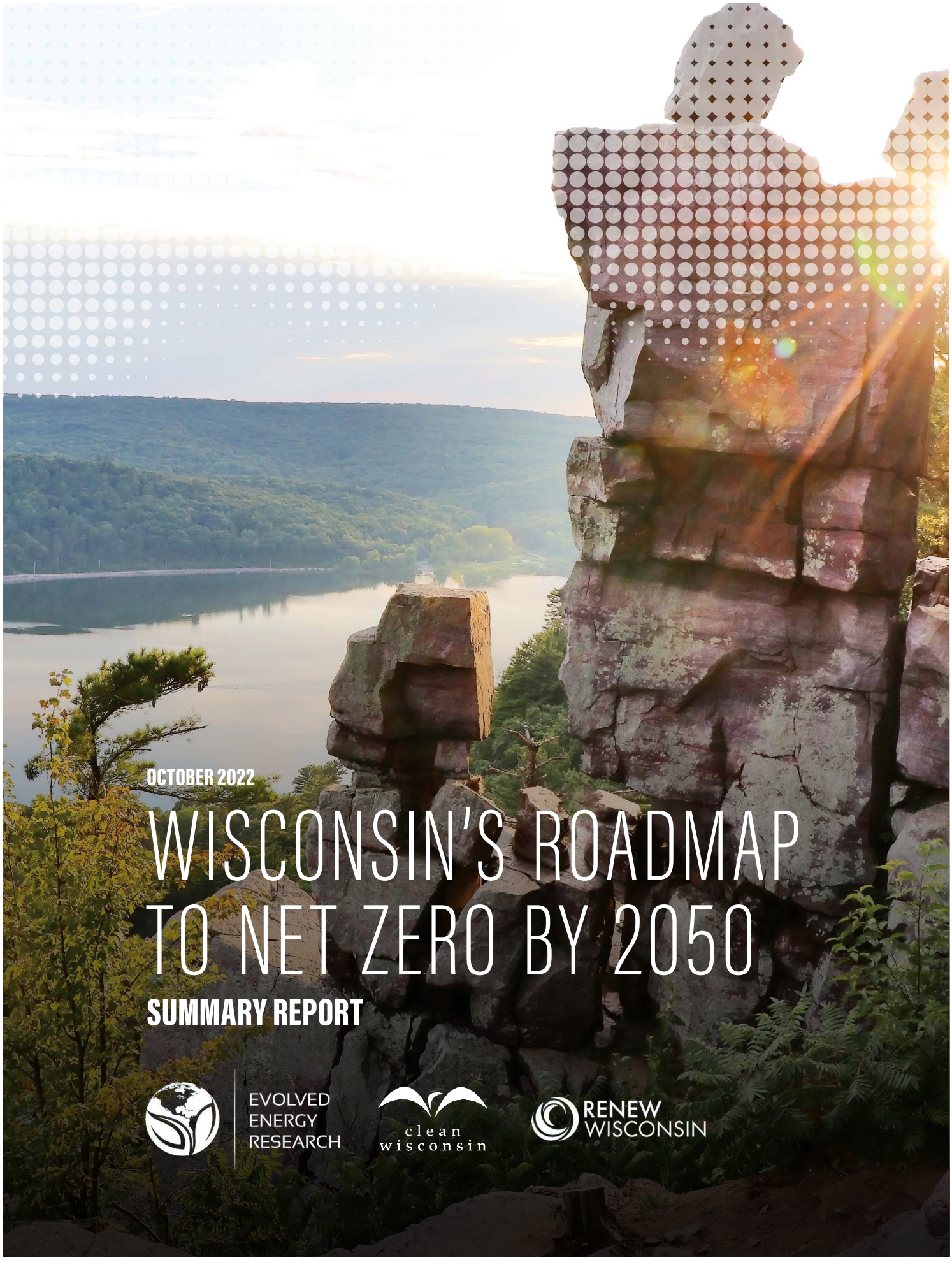


OCTOBER 2022

WISCONSIN'S ROADMAP TO NET ZERO BY 2050

SUMMARY REPORT

EVOLVED ENERGY RESEARCH

clean wisconsin

RENEW WISCONSIN

KEY FINDINGS

- Detailed energy and economic modeling shows Wisconsin can cost-effectively transition to net zero emissions by 2050. This means that within the next three decades, Wisconsin can reach a point where no more carbon is emitted into the atmosphere than can be removed. The cost of achieving net zero emissions is comparable to the cost of reaching a 100% clean electricity standard by 2050 but delivers far more economic and health benefits.
- Transitioning to net zero emissions creates 68,000 additional Wisconsin jobs across various sectors of the economy, including manufacturing, operations, maintenance, and construction.
- Investment in new wind, solar, and battery storage needed for net zero will boost Gross State Product by approximately 3% by 2050, adding around $16 billion to Wisconsin's economy.
- Net zero emissions result in significant health benefits and lower overall healthcare costs in Wisconsin.
- Achieving net zero carbon emissions will require a robust expansion of new interstate transmission.
- The electrification of buildings and transportation is critical to ensuring Wisconsin meets long-term decarbonization goals.
- Advanced technologies help Wisconsin achieve carbon reduction goals.

INTRODUCTION

With strong supporting policy, Wisconsin can cost-effectively achieve net zero emissions by 2050, bringing sweeping economic and health benefits to the state. Reaching this goal means not only pursuing 100% clean electricity generation but also comprehensive, economy-wide decarbonization through the electrification of building appliances, transportation, and industrial processes.

The **Achieving 100% Clean Energy in Wisconsin Report**, produced by **Evolved Energy Research**, **GridLab**, **RENEW Wisconsin**, and **Clean Wisconsin**, analyzes various pathways for the state to rapidly draw down carbon emissions over the next three decades. The study uses advanced power systems modeling and the latest clean energy technology and cost data to demonstrate viable pathways for Wisconsin to achieve significant carbon reductions. While modeling focuses on the impact of electricity sector investments, it does so in the context of key drivers of energy supply and demand throughout all sectors of the economy. The report finds that transitioning to 100% clean electricity while eliminating carbon emissions from the building, transportation, and industrial sectors, is the most cost-effective method to reduce emissions in Wisconsin.

A companion study, **The Economic Impacts of Decarbonization in Wisconsin**, by Cambridge Econometrics, analyzes the economic and employment impacts of this economy-wide transition to clean energy in Wisconsin. The report finds that transitioning to a net zero economy will reap dramatic benefits for Wisconsin, creating 68,000 additional jobs and boosting Gross State Product by 3% in 2050.

These studies were conducted before the signing of the Inflation Reduction Act (IRA), new federal legislation that includes over $300 billion worth of clean energy tax credits, manufacturing incentives, and other appropriations that will accelerate the clean energy transition. While not captured in the **Achieving 100% Clean Energy in Wisconsin Report**, the investments and incentives in the IRA would have the effect of bolstering the energy investments detailed in its modeling analysis and further driving down costs for consumers.

METHODS AND SCENARIOS

To evaluate pathways to decarbonization in Wisconsin, researchers compared several scenarios:

1. **Baseline:** No electricity or emissions policy
2. **100% Clean Electricity:** 100% clean electricity with no economy-wide emissions targets
3. **Net Zero Economy-Wide:** 100% clean electricity AND economy-wide net zero emissions by 2050
4. **No Transmission (Tx) Expansion:** Net zero by 2050 with no interstate transmission expansion
5. **Accelerated Clean Electricity:** Net zero by 2050, 100% clean electricity by 2040
6. **Delayed Action:** Net zero by 2050 with the transition to highly efficient electric end-uses delayed by 10-15 years
7. **Limited Coal and Gas:** Net zero by 2050 with no new gas plants and accelerated retirement of coal

Net Zero Economy-Wide was shown to provide the most economic, health, and emissions benefits, and key findings of this summary are focused on this scenario. Achieving a net zero economy means that the amount of greenhouse gas produced is not greater than the amount taken away. A net zero economy substantially reduces carbon emissions through the advancement of clean electricity and electrification of our buildings and transportation system. Any remaining carbon emissions are captured and permanently sequestered.

The energy modeling for this report was conducted by Evolved Energy Research, a leading expert in evaluating the costs and implications of decarbonization policy. Detailed information on modeling assumptions, methodology, scenario design, and data is covered in an accompanying technical document, **Achieving 100% Clean Energy in Wisconsin Report**.

KEY FINDINGS

Detailed energy and economic modeling shows Wisconsin can cost-effectively transition to net zero emissions by 2050. This means that within the next three decades, Wisconsin can reach a point where no more carbon is emitted into the atmosphere than can be removed. The investment needed to achieve net zero emissions is comparable to the cost of reaching a 100% clean electricity standard by 2050 but delivers far more economic and health benefits.

Achieving **net zero** emissions will mean changes to virtually every sector of Wisconsin's economy, from utility-scale electricity production to transportation and manufacturing. Modeling shows that this transition is possible and cost-effective. Ultimately, Wisconsin can achieve net zero emissions at similar energy costs to taking no policy action or implementing clean electricity policy alone.

For Wisconsin to achieve **net zero** by 2050, the state must reach 100% clean electricity through the construction of wind and solar, and significantly curtail fossil fuel use in other sectors like transportation, manufacturing, and building heating and cooling. The rapid adoption of efficient, zero-carbon technologies such as electric heat pumps to heat and cool buildings, and electric vehicles, are detailed in the **Net Zero Economy-Wide** scenario. Electrification of the entire Wisconsin economy greatly increases electricity demand, such that the total Wisconsin electric load in 2050 is 166% higher than the 2022 levels.

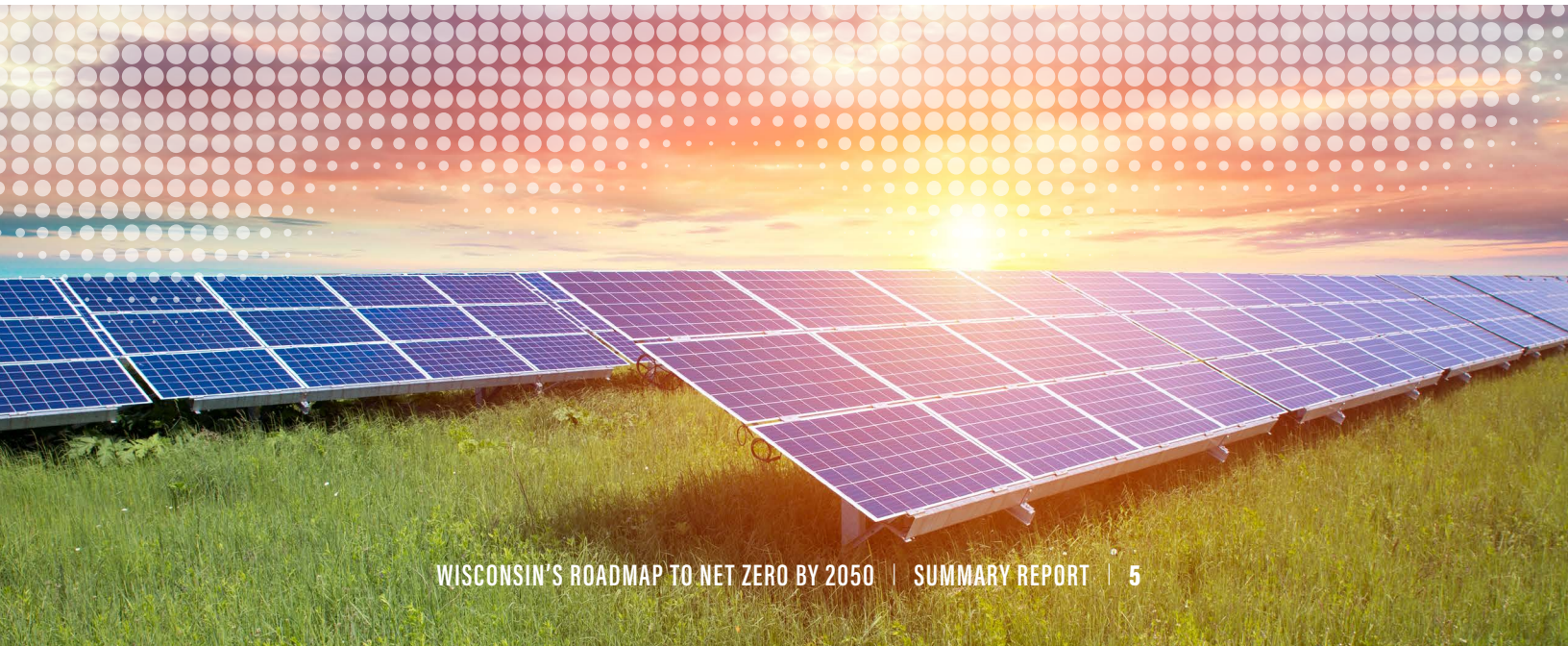
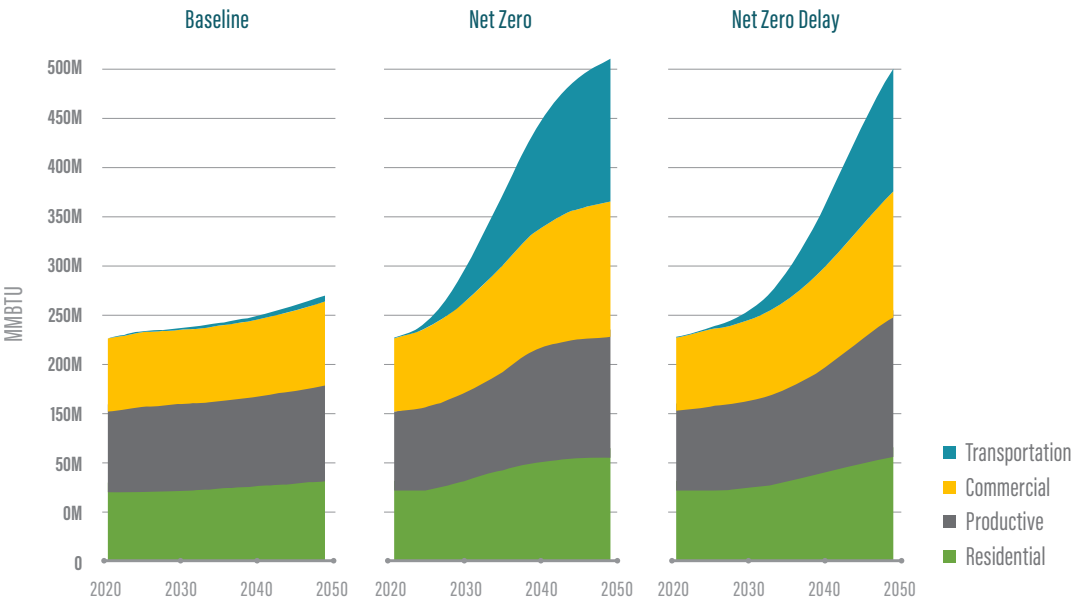


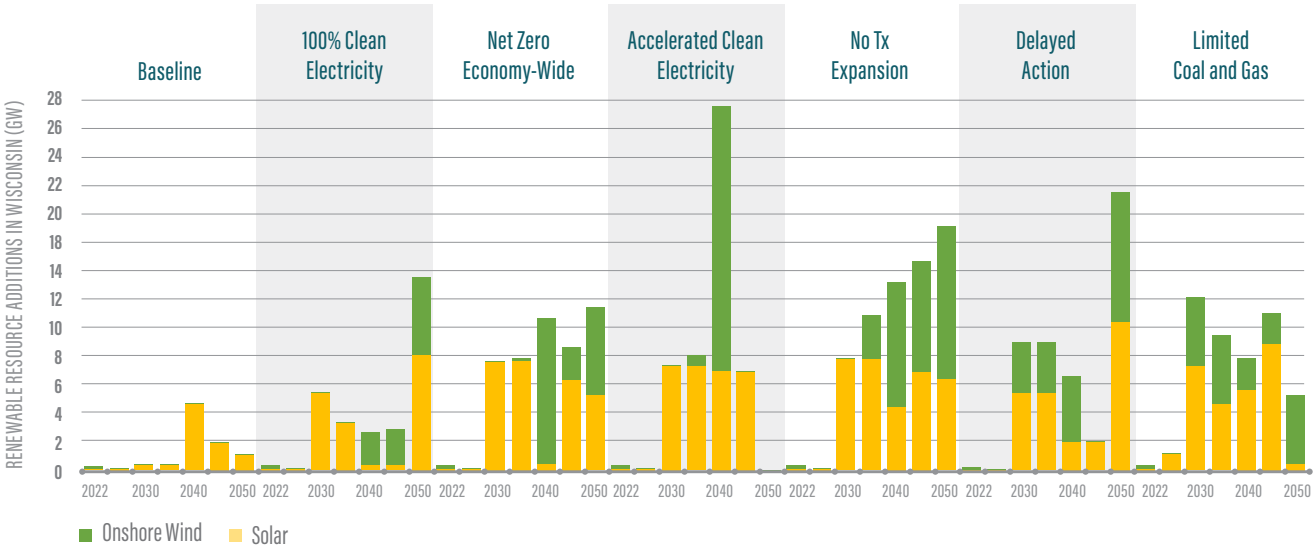
FIGURE 1.

Electricity demand by sector (excluding electrolysis and dual-fuel boilers)



To meet rising electricity demand from new electric end-uses, Wisconsin deploys 8.5 gigawatts (GW) of new solar and 3.5 GW of new gas by 2030. In the next five years, between 2030 and 2035, Wisconsin adds an additional 8.6 GW of solar and wind, followed by 11.6 GW in 2040, 9.4 GW in 2045, and 12.5 GW in 2050. By 2050, the regular end-use load is 125% larger than it was in 2022, with total in-state energy capacity quadrupling from 2022 levels. By 2050, the total installed capacity amounts to 31 GWs of solar, 21 GWs of wind, 7 GWs of battery storage, and 7 GWs of gas. By 2050, gas serves as a reliability resource operating at just a 5% capacity factor and burning entirely carbon-neutral fuels.

FIGURE 2.
Wind and solar additions in Wisconsin



Carbon emissions fall far faster in **Net Zero Economy-Wide** than in the **100% Clean Electricity** scenario as end-uses electrify and renewable resources expand to displace coal and gas generation. In 2018, 34% of Wisconsin's total emissions came from coal generation, suggesting that a clean electricity policy can have an outsized impact on Wisconsin's emissions goals. Notably, the most cost-effective pathway to reducing Wisconsin's total greenhouse gas emissions is to pursue clean electricity generation while also rapidly electrifying other sectors of the economy. Implementing a 100% clean electricity policy alone achieves only 24% of the emissions reductions of a net zero emissions policy relative to the **Baseline** by 2050 at nearly the same cost. With **100% Clean Electricity**, economy-wide greenhouse gas emissions fall 38% by 2050 relative to 2022 levels.

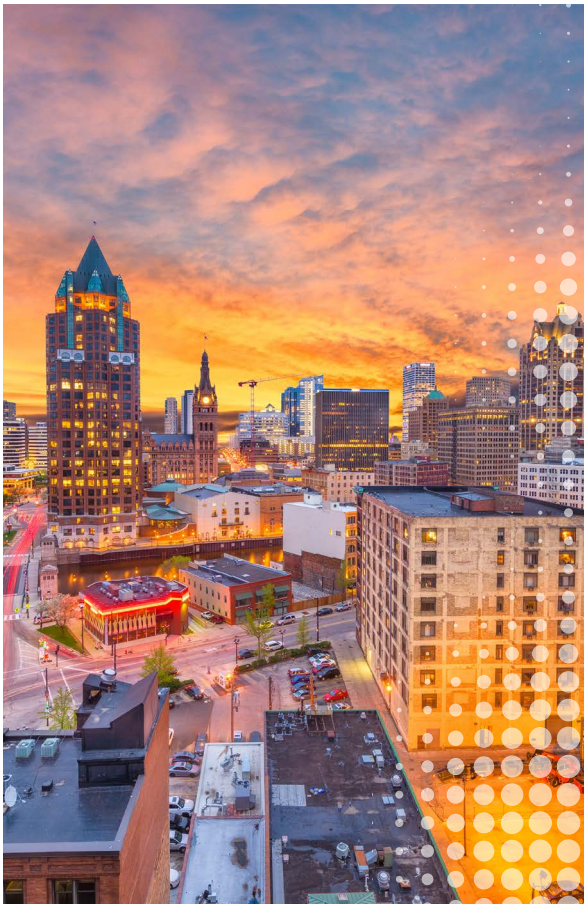
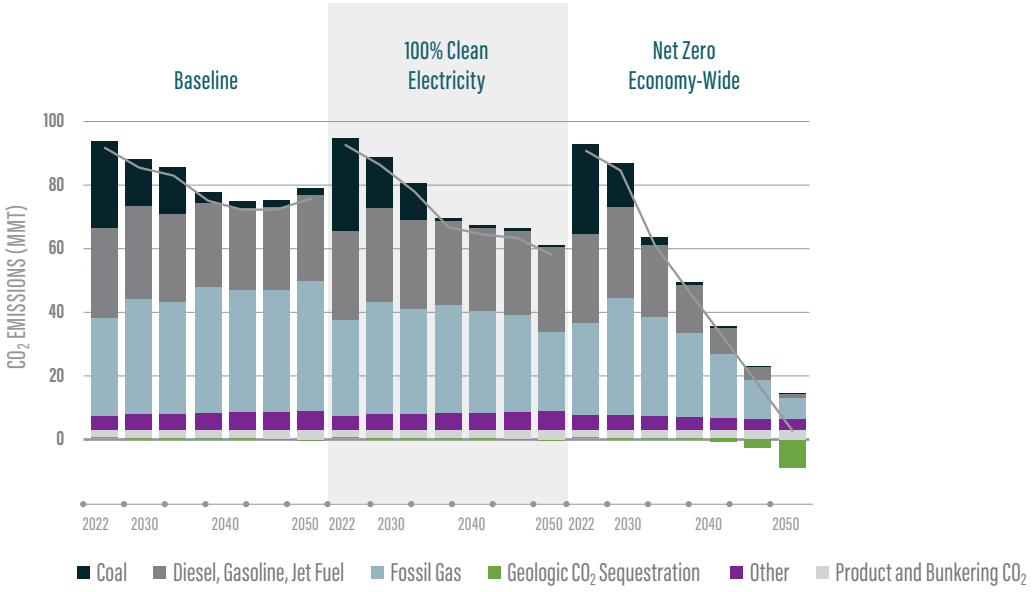


FIGURE 3.

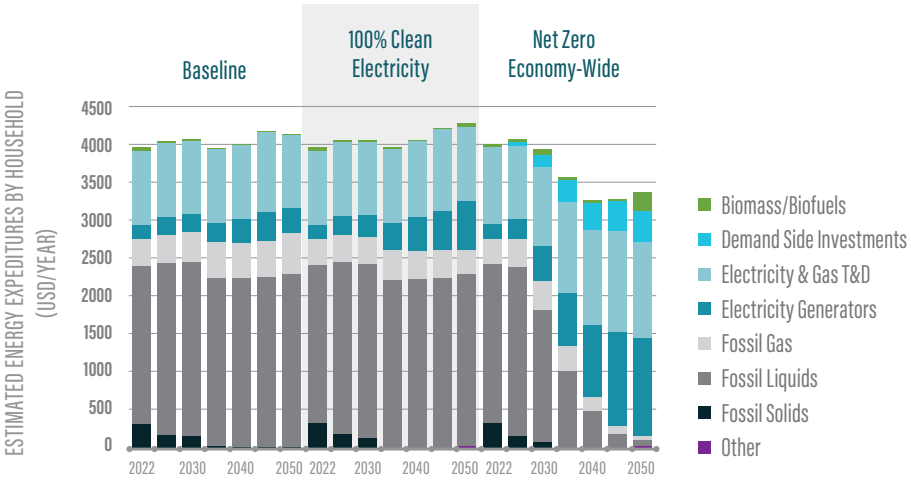
Wisconsin energy and industry emissions



It is also helpful to detail the impact of system-wide energy costs on direct household energy spending. In the **Baseline** scenario, a large portion of household energy spending in 2050 is due to variable costs, much like today, including expenses such as fuel for transportation, gas use in the home for heating and cooking, and gas generation of electricity. On the other hand, in **Net Zero** scenarios, costs primarily reflect capital costs in the form of new clean electricity resources and high-efficiency electric appliances. By 2050, direct household energy costs in the **Baseline** are 6% higher than in 2022. With **100% Clean Electricity**, direct household energy costs are 9% higher than in 2022. In contrast, direct household energy costs are 15% *lower* than the **Baseline** in the **Net Zero Economy-Wide** scenario. In this case, while consumer households must spend money on capital investments for new electric appliances or heat pumps, for example, households stop spending money on expensive fuels and instead power their homes with low-cost, renewable electricity. The impact on residential household energy costs is uniquely driven by the cost-effectiveness of electric vehicles.

FIGURE 4.

Estimated annual household energy expenditures



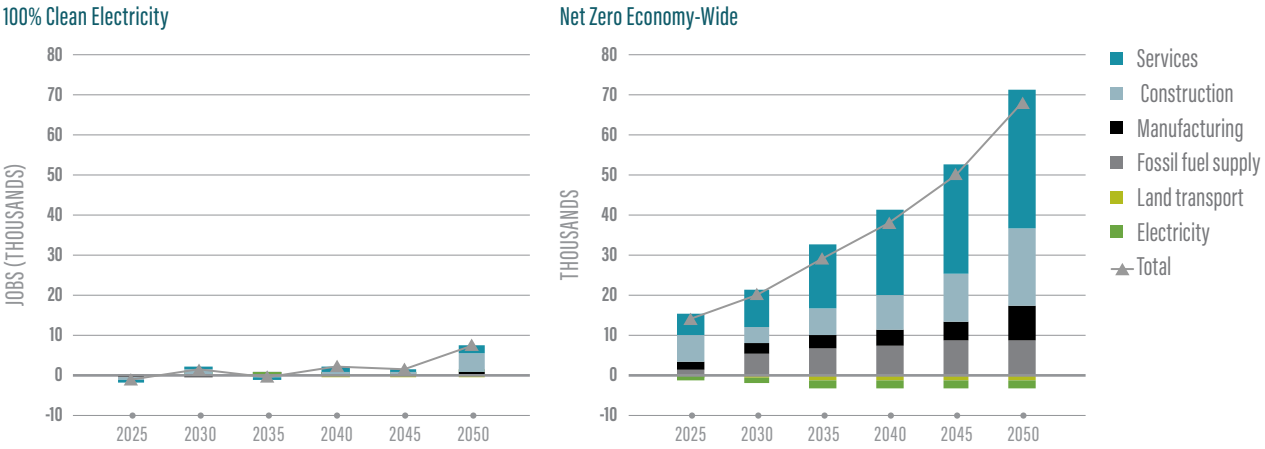
Transitioning to net zero emissions creates 68,000 additional Wisconsin jobs across various sectors of the economy, including manufacturing, operations, maintenance, and construction.

By 2050, transitioning to **Net Zero Economy-Wide** creates an additional 68,000 jobs in Wisconsin, primarily from manufacturing, construction, and services due to increased spending in the economy.

Net Zero Economy-Wide creates additional jobs across the economy, of which approximately half are direct jobs in electricity supply, construction, and manufacturing, and half are concentrated in the supply chain and service sectors due to supply chains and the induced effects of increased economic activity. Induced jobs refer to job creation caused by increased spending on goods and services in the economy. More populated regions of the state see the majority of new job creation, including the Bay Area, Milwaukee, and South Central. Importantly, these jobs are evenly distributed among various skill levels, including approximately 15,000 highly-skilled non-manual jobs, 18,000 skilled non-manual jobs, 19,000 skilled manual jobs, and 16,000 nonspecialized jobs. Wisconsin is well-prepared for the energy transition. The state has a highly skilled workforce with the potential to uptake new jobs and adapt to the changing industries. According to Cambridge Econometrics, "decarbonization is expected to create employment opportunities at all skill levels, part of a more inclusive economy transition."

FIGURE 5.

Employment impacts by industry, 100% Clean Electricity and Net Zero Economy-Wide scenarios relative to Baseline (thousands)



All scenarios, including **Baseline**, detail a similar decline in coal generation, suggesting that preparing for reduced fossil fuel jobs is imperative regardless of which pathway Wisconsin pursues. There will be regional implications to this transition. Policy intervention is critical to ensure that good-paying jobs are realized, and workers currently dependent on the fossil fuel economy are supported.

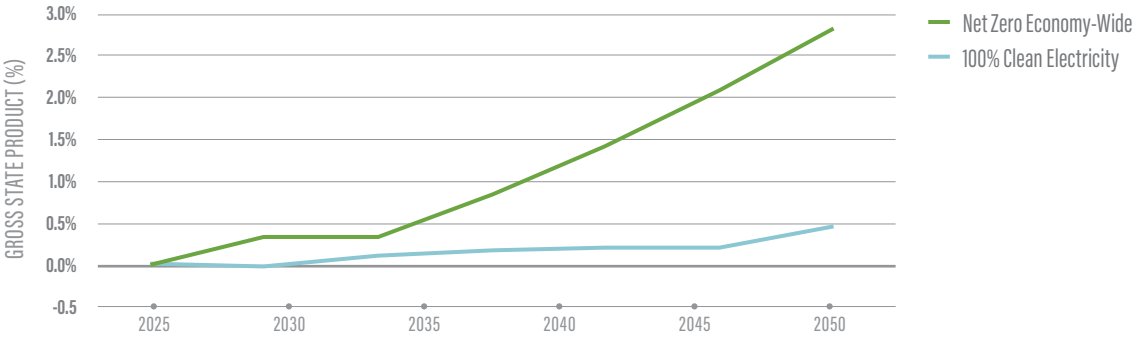
Investment in new wind, solar, and battery storage needed for net zero will boost GSP by approximately 3% by 2050, adding around $16 billion to Wisconsin's economy.

Economy-wide decarbonization drives down consumer energy costs and bolsters economic activity. Modeling from Cambridge Econometrics, detailed in the supporting report, **The Economic Impacts of Decarbonization in Wisconsin**, articulates the vast economic gains associated with a net zero future. Because household energy expenditures are substantially lower in **Net Zero Economy-Wide** compared to **Baseline**, consumers can shift spending to local goods and services, further boosting the economy.

Compared to **Baseline, Net Zero Economy-Wide** requires more ambitious investments across all sectors of the economy, including the electricity sector. Because of the substantial demand-side investments, such as in electric vehicles and heat pumps, total in-state investment is far more significant than in the **100% Clean Electricity** scenario**.** In total, this results in $14 billion worth of direct investments in **Net Zero Economy-Wide** by 2050 relative to **Baseline**. As a result, this scenario greatly increases Gross State Product (GSP), resulting in approximately 3% growth by 2050. By 2050, Wisconsin's economy is roughly $16.1 billion larger than **Baseline**.

FIGURE 6.

Wisconsin Gross State Product, 100% Clean Electricity and Net Zero Economy-Wide scenarios relative to Baseline (%)



As a portion of Wisconsin's annual GSP, the costs of decarbonization are modest. In **Net Zero Economy-Wide**, spending in 2050 increases to just .25% of the forecasted GSP. While a 100% clean electricity policy achieves the single most impactful emissions-reduction measure — accelerating the removal of coal from Wisconsin's energy mix – an economy-wide emissions policy, as modeled in **Net Zero Economy-Wide**, is the most cost-effective means of achieving long-term emissions reductions. Through the rapid electrification of buildings, transportation, and industry coupled with clean energy deployment, Wisconsin can achieve net zero carbon emissions economy-wide at a small cost premium in 2050 relative to **Baseline**.

Net zero emissions result in significant health benefits and lower overall healthcare costs in Wisconsin.

The health benefits and associated economic impacts as a result of economy-wide decarbonization are substantial because most of the major particulate matter emissions are removed in Wisconsin when combustion engine vehicles and coal and gas plants are retired. By 2050, Net Zero Economy-Wide avoids 28-63 mortalities per million people each year, significantly reduces hospital admissions and lost work days, and drastically improves all health metrics modeled. As early as 2030, Wisconsinites will save $255-$275 per person every year in healthcare-related costs compared with the Baseline scenario. By reducing major particulate air pollutants in transitioning to net zero, Wisconsin will save its residents $2-$4.4 billion in 2050 in avoided health costs.

Achieving net zero carbon emissions will require a robust expansion of new transmission.

As Wisconsin decarbonizes and expands its clean energy system, the state becomes increasingly connected to neighboring states in order to cost-effectively import and export clean electricity to meet demand. Expanding transmission to neighboring states increases Wisconsin's access to a diverse set of energy resources, providing increased reliability benefits that allow utilities to more cost-effectively meet customer demand.

Evolved's analysis tools model existing and future generic transmission connections between Wisconsin and neighboring states, helping reveal flows of electricity in a future energy system. For example, in 2022, there will be 2400 MW of transfer capacity between Wisconsin and Minnesota and 2200 MW of transfer capacity between Wisconsin and Illinois. Wisconsin, much like the entirety of the U.S. electric grid, is closely connected with neighboring states through its participation in MISO, the regional system operator. The model has the option to build up to 6 GW of new transmission capacity per state-to-state intertie.

Importantly, distributed energy resources and other local renewables can reduce the pace and scale of grid-scale resource investment, which might reduce the potentially challenging rates of deployment and barriers to transmission development. All scenarios modeled in this analysis, with the exception of **Delayed Action**, include 2.5 GW of distributed solar. The **Delayed Action** scenario cuts the amount of distributed solar deployed in half to 1.25 GW. Lower rates of demand side transformation in that scenario, including less electrification of vehicles and appliances, less demand response, and half the deployment of distributed solar results in far higher costs than other scenarios.

This analysis does not explicitly capture the recently approved MISO Long Range Transmission Planning (LRTP) Tranche 1 investments, which include nearly 2,000 miles of transmission lines that would have the potential to integrate over 50 GW of new renewable energy resources. The LRTP includes three lines in Wisconsin. The transmission expansion detailed in this analysis can effectively help Wisconsin and MISO identify additional opportunities for renewable energy integration and necessary transmission corridors.

In **Net Zero Economy-Wide**, one-third of all energy used in Wisconsin in 2050 is imported from neighboring states. As customer demand increases due to electrification and new loads, transmission capacity expands in order to gain greater load and renewable resource diversity. Transmission expansion begins in 2035 with an additional 2 GW of capacity built between Wisconsin and Iowa and Wisconsin and Minnesota, as well as an additional 1 GW of capacity between Wisconsin and Illinois. This accelerates as electrification and renewable generation increase through 2050, such that the model maxes out transmission expansion to an additional 6 GW of transfer capacity to Illinois, Minnesota, and Iowa.

One scenario evaluated, **No Transmission Expansion**, requires Wisconsin to meet its clean energy goals with entirely in-state resources. Without the opportunity to import and export power to neighboring states, Wisconsin must meet all its reliability and grid balancing needs without the load and resource diversity that the regional system provides. Relative to **Net Zero Economy-Wide**, preventing the expansion of interstate transmission increases total costs by $1 billion in 2050. Without additional import capacity, Wisconsin must keep additional gas generation online for peaking and load balancing purposes, which increases emissions in the electric sector relative to other scenarios.

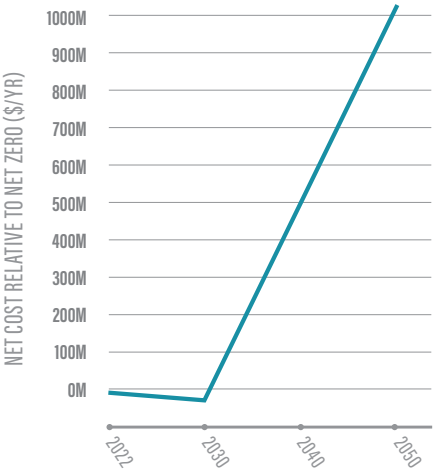


FIGURE 7.
No Transmission Expansion net cost relative to Net Zero Economy-Wide ($/yr)

As this scenario details, transmission expansion to neighboring states is a critical tool to enable cost-effective decarbonization in Wisconsin. Without additional transmission infrastructure, the in-state capacity of wind, solar, and storage increases by 13%. Wisconsin must also invest in additional carbon reduction measures that are far more costly than electricity decarbonization, such as carbon sequestration and zero-carbon fuel production. Additionally, spending will increase on in-state transmission, which is required to bring electricity from additional renewable resources around Wisconsin to load centers. Failure to expand interstate transmission leads to a higher reliance on in-state resources and a faster rate of renewable energy deployment. Given the potential difficulties in siting and permitting new infrastructure projects, greater reliance on high renewable deployment targets as opposed to expanding transmission capacity increases the chances of failing to meet decarbonization targets.

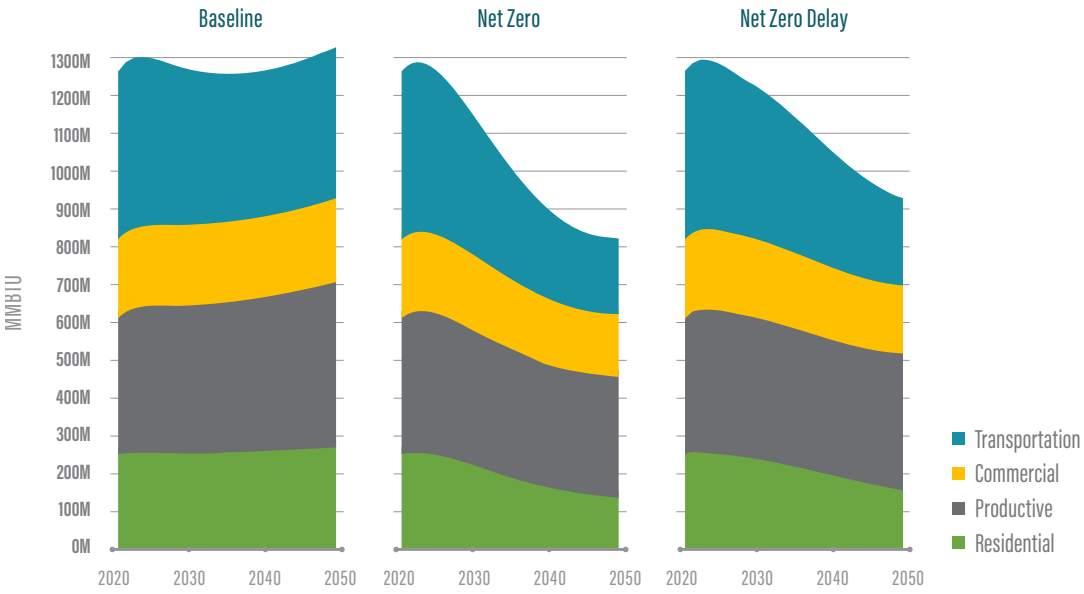
The electrification of buildings and transportation is critical to ensuring Wisconsin meets long-term decarbonization goals.

The role of demand-side resources and changes to load cannot be understated, particularly as Wisconsin targets economy-wide decarbonization goals. The **Baseline**

scenario provides insight into today's reality but fails to capture the accelerating trends of electric vehicle adoption, advances in heat pump technology, and the shift to electrified end-uses and increased efficiency. While total energy use declines slightly as consumers adopt more efficient appliances and vehicles, the final total energy consumption in 2050 is slightly higher than it is today due to productivity and population growth.

FIGURE 8.

Final energy consumption by sector



The **Net Zero Economy-Wide** scenario represents a more accurate representation of the future, in which Wisconsin consumers rapidly shift to highly-efficient electric end-uses, including hybrid-electric heat pumps and electric vehicles. In all **Net Zero** scenarios, we model a future in which buildings, transportation, and industrial sectors all transition to highly-efficient electric end-uses with increasing efficiency through 2050. In transportation, 100% of light- and medium-duty vehicles sold in 2035 are electric. In buildings, all sales of appliances, such as air conditioners and stoves, are fully electric or hybrid, and all building technology sales are highly efficient by 2035. In industry, generic efficiency gains improve the performance of production processes and factories fuel switch heat and drive applications to zero-carbon sources. All these measures have the effect of reducing or nearly eliminating fuel consumption, ensuring that electricity is the major energy source in 2050, as opposed to gas or other fossil fuels. This greatly increases the total amount of electricity that Wisconsin uses, expanding the electric load by 125%, not including new electrolyzer and electric boiler loads, and 166% overall, relative to today. However, even as the electricity sector dramatically increases, switching from inefficient internal combustion engines and boilers to highly efficient

electric end-uses, coupled with investments in energy efficiency measures, has the effect of greatly reducing total energy use. Total Wisconsin energy consumption, which includes energy consumed via electricity and fossil fuels, falls 38% in 2050 relative to the **Baseline**.

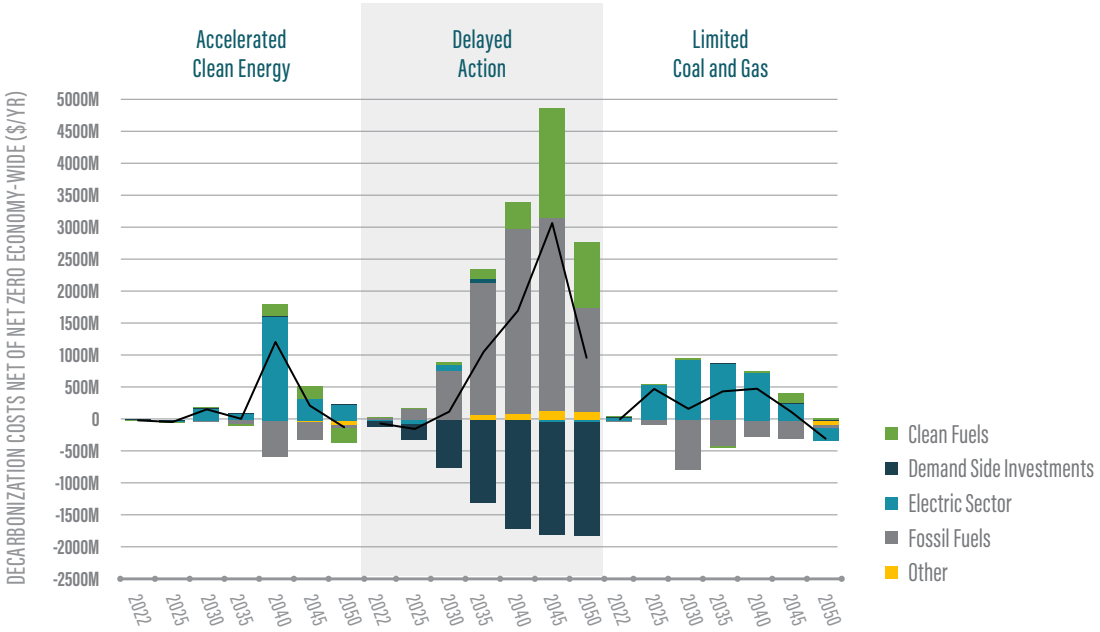
Fuel-switching and efficiency gains help detail the enormous implications that transitioning to a Net Zero economy has for Wisconsin. In 2022, transportation makes up a majority of total energy consumption. However, in **Net Zero Economy-Wide**, energy consumption from the transportation sector is just half of what it is in **Baseline by 2050** due to the transition to a nearly 100% electrified vehicle fleet. The transition to highly efficient electric drive trains has the effect of both reducing total energy consumption and reducing consumer spending on expensive fossil fuels. In order to further detail this benefit, the Project Team evaluated a scenario in which the transition to highly efficient electric end-uses is delayed by 10-15 years. In **Net Zero Delay**, the full magnitude of efficiency gains are not realized, leading to just a 30% reduction in total energy consumption by 2050 relative to **Baseline**.

Net Zero Delay represents a plausible future in which policymakers or regulators fail to accelerate the adoption of highly efficient electric end-uses, which could have severe consequences for the cost to consumers of the energy transition. In delaying the transition to electric end-uses, Wisconsin retains fossil fuels for longer, which increases the need for greater emissions reductions in other sectors. Liquid fuels remain in the economy longer, helping to fuel the remaining internal combustion engine vehicles and other end-uses. Instead, the model chooses to invest in expensive alternatives, such as carbon sequestration and biofuel production.

Failure to electrify the demand side rapidly dramatically increases costs to consumers. As a result, **Net Zero Delay** peaks at more than $3 billion more expensive in 2045 relative to **Net Zero Economy-Wide**, $1 billion more expensive in 2050, and $21 billion more in present value costs over the next 28 years.

FIGURE 9.

Net costs relative to Net Zero Economy-Wide ($/yr)



The **Net Zero Delay** scenario affects an additional resource critical to Wisconsin's clean energy goals: rooftop solar. In this analysis, rooftop solar is an input assumption to the model, based on solar forecasting performed by Cadmus that considers the economic potential from a customer perspective. In all scenarios except **Net Zero Delay**, rooftop solar reaches 2.5 GW of capacity by 2050. In **Net Zero Delay**, this amount is cut in half to just 1.25 GW of rooftop solar deployed by 2050. Distributed energy resources (DER), including rooftop solar and flexible loads, are deployed in all scenarios. These can reduce the pace and scale of grid-scale resource investment, taking the pressure off potentially challenging rates of deployment and giving Wisconsin more options to achieve clean electricity and net zero emissions targets.

Advanced technologies help Wisconsin achieve carbon reduction goals.

A fully decarbonized economy, as we envision in the **Net Zero** scenarios, requires a proliferation of advanced technologies, including decarbonized fuels such as green hydrogen, electric boilers and electrolyzers to help balance the grid, and carbon sequestration to tuck carbon away when it can not otherwise be eliminated. This analysis presents a number of pathways for Wisconsin to decarbonize and evaluates a range of outcomes that will eventually be dependent on how technology develops and costs of certain resources decline.

In a net zero future, hydrogen and carbon become commodities. Hydrogen can be a fully renewable resource that can directly replace fossil fuels in some end-use applications, such as burning hydrogen in fuel cells to power heavy-duty vehicles or carrying hydrogen through pipelines to burn in generating facilities. In other applications, hydrogen can be combined with carbon to produce synthetic fuels that can be dropped in to run vehicles or appliances.

In order to produce zero-carbon hydrogen, Wisconsin deploys electrolyzers that split water molecules into hydrogen and oxygen. The electrolyzers serve multiple purposes, including soaking up additional renewable energy generation to generate a fuel that can be stored for use during a later time. In a net zero future, the majority of hydrogen is utilized in direct end-uses, such as in heavy-duty vehicles, based on the modeled assumptions. That hydrogen is also sent directly through pipelines to generate electricity in small amounts. In **Net Zero Economy-Wide,** Wisconsin adds 2 GW of hydrogen electrolyzers by 2050.

Synthetic and alternative fuels become increasingly important, regardless of the scenario. However, in a net zero future, the demand for these fuels increases as other sectors of the economy must decarbonize. In all scenarios, gas continues to operate at a very low frequency in 2050, serving as a reliability resource. However, its fuel source, traditionally natural gas, must be decarbonized. In this analysis, waste gasses from anaerobic digestion of agricultural materials meet that need, suggesting a need to further develop the waste gas industry. In **Net Zero Economy-Wide,** the remaining gas used in the electricity sector is derived entirely from waste gasses.

It is likely that all these technologies will play some role in a net zero future. Less clear is how prevalent or in what applications they will end up. For example, pipeline gas going to electricity must be decarbonized by 2050 in our analysis. Economics and resource availability in Wisconsin favor gasses from anaerobic digestion of agricultural waste, suggesting that Wisconsin's major agricultural industry can also play a critical role in supporting the transition to clean energy. As this analysis details, there are multiple pathways to decarbonization in Wisconsin, all with various tradeoffs that are subject to changing economics, market conditions, consumer preferences, and policy changes.

KEY POLICY ACTIONS

The Wisconsin Clean Energy Pathways Report demonstrates that Wisconsin can cost-effectively transition to 100% clean electricity by 2050 while rapidly eliminating carbon emissions from other sectors of the economy, such as from buildings and transportation. Achieving these goals will require coordinated policy intervention across multiple industries, regulatory agencies, and policymakers. The state can build on existing analysis, such as the Clean Energy Plan produced by the Wisconsin Office of Sustainability and Clean Energy, which highlights numerous policy opportunities that can help the state achieve 100% clean electricity. In coordination with local, state, and federal lawmakers and regulators, Wisconsin can rapidly reduce emissions across the economy while creating thousands of new jobs and reducing energy costs for consumers. Below are some specific actions Wisconsin should take to realize the promise of this report.

KEY

 **Public Service Commission**

 **Legislature**

 **Multiple Actors/Other**

Emissions Policy

Action		Policy
100% Clean Electricity		Codify a 100% clean electricity standard by 2050 in statute.
Economy-Wide Net Zero Emissions Target		Codify a binding, economy-wide net zero target by 2050.
		Direct the Wisconsin Office of Sustainability and Clean Energy to build off the Clean Energy Plan and establish an economy-wide decarbonization roadmap via rigorous, sector-based modeling, updated periodically.

Electricity Policy

The electric sector is the linchpin of an economy-wide decarbonization strategy. As other sectors, such as buildings and transportation, electrify, an increasing share of renewable electricity must be brought online to meet new electricity demand. The most cost-effective decarbonization gains begin first by decarbonizing the electricity sector while electrifying other end-uses that utilize clean, cost-effective renewable energy.

Action	Policy
Retire Coal by 2030 *Our modeling indicates that the most cost-effective and highest impact decarbonization tool is the accelerated retirement of the coal fleet. The Wisconsin coal fleet is currently set to retire almost entirely by 2035. This analysis suggests earlier coal retirements may be economic.*	Require independent economic analyses of each coal power plant to understand optimal retirement dates.
Deploy Substantial New Clean Energy Resources *In order to achieve net zero emissions economy-wide, Wisconsin will need to install nearly 60 GW of new renewable resources at a rate of approximately 2 GW per year.*	Pass legislation requiring a formal Integrated Resource Planning process developed by the Public Service Commission (PSC). • A robust IRP law should require bi-annual filing from all major generation-owning utilities in Wisconsin. • The law should require that utilities evaluate least-cost pathways to meeting demand, with equal treatment of all generating, supply-side resources, the inclusion of energy efficiency and demand-side measures, and appropriate scenario and sensitivity analysis.
	Complete revisions of PSC Admin Code 119 (Interconnection Rules) and develop a Performance Incentive Mechanism to support interconnection requests.
	Clarify, in ongoing or future dockets, that third-party financing of renewable resources is allowed under Wisconsin law, and require uniform standardized contracts for Qualifying Facilities.
	Create and implement consistent net metering tariffs across utilities that support the integration of customer-sited renewable resources. The PSC should also clarify eligibility for 'submetering' that allows owners of multi-family buildings to install clean energy resources for the benefit of all renters within those buildings.
	The state legislature should also pass Community Solar legislation and codify the legality of third-party charging of EVs.
	Pass legislation that doubles the funding for the statewide Focus on Energy program.

Action	Policy
Plan for Robust Transmission Expansion *In **Net Zero Economy-Wide**, transmission expansion begins in earnest by 2035, with Wisconsin adding at least 5 GW of new capacity by 2035.*	Require utilities to align their planning processes with MISO's Long Range Transmission Planning process in order to ensure Wisconsin utilities are appropriately planning for new generation and transmission infrastructure in conjunction with grid expansion articulated by MISO's grid planners.
	The PSC should require utilities to evaluate fossil plant retirement plans to utilize existing points of interconnection or injection points when replacing those units with renewable energy.
Improve Monitoring and Pollution Control on Gas Generation	Scrutinize any proposed new gas investments for future economic risk, and evaluate them against a portfolio of clean energy alternatives, specifically for consistency with Wisconsin's Energy Priorities Law, EO 38, the state's Clean Energy Plan, and recommendations from the Governor's Task for on Climate Change.
	The state should establish strict emissions limits on existing gas generation. Specifically, older, less efficient plants should be prioritized for retirement in order to protect human health and reduce carbon emissions.
	Scrutinize any proposed new gas investments for their ability to burn decarbonized fuels, such as waste gasses or hydrogen.

Transportation and Building Policy

Achieving the benefits of electrification requires significant changes to the way customers consume energy. For the average household, electricity consumption and their monthly electricity bills will increase while spending on other fuels, such as gasoline, decreases. This transition will come with challenges, including, for example, customer acceptance, customer economics and ratemaking, and equity between customer groups. Rapid electrification will need early planning and policy support if aggressive sales targets needed for economy-wide decarbonization are to be met. Incentives and rebates should be targeted at low-income consumers and marginalized communities, particularly environmental justice communities.

Action	Policy
Establish Targets for Vehicle Electrification *Energy-consuming technologies require long lead times as it takes significant time for the existing vehicle stock to rollover.*	Reduce consumer fuel costs through the increased deployment of electric vehicles via tax credits or rebates to supplement those in the recent Inflation Reduction Act.
	Expand access to electric vehicle charging infrastructure at both residential and commercial locations, with a priority focus on low-income communities, including renters and multi-family housing. For example • Leverage federal funding in the Inflation Reduction Act and Infrastructure Investment and Jobs Act to fund charging infrastructure. • Update new building codes to enact EV-ready building standards. • Promote opportunities for businesses and municipalities to provide retail charging.
	Require robust planning with appropriate load forecasts to ensure utilities are prepared for increased load growth, as well as commensurate distribution infrastructure.
Establish Targets for Efficiency and Electrification of Buildings *Energy-consuming technologies require long lead times as it takes significant time for the stocks to rollover.*	Save consumers money and reduce energy use through the promotion of highly efficient, all-electric technologies, including incentives or point of sale rebates to increase the deployment of heat pumps, heat pump water heaters, and other electric appliances to supplement those offered in the Inflation Reduction Act.
	Implement incentives or rebates to improve home efficiency and expand access to home retrofit opportunities.
	Increase funding for the Focus on Energy Program to offer incentives or rebates to improve home efficiency and expand access to home retrofit opportunities.
	Adopt the latest IECC building codes for commercial and residential buildings at a minimum. Adopt additional amendments for solar and EV-readiness.
	Local governments should adopt benchmarking and tune-up ordinances to assess and improve building energy use.
	State and local agencies should establish a collaborative one-stop-shop for whole-home retrofits to holistically address energy efficiency, appliance electrification, health and safety, and energy assistance.
	Implement a gas planning process, such as a future of natural gas proceeding or a long-term gas resource planning process, in order to investigate the implications of future electrification and prepare utilities for the energy transition.

Clean Fuels and Advanced Technologies

Wisconsin will need to develop, alongside the rest of the nation, a robust clean fuels economy supported by new technology. While not all the proposed technology alternatives will be major players, innovation in this sector will ensure that Wisconsin can compete in the clean energy economy and continue to meet its long-term emissions targets.

Action	Policy
Develop a Clean Fuels Industry *Modeling demonstrates the need for clean, alternative fuels as Wisconsin reaches net zero carbon emissions. Wisconsin will need at least 2 GW of electrolysis capability to meet clean hydrogen demand, as well as additional biofuels and synthetic fuels.*	Further develop Wisconsin's waste gas industry through the development of anaerobic digesters and the production of clean waste gas. Incentivize the agricultural industry to install and utilize on-site generation, which includes access for smaller-scale farms and requires additional water filtering and processing technologies.
	Implement rigorous carbon accounting protocols to ensure new fuels are carbon neutral or better.
	Invest in research and development to build clean fuel technology, including enhanced biodigesters, clean hydrogen production, and more.
	Incentivize electrolysis development through pilot project demonstration.

Employment and State Economic Impact

Moving towards net zero emissions economy-wide will have dramatic economic implications for Wisconsin. As the electricity sector expands, wholesale electricity prices decrease, and consumers spend less on fossil fuels for driving and heating, the economy grows and creates additional jobs. By 2050, **Net Zero Economy-Wide** creates an additional 68,000 jobs in manufacturing, construction, electricity, and other services. In order to realize these potential employment and economic benefits, the state must actively engage economic development, incentivize industry growth, and encourage equitable job creation, as outlined below.

Action	Policy
Workforce Development and Economic Impact	Direct the Wisconsin Economic Development Corporation to evaluate job creation and expansion opportunities based on employment modeling of the energy transition.
	Prioritize transition for workers and those communities impacted by fossil fuel plant retirements or transitions of significant industrial activities.
	• The PSC should open a proceeding to investigate community development and workforce transition plans for relevant fossil fuel plant retirements, including the potential of using savings from securitization to fund such plans.
	Identify potential areas of advanced manufacturing or new development of nascent industries highlighted in the report, including biofuel production, advanced fuels, electrolysis, electric vehicle manufacturing, and more.

CONCLUSION

There is a pathway for Wisconsin to achieve a net zero future within a generation. It will require aggressive action at virtually every level, from the rapid deployment of clean energy resources like wind and solar to the development of new technologies and expanded transmission. But the benefits of these large-scale investments are far-reaching: 28 to 63 fewer deaths per million people from particulate matter air pollution each year, along with $2-4.4 billion in avoided healthcare costs, 68,000 additional Wisconsin jobs, lower out-of-pocket costs for fuel and energy, and an astounding reduction in greenhouse gas emissions—some 122 million metric tons by 2050.

What happens if Wisconsin doesn't choose this path? In every scenario, costs are higher, and outcomes for Wisconsinites are poorer. Changing nothing, the **Baseline Scenario** results in similar energy costs but far higher health costs associated with significantly more mortality and morbidity. Transitioning to **100% Clean Electricity** by 2050 requires a comparable investment to **Net Zero Economy Wide** but brings only modest carbon reduction and higher health costs. And making these investments more slowly with **Delayed Action** to net zero by 10-15 years comes with a much higher price tag.

There are all kinds of adjectives to describe the next steps on this pathway to net zero by 2050—bold, robust, aggressive, visionary. But the first step is the one just taken, one that shows a healthier, more resilient, and prosperous Wisconsin within reach.

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