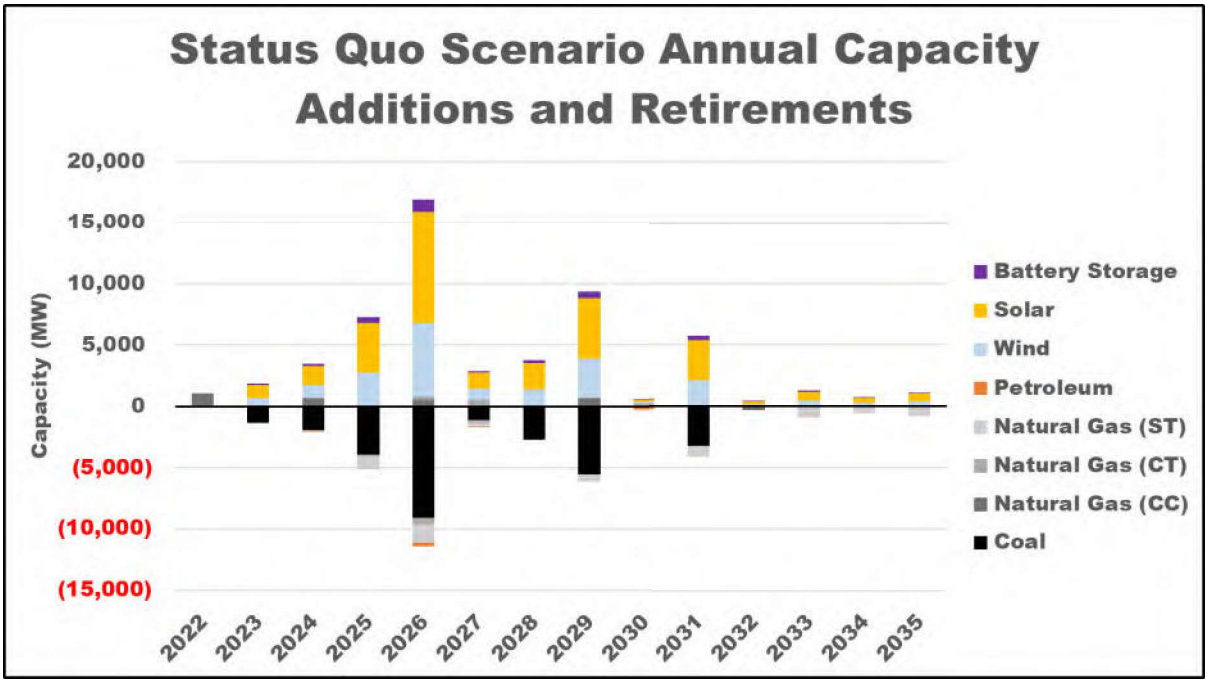


Figure D-13. This graph shows the annual capacity additions and subtractions needed to maintain resource adequacy using EPA's capacity accreditation metrics.

Partial scenario: The Partial scenario results in the retirement of 29,908 MW of coal resources, 7,852 MW of natural gas capacity, and 462 MW of petroleum capacity. To replace this retired capacity, additions in the Partial scenario consist of 4,306 MW of natural gas, 20,451 MW of wind, 31,201 MW of solar, and 3,477 MW of storage (see Figure D-14). The incremental closure of 1,151 MW of lignite capacity results in an incremental increase in a replacement capacity of 1,015 MW wind, 1,549 MW solar, and 173 MW storage (see Figure D-15).[84]

[84] Replacement capacity is more than the retiring 1,151 MW of coal capacity because intermittent resources like wind and solar have lower capacity values than coal capacity.

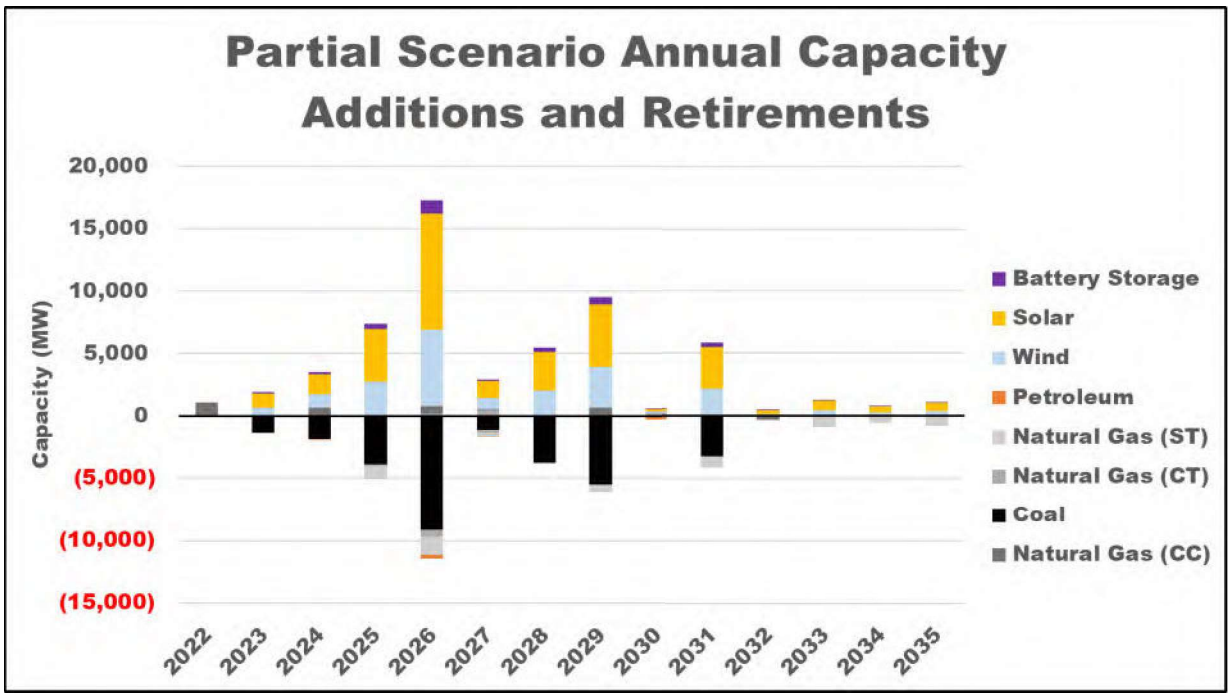


Figure D-14. This graph shows the annual capacity additions and subtractions needed to maintain resource adequacy using EPA's capacity accreditation metrics.

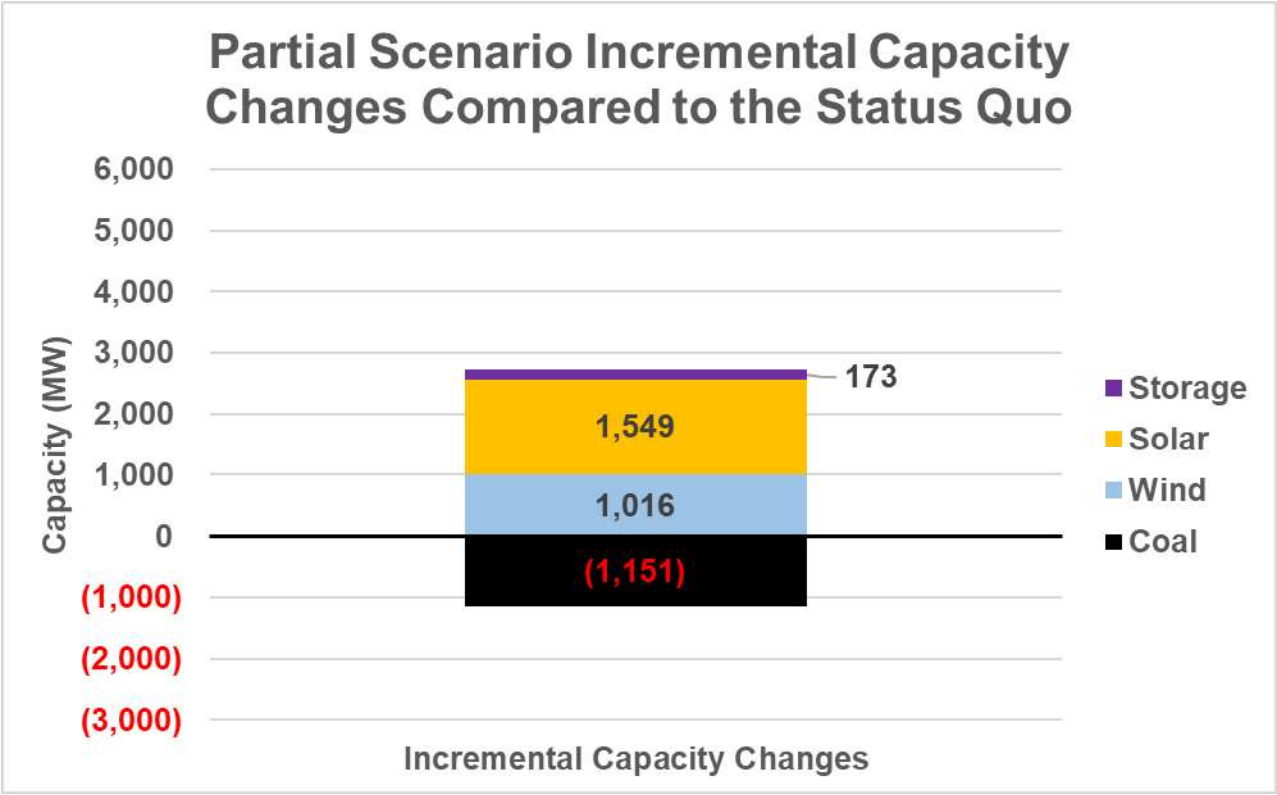


Figure D-15. This figure shows the incremental capacity retirements and additions in the MISO region under the Partial scenario.

Full Scenario: The Full scenario results in the retirement of 31,021 MW of coal resources, 7,852 MW of natural gas capacity, and 462 MW of petroleum capacity. To replace this retired capacity, additions in the Full scenario consist of 4,306 MW of natural gas, 21,433 MW of wind, 32,700 MW of solar, and 3,644 MW of storage (see Figure D-16). The incremental closure of 2,264 MW of lignite capacity results in an incremental increase in a replacement capacity of 1,997 MW wind, 3,048 MW solar, and 304 MW storage, compared to the Status Quo scenario (see Figure D-17).

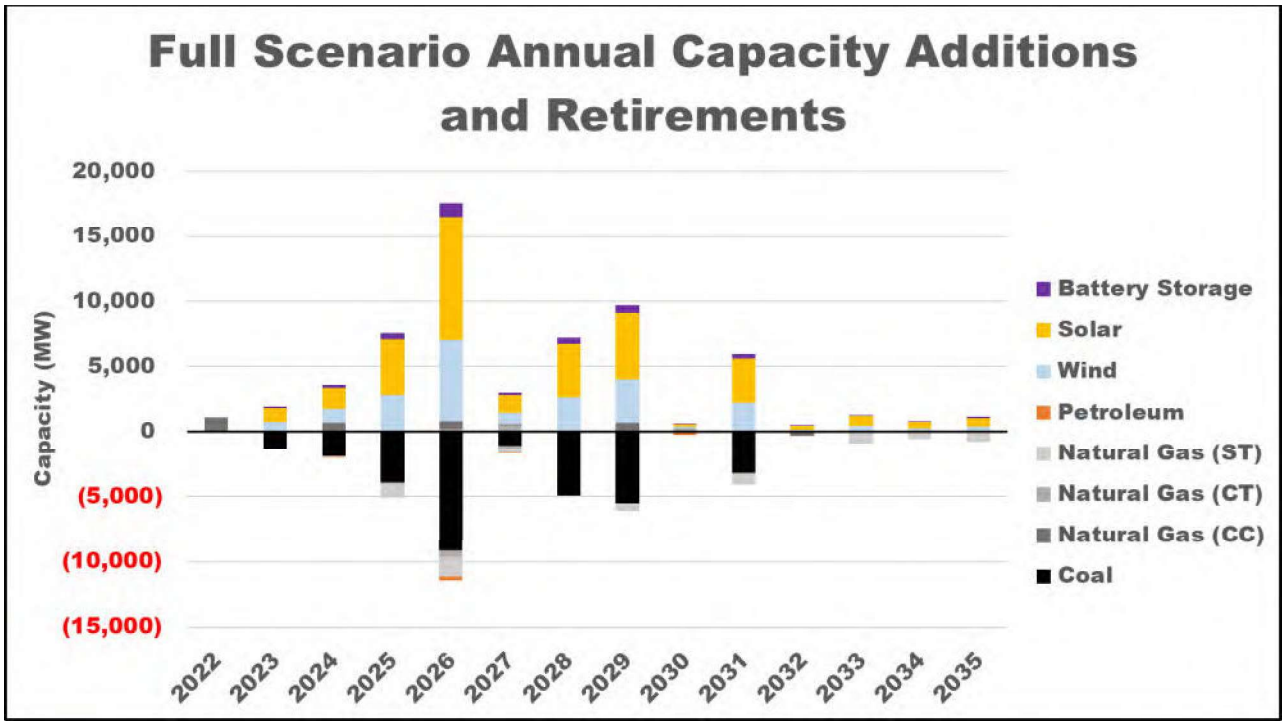


Figure D-16. This graph shows the annual capacity additions and subtractions needed to maintain resource adequacy using EPA's capacity accreditation metrics.

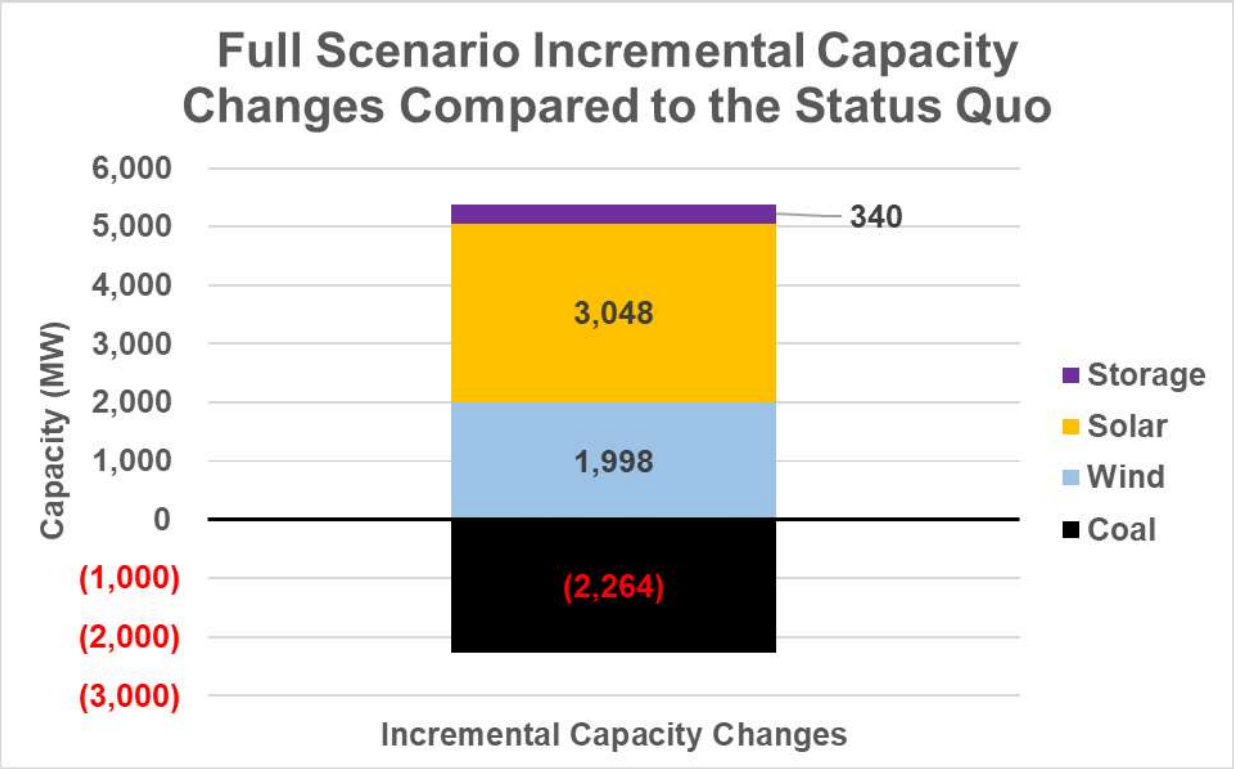


Figure D-17. This figure shows the incremental capacity closures and additions in the Full scenario.

Figure D-18 shows the capacity retirements and additions in the Partial and Full scenarios.

Comparison:

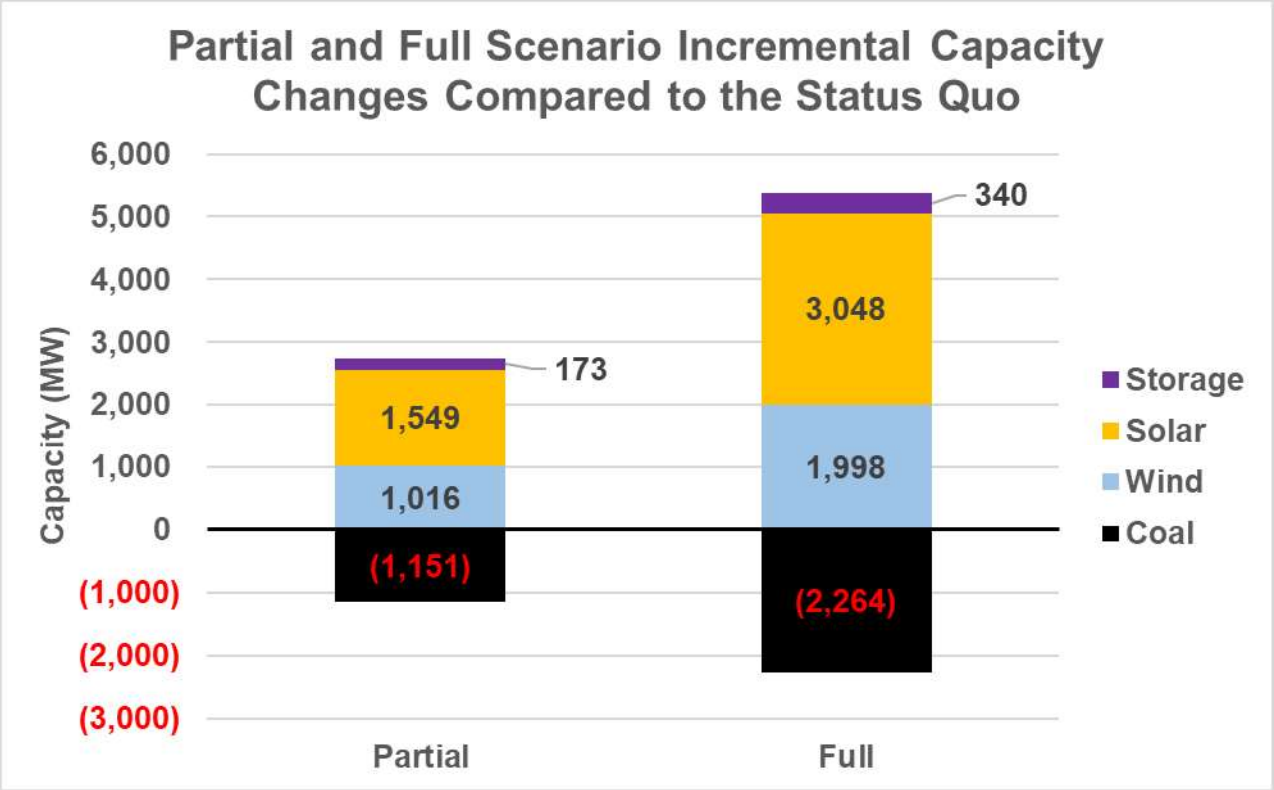


Figure D-18 comparison. This figure demonstrates the incremental retirements and additions in each scenario.

Appendix 3: Replacement Capacity Based on EPA Methodology for Resource Adequacy

The capacity selected in our model to replace the retiring resources is based on two main factors. The first factor is the MISO interconnection queue, which is predominantly filled with solar and wind projects and a relatively small amount of natural gas. The second factor is the EPA's resource adequacy (RA) accreditation values in the Integrating Planning Model's (IPM) Proposed Rule Supply Resource Utilization file and Post-IRA Base Case found in the Regulatory Impact Analysis.

The IMP assumes a capacity accreditation of 100 percent for thermal resources, and variable intermittent technologies (primarily wind and solar) receive region-specific capacity credits to help meet target reserve margin constraints. Due to their variability, resources such as wind and solar received a lower capacity accreditation when solving for resource adequacy (see Table D-4).

EPA Integrated Planning Model

Capacity Accreditation in MISO

Resource	Capacity Value
Existing Wind	19%
Existing Solar	55%
New Onshore Wind 2035	17%
New Solar 2035	52%
Thermal	100%
Battery Storage	100%

Table D-4. This figure shows the capacity values for each resource based on EPA's estimates in its IPM.

In order to determine whether the available blend of power generation sources will be able to meet projected demand, each available generation source is multiplied against its capacity value, and the available resources are then "stacked" to determine if there is enough accredited power generation capacity to meet projected demand and maintain resource adequacy.

It should be noted that EPA's accreditation values from the IPM are generous compared to the accreditation values given by RTOs. For example, in the MISO region, grid planners assume that dispatchable thermal resources like coal, natural gas, and nuclear power plants will be able to produce electricity 90 percent of the time when the power is needed most, resulting in a UCAP rating of 90 percent. In contrast, MISO believes wind resources will only provide about 18.1 percent of their potential output during summer peak times, and solar facilities will produce 50 percent of their potential output. This report uses the generous capacity values provided by EPA; however, if the capacity values used by the RTOs were to be utilized, the projected energy shortfalls and blackouts would be even worse.

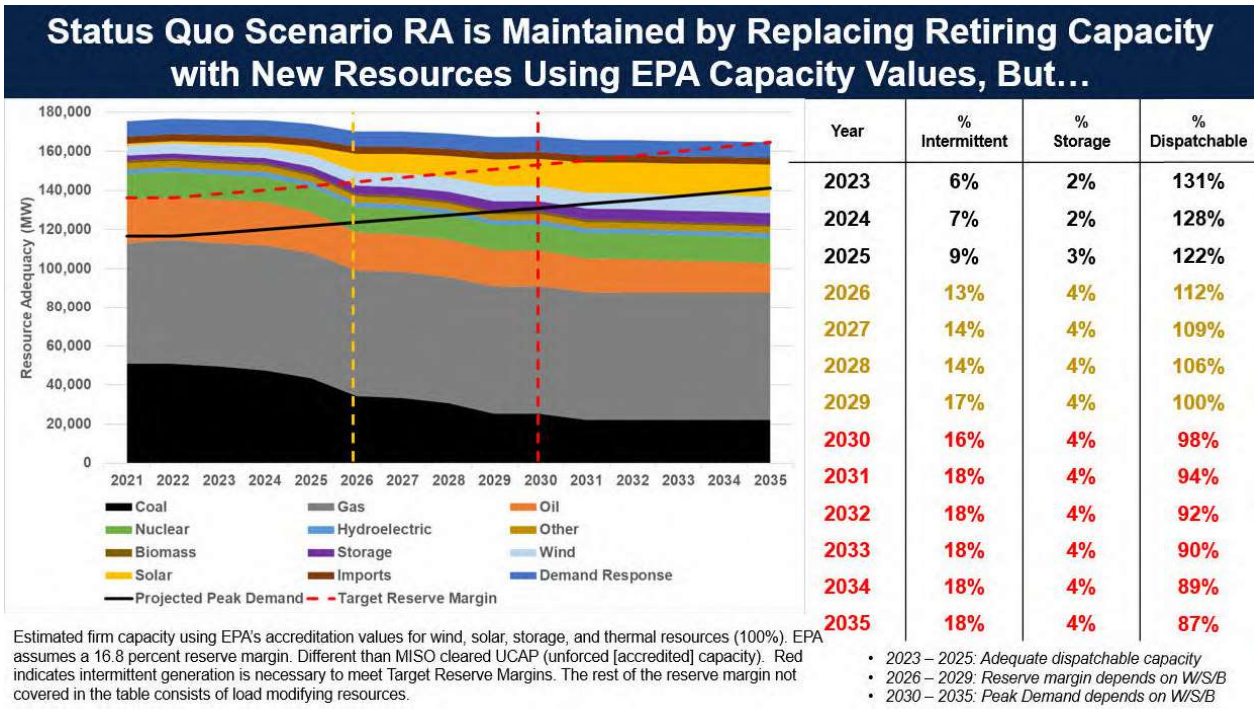
Appendix 4: Resource Adequacy in Each Scenario

We performed a Resource Adequacy analysis on each of the three scenarios modeled to determine the potential impact to grid reliability in MISO region if implementation of the MATS Rule results in the forced retirement of lignite power plants.

Status Quo scenario

Under the Status Quo scenario, there is enough dispatchable capacity in MISO to meet the projected peak demand and target reserve margin established by EPA in the RIA documents

Proposed Rule Supply Resource Utilization file until the end of 2025, shown in the black font in the table in Figure D-19.[85]



Year	% Intermittent	% Storage	% Dispatchable
2023	6%	2%	131%
2024	7%	2%	128%
2025	9%	3%	122%
2026	13%	4%	112%
2027	14%	4%	109%
2028	14%	4%	106%
2029	17%	4%	100%
2030	16%	4%	98%
2031	18%	4%	94%
2032	18%	4%	92%
2033	18%	4%	90%
2034	18%	4%	89%
2035	18%	4%	87%

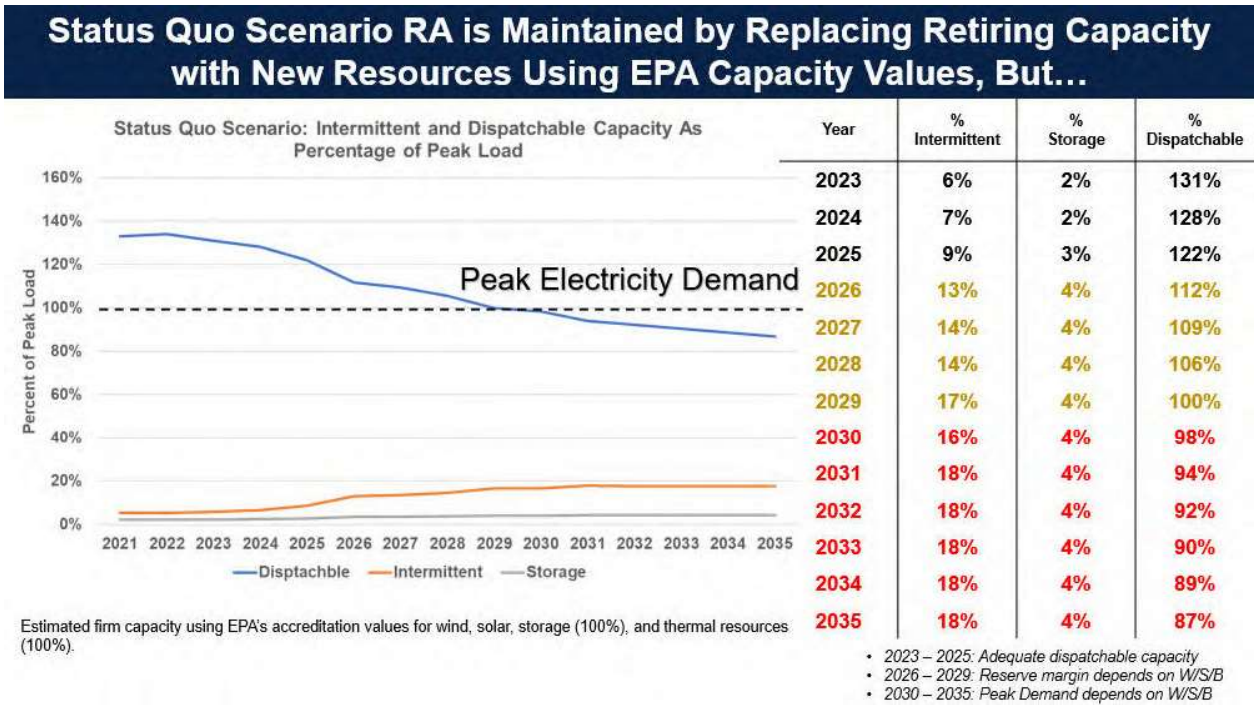
Figure D-19. By 2030, MISO will rely on wind, solar, and battery storage to meet its projected peak demand and target reserve margin.

Beginning in 2026, MISO becomes reliant upon wind, solar, imports, or demand response (DR) to meet its target reserve margin, but the RTO still has enough dispatchable capacity to meet its projected peak demand. By 2030, the MISO region will rely on thermal resources and 4-hour battery storage to meet its peak demand, and by 2031 the region will no longer have enough dispatchable capacity or storage to meet its projected peak demand, and it will rely exclusively on non-dispatchable resources and imports to meet its target reserve margin.[86]

The trend of falling dispatchable capacity relative to projected peak demand can be seen more clearly in Figure D-20 below. By 2035, dispatchable capacity consisting of thermal generation and battery storage will only be able to provide 91 percent of the projected peak demand, necessitating the use of wind and solar to maintain resource adequacy.

[85] Analysis of the Proposed MATS Risk and Technology Review (RTR) | US EPA, https://www.epa.gov/power-sector-modeling/analysis-proposed-mats-risk-and-technology-review-rtr

[86] While battery storage is considered dispatchable in this analysis for the sake of simplicity, battery resources are not a substitute for generation because as grids become more reliant upon wind and solar, battery resources may not be sufficiently charged to provide the needed dispatchable power.



D-20. By 2035, dispatchable generators will only constitute 87 percent of projected peak demand, with storage accounting for four percent of peak demand capacity.

Partial scenario

Like the Status Quo Scenario, there is enough dispatchable capacity in MISO under the Partial scenario to meet the projected peak demand and target reserve margin established by EPA in the RIA documents Proposed Rule Supply Resource Utilization file until the end of 2025, shown in the black font in the table in Figure D-21.

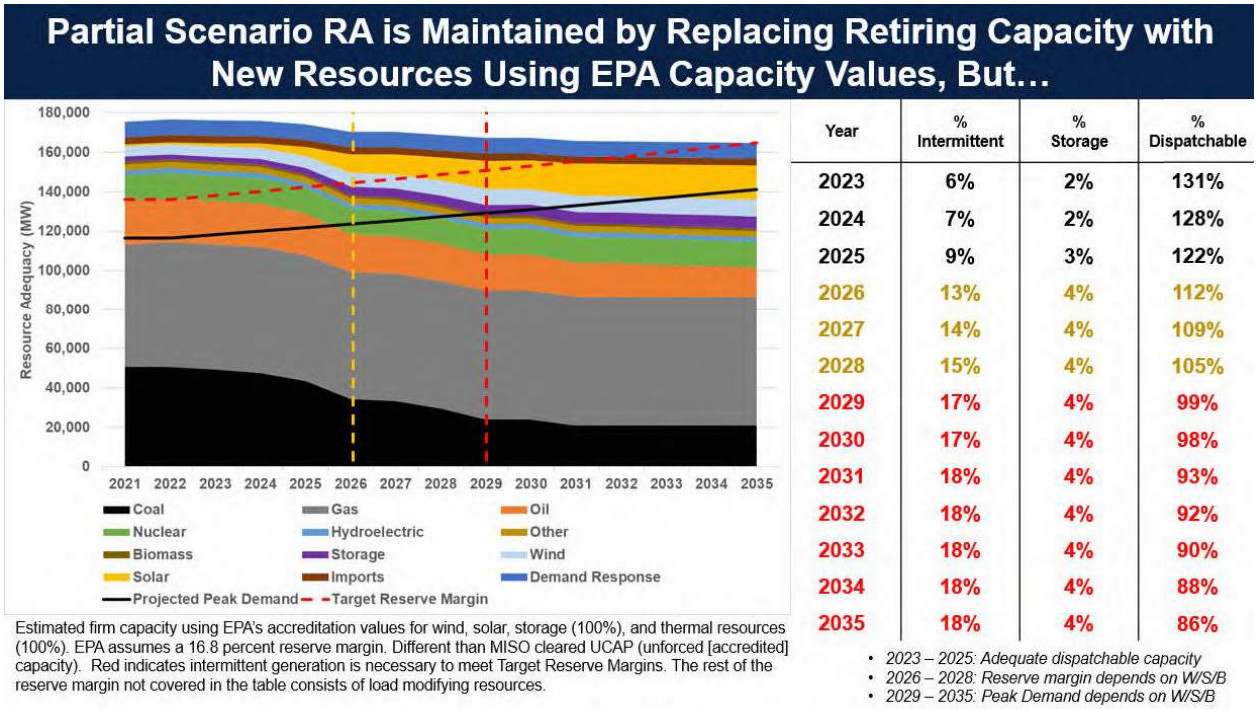
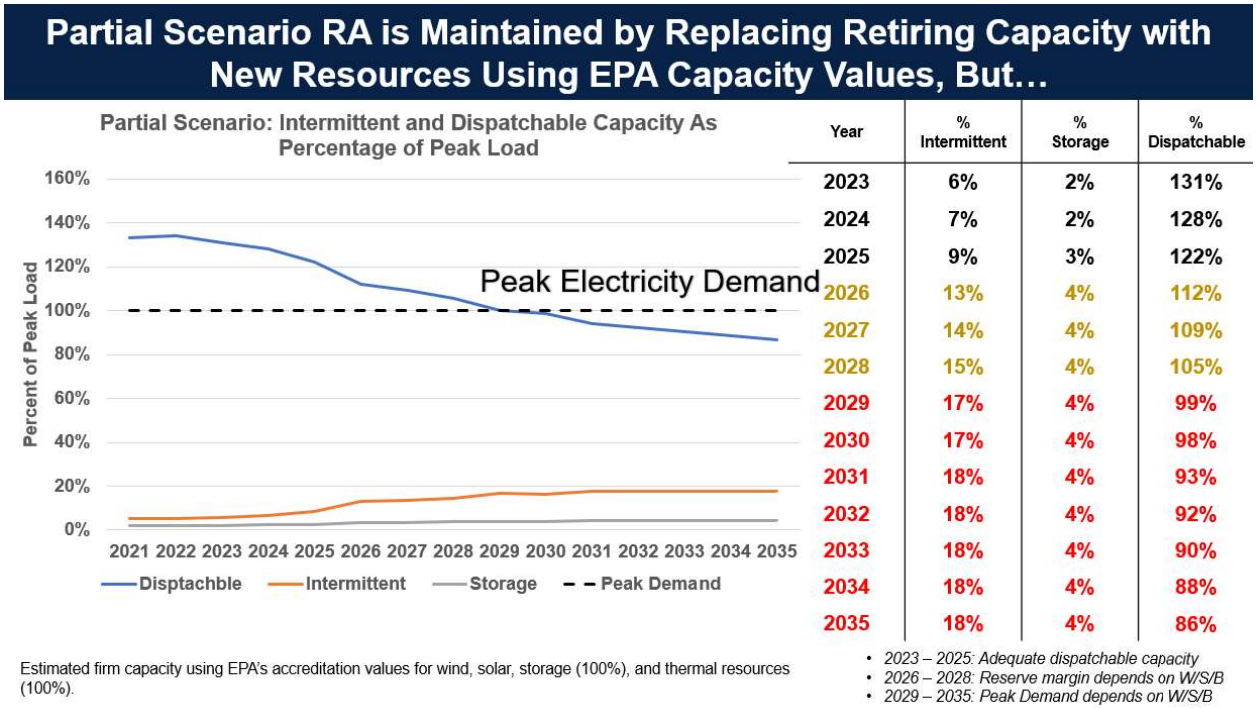


Figure D-21. By 2029, MISO will rely on wind, solar, and battery storage to meet its projected peak demand and target reserve margin.

MISO becomes reliant upon wind, solar, imports, or demand response (DR) to meet its target reserve margin in 2025, but the RTO still has enough dispatchable capacity to meet its projected peak demand. The percentage of MISO's projected peak demand that will be met by dispatchable resources in 2028 declines from 106 percent in the Status Quo scenario to 105 percent in the Partial scenario, reflecting the loss of 1,151 MW of lignite power plants in North Dakota.

In this scenario, the MISO region will no longer have enough dispatchable capacity to meet its projected peak demand in 2029, a year earlier than the Status Quo scenario, and it will rely on non-dispatchable resources, imports, or storage to meet its target reserve margin.

The trend of falling dispatchable capacity relative to projected peak demand can be seen more clearly in Figure D-22 below. By 2035, dispatchable capacity will only be able to provide 86 percent of the projected peak demand.



Year	% Intermittent	% Storage	% Dispatchable
2023	6%	2%	131%
2024	7%	2%	128%
2025	9%	3%	122%
2026	13%	4%	112%
2027	14%	4%	109%
2028	15%	4%	105%
2029	17%	4%	99%
2030	17%	4%	98%
2031	18%	4%	93%
2032	18%	4%	92%
2033	18%	4%	90%
2034	18%	4%	88%
2035	18%	4%	86%

Figure D-22. The percentage of peak electricity demand being served by dispatchable resources drops by one percent in 2028, relative to the Status Quo scenario, due to the closure of lignite capacity in MISO due to the MATS rule.

Full scenario

Like the Status Quo scenario and Partial scenario, there is enough dispatchable capacity in MISO under the Full scenario to meet the projected peak demand and target reserve margin established by EPA in the RIA documents Proposed Rule Supply Resource Utilization file until the end of 2025, shown in the black font in the table in Figure D-23.

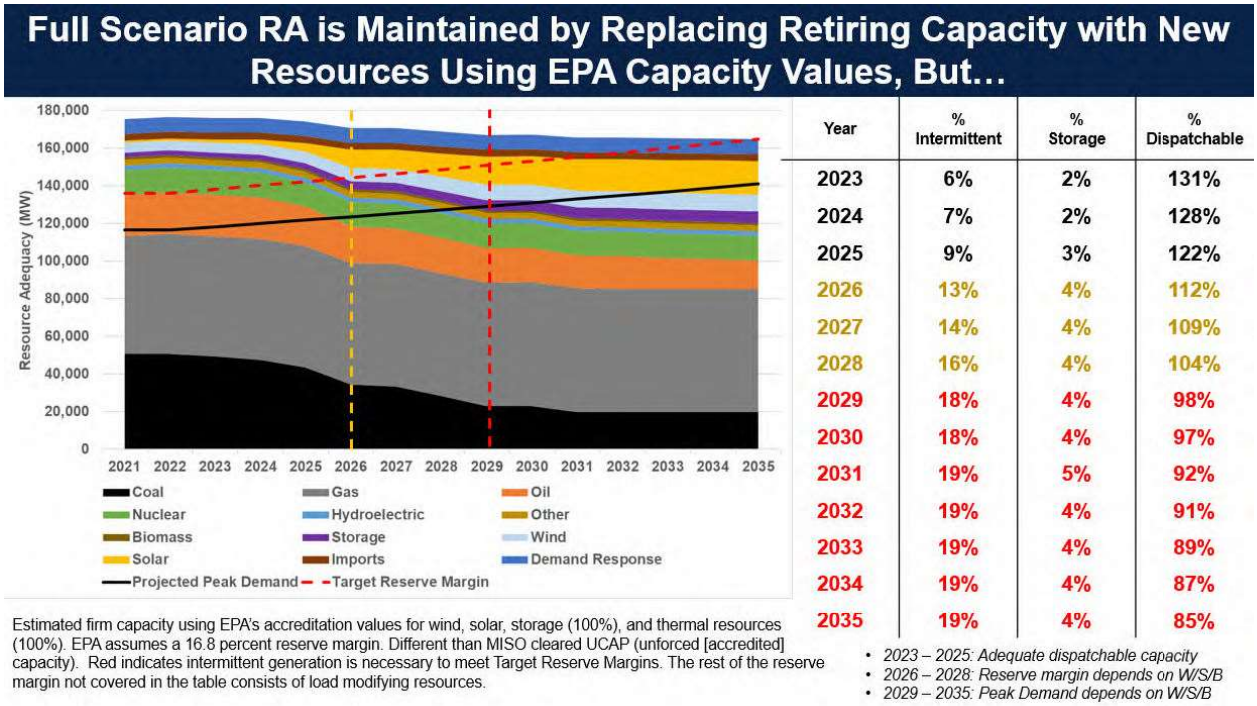
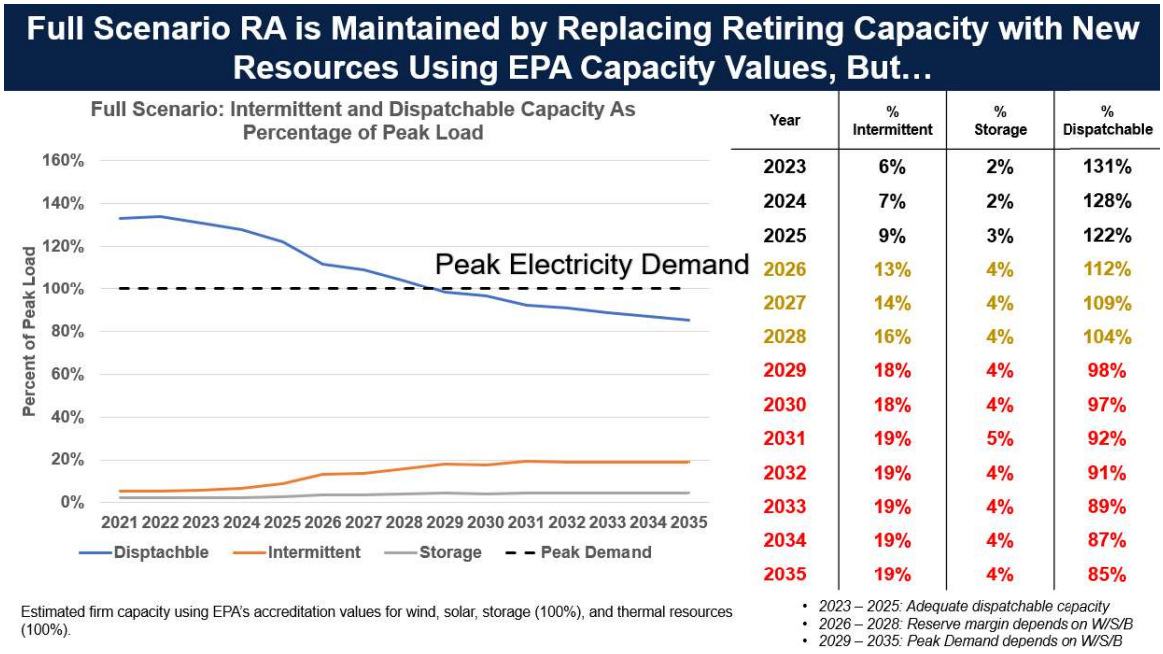


Figure D-23. The amount of dispatchable capacity available to meet projected peak demand in 2028 falls from 106 percent in the Status Quo scenario to 104 percent in the Full scenario, reflecting the closure of all the lignite capacity in MISO that year.

MISO becomes reliant upon wind, solar, imports, or demand response (DR) to meet its target reserve margin in 2025, but the RTO still has enough dispatchable capacity to meet its projected peak demand. The percentage of MISO's projected peak demand that will be met by dispatchable resources in 2028 declines from 106 percent in the Status Quo scenario to 104 percent in the Full scenario, reflecting the loss of 2,264 MW of lignite power plants in North Dakota.

In this scenario, the MISO region will no longer have enough dispatchable capacity to meet its projected peak demand in 2029, a year earlier than the Status Quo scenario, and it will rely on non-dispatchable resources, imports or storage to meet its target reserve margin.

The trend of falling dispatchable capacity relative to projected peak demand can be seen more clearly in Figure D-24 below. By 2035, dispatchable capacity will only be able to provide 85 percent of the projected peak demand, a two percent decline relative to the Status Quo scenario, necessitating the use of wind and solar to maintain resource adequacy.



Year	% Intermittent	% Storage	% Dispatchable
2023	6%	2%	131%
2024	7%	2%	128%
2025	9%	3%	122%
2026	13%	4%	112%
2027	14%	4%	109%
2028	16%	4%	104%
2029	18%	4%	98%
2030	18%	4%	97%
2031	19%	5%	92%
2032	19%	4%	91%
2033	19%	4%	89%
2034	19%	4%	87%
2035	19%	4%	85%

Figure D-24. The amount of peak demand that can be met with dispatchable resources in 2028 falls from 106 in the Status Quo scenario to 104 in the Full scenario.

Attachment B

to the Declaration of Christopher D. Friez

NDSU Agribusiness and Applied Economics Report No. 819-S March 2023

North Dakota Lignite Energy Industry

Economic Contribution Analysis

Report Content

Preface

This report is the latest biennial assessment of the economic contribution of the North Dakota lignite energy industry.

Data for this study came from industry surveys, state and federal agencies, and other secondary sources,

The definition of the lignite energy industry and methods used to estimate its economic contribution are consistent with studies examining the economic contribution of other industries in the state. As usual, these studies are snapshots in time and economic contributions often vary from year to year with commodity-based industries.

Industry Highlights

The following figures are based on activity during 2021 and projections of industry output in 2022. All values include direct and secondary economic effects.

North Dakota Lignite Energy Industry in 2021

- $5.64 billion gross business volume
  - $0.9 billion from mining
  - $3.2 billion from coal conversion and electricity generation
  - $1.5 billion from transmission/distribution
- 12,800 jobs (direct and secondary)
  - 3,300 jobs supported by mining
  - 8,400 jobs supported by coal conversion and electricity generation
  - 1,050 jobs supported by transmission/distribution
- $119 million in local and state government revenues

North Dakota Lignite Energy Industry in 2022

- $5.75 billion gross business volume
  - $0.8 billion from mining
  - $3.2 billion from coal conversion and electricity generation
  - $1.7 billion from transmission/distribution
- 12,000 jobs (direct and secondary)
  - 3,250 jobs supported by mining
  - 7,725 jobs supported by coal conversion and electricity generation
  - 1,060 jobs supported by transmission/distribution
- $104 million in local and state government revenues

**Bangsund is a Research Scientist, Department of Agribusiness and Applied Economics and Hodur is Director, Center for Social Research, North Dakota State University

Understanding the Numbers

Economic contribution assessments measure the gross size of an industry or economic sector.

Size is estimated by combining ***direct*** or first-round effects (i.e., sales, spending, and/or employment) with economic modeling to estimate secondary effects of business-to-business transactions (***indirect***) and household spending for goods and services (***induced***).

Economic measures frequently used in economic contribution assessments:

- **Labor income** – earnings of workers and sole proprietors
- **Employment** – wage and salary jobs and sole proprietor/self-employed jobs
- **Gross business volume** – includes direct sales of products and services of the industry being measured, and sum of all business-to-business and household-to-business transactions associated with indirect and induced economic activity
- **Value-added** – represents share of gross state product

An overview and additional information on study methods, data sources, and economic definitions are appended to the end of this report.

Composition of Lignite Energy Industry

Coal Mining: this segment involves the process of extracting lignite coal and delivering it to conversion facilities.

Coal Gasification: this segment involves converting lignite coal into chemicals and other products. It is grouped with electricity generation segment of the industry.

Electricity Generation: this segment burns lignite coal to produce electricity.

Transmission and Distribution: this segment includes moving electricity to local (in-state) distributors and exporting electricity to out-of-state markets.

Industry Contribution 2021

Coal mining had 1,131 direct jobs; business activity relating to coal mining operations supported another 1,220 jobs. Personal spending on goods and services by employees working in the coal mining sector and employees of businesses affected by coal mining supported an additional 960 jobs. The combined effects on statewide employment from coal mining was estimated at 3,300 jobs. Other economic effects from coal mining included $300 million in labor income and $915 million in gross business volume.

Coal conversion and electricity generation from lignite was estimated to have nearly 1,700 direct jobs, and business activity relating to those lignite operations supported another 4,680 jobs. Personal spending on goods and services by employees working in the coal conversion and generation activities and employees of businesses affected by those activities supported an additional 2,070 jobs. The combined direct, indirect, and induced effects on statewide employment from coal conversion and electricity generation was estimated at 8,400 jobs. Other economic effects from coal conversion and electricity generation included $670 million in labor income and nearly $3.2 billion in gross business volume.

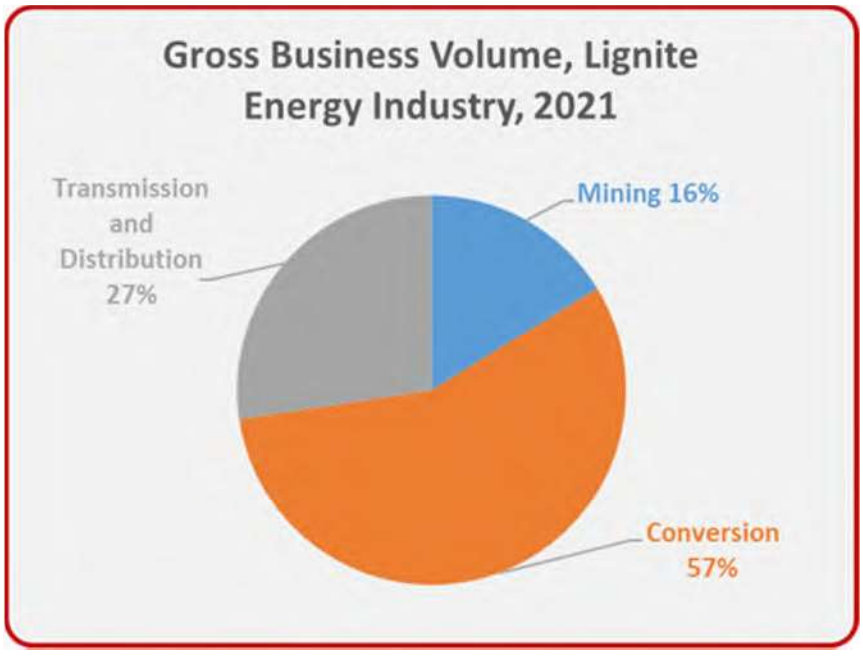
Electricity transmission and generation from lignite-based activities was estimated to have 480 direct jobs; business activity relating to those lignite operations supported another 290 jobs. Personal spending on goods and services by employees working in coal-related electricity transmission and distribution and employees of businesses affected by those activities supported an additional 280 jobs. The combined direct, indirect, and induced effects on statewide employment from coal-related electricity transmission and distribution was estimated at 1,060 jobs. Other economic effects from transmission and distribution included $84 million in labor income and $1.5 billion in gross business volume.

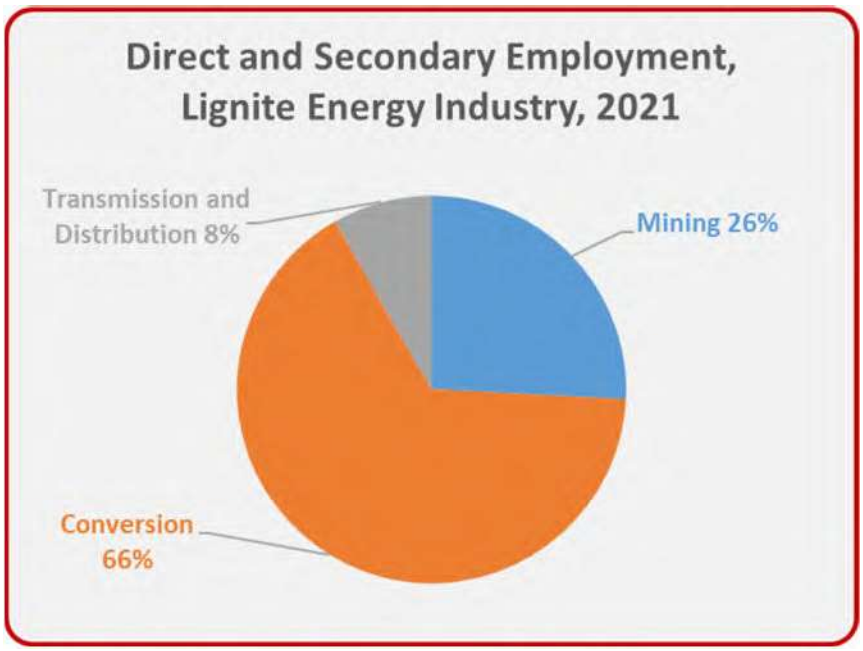
The combination of coal mining, coal conversion, coal-fired electricity generation, and electricity transmission and distribution was estimated to have 3,300 direct jobs in North Dakota in 2021. These lignite coal activities supported about 6,190 jobs through business purchases of goods and services in the state. The combined personal spending of employees in the Lignite Industry, and employees of businesses involved with supplying goods and services to the industry supported another 3,310 jobs. Collectively, the industry was estimated to support 12,800 jobs in the state.

The lignite industry also generated over $1 billion in labor income, which represents wages, salaries, benefits, and sole proprietor's income. The industry also contributed $2 billion to the state's gross domestic product, and the industry's gross business volume was estimated at $5.6 billion.

Direct, Indirect, and Induced Economic Effects, Key Economic Metrics, North Dakota Lignite Industry, 2021				
Industry Segment/Type of Economic Effect	Employment[1]	Labor Income	Value-added	Output
Coal Mining		---------- millions 2021 $ ----------		
Direct effects	1,131	165	227	560
Indirect effects	1,220	84	152	270
Induced effects	960	51	84	85
Total economic effects	3,311	300	463	915
Electricity Generation and Coal Conversion				
Direct effects	1,694	228	240	1,728
Indirect effects	4,680	332	568	1,120
Induced effects	2,070	110	182	331
Total economic effects	8,444	671	990	3,178
Electricity Transmission and Distribution				
Direct effects	483	50	453	1,386
Indirect effects	290	19	69	111
Induced effects	285	15	25	45
Total economic effects	1,058	84	547	1,543

[1] Employment represents total jobs, and does not represent employment in FTE.





Direct, Indirect, and Induced Economic Effects, Key Economic Metrics, North Dakota Lignite Industry, 2021

Type of Economic Effect	Employment[1]	Labor Income	Value-added	Output
ND Lignite Industry		---------- millions 2021 $ ----------		
Direct	3,308	443	919	3,674
Indirect	6,190	436	789	1,501
Induced	3,310	177	291	461
Total	**12,808**	**1,056**	**1,999**	**5,636**

[1] Employment represents total jobs, and does not represent employment in FTE.

Industry Contribution 2022 (projected)

The following figures and values were based on an industry survey soliciting estimates of calendar year 2022 business activities, although the survey was administered prior to yearend. Firms were asked to estimate what their 2022 revenues and expenditures would be based on data available at the time of the survey and augment that information with expected activities for the remaining months in 2022. Data provided by the industry for 2022 is treated as a projection. However, the projection is considered a reasonable estimate of 2022 since, in many cases, the estimates included actual revenues and expenditures for 10 to 11 months of 2022.

Coal mining had 1,170 direct jobs; business activity relating to coal mining operations supported another 1,090 jobs. Personal spending on goods and services by employees working in the coal mining sector and employees of businesses affected by coal mining supported an additional 990 jobs. The combined effects on statewide employment from coal mining was estimated at 3,250 jobs. Other economic effects from coal mining included $300 million in labor income and $830 million in gross business volume.

Coal conversion and electricity generation from lignite was estimated to have 1,630 direct jobs, and business activity relating to those lignite operations supported another 4,240 jobs. Personal spending on goods and services by employees working in the coal conversion and generation activities and employees of businesses affected by those activities supported an additional 1,850 jobs. The combined direct, indirect, and induced effects on statewide employment from coal conversion and electricity generation was estimated at 7,720 jobs. Other economic effects from coal conversion and electricity generation included $620 million in labor income and over $3.2 billion in gross business volume.

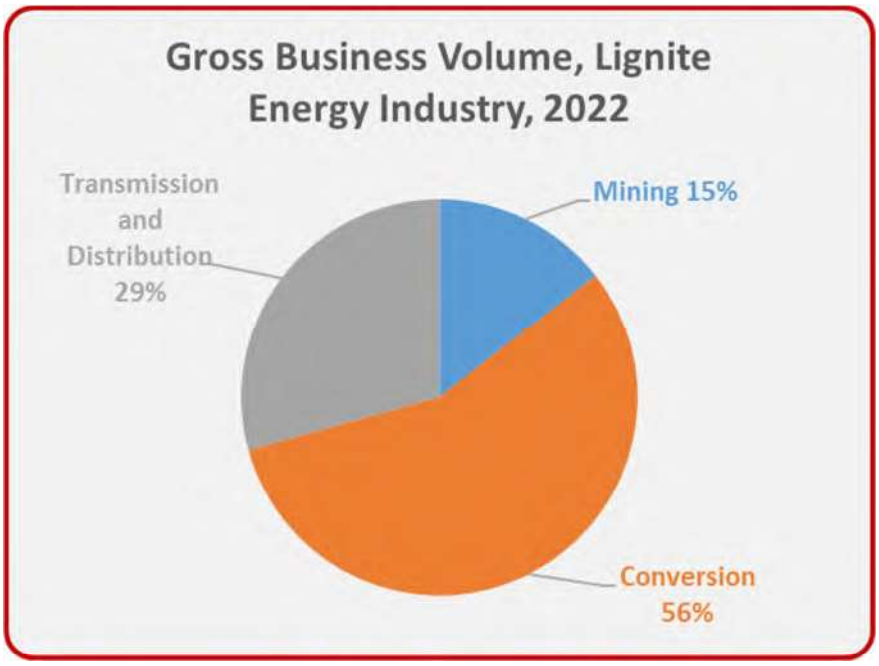
Electricity transmission and generation from lignite-based activities was estimated at 470 direct jobs; business activity relating to those lignite operations supported another 300 jobs. Personal spending on goods and services by employees working in coal-related electricity transmission and distribution and employees of businesses affected by those activities supported an additional 280 jobs. The combined direct, indirect, and induced effects on statewide employment from coal-related electricity transmission and distribution was estimated at 1,050 jobs. Other economic effects from transmission and distribution included $86 million in labor income and $1.7 billion in gross business volume.

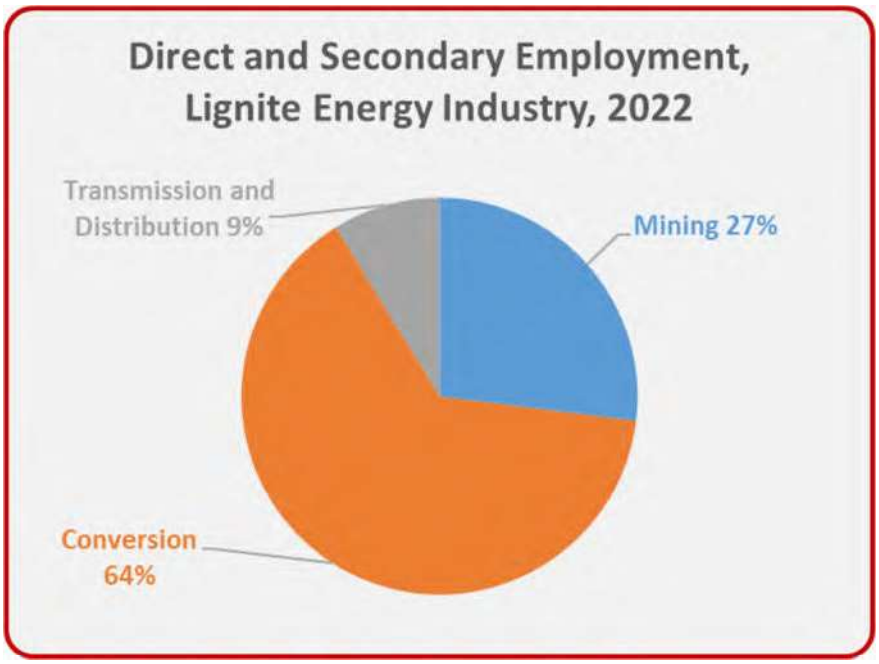
The combination of coal mining, coal conversion, lignite coal-fired electricity generation, and electricity transmission and distribution was estimated to have 3,270 direct jobs in North Dakota in 2022. These lignite coal activities supported about 5,630 jobs through business purchases of goods and services in the state. The combined personal spending of employees in the Lignite Industry, and employees of businesses involved with supplying goods and services to the industry supported another 3,120 jobs. Collectively, the industry was estimated to support 12,020 jobs in the state.

The lignite industry also generated over $1 billion in labor income, which represents wages, salaries, benefits, and sole proprietor's income. The industry also contributed nearly $2.2 billion to the state's gross domestic product, and the industry's gross business volume was estimated at $5.8 billion.

Direct, Indirect, and Induced Economic Effects, Key Economic Metrics, North Dakota Lignite Industry, Projected 2022				
Industry Segment/Type of Economic Effect	Employment[1]	Labor Income	Value-added	Output
Coal Mining		---------- millions 2022 $ ----------		
Direct effects	1,168	177	219	537
Indirect effects	1,090	76	123	207
Induced effects	990	53	87	88
Total economic effects	3,248	306	430	832
Electricity Generation and Coal Conversion				
Direct effects	1,633	225	510	2,008
Indirect effects	4,240	295	534	935
Induced effects	1,850	99	163	297
Total economic effects	7,723	619	1,208	3,239
Electricity Transmission and Distribution				
Direct effects	473	51	473	1,525
Indirect effects	300	20	47	116
Induced effects	280	15	25	45
Total economic effects	1,053	86	545	1,687

[1] Employment represents total jobs, and does not represent employment in FTE.





Direct, Indirect, and Induced Economic Effects, Key Economic Metrics, North Dakota Lignite Industry, 2022 (projected)

Type of Economic Effect	Employment[1]	Labor Income	Value-added	Output
ND Lignite Industry		millions 2022 $		
Direct	3,274	453	1,202	4,070
Indirect	5,630	391	704	1,258
Induced	3,120	167	275	430
Total	**12,024**	**1,011**	**2,182**	**5,758**

[1] Employment represents total jobs, and does not represent employment in FTE.

Government Revenues 2021

Government revenues are often used as a measure of how effectively an industry supports public services. In North Dakota, the most common sources of in-state public revenues are severance taxes, sales and use taxes, property taxes, and income taxes. A host of other taxes and revenue sources are often tracked in economic contribution and impact assessments, but those sources have varying levels of contribution to government revenue.

The lignite industry was estimated to contribute $64.5 million in government revenues directly from the firms in the industry. Tax revenues arising from secondary business activity were estimated to generate an additional $54.5 million in state and local government revenues. A total of $119 million in state and local tax revenues were generated by the Lignite Industry in North Dakota in 2021.

Coal conversion and coal severance taxes were estimated at $26.5 million. Other substantial contributions to state and local government revenues from secondary economic effects were from sales taxes ($25 million) and property taxes ($19.5 million).

State and Local Government Revenues, Lignite Industry, North Dakota, 2021

Government Revenue	Paid Directly by the Industry	Collected from Indirect and Induced Activity	Total Collections
	---------- 000s 2021 $ ----------		
Coal Severance Tax	10,518	---	10,518
Coal Conversion Tax	15,991	---	15,991
Sales, Property, and Corporate Income Taxes (reported in survey data)	25,861	---	25,861
Social Insurance Tax	1,952	1,247	3,200
Personal Income Tax	3,039	2,377	5,416
Sales Tax	see above	25,336	25,336
Property Tax	see above	19,531	19,531
Corporate Income Tax	see above	1,362	1,362
Other Taxes	2,666	1,438	4,104
Non Taxes	4,568	3,222	7,789
Totals	**64,595**	**54,512**	**119,107**