

---

# Economic Impacts of Relicensing the Quad Cities Clean Energy Center (QCCEC)

**PREPARED FOR**

Constellation Energy Generation, LLC

**PREPARED BY**

Dean Murphy  
Wonjun Chang  
Sophie Edelman  
Natasha Abrol  
James Herringel  
Emine Taha



---

## NOTICE

This report was prepared for Constellation Energy. Funding was provided by Constellation.

This report is intended to be read and used as a whole and not in parts. All results and any errors are the responsibility of the author and do not represent the opinions of The Brattle Group or its clients.

© 2026 The Brattle Group

---

TABLE OF CONTENTS

Executive Summary.....1

I. Background.....4

II. Analytic Approach.....7

III. Characterizing the Power System Impacts of QCCEC .....9

    A. Electric System Impacts of Relicensed Scenario ..... 10

    B. Electric System Impacts of QCCEC Retires Scenario ..... 12

    C. Impacts on Electricity Prices and Customer Costs ..... 16

IV. Economic Impacts.....17

    A. Regional GDP and Employment Impacts..... 18

    B. Distribution of Impacts Across Neighboring Counties ..... 20

    C. Effect on Tax Revenue..... 24

V. Conclusion .....25

Appendix 1: Electric System Modeling.....26

    A. gridSIM Overview ..... 26

    B. Model Topology ..... 27

    C. Quad Cities Clean Energy Center ..... 30

        1. Plant Parameters..... 30

        2. Quad Cities Market Participation..... 31

    D. Modeled Policies ..... 31

        1. Renewable, Clean Energy, and Emissions Goals..... 31

        2. Federal Tax Credits..... 33

        3. Climate and Equitable Jobs Act..... 33

    E. Load Growth Assumptions ..... 34

        1. PJM Load Growth..... 34

        2. MISO Load Growth..... 35

    F. Resource Assumptions ..... 36

        1. Existing and Planned Capacity ..... 36

        2. Resource Availability..... 37

        3. Resource Costs..... 37

4.	Fuel Costs .....	38
5.	Build Limits for Wind and Solar .....	38
6.	Nuclear .....	39
7.	Demand Response (DR) and Behind the Meter (BTM) Solar.....	39
8.	Carbon Capture and Storage (CCS) .....	39
9.	Hydrogen.....	41
G.	Future Resource Mix .....	42
1.	PJM Resource Mix.....	42
2.	MISO Resource Mix.....	42
H.	Retail Electricity Price Calculations .....	42
<b>Appendix 2: Economic Modeling.....</b>		<b>43</b>
A.	REMI Overview .....	43
B.	County-Level Economic Impacts .....	50

# Executive Summary

---

Our study of the economic and power sector impacts of the Quad Cities Clean Energy Center (QCCEC) nuclear plant shows that relicensing the plant would prevent significant carbon emissions over its extended operating life, and also offer material positive economic impacts, in terms of GDP and jobs, in Illinois and the three adjacent Iowa counties (Muscatine, Scott, and Clinton counties).

The positive economic impacts of relicensing QCCEC are driven by continued plant expenditures and employment, which stimulates significant economic activity, as well as a decrease in electricity prices. The gain in GDP would be concentrated in Rock Island County, IL, and the counties surrounding the plant. The positive economic impacts of relicensing would be partially offset by the foregone investment in in-state generating resources that would otherwise be needed to replace the plant's capacity. However, those investments would be spread widely across the region and thus do not offset the local concentration of economic benefits in the counties surrounding the plant. As a result, the local economy would experience most of the positive GDP and employment impacts of plant relicensing, but only a very small share of the offsetting impacts from foregone electricity sector investments.

Renewing the license for QCCEC will be critical for Illinois to meet its goals to combat climate change, as the plant produces as much energy annually as 55% of Illinois' current in-state renewable generation. Continuing to operate the plant will also help support a reliable and affordable grid amidst surging demand and rising energy infrastructure costs, given that QCCEC's annual generation accounts for around 9% of Illinois' annual electricity demand and 7% of Iowa's annual electricity demand.<sup>1</sup> Retiring QCCEC in the near term would impede progress in achieving the clean energy and emissions reduction goals outlined in the Climate and Equitable Jobs Act (CEJA) and increase the challenge of meeting growing electricity demand reliably.<sup>2</sup>

---

<sup>1</sup> Actual output varies slightly from year to year, mostly due to refueling schedules. 75% of QCCEC participates in the PJM wholesale electricity market and the remaining 25% participates in MISO's wholesale electricity market as an external resource. 2024 retail electricity sales in Illinois were 133 TWh ([EIA Illinois Electricity Profile](#)) and 2024 retail electricity sales in Iowa were 55 TWh ([EIA Iowa Electricity Profile](#)).

<sup>2</sup> See the [Clean Energy and Jobs Act \(CEJA\)](#) for further details.

Relicensing QCCEC guarantees reliable, emissions-free power and will displace a significant amount of fossil generation and emissions in the near-term. Securing this clean power is pivotal to achieving Illinois' 2045 electric sector decarbonization targets, as well as limiting emissions in neighboring states with less stringent policies, where fossil generation would increase in the absence of QCCEC. In addition to the emissions impact, Illinois and Iowa customers would likely face lower electric bills with relicensing, as retail electricity prices are estimated to increase in the event of plant shutdown.

To characterize the impacts of QCCEC, our analysis considers two scenarios – a Relicensed Scenario where QCCEC is relicensed and operates until the end of 2050; and a QCCEC Retires Scenario in which QCCEC retires at the end of its current license, end of 2032.<sup>3</sup> By holding all other variables constant, the two scenarios allow for a direct comparison of QCCEC's impact on the power system and the broader economy.

We find that continuing to operate QCCEC through 2050 would:

- Reduce emissions by over 88 million metric tons of CO<sub>2</sub> (MMT CO<sub>2</sub>) through 2050, or around 4.8 MMT annually on average;
- Increase GDP by a total of \$21 billion in the study region, \$14.4 billion within Illinois and the remaining \$6.3 billion within the three adjacent Iowa counties;
- Support 1,439 jobs in the study region, including both direct and secondary employment effects;
- Prevent the loss of 15.6 TWh of firm, emissions-free generation each year, avoiding higher electricity prices and \$6.7 billion in increased Illinois ratepayer costs by 2050.

We also find that the positive economic impacts of relicensing would be localized in Rock Island County, IL, and the other counties surrounding the plant, while the partially offsetting impacts that do exist would be distributed broadly across the region. Thus, the local area surrounding the plant would experience an outsize share of the positive net impacts.

Our analysis demonstrates that nuclear power and renewable energy can be viewed as complementary clean technologies that can contribute to achieving Illinois' ambitious clean energy goals, while simultaneously supporting the state's economy. Extending the license of

---

<sup>3</sup> QCCEC would operate until 2052 if its license is extended, but the model horizon for our analysis ends in 2050.

this existing nuclear plant can help to support growing electricity demand and facilitate the transition to a decarbonized energy future.

# I. Background

---

The Quad Cities Clean Energy Center (QCCEC) is located in Rock Island County, IL, near the border between Illinois and Iowa. The plant has two operating units, both boiling water reactors, totaling 1,819 MW of generating capacity. QCCEC produces about 15.6 TWh (15.6 million MWh) of clean energy annually, accounting for around 9% of Illinois' annual electricity demand and 7% of Iowa's annual electricity demand. Brattle has been asked to characterize the impacts of retiring QCCEC on the power sector and the regional economy, including impacts on greenhouse gas emissions, employment and GDP, and implications for achieving Illinois' clean energy goals.

Like many states, Illinois has implemented a Renewable Portfolio Standard (RPS) and Clean Energy Standard (CES) to accelerate the adoption of renewable energy resources. The Climate and Equitable Jobs Act (CEJA) of 2021 stipulates that electricity suppliers must procure a minimum portion of their electricity from renewable sources. Under the RPS, utilities are required to procure 40% of their electric power from renewable resources by 2030 and 50% by 2040 through the procurement of Renewable Energy Credits (RECs).<sup>4</sup> CEJA also mandates the phase-out of coal and natural gas plants in Illinois, with a requirement of zero emissions for private coal plants by 2030 and municipal coal and natural gas plants by 2045, bringing all in-state electricity generation to zero emissions by 2045.<sup>5</sup> QCCEC plays an important role in the state's transition to zero-emissions sources of energy – it provides enough energy to offset around 50% of the output of the existing coal plants that must retire under CEJA,<sup>6</sup> and is estimated to prevent an average of 4.8 MMT of emissions annually between 2033-2050. To put this in perspective, this represents around 93% of Chicago's current annual on-road vehicle emissions (approximately 1 million light duty vehicles).<sup>7</sup>

---

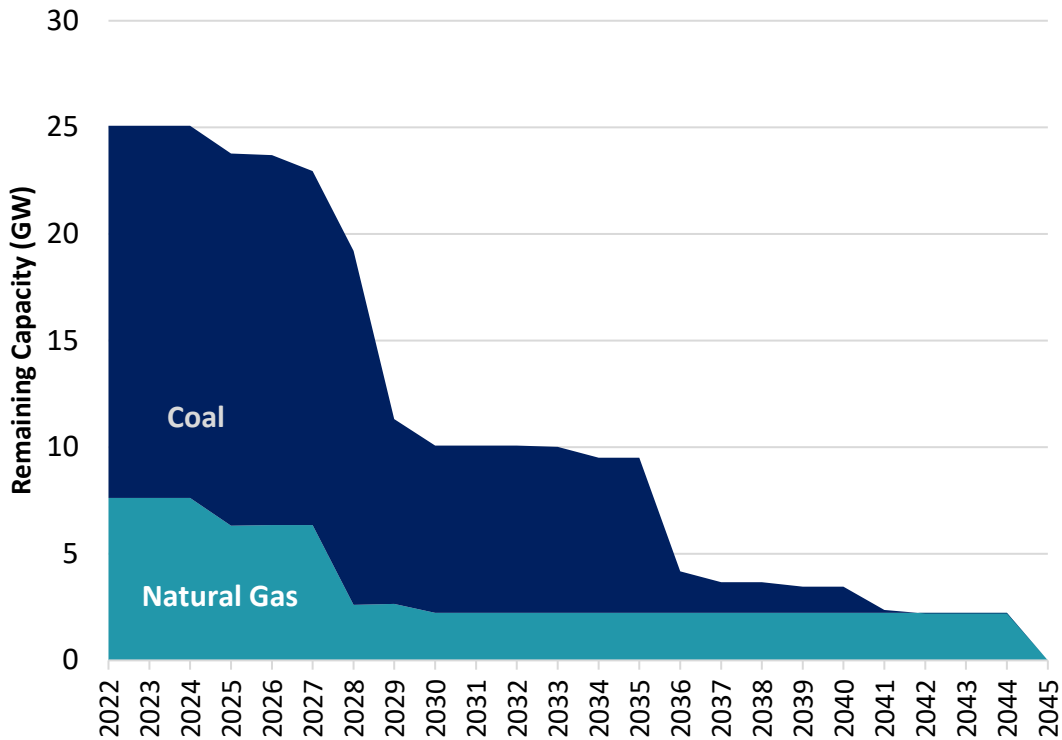
<sup>4</sup> RECs are eligible to count towards Illinois' RPS if they are generated from facilities located within Illinois. The Illinois Power Agency (IPA) may also qualify RECs from facilities in states adjacent to Illinois if the generator fulfills Illinois' public interest criteria ([ILGA](#)).

<sup>5</sup> See the [Clean Energy and Jobs Act \(CEJA\)](#) for further details.

<sup>6</sup> Scheduled fossil plant closures would result in 23 TWh of annual gas generation losses and 31 TWh of annual coal generation losses ([IL Department of Labor](#)).

<sup>7</sup> On-road vehicles produced 5.11 MMT of GHG emissions in Chicago in 2022 ([Regional GHG Emissions Inventory](#)); emissions offset is equivalent to ~1 million light-duty vehicles (LDVs) ([EPA GHG Emissions](#)).

FIGURE 1: PROJECTED REMAINING COAL AND NATURAL GAS CAPACITY UNDER CEJA



Note: Analysis of expected coal and gas retirements from the [IL Department of Labor](#).

Illinois straddles two electric systems – the Midcontinent Independent System Operation (MISO) and the PJM Interconnection (PJM). MISO is the electric grid operator for the central U.S., with a footprint stretching from North Dakota to Michigan and south to Louisiana. PJM operates across 13 states plus Washington, D.C., reaching from New Jersey to North Carolina and as far west as northern Illinois. Around one-third of Illinois’ electricity demand is located in Load Resource Zone 4 (LRZ 4) of MISO Central, with the other two-thirds being located within the Commonwealth Edison (ComEd) zone of PJM. Although QCCEC is located within ComEd, only 75% of QCCEC participates in the electricity market as a PJM resource. The remaining 25% of QCCEC bids into MISO’s capacity market as an LRZ 3 external resource. Given the proximity of QCCEC to the MISO-PJM interface and the exchange of energy that occurs between these two markets, both MISO and PJM provide important context in which the impacts of QCCEC’s relicensing must be understood. Figure 2 illustrates the location of the QCCEC, as well as Rock Island County and the neighboring counties that are considered individually in this analysis.

FIGURE 2: LOCATION OF THE QCCEC NUCLEAR PLANT

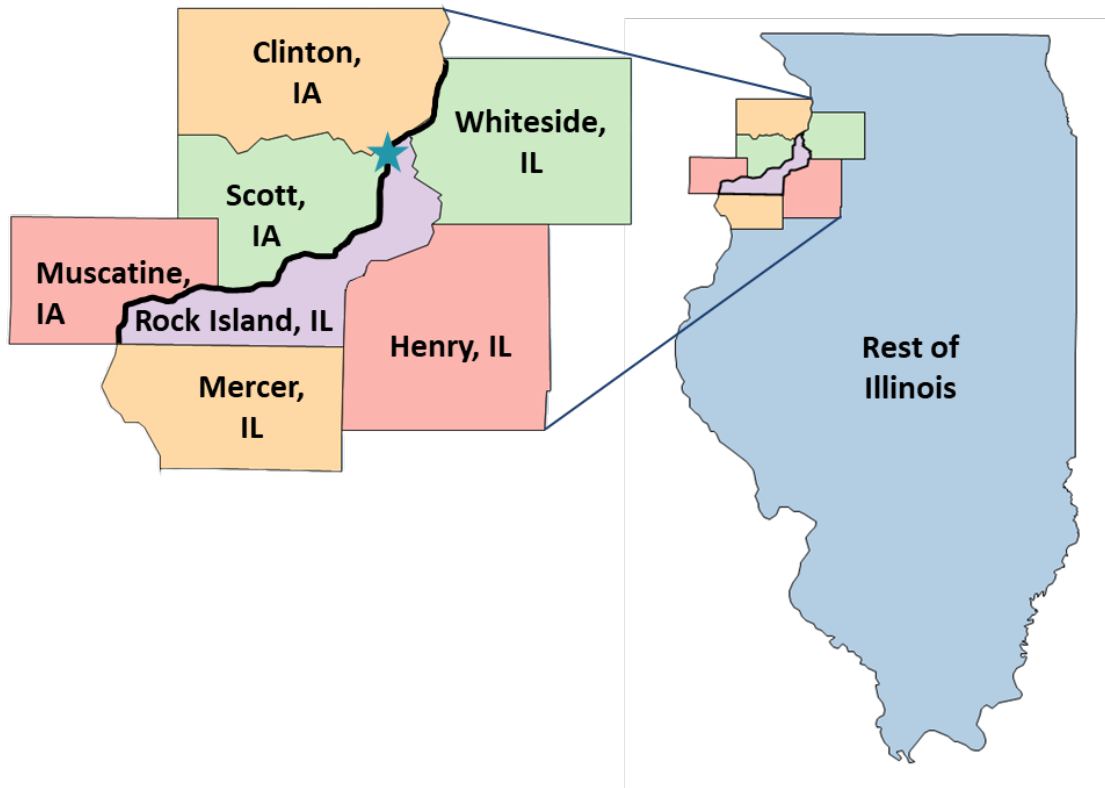
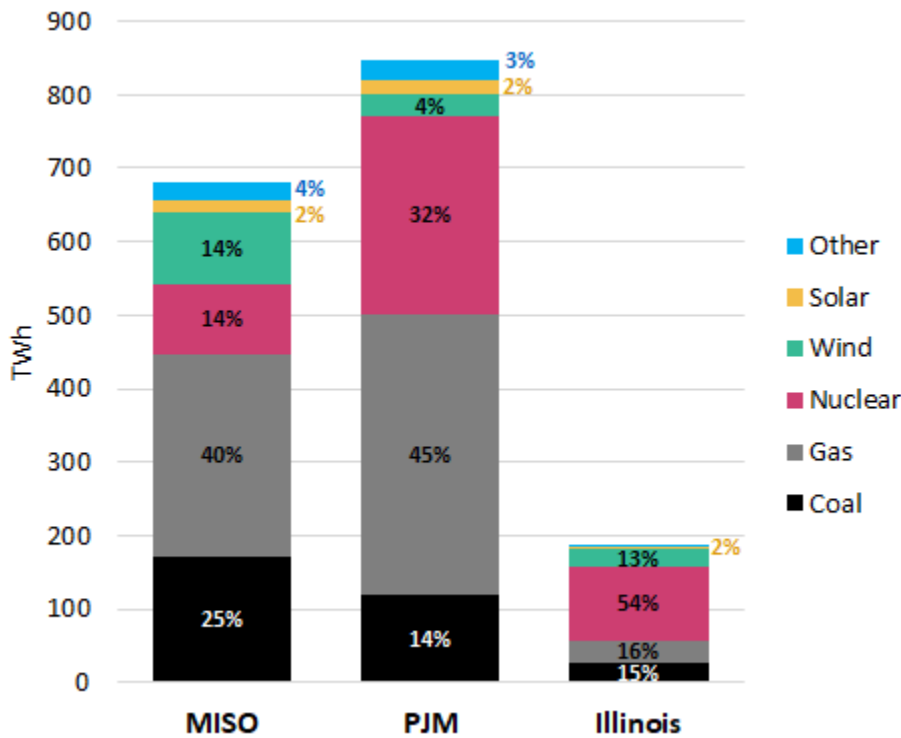


Figure 3 illustrates the recent generation mix for PJM, MISO, and Illinois. As of 2024, natural gas and coal resources accounted for the majority of generation in both PJM and MISO. Nuclear makes up 32% of PJM’s generation and 14% of MISO’s generation, while Illinois has a much larger nuclear share – it makes up 54% of the state’s generation. QCCEC’s annual generation accounts for around 4% of PJM & MISO’s combined nuclear generation and about 16% of Illinois’ nuclear generation.

FIGURE 3: PJM, MISO, AND ILLINOIS 2024 GENERATION BY RESOURCE TYPE



Note: “Other” includes biomass, oil, hydroelectric, pumped storage, battery storage, and waste. Sourced from S&P Global Market Intelligence and [EIA Electric Power Annual](#).

## II. Analytic Approach

We analyze the environmental and economic impacts of QCCEC over the period 2033 to 2050, considering the hypothetical shutdown of the plant at the end of 2032 if it is not relicensed. To do this, we simulate the MISO and PJM power systems and the economic impact in Illinois and neighboring Iowa counties, incorporating the outputs of the power system simulation as inputs to the economic model. We perform this set of simulations twice—first with QCCEC operating through the 20-year relicensing horizon, then a second time removing the plant at the end of 2032 to simulate the hypothetical retirement. By comparing the results of these two simulations in terms of power system operations, emissions, power prices, and economic performance, we can see the impact of QCCEC’s retirement.

We characterize the power system using gridSIM, Brattle’s proprietary power system simulation model, which portrays short-term hourly operations as well as longer-term capacity additions and retirements, to capture the dynamics of plant operation, power markets, and

prices over time. We simulate the entire MISO and PJM power systems (accounting for power interchange between the systems and with other neighboring systems) to best capture the dynamics of these interconnected electricity markets. This power sector model allows us to simulate the impact of QCCEC on the system's generating capacity mix (via retirements and new plant developments), power system operations (the utilization of each plant, which directly determines GHG emissions), and the cost of electricity to Illinois consumers. Appendix 1: Electric System Modeling includes an overview of the gridSIM model and further details on modeling assumptions.

In addition to its impacts on emissions, QCCEC also has substantial economic impacts in Illinois.<sup>8</sup> These occur through three primary channels, with additional ripple effects through the economy. First, the retirement of QCCEC would remove the direct spending and employment associated with the ongoing operations of the plant, and thus would directly reduce local economic activity. Second, indirect economic effects would result from the absence of QCCEC as it is replaced by other sources of generation. This indirect economic activity partially offsets the negative impacts of QCCEC's closure, as construction of new renewables resources and increased operations of natural gas and coal plants across the region would create some positive economic activity. Third, the absence of QCCEC would cause a modest increase in retail electricity price in Illinois, Iowa, and beyond—a result of the law of supply and demand, which says that, other things equal, a reduction in supply generally leads to higher prices, which translate to higher customer costs. Because electricity is ubiquitous throughout the economy, higher power costs mean producers and consumers would have somewhat less to invest and spend in other ways, which acts to slow the broader economy.

We utilize REMI, a widely used regional economic model, to study the economic impacts and interactions in Illinois and neighboring Iowa counties. We incorporate the in-state economic activity and jobs associated with QCCEC and other generating resources, as well as the effects on power prices.<sup>9</sup> This allows us to estimate the plant's aggregate effects on the economies of Illinois and the neighboring Iowa counties.

To best reflect the impacts of QCCEC, our modeling approach explicitly includes the responses of the power system, the electricity market, and the broader economy to the plant's presence or absence. These responses can partially mitigate the direct effects of retiring the plant. The economic modeling captures the ways in which the larger economy responds to the changes in

---

<sup>8</sup> Emissions ultimately have economic costs as well, of course, but these emissions-induced costs are not included among the economic impacts cataloged here.

<sup>9</sup> For information on the REMI model, see [www.remi.com](http://www.remi.com).

the electricity system, including the positive economic contributions of alternative generation that would substitute for the lost nuclear generation.

### III. Characterizing the Power System Impacts of QCCEC

To characterize the impacts of the QCCEC, our analysis considers two scenarios – a Relicensed Scenario in which QCCEC’s license is extended through 2050, and a QCCEC Retires Scenario in which the plant is retired at the end of 2032. By holding other variables constant and allowing the system to respond to the presence or absence of QCCEC, these two scenarios allow for a direct comparison of QCCEC’s impact on the power system and ultimately the broader economy.

Both scenarios model substantial decarbonization, driven by state clean energy goals as well as federal support for renewable generation. RPS and CES targets are modeled at the state level, including technology-specific procurement targets. Emissions reduction goals are also modeled based on state decarbonization targets. At the federal level, production tax credits (PTC) and investment tax credits (ITC) are modeled for solar and wind resources placed in service before 2028, while nuclear and battery storage credits are phased out between 2034-2036, in line with recent legislation.<sup>10</sup> Tax credits for carbon capture and storage (CCS) are modeled for all new and retrofitted CCS units that begin construction by 2033, based on the Section 45Q credit for carbon oxide sequestration.

Illinois’ RPS and CES targets are modeled under the Climate and Equitable Jobs Act (CEJA) of 2021, which stipulates that electricity suppliers must procure a minimum portion of their electricity from renewable sources. Under the RPS, utilities are required to procure 40% of their electric power from renewable resources by 2030 and 50% by 2040 through the procurement of Renewable Energy Credits (RECs). CEJA also mandates the phase-out of coal and natural gas plants in Illinois, with a requirement of zero emissions for private coal plants by 2030 and municipal coal and natural gas plants by 2045, bringing all in-state electricity generation to zero emissions by 2045. Further details on modeled policies and other power sector assumptions for the Relicensed Scenario and QCCEC Retires Scenario, including modeled

---

<sup>10</sup> Solar and wind projects must begin construction before July 5, 2026, or be placed in service before January 1, 2028, to be eligible to receive tax credits. There is a four-year safe harbor if construction begins before July 5, 2026, and the project is completed by the end of 2030, but additional ownership and FEOC provisions apply. Given these limitations, tax credits for wind and solar in gridSIM are only modeled for resources online by 2028.

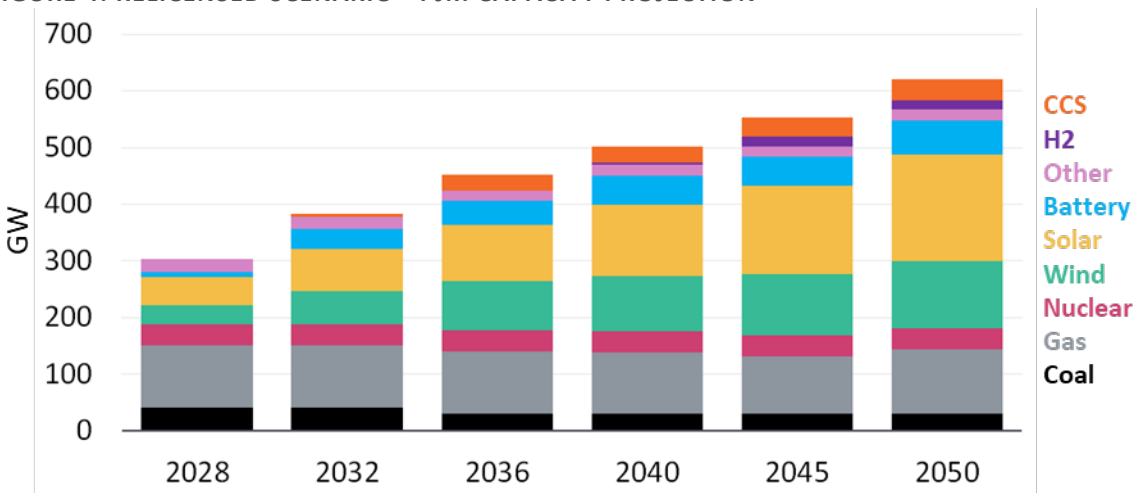
zones, load projections, and technology assumptions, are summarized in Appendix 1: Electric System Modeling.

## A. Electric System Impacts of Relicensed Scenario

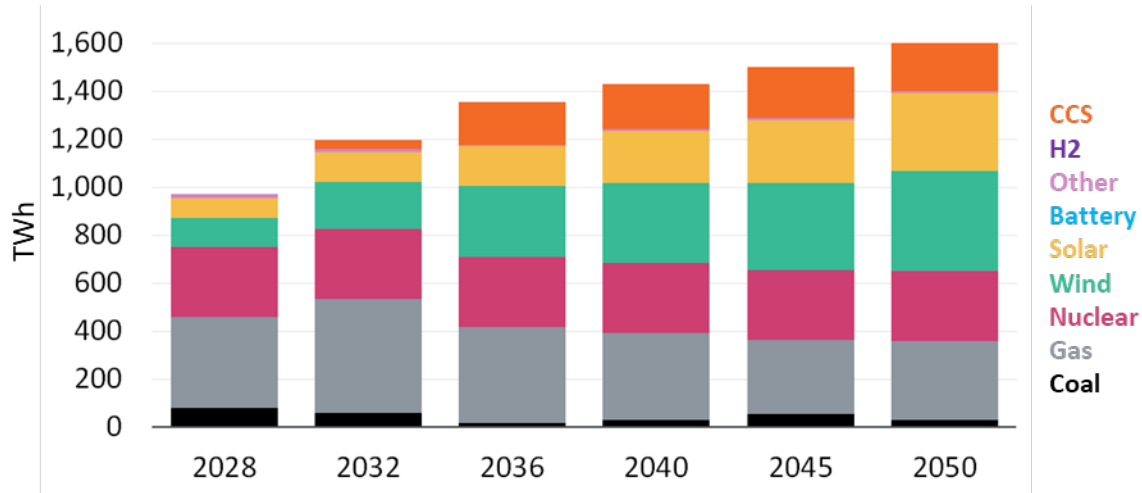
The Relicensed Scenario characterizes the electric system with QCCEC’s license extended through 2050.

Our Relicensed Scenario shows that in this context, the MISO and PJM power systems would decarbonize substantially over the coming decades. By 2045, wind and solar would make up 48% of PJM’s capacity mix and 42% of its generation. Storage, natural gas, and smaller amounts of gas with CCS and hydrogen would comprise the remaining resource mix. Figure 4 and Figure 5 show how PJM’s capacity and generation would change over time, assuming QCCEC continues to operate. Note that although IL eliminates fossil generation, other PJM states have less ambitious climate goals, so fossil generation continues in PJM, though accounting for a declining share of generation. More details on benchmarking PJM’s future resource mix can be found in Appendix 1: Electric System Modeling.

FIGURE 4: RELICENSED SCENARIO—PJM CAPACITY PROJECTION



**FIGURE 5: RELICENSED SCENARIO—PJM GENERATION PROJECTION**



MISO shows similar renewable growth, with wind and solar making up 52% of the capacity mix and 58% of generation by 2045. Storage and natural gas would also comprise a large portion of the resource mix, as well as a smaller amount of gas with CCS and hydrogen. Figure 6 and Figure 7 show how MISO’s capacity and generation would change over time, assuming QCCEC continues to operate. As with PJM, fossil generation continues in MISO, though accounting for a declining share. More details on benchmarking MISO’s future resource mix can be found in Appendix 1: Electric System Modeling.

**FIGURE 6: RELICENSED SCENARIO—MISO CAPACITY PROJECTION**

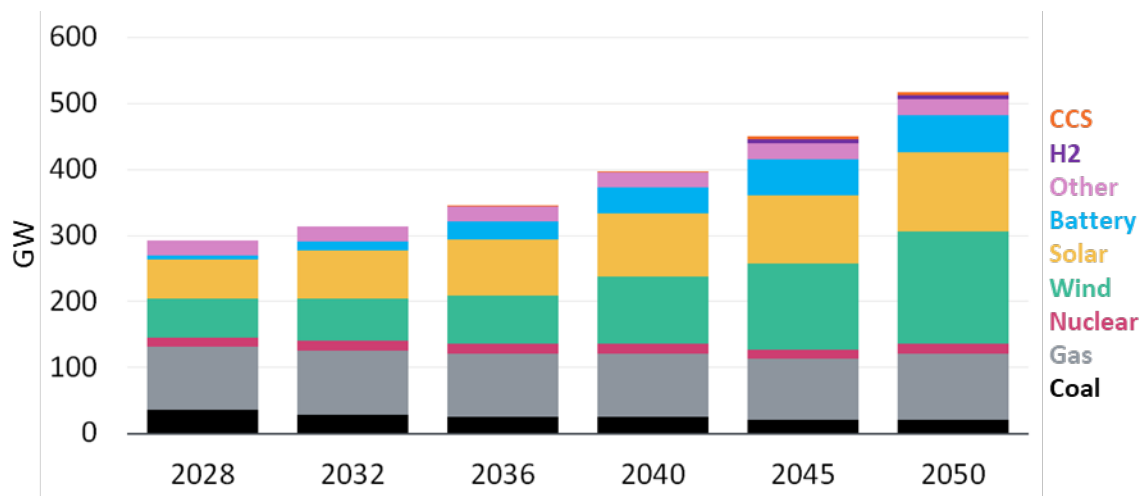
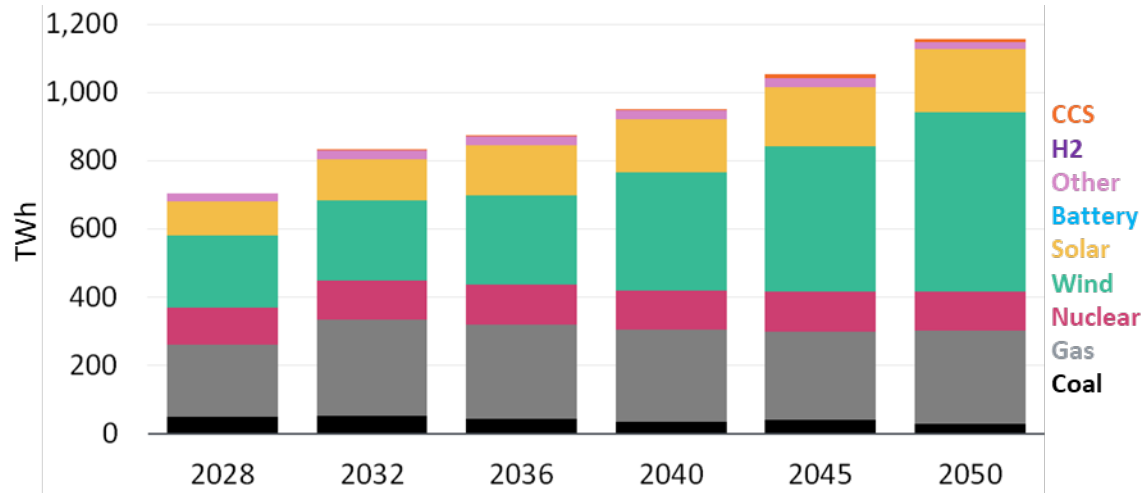


FIGURE 7: RELICENSED SCENARIO—MISO GENERATION PROJECTION



## B. Electric System Impacts of QCCEC Retires Scenario

With this Relicensed Scenario baseline established, we estimated the impact of the QCCEC by removing the plant at the end of 2032 and allowing the system to respond naturally according to operating requirements and natural economic forces. By comparing the results of these two simulations—with vs. without QCCEC—on various dimensions, we can observe the impacts of the plant. Most of the incremental resources that are needed to satisfy Illinois and Iowa’s resource adequacy and RPS requirements in QCCEC’s absence would be met with additional resources within both states. Where additional clean energy is needed to meet policy goals, new clean energy resources are developed to replace QCCEC. During times that policy goals are not binding, some of QCCEC’s output would be replaced by fossil generation, increasing emissions of greenhouse gases and other pollutants.

Figure 8 to Figure 13 below show the differences between the QCCEC Relicensed Scenario and the QCCEC Retires Scenario. Without QCCEC, a large portion of Illinois’ local resource adequacy obligations are met through internal resource builds of solar, storage, hydrogen CTs, and a small amount of gas w/ CCS, as shown in Figure 8. Solar and storage builds are driven by CEJA, while hydrogen CTs are built to provide resource adequacy and operate as peakers during hours that cannot be served economically by solar plus storage. Gas w/ CCS, while limited, helps meet the system’s need for clean, firm baseload generation. By 2050, around 8 GW of replacement capacity is built within Illinois to replace the loss from QCCEC. The 8 GW of replacement capacity exceeds QCCEC’s capacity of 1.8 GW due to system needs for both clean energy resources and peaker units to meet demand during times of lower solar output.

**FIGURE 8: IMPACT OF QCCEC ON ILLINOIS CAPACITY  
(QCCEC RETIRES MINUS QCCEC RELICENSED)**

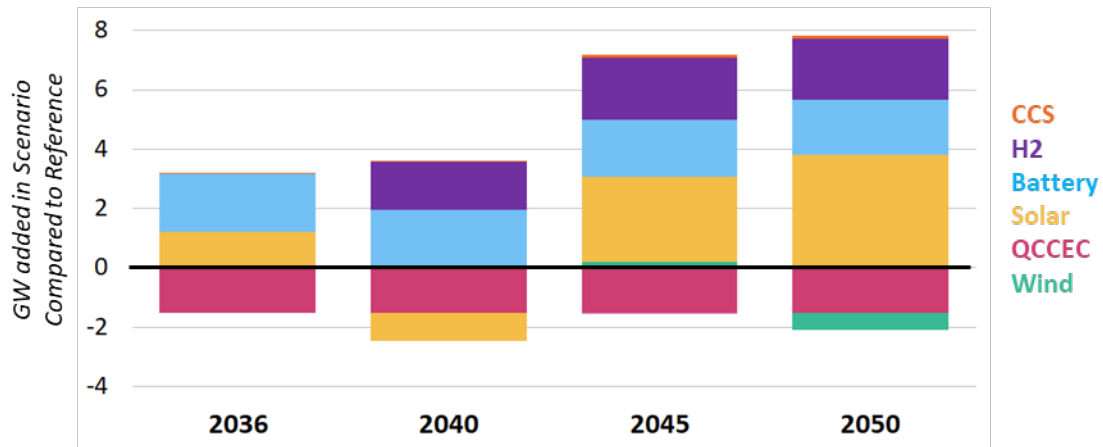
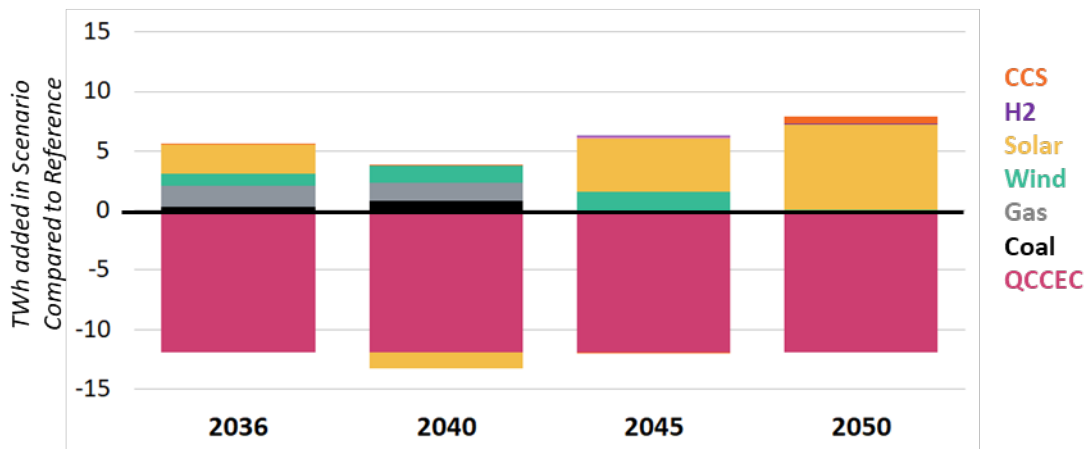


Figure 9 shows the impact of retiring QCCEC on Illinois' generation mix. Fossil generation increases through 2040, before emissions limits become binding, and solar generation ramps up after 2045. Not all the lost generation from QCCEC is replaced internally; because Illinois is a net exporter, the Illinois power system responds to QCCEC's retirement in part by reducing exports to neighboring regions. The earlier years also see a slight reduction in wind curtailment in QCCEC's absence.

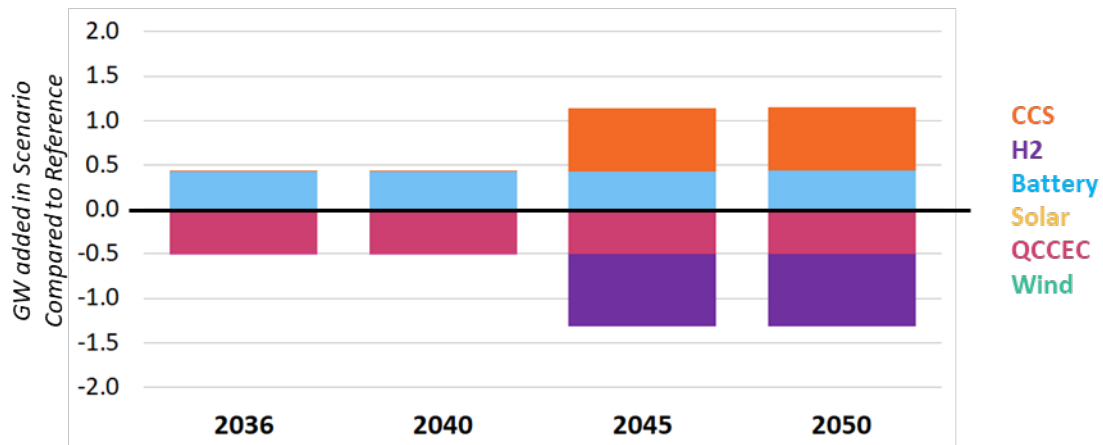
**FIGURE 9: IMPACT OF QCCEC ON ILLINOIS GENERATION  
(QCCEC RETIRES MINUS QCCEC RELICENSED)**



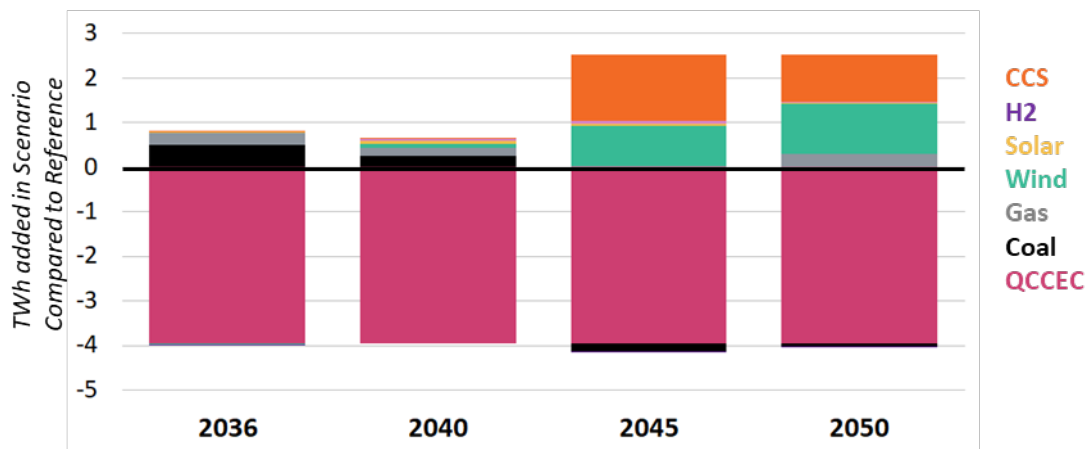
Within Iowa, retiring QCCEC leads to increased builds of storage and gas w/ CCS capacity and a reduction in hydrogen capacity, shown in Figure 10. Gas w/ CCS operates as clean, firm baseload generation while storage is used to meet demand internally, reducing the need for hydrogen CTs. The generation impact in Figure 11 shows that Iowa also reduces net exports to

neighboring regions in the absence of QCCEC. Iowa sees a slight increase in fossil generation through 2040, followed by more wind, gas w/ CCS, and some gas generation in the later years. 2045 and 2050 also see a slight reduction in wind curtailments.

**FIGURE 10: IMPACT OF QCCEC ON IOWA CAPACITY  
(QCCEC RETIRES MINUS QCCEC RELICENSED)**



**FIGURE 11: IMPACT OF QCCEC ON IOWA GENERATION  
(QCCEC RETIRES MINUS QCCEC RELICENSED)**

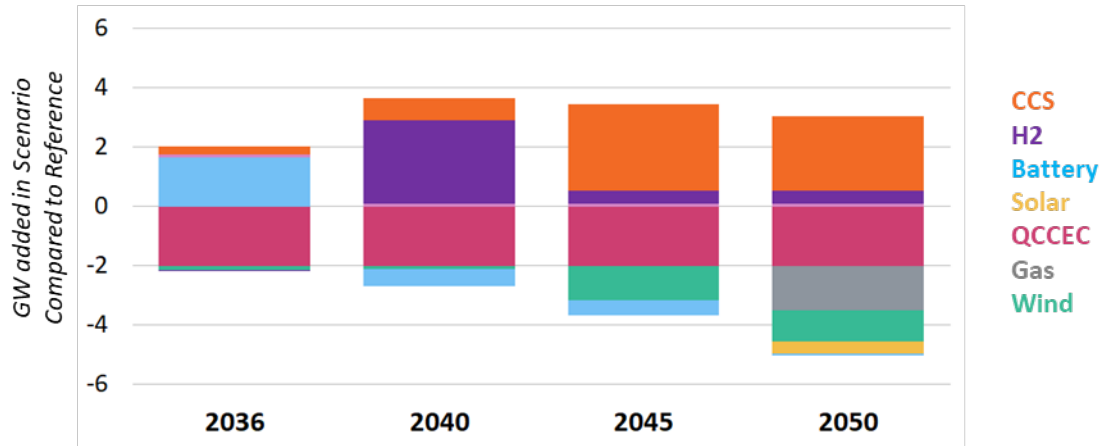


Across the entire PJM & MISO systems, QCCEC’s capacity is replaced by more hydrogen CTs and gas w/ CCS, as shown in Figure 12, and some shuffling of other resources. Storage and hydrogen builds are shifted earlier to replace lost nuclear capacity and supplement the need for flexible generation. Gas w/ CCS fills the system’s need for clean, firm baseload resources in the long-term.

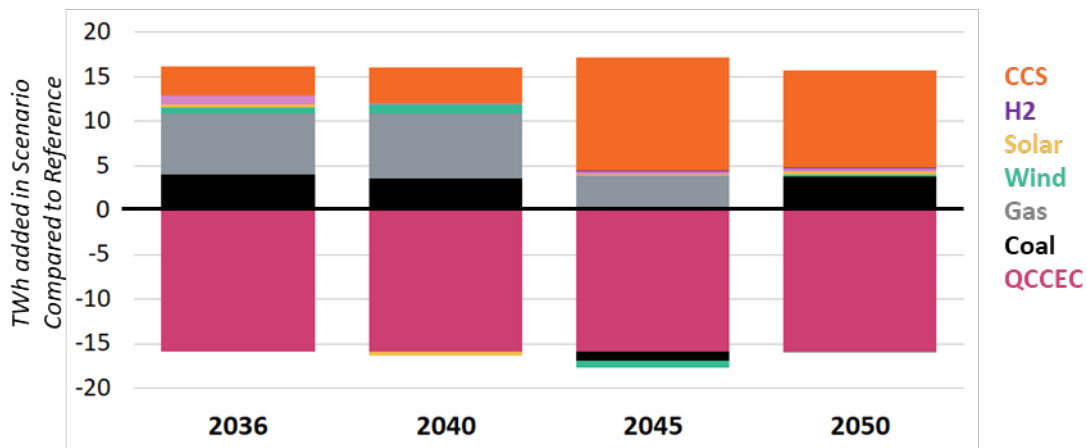
Retiring QCCEC leads to increased fossil generation and more emissions (both GHGs and other pollutants) across PJM & MISO, particularly before 2045 when emissions goals are less

stringent. Although fossil capacity is not added, gas and coal resources operate at higher capacity factors absent QCCEC, resulting in increased emissions. Generation from gas w/ CCS replaces some of the gas and coal generation after 2045. Most of the increase in fossil generation shown in Figure 13 occurs outside of Illinois and Iowa.

**FIGURE 12: IMPACT OF QCCEC ON PJM & MISO CAPACITY (QCCEC RETIRES MINUS QCCEC RELICENSED)**



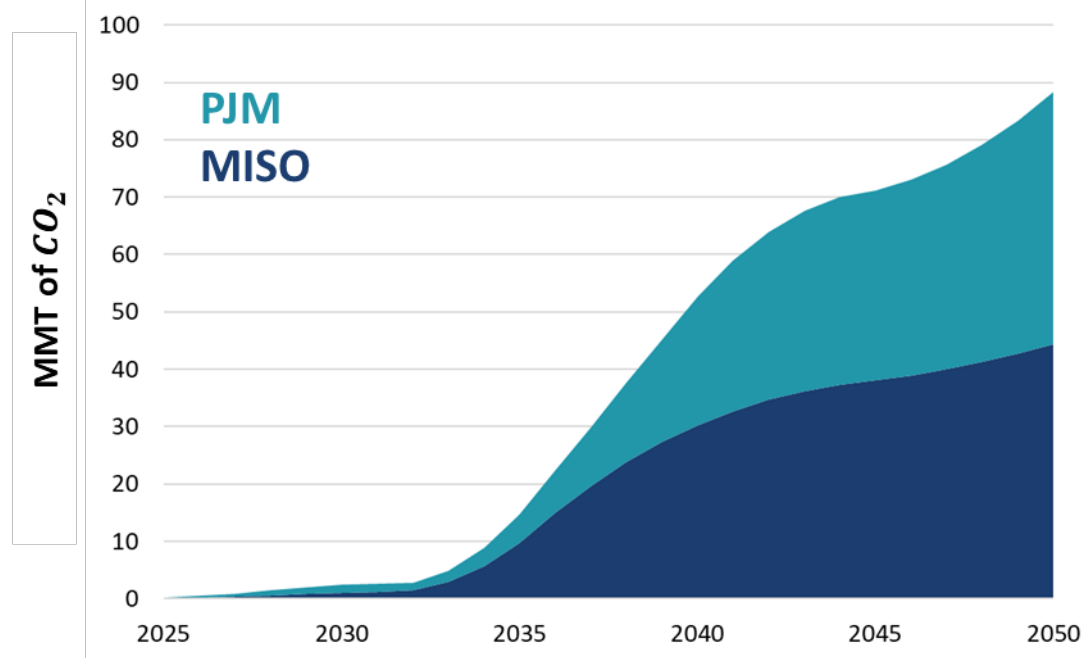
**FIGURE 13: IMPACT OF QCCEC ON PJM & MISO GENERATION (QCCEC RETIRES MINUS QCCEC RELICENSED)**



Since replacement generation is predominantly from emitting resources, particularly in the near and medium term, retirement leads to increased emissions across the PJM and MISO systems. Figure 14 shows the cumulative change in GHG emissions that would accompany QCCEC’s retirement. Emissions increase by approximately 88 MMT CO<sub>2</sub> cumulatively by 2050, averaging 4.8 MMT per year between 2033-2050. This is equal to around 93% of Chicago’s

current annual on-road vehicle emissions (approximately 1 million light duty vehicles).<sup>11</sup> The rate of increasing emissions pauses briefly in 2045 as CCS generation is heavily utilized (to take advantage of temporary tax credits) and remaining Illinois fossil is retired under CEJA. Emissions increase after 2045 as the PJM & MISO regions (outside Illinois) rely in part on fossil to meet continuing load growth.

FIGURE 14: CUMULATIVE GHG EMISSIONS CAUSED BY QCCEC RETIREMENT



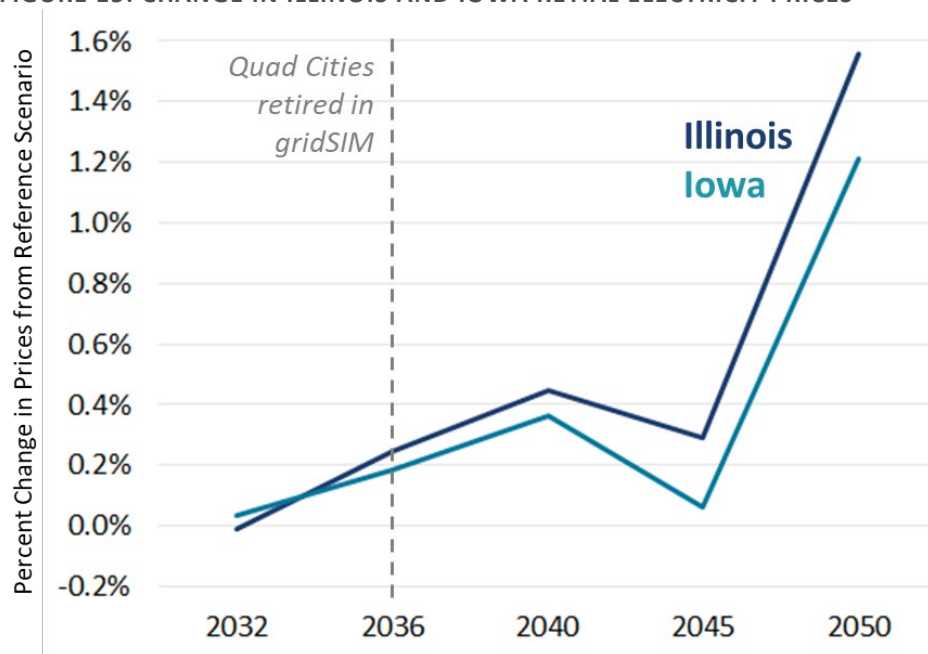
### C. Impacts on Electricity Prices and Customer Costs

In addition to the emissions impacts, the loss of QCCEC has a modest effect on electricity prices and thus customer costs. As with any market, a loss of supply generally causes an increase in price. In the PJM and MISO electricity markets, the loss of a large generator with essentially zero variable cost (such as nuclear) would generally increase hourly energy prices (though changing energy prices can have ensuing effects on the prices of other electricity products, such as capacity). The Illinois retail electricity price is calculated as the load-weighted average of the PJM-ComEd and MISO-LRZ4 regions. The Iowa retail electricity price is taken directly from the MISO-LRZ3 average price.

<sup>11</sup> On-road vehicles produced 5.11 MMT of GHG emissions in Chicago in 2022 ([Regional GHG Emissions Inventory](#)); emissions offset is equivalent to ~1 million light-duty vehicles (LDVs) ([EPA GHG Emissions](#)).

The overall percentage impact on retail electricity prices is illustrated in Figure 15. It is driven by modestly higher wholesale energy prices due to greater reliance on fossil generation (gas and coal) through 2040, shifting to more costly gas w/ CCS and hydrogen generation in later years. The price percentage difference is initially moderated in 2045 as capacity tightness in Illinois and surrounding regions keeps energy prices high with or without QCCEC online. The increased price impact in 2050 is due to high energy prices driven by increased penetration of hydrogen and gas w/ CCS added in 2045 after the 45Q tax credit expires. Higher energy prices are partially offset by lower wholesale capacity prices, as greater utilization of existing gas resources and higher energy prices leads to more energy market revenue, and thus lower going-forward costs that resources must recover in the capacity market. On average over 2033 to 2050, retail electricity prices are estimated to be 0.7% higher in Illinois and 0.5% higher in Iowa in the event of plant shutdown.

FIGURE 15: CHANGE IN ILLINOIS AND IOWA RETIAL ELECTRICIY PRICES<sup>12</sup>



## IV. Economic Impacts

<sup>12</sup> The retail electricity price impact is calculated as one-third of the wholesale electricity price impact, reflecting the fact that delivered price also includes transmission and distribution costs, which are assumed to remain constant. Wholesale prices (\$/MWh) are the sum of energy and capacity. Further details are available in the Appendix.

We utilized the REMI E3+ macroeconomic model to measure the economic impacts that would result from the QCCEC’s relicensing. We focus on two impact metrics over the period from 2033 to 2050: Gross Domestic Product (GDP) and employment. The GDP metric, which focuses on final demand and production, is the most common measure of economic activity. We also use this metric to estimate tax revenue impacts. The employment metric includes direct and secondary jobs. Direct jobs refer to those employed directly at the QCCEC. Secondary jobs include those involved in providing goods and services used by the plant, plus additional jobs created by changes in economic activity elsewhere in the economy (e.g., from expenditures by plant workers).

Our macroeconomic results are specific to the study region. QCCEC is in Illinois, but in a population center that straddles the Illinois and Iowa border. Therefore, to more accurately capture the economic impact of relicensing the facility, our study considers eight regions, including four Illinois counties (Rock Island, Whiteside, Henry, and Mercer), the remainder of Illinois (as one region), and three Iowa counties (Muscatine, Scott, and Clinton). Results for Illinois, therefore, represent complete state level impacts, while Iowa results are specific only to the three modeled counties.

In this section, we discuss results for the complete study region. State and county specific results are presented in Appendix 2 Section B.

## A. Regional GDP and Employment Impacts

Table 1 below summarizes the cumulative GDP and average annual employment impact of the QCCEC’s relicensing in the full study region, incorporating all relevant effects. This includes the effects of continued plant operations (changes in plant expenditures and direct employment), changes in electricity prices (affecting costs for regional producers and consumers), avoided expenditures for the construction of replacement generating capacity, and avoided operations and maintenance of existing and new plants which would otherwise be necessary.

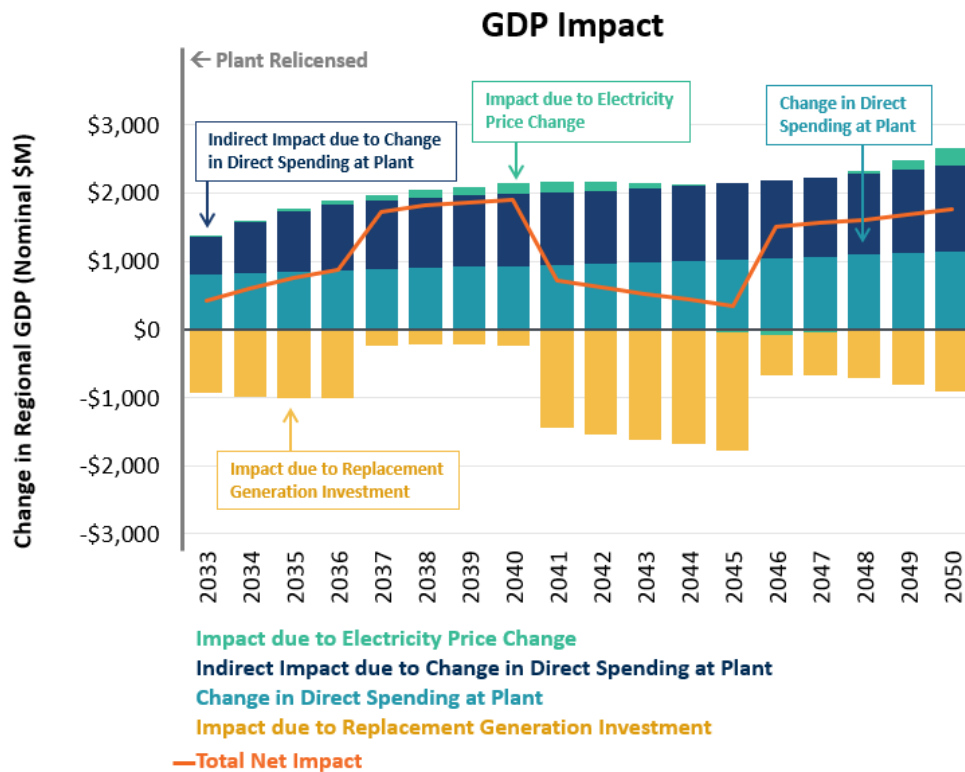
**TABLE 1: ECONOMIC IMPACTS OF THE QCCEC RELICENSING IN THE STUDY REGION**

Dimension	Impact
Net GDP Impact (Nominal, \$ Billion)	+\$20.7
Employment Impact (Average Annual Jobs)	+1,439

Between 2033 to 2050, relicensing the QCCEC would bring a cumulative \$20.7 billion to Illinois and the Iowa Counties included in the study region (in cumulative, undiscounted terms). This

gain includes \$36 billion from the direct effects of continued plant operation and \$1.3 billion from prevented electricity price increases, partially offset by the loss of \$16.6 billion in new plant construction and utilization of existing plants that would otherwise be required to replace QCCEC. Figure 16 and Figure 17 below show the annual GDP and employment impacts by category of economic driver.

FIGURE 16: REGIONAL GDP IMPACTS OF THE QCCEC RELICENSING

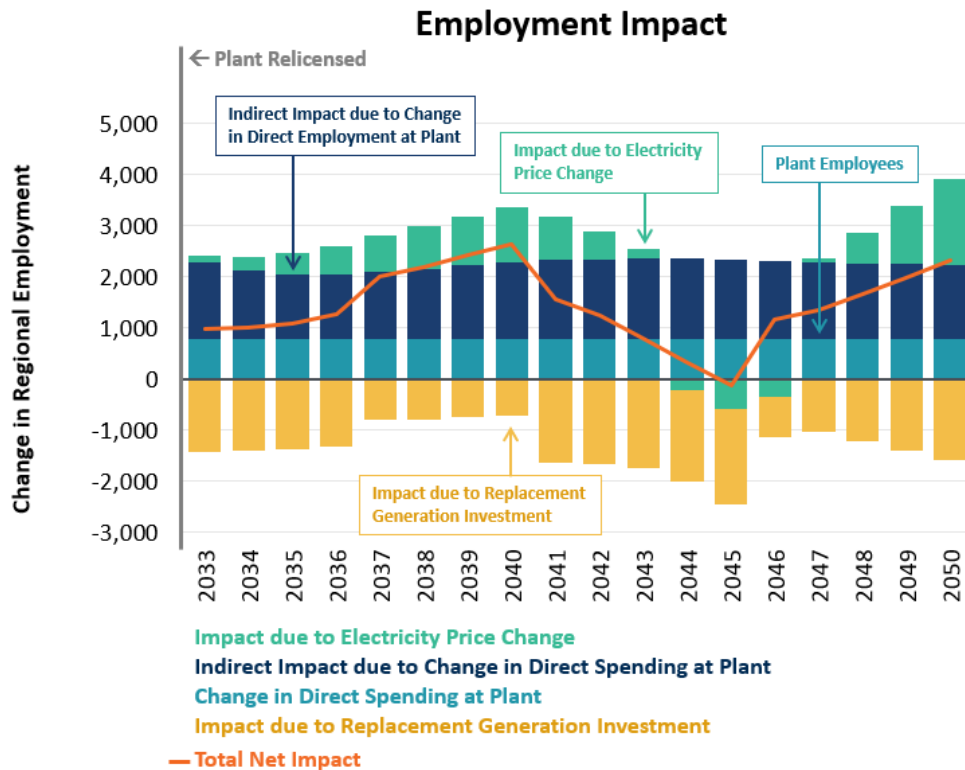


Note: Change in Direct Spending at the Plant is not a direct component of total GDP impacts but is included to show the size of total impacts relative to the impact source (the change in direct spending at the plant).

Average job gains across the region due to the QCCEC’s relicensing would be 1,439 annually, reflecting an annual average of 792 plant employees,<sup>13</sup> 1,445 secondary annual average job gains related to the plant relicensing, and another 498 annual average job gains related to lower electricity prices. These gains are partially offset by an average annual loss of 1,297 direct and secondary jobs from developing and operating new generation and extended operation of existing generation which would be necessary if QCCEC did not relicense.

<sup>13</sup> The QCCEC has 742 employees at the plant and employs an additional 50 full time employees for refueling, which occurs every year (<https://www.constellationenergy.com/our-company/locations/location-sites/quad-cities-clean-energy-center.html>)

FIGURE 17: REGIONAL EMPLOYMENT IMPACTS OF THE QCCEC RELICENSING



Note: Change in Direct Employment at the Plant is included to show the size of total impacts relative to the change in employment at the plant.

Overall, the impacts are qualitatively similar for GDP and employment. Most of the estimated economic impacts result from direct spending at the QCCEC and jobs supported by plant operations after relicensing. These direct spending and employment impacts in turn support significant indirect economic benefits in the region. The impacts from lower electricity prices are positive but smaller by comparison. These positive impacts are partially offset by avoided spending and employment associated with alternative generation that would otherwise be required if the QCCEC were not relicensed.

## B. Distribution of Impacts Across Neighboring Counties

In addition to aggregate results over the full study region, it is important to consider localized impacts as positive and negative effects are distributed quite differently. The positive economic impacts of the QCCEC’s relicensing are concentrated heavily in and around Rock Island County, IL, where the QCCEC is located, and the surrounding counties (Whiteside, Henry,

and Mercer Counties in Illinois; Muscatine, Scott, and Clinton Counties in Iowa). This is due to the proximity of increased economic activity from plant relicensing— plant workers make up a substantial share of the local population, income, and expenditure. The distribution of impacts across neighboring counties are driven by inter-county relationships that include:

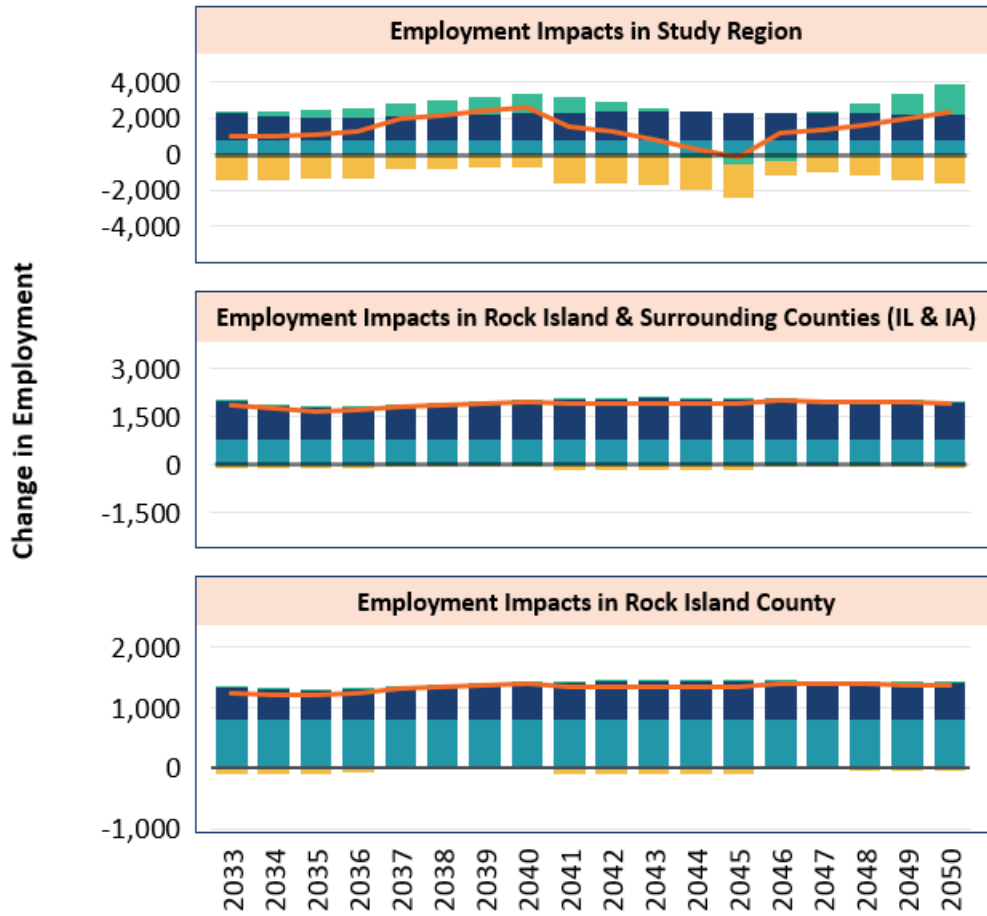
- **Industry-level trade flows**, which dictate where Rock Island businesses spend on their supply chains and where Rock Island consumers spend their disposable personal income.
- **Commuting patterns**, which dictate how much income earned in Rock Island stays local and how much is spent in the surrounding counties from which workers commute.
- **Population migration**, specifically in response to changing economic conditions.

The REMI model reflects that people stay within or relocate into or out of a region over time, based on relative employment opportunities and earnings.

In contrast, only some of the additional generation resources that would be needed to replace the QCCEC would be built in Illinois and Iowa. The small regional generation additions that do occur in these states would be further distributed across counties based on the size of their utility sectors, so their impact would do little to offset the local concentration of positive impacts enjoyed in case of plant relicensing. That is, the local economy experiences most of the positive economic impacts of plant relicensing, but only a very small share of the offsetting impacts that would result from additional electricity sector investments in case of plant retirement.

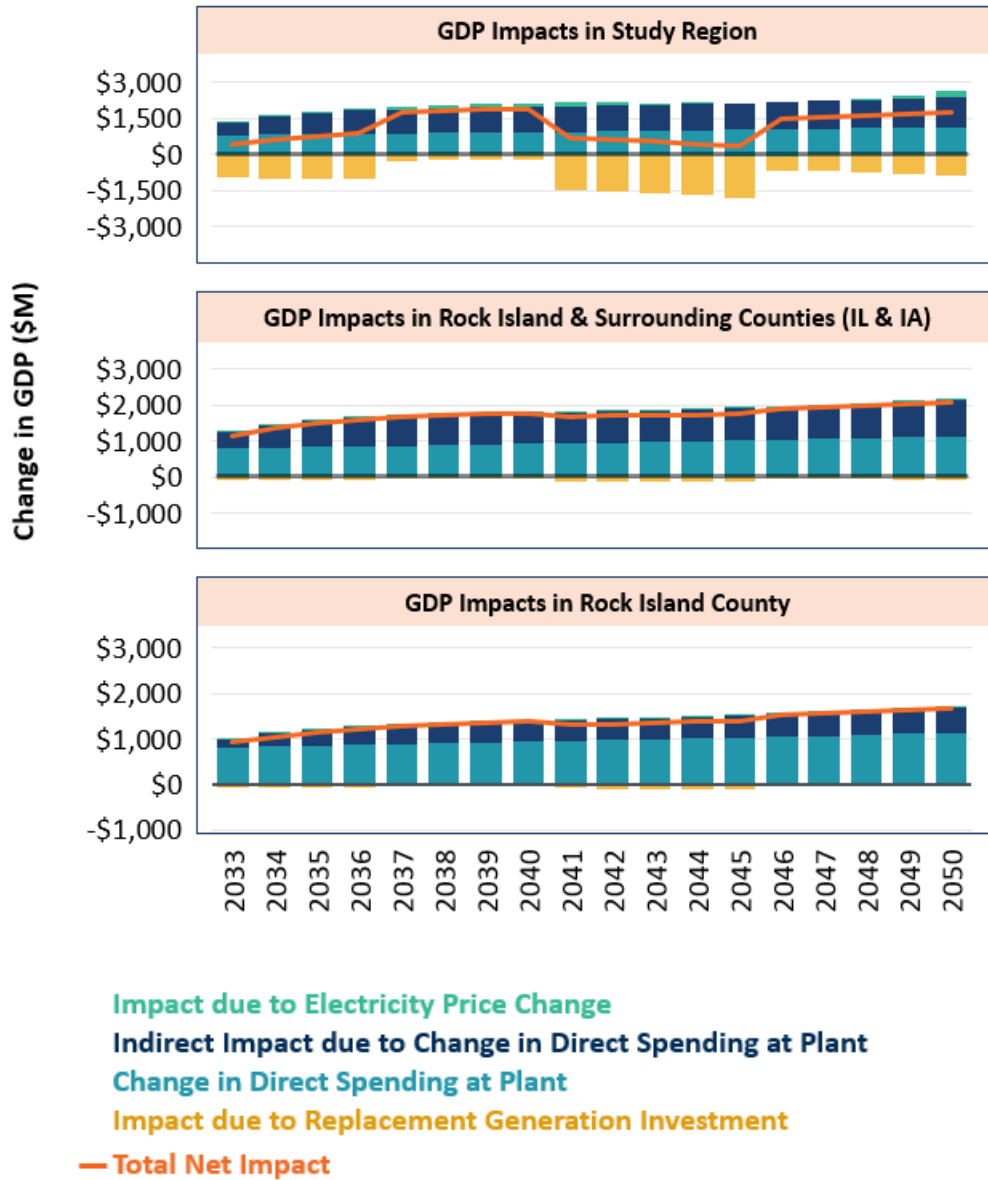
Figure 18 and Figure 19 below illustrate the impact on GDP and employment by region, showing first the impacts in the full study region, then the impacts in Rock Island and the six counties surrounding the QCCEC, and finally just the impacts for Rock Island County. As the geographic scope of the region considered narrows to focus on the region closest to the plant, the positive impacts diminish slowly, while the offsetting impacts shrink much more quickly. That is, Rock Island County and its surrounding counties enjoy the majority of the positive impacts, and a roughly proportionate share of the partial offset.

FIGURE 18: EMPLOYMENT IMPACTS BY REGION



- Impact due to Electricity Price Change
- Indirect Impact due to Change in Direct Spending at Plant
- Change in Direct Spending at Plant
- Impact due to Replacement Generation Investment
- Total Net Impact

FIGURE 19: GDP IMPACTS BY REGION



Detailed state and county level economic impacts are provided in Appendix 2: County Level Economic Impacts.

## C. Effect on Tax Revenue

Relicensing QCCEC would have a considerable effect on Illinois and Iowa’s state and federal tax revenues. We estimate that the QCCEC’s relicensing would result in a \$4.6 billion cumulative increase in tax revenue over 18 years. Tax revenue is estimated as a fixed share of GDP based on their historical relationship. IL and IA tax revenue is estimated based on average tax revenue as a percentage of state GDP between 2013-2022 (5.2% for Illinois, 5.4% for Iowa). Federal tax revenue is estimated using average tax revenues as a share of federal GDP between 2014-2023 (16.95%). Table 2 summarizes the increase in federal and state tax revenue by geographic region due to the QCCEC’s relicensing.

**TABLE 2: EFFECT ON TAX REVENUE OF QCCEC RELICENSING (\$ MILLION OVER 20 YEARS)**

**Increase in Provided Tax Revenue at State and Federal Level by Region (\$ Million)<sup>1</sup>**

Region	State Tax Impact <sup>2</sup>	Federal Tax Impact <sup>3</sup>	Total Tax Impact
All of Illinois	\$752	\$2,444	\$3,196
Rock Island & Surrounding IL Counties (Whiteside, Henry, and Mercer)	\$1,297	\$4,217	\$5,515
Rock Island County, IL	\$1,272	\$4,133	\$5,405
Iowa Counties Adjacent to Rock Island <sup>4</sup> (Muscatine, Scott, and Clinton)	\$340	\$1,067	\$1,407
Scott County, IA	\$322	\$1,011	\$1,333

Sources and Notes:

1. Tax revenue is approximated as a fixed portion of GDP based on their historical relationship. It includes both direct spending at the plant and indirect spending.
2. State tax revenue estimated using average over 2014-2023 of IL tax revenue as percent of IL GDP (5%).
3. Federal tax revenue estimated using average over 2014-2023 of federal tax revenue as percent of federal GDP (17%).
4. Iowa state and federal tax revenue is from the three modeled counties only.

## V. Conclusion

---

Extending the operating life of the Quad Cities Clean Energy Center would prevent significant carbon emissions and would provide economic benefits for Illinois and Iowa consumers in terms of GDP and jobs. Relicensing QCCEC guarantees reliable, emission-free power and will displace a significant amount of fossil generation and emissions in the near-term. Securing this clean power is pivotal to achieving Illinois' 2045 electric sector decarbonization targets, as well as limiting emissions in neighboring states with less stringent policies, where fossil generation would increase in the absence of QCCEC. In addition to the emissions impact, Illinois and Iowa customers would likely face lower electric bills with relicensing, as retail electricity prices are estimated to increase in the event of plant shutdown. This combination of effects would have substantial negative impacts on the Illinois and surrounding Iowa counties economy in terms of GDP and employment.

We find that continuing to operate QCCEC through 2050 would:

- Reduce emissions by over 88 million metric tons of CO<sub>2</sub> (MMT CO<sub>2</sub>) through 2050, or around 4.8 MMT annually on average;
- Increase GDP by a total of \$21 billion in the study region, \$14.4 billion within Illinois and the remaining \$6.3 billion within the three adjacent Iowa counties;
- Support 1,439 jobs in the study region, including both direct and secondary employment effects;
- Prevent the loss of 15.6 TWh of firm, emissions-free generation each year, avoiding higher electricity prices and \$6.7 billion in increased Illinois ratepayer costs by 2050.

We also found that the positive net economic impacts of the QCCEC's relicensing would be localized in Rock Island County, IL, and the six other counties surrounding the plant in IL and IA.

As Illinois moves towards a decarbonized economy, existing nuclear plants would play a crucial role in preventing backsliding on emissions and supporting local economies.

# Appendix 1: Electric System Modeling

## A. gridSIM Overview

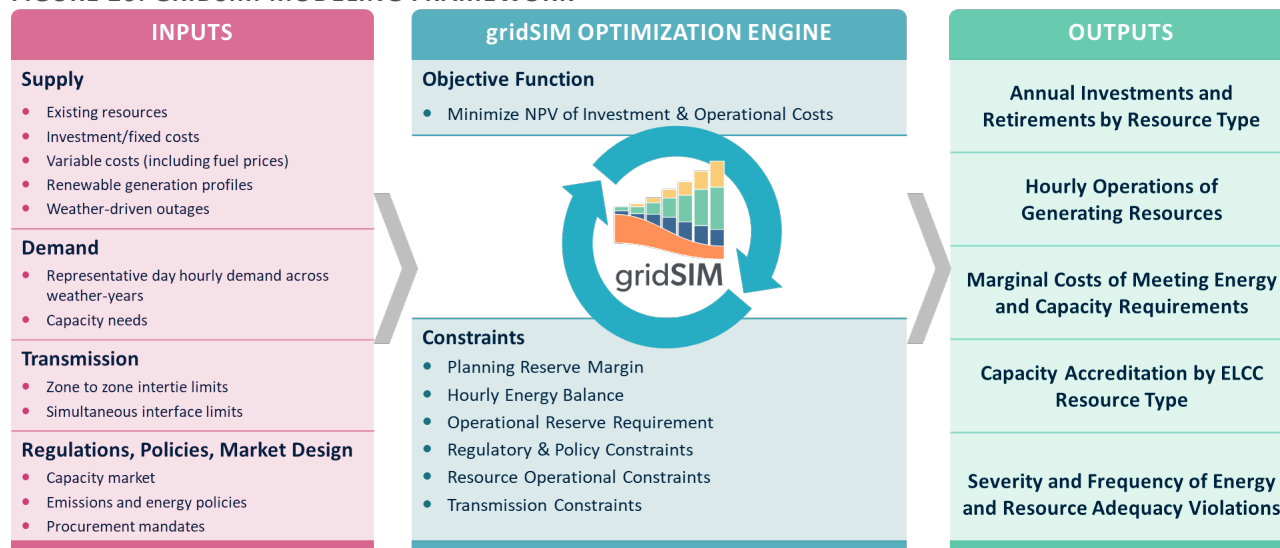
gridSIM is Brattle's proprietary long-term electricity simulation and capacity expansion model. Brattle developed gridSIM to analyze how clean energy policies and technological change would affect future market outcomes, particularly in high-renewable futures. Like most capacity expansion models, gridSIM identifies the least-cost expansion plan while considering the basics of electricity demand and supply, transmission, and regulation, policy and market design.

To accurately analyze how key drivers of the grid will affect future market outcomes given a rapidly evolving energy landscape and technological innovation, gridSIM excels over conventional capacity expansion modeling in several ways:

- gridSIM models energy chronologically and over long-periods so storage can be scheduled and traditional generation can be committed to balance variable wind and solar profiles. Not only is this more realistic operationally, but it is also necessary for representing the value of each technology (e.g., different storage durations, including long-duration storage) and developing a credible investment trajectory in a high-renewable future.
- gridSIM's representation of resource adequacy ensures that capacity accreditation of renewable and storage resources are dynamically and endogenously represented, based on the resources' respective contributions in meeting peak demand and how those contributions change as the renewable and storage resource mix evolves over time. This, along with the energy value described above, enables gridSIM to project a more realistic build mix and prices.
- gridSIM represents adjacent external regions of the main ISO/RTO modeled, to capture how the evolution of resource mix in adjacent ISO/RTOs can influence the optimal capacity expansion trajectory.
- gridSIM can account for several years (10-20 years) of historical weather-year data to realistically capture the variability in renewable generation profiles, load, and thermal generation outages when assessing resource adequacy in long-term capacity expansion studies.

Together, these features form the foundation for gridSIM’s representation of the electricity system conditions, including resource builds and retirements, hourly operating conditions, and wholesale energy and capacity prices. The graphic below illustrates gridSIM’s structure, inputs and outputs.

**FIGURE 20: GRIDSIM MODELING FRAMEWORK**



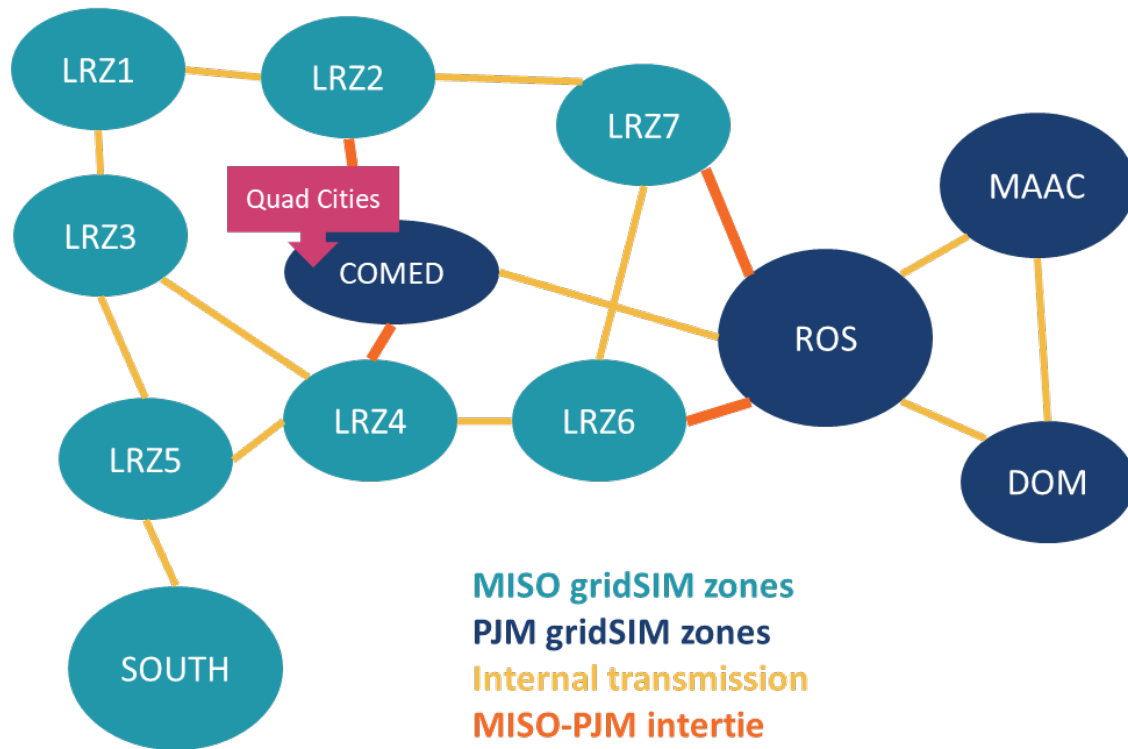
## B. Model Topology

gridSIM optimizes capacity expansion and generation across both MISO and PJM. Model topology is based on a pipe and bubble framework representing 12 MISO and PJM zones, shown in Figure 21 below. Energy transfer limits between two connected zones are calibrated based on the physical transmission limits specified in NREL’s Regional Energy Deployment System (ReEDS) model.<sup>14</sup> Capacity transfer limits are based on MISO CIL/CEL limits and PJM CETL limits.<sup>15</sup> Zonal energy and capacity limits have summer and winter ratings to reflect seasonal variation.

<sup>14</sup> [Regional Energy Deployment System \(ReEDS\)](#).

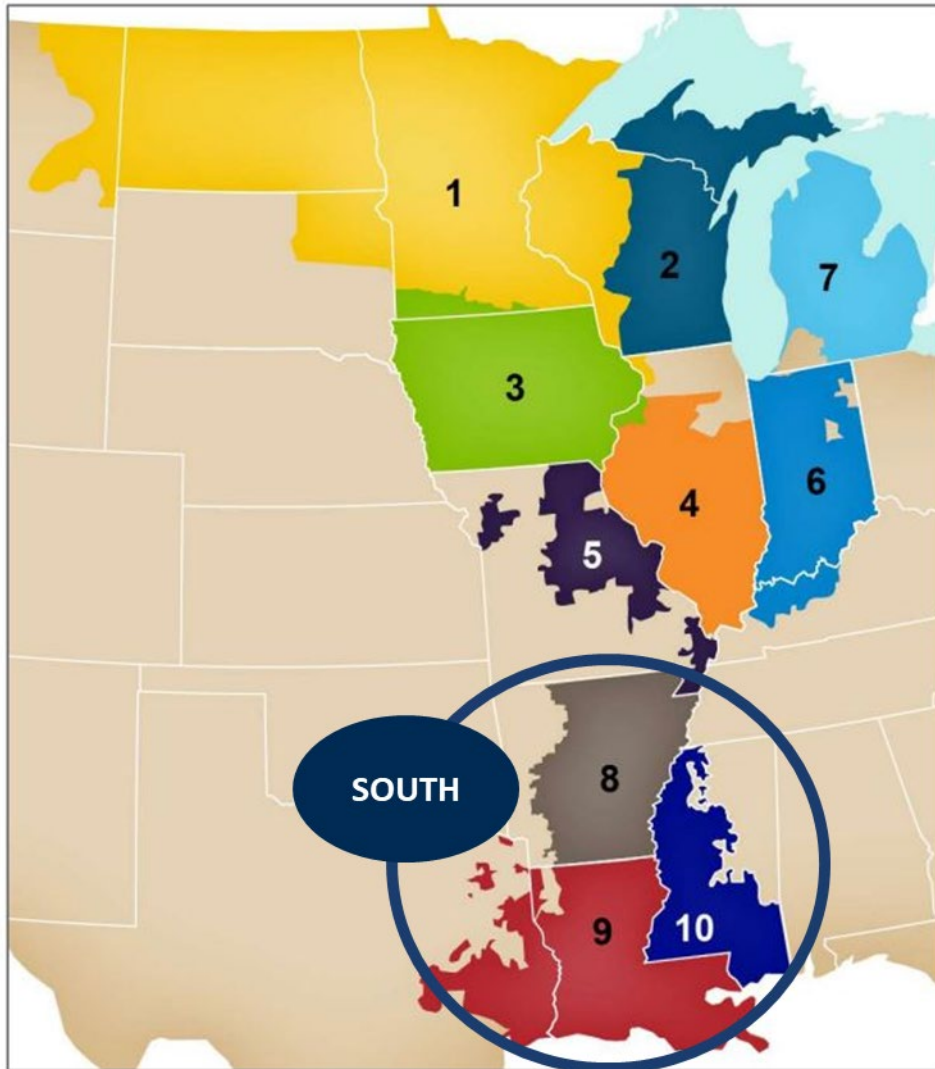
<sup>15</sup> [MISO 2025-2026 PY Seasonal CIL/CEL; PJM 2026/2027 RPM Base Residual Auction Planning Period Parameters](#).

FIGURE 21: GRIDSIM MODEL TOPOLOGY



The MISO system is comprised of ten local resource zones (LRZs). These zones are modelled independently except for LRZs 8, 9, and 10, which are aggregated into MISO South. The modeled MISO zones are shown in Figure 22 below.

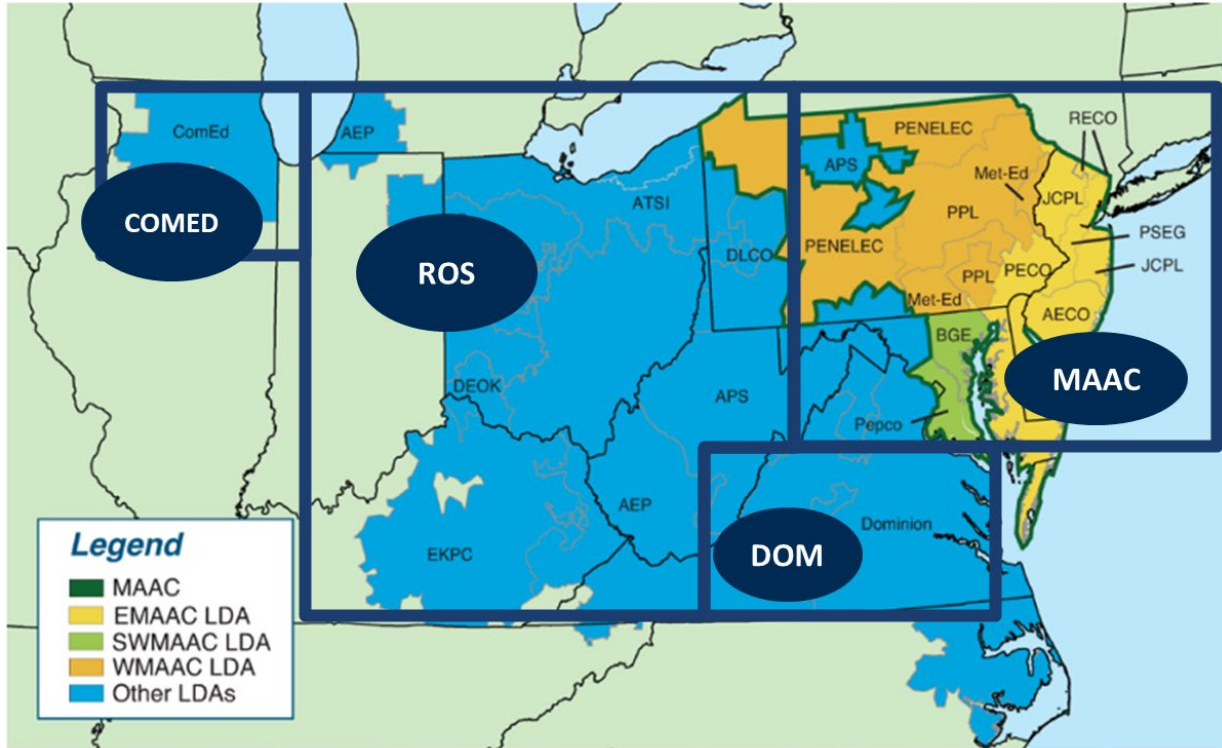
FIGURE 22: MODELED MISO ZONES



The PJM system is comprised of 21 transmission zones. The system is modeled as four aggregated zones in gridSIM, shown in Figure 23 below.<sup>16</sup>

<sup>16</sup> See here for more information on PJM transmission zones: [www.pjm.com](http://www.pjm.com).

FIGURE 23: MODELED PJM ZONES



## C. Quad Cities Clean Energy Center

### 1. Plant Parameters

Quad Cities summer capacity, capacity factor, and retirement assumptions are shown in Table 3 below. Although the extended retirement year is 2052, the model horizon for our analysis ends in 2050.

TABLE 3: QUAD CITIES PARAMETERS

Assumption	Value
Net Summer Capacity (MW)	1,819
Capacity factor	94.7%
Currently scheduled retirement year	2032
Extended retirement year	2052

## 2. Quad Cities Market Participation

Although Quad Cities is physically located within PJM-ComEd, it participates in both the MISO and PJM wholesale energy and capacity markets. The details of Quad Cities market participation are shown in Table 4. Accordingly, 25% of Quad Cities' capacity is modeled within MISO LRZ 3 and the remaining 75% is modeled within PJM ComEd.

TABLE 4: QUAD CITIES MARKET PARTICIPATION

Owner	Capacity market	Energy market
<b>Constellation (75%)</b>	Participates as PJM ComEd resource	Participates as PJM ComEd resource
<b>MidAmerican (25%)</b>	Bid into MISO capacity market as LRZ 3 external resource	Scheduled into MISO as an import; receives PJM interface price

## D. Modeled Policies

### 1. Renewable, Clean Energy, and Emissions Goals

- Renewable Portfolio Standards (RPS) and Clean Energy Standards (CES) are modeled at the state level across PJM and MISO.
- Carbon emissions limits are modeled based on state decarbonization goals.

**TABLE 5: STATE POLICIES MODELED IN PJM**

State	Renewable and Clean Energy Goals	Emissions Reduction Goals (2005 Baseline)
Delaware	<u>RPS</u> : 40% by 2035 (10% from solar)	50% reduction by 2030, zero emissions by 2050 ( <a href="http://de.gov">de.gov</a> )
DC	<u>RPS</u> : 100% by 2032 (5.5% Solar)	Zero emissions by 2032 ( <a href="http://dccouncil.gov">dccouncil.gov</a> )
Illinois	<u>RPS</u> : 40% by 2030, 50% by 2040 (55% solar and 45% wind) <u>CES</u> : 100% by 2045	Zero emissions by 2045 ( <a href="http://ilga.gov">ilga.gov</a> )
Maryland	<u>RPS</u> : 52.5% by 2030 (50% Tier I, 2.5% Tier II)	60% reduction by 2031, zero emissions by 2045 ( <a href="http://md.gov">md.gov</a> )
New Jersey	<u>RPS</u> : 52.5% by 2029 (50% Class I, 2.5% Class II) <u>CES</u> : 100% by 2050	80% reduction by 2050 ( <a href="http://nj.gov">nj.gov</a> )
North Carolina	<u>RPS</u> : 12.5% (completed)	n/a
Ohio	<u>RPS</u> : 8.5% by 2026	n/a
Pennsylvania	<u>RPS</u> : 18% (completed)	80% reduction by 2050 ( <a href="http://pa.gov">pa.gov</a> )
Virginia	<u>RPS</u> : 100% by 2050 (APCo), 100% by 2045 (DOM) <u>CES</u> : 100% by 2050 (APCo), 100% by 2045 (DOM)	Zero emissions by 2045 ( <a href="http://va.gov">va.gov</a> )

**TABLE 6: STATE POLICIES MODELED IN MISO**

State	Renewable and Clean Energy Goals	Emissions Reduction Goals (2005 Baseline)
Illinois	<u>RPS</u> : 40% by 2030, 50% by 2040 (55% solar and 45% wind) <u>CES</u> : 100% by 2050	Zero Emissions by 2045 ( <a href="http://ilga.gov">ilga.gov</a> )
Indiana	<u>RPS</u> : 10% by 2025	n/a
Iowa	<u>RPS</u> : 105 MW (completed 2007)	n/a
Louisiana	<u>RPS</u> : 80% by 2050	Zero Emissions by 2050 ( <a href="http://louisiana.gov">louisiana.gov</a> )
Minnesota	<u>RPS</u> : 25% by 2025, 55% by 2035 (10% solar by 2030) <u>CES</u> : 80% by 2030, 90% by 2035, 100% by 2040	Zero Emissions by 2040 ( <a href="http://mn.gov">mn.gov</a> )
Michigan	<u>RPS</u> : 50% by 2030, 60% by 2035 <u>CES</u> : 100% by 2040	Zero Emissions by 2050 ( <a href="http://michigan.gov">michigan.gov</a> )
Missouri	<u>RPS</u> : 15% by 2021 (2% from solar) (achieved)	n/a

## 2. Federal Tax Credits

- Investment Tax Credits (ITC) equal to 30% of installation cost are available for solar, offshore wind, battery storage.
- Production Tax Credits (PTC) of \$0.03/kWh are available for land-based wind.
- Solar and wind credits are available to resources placed in service before 2028, while nuclear and battery storage credits are phased out between 2034-2036, in line with recent legislation.<sup>17</sup>
- Section 45Q tax credit of \$85/ton-CO<sub>2</sub> is available to new and retrofitted CCS units online by 2036 (must begin construction by 2033).

## 3. Climate and Equitable Jobs Act

- We model a 2045 zero-emissions deadline for IL as outlined in CEJA. The emissions limit slopes linearly from present-day levels down to zero in 2045.
- CEJA mandates zero emissions deadlines for GHG-emitting units according to their NO<sub>x</sub> and SO<sub>2</sub> emissions and the unit's proximity to an environmental justice (EJ) community or equity investment eligible community (EIEC). CEJA does not explicitly call for the retirement of fossil units. However, plants that don't comply with emissions targets by the deadline (e.g., through CCS) would be forced to retire.<sup>18</sup>
- Our model implements a phased retirement or retrofit of fossil units according to the timeline identified by the IL Dept. of Labor. Cumulative coal and gas retirements are shown in Figure 24 below.<sup>19</sup>

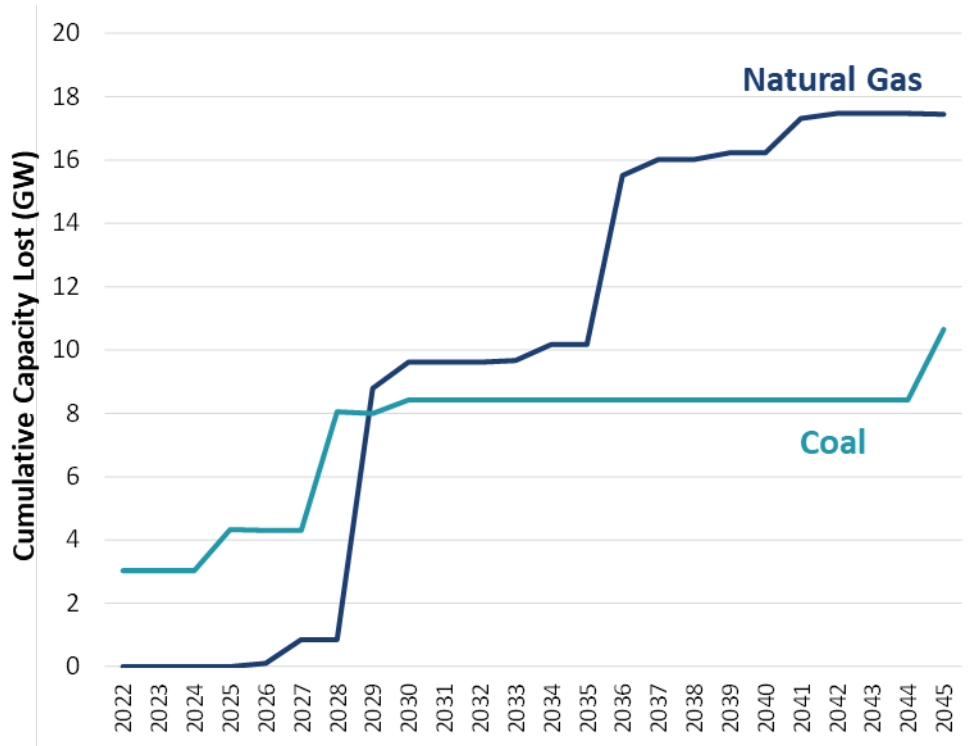
---

<sup>17</sup> Solar and wind projects must begin construction before July 5, 2026, or be placed in service before January 1, 2028, to be eligible to receive tax credits. There is a four-year safe harbor if construction begins before July 5, 2026, and the project is completed by the end of 2030, but additional ownership and FEOC provisions apply. Given these limitations, tax credits for wind and solar in gridSIM are only modeled for resources online by 2028.

<sup>18</sup> See [Clean Energy and Jobs Act \(CEJA\)](#) and [EGU Requirements](#) for further details.

<sup>19</sup> [IL Department of Labor](#).

FIGURE 24: COAL AND GAS RETIREMENTS IN ILLINOIS UNDER CEJA



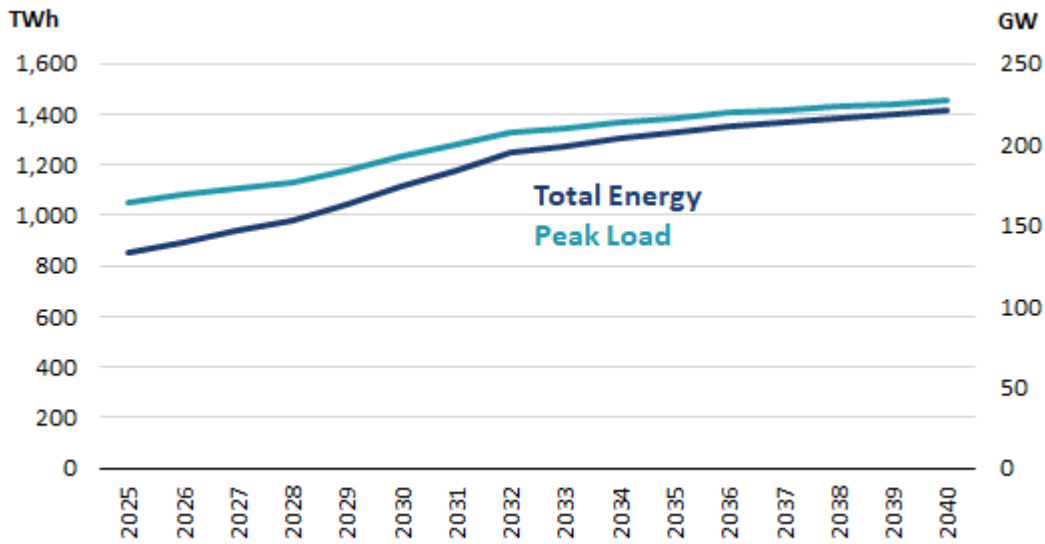
## E. Load Growth Assumptions

### 1. PJM Load Growth

- Forecasted total annual and peak load for PJM is from PJM’s 2025 Load Forecast Report through 2040.<sup>20</sup> Load growth is extrapolated for 2045 and 2050.
- Hourly load shapes are also sourced from the underlying data in PJM’s 2025 Load Forecast Report for all zones

<sup>20</sup> [PJM Long-Term Load Forecast Report](#).

FIGURE 25: PJM LOAD FORECAST



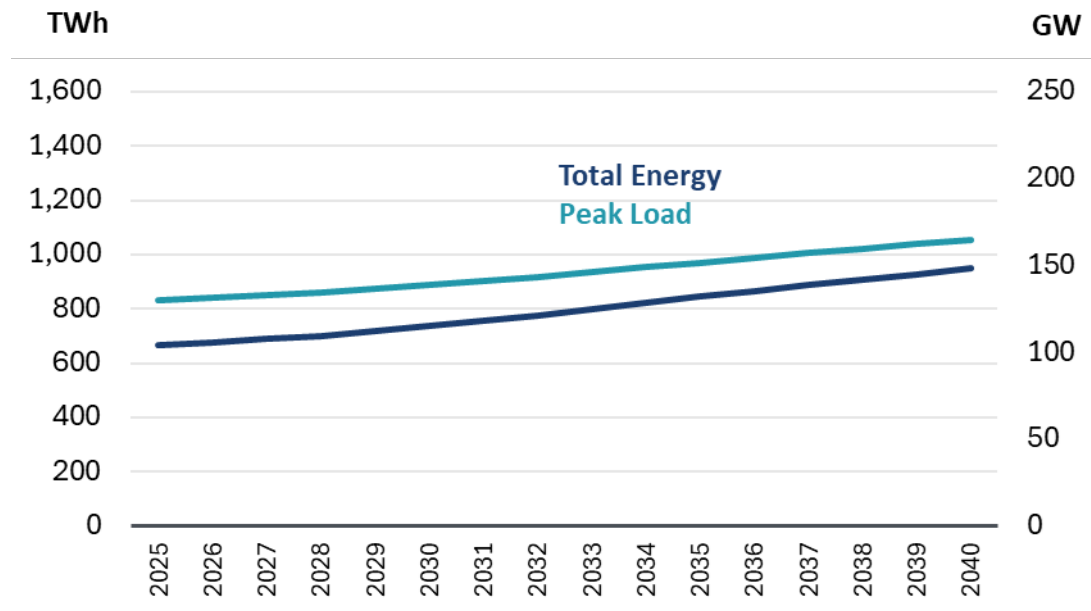
## 2. MISO Load Growth

- Forecasted total annual and peak load for MISO is consistent with the 2024 MISO Long Term Load Forecast’s Current Trajectory.<sup>21</sup>
- Purdue’s 2023 MISO Demand Forecast is used to allocate historical MISO demand to each LRZ.<sup>22</sup>
- Historical hourly load profiles are adjusted to account for electrification based on NREL Cambium.

<sup>21</sup> [MISO Long-Term Load Forecast \(December 2024\)](#).

<sup>22</sup> [2023 MISO Independent Energy and Peak Demand \(Purdue\)](#).

FIGURE 26: MISO LOAD FORECAST



## F. Resource Assumptions

### 1. Existing and Planned Capacity

- Existing 2024 generation capacity by zone is based on data from Hitachi Energy Velocity Suite for both MISO and PJM.
  - Individual units are clustered (based on unit type and heat rate) into representative units for computational efficiency.
  - Installed capacities are subject to seasonal multipliers (summer and winter) to account for variation in resource availability.
- Planned additions and retirements for MISO are based on the 2024 MISO Regional Resource Assessment, which is a MISO-complied source including members’ and states’ publicly announced resource plans.<sup>23</sup> Planned additions and retirements for PJM are based on Hitachi Energy Velocity Suite.
- Additional natural gas and coal phase outs are required in Illinois as part of CEJA.

<sup>23</sup> [2024 MISO Regional Resource Assessment](#).

## 2. Resource Availability

- gridSIM can build endogenously on top of planned capacity additions beginning in model year 2028.
- The primary clean dispatchable resource options in gridSIM are hydrogen CTs (new and retrofit), gas CCs with CCS (new and retrofit), and nuclear SMR.

TABLE 7: FIRST BUILD YEAR FOR MODELED TECHNOLOGIES

Resource Type	First Model Build Year
Biogen	2028
Coal	2028
NG CC	2032
NG CT	2028
NG ST	2028
Nuclear	2032
Nuclear SMR	2032
Solar	2028
Storage (2, 4, 8 Hr)	2028
Onshore Wind	2028
Hydrogen CT	2036
NG CCS	2032

## 3. Resource Costs

- Capital costs are based on the NREL Annual Technology Baseline, with regional multipliers based on EIA data.
- Costs are adjusted to reflect more realistic commodity prices (based on Brattle report for PJM) and interconnection costs (based on LBNL Study).
- Unique modifiers are calculated for natural gas combined cycle units, natural gas combustion turbines, battery storage, solar, and wind.

## 4. Fuel Costs

- Natural gas: Price forecasts are based on S&P Market Intelligence Forwards through 2037, with extrapolation to 2050 based on EIA Annual Energy Outlook. Each zone is mapped to the nearest trading hub, and prices are reported on a monthly basis.
- Oil and coal: Annual price forecasts are taken from EIA AEO.
- Biomass: Annual price forecasts are based on the EIA Monthly Densified Biomass Fuel Report.
- Nuclear: Annual price forecasts are based on NREL Annual Technology Baseline.

## 5. Build Limits for Wind and Solar

- NREL estimates generation potential across the continental U.S. after removal of protected lands, zoning requirements, and setback requirements.<sup>24</sup>
- Nature Conservancy Power of Place Data estimates environmental and social impact of solar and wind development; this provides context to land importance beyond NREL's generation potential.<sup>25</sup>
- NREL provides the generation potential which we overlay on buildable land from The Nature Conservancy to estimate limits, coupled with our own GIS data analysis.
- Based on our land use analysis, we implemented cumulative wind and solar capacity limits.
  - PJM: 820 GW for solar and 120 GW for onshore wind
  - MISO: 1,530 GW for solar and 270 GW for onshore wind
- For PJM, solar and onshore wind annual build limits are 6.1 GW and 4.5 GW, respectively, based on PJM Capacity Expansion results implied build rates.<sup>26</sup>

---

<sup>24</sup> [NREL Solar Supply Curves.](#)

<sup>25</sup> [The Nature Conservancy, Power of Place.](#)

<sup>26</sup> [PJM Capacity Expansion.](#)

- For MISO, renewable build rates in gridSIM were determined to be consistent with MISO Futures Series 2 assumptions.<sup>27</sup>

## 6. Nuclear

- Nuclear generation is modeled using a monthly average capacity factor for each ISO. This average capacity factor is based on 10 years of historical data (2015-2024).
- All licenses for nuclear units in PJM and MISO are assumed to be extended for an additional 20 years past the license expiration (consistent with the MISO Futures)
- In the Reference scenario, Quad Cities is assumed to operate to its extended retirement year of 2050. In the Retirement scenario, Quad Cities is assumed to retire at the end of 2032 (so it is retired in the model at the beginning of model year 2036).

## 7. Demand Response (DR) and Behind the Meter (BTM) Solar

- For MISO, existing DR and BTM solar capacity is based on the 2024 Organization of MISO States (OMS) DER Survey Results and anticipated capacity is based on the 2023 MISO Futures Report.<sup>28</sup>
  - 5.8 GW of DR and 5.7 GW of BTM solar in 2024, 14 GW of DR and 23 GW of BTM solar by 2042.
  - \$1,000/MWh cost associated with utilizing emergency DR.
- For PJM, demand response resources are modeled by zone based on the amount of cleared demand response capacity in the 2026-2027 Base Residual Auction.<sup>29</sup>
  - \$1,000/MWh cost associated with utilizing emergency DR.

## 8. Carbon Capture and Storage (CCS)

- Model can choose to retrofit existing NG CC units or build new NG CCs with CCS beginning in 2032.

---

<sup>27</sup> [MISO Futures Series 2.](#)

<sup>28</sup> [2024 Organization of MISO States \(OMS\) DER Survey Results; 2023 MISO Futures Report.](#)

<sup>29</sup> [PJM 2026/2027 Base Residual Auction Report.](#)

- Increased costs and reduced efficiency due to parasitic load.
- 45Q Credit of \$85/ton applied based on credit for geologically sequestered CO<sub>2</sub>, meeting certain wage requirements.
  - Only CCS resources constructed prior to 2033 are eligible (implemented as online by 2036).
  - Tax credits can be received through 12-year claim period.

**TABLE 8: PARAMETERS FOR GAS WITH CCS**

Parameter	Assumption	Source
First Allowed Build Year	2032	<a href="#">NREL</a> , <a href="#">DOE</a>
Carbon Capture Rate	90%	<a href="#">EPA</a>
Capital Cost (2032\$/kW)	New NG CC w/ CCS: \$3,186 NG CC Retrofit: \$1,581	<a href="#">NREL ATB 2024</a>
FOM (2032\$/kW-yr)	New NG CC w/ CCS: \$70.73 NG CC Retrofit: \$81.93	<a href="#">NREL ATB 2024</a>
Fuel Cost	Same as NG CC	
Transport and Sequestration Cost	\$9/ton-CO <sub>2</sub> for storage (all regions) \$20/ton-CO <sub>2</sub> for transport (MISO) \$38/ton-CO <sub>2</sub> for transport (PJM)	Cost estimates from <a href="#">Congressional Budget Office</a> ; Difference in transport costs informed by distance to EOR and DSS storage sites from <a href="#">CATE</a>
Tax Credits	\$85/ton-CO <sub>2</sub> from 45Q Credit	<a href="#">45Q Tax Credit</a>
Parasitic Losses	30% losses from parasitic load	<a href="#">Advanced Post-Combustion CO<sub>2</sub> Capture (mit.edu)</a> ; <a href="#">Global CCS Institute</a>

## 9. Hydrogen

- Model can build new hydrogen turbines or retrofit existing NG CTs beginning in 2036.
- No PTC for hydrogen production is assumed.

**TABLE 9: PARAMETERS FOR HYDROGEN GAS TURBINE**

Parameter	Assumption	Source
First Allowed Build Year	2036	<a href="#">MISO Futures report</a> adds “Flex” resources in 2027; <a href="#">IL production cost modeling</a> introduces zero emissions fuels in 2045
Operating Parameters	Operations are the same as NG CT	
Capital Cost	New build: 125% of NG CT capital cost Retrofit: 25% of NG CT capital cost	<a href="#">ETN Global</a>
FOM	50% greater than NG CT	<a href="#">ETN Global</a>
VOM	Same as NG CT	<a href="#">NREL ATB 2024</a>
Fuel Cost (2024\$)	Production and delivery cost: \$64/MMBtu in 2036 and trending down to \$58/MMBtu in 2050	Production cost of hydrogen produced through polymer electrolyte membrane (PEM)

## G. Future Resource Mix

### 1. PJM Resource Mix

The buildout of wind and solar resources as a whole (at the portfolio level) in PJM is aligned with the National Renewable Energy Laboratory's (NREL's) Cambium 2023 dataset. In 2040, total wind and solar capacity in gridSIM is 224 GW compared to 217 GW reported by NREL. Penetration by resource type (wind vs. solar) differs due to differences in modeled capacity accreditation (gridSIM explicitly models how intermittent and correlated renewables affect system capacity, whereas Cambium makes simplifying assumptions). gridSIM's remaining gas capacity of 101 GW plus 34 GW CCS in 2045 is consistent with NREL Cambium's high electrification scenario, which shows 125 GW.<sup>30</sup>

### 2. MISO Resource Mix

Resource buildout is aligned with the MISO Futures Series 2 Preliminary Results. Total wind and solar capacity account for 52% of MISO's capacity mix in gridSIM by 2045, compared to 50% to 61% across the Series 2 Futures. Remaining fossil capacity of 113 GW in 2045 is consistent with Future 2, MISO's moderate load growth scenario. gridSIM adds around 50 GW of battery storage by 2050, higher than the 12 to 15 GW built across MISO Futures. Greater battery penetration in gridSIM can be attributed to the Future report's treatment of energy efficiency as a supply-side resource, which mitigates system need for flexibility. Further, transmission capability between MISO as well with external regions such as PJM encourages the buildout of batteries in order to take advantage of regional diversity.<sup>31</sup>

## H. Retail Electricity Price Calculations

- Energy prices (\$/MWh):

---

<sup>30</sup> For more information, see [NREL Cambium's High Electrification Scenario](#).

<sup>31</sup> For more information, see [MISO Futures Series 2](#).

- Energy prices are calculated as the marginal cost of energy in each hour. The annual energy price is the load-weighted average price.
- Capacity prices (\$/MW-yr):
  - Capacity costs are calculated based on Net Cost of New Entry (CONE). Net CONE is the sum of fixed O&M and capital costs minus revenues obtained through the energy, ancillary services, and ZEC markets.
  - Net CONE is divided by each resource's accredited capacity to obtain a \$/MW-yr cost. The capacity price is set by the most expensive resource in each zone.
- Wholesale electricity prices (\$/MWh):
  - Energy and capacity prices are converted to \$/MWh and summed to calculate an all-in wholesale electricity price.
- All-in retail electricity price impact (%):
  - The retail price impact is calculated as one-third of the wholesale electricity price impact, based on the assumption that T&D costs remain fixed.

## Appendix 2: Economic Modeling

### A. REMI Overview

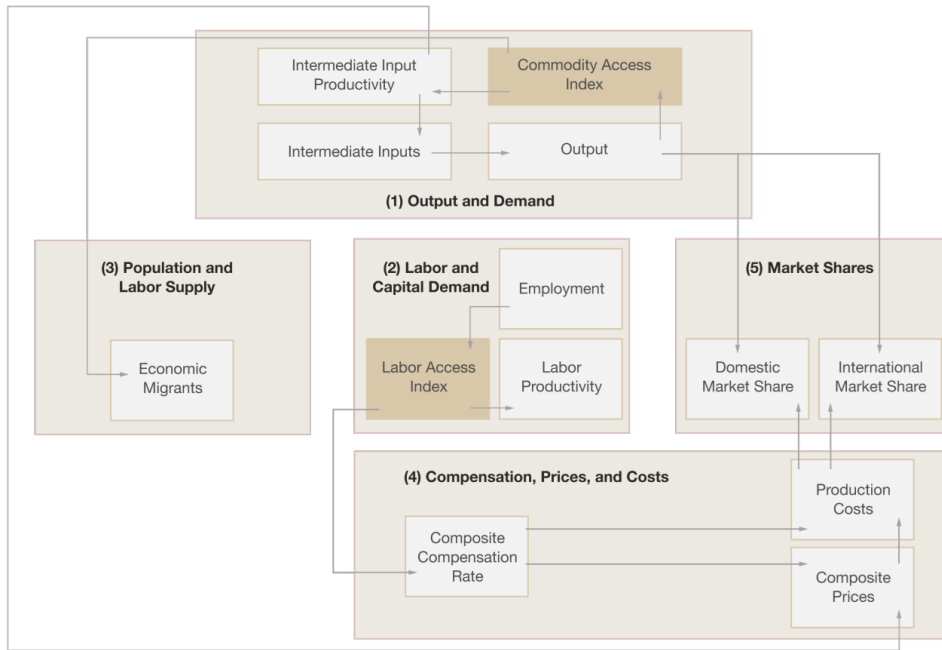
We used the REMI E3+ model with 160 sectors and 14 regions for our analysis. REMI has developed several macroeconomic models that are widely used in both public and private sectors. The summary below was provided by REMI. See [www.remi.com](http://www.remi.com) for further information.

E3+ is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to compensation, price, and other economic factors. E3+ includes additional functionality beyond REMI PI+ to evaluate detailed scenarios pertaining to energy and environmental policy analysis.



FIGURE 28: REMI GEOGRAPHY LINKAGES

Economic Geography Linkages



The Output and Demand block consists of output, demand, consumption, investment, government spending, exports, and imports, as well as feedback from output change due to the change in the productivity of intermediate inputs. The Labor and Capital Demand block includes labor intensity and productivity as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Supply block. The Compensation, Prices, and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the compensation equations. The proportion of local, inter-regional, and export markets captured by each region is included in the Market Shares block.

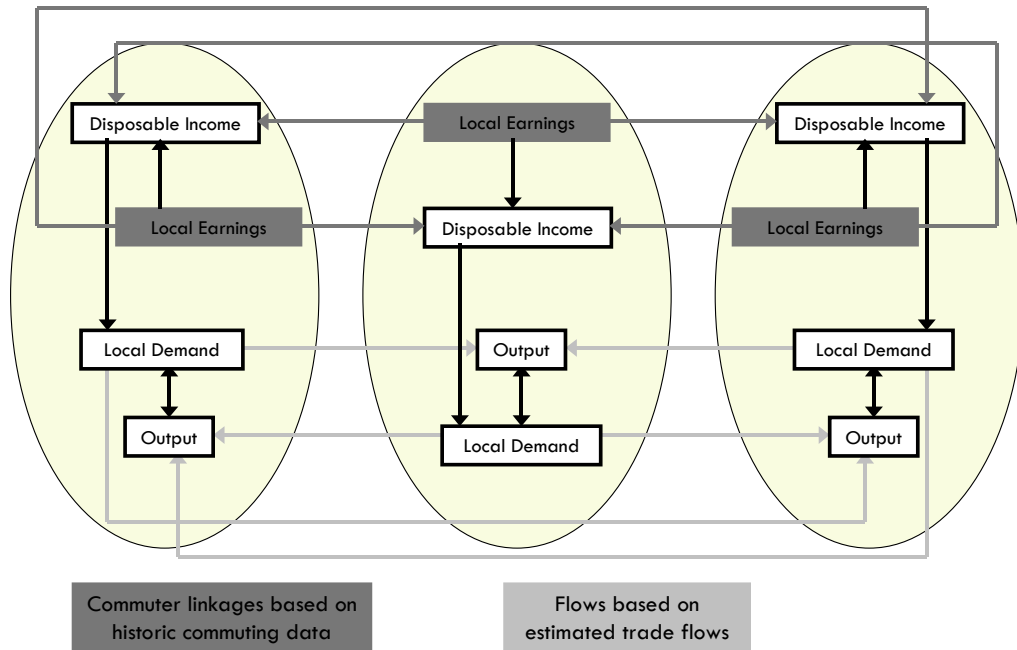
Models can be built as single region, multi-region, or multi-region national models. A region is defined broadly as a sub-national area, and could consist of a state, province, county, or city, or any combination of sub-national areas.

Single-region models consist of an individual region, called the home region. The rest of the nation is also represented in the model. However, since the home region is only a small part of the total nation, the changes in the region do not have an endogenous effect on the variables in the rest of the nation.

Multi-regional models have interactions among regions, such as trade and commuting flows. These interactions include trade flows from each region to each of the other regions. These flows are illustrated for a three-region model in the below figure.

FIGURE 29: TRADE AND COMMUTER FLOW LINKAGES

## Trade and Commuter Flow Linkages



Multiregional national models also include a central bank monetary response that constrains labor markets. Models that only encompass a relatively small portion of a nation are not endogenously constrained by changes in exchange rates or monetary responses.

### Block 1. Output and Demand

This block includes output, demand, consumption, investment, government spending, import, commodity access, and export concepts. Output for each industry in the home region is determined by industry demand in all regions in the nation, the home region's share of each market, and international exports from the region.

For each industry, demand is determined by the amount of output, consumption, investment, and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities, and population. Input productivity depends on access to inputs because a larger choice set of inputs means it is more likely that the input with the specific characteristics required for the job will be found. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital

stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

## **Block 2. Labor and Capital Demand**

The Labor and Capital Demand block includes the determination of labor productivity, labor intensity, and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

## **Block 3. Population and Labor Supply**

The Population and Labor Supply block includes detailed demographic information about the region. Population data is given for age, gender, and race, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after-tax compensation rate. Migration includes retirement, military, international, and economic migration. Economic migration is determined by the relative real after-tax compensation rate, relative employment opportunity, and consumer access to variety.

## **Block 4. Compensation, Prices and Costs**

This block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the compensation equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods, and services.

These prices measure the price of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs of distance are significant. Composite prices for each industry are then calculated based on the production

costs of supplying regions, the effective distance to these regions, and the index of access to the variety of outputs in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by the cost of labor, capital, fuel, and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non-residential structures and equipment, while fuel costs incorporate electricity, natural gas, and residual fuels.

The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing prices change from their initial level depending on changes in income and population density.

Compensation changes are due to changes in labor demand and supply conditions and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

#### **Block 5. Market Shares**

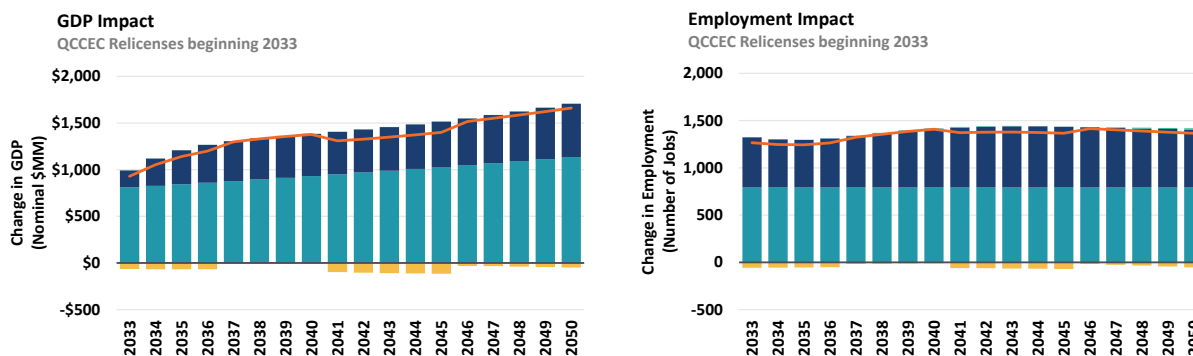
The market shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and the effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

## B. County-Level Economic Impacts

We evaluated GDP and employment impacts in eight regions, including Rock Island County (where QCCEC is located), the three adjacent Illinois counties (Whiteside, Henry, and Mercer counties), the three adjacent Iowa counties (Muscatine, Scott, and Clinton counties), and the rest of Illinois (treated as one region).

Variation in economic impacts between counties are due to differences in regional demographics, geographic proximity to the QCCEC, and economic profiles. If QCCEC is relicensed, Rock Island County would experience significant GDP and employment benefits, driven largely by direct plant spending.

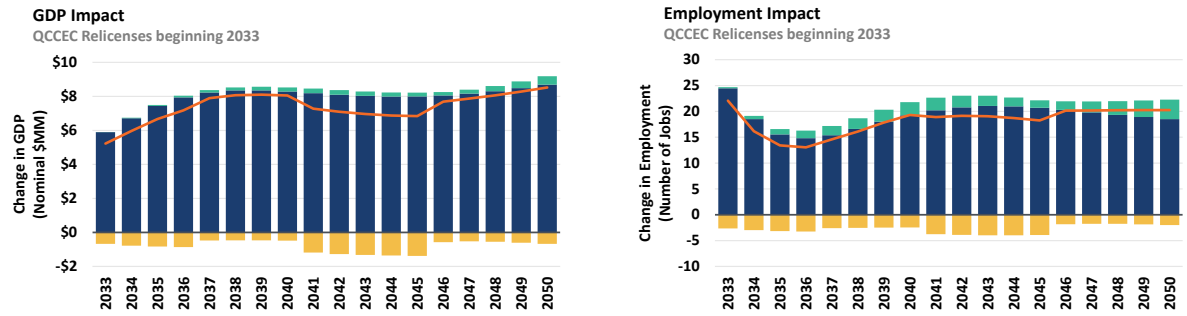
FIGURE 30: ECONOMIC IMPACTS IN ROCK ISLAND COUNTY



- Impact due to Electricity Price Change
- Indirect Impact due to Change in Direct Spending at Plant
- Change in Direct Spending at Plant
- Impact due to Replacement Generation Investment
- Total Net Impact

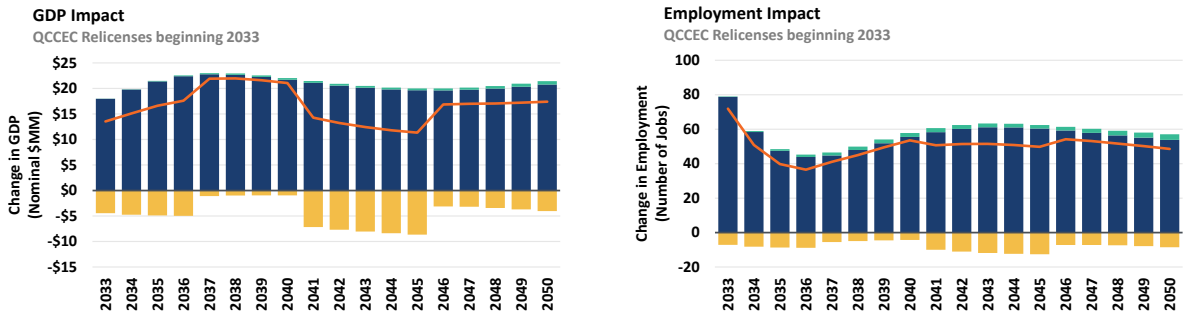
Whiteside, Henry, and Mercer counties surround Rock Island on the Illinois side. In all three counties, indirect GDP and employment impacts, driven by spillover effects of plant spending and lower electricity prices, would be overwhelmingly positive. This suggests that the vast majority of replacement generating capacity, developed and utilized in the absence of relicensing, would not benefit these regions.

FIGURE 31: ECONOMIC IMPACTS IN WHITESIDE COUNTY, IL



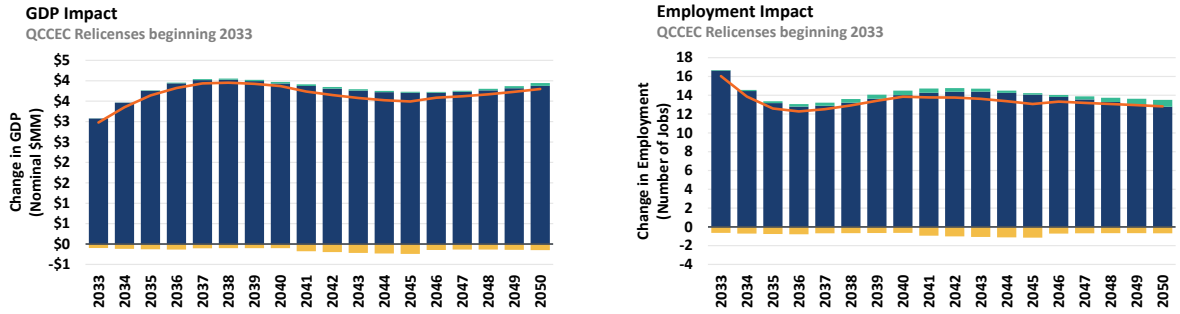
Impact due to Electricity Price Change  
 Indirect Impact due to Change in Direct Spending at Plant  
 Change in Direct Spending at Plant  
 Impact due to Replacement Generation Investment  
 —Total Net Impact

FIGURE 32: ECONOMIC IMPACTS IN HENRY COUNTY, IL



Impact due to Electricity Price Change  
 Indirect Impact due to Change in Direct Spending at Plant  
 Change in Direct Spending at Plant  
 Impact due to Replacement Generation Investment  
 —Total Net Impact

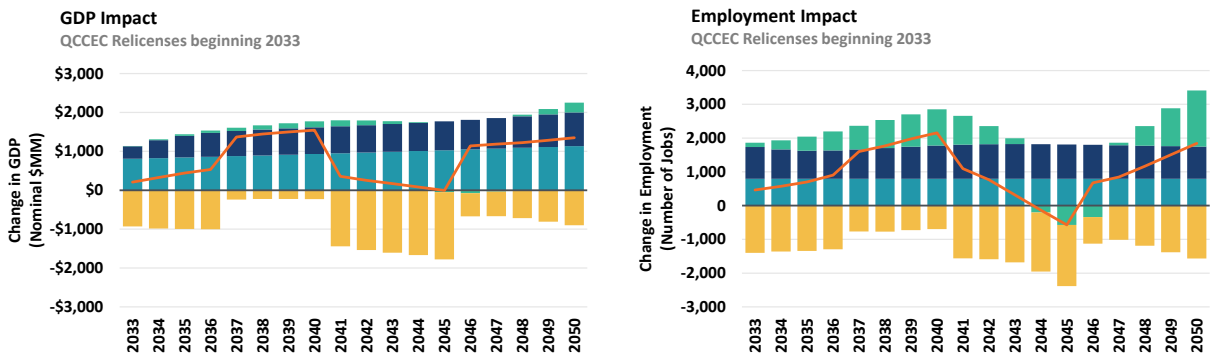
FIGURE 33: ECONOMIC IMPACTS IN MERCER COUNTY, IL



Impact due to Electricity Price Change  
 Indirect Impact due to Change in Direct Spending at Plant  
 Change in Direct Spending at Plant  
 Impact due to Replacement Generation Investment  
 —Total Net Impact

While the rest of Illinois would lose the most from the foregone development of replacement generating capacity, net GDP and employment impacts in the region would remain generally positive throughout the time period post-relicensing. This indicates that the alternative – retiring QCCEC and investing in replacement resource development – would not be a net positive addition to the state.

FIGURE 34: ECONOMIC IMPACTS IN ILLINOIS



Impact due to Electricity Price Change  
 Indirect Impact due to Change in Direct Spending at Plant  
 Change in Direct Spending at Plant  
 Impact due to Replacement Generation Investment  
 —Total Net Impact

On the Iowa side, Rock Island is surrounded by Muscatine, Scott, and Clinton Counties. Scott County, where a significant proportion of QCCEC employees reside, would experience significant positive indirect GDP and employment impacts in the event of relicensing. In the

alternative, it would experience heavy economic losses as it would accrue negligible benefits from replacement resource cultivation. This outcome holds true for Clinton County as well.

FIGURE 35: ECONOMIC IMPACTS IN SCOTT COUNTY, IA

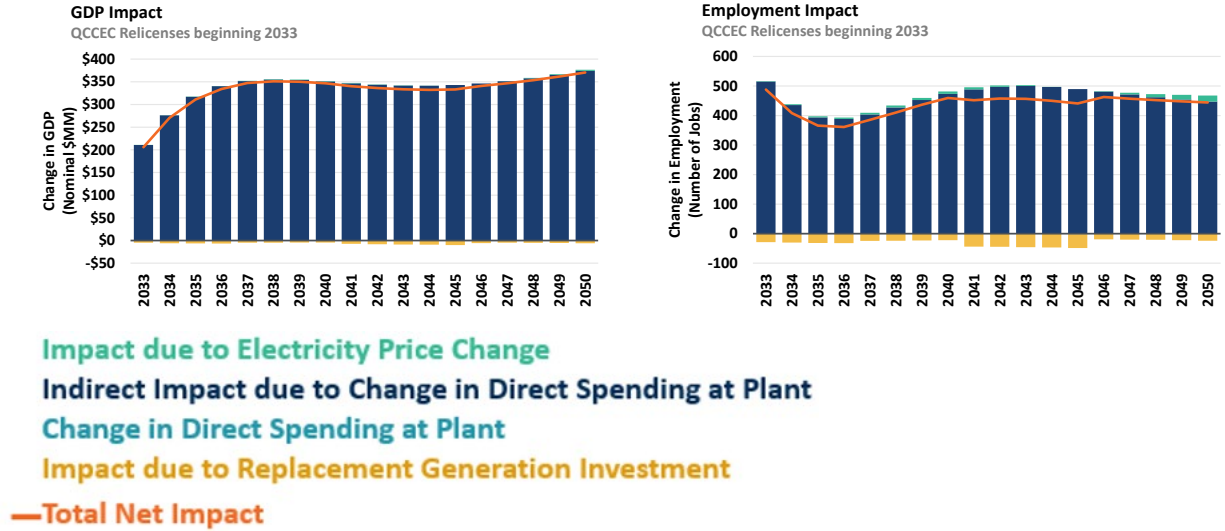
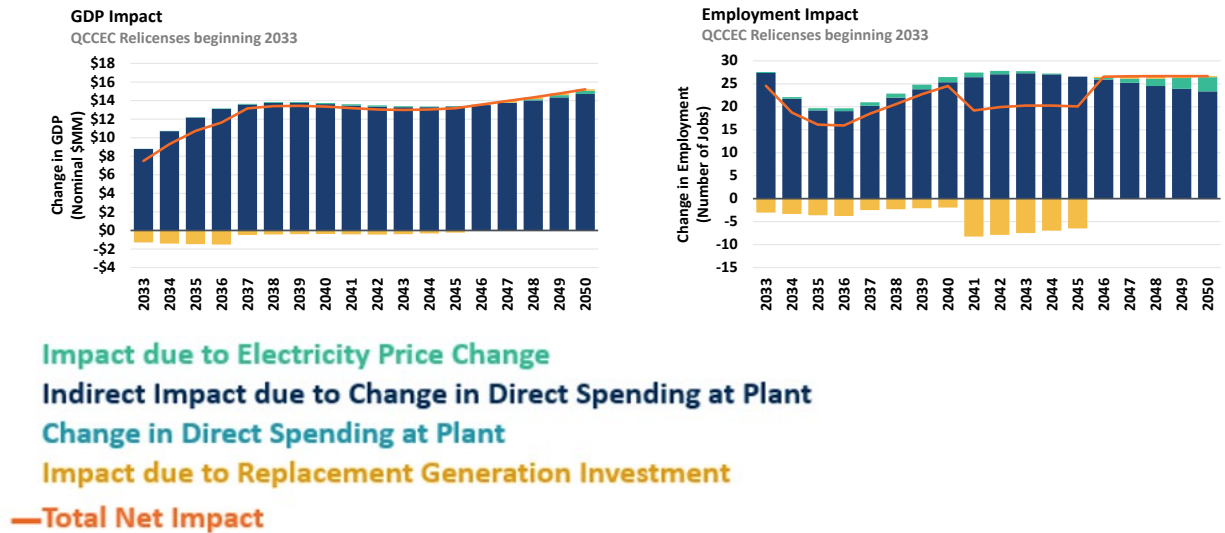


FIGURE 36: ECONOMIC IMPACTS IN CLINTON COUNTY, IA



Muscatine County would experience consistent GDP additions from relicensing, driven by indirect plant expenditure in earlier years, and aided by lower electricity prices and additional resource buildout in later years. Employment impacts in Muscatine would be moderated in earlier years by foregone replacement generation capacity, which would have been developed if QCCEC was retired. However, in the long term, employment impacts would resume a positive trajectory.

FIGURE 37: ECONOMIC IMPACTS IN MUSCATINE COUNTY, IA

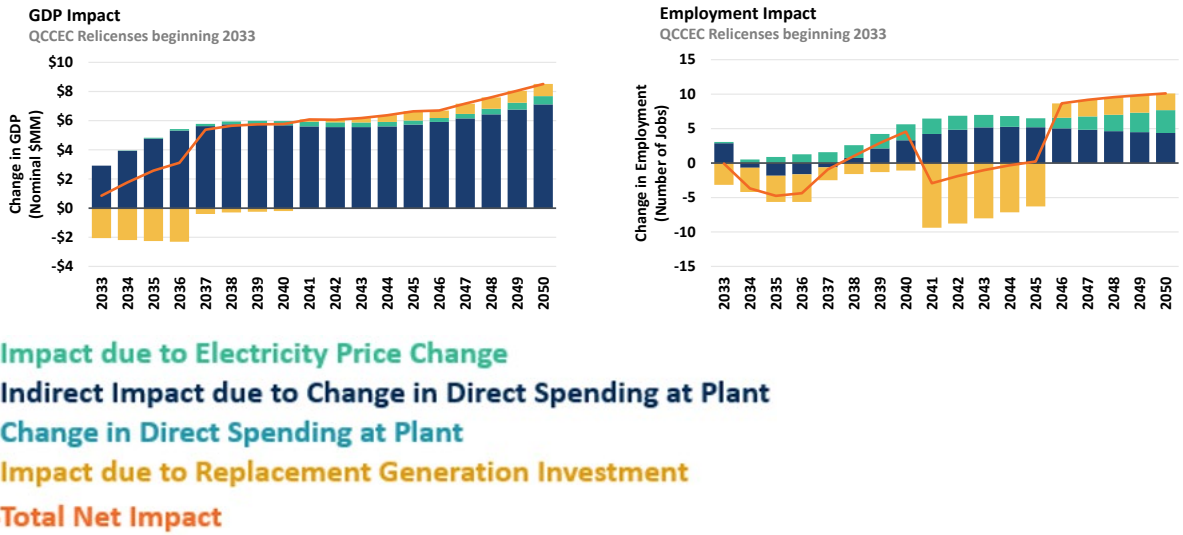


Figure 38 through Figure 40 below show the GDP and employment impacts by various sub-region combinations as well, all indicating that relicensing QCCEC would be a net benefit for the region.

FIGURE 38: ECONOMIC IMPACTS IN IOWA COUNTIES (MUSCATINE, SCOTT, AND CLINTON COUNTIES)

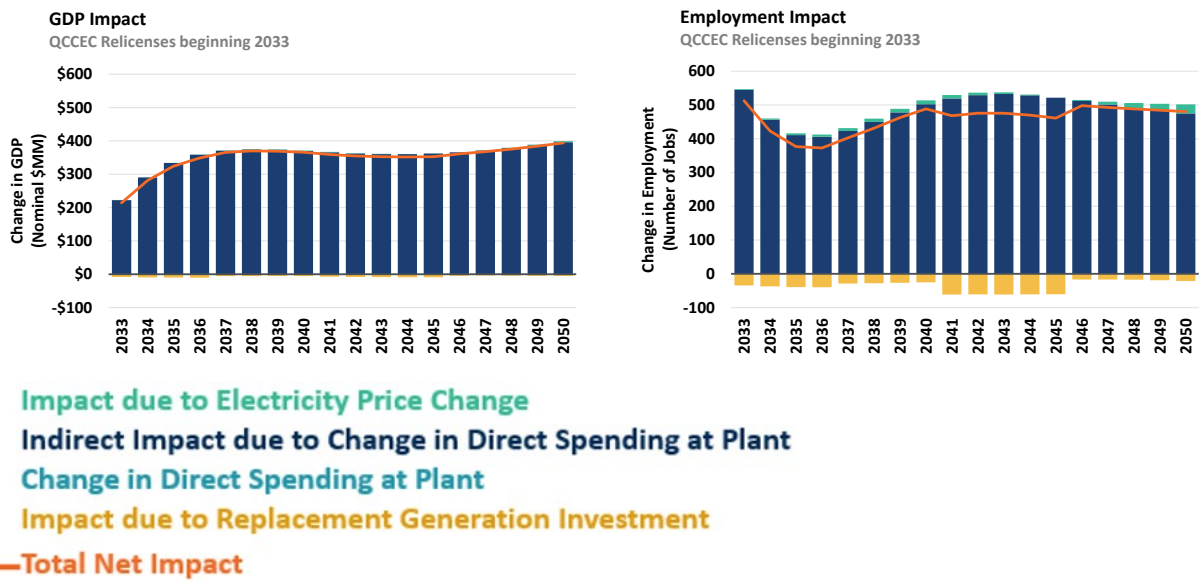


FIGURE 39: ECONOMIC IMPACTS IN ILLINOIS

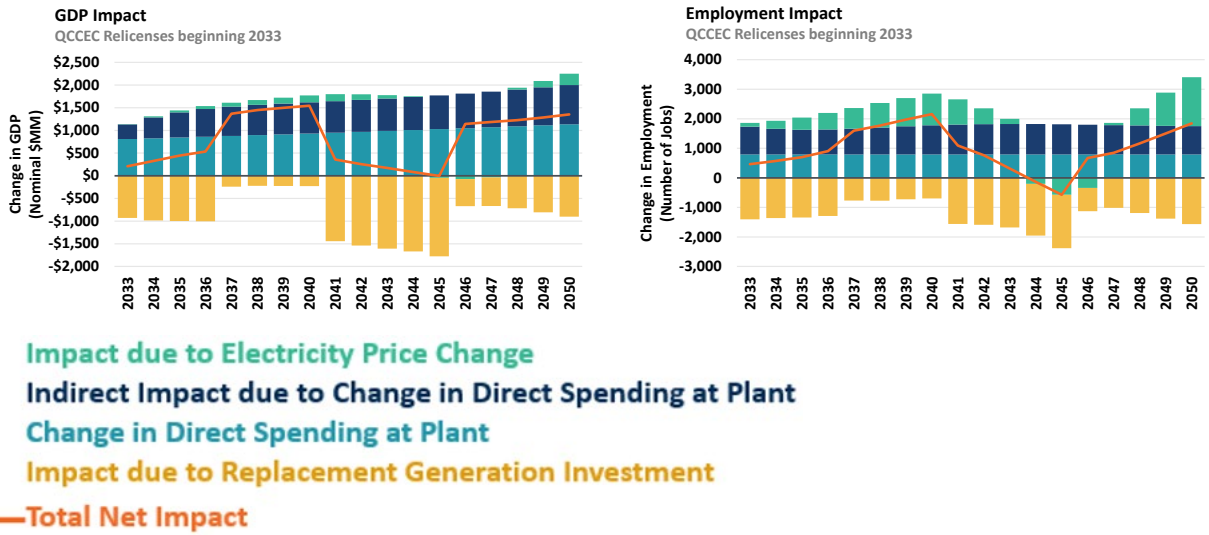


FIGURE 40: ECONOMIC IMPACTS IN COUNTIES SURROUNDING QCCEC (ROCK ISLAND, WHITESIDE, HENRY, AND MERCER, COUNTIES, ILLINOIS; MUSCATINE, SCOTT, AND CLINTON COUNTIES, IOWA)

