Technical Support Document (TSD)

for the Final Federal Good Neighbor Plan for the 2015 Ozone National Ambient Air Quality Standards

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Resource Adequacy and Reliability Analysis
Final Rule TSD

U.S. Environmental Protection Agency

Office of Air and Radiation

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This document supports the EPA's final Federal Good Neighbor Plan for the 2015 Ozone National Ambient Air Quality Standards and describes projected resource adequacy and reliability impacts of the final rule. As used here, the term resource adequacy is defined as the provision for adequate generating resources to meet projected load and generating reserve requirements in each power region[1], while reliability includes the ability to deliver the resources to the loads, such that the overall power grid remains stable. This document is meant to serve as a resource adequacy assessment of the impacts of the final rule and how projected outcomes under the final rule compare with projected baseline outcomes in the absence of the IRA.

The final rule establishes emissions-trading budgets for electric generating units (EGUs) in the covered states. The stringency of these budgets is set through assuming the installation and/or optimization of various conventional nitrogen oxides (NO_X) emissions control technologies. Covered sources would therefore be able to comply with the rule with these technologies and are not required to reduce utilization or shift generation. Nonetheless, in light of the transition of the power sector toward lower-emitting generating resources, as highlighted by commenters, it is anticipated that EGU owners and operators may pursue alternative compliance strategies. Should those strategies involve the curtailment or retirement of existing generating resources, commenters have separately raised concerns that this could impact the reliability of the power grid.

While such potential impacts would not be a direct result of this rule but rather of the compliance choices source owners and operators may pursue, we have analyzed whether the projected effects of the rule would in this regard pose a risk to resource adequacy, a key planning metric that informs grid reliability. It is important to recognize that the final rule provides multiple flexibilities that preserve the ability of responsible authorities to maintain electric reliability. For more detail on how the final rule addresses reliability concerns, see Section VI of the final rule preamble. The results presented in this document show that the projected impacts of the final rule on power system operations, under conditions preserving resource adequacy, are modest and manageable.

The results presented in this document further demonstrate, for the specific cases illustrated in the Regulatory Impact Analysis (RIA), that the implementation of this rule can be achieved without undermining resource adequacy or reliability. The focus of the analysis is on comparing the illustrative final rule scenario from the RIA to a base case (absent the rule requirements) that is assumed to be adequate and reliable. In this framework, the emphasis is on the incremental changes in the power system that are projected to occur under the presence of the rule in the 2023, 2025 and 2030 model run years. The EPA uses the Integrated Planning Model (IPM) to project likely future electricity market conditions with and without the proposed rule.[2]

IPM's least-cost dispatch solution is designed to ensure generation resource adequacy, either by using existing resources or through the construction of new resources. IPM addresses reliable delivery of generation resources for the delivery of electricity between the 78 IPM regions, based on current and planned transmission capacity, by setting limits to the ability to

[1] As analyzed in this document, power regions correspond to aggregates of IPM regions corresponding to NERC assessment areas.

[2] See final rule Regulatory Impact Analysis for more detail on the power sector impacts of the final rule.

transfer power between regions using the bulk power transmission system. Within each model region, IPM assumes that adequate transmission capacity exists to deliver any resources located in, or transferred to, the region. This document focusses on key regional results important to management of the power system. For a more complete presentation of the projected power sector impacts of the proposed rule, see the Regulatory Impact Analysis.

Overview

This rule establishes NO_X emissions budgets requiring fossil fuel-fired power plants (EGUs) in 22 states to participate in an allowance-based ozone season (May 1 through September 30) trading program beginning in 2023. The EGUs covered by the FIPs and subject to the budget are fossil-fired EGUs with >25-megawatt (MW) capacity. For details on the derivation of these budgets, please see Section V.C. of the preamble.

This TSD uses the same scenarios and years of analysis contained in the RIA.[3] The scenarios include a base case, and the final rule scenario. For purposes of this resource adequacy and reliability assessment, estimates and projections are taken from those same scenarios and years as shown in the RIA (2023, 2025, and 2030).

Summary of Changes in Operational Capacity

Total operational capacity remains similar between the base and policy scenarios. The model is constrained to disallow any incremental retirements, retrofits or builds beyond those that occur in the base case in 2023. This constraint is relaxed in future years. Operational generating capacity[4] changes from the base case in 2025 are summarized below:

Table 1. Operational Capacity Summary (2023, 2025, 2030)

Capacity (GW)	2023	2025	2030
Base Case Operational Capacity	1,211	1,209	1,262
Minus Retirements			
Coal	0.0	-1.5	-12.9
Oil/Gas	0.0	-0.1	-0.1
NGCC	0.0	0.0	0.0
NGCT	0.0	0.0	0.0
Nuclear	0.0	0.0	0.5
Plus Additions			
NGCC	0.0	0.0	0.0
NGCT	0.0	0.3	9.0
Wind	0.0	0.0	0.3
Solar	0.0	3.0	3.0
Storage	0.0	0.0	0.0
Other	0.0	0.0	0.0
Policy Case Operational Capacity	1,211	1,211	1,261

[3] See Chapter 4 of the RIA for additional details on the scenarios examined.
[4] Operational capacity is any existing, new or retrofitted capacity that is not retired.

Since the model must maintain adequate reserves in each region, projected retirements must be offset by reliance on existing baseline excess reserves, incremental builds, and the ability to shift transmission flows between regions in response to changing generation mix. In response to tightening budgets, a first wave of incremental coal retirements is projected to occur in the model's 2025 run year[5] (which includes representation of calendar year 2026 by which the final rule begins incorporating SCR-retrofit-related emission reduction potential into emission budgets), offset by increases in solar and NGCT builds. In 2030, the model projects that a larger wave of large coal units lacking SCR elect to retire in lieu of retrofitting SCR when subject to the tighter emission budgets and the backstop rate; this retiring capacity is offset primarily by incremental NGCT and builds.

Reserve Requirements

IPM uses a target reserve margin in each region[6] as the basis for determining how much capacity to keep operational in order to preserve resource adequacy. IPM retires capacity if it is no longer needed to provide energy for load or to provide capacity to meet reserve margin during the planning horizon of the projections. Since current regional reserves may be higher than the target reserve margin for a region, IPM may retire reserve capacity if it is not economic to use it to maintain adequate reserve margins. Existing resources may also be more expensive, compared to alternatives such as building new capacity or transferring capacity from another region. As a result, some of the plants that are projected to retire will not need to be replaced. Because some existing plants eventually retire in most regions, and IPM builds no more than what it needs to maintain a target reserve margin in each region, the actual reserve margins tend to approach the target reserve margins over time. For details on projected reserve margins under the base and policy scenarios, please see Appendix A-3, B-3 and C-3.[7]

Changes in Retirements and New Capacity Additions under the Final Rule

The incremental retirements in the final rule case are shown above in Table 1; the 13 GW of retirements in 2030 are in addition to 69 GW of coal and 15 GW of oil/gas retirements already occurring in the base case.

By 2030, the final rule scenario as compared to the base case leads to higher levels of overall existing coal retirements and new capacity additions (shown regionally in Table A5, B5

[5] IPM uses model years to represent the full planning horizon being modeled. By mapping multiple calendar years to a run year, the model size is kept manageable. For this analysis, IPM maps the calendar year 2023 to run year 2023, calendar years 2024-2026 to run year 2025 and calendar years 2027-2029 to run year 2028. For model details, please see Chapter 2 of the IPM documentation, available at: https://www.epa.gov/system/files/documents/2021-09/epa-platform-v6-summer-2021-reference-case-09-11-21-v6.pdf.

[6] In IPM, reserve margins are used to represent the reliability standards that are in effect in each NERC region. Individual reserve margins for each NERC region are derived from reliability standards in NERC's electric reliability reports. The IPM regional reserve margins are imposed throughout the entire time horizon.

[7] See maps of IPM regions and NERC Assessment Regions, and the table of target and projected reserve margins in Appendix D. IPM regions are based on the regions NERC uses for regional assessments. These regions are used for the Appendix tables in this document

and C5). Renewable additions are higher under the policy case. The largest increases in new capacity are in NGCT (9 GW), followed by solar and wind (3 GW). These retirements and additions in the projections are the result of the model's optimization of economic planning for energy and capacity needs ; they do not represent required outcomes for any individual units, which will be able to consider multiple compliance options in response to the final rule. In particular, new additions in a base case scenario that do not occur in the policy scenario projections might, in reality, be retained under a policy if local reliability conditions rendered this development the most appropriate choice. This rule does not prevent generation owners from shifting retirements and additions among specific sources to ensure reliability in such circumstances.

Reserve Transfers

In cases where it is economic to transfer reserves from a neighboring region, rather than supply reserves from within a region, IPM will transfer reserves, subject to summer and winter limits that are designed to ensure that these reserves can be transferred reliably. The transfer of reserves can occur, for example, if a region retires capacity that was used in the base case to meet reserve requirements, but a neighboring region has lower cost reserves that are not needed for its own reserve requirements. To examine these transfers, the EPA analyzed the change in net transfers from each region, where the net transfer for the base and policy cases is measured by the reserves sent to neighboring regions. In these cases, a positive value signifies the reserve capacity sent to other regions is larger than the reserve capacity received from other regions (sending and receiving regions can be different), while a negative value signifies that the capacity received is larger than the capacity sent. Thus, the value measures the degree to which resources in the region were reserved for use by other regions (positive value), or where the capacity to meet load in the region was served by resources in other regions (negative value). In each case these reserve transfers represent the use of the transmission system on a firm basis for at least a season.

To look at the projected impact of the policy case on transfers, the measure used was the change in the summer reserves sent in the policy case compared to the base case. To develop a relative measure of the impact of the policy, the change in reserves was measured as a percentage of load in the sending region. This percentage gives an indication of the significance of the policy for changes in the grid. In general, the percentage changes in the final rule are below 2%. For details on projected transfers under the base and policy scenarios, please see Appendix A-6, B-6 and C-6.

Appendix A: Tables by IPM Region for Final Rule in 2023
(Note: All Results Cumulative through Projection Year)

A1. Projected Operational Capacity in GW (2023)

Region	All generation sources		Change from Base	Coal Only		Change from Base
	Base	Policy		Base	Policy	
US	1,211	1,211	0	192	192	0
ERCOT	132	132	0	14	14	0
FRCC	64	64	0	5	5	0
MISO - South	45	45	0	7	7	0
MISO - North	48	48	0	11	11	0
MISO - Central	85	85	0	31	31	0
ISONE	44	44	0	1	1	0
NYISO	45	45	0	0	0	0
PJM	207	207	0	38	38	0
SERC	183	183	0	43	43	0
SPP	94	94	0	21	21	0
WECC - non CAISO	183	183	0	22	22	0
CAISO	82	82	0	0	0	0

A2. Summary of Summer Peak Loads and Reserve Capacity in GW (2023)

Region	Projected Reserve Margins			
	Peak Demand Base	Peak Demand Policy	Reserve Capacity Base	Reserve Capacity Policy
US	783	783	958	958
ERCOT	72	72	83	83
FRCC	48	48	60	60
MISO - South	35	35	43	43
MISO - North	26	26	30	30
MISO - Central	65	65	76	76
ISONE	25	25	34	34
NYISO	33	33	38	38
PJM	147	147	184	184
SERC	135	135	170	170
SPP	52	52	61	61
WECC - non CAISO	94	94	121	121
CAISO	50	50	57	57

A3. Summary of Target and Projected Reserve Margin % (2023)

Region	Target Reserve Margin	Base Case	Policy Case	Policy % Above Margin	Policy Change from Base
US	15%	22%	22%	7%	0%
ERCOT	14%	15%	15%	2%	0%
FRCC	19%	26%	26%	7%	0%
MISO - South	17%	24%	24%	7%	0%
MISO - North	17%	17%	17%	0%	0%
MISO - Central	17%	17%	17%	0%	0%
ISONE	18%	36%	36%	18%	0%
NYISO	15%	15%	15%	0%	0%
PJM	16%	25%	25%	9%	0%
SERC	15%	25%	26%	11%	0%
SPP	12%	18%	18%	6%	0%
WECC - non CAISO	14%	28%	28%	15%	0%
CAISO	14%	14%	14%	0%	0%

A4. Policy Case Retired Capacity Incremental to Base Case in GW (2023)

Region	CC	Coal	CT	Nuclear	OG Steam	Total
US	0	0	0	0	0	0
ERCOT	0	0	0	0	0	0
FRCC	0	0	0	0	0	0
MISO - South	0	0	0	0	0	0
MISO - North	0	0	0	0	0	0
MISO - Central	0	0	0	0	0	0
ISONE	0	0	0	0	0	0
NYISO	0	0	0	0	0	0
PJM	0	0	0	0	0	0
SERC	0	0	0	0	0	0
SPP	0	0	0	0	0	0
WECC - non CAISO	0	0	0	0	0	0
CAISO	0	0	0	0	0	0

A5. New Capacity in Policy Case Incremental to Base Case in GW (2023)

Region	CC	CT	Wind	Solar	Storage	Other	Total
US	0	0	0	0	0	0	0
ERCOT	0	0	0	0	0	0	0
FRCC	0	0	0	0	0	0	0
MISO - South	0	0	0	0	0	0	0
MISO - North	0	0	0	0	0	0	0
MISO - Central	0	0	0	0	0	0	0
ISONE	0	0	0	0	0	0	0
NYISO	0	0	0	0	0	0	0
PJM	0	0	0	0	0	0	0
SERC	0	0	0	0	0	0	0
SPP	0	0	0	0	0	0	0
WECC - non CAISO	0	0	0	0	0	0	0
CAISO	0	0	0	0	0	0	0

A6. Net Reserves Sent by NERC Assessment Region in GW (2023)

Region	Base	Policy	Change from Base to Policy	Change as a percent of summer peak
US	1.2	1.2	0.1	0%
ERCOT	0.2	0.2	0.0	0%
FRCC	0.0	0.0	0.0	0%
MISO – South	1.1	1.1	0.0	0%
MISO – North	-1.0	-1.0	0.0	0%
MISO – Central	-0.6	-0.6	0.0	0%
ISONE	0.2	0.3	0.1	0%
NYISO	0.0	0.0	0.0	0%
PJM	2.5	2.8	0.3	0%
SERC	-1.5	-1.8	-0.3	0%
SPP	0.0	-0.1	0.0	0%
WECC – non CAISO	3.9	3.9	0.0	0%
CAISO	-3.6	-3.6	0.0	0%

Appendix B: Tables by IPM Region for Final Rule in 2025
(Note: All Results Cumulative through Projection Year)

B1. Projected Operational Capacity in GW (2025)

Region	All generation sources		Change from Base	Coal Only		Change from Base
	Base	Policy		Base	Policy	
US	1,209	1,211	2	146	145	-1
ERCOT	139	139	0	13	13	0
FRCC	63	63	0	3	3	0
MISO - South	43	44	1	6	6	-1
MISO - North	50	50	0	10	10	0
MISO - Central	87	87	0	22	22	0
ISONE	43	43	0	0	0	0
NYISO	48	48	0	0	0	0
PJM	208	208	0	26	26	0
SERC	174	175	1	31	32	0
SPP	91	91	0	19	19	0
WECC - non CAISO	181	182	0	14	14	0
CAISO	82	82	0	0	0	0

B2. Summary of Summer Peak Loads and Reserve Capacity in GW (2025)

Region	Projected Reserve Margins			
	Peak Demand Base	Peak Demand Policy	Reserve Capacity Base	Reserve Capacity Policy
US	790	790	917	918
ERCOT	72	72	82	82
FRCC	48	48	58	58
MISO - South	35	35	41	42
MISO - North	26	26	30	30
MISO - Central	65	65	77	76
ISONE	25	25	32	32
NYISO	33	33	38	38
PJM	148	148	174	174
SERC	137	137	158	158
SPP	53	53	59	59
WECC - non CAISO	96	96	109	109
CAISO	51	51	58	58

B3. Summary of Target and Projected Reserve Margin % (2025)

Region	Target Reserve Margin	Base Case	Policy Case	Policy % Above Margin	Policy Change from Base
US	15%	16%	16%	1%	0%
ERCOT	14%	14%	14%	0%	0%
FRCC	19%	21%	21%	2%	0%
MISO - South	17%	17%	19%	3%	2%
MISO - North	17%	17%	17%	0%	0%
MISO - Central	17%	17%	17%	0%	0%
ISONE	18%	27%	27%	9%	0%
NYISO	15%	15%	15%	0%	0%
PJM	16%	18%	18%	2%	0%
SERC	15%	15%	15%	0%	0%
SPP	12%	13%	13%	1%	0%
WECC - non CAISO	14%	14%	14%	0%	0%
CAISO	14%	14%	14%	0%	0%

B4. Policy Case Retired Capacity Incremental to Base Case in GW (2025)

Region	CC	Coal	CT	Nuclear	OG Steam	Total
US	0.0	1.5	0.0	0.0	0.1	1.6
ERCOT	0.0	0.4	0.0	0.0	0.0	0.4
FRCC	0.0	0.0	0.0	0.0	0.0	0.0
MISO - South	0.0	0.6	0.0	0.0	0.1	0.6
MISO - North	0.0	0.0	0.0	0.0	0.0	0.0
MISO - Central	0.0	0.3	0.0	0.0	0.0	0.3
ISONE	0.0	0.0	0.0	0.0	0.0	0.0
NYISO	0.0	0.0	0.0	0.0	0.0	0.0
PJM	0.0	0.3	0.0	0.0	-0.1	0.2
SERC	0.0	0.0	0.0	0.0	0.1	0.1
SPP	0.0	0.0	0.0	0.0	0.0	0.0
WECC - non CAISO	0.0	0.0	0.0	0.0	0.0	0.1
CAISO	0.0	0.0	0.0	0.0	0.0	0.0

B5. New Capacity in Policy Case Incremental to Base Case in GW (2025)

Region	CC	CT	Wind	Solar	Storage	Other	Total
US	0	0	0	3	0	0	3
ERCOT	0	0	0	0	0	0	0
FRCC	0	0	0	0	0	0	0
MISO - South	0	0	0	1	0	0	1
MISO - North	0	0	0	0	0	0	0
MISO - Central	0	0	0	1	0	0	1
ISONE	0	0	0	0	0	0	0
NYISO	0	0	0	0	0	0	0
PJM	0	0	0	0	0	0	0
SERC	0	0	0	1	0	0	1
SPP	0	0	0	0	0	0	0
WECC - non CAISO	0	0	0	0	0	0	0
CAISO	0	0	0	0	0	0	0

B6. Net Reserves Sent by NERC Assessment Region in GW (2025)

Region	Base	Policy	Change from Base to Policy	Change as a percent of summer peak
US	0.3	0.3	0.0	0%
ERCOT	1.6	1.2	-0.4	-1%
FRCC	0.0	0.0	0.0	0%
MISO - South	0.0	0.0	0.0	0%
MISO - North	-1.9	-1.9	0.0	0%
MISO - Central	-2.7	-2.4	0.4	1%
ISONE	0.0	0.0	0.0	0%
NYISO	0.3	0.3	0.0	0%
PJM	3.2	2.9	-0.3	0%
SERC	0.2	0.5	0.2	0%
SPP	-0.9	-0.9	0.0	0%
WECC - non CAISO	7.6	7.6	0.0	0%
CAISO	-7.1	-7.1	0.0	0%

Appendix C: Tables by IPM Region for Final Rule in 2030
(Note: All Results Cumulative through Projection Year)

C1. Projected Operational Capacity in GW (2030)

Region	All generation sources		Change from Base	Coal Only		Change from Base
	Base	Policy		Base	Policy	
US	1,262	1,261	0	124	111	-13
ERCOT	139	139	0	11	9	-2
FRCC	65	65	0	3	3	0
MISO - South	43	42	-1	3	1	-2
MISO - North	51	50	0	9	9	0
MISO - Central	92	94	1	18	17	-1
ISONE	45	45	0	0	0	0
NYISO	48	48	0	0	0	0
PJM	221	221	0	22	20	-2
SERC	183	183	0	25	23	-1
SPP	95	95	0	19	15	-4
WECC - non CAISO	191	191	0	14	13	-1
CAISO	87	87	0	1	1	0

C2. Summary of Summer Peak Loads and Reserve Capacity in GW (2030)

Region	Projected Reserve Margins			
	Peak Demand Base	Peak Demand Policy	Reserve Capacity Base	Reserve Capacity Policy
US	818	818	942	942
ERCOT	74	74	84	84
FRCC	51	51	60	60
MISO - South	37	37	43	43
MISO - North	27	27	31	31
MISO - Central	67	67	78	78
ISONE	27	27	31	31
NYISO	33	33	38	38
PJM	152	152	176	176
SERC	143	143	164	164
SPP	54	54	61	61
WECC - non CAISO	102	102	116	116
CAISO	53	53	60	60

C3. Summary of Target and Projected Reserve Margin % (2030)

Region	Target Reserve Margin	Base Case	Policy Case	Policy % Above Margin	Policy Change from Base
US	15%	15%	15%	0%	0%
ERCOT	14%	14%	14%	0%	0%
FRCC	19%	19%	19%	0%	0%
MISO - South	17%	17%	17%	0%	0%
MISO - North	17%	17%	17%	0%	0%
MISO - Central	17%	17%	17%	0%	0%
ISONE	18%	18%	18%	0%	0%
NYISO	15%	15%	15%	0%	0%
PJM	16%	16%	16%	0%	0%
SERC	15%	15%	15%	0%	0%
SPP	12%	12%	12%	0%	0%
WECC - non CAISO	14%	14%	14%	0%	0%
CAISO	14%	14%	14%	0%	0%

C4. Policy Case Retired Capacity Incremental to Base Case in GW (2030)

Region	CC	Coal	CT	Nuclear	OG Steam	Total
US	0.0	12.9	0.0	-0.5	0.1	12.5
ERCOT	0.0	2.1	0.0	0.0	0.0	2.1
FRCC	0.0	0.0	0.0	0.0	0.0	0.0
MISO - South	0.0	2.2	0.0	0.0	0.1	2.3
MISO - North	0.0	0.0	0.0	0.0	0.0	0.0
MISO - Central	0.0	0.5	0.0	0.0	0.0	0.5
ISONE	0.0	0.0	0.0	0.0	0.0	0.0
NYISO	0.0	0.0	0.0	0.0	0.0	0.1
PJM	0.0	1.9	0.0	-0.5	-0.1	1.4
SERC	0.0	1.4	0.0	0.0	0.1	1.5
SPP	0.0	3.9	0.0	0.0	0.0	3.8
WECC - non CAISO	0.0	0.8	0.0	0.0	0.0	0.8
CAISO	0.0	0.0	0.0	0.0	0.0	0.0

C5. New Capacity in Policy Case Incremental to Base Case in GW (2030)

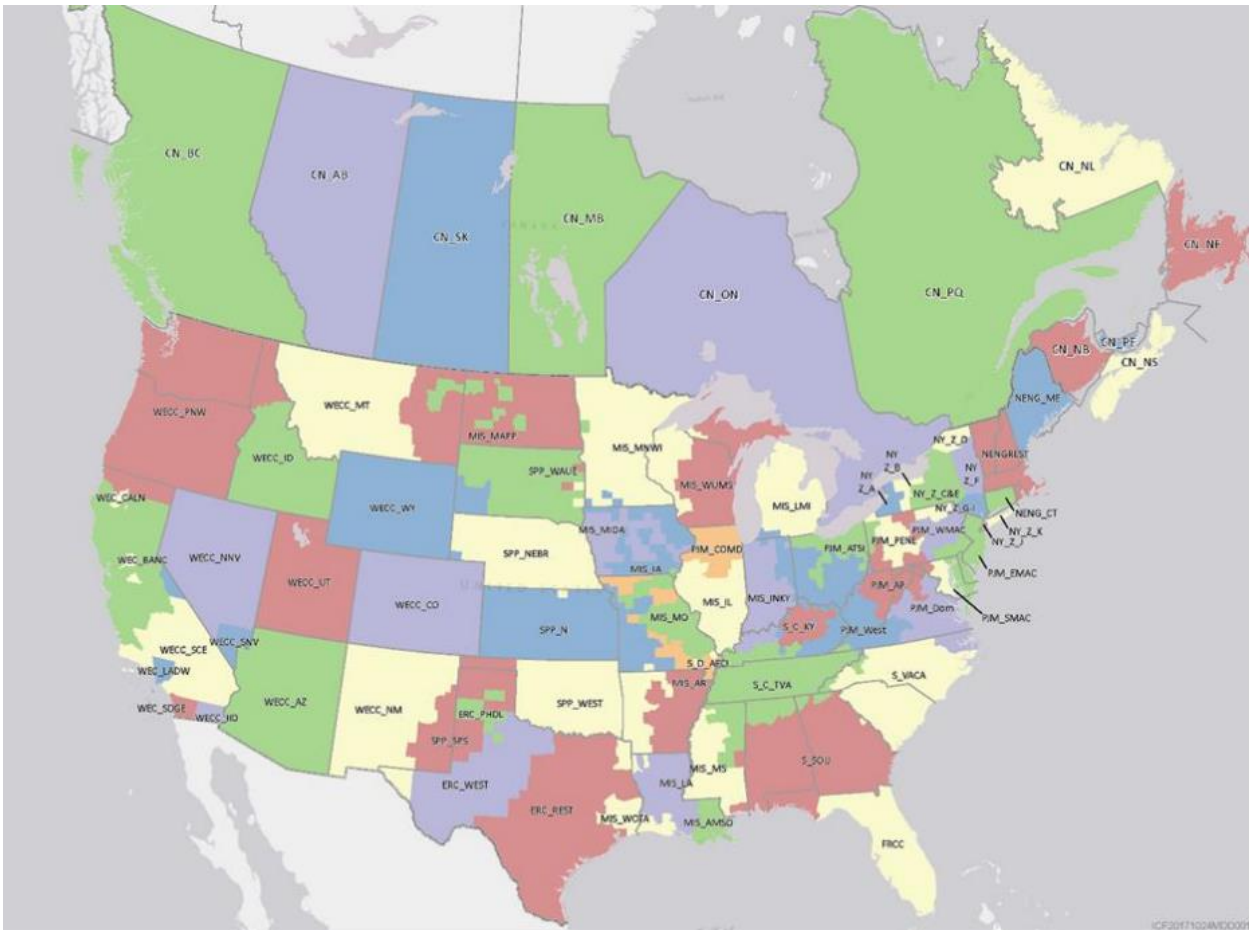
Region	CC	CT	Wind	Solar	Storage	Other	Total
US	0	9	0	3	0	0	12
ERCOT	0	2	0	0	0	0	2
FRCC	0	0	0	0	0	0	0
MISO - South	0	1	0	0	0	0	1
MISO - North	0	0	0	0	0	0	0
MISO - Central	0	2	0	0	0	0	2
ISONE	0	0	0	0	0	0	0
NYISO	0	0	0	0	0	0	0
PJM	0	2	0	0	0	0	1
SERC	0	1	0	0	0	0	1
SPP	0	0	0	4	0	0	4
WECC - non CAISO	0	1	0	0	0	0	1
CAISO	0	0	0	0	0	0	0

C6. Net Reserves Sent by NERC Assessment Region in GW (2030)

Region	Base	Policy	Change from Base to Policy	Change as a percent of summer peak
US	-3.5	-3.6	-0.1	0%
ERCOT	-0.7	-1.0	-0.3	0%
FRCC	-0.2	0.0	0.2	0%
MISO - South	-1.3	-2.1	-0.8	-2%
MISO - North	-2.5	-2.5	0.0	0%
MISO - Central	0.4	1.5	1.1	2%
ISONE	-0.7	-0.7	0.0	0%
NYISO	-0.1	-0.1	-0.1	0%
PJM	0.4	0.4	0.0	0%
SERC	2.0	1.8	-0.2	0%
SPP	1.0	1.1	0.1	0%
WECC - non CAISO	5.5	5.5	0.0	0%
CAISO	-7.4	-7.4	0.0	0%

Appendix D: Maps

IPM v6 Map



D2: NERC Assessment Areas in Long Term Reliability Assessment.

Source: NERC 2022 Long-Term Reliability Assessment