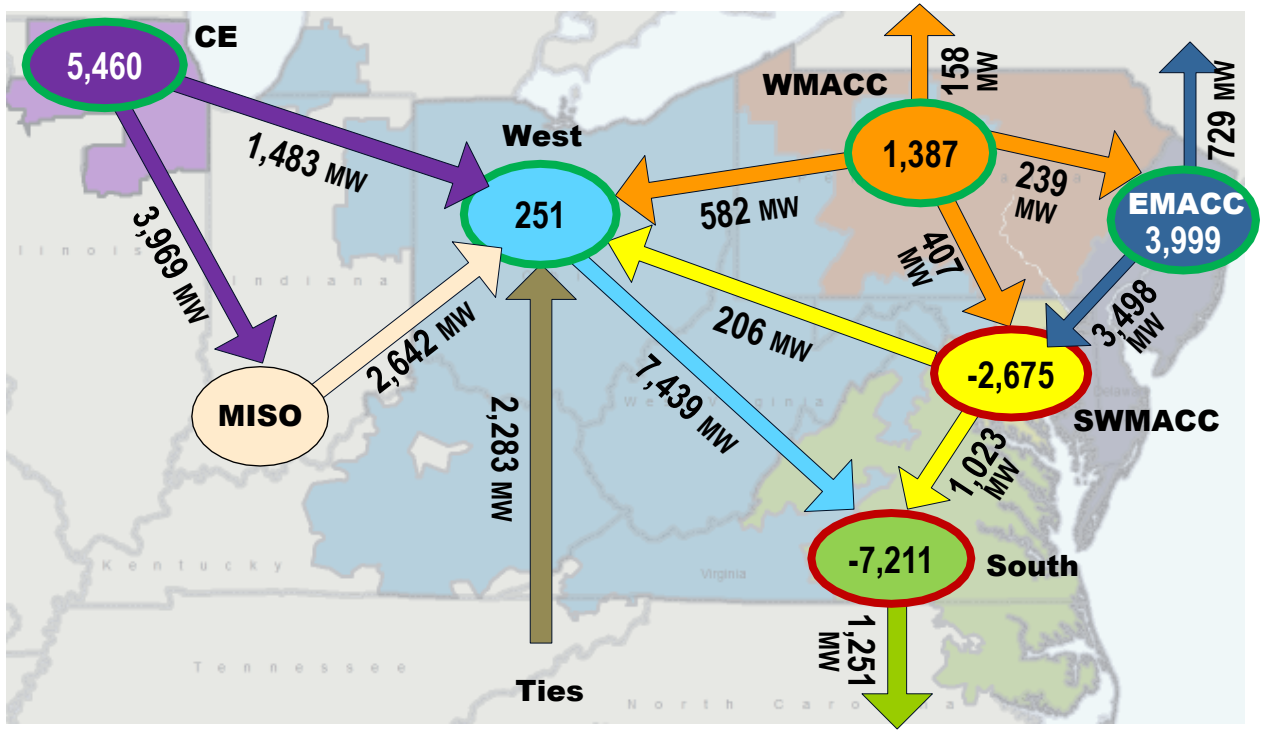
Light Load: Regional Gen/Flow in S3/S5

Net Import Net Export

2032 Scenario 3



2032 Scenario 5



In Scenario 5:	Net Generation
SWMACC	2 GW ↖
EMACC	1.5 GW ↖
South	3.2 GW ↗

In Scenario 5:	Regional Transfer
West-South	1.2 GW ↖
West-SWMACC	1 GW ↗
West-WMACC	1 GW ↗
South-SWMACC	1.5 GW ↗

Summer: S3/S5 Unique Overloaded Facilities

KEY TAKEAWAYS

- Top three areas with new violations are in AEP, DP&L and DOM.
- Significant number of new violations on PJM BES.
- Increase in number of facility violations may be attributed to change of generation dispatch within regions and change in inter-regional flows.

Changes in S5 Compared to S3

Area	230–345 kV		500–765 kV		Total
	Line	Transformer	Line	Transformer	
AEP	24	0	12	2	38
DP&L	20	0	2	1	22
Dominion	14	0	6	0	20
AP	2	0	8	3	13
PENELEC	5	0	3	1	9
PECO	6	0	2	0	8
PEPCO	5	0	2	1	8
PSEG	6	0	0	1	7
ComEd	4	0	0	2	6
BGE	3	0	1	2	6
ATSI	5	0	0	0	5
PPL	2	0	1	0	3
METED	1	0	0	1	2
JCPL	2	0	0	0	2
DEO&K	2	0	0	0	2
DLCO	1	0	0	0	1
OVEC	1	0	0	0	1
DAY	1	0	0	0	1
AE	0	0	0	0	0
EKPC	0	0	0	0	0
Total	**102**	**0**	**35**	**13**	**150**

2032 Scenario 6: Battery Dispatched

- 2032 base cases (S3) modified by dispatching batteries
  - **Summer:** over 8,000 MW
    (based on battery CIR MWs available for 8 hours)
  - **Winter:** over 5,000 MW
    (based on battery CIR MWs available for 12 hours)
- Remainder of PJM Generation scaled down to maintain power balance.
- Gen Deliv test was performed.