2020 Dane County Climate Action Plan

TODAY'S OPPORTUNITY FOR A
BETTER TOMORROW

Dane County Office of
Energy & Climate Change

Today's Opportunity for a Better Tomorrow: 2020 Dane County Climate Action Plan

Published by the Dane County Office of Energy and Climate Change

April, 2020

We want to thank the Carolyn Foundation and the McKnight Foundation whose generous support made this report possible.
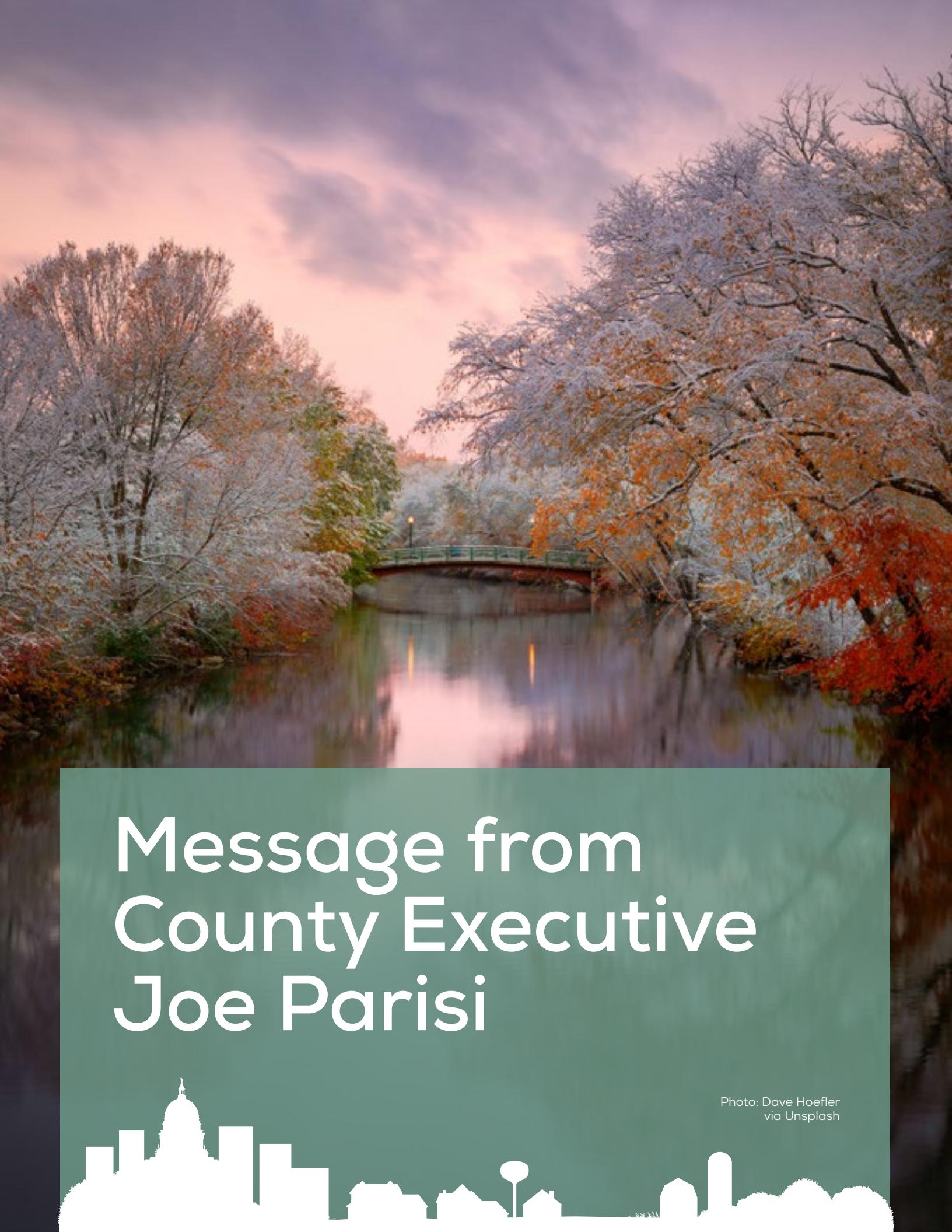
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Message from County Executive Joe Parisi

Photo: Dave Hoefler
via Unsplash

Dane County continues to the lead the state and the region in clean energy investments and addressing climate change. Three years ago, I created the Dane County Office on Energy & Climate Change that has led the effort to develop our first county-wide Climate Action Plan (CAP) to put Dane County on a path to "deep de-carbonization" within the next 10 years.

Climate change is one of the greatest challenges of our generation and it is incumbent upon us all to demonstrate the leadership needed to mitigate the impacts of flooding, extreme heat, and drought we are already experiencing.

▲ Dane County Executive Joe Parisi created the nation's first county Office of Energy and Climate Change in 2017. The creation of a county-wide, economy-wide climate action plan is a primary duty of the office.

The scientific debate on climate change is over. Climate change will have long-term consequences for the economy, environment, and public health and safety in Dane County.

The Office of Energy & Climate Change created the Council on Climate Change, a council of 38 local governments, public utilities, businesses, and organizations that has provided important input into the development of this action plan of policies, programs, and projects to drastically reduce our greenhouse gas emissions across all 61 cities, towns, and villages as well as the entire private sector. It is a plan that will: 1) result in major economic and health benefits; 2) address racial and economic equality to ensure the benefits of carbon reductions are equitably distributed; and 3) lead to energy security and greater resilience to the harmful impacts of our changing climate.

Our many efforts to reduce Dane County's carbon footprint contribute to what should be an overall global goal of slowing the advance of climate change. Expanding our county fleet of compressed renewable natural gas cars and trucks, capturing methane and carbon at our landfill and converting it into cleaner burning vehicle fuel, increasing the use of solar and wind power for our facilities, restoring prairies, and promoting the development of dairy

▲ County Executive Parisi describes his clean fuel investments at the outset of a renewable natural gas facility tour he led for the Dane County Climate Council. The facility takes methane from the landfill and turns it into clean transportation fuel that results in an 88% reduction in greenhouse gas (GHG) emissions.

bio-digesters are all ongoing success stories demonstrating our local commitment and leadership.

Similarly, cities, villages, school districts, utility companies, and businesses throughout Dane County are demonstrating their commitment to a swift transition to a clean energy economy. While we here in Dane County through our united actions cannot alone change the course of worldwide climate change, we must do our part. We cannot wait for the federal government – we must lead the effort at the local level to address climate change. Now more than ever the effort of local elected officials, citizens, and business and community leaders across Dane County is required to produce a climate-ready, carbon-free future.

The Dane County CAP is my promise to take bold action, reduce greenhouse gas emissions, increase our resiliency and quality of life, and ensure that Dane County continues to lead in confronting climate change.

Executive Summary

The Dane County Office of Energy & Climate Change initiated work on this climate action plan in 2017, working with representatives from 38 organizations and another 75 individuals from across the county to help research and develop the top program, policy, and project recommendations that will enable Dane County to sharply reduce greenhouse gas emissions (GHG) and put Dane County on a path to deep decarbonization.

Major findings

1. Southern Wisconsin will continue to get hotter and wetter. The number of days each summer that the high temperature is above 90 °F is historically 10 to 15 days a year. In 2050 that range will be 30 to 40 days each summer.

2. The Intergovernmental Panel on Climate Change (IPCC), says that to keep global warming to 1.5 °C, we need to reduce GHG emissions by 45% by 2030. Modeling shows that by implementing the policies, programs, and projects in this Climate Action Plan we will reduce Dane County-wide fossil-fuel GHG emissions by up to 50% by 2030 and put Dane County on a path to deep decarbonization.

3. The modeling done as part of this plan shows that the recommendations will leave us far short of the goal the plan establishes to make Dane County carbon-neutral by 2050, and new solutions will be required in areas such as replacing natural gas as a heating fuel.

4. This plan gives Dane County a goal to meet one-third of its electricity use with solar power (1200 MW) and one-half with wind power (700 MW) by 2030.

5. Dane County, as a whole, needs to transition away from petroleum-based vehicles to electric vehicles (EVs) and renewable natural gas (RNG) vehicles as quickly as possible. Dane County government is a national leader in the transition to RNG.

6. All of Dane County needs to drastically increase its investment in energy efficiency, energy conservation, and other demand-side emission reduction strategies.

7. By reducing our GHG emissions by more than 45% by 2030 we can give a major boost to economic development in Dane County, a major boost to equity, and a major boost to public health.

8. To reach the necessary GHG emission levels in Dane County and globally, we need more sustainable agriculture systems, and Dane County can be a leader in that transition.

This report is about the geographic place we call Dane County. More specifically, it is about how coming together as the community of Dane County to address climate change can preserve and enhance the quality of life here in many ways, especially for future generations. Any time we come together to consider topics of great consequence to the geographic place we stand, it is important to recognize the people who lived here first; the people who lived here in harmony with nature and the land, in this case, the Ho-Chunk Nation. It is our hope that we can learn from their teachings.

We cannot talk about the impacts of climate change and the strategies to mitigate them without talking about climate justice. Climate change, like so many other environmental disasters, disproportionately affects low-income citizens, communities of color, and other vulnerable populations such as the youngest

▼ Food waste is a major contributor to greenhouse gas emissions. Locally grown organic food tends to be healthier and to reduce greenhouse gas emissions by decreasing transportation distances. *Photo: Center for Resilient Cities 2019*

and oldest among us. Invariably climate change has the largest impact on the individuals who have the smallest carbon footprints, and we considered that as we constructed this plan.

We used these six guiding principles to develop the climate action recommendations:

1. Equity/Justice The climate solutions must be available to all Dane County citizens, regardless of race, income levels, or any other differences. The CAP must put the most vulnerable people in our communities first.

2. Economic Benefits We will pursue climate solutions in the most cost-effective way possible and in ways that maximize the considerable local economic benefits.

3. Health Benefits We will also implement these climate mitigation strategies in ways that maximize the considerable health benefits that will accrue from reducing GHG emissions.

4. Resiliency/Security We will design and implement climate solutions in ways that build the resiliency of our communities, provide critical infrastructure, and give vulnerable communities increased energy security.

5. Bridging the Urban and Rural Divide The CAP will recognize the critical role that the rural areas play in Dane County's economy and quality of life and the enormous role rural areas can play in climate solutions.

6. Ecosystem Benefits Nature provides critical food, water quality, medicine, fiber, and construction material resources to our society. Nature also provides critical cognitive developmental, educational, inspirational, and spiritual benefits. We need to design and implement our climate solutions in ways that protect, preserve, and increase the ecosystem's ability to provide these benefits to Dane County citizens.

This CAP presents more than 100 different climate actions we can take to reduce greenhouse gas emissions. These actions were modeled by Sustainable Energy Economics and the modeling tells us that the actions proposed here can achieve up to a 50% reduction of greenhouse gas emissions by 2030 and a 68% reduction by 2050. The specific actions fall under nine main recommendation categories.

Recommendation Categories

1. **Energy Efficiency** Dane County will develop, commission, and execute a county-wide energy efficiency program that will reduce GHG emissions by increasing the efficiency of energy and transportation systems for homeowners, renters, and businesses. The Dane County energy efficiency program will prioritize the most vulnerable communities and neighborhoods.

2. **Buildings** The Office of Energy & Climate Change will support the creation of advanced, voluntary building guidelines to help developers build highly energy efficient, and eventually net-zero energy and net-zero carbon buildings.

3. **Transportation** Dane County will work with municipalities, utilities, and other stakeholders to implement up to a dozen programs designed to encourage and incentivize the purchase of EVs. We will continue to expand our nation-leading RNG efforts to transition Dane County diesel vehicle fleets to RNG. And Dane County will pursue multiple strategies to reduce driving including smart growth, urban villages, active transportation, regional transit, and other strategies to reduce vehicle miles traveled. We will prioritize these transportation solutions for communities of color, low-income neighborhoods, and otherwise vulnerable citizens.

4. **Renewable Energy** The Office of Energy & Climate Change will accelerate solar and wind energy development to meet one-third of Dane County's electricity use with solar and one-half with wind power by 2030. We will accelerate energy storage development at Dane County facilities and will help to identify finance tools for storage projects at municipal government facilities as well as private businesses. We will also launch a comprehensive solar education program aimed at businesses, make incentives available for solar on affordable housing, and work with municipalities to help them reach their renewable energy and GHG emission goals.

5. **Agriculture and Forestry** Dane County will pursue a variety of advanced agriculture systems and practices that sequester more carbon including alley cropping, silvopasture, perennial cropping, and riparian buffers. We will also accelerate development of biodigesters, composting, and other manure management strategies. We will use a combination of existing tree and canopy inventories to establish a tree canopy baseline and then implement several reforestation and afforestation strategies, and help private landowners manage existing forests for greater carbon sequestration.

Compressed renewable natural gas (RNG) from the Dane County landfill is sold in Kwik Trip gas stations across the state. RNG achieves an 88% reduction in carbon pollution compared to diesel vehicles.

6. **Water** The Office of Energy & Climate Change will support the efforts of the Madison Water Utility to develop and implement a residential water efficiency and rainwater incentive program and work with all the municipalities to build off Madison's successes. We will also build a water efficiency focus into the energy efficiency program developed per the first recommendation (Energy Efficiency).

7. **Waste Materials to Resources** Dane County will continue the transition from traditional waste programs to resource management systems in a circular economy. Dane County will create new programs to divert additional waste materials from landfilling, in ways that are economically and environmentally sustainable, thus reducing methane emissions from landfill operations and other GHG emissions from the use of more virgin materials. Dane County will continue to expand our nation-leading renewable natural gas (RNG) efforts to convert landfill gas to renewable vehicle fuel, with future efforts aimed at capturing the carbon component of the remaining landfill emissions.

8. **Finance Solutions** The Office of Energy & Climate Change will work with existing finance programs, such as the Property Assessed Clean Energy (PACE) program and performance contracting, to help finance clean energy projects for businesses, governments, and other organizations. The Office of Energy & Climate Change will also explore tools such as loans with credit enhancements, climate bonds, and green banks, and work with key stakeholders to create a voluntary carbon market.

9. **Cross-sector Solutions** The Office of Energy & Climate Change will develop and award Dane County Clean Energy District designations to neighborhoods and communities that develop broad-based clean energy programs for their citizens and businesses and create plans to target clean energy benefits to those most vulnerable within their community. The Office of Energy & Climate Change will also work to establish a research and development fund to support research directly related to climate mitigation and adaptation.

▼ Modeling analysis tells us that large precipitation events that cause floods will become increasingly frequent in the future if we don't achieve deep reductions in carbon pollution emissions. Here rescue workers get a family safely out of their home in Mazomanie during severe flooding in August 2018. *Photo: Mitchell Travis*

The 1,000-year flooding that occurred in Madison and western Dane County in August 2018, causing loss of life and more than a hundred million dollars of property damage, was surely just a taste of the costly effects of climate change to come. You, your family, your neighbors, and your co-workers, can have a significant influence on the degree of future climate impacts. And the good news is that taking the actions described in the following pages will not only reduce climate change, but holds the potential to promote equity and justice, boost our economy, and protect public health and welfare.

By combining our efforts with the research and practices other communities, counties, and countries around the world are implementing, Dane County can reach up to a 50% reduction of greenhouse gas emissions by 2030. To reach the lofty goal of 100% reduction by 2050 will require continued research and innovation, and we are committed to filling those roles.

This is a high-level climate action plan that lays out some broad goals, some specific goals, and some broad recommendations for how to reach those goals. The next phase of the Office of Energy & Climate Change climate mitigation work will include a lot of community listening and community outreach to further develop the details of program design and implementation plans for the recommendations included here (see the Public Engagement section). Following those efforts, we will begin implementing these programs, projects, and policies (see the Moving Forward section). This CAP embodies many great thoughts and ideas from this particular time, but as we learn more, as technologies and markets advance, and as organizations, businesses, and individuals innovate, this plan will need to be revised and updated to ensure that we meet our longer-term GHG emission goals, and stay on the pathway to deep-decarbonization. We sincerely hope that you will join us on that pathway, because it will take all of us working together to achieve our climate goals and create a safer, healthier, more equitable and prosperous future for all citizens of Dane County.

Ho-Chunk
# Introduction

Photo: Kayree Funmaker
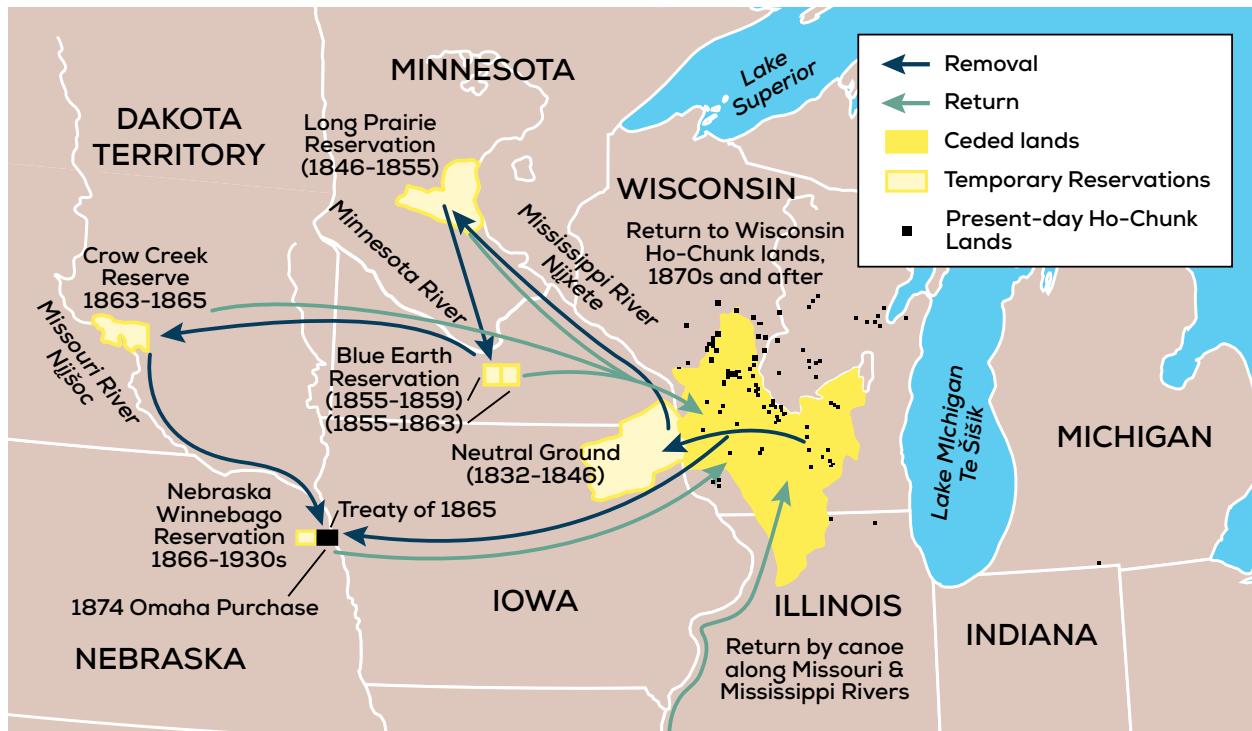
Early History

The ancient people of Wisconsin have always called themselves Ho-Chunk (Hochungra) meaning 'People of the Sacred Voice'. Oral history of the Ho-Chunk places them living in the region, now known as Madison, since the glaciers receded. The original name for the Madison area and lakes is Teejop (day jope) which translates to the Four Lakes. Generations of Ho-Chunk people had a homeostatic relationship with the bountiful lands and crystal-clear waters from which they lived. This enabled the women to be prolific and accomplished farmers while the men were able to hunt, fish and trap game with ease. They followed the advice of their elders to take only what they needed and never more, to create a thriving community.

Teejop was the center of the mound building culture which is a unique feature to North America. The Ho-Chunk people often built mounds on bluffs, hills, or near springs, and commonly aligned the mounds with celestial bodies or built them as burial mounds. The first mounds were built around 2,700 years ago and some estimations state that there were as many as 3,000 mounds in the area. However, early colonizers did not recognize the significance of the mounds and most were destroyed leaving only about 10% intact. Colonizers used many of the mounds to fill in the wetlands, tilled them under for farm fields and used them as infill when building Madison's downtown spaces. It was a common Sunday practice to dig through the mounds that remained to find the valuable artifacts hidden inside.

Colonization

Through a series of mistranslations of Indigenous and European languages, the Ho-Chunk became widely referred to as the 'Winnebago'. The first major tragedy occurred shortly after Nicolet touched the shores of Green Bay and introduced foreign disease. Throughout the 1600s and 1700s, the tribe was able to remain generally autonomous as the French and then the British moved into the region. Later, the desire for their fertile and resource rich land led the United States federal government to begin a series of forced removals. In 1829, the first treaty signed included a major land cession of 2.5 million acres sold for 29 cents an acre, although the actual value was $1.25 an acre (a conservative estimate). In 1830, the first official order to remove the Ho-Chunk Nation was given and close to 1,000 died as a result of the journey to Iowa and poor living conditions on the reservation in the summer and fall of 1840. In 1855, upon further guarantee by the U. S. covering payment under former treaties, the tribe ceded more lands in Wisconsin. The government moved members of the tribe to a reservation in Blue Earth, Minnesota. In 1862, Minnesota's ethnic-cleansing policy called for

Ho-Chunk Forcible Removals and Return to Ancestral Land. Each removal and relocation required an arduous journey and resulted in tremedous hardship and many deaths.

removal of Dakotas and Ho-Chunks to Crow Creek in South Dakota. 2,000 made the journey and 550 died. In 1866, those who were still at Fort Thompson, South Dakota, were moved to a reservation in Nebraska. Throughout the removals, Ho-Chunks continued to return to Wisconsin, making the arduous journeys by foot or canoe. Eventually, the federal government gave up these efforts and by 1875 the government allowed those in Wisconsin to stay, though there was little left of their original lands. Today, the Ho-Chunk Nation is the only recognized tribe in Wisconsin without a reservation.

Through the Indian Homestead Act of 1884 many Ho-Chunks acquired homesteads. Shortly after, the federal government began the mission/boarding schools period and removed young children from their families to get the 'Indian' out ('Kill the Indian, Save the Man'). This forced assimilation stripped them of traditional clothing, cultural practices, and their language. The boarding schools cut the Ho-Chunk children's hair and dealt out harsh punishment if they spoke their language. Many are still dealing with the generational trauma of this destructive period today.

Revival

In 1962 the tribe voted to adopt a constitution to form the Wisconsin Winnebago Business Committee (WWBC) under the Indian Reorganization Act of 1934. This allowed the aboriginal people of these lands to be a federally recognized sovereign nation and to receive federal funding for economic and social development. In 1993 the constitution was ratified, and the former Wisconsin Winnebago Business Committee changed its name to become the Ho-Chunk Nation. The Nation built casinos in the early 1990s, which became the economic engines that drove social programs including housing, elder and veteran care, and language and cultural preservation. The revenue has also provided funding to purchase back the land taken by the government.

Today, Ho-Chunk Gaming Madison, one of six Ho-Chunk owned and operated casinos in Wisconsin, is mindful of traditional knowledge while constant evaluation and planning is taking place to ensure every effort is made to encourage employees to consider the environment. As we look to grow our campus, we seek the latest

Ho-Chunk woman with black ash baskets. What began as an everyday object became functional decorative pieces sold to tourists and locals alike, starting in the late 1800s. Although the emerald ash borer invasion and intensive nature of processing black ash has led to a decline, professional Master Basket Weavers continue this fine artistry.

Ho-Chunk traditional dancers on the steps of the Wisconsin State Capitol. From L to R: Lillian White Eagle, Frankie Brandon, and Angel Logan.
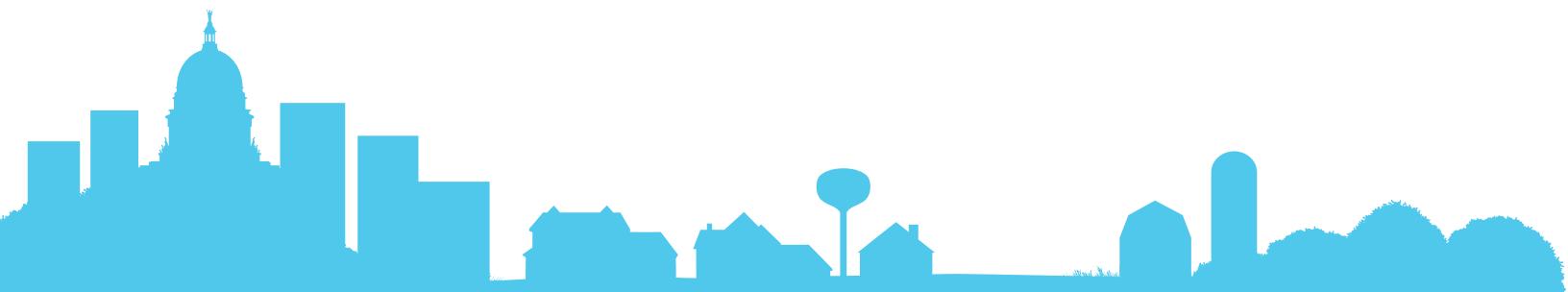
Shown at the Dane County Landfill renewable natural gas station are Dane County Executive Joe Parisi (left) and Ho-Chunk Gaming Madison Executive Manager Daniel Brown (right).

technology to ensure sustainability is present in current and future practices while embracing the diversity of the changing world.

This region has seen vast changes and in the recent years even more so as we have experienced the effects of climate change alongside our neighbors. As we move forward, we're encouraged by our many partnerships, with Dane County and others, as we are all on the cusp of a momentous time in history and the opportunity to restore and heal has never been greater. We look forward to sharing the knowledge passed down and the role of stewardship with those who wholeheartedly take on the responsibility alongside us.

Dane County Office of Energy & Climate Change Introduction

Photo: Holger Link via Unsplash

◄ Madison Gas and Electric proudly sponsored "Energized Bucky" as part of Bucky on Parade. Energized Bucky spent his first few months in front of the (Madison/Dane) City County Building.

We can slow and reduce climate change. We can reduce flood damage, protect forests, protect public health, promote equity, increase economic development; we can increase the quality of life across the globe, we can even save lives. We can reduce climate change. In fact, we can do more to slow and reduce climate change than most people on this planet. There are several reasons for this, but a big one is because we are part of the community that is Dane County (and you can be part of it whether you live in Dane County or not).

Dane County has experienced and continues to experience rapid growth, and the need for infrastructure investments provides opportunities for new solutions to be put in place. Dane County has tremendously strong climate leadership among its elected officials. And Dane County has a wealth of leaders and experts in many areas critical to mitigating climate change. Many of them helped to develop and write this report.

We in Dane County must do our share to mitigate the GHG emissions we cause, but we must also take advantage of the unique opportunities in Dane County to educate, inspire, and support the actions of other jurisdictions.

Without question, global warming will increase natural disasters including flooding, drought, and heat waves, increase the spread of vector-borne diseases, increase sediment and nutrient loading in our lakes and streams, and create a multitude of other adverse impacts. Our efforts to address climate change locally provide us with multiple major opportunities to increase equity, create a healthier environment, realize major economic development opportunities, reduce utility costs, create jobs, increase resiliency, and bring communities together.

The epic flooding in western Dane County in August 2018 turned deadly when unofficial recorded rainfall totals as high as 15.33 inches fell in a 24-hour period, and more than 8 inches fell in multiple locations within three hours. One life was lost, and it took more than 80 heroic rescue missions by first responders to prevent more deaths. Homes, businesses, and governments suffered more than $155 million in damages. We can expect to see more extreme rainfall events in the future due to global warming.

The Fourth National Climate Assessment report predicts that all regions of the United States will see somewhere from a 50% to 300% increase in heavy rainfall events by the end of this century, depending on the success of our carbon

reduction efforts. Over the next two decades we can expect increases no matter what we do, and while heavy rainstorms will increase everywhere, the Northeast and Midwest can expect the most. The report also points out that the number of largest heavy rainfall events will show the biggest increase.

The good news is that there are many solutions that will help mitigate climate change. There are solutions that everyone in Dane County can be a part of, solutions that will both reduce GHG emissions and make our communities more resilient and better able to adapt to the extreme weather that will inevitably come with climate change.

Purpose Statement
& Collaborative Framework

This climate action plan is meant to be a high-level roadmap that builds support for GHG emission reduction strategies and actions to meet emission reduction targets. The plan will help all the people of Dane County take responsibility and do our share to mitigate climate change, but it will also serve to educate, inspire, and facilitate mitigation efforts by other governments, businesses, organizations, and individuals. Our hope is that this document will bring people in Dane County together, at many levels, to support each other in their efforts to address climate change.

On June 5, 2017, County Executive Joe Parisi opened the Dane County Office of Energy & Climate Change. The office's highest initial priority was to develop a county-wide, economy-wide climate action plan that will put Dane County on a path to deep-decarbonization and make Dane County a leader in the effort to mitigate climate change in a way that is just and equitable and that maximizes health benefits, economic benefits, and resiliency. This document is the culmination of that effort. There have been more than 100 volunteers from across Dane County involved in developing this CAP. Many of them are engineers, scientists, farmers, consultants, CEOs, activists, attorneys, and community leaders. All of them are Dane County citizens with a unique perspective and a pride in ensuring that Dane County remains a safe, productive, beautiful place to live in the face of a rapidly changing climate.

Fig. 5.1

Dane County Council on Climate Change Member Organizations

1000 Friends of Wisconsin	H & H Energy Services
Alliant Energy	Ho Chunk Nation
Azar Law LLC	Home Savings Bank
BIOFerm Energy Systems	IBEW Local 2304
Citizens Utility Board	Krupp General Contractors
City of Fitchburg	Madison Metropolitan Sewerage District
City of Madison	Madison Gas and Electric
City of Middleton	Nelson Institute for Environmental Studies
City of Monona	Public Health Madison & Dane County
City of Sun Prairie	RENEW Wisconsin
Clean Fuel Partners	Sierra Club
Clean Wisconsin	SunPeak
Capital Region Advocacy Network for Environmental Sustainability	Sustain Dane
Dane County Emergency Management	Urban League of Greater Madison
Dane County Office of Equity & Inclusion	UW Health
Derr Farms	Wisconsin Energy Institute
Exact Sciences	Wisconsin Initiative on Climate Change Impacts
Fiskars	WPPI Energy
Greater Madison Chamber of Commerce	YWCA Madison

Figure 5.1 provides a list of the 38 organizations that make up the Dane County Council on Climate Change which is the group that was invited by the County Executive to bring diverse stakeholder perspectives to this process and ultimately give input on, or reaction to, the various recommendations presented in this CAP. Please see Appendices 1 and 2 for lists of the Climate Council member individuals and the makeup of the various working groups that helped advise the Office of Energy & Climate Change and the Council, and provided program and policy ideas for inclusion in the CAP. Other ideas came from members of the public. These work groups will continue to work with the Office of Energy & Climate Change in the coming years to help implement the CAP.
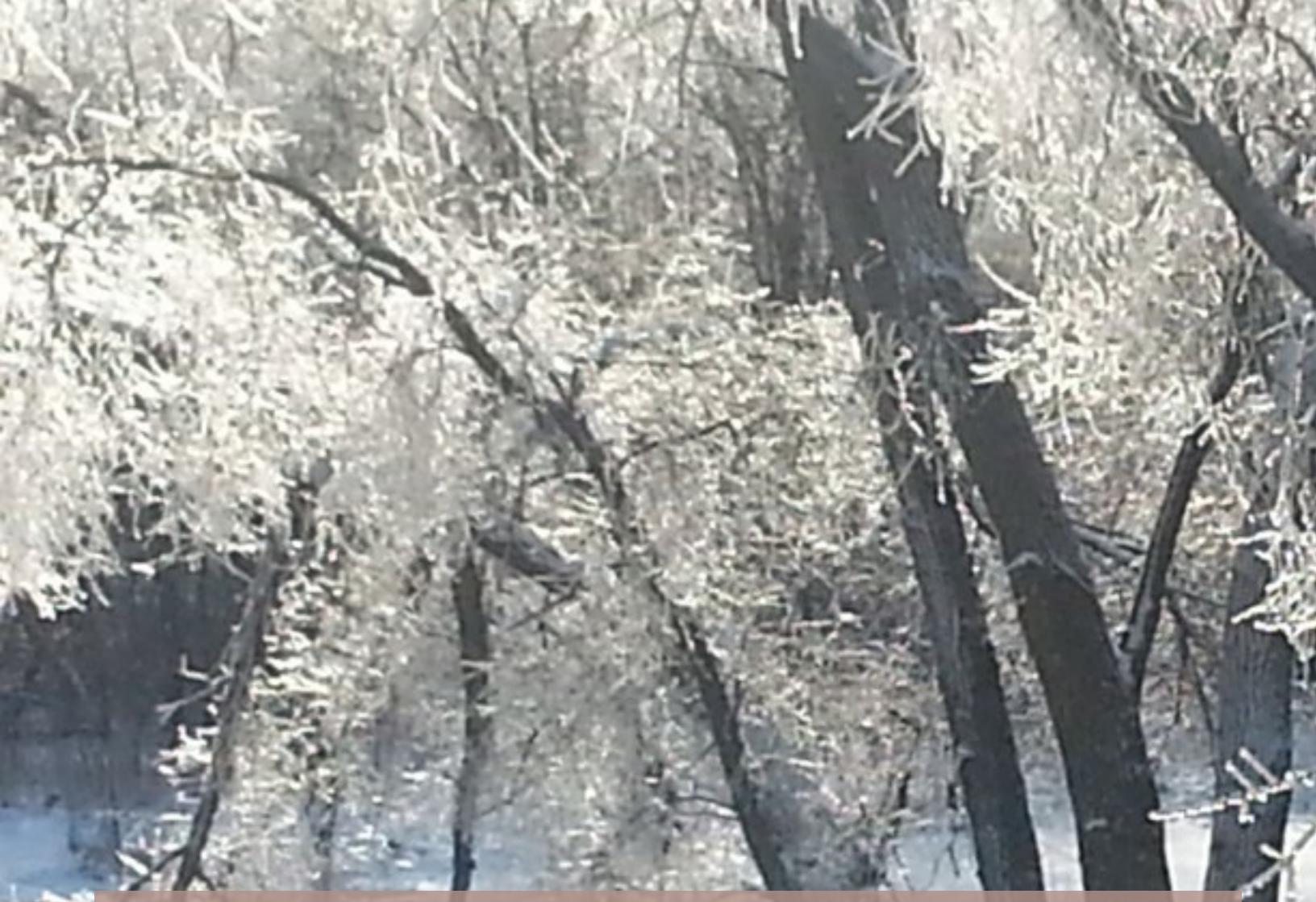
This has been a collaborative effort among the Office of Energy & Climate Change, the Dane County Climate Council, and the work groups. Not every Council member and work group member supports every recommendation or view in this report and nothing in this CAP report obligates any participant to dedicate resources to any recommendation or action.

The work groups and Climate Council considered eight key criteria in selecting and developing the 109 specific program, policy, and project recommendations contained in this CAP report:

- GHG emission reduction potential
- Feasibility
- Cost
- Equity and justice considerations
- Economic benefits
- Public health and other co-benefits
- Adaptation and resiliency benefits
- Temporal considerations (length of time to implement)

Now that this CAP is written and distributed, there are several additional steps that need to happen without delay including engaging communities to help flesh out implementation plans for the various programs and policies envisioned in this CAP, followed by the actual implementation. We will share more thoughts about these next steps in subsequent sections of this report.
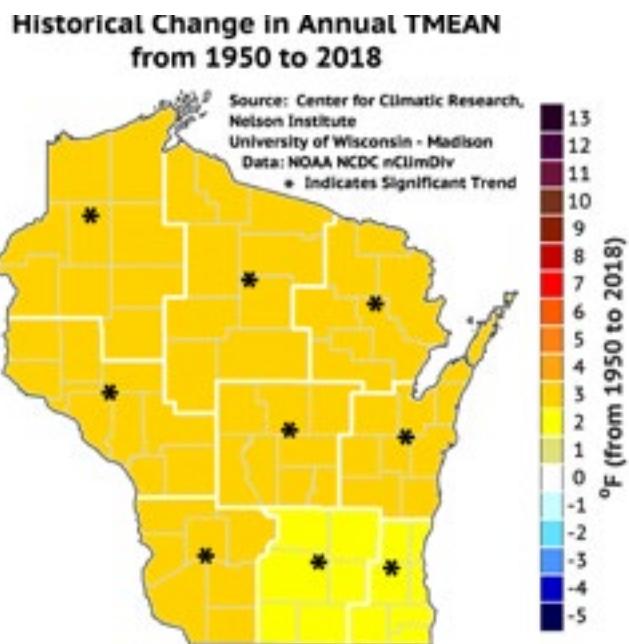
Climate Change in Wisconsin:

The Historical Record & Future Projections

Submitted by the Wisconsin Initiative on Climate Change Impacts
Climate Working Group

Our Earth's climate is rapidly changing. According to the *Climate Science Special Report of the Fourth US National Climate Assessment* (USGCRP 2017), global temperatures have risen by about 1.8 °F from 1901–2016, with most of that warming occurring in the last six decades. At the same time, carbon dioxide (CO_2) continues to rise due to human emissions. Ice core records tell us that over the last 800,000 years (which extends well beyond the first fossil evidence of homo sapiens), atmospheric CO_2 levels have naturally fluctuated between about 150 parts per million (ppm) and 300 ppm. In April 2014, monthly CO_2 concentration at Mauna Loa observatory passed 400 ppm, probably for the first time in the history of human occupation of our planet. We know, from carbon isotope ratios and other lines of evidence that the increase in CO_2 that Earth has experienced over the last six decades is due to human emissions. Furthermore, data and scientific evidence shows that it is extremely likely that the warming our planet has experienced over the last 60 years is due to human activity, especially increases in CO_2.
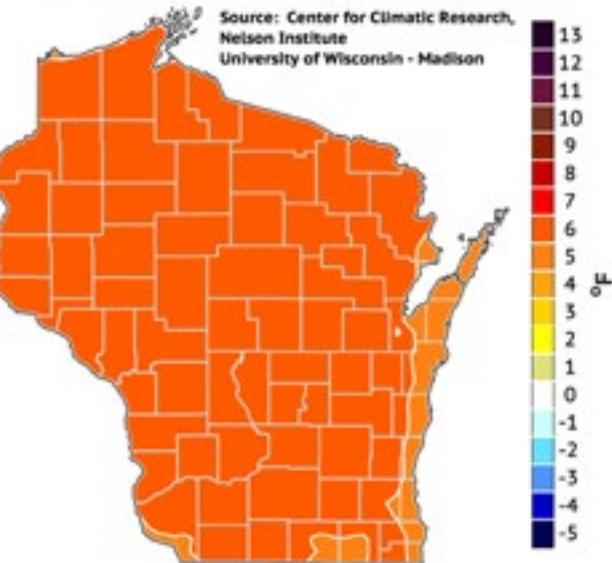
Over the last six decades, Wisconsin has experienced similar climatic changes. In 2011, the Wisconsin Initiative on Climate Change Impacts (WICCI) issued its *First Assessment Report* (WICCI 2011) describing how climate has changed in Wisconsin, and will likely to continue to change, together with ways that those climatic changes may affect Wisconsin's natural and built resources and economic interests. Since then, WICCI has continued to investigate historical and projected climatic changes in Wisconsin and to develop new tools for assessing possible future impacts. Some of these results are summarized here for Dane County by leading WICCI climate scientists – Dan Vimont, Michael Notaro, Steve Vavrus, and David Lorenz.

Historical Change in Annual TMEAN from 1950 to 2018

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison Data: NOAA NCDC nClimDiv
• Indicates Significant Trend

°F (from 1950 to 2018)

◀ **Fig. 6.1:** Annual average temperature change for each of Wisconsin's nine climate divisions from 1950-2018. Asterisks indicate that the linear trend from 1950-2018 is statistically significant. See Methods section for a description of data and trend calculations.

▶ **Fig. 6.2:** Projected change in annual mean temperature in Wisconsin by 2050, shown as the average from 2041-2060 minus the average from 1981-2010. The map shows the average change across all 24 models contributing to the representative concentration pathway 8.5 (RCP8.5) scenario in the UWPD2.0 data set.
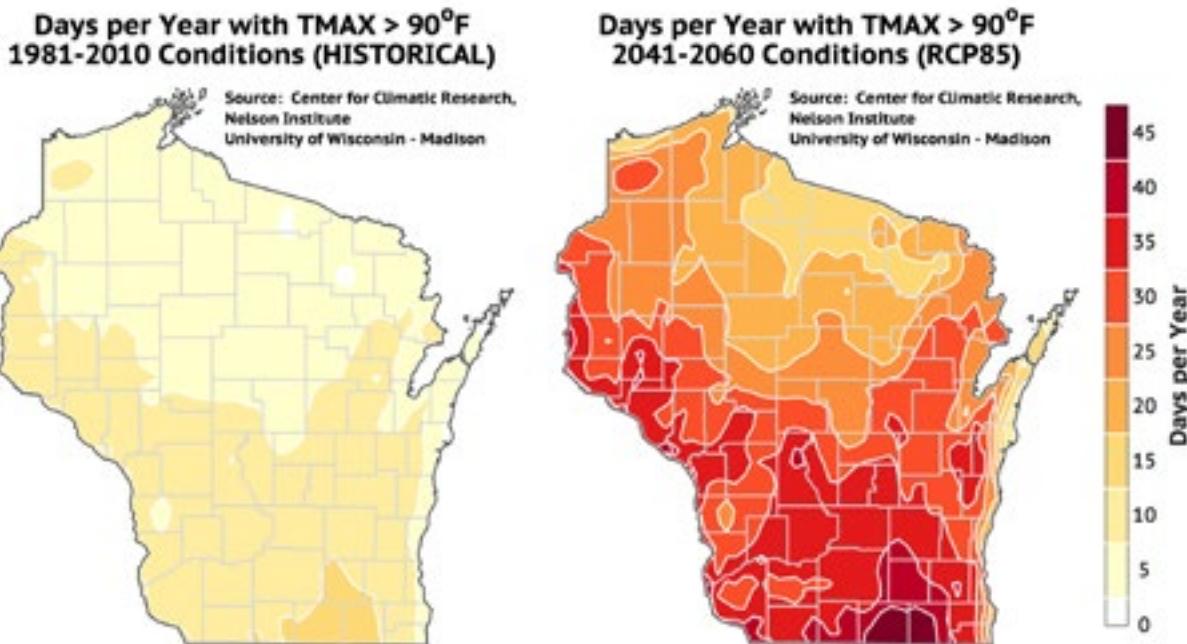
Temperature

The historical record indicates that south-central Wisconsin's average temperature has warmed by about 2 °F since 1950. This warming is robust, with statistically significant trends during all seasons of the year for South Central Wisconsin. The warming is not uniform throughout the year, though, with the greatest amount of warming occurring during the winter season (December-February average warming of about 4 °F) and the least during summer (June-August average warming of about 1 °F). Both spring and fall have warmed by about 2-3 °F. Warming is more pronounced in the nighttime minimum temperatures, which have warmed by about a degree more than the daily maximum temperatures.

Future projections indicate that Wisconsin will continue to warm by about 6 °F (3-9 °F) by 2050 (Fig. 6.2). Like the historical record, this warming is slightly more pronounced during winter (3-11 °F) than summer (3-8 °F) and shows the least amount of warming during spring (2-8 °F). Projections are robust in showing that nighttime low temperatures will warm by about 1 °F more than

▶ **Dan Vimont, Ph.D.** Professor of Atmospheric and Oceanic Sciences, Nelson Institute Center for Climatic Research, University of Wisconsin-Madison

Days per Year with TMAX > 90°F
1981-2010 Conditions (HISTORICAL)

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison

Days per Year with TMAX > 90°F
2041-2060 Conditions (RCP85)

Source: Center for Climatic Research,
Nelson Institute
University of Wisconsin - Madison

45
40
35
30
25
20
15
10
5
0

Days per Year

▲ **Fig. 6.3:** Average number of days per year when then daily high temperature exceeds 90 °F. Left: 1981-2010 conditions. Right: 2041-2060 conditions. Maps show the number of extreme days averaged across all 24 models contributing to the RCP8.5 scenario in the UWPD2.0 data set.

daytime high temperatures. We note that the seasonal warming differences are largely due to three models that show warming of 10-13 °F during winter; the remaining models show relatively consistent warming of about 3-8 °F throughout the year by mid-century. Further, dynamically downscaled model simulations (that may include more realistic representation of land surface processes) suggest that summer temperatures will warm more than winter temperatures (Notaro et al. 2015). While the differences between daytime and nighttime temperature changes are robust, work is underway to better understand the differences in seasonal projections.

In the historical record, it is rare to experience a year in which a daily high temperature exceeds 100 °F; by mid-century, it is likely that these kinds of events will occur three to four times each year.

One way that we will experience this change in temperature is through a change in extreme daily temperatures. In the historical record in southern Wisconsin, daily high temperatures typically exceed 90 °F on 10-15 days per year (Fig. 6.3). By 2050, that frequency triples, with daily high temperatures expected

to exceed 90 °F on 30-40 days per year. Southern Wisconsin may also see unprecedented high temperature events.
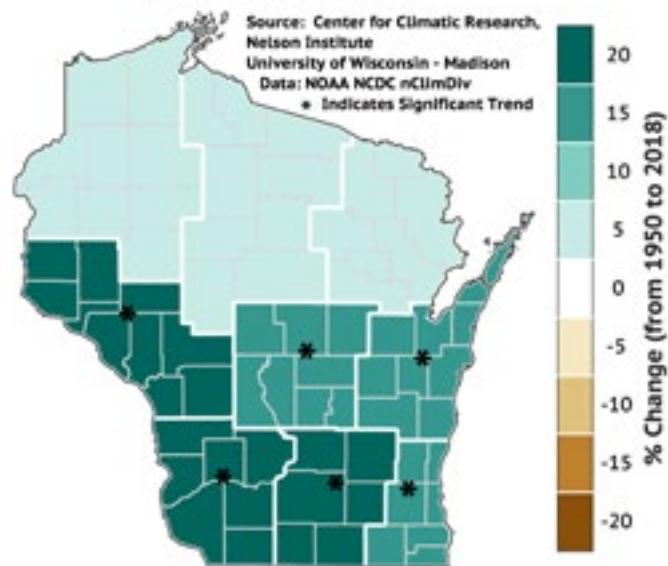
In addition to extreme daytime highs, extreme nighttime lows are expected to change as well. During winter, we will see a decrease in extremely cold days (Fig. 6.4). In the historical record, low temperatures dip below 0 °F on 15-20 nights per year. By 2050, these cold nights are expected to occur only about five times per year. During summer, extremely warm nights have a disproportionately high impact on human health. From 1981-2010, nighttime low temperatures remain above 70 °F about six times per year. This kind of event is likely to quadruple by 2050, with nighttime lows exceeding 70 °F for 25-30 days each year. This suggests that this kind of currently rare event will become a regular occurrence during summers by 2050.

Wisconsin's warming temperatures will also affect other climatic conditions. For example, warming winter temperatures will be experienced as changes in the characteristics of winter. Historical data shows significant decreases in the duration of lake ice around the world, including Lake Mendota (Sharma et al. 2019), that are consistent with warmer winter weather. These trends toward

▼ **Fig. 6.4**: Average number of nights per year when then daily low temperature dips below 0°F. Left: 1981-2010 conditions. Right: 2041-2060 conditions. Maps show the number of extreme days averaged across all 24 models contributing to the RCP8.5 scenario in the UWPD2.0 data set.

Nights per Year with TMIN < 0°F
1981-2010 Conditions (HISTORICAL)

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison

Nights per Year with TMIN < 0°F
2041-2060 Conditions (RCP85)

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison
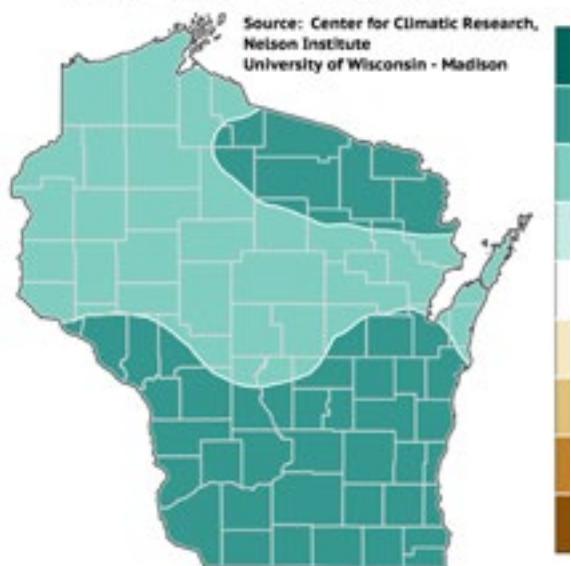
Historical Change in Annual PRECIP (%) from 1950 to 2018

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison
Data: NOAA NCDC nClimDiv
* Indicates Significant Trend

% Change (from 1950 to 2018)
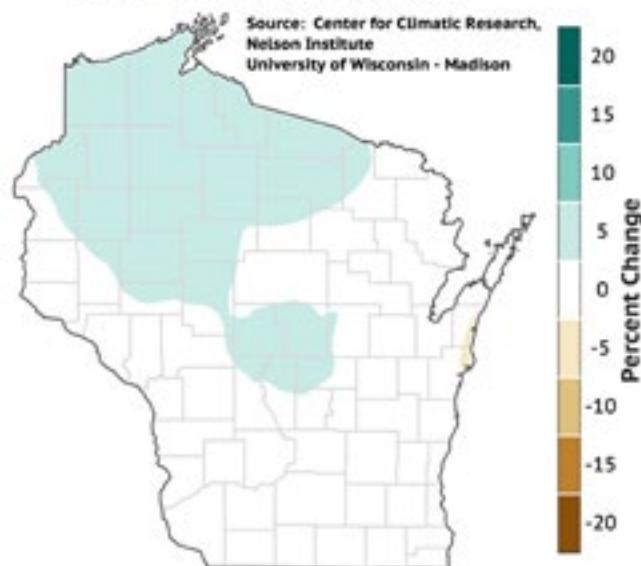
Fig. 6.5: Total annual precipitation change (in percent) for each of Wisconsin's nine climate divisions from 1950-2018. Asterisks indicate that the linear trend from 1950-2018 is statistically significant. See Methods section for a description of data and trend calculations.

Fig. 6.6: Projected change in (left) winter and (right) summer precipitation in Wisconsin by 2050, shown as the percent change by 2041-2060 relative to the 1981-2010 average. The map shows the average percent change across all 24 models contributing to the RCP8.5 scenario in the UWPD2.0 data set.

Change in DJF PRCP (%), RCP85: 2041-2060 minus 1981-2010

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison

Change in JJA PRCP (%), RCP85: 2041-2060 minus 1981-2010

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison

Percent Change
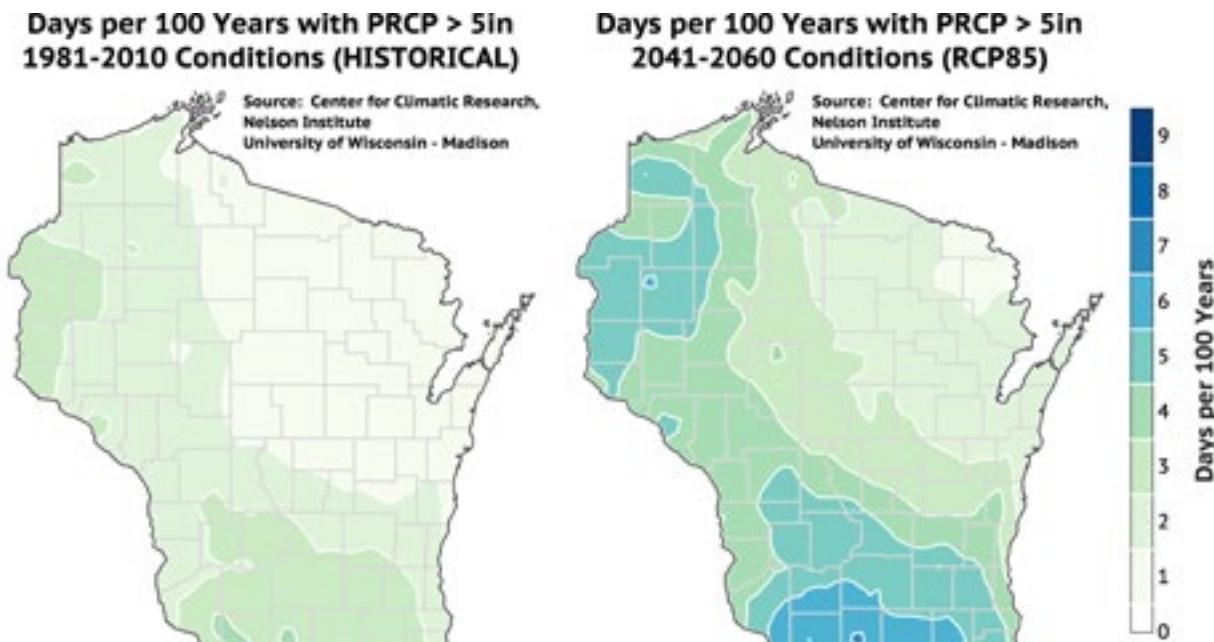
reduced lake ice are expected to continue. Warming winter also translates to large reductions in snowfall, snowfall events, and snow depth in Wisconsin (Notaro et al. 2014). This reduction in snow will also be experienced as an overall shorter snow season for southern Wisconsin (Notaro et al. 2010). During summer, warmer temperatures tend to increase evaporation and reduce soil moisture, resulting in expected changes in vegetation across Wisconsin (Notaro et al. 2012).

Precipitation

Precipitation is much more variable than temperature, and as a result, changes in precipitation during the historical record are more difficult to attribute to anthropogenic climate change than changes in temperature. Further, precipitation in Wisconsin undergoes a large seasonal cycle with little total precipitation during winter and large total precipitation during summer. In southern Wisconsin annual total precipitation has increased by about 20% since 1950 (Fig. 6.5), while annual total precipitation in northern Wisconsin has experienced no significant change.

▼ **Fig. 6.7:** Extreme precipitation occurrence in Wisconsin, denoted as the number of days per century that a given location is likely to experience a daily precipitation event equal to or greater than 5 inches. Left: 1981-2010 historical conditions. Right: 2041-2060 conditions. Maps show the number of extreme days averaged across all 24 models contributing to the RCP8.5 scenario in the UWPD2.0 data set.


Days per 100 Years with PRCP > 5in
1981-2010 Conditions (HISTORICAL)

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison

Days per 100 Years with PRCP > 5in
2041-2060 Conditions (RCP85)

Source: Center for Climatic Research, Nelson Institute University of Wisconsin - Madison

Projections indicate that total precipitation will likely increase in Wisconsin by 2050. The change in precipitation is seasonally dependent (Fig. 6.6), with winter and spring experiencing the most robust increase of about 10-15% (increases ranging across models from 0-25% in winter and 0-20% in spring) and summer experiencing the least robust change of about 0% (with models varying between a 10-15% loss to a 10-15% increase in total precipitation).

In addition to changes in seasonal total precipitation, it is highly likely that large precipitation events will increase in frequency and intensity by mid-century. During the historical record, a given location in southern Wisconsin experiences an average of 12 two-inch (or greater) precipitation events each decade. By mid-century, this increases to about 16 two-inch (or greater) precipitation events per decade, equivalent to a 33% increase. Extremely large precipitation events are likely to experience an even greater increase in frequency. For example, during the historical record a five-inch precipitation event (Fig. 6.7) is likely to occur at a given location in south-central Wisconsin about three times per century (approximately a 30-year event), and by mid-century this kind of event is projected to nearly double in frequency, occurring five to six times per century (a 15- to 20-year event).

Conclusions

Historical records and future projections show consistent climatic changes across Wisconsin. In particular, the historical record indicates that Wisconsin has warmed by 2-3 °F since 1950, and models project an additional 3-9 °F of warming by mid-century. Importantly, the models and historical records both agree on the characteristics of the warming as well, with both indicating the most change occurring for winter nighttime low temperatures and the least amount of change for summer daytime high temperatures. In addition, model projections show an approximate tripling to quadrupling of extremely hot days and nights in Wisconsin. Precipitation changes are less robust, but model projections suggest a slight increase in total precipitation in Wisconsin. The total change, though, is strongly dependent on the amount of rain that falls during summer which could increase, decrease, or stay the same. Robust increases in winter and spring precipitation are expected by the middle of the 21st century.

Methods, see Appendix 3.

Guiding Principles

Equity & Justice

Globally nations and communities of color, as well as low-income populations, are responsible for fewer GHG emissions than other populations and are more vulnerable to, and disproportionately affected by, the adverse impacts of climate change, including health impacts, loss of home and property, and general quality of life. There is no reason to think that this is any different here in Dane County. In fact, there is data that tells us it is the same. The *Race to Equity* initiative baseline report released in 2013 by the Wisconsin Council on Children and Families (now Kids Forward) documents the "exceptional magnitude" of disparities between African Americans and whites in Dane County. On indicators such as unemployment rate, childhood poverty, adult poverty, graduation rates, school suspension rates, foster care, juvenile arrests, adult arrests, and others, the report shows that the disparity between blacks and whites in Dane County is greater than it is in Wisconsin as a whole and greater than it is nationally; in most cases, much greater. These inequities, which the Race to Equity initiative acknowledges apply to other ethnicities, not just African Americans, compromise the ability for communities of color in Dane County to adapt to climate change

and effectively prepare for severe weather events and other climate-related impacts. It is important to note the Race to Equity Initiative is a long-term effort focused on solutions and the Initiative developed a roadmap, made many recommendations, tracked progress, and measured many positive changes since the baseline report.

A strong focus on equity is also important because it will take everyone's involvement to get Dane County on the path to deep decarbonization; and it is likely that people of color will be among the strongest champions of mitigating climate change. There is solid data behind this claim. According to a Yale Program on Climate Change Communication study, a large majority of Latinos think the US should reduce its GHG emissions regardless of what other countries do, and 81 percent of Latinos support requiring fossil fuel companies to pay a carbon tax.

The Spirit Level

An equity focus is critical to ensure that our climate solutions are not only just, fair, and equitable but also effective. It is also important to understand that just as effective climate solutions have many co-benefits such as health and economic benefits, work to increase equity will directly improve a litany of social problems. Richard Wilkinson and Kate Pickett make an incredibly strong case for this point in their best seller "The Spirit Level, Why Greater Equality makes Societies Stronger." Wilkinson and Pickett look at the relationship between equity and nine social problems with readily available, international data. The nine social problems or concerns are:

- Level of trust
- Mental illness, including drug and alcohol addiction
- Life expectancy and infant mortality
- Obesity
- Children's educational performance
- Teenage births
- Homicides
- Imprisonment rates
- Social mobility
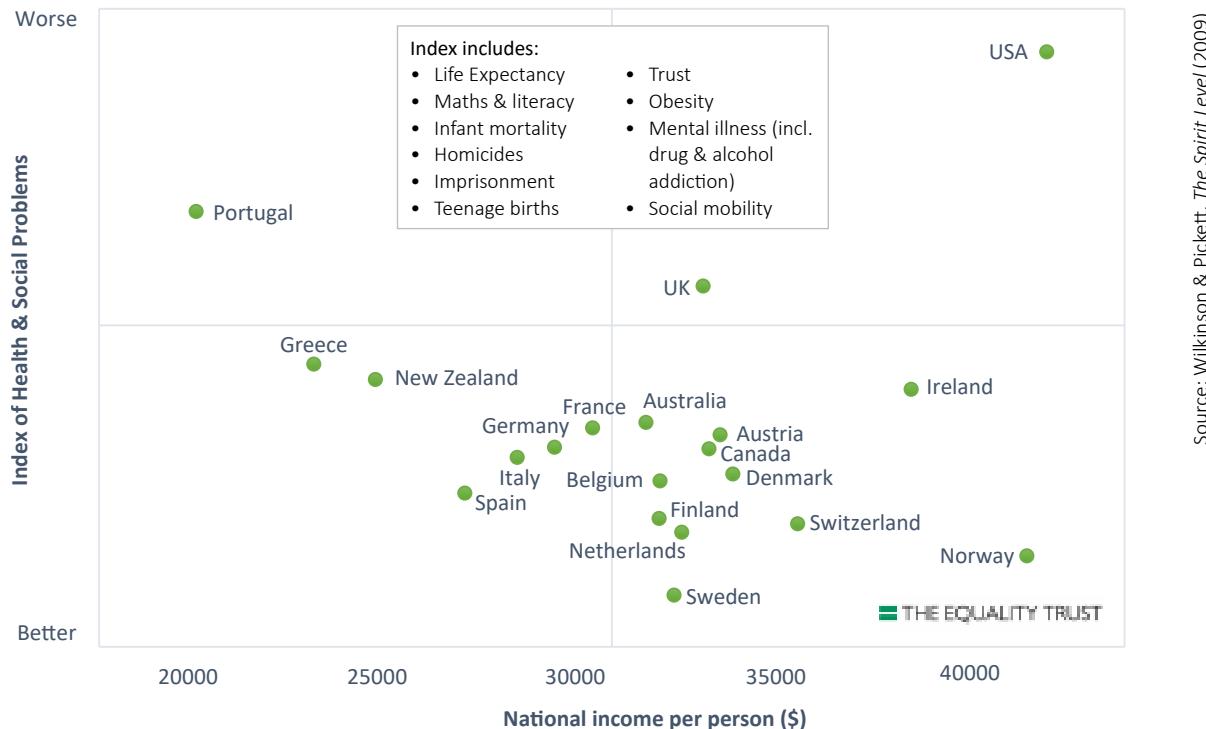
They combined the data from all of these and created an index of health and social problems and showed that national income level per person is only weakly related to the health and social problems index (Fig. 7.1), however, health and social problems are very closely related to inequality in relatively rich countries

(Fig. 7.2). Countries with greater equality tend to have fewer health and social problems. They make the case even stronger by showing statistically, the social problems are also correlated with equity across all the United States (Fig. 7.3). They go on to show that across countries and states, each of these social problems also directly correlates to inequality, so that the higher the inequality the greater the social problems. Inequality is at the root of many of our social problems, and addressing equality is important when addressing climate change.
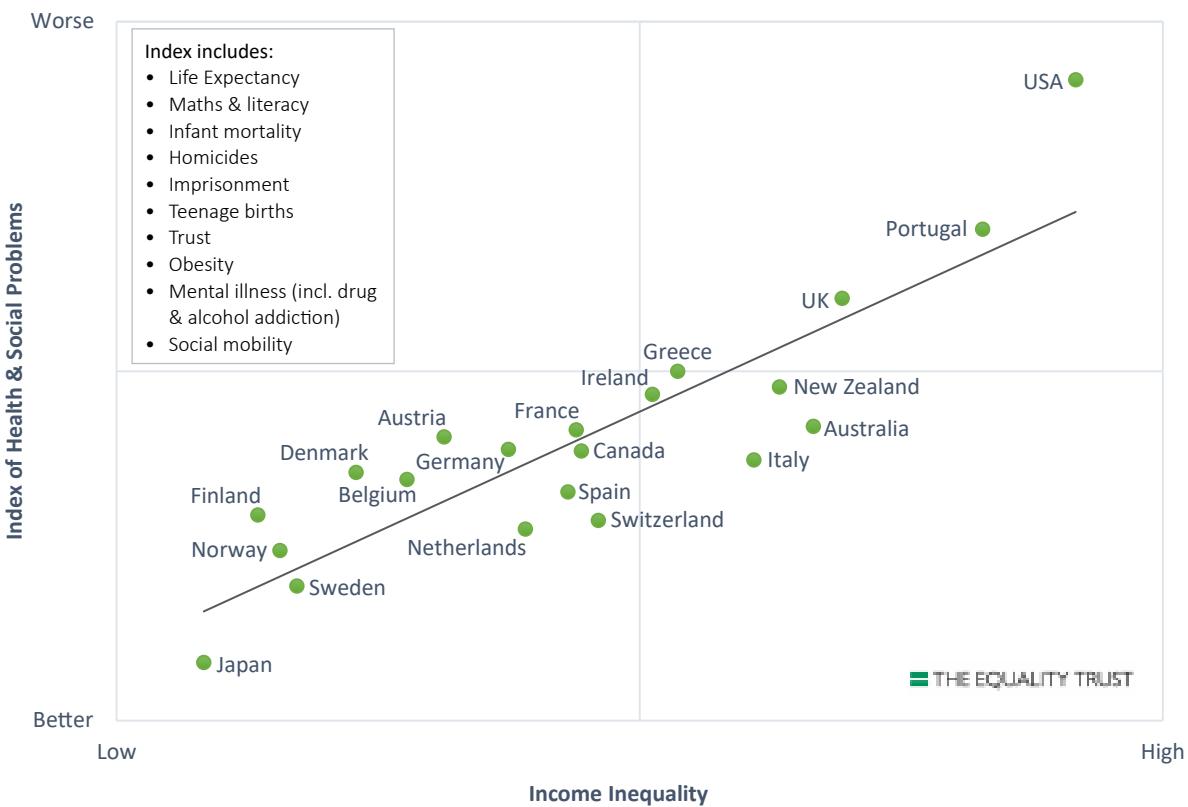
A Social Justice Lens

As we flesh out the details of this CAP and its implementation, the Office of Energy & Climate Change is prioritizing communities of color, low-income communities, and other vulnerable communities in a variety of ways. One way is by collaborating with the Madison-Dane County Public Health Department and the City of Madison on public engagement with community-based organizations. Another way is through health equity training provided by the Healthy Wisconsin Leadership Institute. The Healthy Wisconsin Leadership Institute (HWLI) conducts training for health professionals and others that focuses on the social determinants of health through an equity and justice lens.

Fig. 7.1: Health and social problems are not related to average income in rich countries.

Index includes:
- Life Expectancy
- Maths & literacy
- Infant mortality
- Homicides
- Imprisonment
- Teenage births
- Trust
- Obesity
- Mental illness (incl. drug & alcohol addiction)
- Social mobility

Source: Wilkinson & Pickett, *The Spirit Level* (2009)

Worse

Index of Health & Social Problems

Index includes:
- Life Expectancy
- Maths & literacy
- Infant mortality
- Homicides
- Imprisonment
- Teenage births
- Trust
- Obesity
- Mental illness (incl. drug & alcohol addiction)
- Social mobility

USA

Portugal

UK

Greece

Ireland

New Zealand

France

Austria

Australia

Canada

Italy

Denmark

Germany

Spain

Belgium

Finland

Switzerland

Norway

Netherlands

Sweden

Japan

Better

Low   High

Income Inequality

THE EQUALITY TRUST

Source: Wilkinson & Pickett, *The Spirit Level* (2009)

Fig. 7.2: Health and social problems are worse in more unequal countries.

Fig 7.3: Health and social problems are worse in more unequal US states.

Worse

Index of Health & Social Problems

MS

LA

AL

SC

AR

GA

KY

TX

NV

NC

OK

NM

TN

WV

IN

MI

MO

CA

AK

DE

MD

OH

AZ

IL

FL

PA

VA

WI

ID

OR

RI

NJ

UT

HI

KS

CO

WA

CT

NY

IA

NE

WY

SD

ME

MA

NH

VT

ND

MT

MN

Better

Low   High

Income Inequality

THE EQUALITY TRUST

Source: Wilkinson & Pickett, *The Spirit Level* (2009)

The Office of Energy & Climate Change with the City of Madison, health officials, and community groups has completed a ten-month training with the HWLI and has now begun a second, three-year phase of training in the health-equity space.

It is useful to recognize that there is a similar deep-decarbonization effort at the Midwest region level. RE-AMP is a network of approximately 130 NGO organizations focused on equitable deep decarbonization. Many organizations are advocating for, analyzing, or modeling what deep decarbonization looks like for their area. RE-AMP is one of the few that is conducting this work through a very deliberate and thoughtful equity lens. The Office of Energy & Climate Change will develop a strong collaborative working relationship with RE-AMP going forward.

Equitable and Just National Climate Platform

On July 19, 2019, a critical paper was released with the title: "Equitable & Just National Climate Platform" (EJNCP). The 19 national and regional environmental justice organizations and national environmental organizations who authored it describe it this way:

> This platform lays out a bold national climate policy agenda that advances the goals of economic, racial, climate, and environmental justice. The platform identifies areas where the undersigned environmental justice (EJ) and national groups are aligned on desired outcomes for the national climate policy agenda. The platform also lays the foundation for our organizations to vastly improve the way we work together to advance ambitious and equitable national climate policies and to work through remaining differences.

The EJNCP describes 13 achievements necessary to build an inclusive, just, and clean-energy economy:

- No community left behind
- A healthy climate and air quality
- Reduction in cumulative impacts
- An inclusive, just, and pollution-free energy economy
- Access to affordable energy
- A healthy transportation and goods movement system
- Safe and healthy communities and infrastructure
- Economic diversity and community wealth building
- Anti-displacement, relocation, and right to return
- Water access and affordability

Climate Champions
Results Ahead of the Plan

Dane County convened the Dane County Council on Climate Change to create this Climate Action Plan, and before the plan was even half finished, council members began partnering together to increase equity and promote clean energy.

At an early Climate Council meeting Chad Sorenson, the CEO of SunPeak, a Madison-based firm that designs and installs PV systems for businesses around the nation, met the Director of Workforce Development Services at the Urban League. Chad learned about the Urban League's Skilled Trades Apprenticeship Readiness Training (START) program, which works with underemployed and formerly incarcerated individuals, preparing them for careers in the trades.

Sorenson recognized that the START graduates could be great entry-level staff at SunPeak. So SunPeak's Director of Project Management, Casey Joyce, started working with the Urban League.

Terry Birts, the Construction Manager at the Urban League, coordinates the

▲ Cornelius Perkins (center), has quickly become a team leader at SunPeak. The solar Installers always start their day with stretching, then a team-building huddle which ends with everyone putting a hand in the center and saying, "1-2-3 SunPeak!" Here Cornelius fires up his co-workers in the rally circle before attacking the job.

START program and notes "We met with Chad to talk about how we could help him gain good, work-ready employees. They wouldn't be seasoned, but they're eager and ready to start a career." The partnership has resulted in SunPeak hiring about a dozen START graduates from the Urban League. Everyone is excited about the results.

Cornelius Perkins, a solar installer at SunPeak and START graduate, is enthusiastic about his future at SunPeak. "(Joyce) took a chance with me. Knowing my prison background, he didn't discriminate. He just wanted me to have an opportunity with a great company that's taking off. I really appreciate that from him. I always say, when someone says they believe in me, I go hard."

The partnership benefits SunPeak, too, giving them access to job-ready, entry-level employees who receive ongoing mentor support from the Urban League. "I like to think of this as a perfect example of how we can do well by doing good. And that is really rewarding, not only for me but for everybody that works here," says Joyce. "We benefit greatly from all the Urban League employees." ☀

- Self-determination, land access, and redevelopment
- Funding and research
- U.S. responsibility for climate action and international cooperation

You can read more about the platform here: ajustclimate.org.

Other Resources for Creating an Inclusive Process

We made a concerted effort to have diversity in our Climate Council, both in terms of ethnicity and race, but also in terms of perspective and experience. While we had four organizations that brought strong equity and justice perspectives, we didn't achieve the amount of diversity we would have preferred. We developed this CAP with a process very similar to the process used in probably 99% of all city and county climate action plans across the country – essentially a top-down process. At the end of our Climate Council process, I learned of another way – a more inclusive way, a bottom-up process. The NAACP Environmental and Climate Justice Program has developed a toolkit to help you conduct this type of process called *Our Communities, Our Power, Advancing Resistance and Resilience in Climate Adaptation, Action Toolkit*. Another excellent resource for this type of planning is the National Association of Climate Resilience Planners and the *Community Driven, Climate Resilience Planning: A Framework*. I strongly recommend you consult these excellent resources before undertaking climate action planning.

Economic Benefits

It is critical to consider costs and benefits of the goals and actions that are contemplated in the recommendation sections ahead. All actions, including the programs, policies and projects in this document incur costs and result in benefits. While the Office of Energy & Climate Change did not have the resources or bandwidth to conduct a formal cost analysis of each of the recommendations in this report, it was one of several explicit criteria the Climate Council considered as part of each recommendation. Some overarching cost-benefit and economic considerations will help put the recommendations for climate mitigation action in this report into perspective.

Major investments in energy production, food production, transportation, or any type of infrastructure result in economic development and benefits. But the cost-benefit analysis for various alternatives will yield very different results; and we have alternatives.

Fortunately, many clean energy resources today cost less than traditional fossil fuel energy resources, which are major sources of greenhouse gas emissions. This has been the case for energy efficiency resources for a long time. Meeting a kilowatt hour of electric energy demand through energy efficiency not only costs less than fossil fuel generation (or any electric generation for that matter), but it actually saves utility customers considerable money on their energy bills.
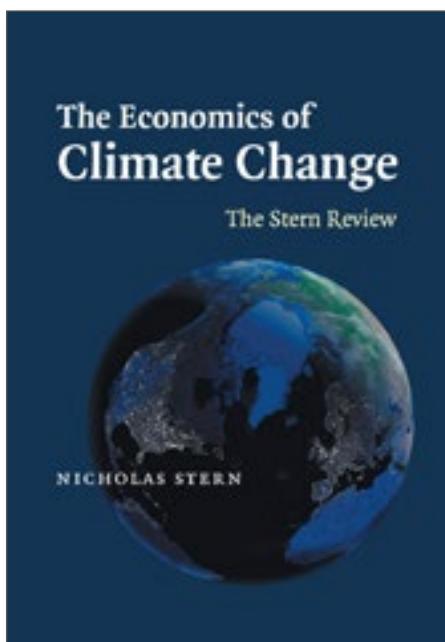
▲ Clean energy was one of the fastest growing sectors over the past decade nationally and worldwide. Solar employment reached more than a quarter of million in 2017 nationally. In 2018 Wisconsin had a little more than 3,000 people in solar jobs, ranking it number 24 in the nation according to The Solar Foundation.

The statewide energy efficiency program – Focus on Energy (FOE) – is a great example of this. For every dollar that ratepayers pay into the FOE program, utility customers see nearly a $4 benefit in the form of lower energy bills and avoided investment in infrastructure such as power plants and transmission lines. If you include economic benefits such as jobs created (delivering energy efficiency services), increased sales (of high-efficiency light bulbs and appliances), and increased disposable income (more money to spend on other things because

utility bills are lower), then each dollar in the FOE program resulted in about $6 in benefits to citizens and the economy in 2017.

An evaluation analysis of the economic impacts of the program showed that FOE created more than 1,000 jobs a year in 2015 and 2016 and the energy efficiency investments made in those two years will continue to create jobs – a total of approximately 8,770 jobs by 2040. Seven hundred of the jobs FOE created in 2015-16 were manufacturing jobs. The study further showed that FOE investments in 2015 and 2016 over the life of the measures or equipment installed, will cumulatively result in $1.3 billion in electric bill savings, $590 million in gas heating bill savings, $1.7 billion in increased sales of energy efficient equipment, a $370 million increase in personal income, and a cumulative net economic benefit of $760 million. This statewide energy efficiency program is a major economic development engine for Wisconsin. There is no reason that a county-level efficiency program couldn't do the same for Dane County.

As we think about the costs and benefits of investments in the transition to a clean energy economy, it makes sense to consider the environmental and quality-of-life costs, particularly in the context of a climate action plan. There have been several studies conducted looking at the cost of mitigating climate change and the cost of doing nothing about climate change. One of the earlier and best known was conducted in 2006 by the British economist Nicholas Stern. Known as the *Stern Review on the Economics of Climate Change,* the 700-page report concludes that climate change will have an enormous adverse economic impact on the global economy if left unchecked, equivalent to losing five percent of the global gross domestic product (GDP) each year, forever. At higher levels of warming, the loss could be as high as 20% of global GDP. The report finds, on the other hand, that early action with investments to mitigate climate change would be money well spent and would avoid some of those losses. The benefits of strong, early action on climate change greatly outweigh the costs.

More recently, The Economist Intelligence Unit published a study entitled *The Cost of Inaction: Recognizing the Value at Risk from Climate Change.* Addressing the finance industry, the study attempted to estimate the risk climate change poses to the global stock of manageable assets. Researchers found the current

(2015) stock of manageable assets to be an estimated $143 trillion (in US dollars). The study concluded that the expected losses to those assets from climate change are $4.2 trillion – roughly equal to the value of all the world's oil and gas companies, or the entire GDP of Japan. They further found that the warming of 5 °C would result in $7 trillion in losses and 6 °C could lead to a $13 trillion loss – roughly 10% of the global total. Another key finding was that from a public-sector perspective, a 6-degree warming represents losses worth $43 trillion – 30% of the world's manageable assets.

The cost of inaction:
Recognising the value at risk from climate change

Recognizing the inherent uncertainty in the IPCC's modeling, one of the study's reviewers, Nick Robbins, stated "We wouldn't get on a plane if there was a 5% chance of the plane crashing, but we're treating the climate with that same level of risk in a very offhand, complacent way."

Another recent analysis of this type was performed in 2015 by Citi GPS (Global Perspectives & Solutions), the research arm of Citigroup, which is an international financial services company based in New York. The study, called *Energy Darwinism II*, was written by a team of 10 economists and analysts and compares two scenarios, one a business-as-usual path where we don't make a concerted effort to address climate change, and the other a low-carbon path needed to keep warming to, or near, 2 °C (the IPCC's recommendation prior to their 1.5 degree report released in October 2018). The Citi GPS team prefaced the analysis with this statement:

> We are not climate scientists, nor are we trying to take sides in the global warming debate, rather we are trying to take an objective look at the economics of the discussion, to assess the incremental costs and impacts of mitigating the effects of emissions, to see if there is a "solution" which offers global opportunities without penalizing global growth, whether we can afford it (or indeed we can afford not to), and how we could make it happen.

The Citi analysis concluded

> The sums of money at stake in terms of investment in the energy sector are staggering – we estimate at $190.2 and $192.0 trillion between 2015 and 2040 for Citi's "Action" and "Inaction" scenarios respectively. The difference is marginal between the two scenarios…. However, going down the route of

"Inaction" would lead to a reduction in global GDP which could reach $72 trillion by 2060 depending on temperature increase, scenario and discount rate used.

The amount of warming they predict would lead to a $72 trillion loss of global GDP is 4.5 °C. At 2.5 °C they estimate a $44 trillion loss and at 1.5 °C, a $20 trillion loss. These estimates were derived applying a discount rate of 0%. With a discount rate of 3% (approximately double the rate used in the Stern Review), the GDP losses were estimated to be $7 trillion, $16 trillion, and $25 trillion at 1.5, 2.5 and 4.5 °C respectively. None of these studies had the benefit of the IPCC's 1.5-degree report – the cost/loss numbers presumably would be significantly larger if they had.

If losing $25, $40, or $70 trillion of net GDP value in our economy is bad at the global scale, then it is obvious we need to invest in clean energy solutions at the Dane County or Wisconsin level. We don't have any commercially viable fossil fuels in the ground here; but we do have a wealth of energy efficiency businesses. We also have lots of solar and wind developers. Wisconsin sends over $10 billion out of the state every year importing fossil fuels such as gas, petroleum, and coal to meet our energy needs. By investing in clean energy alternatives, we will keep more of those dollars circulating in our local economy.

Health Benefits

Fourth National Climate Assessment on human health impacts in the Midwest:

> Climate change is expected to worsen existing health conditions and introduce new health threats by increasing the frequency and intensity of poor air quality days, extreme high temperature events, and heavy rainfalls; extending pollen seasons; and modifying the distribution of disease-carrying pests and insects. By mid-century, the region is projected to experience substantial, yet avoidable, loss of life, worsened health conditions, and economic impacts estimated in the billions of dollars as a result of these changes. Improved basic health services and increased public health measures— including surveillance and monitoring—can prevent or reduce these impacts.

The Dane County Public Health Department, or Public Health, Madison & Dane County (PHMD),developed a climate change and health white paper recently that identified adverse health consequences in Dane County as a result of climate change including:

Climate Champions
A Youthful Climate Justice Hero Emerges

Stephanie Salgado, 18, a student at Memorial High School, waited her turn to speak at the youth-led climate rally in Madison.

"I felt my heart pounding, yet I held the microphone tight knowing that what I was about to say was right. I felt empowered, despite the hours that had gone by screaming through the day's climate fight. Reaching the podium along with my friend Sophie Guthier, allowed me to absorb the unbelievable sight. Little did I know as I spoke truth to power that my words would have such might."

On March 15, 2019, hundreds of students from the Madison area and around Wisconsin came out to take over the streets with leaders from the Youth Climate Action Team, and take back what belonged to them. Many of them, involved in their first protest, were afraid, but Stephanie was trained. Her determination was strong after months of contemplating the scary future of the planet she was inheriting. A few months later she was surprised by a phone call.

▲ Stephanie Salgado speaks in front of the Capitol in Madison at a youth climate rally and strike on March 15, 2019. The demonstration was organized by the Youth Climate Action Team of Wisconsin and other groups.

With that call she was appointed by both Lieutenant Governor Mandela Barnes and Governor Tony Evers to be a member of the state's Climate Change Task Force. The mission of the Climate Change Task Force is to advise the Governor on the most pragmatic ways to mitigate the effects of climate change. Stephanie at first questioned her potential and her ability as a UW Madison freshman. However, she soon realized that this isn't about her. It is about her community's goals. It is about giving a voice to the ones that have been silenced in the past. It is about representing the collective action of her community.

"I may have once been afraid to speak up due to my lack of enunciation and pronunciation as an immigrant, but nowadays, more than ever, I am anxiously waiting for my next opportunity to speak up and speak out for climate justice." ☀

- Human performance and daily life
- Heat-related injury and death due to heat waves
- Respiratory disease and allergic disorders

Fig. 7.4: Vulnerable populations. Examples of populations at higher risk of exposure to adverse climate-related health threats are shown along with adaptation measures that can help address sisproporionate impacts. When considering the full range of threats from climate change as well as other environmental exposures, these groups are among the most exposed, most sensitive, and have the least individual and community resources to prepare for and respond to health threats. White text indicates the risks faced by those communities, while dark text indicates actions that can be taken to reduce those risks. *Source: EPA.*

- Vector-borne disease from ticks and mosquitoes
- Waterborne and foodborne disease
- Health impacts related to food and nutrition insecurity
- Reduced availability of drinking water

The PHMD Climate and Health Report also did an excellent job of describing the disproportionate climate-related health risk to vulnerable communities and populations, including communities of color. Vulnerable individuals can include the very young, very old, socially isolated, homeless, people with low

socio-economic status, individuals with chronic disease or disabilities, and those often affected by social and economic determinants of health outcomes: people of color, non-English speakers, indigenous groups and those facing discrimination due to gender or religion. These populations, the PHMD explains, are at increased health risk, in part, because they have fewer resources to adapt to climate change impacts; climate change exacerbates socioeconomic inequities which exacerbates health inequities.

Reducing GHG emissions and mitigating climate change will clearly have a multitude of health benefits by avoiding all the direct adverse health effects that we know climate change is causing. In addition, reducing fossil fuel use locally and regionally will also generate very significant co-benefits by reducing additional emissions, such as sulfur dioxide, nitrogen oxides, and particle pollution that have adverse local impacts.

EPA's Clean Power Plan, while only in effect for a very short time, produced many benefits including a great deal of modeling and analysis. EPA estimated that a 30% reduction of carbon emissions (from a 2005 baseline) by 2030 would cut hundreds of millions of tons of carbon pollution, hundreds of thousands of tons of particle, sulfur dioxide, and nitrogen oxides. They further estimated that these emission reductions would prevent anywhere from 1,500 to 3,600 premature deaths and 70,000 to 90,000 asthma attacks in children. These estimated health benefits were limited to the elimination of power plant emissions. In Dane County, the elimination of emissions from gasoline and diesel-powered vehicles would also be a major driver of health benefits.

Key Message 1 from the Fourth National Climate Assessment – Human Health:

Climate Change Affects the Health of All Americans

The health and well-being of Americans are already affected by climate change, with the adverse health consequences projected to worsen with additional climate change. Climate change affects human health by altering exposures to heat waves, floods, droughts, and other extreme events; vector-, food- and waterborne infectious diseases; changes in the quality and safety of air, food, and water; and stresses to mental health and well-being.

Almost half of the projected deaths due to climate-related increases in ground-level ozone nationwide are projected to occur in the Midwest at an estimated cost of $4.7 billion (in 2015 dollars). The health benefits of reducing GHG emissions could result in economic benefits of hundreds of billions of dollars each year by the end of the century.

A very recent study conducted by a team of MIT researchers analyzed the impacts of renewable energy standards and carbon pricing policies on air quality and human health in rust-belt states including Wisconsin. The study found that existing renewable electricity standards produce a health co-benefit of $94 per ton of carbon dioxide reduced and that a carbon pricing policy would deliver health co-benefits of $211 per ton of carbon dioxide reduced in 2015 dollars.

These analyses look at the health impacts and associated cost savings of reducing emissions associated with ground-level ozone (smog) and other direct air pollutants that have respiratory disease impacts. Those are health impacts that have been studied in detail, and while not easy to predict and quantify, they are much easier than some, such as vector-borne diseases that are transmitted by animals, including mosquitoes and other insects.

The world's deadliest animal is not the grizzly bear, crocodile, or the great white shark. The world's deadliest animal is the mosquito. Mosquitoes kill approximately 700,000 people globally every year by transmitting diseases such as malaria, dengue, and yellow fever. These are all characterized as tropical diseases. Dengue is the most prevalent of all such diseases.

Dengue causes fever, joint pain, internal bleeding, and in some cases death. There are approximately 100 million cases of dengue fever, and approximately 10,000 deaths, across the globe each year: most of those in tropical countries such as India, Brazil, and several in central Africa.

Key Message 2 from the Fourth National Climate Assessment – Human Health:

Exposure and Resilience Vary Across Populations and Communities

People and communities are differentially exposed to hazards and disproportionately affected by climate-related health risks. Populations experiencing greater health risks include children, older adults, low-income communities, and some communities of color.

A 2019 paper published by the journal *Nature Microbiology* stated that the geographic range of dengue is expected to expand significantly as a result of climate change and urbanization including into "low-risk or currently dengue-free parts of Asia, Europe, North America and Australia." The study made projections for the spread of the disease in 2050 and 2080 under three IPCC climate scenarios and predicts an estimated 2.25 (1.27–2.80) billion more people will be at risk of dengue in 2080 compared with 2015. The study finds that "much of the southeastern USA is predicted to become suitable by 2050."

Adaptation & Resiliency

Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities.

- Intergovernmental Panel on Climate Change
Third Assessment Report, 2001

As Dane County continues to experience changing climate conditions, adaptation strategies must be used to offset potential social, economic, and ecological impacts. During 2013, Dane County governmental units formed the Dane County Climate Change Action Council as an adaptation planning exercise. Using future climate criteria (below), potential hazards, impacts, and adaptation strategies were identified and compiled in the report *Dane County Climate Change and Emergency Preparedness*.

▼ **Fig. 7.5:** *Source: Wisconsin Initiative on Climate Change Impacts - A1B scenarios for mid-21st century*

Temperature

Annual average temperature +6 °F
Average maximum temperature +6 °F
Annual peak temperature 110-112 °F
Twenty more days over 90 °F
Five hundred more cooling degree days
More frequent-longer heat waves

Precipitation

Annual precipitation +2"
Rainfall frequency and intensity increasing
Extreme rainfall event (6" in 24 hours)
Increased rainfall in winter and spring
Increased groundwater recharge
Changing snowfall rates and snow cover

Ongoing Climate Adaptation

Beginning in 2014, the Dane County budget included funding for climate adaptation strategies identified by the Climate Change Action Council, and Dane County departments have implemented plans to prepare for climate impacts upon public safety, transportation and other infrastructure, public health, and Dane County lakes and waterways. Examples include:

- $10,000 emergency sandbag program.
- $250,000 for the replacement of undersized road culverts.
- $75,000 to model the benefits and considerations for various lake level management scenarios to reduce flood impacts.
- $200,000 to analyze restoration of the Door Creek wetlands.
- $8 million for potential conservation acquisitions to improve the county's ability to reduce storm water run-off and improve water quality.

Adaptation and Mitigation

As Dane County moves forward with efforts to reduce its carbon footprint through the climate mitigation strategies described in this report, consideration must be given to additional opportunities to build resilience to climate impacts through adaptation. Office of Energy & Climate Change working groups have considered how future climate conditions might affect their recommended actions, for example the effect of increased demand for summer cooling during heat waves on renewable energy targets. Working groups have also considered how their recommendations can further climate resilience, such as how increased carbon sequestration on agriculture and forest land can improve soil health and thus rainfall infiltration.

As the climate changes, both carbon mitigation and climate impact adaptation strategies will continue to evolve together to take advantage of new understanding and increase resilience to future climate impacts. Some examples of opportunities to improve climate resiliency while reducing carbon emissions include:

- Using projected climate and weather extremes, such as changes in heating and cooling degree days and temperature extremes as criteria when evaluating energy mitigation programs.
- Prioritizing future land conservation efforts to both improve flood management and increase carbon sequestration.

- Identifying climate-appropriate tree species for urban forestry and rural afforestation.
- Making improvements to sanitary sewers to reduce carbon emissions attributable to increased pumping of stormwater inflow and infiltration.

Climate Adaptation Partnerships

Identifying and implementing successful adaptation strategies often requires viewpoints and expertise not found in county government. In the past, Dane County has actively partnered with Dane County UW-Extension for the public process around climate change impacts and adaptation, and the Wisconsin Department of Health Services for heatwave response and zoonotic disease prevention.

Moving forward, Dane County will partner with:

- The Wisconsin Initiative on Climate Change Impacts (WICCI) for access to the latest climate science and projections of future climate impacts.
- The Wisconsin Department of Natural Resources for natural resource management strategies to minimize impacts to streams and wetlands.

Bridging the Rural & Urban Divide

Rural Dane County contributes significantly to the County's overall economy. Dane County had the highest total corn (for grain) production of all 72 counties in the state in 2017. It also had the highest soybean production in the state. It had the third highest wheat production. It had the third highest milk production. It had the fourth highest number of cattle. In addition to one of the most robust farm economies in Wisconsin, rural Dane County has 27 County parks, five watersheds, 69 named lakes and ponds, 475 miles of streams, and more than 52,000 acres of wetlands. Rural Dane County has amazing natural resources, recreational opportunities, and economic production.

But rural Dane County, like all rural Wisconsin, has its share of challenges. In 2018 Wisconsin lost 638 dairy farms according to the Wisconsin Department of Agriculture, Trade and Consumer Protection; the biggest drop since records have been kept. As of August 2019, Wisconsin had lost 449 dairy farms, five of those in Dane County. According to a U.S. Department of Agriculture recently released
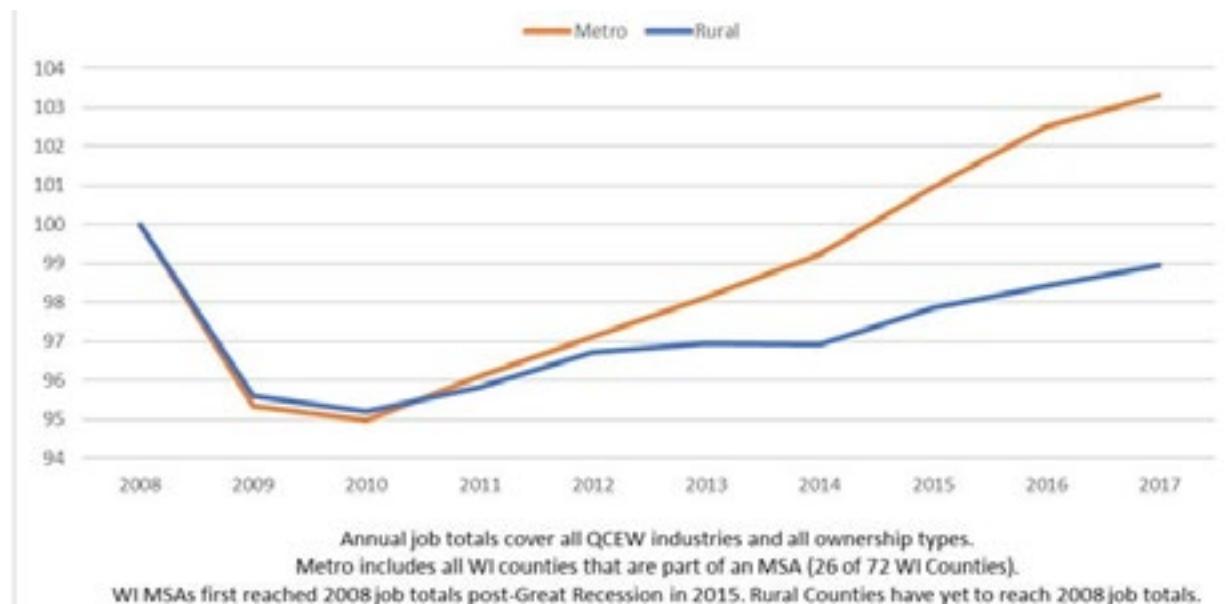
▲ Climate-change-driven flooding and droughts are having an adverse impact on forage crop production such as hay. These impacts, which result in higher costs for livestock feed, will increase more in the future but can be mitigated according to the best climate science.

report, Dane County has lost 142 dairy farms since 2007. There are many factors at play in forcing farmers out of farming; the price of milk is a major one.

Aside from losing farms, there are several factors creating obstacles to achieving broader economic potential, and in some cases, even basic services. A lack of high-speed internet access impedes economic development across much of rural Wisconsin, including rural areas of Dane County. A lack of resources to maintain roads and limited transportation options are also often cited as impediments in access to services such as health care, particularly for senior citizens and citizens with disabilities. The data in Fig. 7.6 shows that the job growth and economic recovery (since the 2008 recession) have lagged in rural areas relative to the urban and metro areas, and the gap continues to widen.

The clean energy investments recommended here hold tremendous economic development potential for rural Dane County. Most of the wind and solar power will be developed in rural areas. While we will prioritize mounting solar panels on as many rooftops as possible, the sheer volume of renewable generation needed to reach the goals in this plan, as well as the economics of attaining high

renewable percentages, dictate rural-based renewable energy systems, which inevitably means economic development and resources for rural landowners and rural governments. Badger Hollow Solar Farm in Iowa County, recently approved by the Public Service Commission, has an electric generation capacity of 300 megawatts and represents an investment of more than $360 million. This project will create an estimated 422 local construction jobs in Iowa County (plus 500 jobs elsewhere in the state), and another 17 long-term local jobs in Iowa County (and 24 long-term jobs elsewhere in the state).

Dane County has more than 10,000 acres enrolled in the federal Conservation Reserve Program which could host solar panels. In areas where solar arrays need to be connected to the grid and most land is in production, it will be critical for solar developers to understand the complex relationships of the various agriculture working lands and to talk to landowners early and often. It will be important for all stakeholders to acknowledge and understand the multiple and substantial benefits of wind and solar power on the landscape. In addition to critical GHG emission reductions, solar farms with native perennial plantings will replenish and build up soil fertility, retain water and reduce flooding, improve water quality by reducing runoff and nutrient loading, and improve ecosystem benefits. Maybe most interestingly, both solar and wind power will preserve farmland and preserve farms. There is no question that the high rent that solar and wind developers are able to pay farmers will give many family farms a

guaranteed income that will make the difference in allowing some farmers to continue farming.

UW-Madison political science professor and researcher Kathy Cramer identified and described Wisconsin's rural and urban divide in her highly acclaimed and deeply insightful book *The Politics of Resentment: Rural Consciousness in Wisconsin and the Rise of Scott Walker* published in March 2016. She described how the fact that poverty and unemployment are higher in rural areas and median income is lower influences the views and opinions in rural communities where there often aren't enough resources to maintain basic necessities, such as roads. I asked Professor Cramer what her best advice is for urban dwellers hoping to bridge the divide and if I had to sum up her response in a word it would be "listen." In a few more words she advised urban residents to spend time with rural residents, come with humility, and take time to listen and appreciate what you hear.

I've lived in rural Dane County for 13 years in two locations, and if you ask me the most important thing to know about rural Dane is the sense of community, the way neighbors help neighbors and communities come together for families in need.

Ecosystem Services

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Key Message A1:

> Nature is essential for human existence and good quality of life. Most of nature's contributions to people are not fully replaceable, and some are irreplaceable. Nature plays a critical role in providing food and feed, energy, medicines and genetic resources and a variety of materials fundamental for people's physical well-being and for maintaining culture.

On May 6, 2019, a body of 150 scientist experts (with input from 1,000 more) from 50 nations across the world issued a biodiversity assessment report that amounted to sounding a global ecological alarm for a biodiversity crisis. The group of scientists is The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (https://www.ipbes.net/). The conclusion: human activities, climate change being one of the most prominent, have pushed up to one million plant and animal species to the brink of extinction. The current rate of extinction, reflecting the decline of entire ecosystems across the globe, is ten to hundreds of times faster than the average rate of extinction

Nearly a quarter of the 14,000 plants and animals in the Americas that have been comprehensively assessed are classified as being at a high risk of extinction.

over the past 10 million years. Without drastic action to conserve habitat, mitigate climate change, and change land use patterns, the rate of extinction will increase even more.

The ecosystem plays a critical role in providing critical benefits for people including food, energy, medicines, genetic resources, and building materials. The IBPES assessment report points out, for example, that an estimated 4 billion people rely primarily on natural medicines for health care and an estimated 70 percent of drugs used to treat cancer are natural compounds or mimic natural compounds. In addition, ecological processes are critical for maintaining clean air, safe drinking water, productive soils, a stable climate, pest control, and pollination of 75% of global food crops.

Climate change is one of several direct causes of ecosystem and biodiversity decline; but perhaps more importantly, climate change is exacerbating the impact of other major drivers such as overexploitation of resources, and land and sea use changes.

Although the Dane County Climate Council did not explicitly consider ecosystem benefits in the development of the recommendations that follow in this report, we

▲ Moths contain compounds that are useful in the treatment of diabetes, cancer, high cholesterol, and high blood pressure.

are proposing a process for doing so as these recommendations are fleshed out, implemented, and evaluated.

The framework for such consideration will be selected key indicators, each of which provides insight into the health and stability of the ecosystem in Dane County. A group of designated specialists and subject matter experts will determine the set of key indicators. Once the group describes the key indicators and their status, they can be leveraged to identify win-win actions that can be incorporated into the CAP implementation to stabilize and improve ecosystems within Dane County.

Step 1 The Office of Energy and Climate Change will designate members for an ecosystem integrity working group to include subject matter experts from the myriad of organizations and institutions in and near Dane County.

Step 2 The Office of Energy and Climate Change will engage the ecosystem integrity working group to review example ecosystem status indicators, revise

and add to the list, and calibrate for relevance in Dane County. They will then produce a final list of key indicators and the criteria used for selection.

Step 3 The group will present the framework of ecosystem status indicators to the Director of the Dane County Office of Energy & Climate Change, representatives of the former Dane County Council on Climate Change, and the Dane County Land and Water Resources Department for input.

Step 4 The Office of Energy & Climate Change and ecosystem integrity work group will review the policies, programs, and projects within the CAP and identify potential opportunities, and adjustments and challenges.

Step 5 The Office of Energy & Climate Change and its partners will track the key ecosystem status indicators through the implementation of the Dane County CAP to understand whether actions are having the projected beneficial outcomes. Progress reports should be incorporated into the overall performance review process for the implementation of the Dane County CAP. The ecosystem integrity working group will reconvene periodically (every one to two years) to revisit the ecosystem status indicators and modify them to reflect changed and emergent conditions and to make recommendations accordingly for adjustments to activities and initiatives.

Focusing on the integrity of the existing ecosystem through direct indicators of its health is also supportive of building our community's resilience toward the effects of climate change. Healthy wetlands, waterways, soils, prairies, forests, and buffer zones are all beneficial in reducing the consequences of a changing climate and extreme weather events. Conversely, if the Dane County CAP is successful, a primary measure of success would logically be ecosystem health, so it makes sense to track ecosystem health directly to determine the effectiveness of plans and actions taken.

Goals & Modeling

The global scientific community, most notably the Intergovernmental Panel on Climate Change (IPCC), has amassed an incredible volume of analysis on the science of climate change, the drivers of climate change, the extent of climate change, the impacts of climate change, and most recently the magnitude of the actions needed to limit climate change and avert the most disastrous results of climate change. The IPCC documents this in a series of "assessment reports," "synthesis reports," "methodology reports," and "special reports." Five rounds of these reports have been issued to date; a sixth is due out in 2021. Taken all together it's a dizzying amount of data and analysis fitting for what most agree is the greatest challenge humankind faces today.

The *Special Report on Global Warming of 1.5 °C* released by the IPCC in October 2018 laid out the difference in climate impacts between a maximum warming of 2 °C, and 1.5 °C and the magnitude of the global emission reductions needed to keep warming to 1.5 °C. To maintain that level requires a reduction of carbon dioxide emissions of 45% globally from 2010 levels by 2030 and a reduction to net zero by 2050. The report looks at a range of pathways to keeping warming from exceeding 1.5 °C for non-carbon emissions. Reductions needed for methane and nitrous oxide are on the order of 60 to 80% and 30 to 50% respectively.

The Dane County Climate Council met shortly after the release of the report in October of 2018 and agreed that the targets set by that report are the most scientifically rigorous and therefore, quickly agreed to adopt these targets for the CAP goals. Figure 8.1 shows how these goals compare with goals of other cities and counties in the U.S. that have written climate action plans.

Given that the goals established by the IPCC need to be met by all economies globally and given that Dane County aspires to be a regional and national leader, we, the Office of Energy & Climate Change, believe that Dane County should aim to be carbon-neutral sooner and go beyond carbon-neutral to carbon-negative by mid-century or even before then.

Transitioning to a clean energy economy and reducing our GHG emissions by these amounts is a massive undertaking. Fortunately, experts from around the globe have invested many resources in analyzing how we can most cost-effectively make these emission reductions, in much the same way that the scientific community has prescribed for us the causes, impacts, and needed goals.

The Deep Decarbonization Pathways Project is a global collaborative effort among experts in 16 countries (which together represent approximately 74% of global GHG emissions) to develop and publish reports describing the most
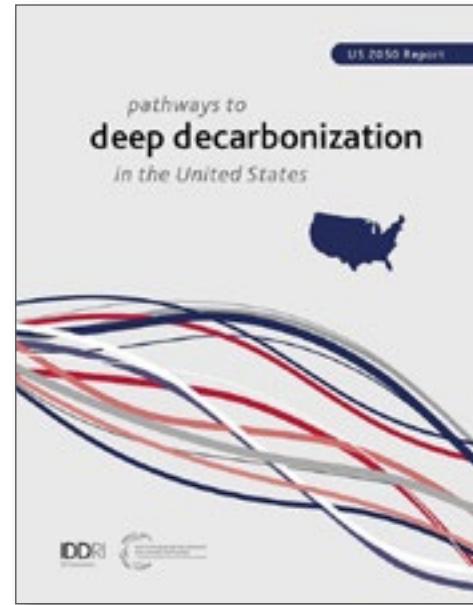
▼ Fig. 8.1: GHG Emission Reduction Targets of US Cities and Dane County

Location	Population	Climate Action Plan Year	CO$_2$ Reduction Target				Measured Progress
			2020	2025	2030	2050	
Ann Arbor, MI	120,782	2012		25%		90%	
Austin, TX	950,715	2015	20%		45%	100%	7% by 2016
Boulder, CO	108,090	2017				80%	13% by 2018
Chicago, IL	2,705,000	2008	25%			80%	
Dane County	537,000	2019			45%	>100%	
Eau Claire, WI	68,339	2018	5%		25%	40%	
Minneapolis, MN	413,651	2012	30%			80%	17% by 2015
New Orleans, LA	393,292	2017	10%	30%	50%		
Oakland, CA	425,195	2012	36%			83%	Above target
Orlando, FL	280,257	2013				100%	25% by 2018
Pittsburgh, PA	303,625	2017			50%	80%	
Portland, OR	639,863	2009			40%	100%	21% by 2014

cost-effective pathways to deep decarbonization for their respective nations' economies. The Deep Decarbonization Report for the U.S. was published in 2015 and, at the very highest level, the strategies to achieve deep decarbonization in the U.S. and elsewhere are relatively straightforward:

- **Energy efficiency** making final energy consumption much more efficient
- **Energy supply decarbonization** reducing net CO$_2$ emissions from energy conversion
- **Fuel switching** switching to energy resources that have lower net CO$_2$ emission factors, essentially recommending electrification

Not surprisingly, under each of these three broad strategies, there are numerous sub-strategies that become more complex. However, the Office of Energy & Climate Change, and in turn, the Climate Council, recognized this important body of climate solution work and the pathways proposed as a very useful and important template and used it as such from the beginning of this process.

Modeling

At the first meeting of the Dane County Climate Change Council, as the convener and facilitator, I made the statement that this climate action plan will be based on science and evidence. The modeling conducted as part of this process has been a critical part of that science and evidence. The modeling, along with the climate science section make this one of the most scientifically rigorous climate action plans written in the U.S.

The Modelers

The modelers who we contracted with, Evelyn Wright and Amit Kanudia, have a combined 50 years of experience in energy policy analysis, model development, and conducting modeling for a wide variety of clients across the country and the globe. Amit Kanudia is the founder and director of KanORS-EMR and has been an energy modeling researcher and consultant for 26 years. Amit also developed the Veda data handling system in use in more than 40 countries and has greatly expanded the power and flexibility of the MARKAL/TIMES models, energy system computer models used by 250 institutions in 70 countries including the EPA here in the U.S.

Evelyn Wright is the founder and principal of Sustainable Energy Economics. She led the development of EPA's MARKAL modeling and scenario analysis team and she was a lead modeler guiding development of national planning models in 11 southeast and eastern European states on behalf of the U.S. Agency for International Development. FACETS, the model used in Dane County, is Evelyn's fourth US MARKAL/TIMES model.

Evelyn Wright
Founder & Principal of Sustainable Energy Economics

Amit Kanudia
Founder & Director of KanORS – EMR
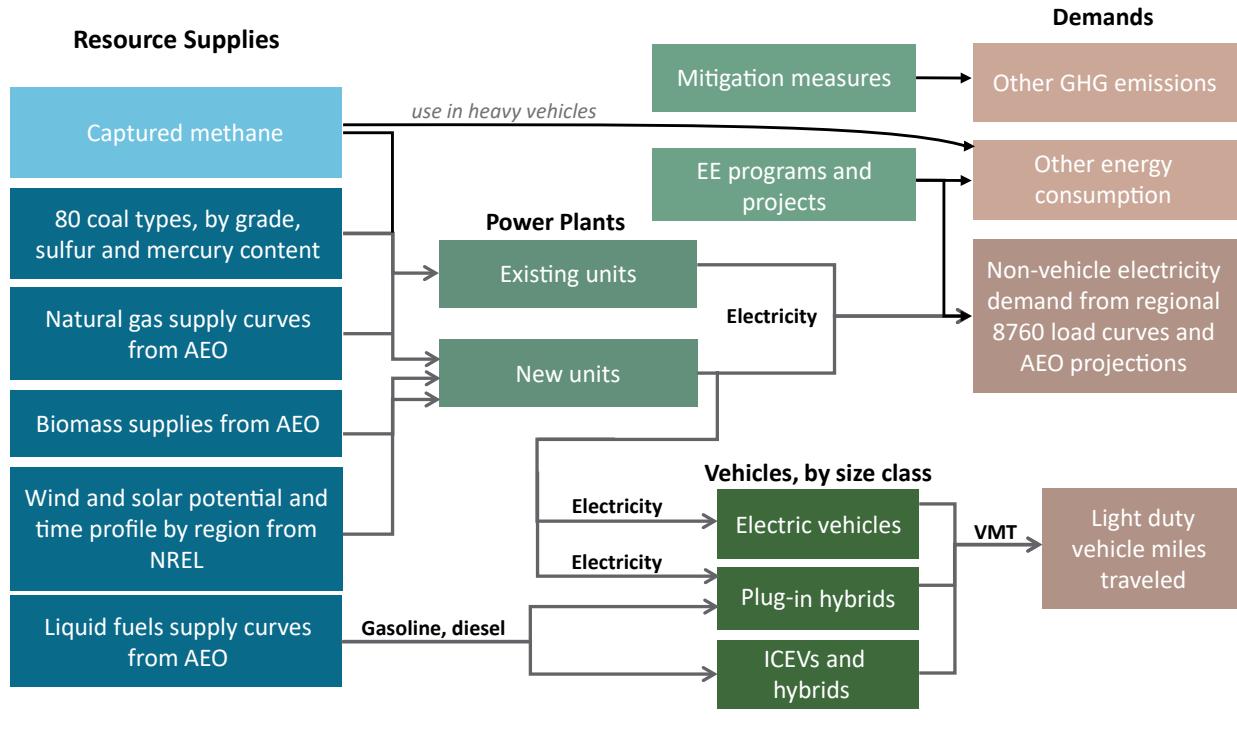
FACETS (Framework for Analysis of Climate-Energy-Technology Systems) is an extremely powerful power sector and economic optimization model that can be adjusted to include other sectors such as transportation. FACETS can integrate dozens of unconnected policies and projects undertaken at federal, regional, state, and local levels in response to diverse energy, climate, and air quality policy goals. The energy, environmental, and economic impacts of the measures can be assessed in the context of energy market uncertainties, and comprehensive climate policies, as well as allowing high priority actions that are robust to future uncertainties to be identified and explored. The FACETS modeling gives us more analytical rigor and it allows us to tell a better story.

The GHG Inventory

To conduct any modeling, we first needed a GHG emission inventory. A GHG emissions inventory was commissioned by Dane County in 2014 and conducted by a University of Minnesota research team.

Since the emissions inventory we had in hand at the beginning of this process is relatively dated, the Office of Energy & Climate Change staff and work groups worked to update those emissions and did so for the three sectors so that electricity use, vehicle emissions, and agriculture emissions were all established for 2017. The electric sector inventory data came from the actual electricity sales that each utility in the county reported for 2017. The transportation inventory data was from the Wisconsin Department of Transportation vehicle registration data for Dane County for 2017. The agriculture-related data came from a large body of research conducted by researchers in the Department of Biological Systems Engineering and the Agroecology Program at the University of Wisconsin – Madison, and the 2017 Wisconsin Agriculture Statistics published by the USDA. These figures were used to update the emissions inventory resulting in the distribution depicted in Figure 8.3. Transportation emissions (29%) and
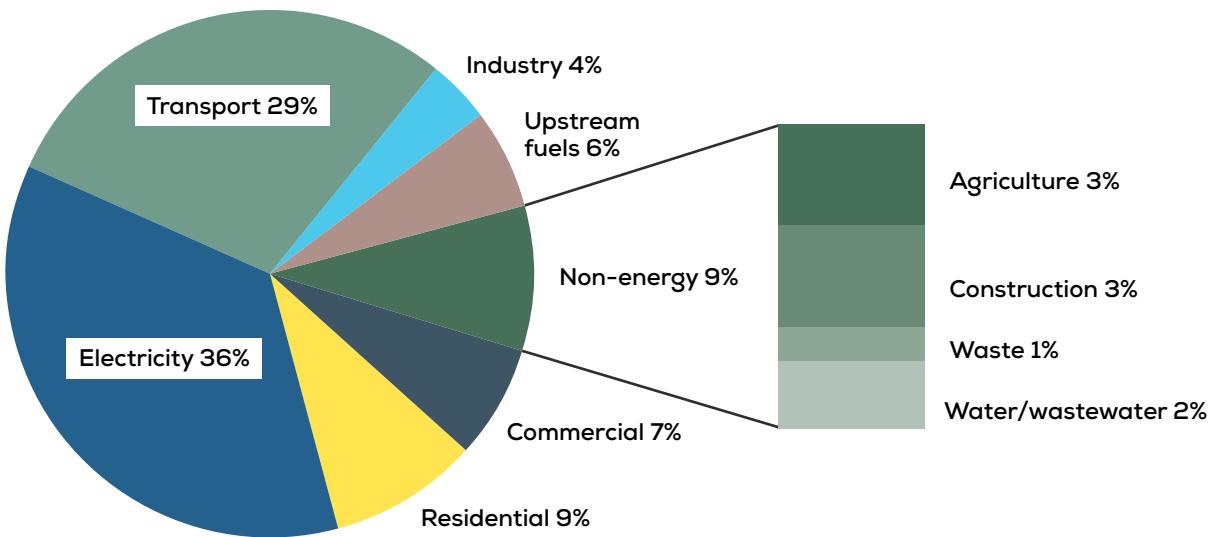
Fig. 8.2: The Dane County FACETS Reference Energy System

electricity emissions (36%) make up two-thirds of the emissions, and all other sources make up the rest.

It is important to recognize that our actions here in Dane County result in GHG emissions elsewhere. An example of this is that the petroleum-powered vehicles we drive here result in GHG emissions where the petroleum oil is extracted, where the oil is refined and shipped here to our gas stations, and where the vehicles are manufactured and shipped here. All those steps result in GHG emissions outside of Dane County. Shipping vegetables and fruit grown in California would be another example. The modeling discussed below does account for most of the energy related emissions we cause outside, or upstream, of Dane County, such as oil drilling, refining, and transport. The model does not have enough information to include the GHG emissions caused by most of the non-energy products we purchase and consume here, such as veggies and fruit grown in California.

The Baseline

The next step in the modeling was developing the baseline model runs. Baseline runs are essentially asking the model to tell us what happens to GHG emissions over time without any policy or other intentional effort, such as a CAP, to reduce
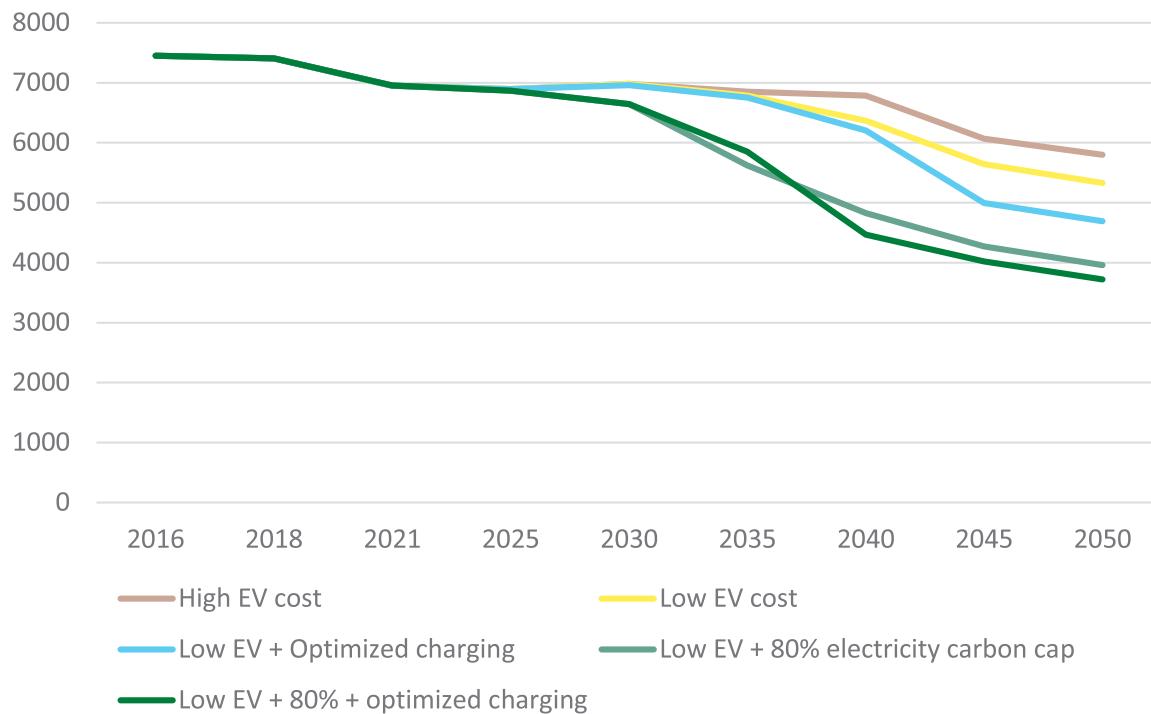
those emissions. Evelyn and Amit did not conduct just one baseline model run, they conducted 36 baseline model runs. The 36 baseline scenario model runs included various combinations of sensitivities (alternative futures) of critical factors such as the future price of natural gas, the future price of renewable technologies, the future cost of electric vehicles, and alternative vehicle miles traveled (VMT) — basically increases and decreases in the number of cars on the road. Figure 8.4 shows that the GHG emissions will decline in Dane County with no climate programs or policies launched, and that's because more renewable resources will be built (because they are cost-effective), more electric vehicles will be purchased (as fossil fuel-powered vehicles are retired), and more energy efficient investments will be made (because they save money). However, the reductions from these actions will not get us even halfway to the targets in the IPCC 1.5 oC report. Under the various baseline runs, GHG emissions are projected to be 7 to 20% below 2010 levels in 2030, and 18 to 40% below 2010 levels in 2050.

Modeling the Policies to 2030

There are more than 100 recommendations in this report for actions the County and our partners can take to reduce GHG emissions. The GHG emission reduction potential of these 100 actions was captured and represented by Evelyn and

Fig. 8.4: Baseline energy-related emissions with medium gas prices and low RE costs (thousand mt CO_2 equivalent)

Amit in the ten policy categories in Figure 8.5. We intentionally broke the policy modeling into two parts, two timeframes. The first is from today to 2030, and the second from today to 2050. There are several good reasons for doing this. One is that the IPCC 1.5 °C report gave us target goals on these timelines. An even more important reason is that this CAP report can say a lot about what we can do in Dane County to mitigate climate change between now and 2030. On the other hand, this CAP report is very limited in what it can say about the best strategies to mitigate climate change between the years 2030 and 2050 because technology, markets, attitudes, and politics can change incredibly fast.

For the near-term modeling Evelyn and Amit fed our 100 climate mitigation actions (the 10 policy categories in Figure 8.5) into their world-class model to see where those 100 actions could get us in terms of emission reductions. They did that more than once; they did it 84 times. They informed our modeling results with the results from another deep-decarbonization effort they modeled for the entire mid-continent (the Midwest extended to the Gulf of Mexico). This helps us understand how our climate actions are affected by what the rest of the Midwest and U.S. are doing in each of these policy areas. These mid-continent scenarios included ones with a carbon policy that reduces emissions on the regional grid

Policy	Name	Near-term Policy Goals	2050 Policy Goals
1	VMT	15% reduction in VMT by 2050 (Low projection)	Same
2	EVs	EVs have 57% sales share by 2040	Same
3	Biogas	60% heavy vehicle fleet to biogas over 2019 to 2026 50% of transit buses are converted to ELC by 2035	Same, biogas emissions accounting adjusted to be full methane combustion emissions. Methane destruction accounted for separately.
4	Solar	1200 MW by 2030	Combined in RE Elec policy: 2030 solar and wind targets, plus 100% of load is met by wind + solar by 2045
5	Wind	Wind meets half of Dane County load by 2030	
6	Water	Decrease per capita water demand by 20%	and 30% by 2040
7	EE	Reduce energy usage by 2% annually per capita by 2030	and 3% by 2035, 4% by 2040 (existing COM buildings only after 2030)
8	Bldgs	Improve performance of new COM buildings starting in 2025	Savings ramp up to all new buildings having 75% less consumption by 2040
9	HP	Convert half of LPG and oil heat to heat pumps by 2030	and all LPG & oil to heat pumps by 2045, and all new residential construction with heat pumps by 2040
10	Digesters	Half of all manure is processed in anaerobic digesters by 2030	All manure is processed in digesters by 2050. Results in reduction of 27% of Ag methane and 25% of N2O

▲ **Fig. 8.5:** Policy measures analyzed

by 80% by 2050. See the Midcontinent Power Sector Collaborative sidebar for a more detailed description of that effort.

Among the various findings in these "near-term" policy model runs we found that:
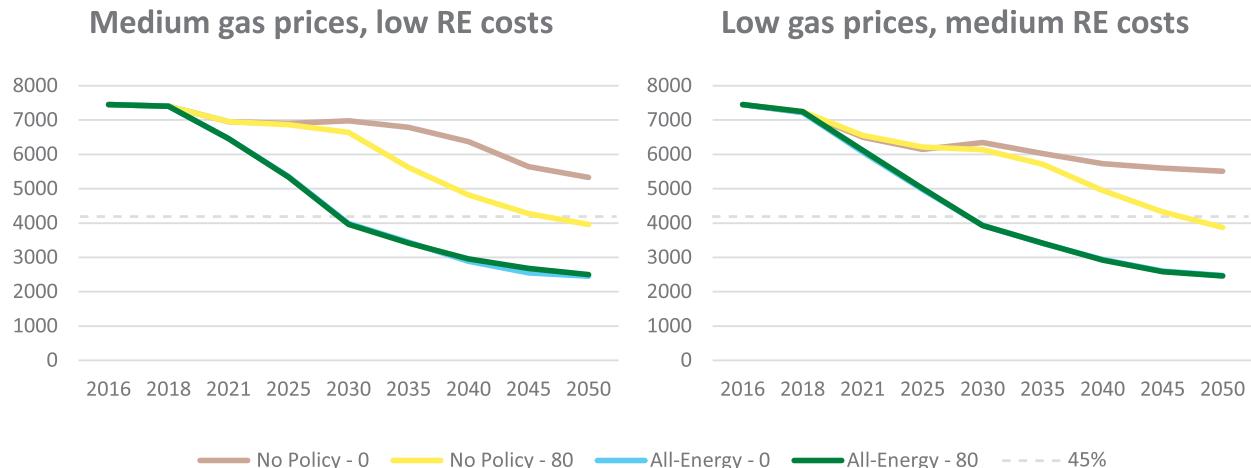
- Reducing vehicle miles traveled has a gradual but increasing emission reduction impact over time making it a critical strategy.
- Actions that increase EV sales over the next 10 to 20 years result in significant emission reductions and technology improvements.
- If we are successful in getting other government and business fleets transitioned to RNG we can create a significant and stable emission reduction from the baseline.
- The solar goal of meeting a third of our electricity needs through solar by 2030 leads to rapid near-term emissions decline, as does the wind goal of meeting one-half of our electricity needs with wind. Together the wind and solar policies drop emissions to nearly 40% below the 2010 levels by 2030, which is much faster than a regional carbon cap.

- The energy efficiency policy impacts on emissions increase over time as new buildings account for a growing percentage of commercial energy use.
- Price-responsive electric vehicle charging helps to incorporate more solar and further reduces emissions. The time of day when we charge electric vehicles matters.

Most important, combining all the policies brings the 2030 GHG emissions to nearly 50% below 2010 levels (Fig. 8.6). These modeling results are good news. They tell us that using the most cost-effective technologies and strategies we can get to levels of deep-decarbonization in the relative near term, meeting the goals that the scientific community is telling us we must reach if we hope to avoid the most disastrous effects of climate change, locally and globally.

The longer range 2050 modeling runs tell a different story. Figure 8.6 shows our best estimates of what might be achieved in each of the policy categories by 2050. When Evelyn and Amit ran the 2050 policy measures through the model, they came up with a range of GHG emission reductions of 65 to 68% (Fig. 8.6 and 8.7). The reasons the 2050 policies fall far short of reaching our 2050 goal are that this plan has done relatively little to reduce natural gas use for heating, the model still assumes a significant amount of transportation fuel being used in the economy (this includes those energy-related emissions outside of Dane County), and mostly because it is really difficult to anticipate and predict changes in technology and markets. Does it mean that we are doomed? Absolutely not. It means we will need to continue to innovate, continue to invest in research and

Fig. 8.6: Energy-related GHG Emissions (Thousand Metric Tons CO_2-equivalent). GHG Emission reductions from all policies. Combining all the policies brings the 2030 reductions to 48-49% below 2010 levels. Emissions continue to fall after 2030, reaching 67-68% below 2010 levels by 2050.
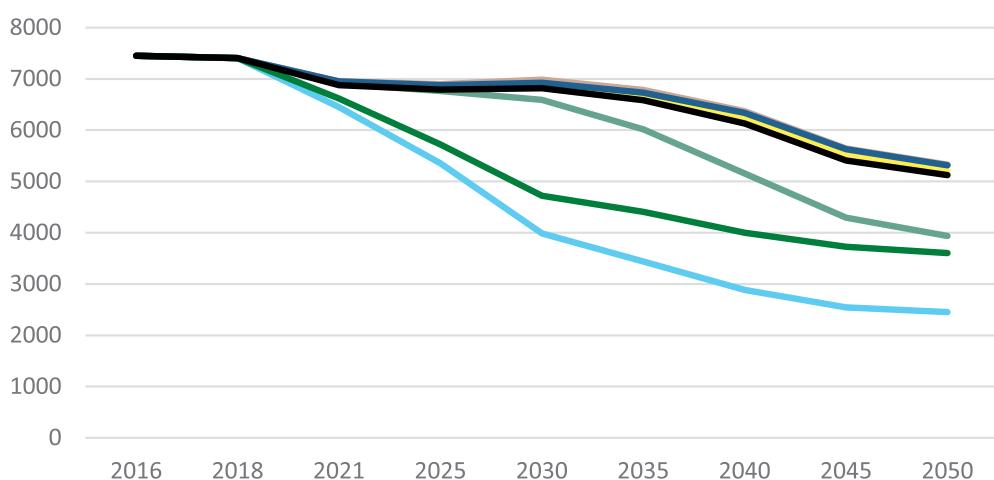
development, continue to collaborate with other jurisdictions, and revise this CAP every three or four years.
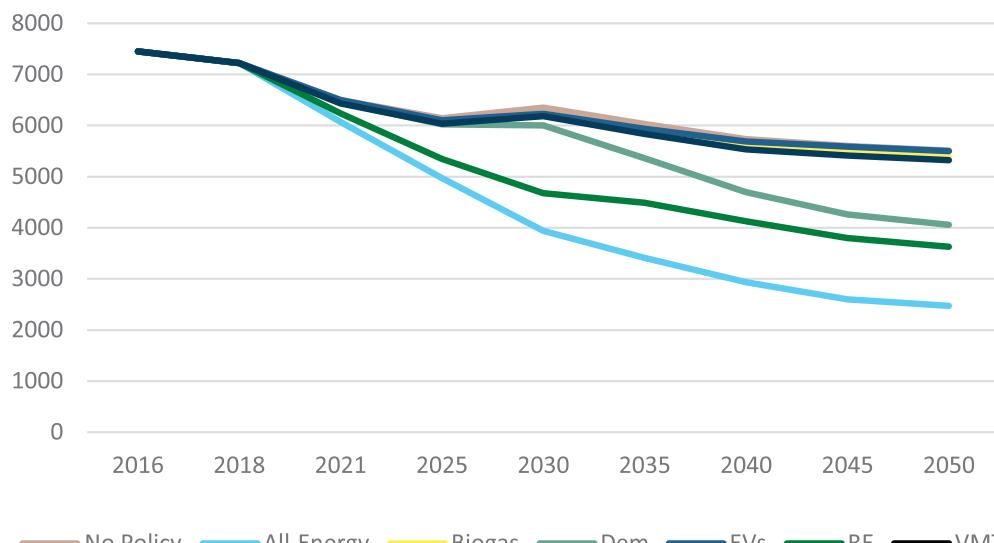
The graphs in Figure 8.7 make it appear that reductions from the transportation policies are relatively small. Figure 8.8 highlights the effects of transitioning to EVs, reducing the vehicle miles traveled (VMTs). It helps show that reducing VMT results in very significant GHG emission reductions and that the higher the VMT,

▼ **Fig. 8.7**: Emission Reductions by Separate Policy Areas

Medium gas prices, low RE costs, no regional carbon cap

Low gas prices, medium RE costs, no regional carbon cap
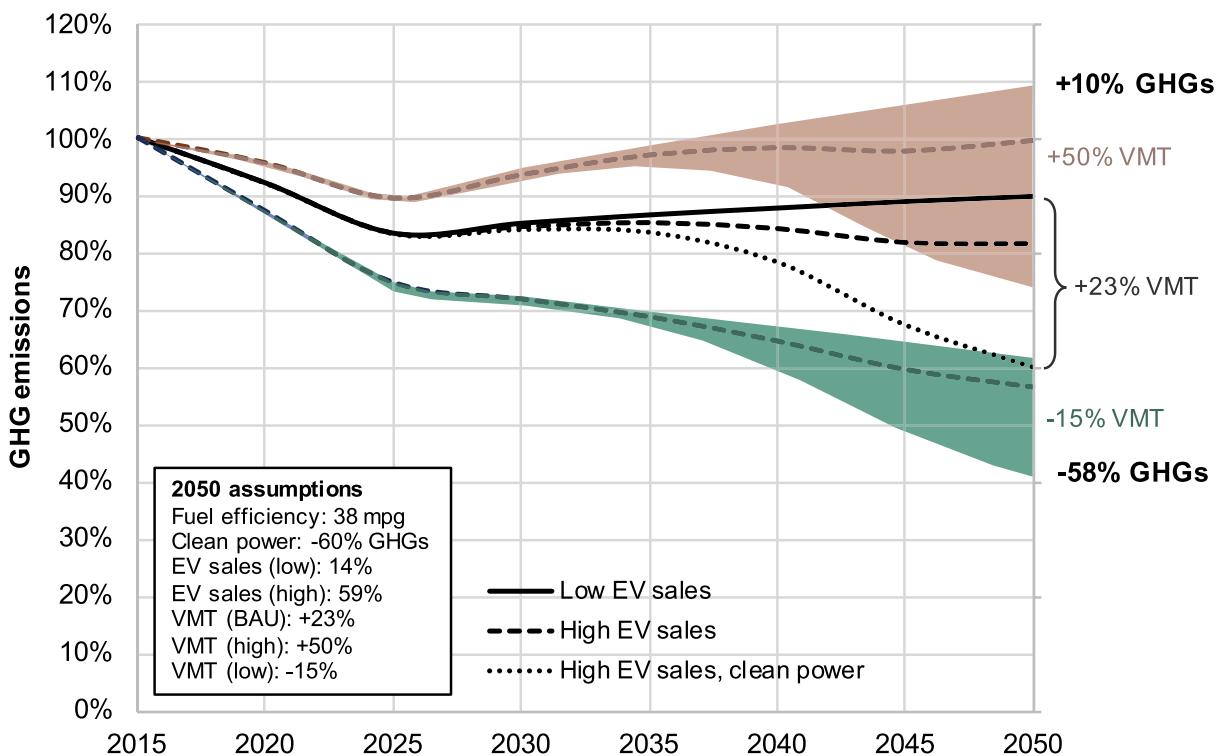
No Policy · All-Energy · Biogas · Dem · EVs · RE · VMT
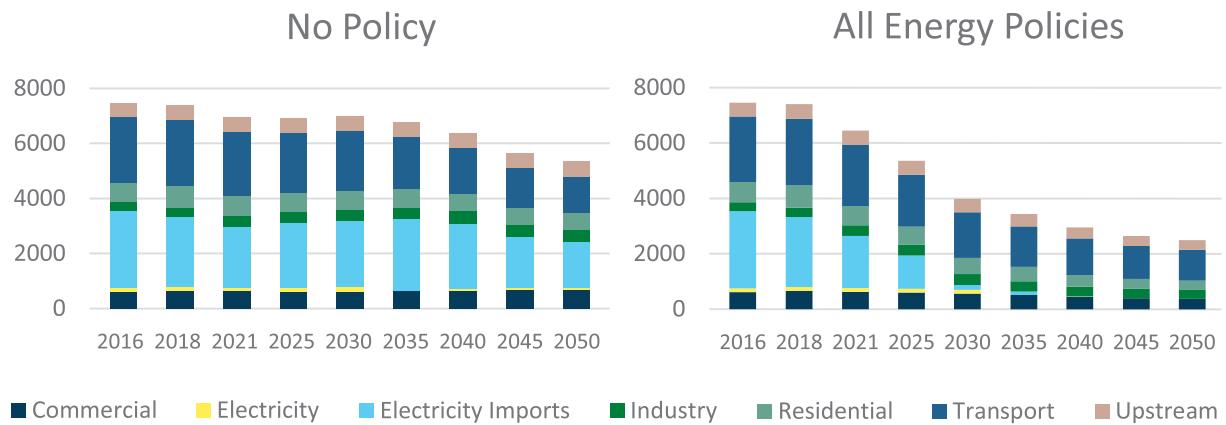
the more important vehicle efficiency (EVs are much more efficient than gasoline) and a clean electricity supply are.

Perhaps the most important thing this modeling tells us is what emissions are left when we meet our 2030 goal and which emissions explain why we fall far short of our 2050 goal. You can see from Figure 8.9 that a lot of transportation emissions remain. A small part of that is jet fuel, but most of it is light and heavy-duty fossil fuel vehicles that are still on the road. The "upstream" emissions remind us that burning fossil fuel not only emits carbon pollution from the tailpipe and the smokestack, but also from the extraction (mining and drilling) processes and transportation that make up the life cycle of fossil fuels.

Figure 8.10 shows us which fossil fuels stand between us and our 2050 goal of net zero carbon. The use of natural gas for residential, commercial, and industrial heating is certainly the big obstacle. We know that heat pumps do not compete economically with natural (fracked) gas today. We need to figure out how they can compete five years from now to help bend those natural gas emissions downward sooner rather than later.

Fig. 8.8: The Relative Effects of VMTs and EV sales on GHG Emissions

2050 assumptions
Fuel efficiency: 38 mpg
Clean power: -60% GHGs
EV sales (low): 14%
EV sales (high): 59%
VMT (BAU): +23%
VMT (high): +50%
VMT (low): -15%

Low EV sales
High EV sales
High EV sales, clean power

No Policy

All Energy Policies

Commercial ■ **Electricity** ■ **Electricity Imports** ■ **Industry** ■ **Residential** ■ **Transport** ■ **Upstream**
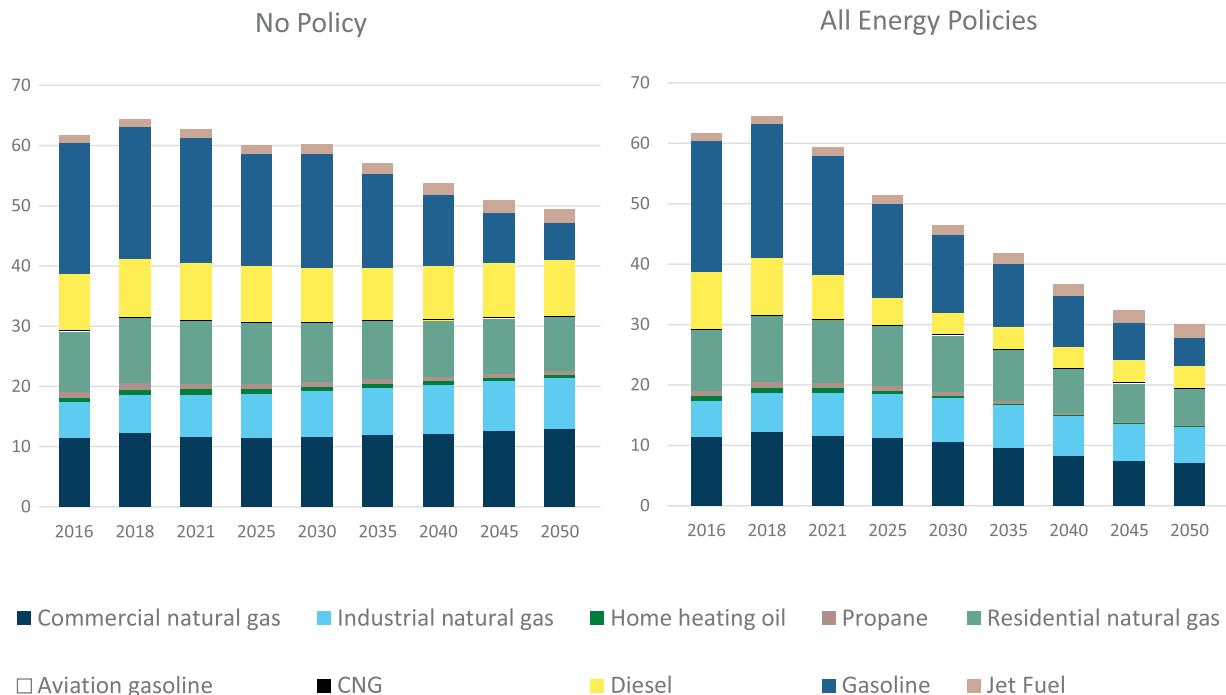
Fig. 8.9: Energy-related GHG emissions (thousand metric tons CO_2-equivalent). Post-2050, remaining major sources of emissions are:
- Heavy vehicles not converted, including "light commercial trucks"
- Air travel
- Remaining residential, commercial, and industrial natural gas consumption
- Upstream emissions from all fuels consumed

Fig. 8.10: End-use fossil fuel consumption (TBTU). Remaining 2050 fossil fuel consumption is 40% lower than in the baseline, and consists of about two thirds natural gas and one third transportation fuels

No Policy

All Energy Policies

■ Commercial natural gas   ■ Industrial natural gas   ■ Home heating oil   ■ Propane   ■ Residential natural gas

☐ Aviation gasoline   ■ CNG   ■ Diesel   ■ Gasoline   ■ Jet Fuel

Modeling Agriculture Emissions

Dane County has significant GHG emissions related to agriculture. In our modeling, we looked at agriculture-related emissions separately from those related to fossil fuel/energy for many reasons:

- The science behind the non-CO_2 agriculture sector emissions is not as advanced and certain as the energy sectors, particularly not in our 2014 inventory.
- The US Deep-Decarbonization Pathways Project envisions an 84% reduction in carbon emissions from fossil fuel combustion and a 12% reduction from non-CO_2 emissions.
- In the IPCC 1.5 °C pathways report, methane emissions from agriculture, forestry, and other land uses become an increasing share of the overall methane emissions going from slightly less than 50% in 2010 to 55 to 70% in 2030 and 60 to 80% in 2050.

The 2014 GHG inventory for Dane County had inconsistencies with other state GHG inventories regarding agricultural emissions, particularly nitrous oxide emissions. Fortunately, a group of UW-Madison researchers has been involved in a study of GHG emissions from agriculture, and specifically the dairy industry, since 2013. The Dairy Coordinated Agricultural Project has been a seven-year, $10 million research project involving 33 co-principal investigators across 13

Fig. 8.11: GHG emissions from dairy farms and crop production in Wisconsin

|	kg CO_2 eq/ kg FPCM	kg CO_2/AU	kg CO_2 eq/ AU/year	kg gas/AU/ year
Enteric methane	0.48	7.72	2819	101
Methane from manure storage	0.18	2.90	1057	38
Nitrous oxide from manure storage	0.05	0.80	294	1
Nitrous oxide from crop production (fertilizer and manure application)	0.14	2.25	822	3
CO_2 from fossil energy and inputs	0.14	2.25	822	822
TOTAL	0.99	15.93	5814	965
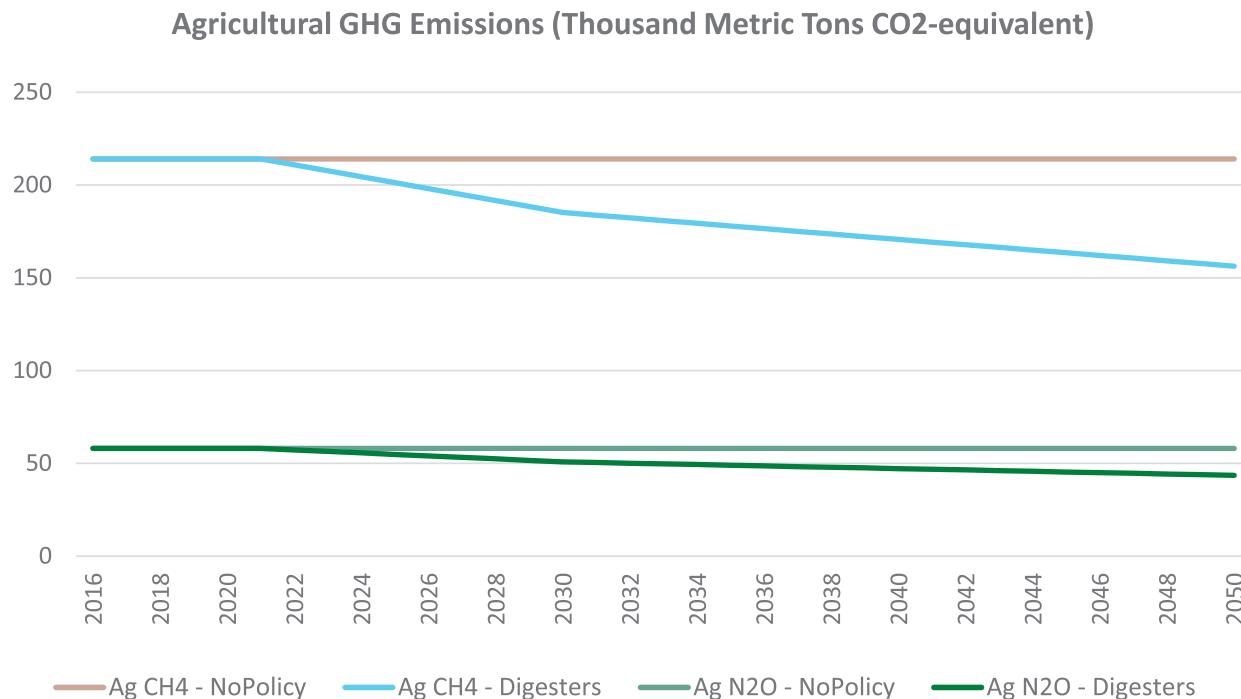
institutions including the United States Department of Agriculture, eight universities, the Innovation Center for U.S. Dairy, and others. The project director, Matt Ruark, and the co-project director, Molly Jahn, are professors at UW-Madison. One of the project's lead researchers, Horacio Aguirre-Villegas, used the findings from a research paper he published in 2017 that looks at GHG emissions from dairy farms and crop production in Wisconsin to develop Figure 8.11 which gives us methane and nitrous oxide emission rates. We applied rates to the Dane County dairy herd numbers in the 2017 Wisconsin Agriculture Statistics report to develop an updated emission inventory for the Dane County agriculture sector.

▶ **Horacio Aguirre-Villegas, Ph.D.**
Assistant Scientist in Biological Systems Engineering at University of Wisconsin-Madison

Enteric methane emissions in Figure 8.11 are emissions that come from the cow's breath because of fermentation in the cow's digestive system. While this inventory doesn't account for every agriculture product or practice in Dane County, given that most of the crop production in the County is grown for dairy feed, we believe that the emission sources in Figure 8.11 do represent the vast majority of the agriculture emissions in Dane County. The Dairy Coordinated Agriculture Project found that anaerobic manure digestion, which turns methane (which has a higher climate change impact) into lower-impact carbon dioxide, is the most effective mitigation strategy available today. The Dane County Climate Council recommends an aggressive goal of treating 50% of the dairy manure in Dane County in digesters by 2030 and 100% by 2050. This results in a 27% reduction of agriculture-related methane emissions and a 25% reduction of nitrous oxide emissions (Fig. 8.12). The nitrous oxide emission reductions are not a direct result of the anaerobic digesters, but rather the result of the separation of the manure solids and liquids which results in liquid manure storage that is less conducive to nitrification and denitrification, or the formation of nitrous oxide.

In addition to the anaerobic digestion, the dairy research project found the potential for greater agriculture emission reductions, as high as 36% (for a 1,500-cow dairy), if the best cow genetics, feed practices, manure handling, and cropping systems are employed. It is worth noting that the dairy research group effort looked at small dairy farms as well and these same practices could achieve a 46% GHG emission reduction on a 150-cow dairy farm.

Agricultural GHG Emissions (Thousand Metric Tons CO2-equivalent)

Fig. 8.12: Digester policy: half of all manure is digested by 2030 and all by 2050. The policy reduces agricultural emissions by about one quarter by 2050. Method: manure is responsible for 27% of ag methane and 25% of N_2O. Starting in 2022, these emissions are linearly reduced, reaching half of their 2016 values in 2030 and fully mitigated by 2050.

While the agriculture sector presents climate mitigation challenges, it also offers a wide range of opportunities. The Dairy Research group found that in addition to significant GHG emission reductions, the best practices they identified will also reduce nitrogen contamination of groundwater by 41%, reduce phosphorus pollution in our lakes and streams by 52%, and increase profitability by as much as 20%. The regenerative agriculture systems identified in the agriculture and forestry section would have even bigger co-benefits, as well as major ecosystem benefits. Going forward, this CAP recommends that the Office of Energy & Climate Change connect with and collaborate with the UW-Madison Dairy Research team members to help establish a public outreach and engagement program to ensure that the dairy research best practice findings are employed as widely as possible. The Office of Energy & Climate Change will need to coordinate this effort with the Dane County Land and Water Resources Department, the Yahara Pride Farms, and other regional farm organizations.

Cost Modeling

In this section we examine the costs and savings associated with each of the 10 policy areas being modeled. The FACETS model contains an amazingly large amount of data including cost data. It is an economic optimization model, so it is possible to calculate the costs for those energy investments that are endogenous to the model. It is a power sector model, so the various electric generation sources are well understood by the model, and Evelyn and Amit have added the transportation sector, so that vehicle-related costs are also in the model.

Electric Vehicles Under the EV policy recommendations, accelerated EV purchases cost an additional $53 million in 2030 and use $40-$45 million per year in electricity, while saving $18 million annually in vehicle repair costs and $95 million per year in gasoline. The fact that electricity is cheaper than gasoline and that EVs have significantly lower maintenance costs than gasoline-powered vehicles means that Dane County residents would see a net savings by transitioning to EVs.

Renewable Electric Generation The renewable energy (RE) policy requires increased investment, mostly in photovoltaic systems, in the 2020-2040 timeframe. Investment cost increases vary by scenario and time period. They peak in 2030 at $90-116 million per year. Some of this cost increase is offset by a decrease in expenditures for imported electricity, ranging from a few million dollars per year up to $60 million per year in some scenarios and years. This trend is reversed in later years as lower capital investments are needed and more wind is imported from outside the county. By 2050, the RE policy scenarios require up to $100 million per year less investment and have import costs between $30 million lower or up to $50 million higher per year than the no-policy case.

Overall, the RE policy costs $50-150 million more per year in 2030 and saves $5-60 million per year in 2050. The cost impact is greater when assumed RE capital costs are greater and when gas prices are lower (lowering the cost of regional grid electricity).
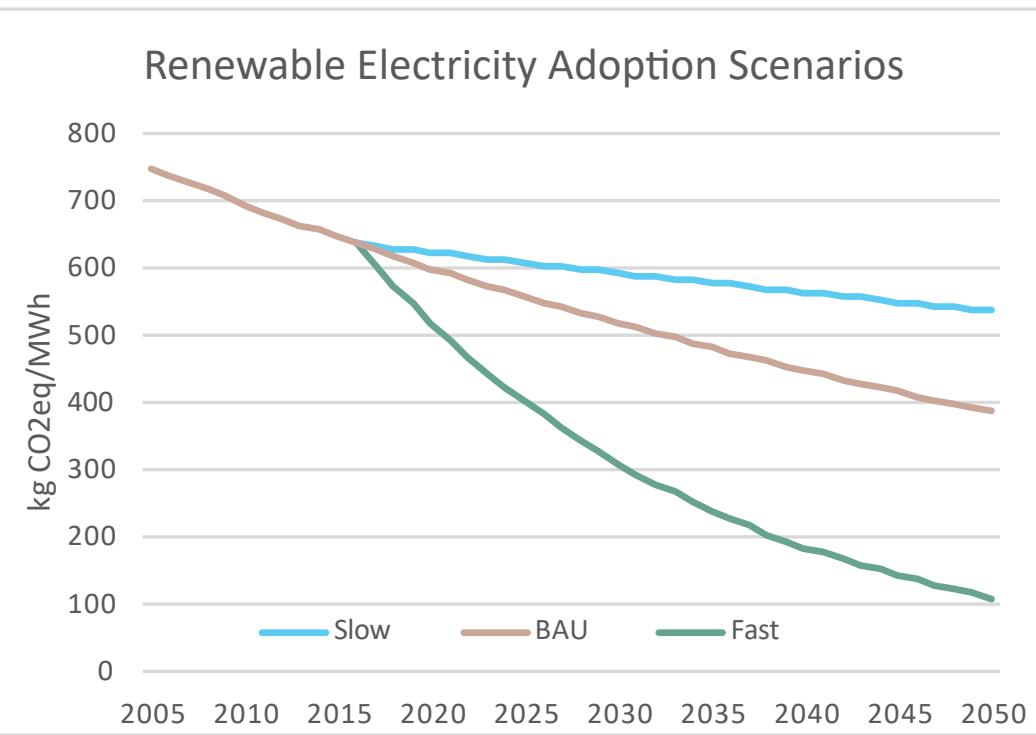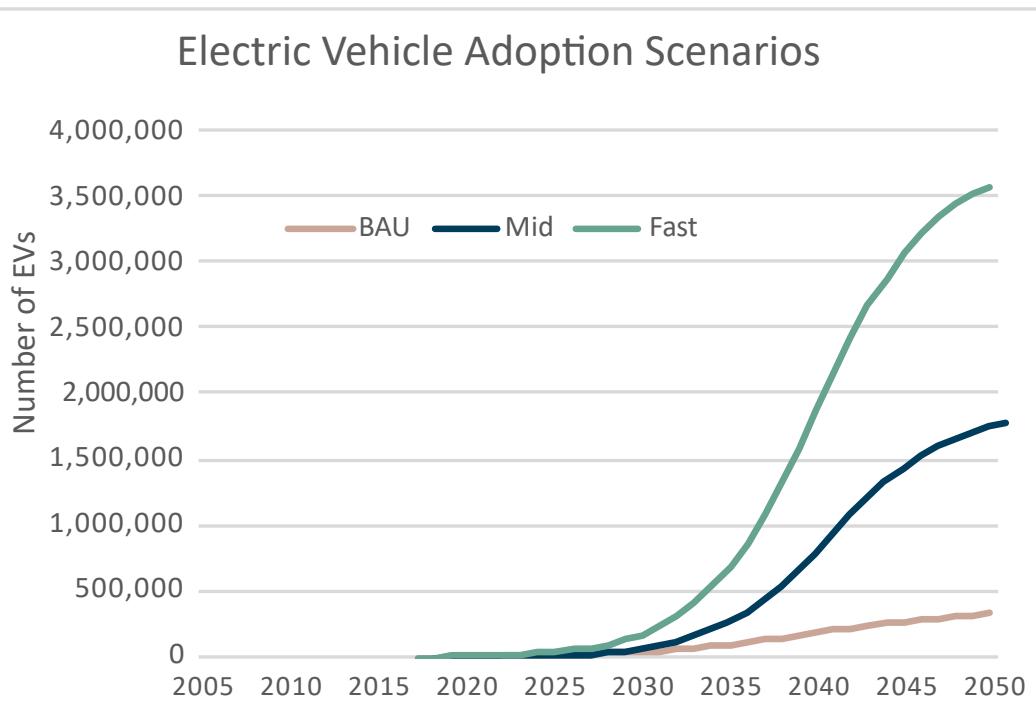
Demand-side Policies Several of the policy areas increase efficiency – the energy efficiency program increases the efficiency of electricity and gas, as do the advanced building standards, and the primary water recommendation increases the efficiency of water use. Because the model tracks electric generation, fuel use, and water service (supply and treatment) it can calculate the savings associated with reduced electricity, gas, and water use. It does not, however, know the increased investments associated the various levels of use reduction.

The model tells us that the reduced electricity, natural gas, and water use save all residents and businesses an average of $35 million per year in their electricity fuel and water bills by 2030, and $225 million per year by 2050.

The statewide Focus on Energy program gives us quantitative data on program costs and rebate costs that are required to incentivize energy efficient installations by homeowners, property owners, and business owners. Over the last four years the FOE program has spent on average about $100 million a year on program costs and direct rebates, to produce, on average, 10.5 trillion kwh (of electricity) and 390 million therms (of heating) in verified gross life cycle savings. What would be much harder to calculate is the cost to the home and business owners to make up the difference between the amount of the rebate received and the total cost of the energy efficient equipment and improvements, including high efficiency lights, motors, furnaces, etc. On the benefit side of the ledger, we know that these investments lower energy bills and that the payback period is typically factored into the decision to make the efficiency investment. At a macro level we know that every ratepayer dollar that funds the FOE program results in approximately $3.5 to $4 in savings to all utility customers (due to avoided energy infrastructure) – those who utilize the program undoubtedly see a significantly greater payback. If economic impacts are factored in, and they are analyzed by the FOE independent evaluators, for every dollar paid into the program, the state realizes $7 of economic benefits.

Renewable Natural Gas (RNG) Vehicles The fuel injection system and other differences in a compressed gas vehicle add little cost to an RNG truck. However, the specialized compressed gas storage tanks add considerable cost with a typical 88-gallon system adding approximately $80,000 to $90,000 in vehicle costs to a large diesel truck such as a dump truck or snowplow. The payback on those RNG vehicles is a function of three things: vehicle efficiency (mpg), miles driven (the more the better) and fuel prices (both the RNG fuel and gasoline prices). The cost of compressed RNG at the Dane County landfill is very low – comparable to $1 gasoline; so even at relatively low gasoline prices of $2 to $2.50 a gallon, the RNG trucks will pay for themselves (recoup the $80,000 to $90,000) over the life of the vehicle. RNG vehicles achieve a net GHG emission reduction of approximately 88% from that of diesel trucks, including the tailpipe emissions and the methane destruction. If the cost of GHG emissions is factored into the cost analysis, which is what the federal renewable fuel standard market does, Dane County taxpayers realize very significant savings. This is evidenced by the fact that the $29 million investment Dane County made to build the RNG facility at the landfill will pay for itself in just four years. After that, the sale of the renewable fuel standards credits associated with the RNG production will offset taxes paid to Dane County.

Fig. 8.13: A range of relative rates of adoption of EVs and renewable electricity
Source: Greg Nemet

Electric Vehicle Adoption Scenarios

Renewable Electricity Adoption Scenarios

The Relationship Between Renewable Electric Generation and Electric Vehicles

Two of the biggest factors in whether we can reach our 2030 GHG emission reduction goals are the rates at which our electricity generation transitions from fossil fuels to carbon-free renewable sources and the rate at which the cars we drive become EVs. These rates of change are connected. If everyone bought EVs tomorrow, we would see a reduction in GHG emissions because even though our grid is still mostly powered by fossil fuels, an EV today has significantly lower emissions than the average gasoline-powered car. But the GHG emission reductions would be much greater if our grid were carbon-free before we bought the EV. My 2016 Prius has slightly lower GHG emissions than an EV today because my Prius gets better than 50 mpg and the electric vehicles are still being powered by fossil-fuel-generated electricity. But that will change as the grid becomes cleaner, and the faster the grid makes that transition, the greater the GHG emission reductions we'll realize as more EVs are purchased. Over the next 10 years and beyond, it is highly likely that our grid will de-carbonize much faster than we will convert to EVs because wind and solar power are more cost effective relative to fossil fuel power plants, than EVs are relative to gasoline-powered cars. Still, in the near term there is a great premium from a GHG emission standpoint on renewable electric generation in and around Dane County, to maximize the benefit of EVs. Importantly, the graphs in Figure 8.13 show that it is highly unlikely that the adoption of EVs would outpace the adoption of renewable electricity sources to such an extent that EVs would actually increase emissions. This is a reason to prioritize RE recommendations for implementation.

Climate Actions

Photo: Ben Amaral
via Unsplash

The following sections lay out a broad range of more than 100 recommendations for policies, programs, and projects to reduce GHG emissions from businesses, homes, apartments, vehicles, and other aspects of the Dane County economy. When recommendations state that Dane County will take specific actions, we are referring to all the citizens and businesses in Dane County (as opposed to other instances where we specify the Dane County government).

Energy Efficiency

Energy efficiency, energy conservation, and demand-side management need to be the foundation of any comprehensive effort to reduce carbon emissions in electric and thermal energy systems. There are many reasons for this but keeping overall costs of the transition as low as possible is one of the most compelling. Wisconsin has a rich history of leadership in energy efficiency (EE) programs and achievement. EE programs not only reduce emissions but create jobs, strengthen the economy, lower utility costs, and improve comfort, productivity, and health. We needn't look any further than the state's own Focus on Energy (FOE) program to see this. FOE, the state-wide EE program for the past 18 years, has been a nation-leading program from its inception. However, FOE is limited in the resources it has and thus its ability to meet the EE needs in any one part of the state. In 2015 FOE reached two percent of the residential customers in Dane County and just one-half of one percent of the commercial customers, leaving a clear place where the Office of Energy & Climate Change can remove barriers to a proven program and delivery mechanism to expand efficiency in Dane County.

Recommendations

The Dane County Office of Energy & Climate Change will launch an energy efficiency (EE) program that will match homeowners, renters, and business owners with incentives, information, and opportunities to save energy. Leveraging the FOE program, municipal programs, and/or financial tools such as Property Assessed Clean Energy (PACE), the Dane County energy efficiency program will serve as a facilitator within communities to increase awareness of, and access to, resources that support energy efficiency.

While the program will obviously focus on energy efficiency, we will use the direct contact opportunity to give businesses, homeowners, and renters as many opportunities to reduce their carbon footprint as possible including helping them access renewable resources, water savings, and cleaner transportation options.

▲ Scott Hackel, Director of Research and Innovation at Slipstream, talks about the energy efficient heating and cooling system at Rethke Terrace, a Passive House and LEED certified affordable housing project in Madison.

The Dane County program will deliver energy efficiency services through direct marketing and will include a broad public relations effort (discussed in more detail below) designed to raise awareness of EE opportunities and make energy savings equipment and strategies available to any business or resident that expresses interest. However, the program will prioritize specific sectors for community-based outreach.

The highest priority sectors will be farms and other agribusinesses, residential customers, and small businesses. Within each of these sectors the program will prioritize underserved communities and neighborhoods. The small business EE program will begin by offering EE services to small business owners of color and to women owned businesses. Larger commercial businesses and manufacturing businesses will be critical priorities in the mid-term (as opposed to near-term) to achieving deep efficiency savings.

Within the broad categories above, residential for example, the Dane County EE program will focus on specific building types, particularly hard-to-reach or underserved buildings such as low-income multifamily housing. The multifamily

Climate Champions

Madison Gas and Electric, A Partner in Electrifying Transportation

MGE partners to electrify transportation, working with residential, and commercial and fleet customers, both public and private. The electrification of transportation is one of MGE's key strategies for achieving deep decarbonization and targeting net-zero carbon electricity by 2050.

MGE's programs include:

MGE's Charge@Home program offers homeowners the convenience of a home charging station for a monthly fee.

- **Charge@Home** for quick, convenient home charging with no upfront cost. MGE will coordinate the installation of a Level 2 charging station in exchange for a monthly fee of about $20 (64 cents per day), plus the cost of electricity. There is no upfront charge for standard installation, and MGE takes care of charger maintenance and repairs. MGE can manage charging sessions remotely, if needed, to better manage the electric grid.
- **Public and multi-family charging.** MGE began installing public charging stations in 2009. MGE's growing network includes more than 30 public charging stations, all powered by wind energy. Since 80% of charging occurs at home, MGE partners with developers and property managers to install chargers at multi-family properties.
- **Workplace charging** to enable employees to charge at work.

Partnering with customers to grow the use of EVs and awareness of their benefits advances shared energy goals for MGE and our broader community. MGE partners with:

- **The City of Madison** to electrify its buses and fleet vehicles.
- **Auto dealerships** to provide resources and education to sales staff.
- **Lyft**, the ridesharing company, to help EV drivers with Lyft share insights with riders.

MGE launched an EV website, LovEV (mge.com/LovEV), and an online feature called EV Rider (energy2030together.com/EVRider), which provide easy-to-understand information on EVs and charging. The LovEV website helps customers who are considering an EV get up-to-date and accurate information about available models, driving range, costs, emissions and charging opportunities. ☀

sector has complex ownership and utility bill payment responsibilities, and often has a lack of capital for improvements.

The Office of Energy & Climate Change will look for multiple partners to help administer the EE program in certain market sectors. For example, in the small business sector, potential program partners could include the Citizens Utility Board, Greater Madison Chamber of Commerce, Wisconsin Women in Business Initiative, Sustain Dane Sustainable Business Network, Small Business Administration, Latino Chamber of Commerce, Madison Black Economic Empowerment Council, and others. These partners could bring many benefits to the program including helping to identify business owners and tailor offerings to serve existing small businesses as well as entrepreneurs in the pre-startup and startup phase of development. Partner organizations could contribute to networking and peer-to-peer exchange of best practices.

Buildings

Buildings consume more than 47% of all the energy used in the U.S. and about 75% of the electricity generated in the U.S. Dane County will join leading local governments across the globe by launching a major effort to tackle carbon emissions from buildings. This section is primarily focused on policies for new building construction and major renovations.

The recommendations below will improve the quality of life in Dane County by offering residents healthier, more productive, and more economical places to live, work, recreate, and learn. To encourage robust participation in this voluntary advanced-buildings program, the County will leverage:

1. Market and peer recognition for builder participants.

2. Health, productivity, and quality-of-life benefits for owners and occupants.

3. Increased economic development and stimulus.

4. Long-term return on investment.

5. Creation of a built environment with Dane County's values of health, sustainability, and resiliency.

The attraction of the advanced-buildings program will mean more families and businesses want to locate in Dane County creating more demand for efficient, sustainable, resilient buildings.

Recommendations

Building Performance Challenge

Whether a building owner or developer wants to make a strong visible commitment to climate leadership or simply seek the health, comfort, and economic benefits of reduced energy use, the voluntary Building Performance Challenge offers a way to participate. Building owners making improvements, whether new construction, remodels, or retrofits, can commit to an energy or carbon performance target appropriate to their building type:

- **Level 1:** A building that uses net zero energy or net zero carbon.
- **Level 2:** A building that uses 75% less energy than other buildings of the same type.
- **Level 3:** A building that uses 50% less energy than other buildings of the same type.
- **Level 4:** An existing building that uses 25% less energy than other buildings of the same type.

Buildings will be rated based on energy use intensity (EUI) or energy use (Btu) per area (square foot). The Building Challenge will recognize that buildings built for different uses use different amounts of energy. That's why the performance target system described above will compare buildings to other buildings of the same type.

Awards will be based on actual measured energy usage. Building owners will measure their energy use for one year before they are eligible for a Dane County Building Performance Challenge Award. When awards are given in the Building Climate Challenge, the County Executive will present the award at a press conference held at the owner's building and the Office of Energy & Climate Change will publicize that building on the Office of Energy & Climate Change website and include the building's location on the Office of Energy & Climate Change Dane County Clean Energy Champions map.

Government Leading by Example

Dane County government owns more than 90 buildings and has been investing in energy efficiency and renewable energy for its buildings for many years. The County government has invested more than $16 million in more than 70 EE projects in our buildings and has installed solar panels on 15 of them. The Office of Energy & Climate Change will take stock of all the facilities and operations and help develop a strategic energy plan that includes all facilities, all operations, its fleets, all equipment and any other aspect of county business that results in energy use. Dane County already benchmarks the energy use in all its buildings, but the County will also join the U.S. Department of Energy's Better Building Challenge to help document and share its data. The BBC asks that building owners commit to a 20% reduction in energy use over 10 years and offers several free tools and programs to assist in meeting this goal. Dane County should shoot for 30% reduction. Lastly, Dane County will join the EPA Green Power Partnership, a voluntary program encouraging organizations to use green power to reduce carbon emissions and other harmful environmental impacts associated with fossil fuel use.

Dane County government and several of its cities are already leading by example, but by joining these voluntary efforts and learning best-in-class practices at the national level, Dane County government will be in a better position to help other counties and municipalities achieve associated goals. The Office of Energy & Climate Change will work with all the cities, villages and towns in Dane County and help them develop comprehensive energy plans and urge them to join the Department of Energy's Better Building Challenge.

	Site Energy [kBtu/ft²]net				
	Existing Buildings				
	New Construction				Existing Average
	Level 1	Level 2	Level 3	Level 4	
Warehouse (non-refrigerated)	0	15	25	30	41
Residential - Single Family	0	15	25	35	48
Religious Worship	0	15	25	40	57
Multifamily (<3 stories) 5+ units	0	20	35	50	66
Multifamily (<3 stories) 2-4 units	0	20	40	60	80
Mobile Homes	0	20	40	65	86
Retail - Service	0	25	35	50	69
School - Secondary	0	25	40	60	75
Office	0	25	45	65	85
Public Assembly	0	25	45	65	86
Public Order & Safety	0	25	45	70	93
Retail - Standalone	0	25	50	70	96
School - Primary	0	25	60	75	94
Apartments (>3 stories)	0	35	60	75	94
Retail - Mall/Strip Mall	0	35	75	100	136
Hotel	0	55	80	100	125
Food Sales	0	60	110	170	221
Health Clinic	0	70	110	140	175
Hospital	0	70	120	180	232
Restaurant - Sit Down	0	275	445	555	694
Restaurant - Fast Food	0	430	680	850	1063

▲ **Fig. 9.1** Dane Building Performance Challenge Metrics. Net site energy means onsite renewable energy can offset building energy consumption in attaining the target EUIs. Net site energy can be determined by using ASHRAE 105-2014 "Standard Methods of Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions." Renewable utility programs in Appendix 4 can also be used to achieve net zero energy.
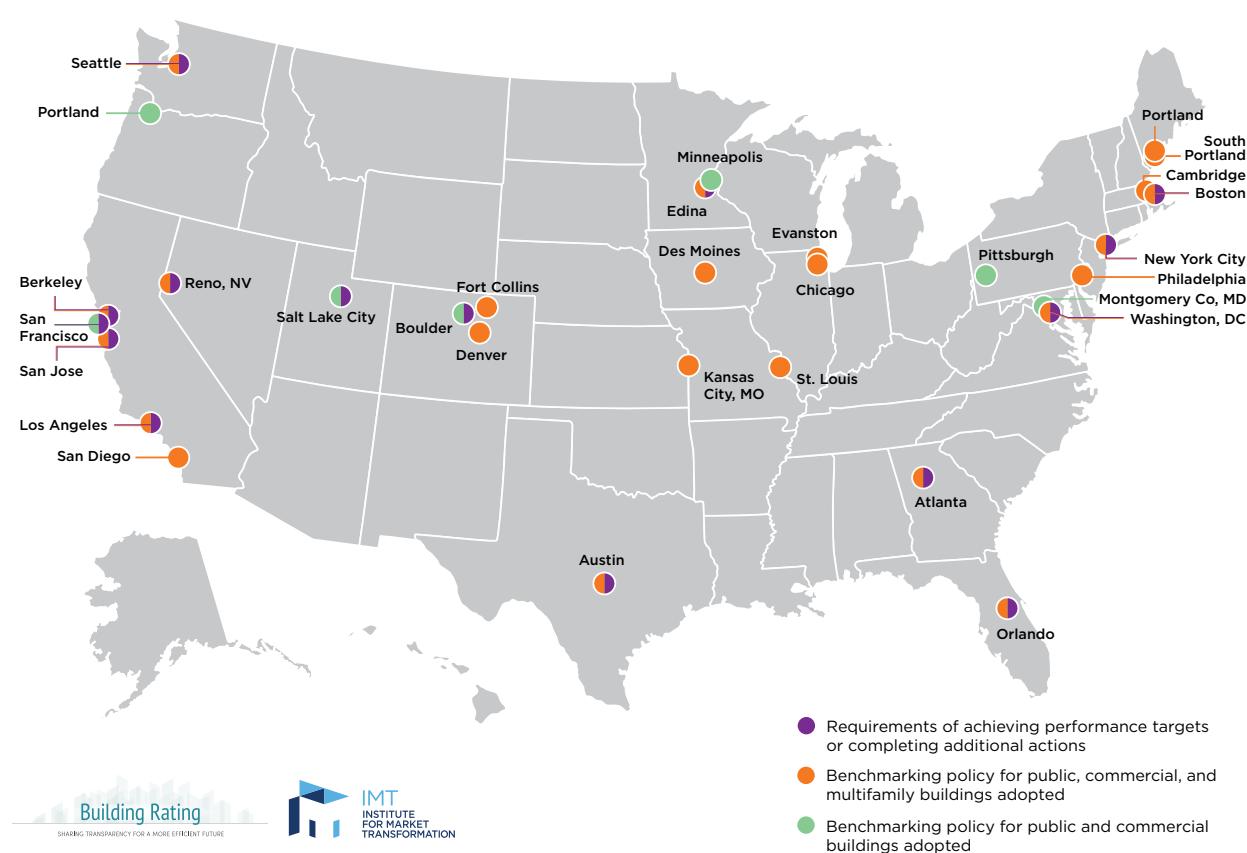
High-Energy-Use Building Assistance

The Office of Energy & Climate Change will identify buildings in Dane County that fall into high-energy-use building classes and reach out to those building owners offering technical assistance and incentives to upgrade energy systems and equipment. The Office of Energy & Climate Change will work with the building owners who choose to participate, helping them gain the economic, social, and productivity benefits of establishing, tracking, and reducing energy use through existing energy efficiency programs and grant opportunities.

Benchmarking

The Office of Energy & Climate Change will develop a voluntary benchmarking registry where building owners who choose to improve their building performance by benchmarking their building's energy use will receive public recognition and peer support for their efforts. Participants will be able to compare their energy use (by building type) with peer buildings using local, regional, and national data sets. Building owners can then create action plans to improve their energy performance and serve as examples for others. The Office of Energy & Climate Change will establish a network for building owners who benchmark their buildings to maximize exchange of best practices related to building performance. The Office of Energy & Climate Change will work with leading building owners, local construction companies, and local building/construction consultants to establish a consensus-model benchmarking ordinance to make available to municipalities that wish to pursue a benchmarking policy.

▼ **Fig. 9.2** U.S. city, county, and state policies for existing buildings: benchmarking, transparency, and beyond

- Requirements of achieving performance targets or completing additional actions
- Benchmarking policy for public, commercial, and multifamily buildings adopted
- Benchmarking policy for public and commercial buildings adopted

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Climate Champions
Geothermal Pays Off for Edgerton Hospital

by Jim Schultz, CEO

Green was at the forefront during the planning and construction of the new Edgerton Hospital and Health Services. What really puts Edgerton Hospital on the map as a pioneer in green building is the fact that it's the first hospital in the State of Wisconsin, as well as the first critical access hospital in the United States, to be built using geothermal heating and cooling. We also included high-performance electrical, onsite construction recycling, green roofs, a healing garden, and zero volatile organic building materials.

We realized hospitals are one of the major consumers of energy and must

▲ Egerton Hospital has many clean energy technologies including a geothermal system for heating and cooling. A healing garden is shown in the foreground.

be focused on providing a cleaner and healthier environment for patients through the most efficient means. We had to really ask ourselves, "How can we reduce our carbon footprint?" We wanted to expand on incorporating high efficiency equipment, Energy Star appliances, energy efficient windows, and other technologies in an effort to provide a high performance building.

In our energy-intensive industry, using geothermal technology is just what the doctor ordered to deliver emission reductions, patient comfort, and reduced energy costs. The hospital complex features a ground-loop geothermal HVAC system that uses the relatively constant temperature of the earth to provide heating and air conditioning. The earth stores nearly 50% of all solar energy, making it a natural source of heat. Using heat pumps, this natural and renewable resource is transformed into usable energy in our hospital. In the winter, these pumps move the heat from the earth into the hospital. In the summer, they pull the heat from the hospital and discharge it into the ground.

Not only are our efforts paying off for the environment and helping to lessen the adverse health effects caused by climate change, they're also helping our pocketbook! Within five years of the hospital opening, the cost savings from reduced natural gas consumption has paid for the approximately $850,000 geothermal system. And, the hospital saves nearly $15,000/month in energy costs.

The use of geothermal fit well within Edgerton Hospital's 'healthy village' concept to set a new standard in healthcare with state-of-the-art technologies, sustainable building materials and systems, and exceptional patient care while promoting community health and wellness. ☀

Green Infrastructure for Climate-Resilient Cities

The world is facing an increasing population and an unprecedented urbanization, while the consequences of global warming are becoming clear with increasing events of extreme weather. Since 1950, heavy downpour events have become more common in many regions of the world, including the U.S. where the Midwest and Northeast have been most affected. Dane County experienced this firsthand in August of 2018. Similar weather patterns are being observed in the Nordic countries, where stormwater management has become paramount in designing a climate-resilient, sustainable city. While densifying cities has proved efficient in reducing carbon emissions, it often leads to a loss of green areas. This is something many of the Nordic cities are trying to address by promoting green infrastructure to combat flooding while greening the urban space. Green infrastructure is an approach to water management that reduces and treats rainwater at its source while providing many community benefits. It is a financially, socially, and environmentally beneficial solution additionally proven to improve the health of the city's citizens. Examples of green infrastructure are green roofs, permeable pavement, rain gardens, and green streets and alleys.

Copenhagen, Denmark, is acknowledged as one of the leading cities in rainwater management, among other things working with New York City on becoming

▲ Tåsinge Plads is Copenhagen's very first climate-adapted urban space. "A green oasis in the climate resilient neighborhood." The rain parasols in the square collect rainwater and tanks beneath the metallic raindrop sculptures store rainwater from the parasols and surrounding roofs. *Photo: Copenhagen Municipal Government, Department of Climate Adaptation.*

more climate resilient. In response to several historic storm surge events, the city designed a "cloudburst management plan" in 2012. The plan relies mostly on a green and blue system approach where stormwater is dealt with at street level through a network of parks, cloudburst boulevards, and retention zones rather than gray infrastructure where water is redirected into the city's existing sewer and drainage system. This was the most financially beneficial solution for Copenhagen, expected to cost the city approximately $1.3 billion.

Here are some examples of innovative green solutions to stormwater management that might be applicable to Dane County communities:

Tåsinge Plads is Copenhagen's first climate adapted urban space. The square is meant to manage stormwater while functioning as an oasis for residents of the neighborhood. During heavy rains, the flowerbeds will fill with water and wait to drain until the storm runoff subsides. The upside-down umbrellas collect rainwater that later can be used to nourish the square's plants. The landscaping directs the water to large underground storage tanks. This water is filtered and purified so it can later be used for water play; above the tanks are bouncy floor panels for children to jump on. The energy from their feet pumps water through the pipes below, with the water appearing at the surface running towards a rain garden. Tåsinge Plads can keep up to 7000 m² of water from running into the sewers.

Green roofs are an efficient means of collecting rainwater in an urban setting. They are becoming increasingly common internationally and many Nordic cities are introducing legislation to ensure their popularity. In Copenhagen green roofs are required by law on all roof slopes of less than 30 degrees. Studies show that green roofs reduce annual runoff by 40-90%, create a habitat for animals and plants, reduce urban temperatures, and increase the functionality of buildings.

The Augustenborg botanical garden is 9,500 square meters (over 100,000 square feet) of greens planted on top of industrial and office buildings. This construction has functioned as a solution to minimize flooding while providing a better local climate.

Rabalderparken is a 450-meter-long drainage canal with the purpose of delaying rainwater. The canal directs rainwater into three bowl-like basins that in totality can hold 23,800 cubic meters, or more than six million gallons of water, which is more than nine Olympic swimming pools.

The destination of the water is a small lake, normally one meter deep, with potential for expanding. The area functions daily as a skate park and popular recreational area. At the largest basin, there is a surface allowing the area

to be used for concerts or similar events. Along the canal are other play and seating areas, making the park attractive to non-skaters as well. The park is only designed to handle extreme rainfall events and is therefore expected to fill approximately once every 10 years.

The Office of Energy & Climate Change will look to neighboring municipalities and others across the country that have been making major investments in green infrastructure for many years and document best practices and the most relatable case studies in a white paper. We will then use that white paper to conduct outreach and solicit input from Dane County businesses that develop and construct green infrastructure and others that might consider investing in green infrastructure on their property. The next step will be to integrate green infrastructure into existing Office of Energy & Climate Change programs or create a new program specifically to encourage, incentivize, and support investments in green infrastructure.

Transportation & Land Use

The transportation sector is responsible for approximately 30% of all the carbon emissions released in Dane County. Nationally, the transportation sector surpassed the electricity sector as the largest carbon emitter in 2016, primarily due to decreasing carbon intensity in the electric sector as coal generation was replaced by natural gas, wind, and solar generation. Dane County has consistently been the largest population growth engine in the state of Wisconsin and shows no sign of slowing down. Therefore, a dual strategy of planning land use and transportation systems to reduce driving, while transitioning our transportation sector away from petroleum-based fuels to electric vehicles and renewable compressed gas is essential.

▲ Dane County has allocated $305,000 in it's 2020 budget to install 15 electric vehicle charging stations at a variety of locations.

Transportation systems impact equity in Dane County communities in a variety of ways. Air pollution from fossil-fueled vehicles disproportionately impacts communities of color as well as low-income communities. A lack of transportation options creates a barrier to healthy and affordable goods and services, and economic opportunities. Creating access to clean, affordable, reliable transportation is critical to addressing inequity in Dane County.

According to the Union of Concerned Scientists, diesel-powered vehicles and equipment account for more than two-thirds of all particulate matter air pollution from transportation sources in the U.S. Equitable and just transportation in Dane County requires and means a lot of things including getting diesel trucks off Dane County roads, affordable access to electric cars, zero-emission accessible transit, zero-emission commercial goods and services transport, and access to safe and beautiful bike trails and other active transportation opportunities.

"The transportation sector is responsible for providing accessibility to basic human needs. Therefore, transportation planning must ensure affordable transportation that provides for community members' mobility and access to daily activities and services, including jobs, education, health care, affordable housing, and social networks."

-Equitable & Just National Climate Platform

Recommendations

Electrifying Transportation

Electrifying the transportation sector is a key strategy for achieving deep decarbonization. As of 2017, 0.1% of all vehicles registered in Dane were EVs. EVs made up just .67% of light-duty vehicle sales in Wisconsin in 2017. As of August 2018, the three states with the highest EV market shares were California, Oregon, and Washington, with 9.96, 4.12, and 3.54% respectively.

Even though more than half of the electric generation in Wisconsin today is from coal (55%), the average EV purchased in Wisconsin today emits approximately 40% less carbon dioxide emissions than the average gasoline-fueled car. The Union of Concerned Scientists maintains a simple tool on their website at evtool.ucsusa.org that allows you to compare carbon dioxide emissions from a

Climate Champions
Zerology, Aiming for Zero Emissions

Zerology is a start-up company that envisions Dane County with fewer cars and greater clean transportation possibilities. Founder and CEO, Shree Kalluri, sees a future where it's affordable for anyone in Dane County to use a shared electric vehicle for day trips or to run errands. Zerology's mission is to reduce the need for individual vehicle ownership by providing unparalleled transportation options with zero emissions.

The Zerology suite of products and technology contributes to a smart and shared mobility ecosystem for Dane County.

▲ Zerology founder and CEO Shree Kalluri is transforming the cab industry in Dane County. He purchased two companies, Green Cab and Badger Cab, and converted both fleets to electric vehicles. *Photo: Zerology*

- Ridesharing creates affordable and convenient options for Dane County residents to use EVs. Zerology recently converted the entire Green Cab of Madison fleet to all-new Tesla Model 3, zero-emission vehicles. In the future, Shree envisions an expanded network of zero-emissions rideshare vehicles as Zerology explores partnerships with other taxi companies in Madison.
- Zerology is piloting a new car sharing program, ZeroCar, in early 2020. Using Zerology's mobile application, members can register, reserve a car, unlock, and go. Zero-emissions vehicles will be available at four area apartment buildings during the pilot. As this network expands to residential and commercial locations throughout Dane County, more people will be able to use zero emissions vehicles.
- Zerology is planning to introduce micro-transit community and corporate shuttle options which will provide more flexibility for eco-friendly travel. These electric shuttles will expand current commuter options with zero-emissions vehicles that will enable easy access to workplaces in city centers or surrounding areas, helping to grow Dane County's workforce and contribute to economic development.
- Beyond moving people, soon Zerology will offer EVs to overhaul how commercial goods and services are delivered in Dane County. Switching from diesel fuel to EVs to deliver packages will reduce air and noise pollution and improve air quality in the area. Fewer diesel emissions will contribute to better health outcomes, including fewer asthma attacks.

With fewer cars, cleaner vehicles, and better transportation systems, the future is more sustainable. Kalluri visualizes a future with more parks and fewer parking lots as part of a Dane County transportation sector that saves money, saves time, and helps save the planet. ☀

wide variety of EVs on the market today with an average gasoline-fueled vehicle in your location.

To get on a path to deep decarbonization, Dane County as a whole needs to accelerate EV sales very quickly, while making an equally expedient shift to renewable electric generation. The Climate Council is recommending a wide variety of programs and policies to promote and encourage electric vehicles.

Specific Actions

Municipal Transportation Electrification

1. Dane County government will work with towns, cities, and villages to replace existing gasoline vehicles with electric vehicles in their fleets as quickly as possible.

2. Dane County government will explore bulk purchasing opportunities that would bring down the cost of both EVs and EV charging infrastructure.

3. The Office of Energy & Climate Change will work with the public and private sector to prioritize electrification of shared-use vehicles: buses, bikes, taxi cabs, carpool vans, and community cars.

Improve and Expand EV Charging Infrastructure

1. Dane County government will identify strategic charging locations and install DC fast charging stations and Level 2 (slower) charging stations in all County-owned priority locations within four years.

2. The Office of Energy & Climate Change will work with utilities to create incentives to increase charging infrastructure at single-family and multifamily housing developments.

3. Dane County government will establish policies that support EV-ready affordable housing.

4. The Office of Energy & Climate Change will work with utilities and other EV stakeholders to develop EV charging hubs with multiple charging stations on key roadways in the County.

5. The Office of Energy & Climate Change will research and develop EV-ready construction requirements and incentives for multifamily dwellings and commercial buildings.

EV Education and Outreach

1. The Office of Energy & Climate Change will work with stakeholders to create a program to educate municipalities, businesses, residents, and developers on the benefits, cost savings, and incentive opportunities provided by EVs.

2. Office of Energy & Climate Change will work with Madison to build on Madison's goal of a 100% renewable and net-zero carbon bus fleet by 2030, and work with other municipalities to adopt similar goals. The Office of Energy & Climate Change will help all cities develop the infrastructure for compressed (renewable) gas vehicles.

3. The Office of Energy & Climate Change will work with utilities and other stakeholders to create a program to educate car dealership sales staff on EVs.

4. The Office of Energy & Climate Change will organize and hold EV "ride & drive" events at existing community events or at local businesses.

5. The Office of Energy & Climate Change will work with electric utilities to incorporate Dane County CAP programs and incentives in utility newsletters, bill inserts, web content, and other outlets.

6. The Office of Energy & Climate Change will partner with EV stakeholders to develop and create an EV education center where consumers can go to learn about and test drive multiple models of EVs with no sales pressure.

7. The Office of Energy & Climate Change will help incorporate EV education into school curriculums and automobile technology training programs.

Renewable Natural Gas Fueled Vehicles

Dane County recently completed construction of a $29 million biogas processing facility to clean up the landfill gas to produce nearly pure methane and inject it into an interstate pipeline. Once in the pipeline, the gas will be sold to

compressed natural gas (CNG) fueling stations to produce 3 million gallons of clean renewable vehicle fuel annually.

Dane County has a compressed natural gas fueling facility at the County Highway garage just east of the landfill. The county has already converted more than 80 vehicles to run on compressed gas including many heavy-duty vehicles such as snowplows and dump trucks. The County Executive has stated that he wants to see all the County's fleet converted to either compressed biogas or electric vehicles.

The County recently secured a $450,000 grant to expand the capacity of the existing CNG vehicle fueling station at the Rodefeld Landfill and to extend renewable CNG or renewable natural gas (RNG) fuel lines to the station. This grant will help fund a $900,000 bio-methane fueling station expansion. This will allow the County to continue to grow its RNG fleet. With the increased capacity, the County will also be able to sell RNG vehicle fuel to other governments and

▼ Dane County has converted more than 80 vehicles to renewable natural gas. Many of them are heavy duty trucks like this dump truck, that used to run on diesel fuel.

businesses with heavy-duty truck fleets. The site is in an ideal location for a fueling station, with quick access to U.S. Highway 12&18 and Interstates 90 and 94.

With the RNG processing infrastructure in place, the savings for Dane County will grow with an increasing number of customers purchasing RNG from Dane County, even as the price for the RNG goes down (as it is spread over a larger customer base). Some of the savings from the sale of RNG can be put into increased fueling capacity to serve more public and private sector fleets. There are 11,975 heavy-duty vehicles registered in Dane County. The CAP is recommending that Dane County adopt a goal of converting 60% of those vehicles that currently burn diesel fuel to RNG by 2026. It may not make sense to convert 100% of the fleet, even if that were possible, because at some point in time EVs will achieve greater GHG reductions. For the foreseeable future, however, RNG vehicles result in a greater GHG reduction.

Reducing Emissions through Reduced Driving

Transitioning to electric vehicles that run on clean energy will take time and cannot fully achieve the necessary emissions reductions. Reducing total vehicle miles traveled (VMT) will be equally important for staying on course toward deep decarbonization. That means the County should take an active role in encouraging land use patterns and travel options that let people meet all their daily needs while making fewer and shorter trips by single occupancy vehicles. In addition, reducing VMT has very significant public health benefits.

Active transportation, such as walking and biking, is an important part of reducing VMT. It's easy to find all kinds of rankings of the best cities in the U.S. for biking, and Madison is often among the top five or 10. Dane County has long been ahead in developing beautiful and safe bike trails and will work with Madison and all of the other cities, villages, and towns to make Dane County a recognized national leader.

Specific Actions

Land Conservation

The preservation of green space, natural areas, and farmland is an important aspect of sound land use and quality of life in Dane County. It will also help to limit greenhouse gas emissions. The Climate Council felt it was important to

recognize that Dane County has been a leader in land conservation for many years. Dane County currently has 12,608 acres in parks and open space (natural and wildlife areas) and another 2,775 acres in conservation easements. It is critical to continue to fund, implement, and expand upon the current (2018-2023) Dane County Parks and Open Space Plan. In particular, this CAP supports the Plan's goal to "preserve large tracts of nature and agricultural rural landscapes at urban fringe areas that will provide regional resource protection and recreation benefits."

This CAP also recommends that the next Dane County Parks and Open Space Plan include this CAP among its "Related Planning Efforts" and coordinate with the Dane County Office of Energy & Climate Change.

Urban Villages

Many cities in the U.S., including Seattle and Denver, and other cities across the globe have pursued the concept of "urban villages" as a way to shape development and land use to be more sustainable, equitable, productive, safe, and healthy. An urban village is an urban development characterized by medium to high-density housing, mixed-use zoning, effective public transit, walkability, bicycle friendliness, and exceptional public spaces that bring communities together. Urban villages include a full range of residential options, employment opportunities, and essential services, such as grocery and hardware stores, banks and restaurants, all within a half-mile wide "circle" or area, making travel on foot or by bicycle very practical and convenient.

This recommendation envisions Dane County, in collaboration with the Capitol Area Regional Planning Commission, creating a set of guidelines and templates that cities, villages, and towns can use to modify their codes and ordinances to promote urban village developments, encouraging development that reduces the number of single-occupancy vehicle trips, increases public transit use, and increases active transportation such as walking, biking, skating, or skiing. Sixty percent of new urban growth should occur as compact development by 2030 and 90% by 2050.

Active Transportation

Dane County government will continue its commitment to bicycle and pedestrian infrastructure by increasing its active transportation budget to achieve the build-out of a comprehensive bike and pedestrian network that enables

non-motorized transportation within and between its communities. This includes its extensive network of shared-use paths, but it could also focus on improved safety and comfort for walking and biking along major County roads. This can be achieved partly through policies and programs like Complete Streets and Safe Routes to Schools, but it also requires an emphasis on bicycles and pedestrians in all road design decisions, including design standards.
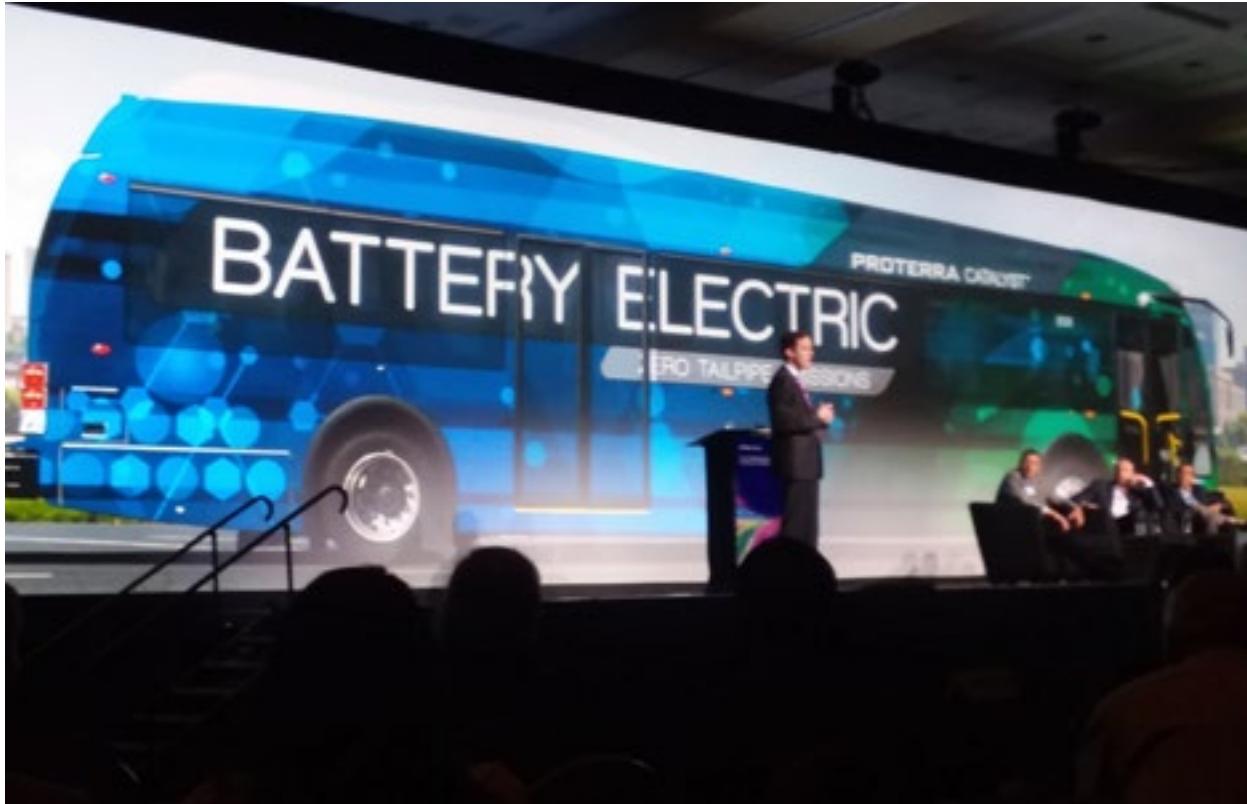
Regional Transit

A strong regional transit system provides an important foundation for reduced car travel by letting people travel reliably between towns, activity centers, and urban villages, where they can then travel by foot, bike, or other feeder services. The County can take several steps in supporting the development of this system, particularly in terms of funding. Regional transit authorities (RTAs), which let communities fund transit through mechanisms like sales taxes, have not been

allowed in Wisconsin since 2001 but the County could help facilitate a discussion among all local units of government to achieve the goals of an RTA through other structures and other sources of funding. Even without an RTA, the County, along with individual municipalities within the County, can prioritize using revenues raised through taxes and fees toward expanded transit service, improved transit facilities, and operating costs.

Verona and Sun Prairie, in coordination with Madison Metro Transit, have developed an express commuter bus service from a surrounding community to the Capitol Square. This is a critical step in linking Dane County communities with transit. Dane County can play an important role in helping other cities connect to Madison and each other with new transit routes or other transportation systems. The County can provide informational materials and talking points regarding the county-wide benefits of regional transit. It will be important to communicate that transit benefits everyone whether they use it frequently or not. For instance, it provides an option to driving in certain circumstances and potentially alleviates traffic for drivers by providing an alternative for many commuters.

> ▾ Electric buses were a topic at a national electrification conference hosted by the Electric Power Research Institute. Madison has begun to convert their bus fleet with a goal of 100% electric buses.

Project Scoring

The Office of Energy & Climate Change will work with partners in County government to establish transportation funding formulas that specifically address deep decarbonization and limit future transportation emissions. Common funding formulas that prioritize congestion relief over multimodal investments, for instance, can often lead to additional vehicle miles traveled through induced demand. This is the phenomenon where, as highways are improved, development spreads outward along rural highways and people drive longer distances. The County can continue making spot improvements to address highway bottlenecks while re-adjusting formulas to prioritize projects that are more likely to reduce overall vehicle travel demand.

Agencies like the San Francisco Bay Area Metropolitan Transportation Commission and the Virginia Department of Transportation have implemented data-driven project scoring approaches based on policy goals like reduced per capita emissions and improved access to destinations. These project scoring approaches can help direct limited transportation funds toward projects that offer the greatest benefit per dollar, including smaller multimodal projects, and move the County toward meeting its long-term emissions reductions goals.

Pricing and Incentives

Pricing mechanisms and other incentives can be put in place to shift the costs of driving and parking from hidden subsidies to more direct payment on a per-mile or per-use basis. This is critical in helping people to make more informed decisions about their day-to-day travel choices.

The County can leverage revenue streams such as vehicle registration fees and fuel taxes to reflect the full costs of road construction and maintenance, but it could also explore more direct pricing methods like tolls or mileage-based fees such as Oregon's voluntary OReGO program. Revenues from these programs should be directed toward improving transportation options, offering travel incentives, offsetting driving costs for low-income families, and benefitting underserved communities.

The County can also promote and guide the implementation of local travel demand management programs or transportation management associations and changes to local zoning codes. These programs and policies should provide incentives for non-single occupancy vehicles travel and reduce or eliminate hidden subsidies for driving and parking, including free parking for employees

at major institutions, free parking for visitors in central business districts, and minimum parking requirements in zoning codes.

The County can also encourage and implement a change in how traffic impact assessments are conducted for new developments, so that environmental impacts are measured in terms of added VMT instead of highway level of service, to promote infill development and multimodal transportation improvements. It can learn from any number of communities in California that are currently making this change in accordance with a new state law (SB 743).

Triple-benefit Transportation Systems

If fewer vehicles on our roads (reducing VMT) is an important strategy for reducing GHG emissions in Dane County, and expediting the transition to electric vehicles is an important strategy, and creating just and equitable access to affordable, clean transportation is an important strategy, then it only stands to reason that transportation systems that accomplish all three strategies should be a very high priority. We can foster creative collaboratives among diverse partners to develop such programs. Ridesharing in electric vehicles is one way. Carsharing with electric vehicles is another. Electric, zero-emission transit is another. We recommend that the Office of Energy & Climate Change work with private sector partners to establish programs that:

1. Create affordable ride sharing programs using electric vehicles that are convenient for all Dane County residents to access, including urban and rural low-income residents.

2. Create affordable electric carsharing programs at, and exclusively for, affordable housing residents.

3. Expand transit options with electric buses in vulnerable communities including electric buses to transport blue-color workers to manufacturing jobs in outlying communities.

4. Create a system for transporting commercial goods and services with electric commercial vehicles.

▲ This Milwaukee Public Library building has a green roof with solar panels, known as "biosolar." The green roof mitigates flooding and the plants make the air around the solar panels cooler which increases the amount of electricity the solar panels produce.

Renewable Energy Production

If Dane County hopes to do its part in addressing climate change by achieving deep reductions in carbon emissions, it must move away from dirty fossil fuel (specifically coal and natural gas) electric generation and transition to clean, renewable generation sources as quickly as possible. While Dane County's wind resource is not as robust as some of those to our west in Iowa and Minnesota, Dane County is blessed with an abundance of wind, solar, and biogas resources; and these renewable resources are very cost-effective. Many home and business owners are lowering their utility bills substantially by installing solar panels on their roofs or other property. The Office of Energy & Climate Change will facilitate a county-wide effort to pursue these seven action items:

1. Accelerate solar development – Establish and achieve a mid-term, 2030, goal of meeting one-third of county-wide electric demand/use, approximately 1,200 MW of capacity, with solar power.

2. Accelerate wind development – Establish and achieve a mid-term, 2030 goal of meeting one half of county-wide electric demand/use, approximately 700 MW of capacity, with wind power.

3. Launch a comprehensive solar education program – Establish partnerships with all County stakeholders to develop and deploy an expansive public education and awareness campaign to highlight the many benefits and affordability of solar power.

4. Municipalities leading by example – Continue to work with Dane County municipalities to develop comprehensive energy plans and develop, adopt, and achieve renewable energy goals.

5. Accelerate energy storage development – Pursue public-private partnerships and make the investments necessary to bring energy storage online in Dane County through multiple ownership and finance models with the dual goals of expanding levels of renewable resources and building resiliency for critical infrastructure and vulnerable citizens.

6. Grid modification - Work with other stakeholders to support utility efforts to modernize the electric distribution grid in Dane County.

7. Establish a geothermal work group to help accelerate investment in geothermal heat pumps for large building owners/developers, particular institutional buildings such as schools, hospitals, municipal buildings, and others.

Recommendations

Accelerate Solar Development

The Dane County Office of Energy & Climate Change should facilitate and lead efforts by all pertinent Dane County departments to collaborate with community leaders, solar developers, utilities, advocates, and Dane County home and business owners, to accelerate solar developments in the County. The County should prioritize solar projects with equity/justice benefits and conduct all the efforts in this section in a way that ensures all residents have equal opportunities to realize the benefits of solar power.

Climate Champions
Charles Hua: Organizing for Renewable Energy

In 2017, a coalition of students and staff at Madison West High School launched a campaign to install solar panels on the school's roof. This group, West Green Club, created an adopt-a-panel program in which individuals and organizations could adopt and name a solar panel with a $500 donation. Within a year, West Green Club raised over $140,000 under the leadership of Charles Hua, a Madison West High School graduate and Harvard College student. West Green Club received funding from countless Madison residents, foundations, businesses, and neighborhood associations. As one of the largest youth-led sustainability efforts in Wisconsin, this clean energy initiative, titled Project Solis, will provide students with hands-on learning opportunities in a growing clean energy job market, generate savings in electricity costs that will save taxpayers money, and reduce the school's carbon footprint. Project Solis received local and state-wide attention and was recognized by many organizations, including Wisconsin State Journal, Sierra Club, and Dane County.

▲ In 2017, Madison West High School students launched Project Solis, an "adopt-a-solar panel" program that raised $150,000 to fund a solar array at the school. Leading the effort were members of the West Green Club, all seniors at the time, (from left to right) Charles Hua, Grace Upham, Kari Weiss, and Nyah Banik.

Since leading Project Solis, Hua, along with other students, parents, and community members, helped found and organize 100% Renew Madison, a group that advocated for the Madison Metropolitan School District to adopt a 100% renewable energy resolution in alignment with the City of Madison's sustainability goals. Months of grassroots advocacy and organizing culminated in 2,500 petition signatures collected and dozens of press hits and on April 29, 2019, Madison became the largest school district in the nation to make a commitment to using 100% renewable energy. Hua hopes to spread this momentum throughout Dane County and has already communicated with several city and school district leaders about his vision of a coordinated county-wide clean energy effort.

West Green Club and 100% Renew Madison hope their efforts will serve as a pilot program for schools looking to pursue renewable energy. The success of these initiatives, and the community support they have both demonstrated and generated, continues to motivate these groups to spearhead sustainability initiatives and promote awareness of pressing environmental challenges facing Dane County. ☀

▲ Many solar farms have rows of panels relatively close to the ground to minimize the use of steel, but in this installation the panels are significantly higher and more widely spaced. Even when panels are closer together there's sufficient sunlight to support prairie grasses and other plantings under a solar farm.

The County will promote both large (utility) scale and small-scale solar projects by:

1. Maximizing development of County building roof tops and appropriate County lands.

2. Exploring co-owned, or co-offtake, solar projects with other municipalities, non-profit organizations, and businesses.

3. Exploring a County role for administrating and/or promoting a County-wide residential group buy program or County rebate/subsidy programs.

4. Prioritizing resources and leveraging existing programs to maximize solar development on affordable housing.

5. Partnering with utilities and solar developers to support and reward solar project landowner participants in instances where participation results in

water quality, farmland preservation, ecosystem, and carbon sequestration benefits.

6. Partnering with utilities and municipalities to develop medium-sized utility-owned solar projects (e.g., the Dane County Airport).

7. Partnering with utilities and municipalities to establish community solar arrays in every city and village in Dane County.

8. Playing a pivotal leadership role in leveraging existing solar financing tools (e.g., commercial PACE) and creating new ones.

9. The purchase of renewable energy credits from strategic solar projects (e.g. project where solar is coupled with a second renewable resource or energy storage).

The Office of Energy & Climate Change will commission an assessment/study of strategic solar deployment throughout the County to determine where solar, and solar with storage, can provide significant benefits to bolstering the transmission and distribution systems, increasing resiliency and energy security/independence, become part of micro grid, power other key CAP technologies such as EV charging infrastructure, contribute to a Dane County clean energy district" (see Cross-sector Solutions), or provide other strategic equity, resiliency, economic, or social benefits.

A shortage of skilled workers is viewed by many in the Wisconsin solar industry as the single biggest barrier to accelerating the expansion of solar locally. Dane County will actively partner with other units of government, non-profit organizations, and higher education institutions to develop workforce training programs for the solar industry.

Accelerate Wind Development

Wind power has arrived. Electric generation from wind is cost competitive with fossil fuels and has been for some time. Besides achieving major carbon emission reductions, wind power creates lots of jobs, generates revenue for rural towns and farmers, and preserves farmland.

Wind power goal: meet 50% (approximately 700 MW of capacity) of Dane County's electric energy use with wind power by 2030.

Achieving this goal will result in:

- More than $1 billion in investments.
- More than 460 high-paying jobs.
- More than $2 million annually in payments to farmers.
- More than $2.5 million annually in payments to local governments.
- Preservation of farmland

The Office of Energy & Climate Change will work with utilities, municipalities, and wind developers to develop new community wind and utility-scale wind projects in and near Dane County to reach this goal.

Launch Comprehensive Solar Education Effort

Dane County, in partnership with solar developers, utilities, solar consultants, clean energy advocates, other Dane County municipalities, Wisconsin Energy Institute, UW Extension, and other organizations and associations with existing educational programs that relate to energy, will develop, test, and launch a solar education and outreach effort to key audiences. The campaign will have the objective of increasing business and individual (homeowner and renter) investment in cost-effective solar photovoltaic systems including:

- Customer sited roof-top and ground-mounted solar arrays.
- Community solar gardens.
- Renewable contracts (e.g. MGE renewable energy rider).
- Utility-scale solar.

The solar education and awareness campaign will target specific audiences, address the biggest barriers (such as up-front costs), describe the many solar benefits, and employ more than a dozen specific communication strategies including:

- Strong and steady social media messaging.
- Outreach materials describing leading finance tools (including PACE).
- A speakers' bureau of trusted messengers.
- Direct targeting of market segments with tailored and tested messages.
- Presentation of high-profile solar success stories and case studies.

Municipalities Leading by Example
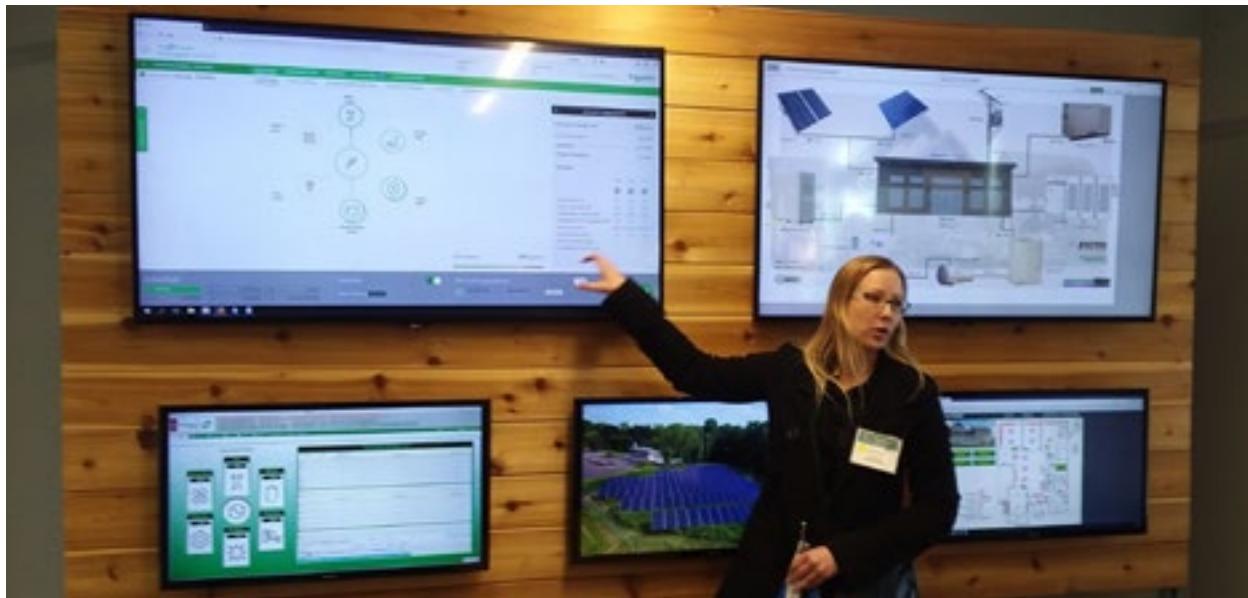
The 61 cities, villages, and towns within Dane County are key players in the effort to reach deep decarbonization. Eleven of those municipalities, and those who live and work in them, make up 91% of the electricity use in the County.

Specific Actions

1. The Office of Energy & Climate Change will work with the municipalities to establish programs and procedures for benchmarking, tracking, and evaluating energy use in their government facilities and operations, as well as the GHG emissions.

2. The Office of Energy & Climate Change will work with municipalities to adopt clean energy goals and develop comprehensive clean energy plans to meet those goals.

3. The Office of Energy & Climate Change will continue to facilitate a municipal clean energy work group and will support their efforts to implement comprehensive clean energy plans. The Office of Energy & Climate Change will support municipalities by helping to identify clean energy project grant opportunities and write successful grant proposals; work with utilities and other stakeholders to identify and pursue clean energy project opportunities; ensure equitable access to clean energy for low and moderate income neighborhoods; identify and coordinate opportunities for group buys of renewable energy, energy efficiency products, energy storage, and other clean energy strategies and technologies. The Office of Energy & Climate Change will also help municipalities establish clean energy districts (see the Cross-sector Solutions Section).

Energy Storage

Electric energy storage will have to play a major role if we hope to generate all, or even close to 100%, of our electricity from renewable, zero-carbon resources. Energy storage also holds promise to greatly increase resiliency within our communities by keeping power flowing to critical facilities and vulnerable facilities when transmission or distribution grids are down. While there are a variety of technically feasible energy storage technologies available, batteries are the most cost-effective technology with diverse applications. In Wisconsin, electric energy

▲ The Gordon Bubolz Nature Preserve teamed up with Faith Technologies and Schneider Electric who together developed and installed multiple clean energy components to create one of Wisconsin's first microgrids. Here Caramy Biederman, a Faith Technologies electrical engineer, leads a tour in the microgrid control room where various components including solar panels, battery storage, a fuel cell, and a microturbine are monitored. You can see the output and usage of each component on this real-time dashboard: bubolzpreserve.org/bubolz-microgrid-data-dashboard

storage is not cost-effective today in most instances if we are only looking at the storage function to supply electricity. However, prices for storage are coming down very steadily, and storage has many potential value streams. As policies are adopted that reward these value streams, storage will become cost effective. Such values include:

- Provision of capacity.
- Energy arbitrage.
- Peak load shaving.
- Demand reduction.
- Voltage control.
- Frequency regulation.
- Spinning reserve.
- Renewable resource firming.
- Power quality.
- Transmission upgrade deferral.
- Distribution upgrade deferral.
- Increased reliability.
- Increased resilience.

The Climate Council urges the Office of Energy & Climate Change to pursue energy storage projects to realize some of these benefits and gain experience with energy storage. To that end, the Council has identified five different potential energy storage project structures:

1. Utility-scale, utility-owned storage on the distribution system.

2. Co-owned (by utility and business or government customer) utility-scale storage sited on customer premises. Operations could also be shared responsibility.

3. Storage for a microgrids for critical Dane County infrastructure.

4. Behind-the-meter storage for commercial or industrial businesses.

5. Behind-the-meter residential storage.

Specific Actions

1. Dane County will partner with utilities and businesses and invest in storage projects that will provide valuable experience. The County should prioritize projects where clean energy storage is coupled with renewable generation and increases equity and resilience.

2. The Office of Energy & Climate Change will engage with the Midcontinent Independent System Operator to support the development of strong rules under Federal Energy Regulatory Commission order 841 for development of strong energy storage markets that maximize opportunities for Dane County utilities and their customers to take advantage of energy storage.

3. The Office of Energy & Climate Change will conduct, or contract for, a comprehensive energy storage potential study focused on storage coupled with new or existing renewable generation. The study should look at costs and benefits, including emission reductions, equity, resiliency, and grid support. The study should identify potential sites that maximize these storage benefits. Feasibility studies on specific projects at specific project sites should be considered depending on the results of the potential study.

4. The Office of Energy & Climate Change will add storage to the list of potential projects and technologies to consider for group purchasing with other municipalities.

5. The Office of Energy & Climate Change will lead a collaborative effort to develop an energy storage action plan, potentially like the one written by the Iowa Energy Office in May 2019.

Grid Modernization

Our existing transmission and distribution grids were developed to accommodate a power system model of relatively few large central generation stations (power plants) and not a lot of thought to the demand side of the supply and demand equation. To achieve deep decarbonization, our grid will need to get much smarter and by this we mean it must accommodate a larger number of more dispersed clean energy generation sources. It will also need to increase use of digital communication, controls technology, and advanced metering to optimize grid operations and resources, increase security, integrate smart appliances and consumer devices, and incorporate demand response, demand-side resources, and energy efficiency resources, among other things.

Our utilities recognize this need to modernize the grid and are taking a variety of steps to do so. However, in Wisconsin, government lags in supporting them in that effort. The Clean Energy Technology Center in North Carolina tracks and reports on grid modernization efforts in all 50 states. The "50 States of Grid Modernization" reports showed that Wisconsin was one of only 13 states that took no actions toward grid modernization in 2017, and one of 14 states that took two or fewer actions in 2018, compared to Michigan and Minnesota that took 10 or more actions in 2018. "Actions" included deployment, policy adoption, investments, studies and investigations, and planning. The GRIDWISE Alliance is a national coalition of power sector stakeholders that includes electric utilities, industry suppliers and service providers that also tracks and ranks grid modernization activities. Their 2018 Annual Grid Modernization Index ranks Wisconsin 39th among the 50 states in grid modernization leadership. Illinois ranks second, Minnesota 10th and Michigan 11th.

While state resources, investments and policies are obviously extremely important to massive infrastructure-transition undertakings such as electric grid modernization, this CAP urges the Office of Energy & Climate Change to work with other government entities, other power sector businesses, and nonprofit groups to take a leadership role in doing all it can to support utility efforts to

modernize the distribution grid within Dane County to transition to a more efficient and effective power sector. This becomes increasingly important as we pursue electrifying the other sectors of the economy such as transportation. There is much less that Dane County can do to improve the transmission grid, for obvious reasons, but most importantly it can support the strategic and environmentally sound buildout of the transmission grid to accommodate more clean renewable generation.

Geothermal Heat Pumps

The Deep Decarbonization Pathways Project tells us, and our modeling confirms, that electrifying heating and cooling to phase out the use of fossil fuels, is a critical strategy to meet our GHG emission reductions goals. Geothermal heat pumps, or ground-source heat pumps, transfer heat to and from the ground. An electric pump pushes a refrigerant liquid from a building through a series of looped tubes in the ground and back to the building. The soil more than 10 feet or so underground remains a constant temperature, around 50 °F at this latitude, and so the refrigerant cools down when it passes through the loops in the summer and warms up beneath the ground in the winter. The same type of technology that is used in air conditioners in homes and cars – a vapor-compression refrigeration cycle – brings the temperature from the ground temperature to where you want it on cold winter days and hot summer days. The same technology is used in air-source heat pumps. You can heat directly with electricity (such as an electric space heater), but an air-source heat pump is more efficient, and less costly. A ground-source, or geothermal heat pump, is even more efficient, because the earth (via the sun) is doing much of the work.

Geothermal heat pumps require a certain amount of land and they are more costly to install because of the amount of earth moving involved. However, geothermal heat pumps are cost effective today for larger businesses and large institutional buildings such as schools, hospitals, and large municipal buildings. EPIC in Verona, for example, has one of the largest geothermal heat pump systems in the U.S. This CAP is recommending that the Office of Energy & Climate Change establish a Geothermal Work Group to come up with a County-wide program to help large building owners finance and install geothermal heat pumps at a much faster rate than is currently happening. That same work group should also come up with recommendations that the County government and the Office of Energy & Climate Change can take to establish pilot programs for air-source heat pumps.

Agriculture & Forestry

Agriculture

Dane County covers approximately 1,238 square miles or 791,978 acres of land. Agriculture, forests, pastures, and other undeveloped lands account for about 82% of the land area. Dane County is one of the top agricultural producing counties in the state.

Dane County's abundant and highly productive agriculture and forest lands hold critical opportunities for climate mitigation, particularly through carbon sequestration. At the same time, Dane County's agricultural lands are considerable sources of greenhouse gas emissions, particularly methane and nitrous oxide. Methane, as a greenhouse gas, is 25 times more potent than carbon dioxide, even though it stays in the atmosphere a fraction as long, and nitrous oxide is nearly 300 times more potent than carbon dioxide. The

Climate Champions
Yahara Pride Farms

Established in 2012, Yahara Pride Farms is a farmer-led 501c (3) non-profit organization that strives to preserve agricultural heritage while simultaneously encouraging farmers to engage in proactive environmental stewardship within the Yahara Watershed. Participating farms employ practices that result in the preservation and enhancement of soil and water resources for today, and for generations to come. In 2018, farmers in the program reduced the risk of phosphorus delivery to Madison lakes and the Yahara River by 22,000 lbs.

▲ Planes are used to plant cover crops that help keep soil in place all year. Coupled with the right management techniques, cover crops can also aid in carbon sequestration.

Research has shown that three conservation practices endorsed by Yahara Pride Farms help to reduce greenhouse gases.

- Composting directly increases soil carbon storage by creating stable carbon and reduces methane and nitrous oxide emissions, which are greenhouse gases that contribute to climate change. Compost releases nutrients to the soil over a span of seasons. When farmers consistently spread compost on their fields, they reduce the need for the application of commercial fertilizers. Farmers are not only saving on fertilizer costs, but they are also avoiding the greenhouse gases related to the production of that fertilizer.
Compost is very nutrient dense and as a result, requires fewer trips across the field than traditional manure/nutrient application reducing fossil fuel use. When farmers apply liquid manure or other fertilizers before they are composted, many times the fields will require more tillage which releases greenhouse gases from the soil.
- Cover crops work to hold nutrients within the plant root zone of the soil, reducing costs and the carbon footprint associated with application of additional nutrients. In many cases, cover crops also result in reduced tillage. Cover crops work to condition the soil for next year's seed bed, reducing the amount of tillage required.
- Strip till, no-till and reduced till decrease the amount of carbon released into the atmosphere by minimizing soil disturbance and the resulting oxidation of soil carbon.

To learn more about Yahara Pride Farms, these practices, and other conservation practices promoted by the group go to yaharapridefarms.org. ☀

substantial and highly productive agricultural lands in Dane County are both a greenhouse gas source and sink. The Climate Council views this fact as a major opportunity – an opportunity to research, learn, document, and demonstrate how to keep Dane County an agriculture industry leader in the state, while at the same time making these productive lands less of a greenhouse gas source and more a of sink.

An important concept to understand before we dive into recommendations is the concept of regenerative agriculture. Regenerative agriculture is a system of farming practices that is sustainable because it regenerates (enriches) topsoil, increases biodiversity, improves water cycles, and generally increases ecosystem services. At the same time, it increases crop yields. These farming systems also increase the capture of carbon in the soil while making crops more resilient to pests, drought, flooding, and other adverse climate impacts. Terra Genesis International (terra-genesis.com) is an excellent place to learn more about regenerative agriculture. Regenerative agriculture reduces nitrogen and carbon emissions from the soil while increasing the amount of carbon that crops sequester in the soil.

A bonus is that these farming systems also increase what is often referred to as "ecosystem services." Ecosystem services are the benefits that people receive from various ecosystems and include basic things like clean water, clean air, and food products, as well as nutrient cycling, soil formation, wildlife habitat, regulation of flooding, drought, and even cultural benefits such as recreation, and spiritual and religious benefits.

Regenerative agriculture practices include:

- No-till cropping.
- Composting.
- Perennial cropping.
- Agroforestry.
- Silvopasture.

Recommendations

1. Dane County will hire staff members with greater expertise in regenerative agriculture systems and dedicate staff to regenerative agriculture projects and practices including composting, perennial cropping, silvopasture, tree intercropping, multi-strata agroforestry, alley cropping, biochar, and others.

2. The Office of Energy & Climate Change will join the 4 per 1000 Initiative, which is an international initiative consisting of governments, foundations, research organizations, private companies, and farm and forestry organizations who are committed to improving soil carbon management, combating poverty and food insecurity, and mitigating climate change. The Office of Energy & Climate Change will establish a commitment under the 4 per 1000 Initiative on behalf of Dane County government, review the states-and-local-authorities list of action item commitments, and take action on all that make strategic sense in the context of this CAP.

3. Dane County government will aggressively market the County Continuous Cover Program to expand perennial native plantings and promote sustainable agriculture practices including continuous cover, prairie strips, and riparian buffers.

4. Dane County government will establish a schedule to convert county-owned farmland, currently leased for row cropping, to regenerative agriculture systems including multi-strata agroforestry, alley cropping, silvopasture, and others. Initially, the emphasis should be on innovation, research, and demonstration. The county will complement this effort with workshops and demonstration projects to encourage these practices on private lands.

5. The Office of Energy & Climate Change will work with the Agriculture and Forestry Work Group to commission a feasibility study to explore the potential costs, benefits, barriers, and opportunities associated with a biomass "upcycling" facility that would process more marginal biomass streams and convert these into value-added biomass products. The upcycling facility could include a regional manure composting operation, a mixed substrate composting operation, and a processing operation for biomass harvested from nutrient catch strips and agricultural land prairie strips.

6. The Climate Council encourages the Dane County Land and Water Resources Department to continue to pursue and accelerate the build-out of anaerobic digesters in the Yahara watershed, but also support, incent, and catalyze the development of anaerobic digesters in the other watersheds as well. The Council urges the County to adopt and pursue the goal of processing half of all the Dane County dairy cow manure in digesters by the year 2030.

7. The Office of Energy & Climate Change will work with other Dane County departments to develop a protocol for calculating GHG emissions from agriculture practices in the County including carbon dioxide, methane, and nitrous oxide. The County should develop a baseline for these emissions as

soon as possible and then track the emissions going forward and estimate the emission reductions resulting from all the initiatives above. The Office of Energy & Climate Change should prepare a report on the agricultural GHG emissions and share this report with all agricultural stakeholders in the County. The report should also analyze and estimate the avoided GHG emissions from digesters, composting and other agricultural practices in place today.

Forestry

Recommendations

The Office of Energy & Climate Change will work with the Dane County Land and Water Resources Department, Dane County Parks, the Dane County Tree Board, and others to implement the following five broad forestry strategies:

- Keep forests as forests.
- Create new forests through reforestation and afforestation.
- Manage existing forests.
- Protect, maintain, and increase urban forests.
- Increase the use of forest products.

Specific Actions

Keep forests as forests
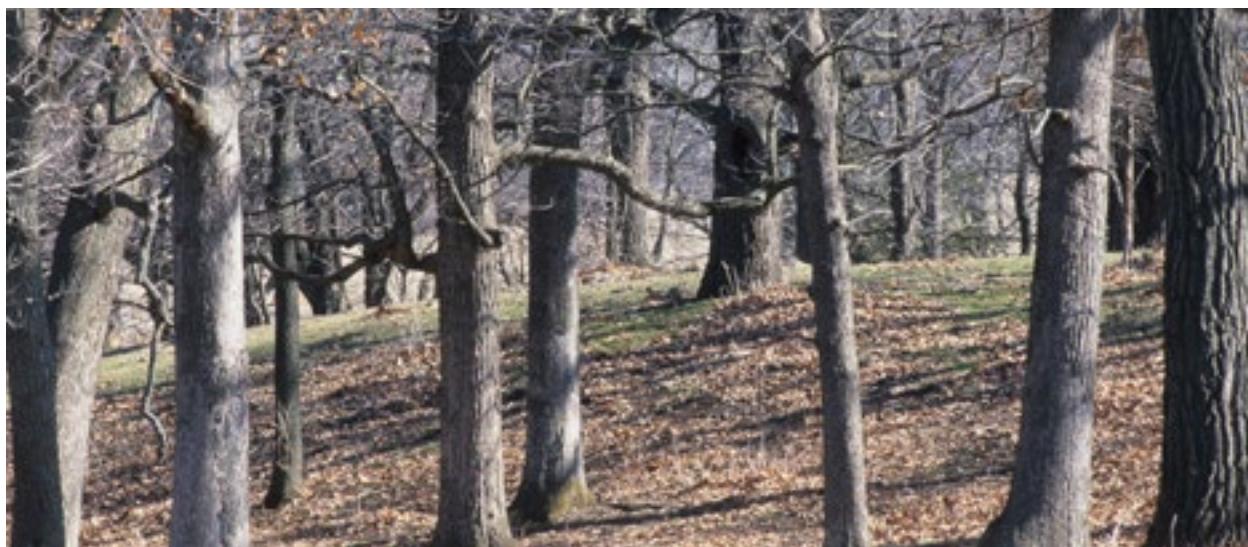
1. The Office of Energy & Climate Change will work with the Ag/Forestry/Food Work Group and the Dane County Tree Board, to conduct an assessment of the existing forest cover in Dane County using the U.S. Forest Service i-Tree Landscape, the National Land Cover Database, and the National Agriculture Imagery Program to establish a tree canopy baseline for the County. The Office of Energy & Climate Change will use i-Tree, the Forest Inventory and Analysis program, or a similar tool, to track the carbon storage and ecosystem services of trees in Dane County and include this data in the CAP evaluation reports.

2. Dane County will encourage land use planning that maintains existing forest canopy (e.g. conservation subdivisions).

3. The Office of Energy & Climate Change will work with the Land and Water Resources Department to identify key parcels of forest land for acquisition to maximize continuous forest ecosystems.

Afforestation

1. Dane County will support and take full advantage of existing federal and state programs that promote afforestation with seed or planted stock.

2. Dane County will create county-level incentives for private sector investment in afforestation. We will track and measure the additions to the forest canopy on a three-year schedule.

3. The Office of Energy & Climate Change will support County applications to the U.S. Department of Agriculture Natural Resource Conservation Service, and other sources, for funds to establish a new grant program for municipalities to plant and inventory urban forests.

4. The Office of Energy & Climate Change will work with community organizations to prioritize and support tree planting programs.

▼ Remnant oak savannas are well adapted to Dane County, featuring the white, red and bur oak species. These oak-dominated forests, which are common in Dane County, represent an excellent opportunity for landowners to sequester carbon, mitigating both the effects of climate change and adapting to new climate conditions. *Photo: Wisconsin Department of Natural Resources*

Manage existing forests

1. The Office of Energy & Climate Change will work with the Land and Water Resources Department to encourage the integration of carbon sequestration management practices into public forest lands. The Office of Energy & Climate Change will also investigate working with other government agencies including Department of Natural Resources and private groups and foundations to hold a conference on managing forests for maximum carbon sequestration.

2. The Office of Energy & Climate Change will work with the Land and Water Resources Department to encourage private landowners to participate in state and/or federal forest management programs.

Protect and expand urban forests

1. The Office of Energy & Climate Change will use existing urban forestry inventories to create an urban forest baseline and to quantify the contribution the urban forests made to the total Dane County tree canopy. We will also estimate the current level of carbon sequestration from urban forests in Dane County.

2. The Office of Energy & Climate Change will work with cities and villages in Dane County to increase public investments in restoring, maintaining, and expanding urban forests, particularly to address insect and disease impacts.

Increase the use of forest products

1. The Office of Energy & Climate Change will integrate information on carbon sequestration in wood used in building construction into the advanced building guidelines discussed earlier in this action plan.

2. The Office of Energy & Climate Change will launch an education and awareness campaign on the carbon that can be sequestered in wood products.

3. The Office of Energy & Climate Change will conduct, or commission, an analysis on cradle-to-grave use of various materials from a GHG standpoint.

Local citizens display their pledges to protect ground water and our environment. Madison Metropolitian Sewerage District is leading this pledge campaign.

Water Energy Nexus

No other single feature helps to define Dane County quite like water. The Yahara chain of lakes is iconic and brings incredible value to the County's economy. Lake Mendota is one of the most studied lakes in the world and the City of Madison is one of only two U.S. cities that is built on an isthmus.

Managing water is critical to both mitigating and adapting to climate change. Much of the GHG emissions related to water are related to the energy it takes to move water. Moving water around the County, from deep underground to your kitchen sink faucet, or from a toilet to the wastewater sewerage plant, uses a tremendous amount of energy. There are 28 water utilities in Dane County that use about 32 million kWh of electricity a year.

Dane County Government will need to continue to collaborate with all of the sewage districts and water supply utilities across the county to maximize water efficiency and energy efficiency, and encourage the use of renewable energy to reduce GHG emissions associated with moving water through Dane County.

Recommendations

1. The Office of Energy & Climate Change will support efforts of the Madison Water Utility to develop and implement a residential water efficiency and rainwater capture incentive program. By replacing older fixtures and appliances with EPA Watersense-labeled products, and by capturing rainwater for non-drinking water uses, the water utility will aim for a goal of reducing residential water use by 20% by 2030.

2. The Office of Energy & Climate Change will work with the Water Work Group to develop best energy efficiency practices and identify the most efficient appliances and equipment for major Dane County commercial sectors and building types. The Office of Energy & Climate Change will, in turn, also work with the Water Work Group to integrate these water efficiency practices and equipment into the Dane County energy efficiency program (see Energy Efficiency).

3. The Office of Energy & Climate Change will work with the Water Work Group and the Madison Water Utility to identify and analyze water efficiency and rainwater capture policies and promote those policies with Dane County municipalities.

4. The Madison Metropolitan Sewerage District will complete an energy master plan and implement key improvements to significantly reduce its energy demand and dependency. Energy reduction and generation projects could include water treatment process efficiencies such as demand-based nutrient removal, improving onsite co-generation, developing a co-digestion program, and constructing renewable energy facilities for treatment plant energy demand needs.

5. The Office of Energy & Climate Change will work with the Water Work Group to analyze the Net Blue model ordinance for water-neutral community growth. Net Blue is a collaborative initiative of the Alliance for Water Efficiency, the Environmental Law Institute, and River Network to support sustainable community growth. The Office of Energy & Climate Change and the Water Work Group will develop a plan for the most impactful application of that ordinance, or another comprehensive water efficiency ordinance, and the Office of Energy & Climate Change will work with Dane County municipalities to adopt the ordinance.

Waste Materials & the Circular Economy

Waste Collection & Disposal

Waste collection and disposal activities contribute significantly to GHG emissions and associated climate impacts. The Environmental Protection Agency states that municipal solid waste landfills are the third-largest source of human-related methane emissions in the U.S., accounting for approximately 14.1% of these emissions in 2017. But what was once a potential liability can become an important community asset. This can be accomplished by transitioning from traditional waste disposal programs to responsible resource management systems in a circular economy.

On average, every person in Wisconsin generates over 1,700 pounds of waste each year. Every year, 250,000 tons of garbage are landfilled in the Dane County-owned-and-operated Rodefeld Landfill. All that garbage is not waste, it is simply wasted resources.

Bikes brought to the Dane County landfill to be discarded are fixed and free for the taking. The County gives many to local non-profit organizations that fix them and get them to children that would not otherwise have a bike. The tires are recycled into products or infrastructure, such as playground surfaces.

Recommendations

The Office of Energy & Climate Change will work with the Dane County Department of Waste & Renewables to implement the following waste strategies:

1. Creation of a comprehensive sustainable materials management policy. The policy should include:

   - Adoption of goals for waste diversion through reuse, repurposing, and recycling, including a prioritization list for new programs to divert additional waste materials from the landfill in ways that are economically and environmentally sustainable. Food waste should be one of the next waste materials on the landfill diversion prioritization list.
   - Procurement rules for products manufactured and brought to market based on GHG lifecycle analysis.
   - Environmental standards for waste collection vehicles, with an emphasis on RNG and EV vehicles.

- Programs and policies to encourage development of local businesses that use waste resources as their product feedstock. This should include the consideration of a sustainable materials business park, similar to the Phoenix Resource Innovation Campus (bit.ly/PhReInCa) or the Kent County Sustainable Business Park (reimaginetrash.org/sbp).
- Education and engagement programs.

2. Creation of a departmental, long-range, solid waste plan. The plan should account for future waste types and volumes, as well as current and future community needs for waste diversion and disposal facilities and programs. This plan should also consider the best use of the land controlled by the Department of Waste & Renewables, both during operations and after final landfill closure. Emphasis should be placed on using portions of the land for solar and biogas renewable energy systems, conservancy, light recreational use, reforestation, and prairie restoration.

3. Adoption of steps to actively reduce the GHG emissions associated with waste disposal and management activities.

- Install landfill gas collection wells sooner and optimize landfill gas collection systems to minimize amount of fugitive emissions. This will help reduce GHG emissions, increase RNG renewable fuel production, increase revenue, and reduce landfill odors.
- Continue to pursue carbon capture from the remaining emissions at the RNG plant.
- Implement fuel efficiency programs and convert landfill equipment to RNG as technology becomes available. Encourage the conversion of our landfill customer garbage truck fleets to renewable fuel vehicles.
- Install solar PV projects to meet the high energy demands associated with managing large volumes of waste and biogas.

4. Work with the Emergency Management Department to update the County's Disaster Debris Management Plan.

Food Waste

According to Paul Hawken's *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*, reducing food waste is the third most important action that we can take to reduce GHG emissions globally. Roughly a third of all the food prepared is not eaten, this translates into 4.4 gigatons of carbon dioxide equivalent released which is approximately 8% of the total human

GHG emissions each year, according to Hawken. The Council felt it important to have a specific set of recommendations focused on food.

Recommendations

1. The Office of Energy & Climate Change should develop a model local, low-carbon farms act to promote low-carbon, regional food systems.

2. The Office of Energy & Climate Change will work with the Department of Waste & Renewables and municipalities to develop a plan for collection and diversion of food waste that includes digestion, composting, and other management tools that maximize the GHG emission reductions associated with food waste.

3. The Office of Energy & Climate Change should investigate the feasibility of a wholesale food terminal that keeps fresh food cold so that more food may flow through our region.

4. The Office of Energy & Climate Change should provide matching funds for the food projects portion of the Partners in Equity grants program.

Creating a Circular Economy

The world's population and the global economy are growing and with them so is the demand for raw materials. Our supply of crucial raw material is limited, so fully utilizing materials and products is paramount to sustainable development.

A circular economy is a model of production and consumption which is an alternative to our current linear "take-make-consume-throw" pattern. In practice, it implies reducing waste to a minimum, keeping materials in the economy for as long as possible, and retaining and fully utilizing the value of products, parts, and materials. To promote the idea of a circular economy, industrial symbiosis programs where one company's waste stream becomes another's raw material have been implemented across the world. This program brings companies together in innovative ways, identifying and enabling mutually beneficial resource exchanges.

One of the oldest and most successful examples of this is the National Industrial Symbiosis Program (NISP) in the U.K. NISP connects businesses of various sectors

Climate Champions
Building Sustainable Food Systems

Food waste is one of the biggest drivers of GHG emissions. The much-celebrated book *Drawdown; The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* ranks reducing food waste as the third most impactful action that can be taken globally to reverse global warming. The authors suggest that 70.53 gigatons of carbon dioxide can be reduced by mid-century with a concerted effort to reduce food waste. Data shows that up to 35 percent of food in high-income economies is discarded, whereas in low-income economies, very little food is wasted at the household level.

Here in Dane County there are several groups that are doing great work to reduce food waste. One is the Badger Prairie Needs Network in Verona. Badger Prairie runs a food recovery program, a kitchen-to-table program, a food pantry, community meals, nutrition classes, cooking classes, and more.

The food recovery program collects perishable and non-perishable food from large institutional and business cafeterias, including Epic, CUNA Mutual, UW Hospital, Festival Foods, and Pick-n-Save. Badger Prairie enables the redistribution of tons of quality food from these sources to many other food pantries and community outlets in Dane County. In all, Badger Prairie keeps more than 50 tons of good food out of the landfill and delivers it to people across Dane County who need it.

▲ The Saturday community meal at Badger Prairie Needs Network brings the community together for a nutritious hot lunch, socializing, and often a hearty laugh.

Another important organization building sustainable food systems is REAP Food Group. REAP is a non-profit that has established several sustainable food programs including the Farm to School and Farm to Business programs. Fresh produce is delivered from cooperative farms in western and central Wisconsin to kitchens at Madison College where food is processed in their culinary arts school and then distributed to schools and institutions in Dane County. Sourcing food from Wisconsin farms not only ensures that it is fresh and healthy, but the hyper-local supply chain results in significant GHG emission reductions by decreasing transportation.

These are just two of many ongoing efforts to reduce food waste and reduce GHG emissions from food systems in Dane County, but they are two incredibly important efforts. ☀

and sizes and identifies potential uses for unwanted materials. The program seeks to reduce waste and emissions and produce economic benefits through reduced disposal costs and new commercial opportunities. Since its launch in 2005, NISP has affected Britain's economy and environmental performance significantly, among other things reducing CO_2 emissions by 42 million tons and creating additional sales worth one billion British pounds (see Fig. 9.3). Similar programs of industrial symbiosis have been implemented across the world with visible, positive results as well (see Fig. 9.4 and Fig. 9.5).

While most industrialized nations in the world have robust industrial symbiosis programs, the U.S. has no such nationwide program. It turns out that southeast Wisconsin, with its strong and diverse manufacturing base, is one of the best places in the nation to incubate such a program. The Office of Energy & Climate Change will reach out and partner with like-minded governments along the southern Lake Michigan shore, such as Milwaukee and Racine to work together to get a pilot industrial symbiosis project off the ground there. If that pilot takes off Dane County businesses will be able to help grow the program faster. The more businesses that participate the more waste-to-resource matches will be made.

Finance Solutions

Most of the projects, programs, and clean energy goals in this climate action plan will require up-front funding, even if they will eventually save money for the owners or participants. There are a wide variety of different clean energy and climate finance tools used across the country. One of these financial tools is well-developed and already available in Dane County – Property Assessed Clean Energy (PACE). PACE can be used for commercial buildings and multifamily housing of more than four-units, and since the enabling laws are in place it will make sense for the Office of Energy & Climate Change to initially prioritize working with the PACE program to finance clean energy projects.

Working with Dane County and Wisconsin energy service provider companies on performance contracting can provide funding for large institutional entities such as governments, health care organizations, and schools. In the medium to long-term, more sophisticated, and flexible financial organizations and tools may be required to achieve the GHG emission reduction goals in this report. Here is a brief description of some of the leading candidates.

▼ Fig. 9.3 National Industrial Symbiosis Program, NISP (Great Britain) results from 2005-2013

Metrics	In Year Benefits*	Lifetime Impact
Landfill diversion	5.9 million tons	47 million tons
CO_2 reduction	5.3 million tons	42 million tons
Virgin material savings	7.5 million tons	60 million tons
Haz waste eliminated	225,000 kg	1.8 million tons
Water savings	9.1 million tons	73 million tons
Cost savings	125,000,000 £	1,000,000,000 £
Additional sales	125,000,000 £	1,000,000,000 £
Jobs	1,250	10,000

1.00 GBP = 1.286 USD

*independently verified.

▼ Fig. 9.4 Western Cape Industrial Symbiosis Program, WISP (South Africa) 2012-2017

Metrics	In Year Benefits*	Lifetime Impact
Landfill diversion	1040 tons	5200 tons
CO_2e reduction	4200 tons	21,000 tons
Cost savings	R2,700,00	R13,400,000
Additional revenue	R2,280,000	1R11,400,000
Private investment	R20,800	R104,000
Jobs	7.2	36

13.84 ZAR = 1.00 USD

*independently verified.

▼ Fig. 9.5 Industrial Symbiosis in Tianjin Binhai New Area (China) 2009-2013

Metrics	In Year Benefits*	Lifetime Impact
Landfill diversion	357,500 tons	1.4 million tons
CO_2 reduction	41,750 tons	167,000 tons
Cost savings	18,250,000 CNY	73,000,000 CNY
Additional revenue	28,000,000 CNY	112,000,000 CNY

6.76 CNY = 1.00 USD

*independently verified.

Recommendations

Loans with Credit Enhancement

Traditional consumer loans can be tied to energy efficiency, renewable energy, and water efficiency measures, and deployed through installation contractors. The credit enhancements can be offered through government entities or other sponsoring entities. Sponsoring entities offer a financial insurance product to incent private investors to offer more favorable financing terms. Additional credit enhancements to reduce interest rates can be the equalization of interest rates across credit scores and extending the loan repayment terms up to 15 years. These measures particularly support low- and moderate-income households that might otherwise not qualify due to their credit score or debt-to-income ratio. This product has been deployed across the nation in leading efficiency programs.

PACE

PACE financing is secured by property tax assessments that may be repaid through the property tax bill. Capital is available from lenders to cover up to 100% of the project cost. Eligible improvements are related to energy efficiency, water conservation, and renewable energy and storage. Loan terms can equal the economic useful life of the measures, which may be more than 20 years, and up to 30 years for solar projects. PACE financing is tied to the property, and therefore may be transferred to subsequent property owners. Currently Wisconsin has available PACE Wisconsin (pacewi.org) which is a statewide commercial PACE program (see Fig. 6). Commercial PACE (C-PACE) helps make a business case for installing clean energy improvements in qualified buildings by offering non-recourse financing that lowers the cost of capital for owners compared to competing sources (equity and mezzanine debt), is transferable to subsequent building owners, and allows landlords to share benefits and costs with building tenants.

Energy Service Companies & Performance Contracting

Energy Service Companies (ESCOs) are large commercial firms that provide a wide range of integrated technical solutions for institutions seeking to improve their energy performance. Typical ESCOs would be Johnson Controls, Siemens, Honeywell Building Solutions, and H&H Energy Services. They offer streamlined approaches, provide initial energy audits, develop comprehensive sets of recommended upgrades, engineer agreed-upon solutions, construct, implement,

▲ Jennifer Quimby, Mayor, City of Waterloo (left); Craig Ellsworth, Waterloo Technology Center; Paul Nikolic, Nikolic Group; and Dan Carey, McFarland State Bank pose for a photo a the Waterloo Technology Center. PACE financing provided by McFarland State Bank enabled efficiency measures that cut energy bills almost in half. McFarland State Bank is the leading PACE lender in Wisconsin.

and monitor. One hundred percent of each project can be funded, and the ESCO guarantees performance of the energy savings. This is generically referred to as "performance contracting." The energy savings are used to pay for the upgrades in efficiency. ESCOs typically work with large commercial, government, or institutional customers when doing performance contracting.

Climate Bonds

Climate bonds are bonds issued specifically for the purpose of funding climate mitigation or climate adaptation projects or programs. Climate bonds could also be used to establish a loan loss reserve program. Like other bonds, climate bonds can be issued by governments, banks, or corporations. The Climate Bonds Standards Board, based in London, has developed a certification program for climate bonds.

Green Banks

A green bank is a dedicated public or non-profit entity, not a depository institution for the general public. There are multiple financing tools available through green banks, but the common theme is to invest public funds to leverage the access to cheap capital (based on government credit rating), and to stimulate the deployment of additional private capital. The bank invests in opportunities to overcome market barriers to clean energy adoption, models that advance clean energy in underserved markets, and companies or projects that test strategies to scale clean energy use. The Montgomery County Green Bank in Maryland is an example of a county-created green bank.

Voluntary Carbon Markets/Funds

Environmental markets and environmental credit trading are general terms referring to a range of market-like transactions where an entity undertakes an activity that provides environmental benefits in exchange for payment from another entity to meet environmental goals. A local carbon market could create credits for carbon emission reductions, carbon sequestration, climate resiliency such as flood control, water quality, ecosystem services, and many other climate-related projects. A variety of project types might generate any one of these credit types or a single project might generate multiple types of environmental credits, called credit stacking. A voluntary market can be established at any jurisdiction level, including county, state, or region.

The carbon market, or fund, needs an administrator and Dane County is very fortunate to have a non-profit organization with tremendous expertise and experience in clean energy finance and finance program administration. Slipstream is a clean energy research, policy, and implementation organization that was an architect of, and now administers, the Wisconsin PACE program. The carbon market fund and its administrative infrastructure are established financially through local government contributions, donations from businesses and individuals, and grants made by supporting foundations or other governmental agencies. Loan repayment, interest, and revenue from carbon offset sales help replenish the fund and enable its ongoing operation.

Specific Actions

The carbon market proposed here will have a strong equity focus in development and implementation of projects that create a healthy environment in which

to live, learn, and work. Dane County and Slipstream will partner with local businesses, community groups, and individual community members to identify specific attributes and project types. The Office of Energy & Climate Change and Slipstream will work with these partners to create a menu of projects that fit the specific circumstances and culture of the people here, as well as the built and natural landscapes. Some example project types might include:

- Anaerobic digester deployment.
- Afforestation.
- "Deeper" home retrofit.
- Residential heat pump technology deployment.
- Home weatherization.
- Electric vehicle and charging deployment.
- Community solar arrays in single family, multifamily, and manufactured home neighborhoods.
- Small business lighting, equipment, and envelope retrofits.
- Home electrification.

Projects can be bundled and scaled flexibly. For example, a local unit of government using this carbon fund platform and inaugural sponsoring businesses could select a multifamily solar array for an urban city block or a deeper home retrofit for all of the homes in a neighborhood, or a rural township or valley. The recommendation here is to launch this carbon fund at the Dane County regional level including Dane and contiguous counties, and expand it over time to statewide, and eventually the Midwest.

Cross-sector Solutions

"Shifting Currents"
by Aaron D Laux

Collaborative efforts will be imperative to accomplish the innovative projects in this CAP and meet our goals. Fortunately, Dane County has many partnerships already in place to facilitate a faster response time, and entities throughout the County have already indicated their support and willingness to work together.

Clean Energy Districts

Clean Energy Districts (CED) will be a way for Dane County to partner with local municipalities, neighborhood associations, business districts, and others to mitigate climate change through local clean energy development and build resiliency at the community level. The Dane County Office of Energy & Climate Change will designate identifiable geographic areas – neighborhoods, business parks, communities – as official Dane County Clean Energy Districts when those jurisdictions meet specific criteria including:

- **Renewable resources** – The district must obtain energy from multiple clean, renewable electricity generation sources.
- **Energy efficiency** – The CED must have a dedicated energy efficiency program or effort made up of some combination of administrative support, technical assistance, and/or rebate incentives.
- **Clean transportation** –The CED must host and incentivize opportunities for clean transportation options, such as EV charging, RNG, or clean vehicle ridesharing.
- **Energy storage** – The Office of Energy & Climate Change will work with the CED to develop and fund energy storage projects.
- **Critical infrastructure** – The Office of Energy & Climate Change and Dane County Emergency Management will work with the CED to identify all critical infrastructure and vulnerable facilities and collaborate on ways to increase resilience.
- **Research and development** – The CED, with support from the Office of Energy & Climate Change and other partners, will establish baselines and collect data on energy use and transportation patterns as well as track and monitor the performance of all clean energy initiatives related to the CED.
- **Equity and justice** – The CED will, with support from the Office of Energy & Climate Change, develop a plan for ensuring that the benefits of all of the other CED requirements above, are targeted to include the most vulnerable residents within the CED.

Communities will apply to the Office of Energy & Climate Change for CED designation, and the requirements above will be fulfilled on the basis of a memorandum of understanding executed between the community and the Office

of Energy & Climate Change. The purpose statement of the memorandum of understanding will identify numerous objectives of the CED designation including:

- To recognize and give credit to communities, neighborhoods, businesses, and others who make a commitment to develop clean energy and transportation infrastructure that will make their community more resilient, increase the energy security, and help mitigate climate change.
- To make our buildings, facilities, and transportation systems more efficient, and to help business owners, homeowners, and renters reduce their energy bills and create other local economic benefits.
- To strengthen and modernize the electric energy grid and transportation systems in Dane County in ways that increase resiliency and help protect critical infrastructure facilities and vulnerable facilities to protect the well-being of Dane County's most vulnerable citizens.
- To contribute to a network of clean energy resources and transportation options that will help Dane County as a whole reach the climate mitigation, adaptation, and resiliency goals identified in the Dane County CAP.
- To gain experience with emerging clean energy and energy security technologies such as energy storage technologies.

Climate/Clean Energy R&D

In this CAP we have made the case that Dane County needs to be carbon neutral by the middle of this century. Yet this CAP cannot lay out all the specific actions showing exactly how to get there. Madison Gas and Electric announced earlier this year their goal of "net-zero carbon electricity by 2050." In their press release, MGE President and CEO Jeff Keebler stated "Our net-zero carbon goal is aggressive, and it will require technologies not yet commercially available or cost-effective, but it is where we need to be."

The fact is, to get where we need to go on GHG emission reductions, we'll need science advancements, technology advancements, market innovations, and policy changes. We need research and development (R&D); R&D investments are critical. Dane County is in a position to be a regional, if not a national, leader. We recommend that Dane County establish a climate/clean energy R&D fund, to support research specific to Dane County climate solutions. This could be established in partnership with other organizations such as the Wisconsin Initiative on Climate Change Impacts (WICCI).

Wisconsin, and more specifically, a number of individuals in Dane County, have considerable experience with administering a clean energy R&D fund. When the

▲ At the UW-Madison Space Science and Engineering Center (SSEC) scientists collect data from satellites around the globe for forecasting, monitoring, and researching the atmosphere. The data center (pictured here) receives more than 8TB of data per day from space, more than than any other single location, and distributes around 6TB to partners across the globe daily. SSEC has been a leader in satellite remote sensing for more than 55 years and continues to provide important research and data to entities like the National Weather Service and the Federal Aviation Administration.

Focus on Energy program was created as part of 2000 Act 9, it included an R&D fund to complement the energy efficiency and renewable energy programs. That R&D fund began with a focus on the broader impacts of the power sector. Later economic impacts were added to the scope, and over time the focus shifted more to R&D supporting energy efficiency and renewable energy technologies, program design, and delivery. The idea here is a Dane County climate and clean energy R&D fund that will contribute directly to the County's ability to mitigate climate change and/or adapt and build resilience to climate change in Dane County.

Here are a couple of examples of the type of research that would allow Dane County to become even more of a national leader in climate R&D and addressing climate change in general.

Groundwater monitoring research

A community groundwater monitoring network would greatly enrich the understanding of groundwater and groundwater-surface water interactions, within in the four watersheds of Dane County. A nation-leading network could be built thanks to the technology developed by, and in partnership with, the Wisconsin company Wellntel Inc. which provides a cloud-based platform for building networks of high-value monitoring points to collect real-time groundwater-level data. The information is immediately available through the Wellntel Analytics Dashboard for analysis, decision support, community reporting and engagement, and County-specified applications.

The Wellntel monitoring device can turn almost any private submersible-pump well into a monitoring point for groundwater level while also connecting legacy monitoring wells into a network that automates data collection and assembly. Hence, the ability to establish community-scale groundwater networks, enabling citizen science and participation for groundwater that was not possible before.

Critical hydrologic assessments would be advanced by the real-time data generated by this network. The Wellntel Analytics Dashboard will provide the tools for the County to analyze and visualize the groundwater resource, including:

- **Water availability/saturated thickness** – Long-term trends, seasonal trends, event-driven changes, and cumulative impacts of pumping.
- **Nutrient loading** – Vertical and horizontal hydraulic gradients, defining groundwater transport and loads.
- **Groundwater-surface water interaction** – Reveal dynamics of groundwater systems in relation to surface water.

In 2016, the Dane County Land and Water Resources Department, the Madison Metropolitan Sewerage District, the Madison Water Utility, and other municipalities and public water utilities across Dane County funded the Dane County Groundwater Flow Model, a software-based tool to attempt to predict hydrologic responses to weather, climate, and human impacts in the area. However, due to high acquisition costs, the model has depended on only existing groundwater level data.

The Dane County model would be greatly strengthened with data collected by the community groundwater monitoring network, providing real-time data with temporal and spatial density that will increase the value of the model as a decision support tool and adding time-series data in locations of greatest interest.

Modeling to optimize flood mitigation strategies

Dr. Shane Hubbard is an Associate Researcher at the UW-Madison Space Science and Engineering Center who specializes in modeling infrastructure that is vulnerable due to natural hazard events such as flooding and tornadoes. Hubbard recently conducted modeling, in collaboration with the Georgia Department of Natural Resources, to understand how the boundaries of the floodplains in coastal Georgia will change with more intense and severe rainfall events due to climate change. Hubbard points out that this same type of modeling and analysis could be done in Dane County to identify those areas where green infrastructure and conservation practices such as native perennial plantings would achieve the greatest impact in terms of water retention, and reducing runoff and nutrient loading. This would be a watershed-specific analysis that would be immensely informative in terms of flood mitigation, water quality, and carbon sequestration.

The UW-Madison, as well as the Wisconsin Initiative on Climate Change Impacts are both world-class research institutions. An R&D fund at the County level would leverage the incredible talent at these institutions, as well as at Wisconsin state agencies, to build the County's resilience and reach the mitigation goals we must reach.

Municipal Leadership

Governments play multiple roles in helping achieve deep-decarbonization: they are large energy users; they set energy, land use, and other important policies; and they are in a position to lead by example. There are many municipalities in Dane County that have already shown considerable leadership in addressing climate change. We have highlighted a few examples below of municipalities who were members of the Dane County Climate Council. There are many others making major strides to use clean energy and reduce carbon emissions. We look forward to highlighting and telling the stories of others doing their part to contribute to reaching our GHG reduction goals.

Fitchburg

The City of Fitchburg demonstrated clean energy leadership by installing solar PV panels on four City buildings to power municipal facilities, and by achieving LEED Gold recognition for the public library completed in 2010. That project included

geothermal wells for heating and cooling, significant use of recycled materials, and extensive water-reduction technologies.

Fitchburg passed a clean energy resolution with some of the state's most aggressive energy-reduction goals in 2019, including targeting 100% renewable electricity for municipal operations by 2030. The City is also taking steps to further engage the community and streamline processes for private solar installations by achieving designation as a "SolSmart" community. SolSmart, funded by the U.S. Department of Energy, is a national designation program recognizing municipalities that foster the development of mature local solar markets. With SolSmart's technical assistance City departments, including building inspection, public works, and planning, reviewed permitting, zoning, and other practices that impact solar development. The City also launched a new Solar Resources page on the city website to consolidate information for residents.

Fitchburg prioritizes energy reduction in transportation as well: Fitchburg has been recognized as a Bicycle-Friendly Community by the League of American Bicyclists, and energy reduction is also impacted by the City's land use policies which prioritize walkable, traditional neighborhood design through the form-based "SmartCode," and through policies that support urban infill and redevelopment.

Madison

In March 2017, the City of Madison was the first city in Wisconsin to set a goal to achieve 100% renewable energy and zero net carbon emissions. This led to the development of the "100% Renewable Madison Report" that laid out a roadmap on how to achieve these goals, and was adopted in 2019. By 2030, local government operations will cut carbon emissions by 55%, with at least 25% of the city's electricity sourced by self-generated renewable energy. Use of transportation fuels, such as gasoline and diesel, will be reduced to zero. Investments in renewable energy credits (RECs) and/or carbon offsets will make up the remaining 45% of the carbon balance. The "100% Renewable Madison Report" also includes additional suggestions to accelerate progress toward reaching 100% renewable energy and zero net carbon goals for the larger Madison area community by 2050. The City of Madison has already begun to take several steps towards achieving this goal, including a $1.4 million investment in five utility-scale solar projects throughout rural Wisconsin, and its Green Power trainee program, through which the City has trained residents in acquiring solar installation skills and has installed nearly 1 megawatt of solar on City facilities.

Climate Champions
Henry Vilas Zoo & the Polar Bear

The polar bear has become, to some extent, the climate change impacts' poster child. The loss of arctic sea ice is making it increasingly difficult for polar bears to find and capture their primary prey, seals. It is critically important that we educate ourselves about the extent to which climate change is impacting many people in our communities. We have entered an era where we are always a major flood or a major heat wave away from a life-threatening weather event, and where vulnerable communities live with climate-related public health impacts on a daily basis. Polar bears seem far away but they help develop our understanding of climate change's impacts.

The Henry Vilas Zoo is one of a handful of zoos that have no admission charge (Chicago and St. Louis also have free zoos). And yet, even without that source of revenue, the zoo's director, Ronda Schwetz has made a major commitment to investing in sustainable operations and facilities and reducing GHG emissions. The Henry Vilas Zoo has solar arrays on several buildings, a geothermal heat pump, solar lighting, a policy that all new buildings are designed with LEED principles, a climate-friendly purchasing policy, and much more.

▲ Polar bears are one of thousands of species threatened by climate change. The Henry Vilas Zoo is committed to addressing climate change and protecting as many of these species as possible.

The zoo places a great emphasis on climate education and awareness for its 800,000 annual visitors. There are signs that describe how climate change is impacting animals' habitat and food sources, and signs that talk about climate solutions like renewable energy, and "Go Green" signs giving visitors direct actions they can take to conserve. The zoo holds climate-change-related events, such as an annual international polar bear event raising awareness about Arctic sea ice and climate change.

While we need to increase our focus on the myriad adverse health, economic, and other impacts climate change has on humans in our community, when you have an 800-pound polar bear standing right in front of you, the impending losses of climate change take on additional meaning. ☀

As a city that prides itself on its progressive approach to solving community challenges, Madison is eager to be a leader in tackling climate change.

Middleton

The City of Middleton Common Council unanimously passed a resolution in 2018 resolving to address global warming through clean energy (100% Renewable Energy Goals). The resolution establishes goals to meet 100% of all City operations' energy needs with renewable energy by 2040 and 100% of communitywide energy needs with renewable energy by 2050. The sustainability committee worked on this resolution for seven months in concert with the Sierra Club, 350.org, and UW Cooperative Extension. It built upon the city's Sustainability Plan adopted in 2010, and a ballot referendum on climate change in November 2016 which showed a strong 81% mandate from City residents in support of mitigating climate change.

Since that time Middleton has been working in conjunction with six other local municipalities on an Office of Energy Innovation planning grant to develop comprehensive energy plans and a roadmap for achieving energy goals. Most recently, the City of Middleton received final approvals for a 5-megawatt solar project at the Middleton Municipal Airport. Of the 5 megawatts, 10% will be dedicated to City of Middleton operations and 20% will be for the Middleton Cross Plains School District. The remaining 70% will be available through MGE's Shared Solar Program.

Sun Prairie

The City of Sun Prairie is committed to meeting the needs of their community while protecting resources, so they are accessible for future generations. It is a community aspiration that takes the work of everyone in the community as they strive to prioritize and enhance the natural environment, social equity, and economic stability. In the past year, the City of Sun Prairie has embarked on energy efficiency projects. They completed a solar installation and a green roof installation with an additional solar installation to take place later this year. They are in the midst of an LED light replacement project at City Hall. In collaboration with six other municipalities in Wisconsin, Sun Prairie received a municipal energy planning grant and is taking part in collaborative planning to better understand their current energy use and develop plans to save energy, reduce costs, and limit greenhouse gas emissions. In 2019, the City of Sun Prairie and Madison Metro formed a partnership to provide express commuter bus service

to downtown Madison from Sun Prairie during peak commuting times. This is a critical step in moving toward providing region-wide bus service that supports active transportation connections and alternative modes of transportation.

Please contact any of these cities to learn more about what they are doing to address climate change.

Throughout Dane County

On August 15th, 2019 County Executive Parisi and Madison Mayor Rhodes-Conway convened a meeting of city, village, and township officials to share actions they have taken, or plan to take, in clean energy investments. Approximately 35 city, village, and town officials attended the meeting which resulted in an agreement to move forward together in their efforts to reduce GHG emissions. The group goes by the name Dane County Sustainability Leaders Collaborative and has spun off four work groups: renewable resources, energy efficiency, vehicle fleets, and green infrastructure. All Dane County governments are welcome and encouraged to participate in as many of the work groups as they have time for. The larger group will likely meet twice a year. Please contact the Office of Energy & Climate Change for the date of the next meeting of the collaborative or any of the work groups.

◀ UW-Madison Science Hall was built in 1887. It was originally the home for all UW-Madison sciences: geology, geography, anatomy, zoology, botany, physics, etc. Today, it is the home for the Geography Department, the state Cartographer's Office and the Gaylord Nelson Institute for Environmental Studies, a member of the Dane County Council on Climate Change.

The University of Wisconsin–Madison

The University of Wisconsin-Madison is a world leader in climate science and applied research that provides solutions to the global challenges presented by climate change. The University's long tradition of responsible environmental leadership, social responsibility, and an enduring commitment to The Wisconsin Idea ensure that the campus is a vested partner in the health and well-being of Dane County, and the state of Wisconsin. UW-Madison tracks its sustainability

work across 63 relative indicators through the national higher education reporting tool called STARS (Sustainability Tracking, Assessment and Rating System). The depth and breadth of the metrics allow for a cross-sector alignment with the climate-related goals of host communities. The university is a signatory to Second Nature's Resilience Commitment which calls for an integrated task force to address climate change mitigation and adaptation. Addressing the public health impacts resulting from climate change is a critical piece of the university's work, therefore public health and well-being considerations are core to their approach. The campus is proud to partner with the City of Madison and Dane County to come together in the development and implementation of solutions for the community. Information on campus resources, subject matter experts, and opportunities for collaboration can be found at sustainability.wisc.edu.

State, Regional, & National Networks & Solutions

Carbon pollution doesn't stop at geographic or geopolitical boarders, and neither should our climate solution efforts. This CAP is an early step in an ongoing commitment and effort by Dane County government to work collaboratively with our neighbors, and the state, regional, national, and international communities to protect and improve the quality of life for all people.

This CAP begins that collaborative effort by describing potential programs and projects we hope to engage with our immediately adjacent counties and their municipalities: Columbia, Dodge, Green, Jefferson, Iowa, Rock, and Sauk Counties. Once this plan is complete and widely distributed, the Office of Energy & Climate Change will begin actively pursuing partnerships and collaboration with all the other 71 counties in Wisconsin. As we write this plan, the Office of Energy & Climate Change is already collaborating with the state of Wisconsin, both with the Governor's office and state agencies dealing with climate change.

The Office of Energy & Climate Change staff members have considerable experience collaborating with other Midwest and Midcontinent states on climate solutions, and have developed strong relationships with non-governmental organizations, utilities, consultants, and government officials in Illinois, Iowa, Michigan and Minnesota, and Ohio. We will share this CAP with as many of those colleagues as possible and work to identify potential partnerships and best practices in areas of this CAP.

▲ Madison artist Aaron Laux created this piece as part of Phoenix from the Ashes, a multi-artist project to highlight the devastation of ash trees by the emerald ash borer, which is made worse by climate change. The piece, titled "Their Story Our Story" is made from glass, metal, and ash wood.

The Arts & Climate Change

In 1976, Dane County created a Cultural Affairs Commission (today also known as Dane Arts), with a mission to foster and celebrate creative expression among citizens, validating the significant role art, culture, and history play in contributing to the quality of life in Dane County.

Dane Arts' vision is to strengthen the arts, history, and culture throughout Dane County and to support all Dane County citizens and residents leading expressive lives in connection with one another. Dane Arts champions the economic, cultural, creative and community impact the arts generate throughout Dane County.

Effective communication will be a critical component to any successful climate mitigation effort. One of the most important steps in this CAP is catalyzing and facilitating discussions about climate change locally, and Dane County' robust

Katie Musolff is a full-time artist/painter who lives and works in Southwest Wisconsin. Katie uses her art to capture the climate impacts of shifting ecosystems. This watercolor painting titled "Lord Plant My Feet on Higher Ground" appeared in a climate change art exhibit at the James Waltrous Gallery. Here she has documented her observations of many plant and animal species that were disrupted, displaced, and dispatched by the rising Mississippi River floods of 2018.

arts community has a unique ability to raise awareness, educate, and tell stories about climate change.

Eve Mosher was featured in the August 2018 issue of The New York Times Style Magazine in an article titled "12 Artists On: Climate Change" (nytimes.com/2018/08/22/t-magazine/climate-change-art.html). Mosher said this about how artists can contribute to climate solutions:

"Climate change is a wicked problem, and it affects everything else that we are grappling with on a daily basis: social justice, housing, immigration, food and water access. Artists have the capacity to shape climate communications, solutions, and engagement. We can use our unique skill sets to heal communities, tackle complex challenges and even create innovative answers."

The Office of Energy & Climate Change will work with Dane Arts and local artists to infuse climate impacts and solutions into art programs, exhibits, displays, and performances.

For a larger view of artists' contributions to climate change solutions we recommend Artists and Climate Change (artistsandclimatechange.com), a blog with a goal of tracking, assembling, and facilitating networking among artists who specialize in climate change-related subjects. As members of our community work together to implement solutions, artists working in all types of genres and venues will inspire and motivate while they address the issues we must face.

Learning from Global Leaders in Climate Mitigation

Many regard the Nordic countries as pioneers in reducing carbon emissions and see them as countries dedicated to working to reach the Paris Climate agreement goals. Five of the Nordic countries - Norway, Sweden, Denmark, Iceland, and Finland - have set ambitious emission reduction targets, all aiming to reduce carbon emissions by at least 75% by 2050, with Norway, Sweden, and Denmark aiming for a 100% reduction by 2030, 2045, and 2050 respectively (from a 1990 baseline).

Most of these countries have achieved a steady decline in total carbon emissions the past two decades. In 2016, Denmark had reduced carbon emissions by nearly 30% and Sweden by more than 20%.

These reductions are mainly a result of a relatively decarbonized electric supply depending on various sources of renewable energy. Each country has strived to make the most of locally accessible resources and has advanced technology within wind power, solar power, hydropower, geothermal energy (energy generated and stored in the Earth), and forest biomass. Further, the development of low-carbon transportation systems, improved energy efficiency in buildings, and industrial use of carbon capture and storage have been successful measures in reducing carbon emissions.

Norway has the highest number of EVs in the world, with battery electric and plug-in hybrid vehicles reaching a 50% market share in 2018. Denmark has developed an advanced labeling scheme of buildings and Copenhagen is a leader in using green infrastructure as stormwater management. Sweden is aiming to become carbon negative, capturing more carbon from the atmosphere than is emitted after 2045, and industrial symbiosis programs have become increasingly popular across Europe, bringing companies together in innovative ways to exchange resources in terms of material, water, and energy.

The environmental regulations in the Nordic countries have gained widespread social acceptance, as a majority of Nordic citizens are well aware of climate change and its impact. For example, 95% of the Swedish population believes that climate change will affect the country in the future.

Besides reducing greenhouse gas (GHG) emissions, the Nordic countries managed to decouple economic growth and GHG emissions, with the Nordic economy growing 20% while they reduced emissions by 18% between 2000 and 2014 . The transition to renewable energy sources didn't solely happen because of environmental consciousness, but because of an economic incentive as well. This is a development attractive to the rest of the world, allowing the Nordic countries to serve as useful case studies.

Norway leads the world in electric vehicle adoption with approximately 60% of all new vehicle sales being electric. *Elbiler* means "electric vehicles" in Norwegian and *Norsk elbilforening* means "Norwegian EV Policy and Market".

However, while the Nordic Countries are considered leaders on transitioning to renewable energy, carbon emissions per capita are relatively high by global standards in all of the Nordic countries. This can be a result of cold and long winters, long transportation distances in sparsely populated areas, the prevalence of high-energy industries, and high income standards leading to high material consumption. While these emissions need to be reduced, they are still significantly lower than in North America.

There is much we can learn from these global leaders; this CAP is a start to that education.

Public Engagement

To meet aggressive climate goals in Dane County the Office of Energy & Climate Change, with everyone's help, has to facilitate a culture where sustainable practices are the new normal, where people make climate-smart decisions relative to electricity and natural gas as well as transportation choices, purchasing practices, and waste management. And where people talk to each other about climate change. This aspect of the CAP, a comprehensive public outreach and engagement effort, will help give citizens the information they need to make climate smart choices and help them realize that their colleagues, friends, and neighbors are making climate-smart choices too. The Office of Energy & Climate Change will engage Dane County residents in a way that helps empower them so they see themselves and their neighbors as part of an influential group - Dane climate champions, the people who are taking Dane County forward in a sustainable, responsible way.

"Polls on climate change show that 70 percent of Americans believe that climate change is happening and that it will cause harm to future generations, yet two-thirds of Americans say they never talk about it."

-Climate Generation

This outreach and engagement effort will reinforce all other climate and energy programs and policies in this report by highlighting and making accessible what's already happening and available, giving people the inspiration and instructional pathways for their own changes.

This broad public engagement effort will include:

- **Broad awareness raising.**
- **Diverse engagement initiatives** that inspire people to action, giving them clear direction on what they can do to be part of the solution.
- **Awards and storytelling** that showcase the existing successes in our community, demonstrating what's possible.

Lists of the top 10 or 20 or 100 things you can do to address climate change are becoming common. If you read enough of them, you'll notice that one action shows up on the vast majority of them, and it sounds simple: Talk to someone you know about climate change. Interestingly, most people seldom discuss climate change with their friends or family. If you think about it, it is hard to imagine that climate change will become a top-tier, top-of-mind issue for most folks unless people are talking about it. Family and friends are a great place to start.

▲ (L to R, in the foreground) Nathan Larson, Rooted, Lesley Wolf, Healthy Wisconsin Leadership Institute (HWLI), Sophia Seol, Dane County Office of Energy & Climate Change, Ally Burg, UW-Madison, and Laila Azam, Striving to Improve Health for All participate in an HWLI workshop. The HWLI trains community-based coalitions to engage the public in addressing social determinants of health.

There are many organizations across the country focused on climate change that have invested a lot in strategies for constructive dialogue addressing climate change; many research papers and other less academic pieces have been written on the topic. Groups that do excellent work in the area of climate conversations/dialogue include the Climate Reality Project (climaterealityproject. org/blog/3-tips-experts-how-talk-about-climate-crisis-effectively) and the Alliance for Climate Education (acespace.org/).

The Yale Program on Climate Change Communication covers public opinions about climate change. The program's director, Anthony Leiserowitz, and his team conduct the most comprehensive polling in the nation on climate change. In their words:

> A team of psychologists, geographers, political scientists, statisticians, pollsters, and communication scientists, we investigate how and why citizens in the U.S. and around the world are, or are not responding to climate change,

identify key audiences requiring tailored communications, and develop strategies to engage these audiences in climate change solutions.

A small sampling of their projects/studies includes these insightful works:

- Global Warming's Six Americas (climatecommunication.yale.edu/about/projects/global-warmings-six-americas)
- Identifying Climate Messages that Work (climatecommunication.yale.edu/about/projects/identifying-climate-messages-work)
- Engaging Latinos in the US on Climate Change (climatecommunication.yale.edu/about/projects/engaging-american-latinos-climate-change)
- Climate Change in the American Mind (climatecommunication.yale.edu/about/projects/climate-change-in-the-american-mind)

Another group, not too far from Dane County, that we find particularly helpful on the topic of effective climate conversations is Climate Generation (climategen.org) based in Minneapolis. This group's core programing has a very in-depth focus on climate communications and storytelling. Each year they host a two-day, intensive Talk Climate Institute (climategen.org/our-core-programs/trainings/public-trainings/talk-climate-institute-2019-recap) workshop where participants learn more about climate change and a lot more about how to talk about climate change. Climate Generation points out that effective conversations about climate change are not about how well you can talk, but rather, about how well you can listen. They offer these practical steps on "how to talk climate" (adapted content from the Alliance for Climate Education):

1. Ask permission.

2. Ask an open-ended question about the other person's thoughts about climate change.

3. Listen – do not interrupt.

4. Repeat back to them what you heard, instead of responding with your thoughts.

5. Share your personal experience with the issue.

6. Share a fact that helps ground your perspective.

7. Keep the conversation going, preferably by asking for more of their thoughts.

8. Thank them and share what you've learned.

9. Ask them to join you in exploring climate solutions.

Talk to a family member or friend about climate change and the wacky, extreme weather we've been having. You can also begin engaging with us at the Dane County Office of Energy & Climate Change by visiting our website and sharing your climate observations, stories, or solutions. We'd love to hear from you!

State Policy & Local Climate Efforts

State policy, is of course, critical to moving forward in the transition to a clean energy economy and deep de-carbonization. Dane County will continue to collaborate with state officials at every opportunity to make the clean energy transition as quickly and smoothly as possible.

State policy is important locally primarily because state policy can, and often does, directly impact the ability for counties, and local municipalities, including cities, villages, and towns, to set their own policies. This is often referred to as local control. Over the past decade the state legislature has taken local control away from municipalities in key areas that directly affect this, and any, climate action plan (CAP).

For two decades (the 1990s and the first 10 years of the 2000s) Wisconsin was a regional, and even national, leader in the area of commercial building codes, particularly as it pertains to energy efficiency in the commercial building codes. Through those years, Wisconsin developed its own, independent, and tailored commercial building code (many states use a one-size-fits all national

or international code), that often set stronger efficiency goals than the national code.

With the end of the Department of Commerce in 2011, this building code independence and innovation came to halt. However, local municipalities had always been able to adopt their own commercial building codes to fit their own needs and meet their own objectives. So, when Wisconsin began to fall behind other states in their commercial building code development, at least municipalities could individually continue to keep up.

That stopped in 2013, when the state legislature passed a bill that was signed into law stripping local governments of the authority to set their own safety and efficiency standards in building codes. That was particularly unfortunate since the state, at that point, had stopped updating building codes. Recently the state building codes were updated in regard to energy efficiency.

This is one particularly important example of state policy taking away local control. Another example of state policy that directly impacts local government's ability to mitigate and prepare for climate change is a bill in 2016 that took away the requirement for rental properties to bring their buildings up to code when they are sold. Another is legislation that took away the ability of school districts to exceed spending limits specifically for energy efficiency upgrades in their schools. There are many other examples.

While Dane County works to make major investments in clean energy, clean transportation fuels, climate mitigation programs, climate resilience programs, and more at the County level, we will also greatly appreciate and embrace every opportunity to work with the state's administration, the state legislature, and state agencies to make Wisconsin a Midwest and national leader in the transition to a clean energy economy and climate solutions leader.

Moving Forward

Photo: Samantha Haas

This CAP contains approximately 110 recommendations for programs, policies, and projects that will help with climate change mitigation. Now that this initial Dane County CAP is written, the Dane County Office of Energy & Climate Change and other Dane County departments will engage external partners, including the Dane County Climate Council organizations and the Office of Energy & Climate Change work group organizations, to conduct public outreach and engagement, flesh out program design details, acquire resources, and set up tracking, measurement, evaluations, and verification protocols for as many of the recommendations as possible.

The Office of Energy & Climate Change will prioritize programs, policies, and projects based on a combination of GHG reduction potential and feasibility as well as the six guiding principles covered in separate sections earlier in this report. Once prioritized, the Office of Energy & Climate Change will take the lead in identifying and engaging partners, designing programs, and subsequently launching them.

We will also launch a public engagement, awareness, and listening campaign. There are two important types of public outreach and engagement for this CAP. One is a broad public relations campaign that raises awareness across as many sectors and audiences as possible. This public relations campaign will give Dane County residents a variety of immediate ways to take climate mitigation actions, share climate stories and ideas, and engage with friends, neighbors, co-workers, and other like-minded citizens in climate mitigation and adaptation activities.

We will also conduct very targeted outreach that takes the form of listening to and learning from citizens, to seek out experiential knowledge, opinions, and perspectives. This type of outreach will be especially important with the populations, communities, neighborhoods, and individuals most vulnerable to climate impacts. It is our job to seek out, recognize, and value the experiential knowledge of Dane County's first nation, the Ho-Chunk, the communities and cultures we know to be most concerned about climate change, such as the Latino community, and communities most at risk. The section on equity and justice goes into more detail on some of the specific ways the Office of Energy & Climate Change is going about this type of targeted outreach and engagement.

Achieving deep decarbonization at any level, including the County level, is a complex proposition – a "wicked problem." That's why, although we came together as 38 organizations that made up the Dane County Climate Council, and another hundred or so technical experts serving on ten Office of Energy & Climate Change work groups, there are still areas of climate solutions we couldn't completely explore. For these areas we recommend the Office of Energy &

Climate Change create additional ad hoc or permanent work groups. Among the topics we could explore are:

- Green infrastructure
- Geothermal heating and cooling
- Grid modernization
- Air-source heat pumps
- Agricultural emissions

There may be others. Virtually every GHG emission source and associated solution has a learning curve that needs attention, innovation, and diligence. However, the Office of Energy & Climate Change will have to prioritize and decide how to balance resources between implementing recommendations in this CAP (certainly the priority) and figuring out how we, as Dane County, can contribute to finding additional solutions in the five areas above and others.

In many ways, this CAP is a snapshot in time. Technologies evolve at ever-increasing rates. Markets evolve in fits and starts. Innovation in policies, business models, research and development, and solution strategies grow at different paces but together progress as surely as our glaciers now recede.

This CAP lays out a plan to get Dane County on a path to deep decarbonization. It provides a wealth of information on how to reach that path over the next 10 years, but at the same time, has much less to say about what we need to do between the years 2030 and 2050 to ultimately reach a carbon-neutral or carbon-negative economy. In the same way, this CAP informs the next five years better than it does the five years after that, and for that reason, it is important that the Office of Energy & Climate Change not only track, evaluate, measure, and verify our GHG emission reduction progress, but revise this CAP every three to four years. This CAP also recommends that the Office of Energy & Climate Change publish progress reports on a regular basis.

Author's Message

My hope is that this climate action plan (CAP) will help to educate, motivate, inspire, and lead. I have no doubt that if we make a strong effort to dramatically reduce our carbon pollution emissions following this plan, we will also improve public health, build a stronger economy, and help make Dane County a more just and equitable place to live for all. I also know that it will take nearly everyone in Dane County coming together in an open, collaborative, and caring way to make this plan a success.

▲ The author, Keith Reopelle, Director of the Dane County Office of Energy & Climate Change, with a hybrid musky he caught and released on Lake Waubesa. Climate change will eliminate ice fishing on the Yahara chain of lakes in the not-too-distant future.

It has been a great honor and truly humbling experience working with so many smart, driven, and hard-working individuals to put this document together. Dane County is a wonderful place to live, work, and play, and the people here, along with their dedication to making this a better place to live for our children and future generations, are the biggest reason. There are so many people that I want to thank. Appendix 5 has a list of individuals who contributed directly to writing a portion of this CAP, or contributed to tables, graphs, or images. But I will take a minute here to thank a few individuals who made major contributions.

First, and foremost, I want to thank Dane County Executive Joe Parisi for his climate leadership and vision and for giving me the opportunity to lead this incredibly important piece of work. Next, I want to thank the 38 organizations and their lead representatives who served on the Dane County Climate Change Council. This CAP report would not have been possible, nor would it stand much of a chance of succeeding, without them. I hope they are all proud of the work they did here together; they should be. I also want to thank all of the Office of Energy & Climate Change work group members for their valuable input on the recommendations in this CAP and for their ongoing input and support for the implementation for those recommendations.

I want to give special and more specific thanks to several individuals who directly contributed to the drafting of major sections of this CAP report, including Erik Lincoln and his colleagues at the Ho-Chunk Nation for writing the incredibly important and poignant introduction to this report. I want to thank Dan Vimont

and his colleagues at the Nelson Institute Center for Climatic Research and the UW Department of Atmospheric and Oceanic Sciences for writing the climate science section of this report which is a summary of the latest, and greatest, research on the local impacts resulting from climate change. They continue to contribute world-class climate science.

▶ **Smilla Jepsen** of Copenhagen, Denmark, spent a year in Madison over 2018-19 and made many major contributions to the writing of this CAP including the section on how Nordic nations are leading on climate mitigation.

I want to thank John Welch and David Liebl for authoring a majority of the waste materials and adaptation/resiliency sections, respectively. Special thanks go to Smilla Jepsen, who interned in the Office of Energy & Climate Change for a full year before returning to Denmark, and who wrote the "Global Leaders" and "Green Infrastructure" sections of the CAP and made major contributions to other sections, as well. I also want to give a special thanks to designCraft Advertising President, Yvette Jones, for her great editing and sage production advice, and her co-worker Lisa Lombardo for her wonderful design work.

I especially want to thank my lovely wife Trish for her unwavering support of my climate change work throughout my career. Nothing I have accomplished would have been possible without her love and support.

Lastly, I want to dedicate this CAP report to our two daughters, Kestrel and Teal, whose generation will inherit a warmer, somewhat compromised, and certainly less predictable planet earth because of our fossil fuel addiction. This CAP is one piece of my promise to them to do all I can in my lifetime to minimize the degree of compromise.

Sincerely,

Keith Reopelle

Appendix 1: Members of Dane County Council on Climate Change

Nadeem Afghan, *BIOFerm Energy Systems*

Abby Attoun / Kelly Hilyard, *City of Middleton*

Lauren Azar, *Azar Law LLC*

Chris Beedle / Lane Wenner, *H&H Energy Services*

Mary Blanchard / Gary Radloff, *Wisconsin Energy Institute*

Jim Bradley, *Home Savings Bank*

Zach Brandon, *Greater Madison Chamber of Commerce*

Brad Bruun, *City of Monona*

Tom Content, *Citizens Utility Board of Wisconsin*

Drake Daily, *City of Sun Prairie*

Jamie Derr, *Derr Farms*

Mary Evers-Statz, *UW Health*

Ellen Geisler, *City of Fitchburg*

John Haeckel, *Clean Fuel Partners*

Janel Heinrich / Doug Voegeli, *Public Health Madison and Dane County*

Jeanne Hoffman / Stacie Reece, *City of Madison*

Tyler Huebner, *RENEW Wisconsin*

Steve Jackson / Michele Pluta, *Alliant Energy*

Jeff Jaeckels, *Madison Gas and Electric*

Elizabeth Katt-Reinders, *Sierra Club*

Andy Kellen, *WPPI Energy*

Paul Lenhart, *Krupp General Contractors*

Jessie Lerner / Claire Oleksiak, *Sustain Dane*

David Liebl, *Wisconsin Initiative on Climate Change Impacts*

Erik Lincoln, *Ho Chunk Nation*

Ashwat Narayanan, *1000 Friends of Wisconsin*

Karl Niemi, *Fiskars*

David Poklinkoski, *IBEW Local 2304*

Mark Redsten, *Clean Wisconsin*

Paul Robbins, *UW Nelson Institute for Environmental Studies*

Joel Schriever, *Exact Sciences*

Chad Sorenson, *SunPeak*

Wesley Sparkman, *Dane County Office of Equity & Inclusion*

Wayne Strong, *Urban League of Greater Madison*

Charles Tubbs, *Dane County Emergency Management*

Libby Tucci, *YWCA Madison*

William Walker, *Madison Metropolitan Sewerage District*

Gary Werner, *Capitol Region Advocacy Network for Environmental Sustainability*

Appendix 2: Office of Energy & Climate Change Working Groups

These Working Group members contributed to the climate action recommendations in this CAP. (Chairs in bold.)

Agriculture, Forestry and Food

Marcia Caton-Campbell, *Center for Resilient Cities*
Fred Clark, *The Forest Stewards Guild*
Jamie Derr, Derr Farms
John Haeckel, *Clean Fuel Partners*
Robin Lisowski, *Slipstream*
Michelle Olson, *Alliant Energy*
Pam Porter, *UW Center for Integrated Ag Systems*
Gary Radloff, *Wisconsin Energy Institute*
George Reistad, *City of Madison*
Caryl Terrell, *Capital Region Advocacy Network for Environmental Sustainability*
Maria Woldt, *Yahara Pride & DBA*
Darrell Zastrow, *UW-Extension*

Buildings

Jeff Adams, *Alliant Energy*
Marge Anderson, *Slipstream*
Jim Bradley, *Home Savings Bank*
Lee DeBaillie, *UW-Madison*
Ross DePaola, *WESTlab*
Mary Evers-Statz, *UW Health*
Jeanne Hoffman, *City of Madison*
Joanne Kelley, *Madison Gas and Electric*
Paul Lenhart, *Krupp Construction*
Mary Meunier, *Wisconsin Department of Administration - Energy Division*
Eric Truelove, *Green Building Resources LLC*

Efficiency

Jeff Adams, *Alliant Energy*
Chris Beedle, *H & H Energy Services*
Jim Bradley, *Home Savings Bank*
Sara Conzemius, *Illume Advising*
Tyson Cook, *Clean Wisconsin*
Sue Hanson, *TetraTech*
Joanne Kelly, Madison *Gas and Electric*
Kathy Kuntz, *Cool Choices*
Erinn Monroe, *APTIM - Focus on Energy*

Renewable Energy

Nadeem Afghan, *BIOFerm*
Lauren Azar, *Azar Law LLC*
Sherrie Gruder, *UW-Extension*
John Haeckel, *Clean Fuel Partners*
Tyler Huebner, *RENEW Wisconsin*
Tom Karman, *Wisconsin DNR (formerly)*
Elizabeth Katt-Reinders, *Sierra Club*
Andy Kellen, *WPPI Energy*
David Poklinkoski, *IBEW Local 2304*
Dave Sinner, *Alliant Energy*
Scott Smith, *Madison Gas and Electric*
Chad Sorensen, *SunPeak*
Niels Wolter, *Madison Solar Consulting*

Transportation and Land

Debbie Branson, *Madison Gas and Electric*
Phillip Gritzmacher, *City of Madison*
Steve Jackson, *Alliant Energy*
Chuck Kamp, *Madison Metro*
Chris McCahill, *State Smart Transportation Initiative*
Ashwat Narayanan, *1000 Friends of Wisconsin*
Peter Rafferty, *Traffic Operations and Safety Laboratory*
William Schaefer, *Madison Area Transportation Planning Board*
Cassandra Steiner, *Sierra Club*
Steve Steinhoff, *Capital Area Regional Planning Commission*
Gary Werner, *Capital Region Advocacy Network for Environmental Sustainability*

Water

Chuck Dunning, *Wellntel*
Greg Fries, *City of Madison*
John Haeckel, *Clean Fuel Partners*
Tom Heikkinen, *Madison Water Utility*
Ezra Meyer, *Clean Wisconsin*
Wesley Sparkman, *Dane County Office of Equity*
William Walker, *Madison Metropolitan Sewerage District*
Emily Jones, *Madison Metropolitan Sewerage District*

Finance

Jim Bradley, *Home Savings Bank*
Sherrie Gruder, *UW-Extension*
Paul Lenhart, *Krupp Contractors*
Robin Lisowski, *Wisconsin Energy Conservation Corp*
Nancy O'Brien, *Wisconsin Energy Conservation Corp*
Mary Schlaefer, *Wisconsin Energy Conservation Corp*
Jason Stringer, *Wisconsin Energy Conservation Corp*
Eric Truelove, *Green Building Resources LLC*
Niels Wolter, *Madison Solar Consulting*

Modeling

Tyson Cook / Scott Blankman, *Clean Wisconsin*
Jeff Jaeckels, *Madison Gas and Electric*
Andy Kellen, *WPPI Energy*
Michele Pluta, *Alliant Energy*
Evelyn Wright, *Sustainable Energy Economics*
Chris McCahill, *State Smart Transportation Initiate*
Jon Koliner, *Apex Analytics, LLC*

Public Outreach

Bill Davis, *Sierra Club*
Sam Dunaiski, *RENEW Wisconsin*
Sharon Dunwoody, *UW-Madison, School of Journalism and Mass Communications*
Kathy Kuntz, *Cool Choices*
Jessica Niekrasz, *Clean Fuel Partners*
Stacie Reece, *City of Madison*

Appendix 3: Methods Used for "Climate Change in Wisconsin: The Historical Record & Future Projections"

Historical changes for Wisconsin are estimated using the NOAA nClimDiv data set (Vose et al. 2014) which contains monthly temperature (based on daily minimum and maximum) and precipitation averages at a US Climate Division scale. Daily mean temperature is calculated as the average of the daily maximum and daily minimum. The nClimDiv data set is used by NOAA in it is monthly and annual "State of the Climate" analyses. Historical trends are calculated for each of the nine Wisconsin climate divisions over the time period 1950-2018, and the resulting trend (in units of °F per year) are multiplied by 68 years (the period of analysis) to obtain estimates of historical warming since 1950. Trends begin in 1950 due to increases in data availability at that time.

Future changes for Wisconsin are estimated from the University of Wisconsin Probabilistic Downscaling data set, version 2.0 (UWPD2.0). Downscaling refers to a process by which large-scale climatic conditions (as might be produced by a global climate model) are used to estimate local-scale conditions (as might be measured at a station). The UWPD uses statistical methods to relate large-scale climatic conditions to probability distributions of the local-scale conditions; this technique more accurately represents day-to-day climate variability as well as extreme local climate events (Kirchmeier-Young et al. 2014) than other statistical methods. The UWPD version 1 data set is described in more detail in Notaro et al. (2010), Kirchmeier et al. (2014) and Kirchmeier-Young et al. (2016). UWPD2.0 uses the same methodology as version 1 but applies the downscaling to 24 different climate models from the Coupled Model Intercomparison Project, version 5 (CMIP5); these models are the same models that contributed to the Intergovernmental Panel on Climate Change 5th Assessment Report (IPCC 2013).

Projections for 2050 are calculated as the 2041-2060 average minus the 1981-2010 (climate normal) average from each model. Data for the historical period 1981-2010 are taken from the historical simulations through 2005, and from the RCP8.5 scenario for 2006-2010. Future projections for the 2041-2060 time period are taken from the RCP8.5 scenario, which represents a "business as usual" global emissions scenario. By 2050, differences between the RCP8.5 and RCP4.5 (a more moderate emissions scenario) are small: for reference, the expected change in annual average temperature for Wisconsin by 2050 is 3-9 °F for the RCP8.5 scenario, and 2-8 °F for the RCP4.5 scenario. Counts of extreme events (e.g. days per year when temperature exceeds 90 °F) are calculated using the daily probability distributions for each month of the year. When a

range of expected change is presented, that range represents the 10th to the 90th percentile of expected change, as estimated across the distribution of the 24 climate models that contribute large-scale information to the UWPD2.0 data set.

Finally, we note that while no attempt has been made to attribute the historical warming to anthropogenic climate change, the similarity between the amount and characteristics of the warming between the observed record and model simulations does suggest that the observed record has been influenced by anthropogenic climate change.

Appendix 4: Utility Initiatives Supportive of the Dane County Climate Action Plan

Initiative	Description	Company
Focus on Energy programs – Residential and Business	Focus on Energy empowers the people and businesses of Wisconsin to make smart energy decisions with enduring economic benefits. Learn more at focusonenergy.com.	Adams-Columbia Electric Cooperative, Alliant Energy, Black Earth Electric Utility, Madison Gas & Electric (MGE), Mazomanie Electric Utility, Mount Horeb Utilities, Stoughton Utilities, Sun Prairie Utilities, Waunakee Utilities, We Energies
Clean Energy Vision	By 2030: • Renewables will be over 30% of our energy mix • Carbon dioxide (CO_2) emissions from fossil-fueled generation will be reduced by 40% • Water supply needs from fossil-fueled generation will be decreased by 75% By 2050: • We will eliminate all existing coal from our energy mix • CO_2 emissions from fossil-fueled generation will be reduced by 80% More information at: sustainability.alliantenergy.com/energy-climate/	Alliant Energy
Clean Energy Blueprint	Powering What's Next initiative accelerating our transition to cleaner energy for our Wisconsin customers by expanding solar energy generation by up to 1,000 megawatts by the end of 2023. More information at: alliantenergy.com/poweringwhatsnext.	Alliant Energy
Company-Owned Fleet Transition and Employee Electric Vehicle Charging	Company fleet electrification initiative including hybrid bucket trucks; hybrid and electric fleet vehicles; electric forklifts and other equipment. Also provide on-site employee electric vehicle charging. More information at: alliantenergy.com/sustainability.	Alliant Energy
Madison Solar Learning Lab	Energy learning lab with several types of solar structures, multiple electric vehicle charging stations and an energy battery storage system. More information at: alliantsolar.epri.com/madison.	Alliant Energy

Initiative	Description	Company
Prairie du Sac Hydro, Kilbourn Hydro and Wisconsin River Power Company	Own and operate two hydro facilities combined 41-megawatts and also receive power from and own a 50% interest in Wisconsin River Power Company, which operates the Petenwell and Castle Rock Dams on the Wisconsin River. More information at: alliantenergy.com/OurEnergyVision/AdvancingCleanEnergy/HydroEnergy.	Alliant Energy
Bent Tree Wind Farm	201-megawatt wind farm in operation since 2011. More information at: alliantenergy.com/OurEnergyVision/AdvancingCleanEnergy/WindGeneration.	Alliant Energy
Cedar Ridge Wind Farm	68-megawatt wind farm in operation since 2008. More information at: alliantenergy.com/OurEnergyVision/AdvancingCleanEnergy/WindGeneration.	Alliant Energy
Forward Energy Wind Farm	Acquired 55-megawatt ownership interest as of April 2018. More information at: alliantenergy.com/OurEnergyVision/AdvancingCleanEnergy/WindGeneration.	Alliant Energy
Kossuth Wind Farm	New 150-megawatt wind farm. Planned completion in fall 2020. More information at: alliantenergy.com/OurEnergyVision/AdvancingCleanEnergy/WindGeneration.	Alliant Energy
Customer Electrification	Various programs and rebates to support electrification for industrial, commercial and residential customers. More information at: alliantenergy.com/InnovativeEnergySolutions/SmartEnergyProducts/ElectricVehicles.	Alliant Energy
Business demand-response program	Industrial and commercial business interruptible program during peak energy use times, more information at: alliantenergy.com/WaysToSave/SavingsTipsandPrograms/InterruptibleProgramBIZ.	Alliant Energy
Energy Edge program	Online digital platform for commercial and industrial customers to benchmark energy usage and set goals to improve performance by providing cost comparisons over time, weather impacts, and usage breakdowns. More information at: alliantenergy.com/More/ContentPages/EnergyEdge.	Alliant Energy

Initiative	Description	Company
Residential customer demand response	Residential time of day energy savings program - more information at: alliantenergy.com/WaysToSave/SavingsTipsandPrograms/NightsandWeekendsPlanWISRES.	Alliant Energy
Second Nature	Voluntary green energy program that allows residential and business customers to support renewable energy growth. More information at: alliantenergy.com/InnovativeEnergySolutions/SustainableEnergyChoices/SecondNature.	Alliant Energy
Alliant Energy® Community Solar	Alliant Energy® Community Solar provides residential and business customers the option to buy blocks of renewable energy generated from solar panels in a nearby community. Customers will receive a monthly bill credit for 20 years based on solar production. More information at: poweringwhatsnext.alliantenergy.com/my-energy-my-choice.	Alliant Energy
Customer-Hosted Renewable Energy	Alliant Energy is partnering with commercial and industrial customers to find new locations for rooftop solar and/or battery storage systems. More information at: poweringwhatsnext.alliantenergy.com/my-energy-my-choice/#renewable.	Alliant Energy
Renewable Energy Partners	Renewable Energy Partners provides customers a way to offset energy use with renewable energy for one or multiple sites. Alliant Energy builds, owns and maintains a dedicated renewable energy facility. Customers buy the energy generated at a contracted rate. More information at: poweringwhatsnext.alliantenergy.com/my-energy-my-choice/#renewable.	Alliant Energy
Energy 2030 - Carbon Goal	Reduce CO_2 emissions at least 40% by 2030 from 2005 levels. Visit mge2050.com to learn more.	MGE
Energy 2030 - Renewable Energy Goal	Increase renewable energy to at least 25% by 2025 and 30% by 2030. Visit mge2050.com to learn more.	MGE
Net-Zero by 2050	Work with customers to achieve net-zero carbon electricity by 2050. Visit mge2050.com.	MGE
Reduce coal-based generation	Committed to transition away from coal.	MGE

Initiative	Description	Company
Saratoga Wind Farm	66-megawatt (MW) wind farm near Saratoga, Iowa, came online February 2019. Learn about Saratoga at mge.com/Saratoga	MGE
Badger Hollow/Two Creeks Solar	100 MW of new solar capacity from two Wisconsin-based projects approved in 2019; expected online in 2020.	MGE
Badger Hollow II	50 MW of new solar capacity expected to be approved in 2020 and online in 2021.	MGE
Shared Solar - MOC	500-kilowatt community solar project at Middleton Operations Center in City of Middleton is a unique way of providing residential customers locally generated solar energy.	MGE
Shared Solar - Morey	2019-2020 expansion of Shared Solar program with new, large-scale (5-MW) solar array at Morey Field in Middleton; expansion opens program to commercial customers, in addition to residential. Visit mge.com/SharedSolar.	MGE
Lyft	Partnering with the ridesharing company Lyft to spread the use and awareness of electric vehicles.	MGE
Vehicle Fleet Transition	Fleet transition process for the monitoring of emerging technologies and the adoption of alternative fuel vehicles including EVs, hybrid bucket trucks, hybrid service vehicles and other technologies.	MGE
Charge@Home Program	Quick, convenient charging at home with no upfront cost for charger and installation of EV charger for residential customers. Visit mge.com/LovEV for EV-related programs and information, including a total cost of ownership tool called Explore My EV.	MGE
Public EV Charging	35+ EV public charging stations around the Madison area sourced with wind energy.	MGE
Multifamily EV Charging	Facilitation of EV charging at multifamily properties.	
Fleet, Workplace EV Charging	Facilitation of fleet and workplace charging programs for customers.	
Green Power Tomorrow	Green pricing program to purchase up to 100% of energy from renewable sources. Visit mge.com/GPT.	MGE

Initiative	Description	Company
Commerical customer demand response	Business customers participate in pilot to curb demand during peak use. Visit mge.com/ODS.	MGE
Residential customer demand response	2019 expansion of smart thermostat initiative known as MGE Connect to reduce peak residential demand.	MGE
Renewable Energy Rider, Middleton	Partnering with City of Middleton and Middleton-Cross Plains Area School District on solar array at Morey Field under Renewable Energy Rider, which gives MGE ability to negotiate customer-specific contracts for renewable energy projects.	MGE
Renewable Energy Rider, Dane Co.	Partnering with Dane County on up to 9-MW of solar capacity adjacent to Dane Co. Regional Airport.	MGE
City of Madison/MMSD RER	Partnering with City of Madison and Madison Metropolitan School District on 7-MW solar array under Renewable Energy Rider agreements; array expected in 2021, if approved.	MGE
Madison Metro Transit EV Initiative	Partnering with Madison Metro Transit to expand use of electric buses.	MGE
Living in Balance/Viviendo en Balance	Digital format designed and developed to engage with communities of color on energy efficiency, sustainability, green energy, and Focus on Energy. It is available in English and Spanish.	MGE
GENRE 2030	Digital format designed and developed to engage with Millennials and Gen Z on energy efficiency, sustainability, green energy, and Focus on Energy.	MGE
Sustainability Design for Multifamily Development.	Offering workshops on sustainability practices including net zero carbon for Multifamily sector. Participate in consultation for sustainable design with multifamily development.	MGE

Initiative	Description	Company
Community Partnerships	Partnerships with community organizations give us the opportunity to reach customers in environments that are familiar and comfortable to them. It is an effective way to engage with customers that are difficult to reach with other approaches. Some customers have difficulty accessing information due to language and cultural barriers. Our community partnerships help us bridge these barriers and provide energy, sustainability, and Focus on Energy information and resources to customers that may otherwise go without it. Information is available in English, Spanish, and Hmong.	MGE
Conservation Education and Engagment	Serve diverse residential customers through our channels of Ask the Experts (email), Home Energy Line, (telephone), MGE social media, and interactive workshops. Target customer segments include: low income customers, Older adults,Engish language learners and Hmong, Chinese, Latinx, and African American communities, and sustainability conscious congregations. Information offered in English, Spanish, and Hmong.	MGE
EV 101, Kick the Tires Workshops	MGE brings together people interested in EV's and EV owners with their vehicles. Workshop begins with overview from MGE then questions from audience to EV owners. It ends with owners opening up their vehicles for attendees to see. Workshops are held in partnership with libraries, events, and community organizations, such as, Madison Area Chinese Community Organization.	MGE
Sustainability Resources in Libraries	We provide "Watts Up" portable energy meters (PEM), tools, and books to help people control their energy costs and implement sustainability measures through partnerships with local libraries. This includes information about Home Performance with ENERGY STAR® and other Focus on Energy programs. People check out the PEMs to find out operating costs for their plug loads. The libraries issue comment postcards to the users, and the comments that we receive back are very supportive of this kind of energy efficiency equipment being available for customers to use.	MGE

Initiative	Description	Company
Community Media Engagement	Provide energy information and advice in community media serving communities of color and through 35 neighborhood newsletters. E.g., biweekly show Viviendo con Energia de MGE, on La Movida Radio; Capital City Hues; ConNEXTions, Cambodian digital media platform; and Northside News.	MGE
Smart Thermostats in Homes of Low Income Customers	Provide eduation and advice to low-income customers that have one of the 310 Nest-e smart thermostats installed through our partnership with Project Home. Inc and Dane County Housing Authority.	MGE
Multifamily Owners/ Managers Engagement	Provide energy information and advice to owners, managers and developers in the multifamily sector, including site visits, presentations at trade shows and business meetings, quarterly e-newsletter, targeted emails and phone calls.	MGE
Simple Energy Efficiency (SEE) kits direct distribution pilot with Focus on Energy	Partnering with schools, community organizations, energy assistance providers and Focus on Energy we offer one-to-one energy efficiency consulation, SEE kits, and applications for energy assistance and weatherization programs to customers in neighborhoods with low incomes and low participation rates in programs.	MGE
Bishop Hill III Wind Energy Center	132 MW wind project in Illinois, came online in 2018.	WPPI Energy
Point Beach Solar Energy Center	PPA with NextEra Energy for 100 MW Wisconsin solar project, scheduled to come online in 2021.	WPPI Energy
Choose Renewable Program	Green pricing program allowing residential and commercial & industrial customers to purchase their energy from renewable sources.	WPPI Energy Dane Co Members
RFP for Energy Efficiency	Competitive bid program for commercial & industrial energy efficiency projects, used in conjunction with Focus on Energy.	WPPI Energy
Renewable Energy Grants for Non-Profits RFP	Competitive bid program for non-profits aimed at replacing the tax incentives for renewable energy that for-profit companies receive.	WPPI Energy
New Construction Design Assistance Program	Program aimed at incentivizing integrated design systems geared toward overall new building efficiency improvements vs. spec designs.	WPPI Energy

Initiative	Description	Company
Energy Management for Schools Program	Program to work with school districts to energy benchmark all their schools in Energy Star's Portfolio Manager, provide incentives and assistance in auditing, strategic energy planning and working with school board to set goals.	WPPI Energy
Utility and Municipal Building Energy Efficiency Program	Program to provide incentives for energy efficiency improvements and commissionoing services for utility and municipal-owned facilities.	WPPI Energy
Member Energy Efficiency and Renewable Energy Loan Program	Provides interest-free loans to member utilities for qualified energy efficiency and renewable energy projects.	WPPI Energy

Appendix 5: Thanks to Contributors

This Climate Action Plan represents the vision and work of many people who care about Dane County. We especially thank the following individuals who contributed writing, analysis, graphs, and tables. After each name we list the section, or subject area, of the Climate Action Plan to which each person contributed. We are fortunate to have the benefit of their expertise.

Marge Anderson – Buildings

Lauren Azar – Energy Storage

Kyla H. Beard – Ho-Chunk Introduction

Ally Burg – City and County carbon emissions

Sara Conzemius – Energy Efficiency

Kathy H. Frogg – Ho-Chunk Introduction

Sherrie Gruder – municipalities' roles in renewables

Phil Grupe - City of Fitchburg

Kelly Hilyard – City of Middleton

Charles Hua – Organizing for Renewable Energy

Smilla Jepsen – Green Infrastructure, Global Climate Leaders, Circular Economy

Shree Kalluri – Zerology electric vehicles

Marcia Kasieta – Badger Prairie Needs Network and sustainable food systems

Kathy Kuntz – Energy Efficiency

Laura L. La Mere – Ho- Chunk Introduction

Leigh Leonard – ecosystem services

David Liebl – climate adaptation

Erik Lincoln – Ho-Chunk Introduction

Robin Lisowski – Voluntary Carbon Markets/Funds

David Lorenz – Climate Change in Wisconsin

Chris McCahill – Transportation and Vehicle Miles Traveled

Michael Notaro – Climate Change in Wisconsin

Greg Nemet – renewables and electric vehicles

Missy Nergard – UW-Madison

Nancy O'Brian – Finance Solutions

Stacie Reece – City of Madison

Stephanie Salgado – Climate Justice Hero

Mary Schlaefer – Finance Solutions

Jim Schultz – Geothermal at Edgerton Hospital

Sophia Seol – Photos throughout, references

Jason Stringer – Finance Solutions

Edna J. Topping – Ho-Chunk Introduction

Missy F. Tracy – Ho-Chunk Introduction and photos

Stephen Vavrus – Climate Change in Wisconsin

Dan Vimont – Climate Change in Wisconsin

John Welch – Waste Management and the Circular Economy

Lillian N. White Eagle – Ho-Chunk Introduction and photos

Maria Woldt – Yahara Pride Farms

Sandy Xiong – City of Sun Prairie

Darrell Zastrow – Forestry

Appendix 6: Glossary

additionality is a term used in relation to carbon offsets or renewable energy credits (REC). A project has *additionality* if the project would not be completed in a market without carbon offsets. (That is, the carbon offset funding is necessary for the project to be completed.)

afforestation is the process of planting trees on land devoid of any trees to create a forest. This is different than reforestation, which refers to planting native trees into an existing forest. While reforestation increases the number of trees in an existing forest, afforestation is the creation of a "new" forest. For more information on afforestation and its potential impact on carbon emissions, see Project Drawdown's summary here: drawdown.org/solutions/land-use/afforestation.

alley cropping is a farming practice where crops are grown in wide alleyways between rows of trees. The practice can improve crop production, reduce crop failure risks, and increase ecosystem benefits. For more information on alley cropping see the US Department of Agriculture's summary here: fs.usda.gov/nac/practices/alley-cropping.php.

anthropogenic is an adjective that describes changes in nature that are made by people. So *anthropogenic* climate change is climate change caused by humans.

biodigester is a device and facility that processes (digests) organic waste (manure, food waste, etc.) into biogas and a nutrient-rich slurry.

carbon footprint is the amount of greenhouse gases (and especially carbon dioxide) emitted by something or someone. In most cases we measure the annual carbon footprint—which is the total emissions for a business or household in a year.

carbon isotope ratios is a methodology climate scientists use to measure the concentration of carbon in the atmosphere. For more discussion on this measurement, see this blog: skepticalscience.com/From-eMail-Bag-Carbon-Isotopes-Part-2.html.

carbon offset is an action, activity or investment that reduces emissions in a way that cancels out the carbon dioxide emissions from other activities. A business might, for example, offset the emissions associated with its business travel by investing in a solar energy farm that will reduce emissions equivalent to annual

emissions associated with its business travel. When considering carbon offsets the key is to ensure additionality—which means that the project would not have occurred without the additional investment from the entity purchasing the carbon offsets. To learn more about carbon offsets and additionality, check out this article from The Guardian: theguardian.com/environment/2011/sep/16/carbon-offset-projects-carbon-emissions.

carbon sequestration is a process by which carbon dioxide is removed from the atmosphere and stored in liquid or solid form. Sequestration can be a natural process (e.g., trees and other plants sequester carbon naturally by taking it from the air and storing it in roots and wood) or it can be a human-made process (like ongoing projects that sequester carbon dioxide in geological formations underground).

circular economy refers to a vision of the economy where products are used and re-used in a circular fashion so that there's no waste and no negative environmental impacts. To learn more about this model, see this discussion: ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy.

clean energy refers to energy sources that produce energy without also producing greenhouse gases or other pollutants. Stakeholders tend to agree that solar power, wind energy and hydro power are clean energy.

climate is the long-term average of weather conditions. The temperature on a single day is weather; the average temperature for Dane County in July (based on 30 years of data) represents our typical July *climate*.

climate adaptation refers to changes humans make to adjust (or adapt) to a changing climate. In Dane County, the efforts to better handle large rain events is an example of climate adaptation—we are changing land use patterns to adjust to a new climate reality.

climate bond is a financial instrument that is used to generate revenue for climate-related activities. Much like a company or government could issue a bond to finance a new building, entities can issue climate bonds to finance climate-related activities.

climate change refers to a long-term shift in local or global climate patterns, including changes in temperatures, precipitation and wind patterns.

climate mitigation refers to efforts to reduce or prevent the emission of greenhouse gases. Planting trees (which will absorb carbon dioxide from the

atmosphere) and reducing vehicle idling (which prevents emissions) are both examples of climate mitigation.

climate resilience (resiliency) is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate change.

co-benefits refers to the additional positive outcomes that accrue from a specific action (in this case, climate actions). There are often multiple co-benefits of climate adaptation and mitigation. For example, a co-benefit of energy efficiency (which reduces emissions) is that it saves money, which makes business operations more profitable.

credit enhancement is a strategy used to improve the creditworthiness of a business. Through credit enhancement the lender receives assurances that the borrower will repay the loan, perhaps via additional collateral or some sort of insurance.

deep de-carbonization refers to a set of strategies for achieving dramatic reductions in greenhouse gas emissions; the strategies include shifting electricity production to clean energy sources (e.g., wind and solar), shifting all building and transportation energy use to clean electricity and reducing the energy intensity of buildings and transportation systems through more energy efficiency and conservation.

demand-side nutrient removal describes a process for achieving a specified amount of nutrient removal from wastewater using the least possible amount of oxygen. Nutrients are removed from wastewater through an aeration process and that aeration uses energy, so by decreasing the amount of aeration/oxygen used to remove nutrients, wastewater can be treated with lower energy inputs, and therefore, lower carbon emissions.

discount rate is the interest rate that entities use to determine how much future cash flow is worth in the present. In energy efficiency programs, the discount rate helps to determine the value of future savings, for example, which determines which energy-saving actions are cost effective in the present.

dynamically downscaled model simulations refers to a process climate scientists use to study climate change impacts within a specific region rather than at the global level. Global models provide a sound big picture whereas the downscaled simulations provide more specific local insights

ecosystem benefits refers to the specific results of natural processes, as well as

compounds from specific plant and animal species, that benefit humans and enhance life on Earth. Nature provides us with food, water, fiber and construction materials—all of those are *ecosystem benefits*.

energy efficiency (EE) refers to efforts to maximize the results associated with consuming energy. An *energy efficient* refrigerator, for example, uses less electricity to cool soda than does an inefficient model. Similarly, an *energy efficient* office building might include energy efficient lighting, heating and cooling systems as well as practices that encouraged occupants to conserve energy at their desks.

energy security refers to whether an entity—a household, a business, a nation—has access to an energy supply. Because there are no fossil fuel resources in Wisconsin, Dane County becomes more energy secure as we transition to solar and wind power (which can originate in our county).

environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

equity is a strategy for addressing racial and social injustices. When we practice equity we give everyone what they need to be successful; this is different than equality, where we treat everyone the same.

global warming is the long-term rise in the Earth's global temperature, which is primarily due to increased greenhouse gas emissions associated with human use of fossil fuels.

green bank is an entity established to encourage private investments in low-carbon and climate-resilient infrastructure.

greenhouse gas (GHG) is any gas that, in the atmosphere, absorbs heat radiating off of the Earth's surface and reflects that heat back to the Earth. Greenhouse gases—like carbon dioxide and methane—act as a "greenhouse" trapping heat in the Earth's atmosphere.

ground-level ozone is a colorless and highly irritating gas that forms just above the earth's surface that causes respiratory and other health ailments. It is called a "secondary" pollutant because it is produced when two primary pollutants react in sunlight and stagnant air. These two primary pollutants are nitrogen oxides (NOx) and volatile organic compounds (VOCs).

homeostatic refers to a dynamic state of equilibrium. The term comes from biology where organisms and cells maintain equilibrium in response to both internal and external conditions.

ice cores are cylinders of ice drilled from ice sheets and glaciers. These cylinders give scientists insights into the Earth's climate across hundreds of thousands of years. For more information on ice cores, visit the National Science Foundation discussion: icecores.org/about-ice-cores.

industrial symbiosis is a process by which the waste materials from one industry or business become the input resources for another industry or business (to help achieve a circular economy).

manageable assets refers to the non-financial assets held by public and private entities, which would include buildings, land, fleets, and other assets. As delineated in The Economist, climate change presents a substantial risk to these assets: eiuperspectives.economist.com/sites/default/files/The cost of inaction_0. pdf.

net zero energy describes a building that produces as much renewable energy as it consumes over the course of the year.

net zero energy ready describes a building that is so energy efficient that all or most of the annual energy consumption could be offset with renewable energy. In some cases buildings are built to be net zero ready so that renewable energy can be added later.

net zero carbon describes a highly energy efficient building that is fully powered from on-site and/or off-site renewable energy sources. For a more thorough discussion of net zero carbon, see the World Green Building Council's website: worldgbc.org/advancing-net-zero. Note, too, that none of these net zero definitions take into account the emissions associated with constructing the building or with transporting people and materials to and from the building while the building is being used.

perennial cropping is a farming strategy that plants and harvests crops that are alive year-round and that are harvested multiple times before dying. Perennial crops aren't new—apple trees are an example of a perennial crop, as is alfalfa.

rainfall infiltration is the natural process by which water on the ground enters the soil. When the amount of rainfall exceeds the infiltration rate the soil can't absorb all of the rain—which causes runoff and risks of flooding.

reforestation is an effort to add trees to an existing forest or replant trees in an area that once was a forest. This is different than afforestation, which refers to efforts to create a new forest. Reforestation efforts increase the number of native trees in an existing forest.

renewable energy is energy coming from a source that does not deplete—such as solar energy or wind power.

renewable natural gas (RNG) is a pipeline-quality gas, from sources that are not fossil reserves in the ground, that is fully interchangeable with conventional natural gas and thus can be used in natural gas vehicles. RNG is essentially biogas (the gaseous product of the decomposition of organic matter) that has been processed to purity standards. Learn more about the Dane County RNG facility here: daneclimateaction.org/initiatives/Landfill-Natural-Gas.

resiliency refers to the ability to recover quickly from disruptive change. Dane County created this Climate Action Plan to enhance our *resiliency* in face of the climate crisis.

riparian buffer is a vegetated "buffer-strip" near a stream, which helps to shade and partially protect the stream from the impact of adjacent urban, industrial or agricultural land use.

sediment and nutrient loading occurs when water, running over land to rivers or lakes, picks up and carries sediment and nutrients (like nitrogen or phosphorus) into the waterways. In the lakes, nutrients like phosphorus and nitrogen spur algae growth, which jeopardizes water quality.

silvopasture is the intentional combination of trees, pasture, and livestock together as an integrated, intensively-managed system. See Project Drawdown for a full discussion of silvopasture: drawdown.org/solutions/food/silvopasture.

sustainability is most frequently defined as an approach that "meets the needs of the present without compromising the ability of future generations to meet their own needs." simple.m.wikipedia.org/wiki/Sustainability

tree canopy baseline is a measure of the current tree cover in a community or neighborhood. Establishing a baseline is an important first step in any effort to increase trees in an area. The Wisconsin DNR offers tips and resources associated with measuring and increasing a tree canopy here: dnr.wi.gov/topic/urbanForests/ufia/canopyGoals.html.

vector-borne diseases are transmitted to humans and other animals by blood-feeding arthropods, such as mosquitoes, ticks, and fleas. West Nile virus is an example of a *vector-borne disease*.

voluntary carbon market provides an optional way for businesses, governments, NGOs, and individuals to offset their emissions by purchasing carbon offsets. There is no requirement to participate in a voluntary market.

zoonotic diseases refers to diseases that normally exist in animals but can be transmitted to people. Rabies is an example of a *zoonotic disease*.

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"What we do know is that our human activities have played the defining role in the global burning and climate change we are currently experiencing. Our response to this knowledge will play a defining role in how much disruption to life will occur... We must ensure future generations will have good stories to tell and songs to sing about the legacy with which we left them to live."

- Daniel R. Wildcat

Red Alert! Saving the Planet with Indigenous Knowledge

Dane County Office of
Energy & Climate Change