Goals & Modeling

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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

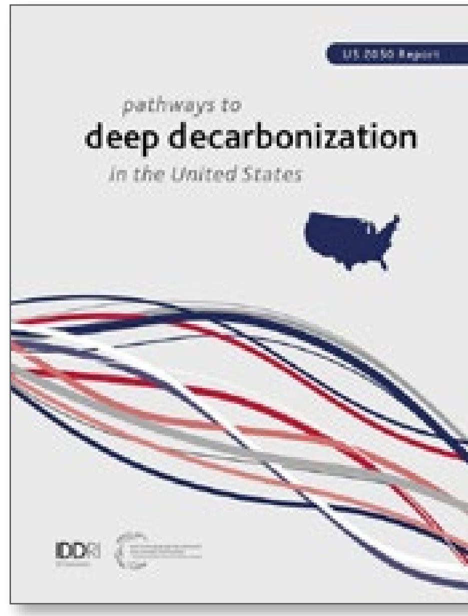
Fig. 8.1: GHG Emission Reduction Targets of US Cities and Dane County

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

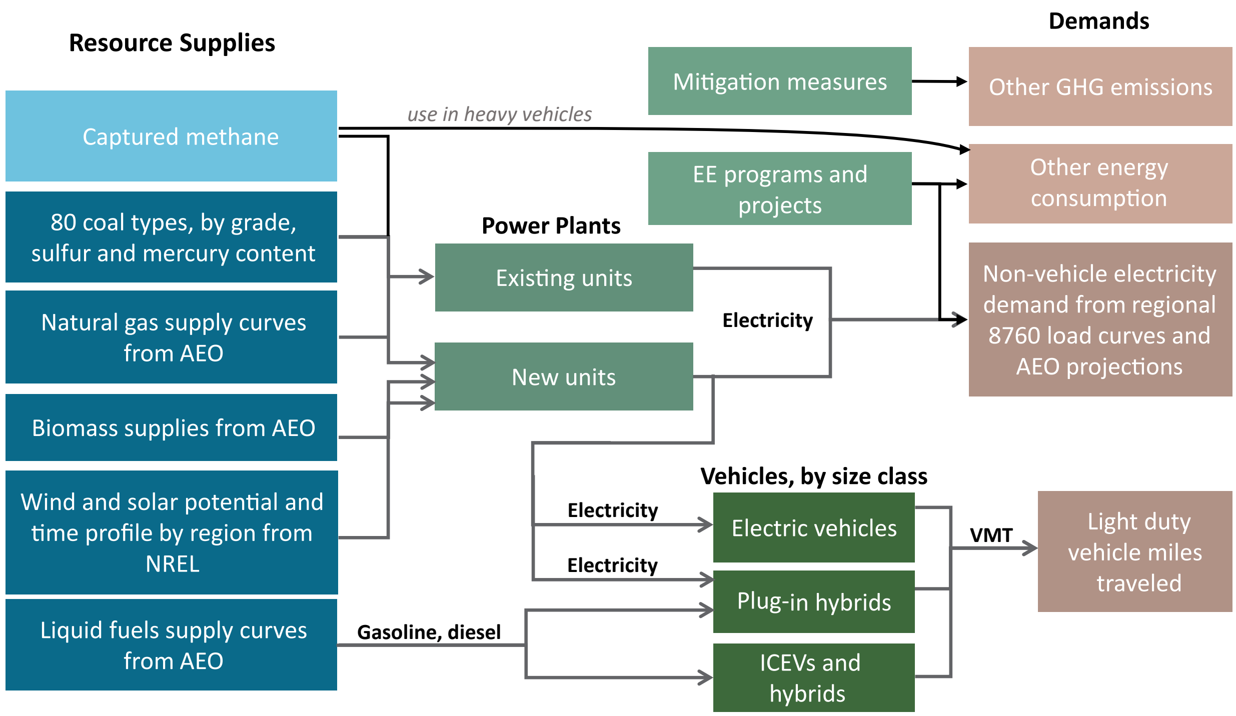


Fig. 8.2: The Dane County FACETS Reference Energy System

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

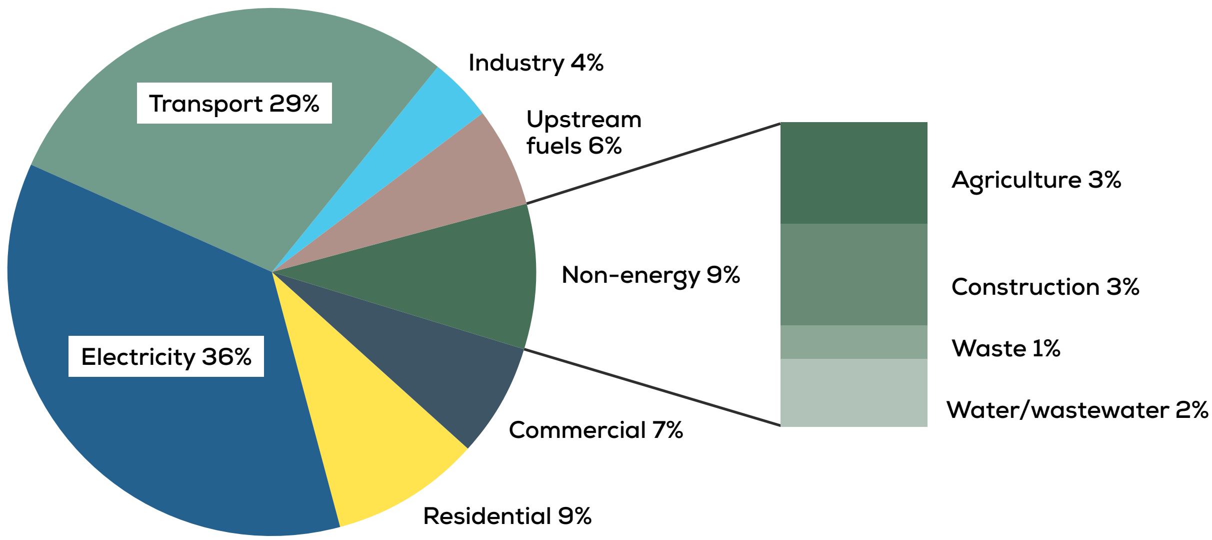


Fig. 8.3: Base year (2017) Dane County emissions (7451 thousand metric tons CO_2 equivalent)

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

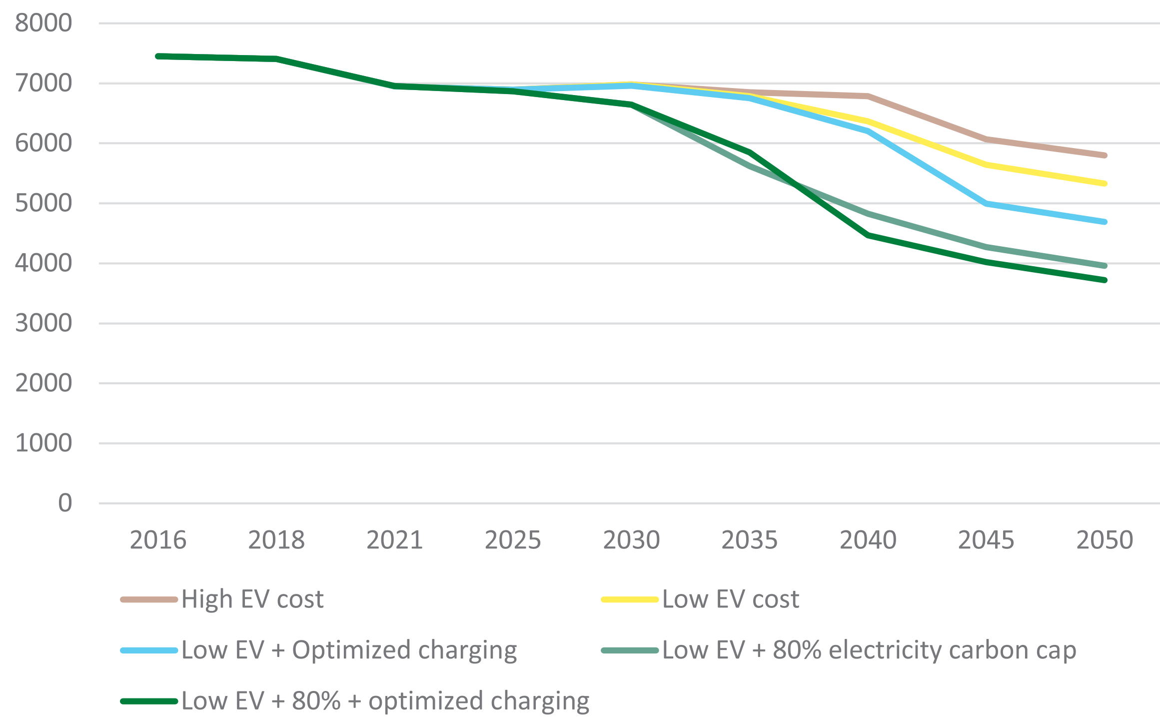


Fig. 8.4: Baseline energy-related emissions with medium gas prices and low RE costs (thousand mt CO_2 equivalent)

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:

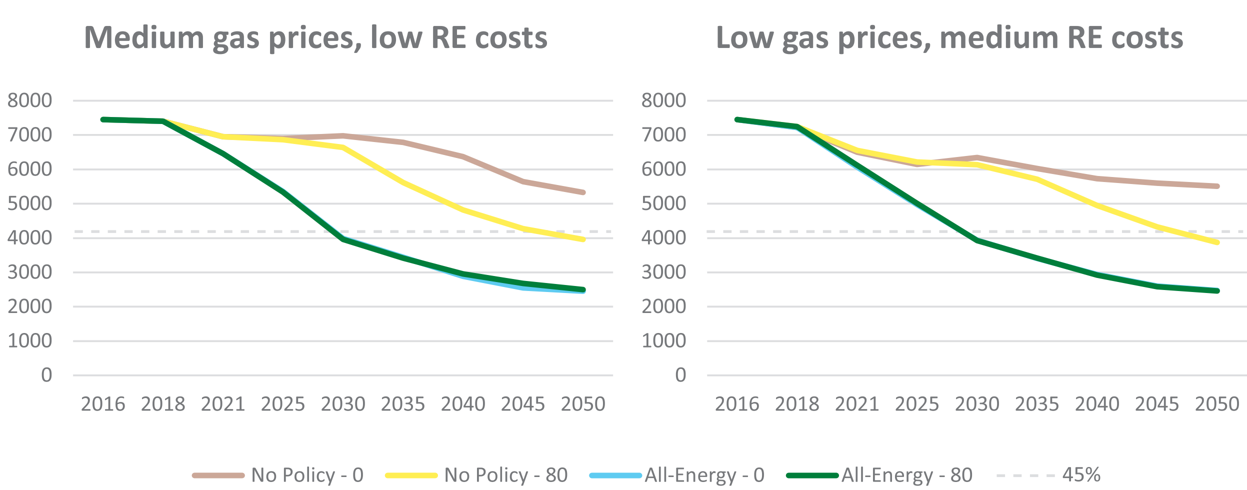
- Reducing vehicle miles traveled has a gradual but increasing emission reduction impact over time making it a critical strategy.
- Actions that increase EV sales over the next 10 to 20 years result in significant emission reductions and technology improvements.
- If we are successful in getting other 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

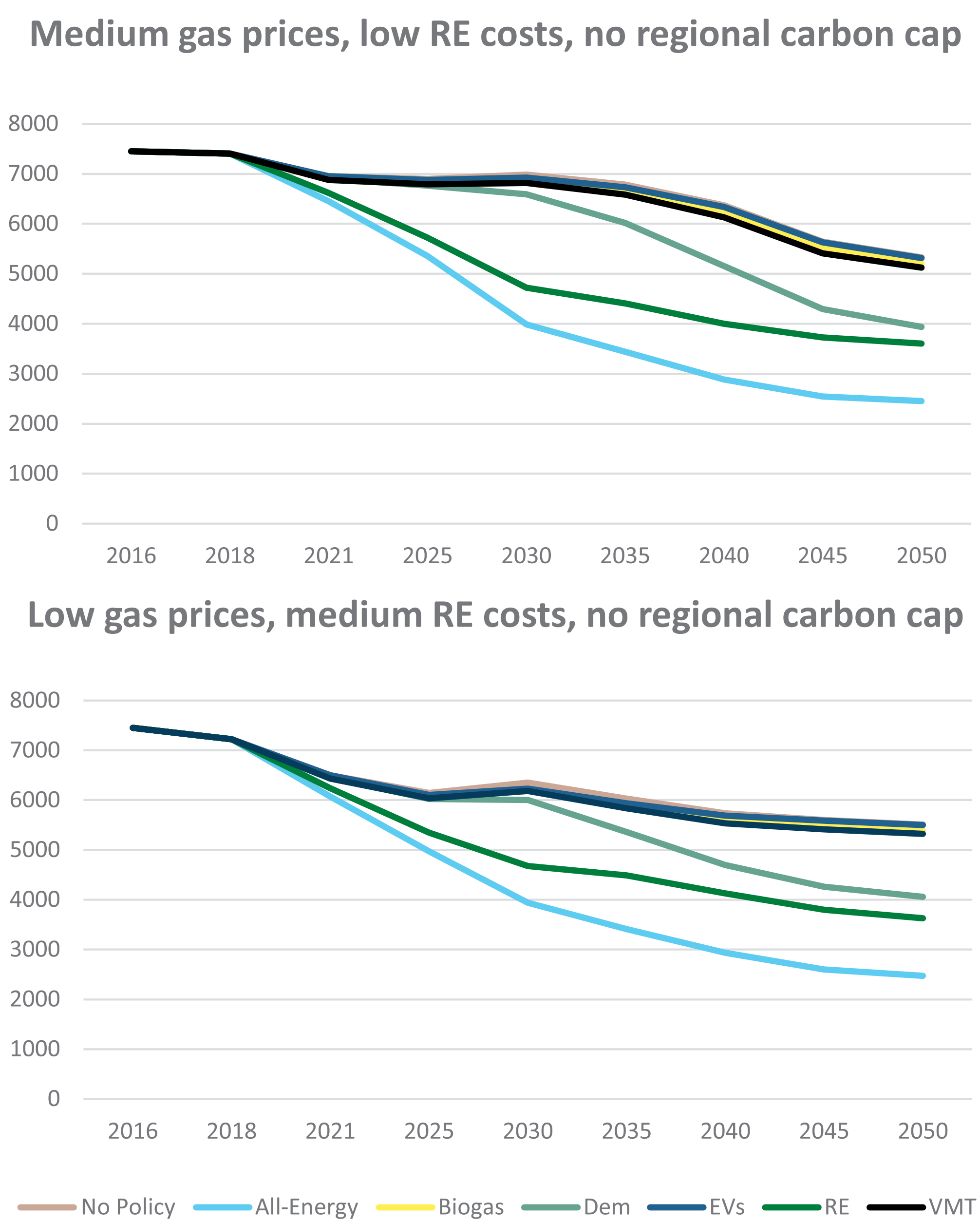
Fig. 8.6: Energy-related GHG Emissions (Thousand Metric Tons CO_2-equivalent). GHG Emission reductions from all policies. Combining all the policies brings the 2030 reductions to 48-49% below 2010 levels. Emissions continue to fall after 2030, reaching 67-68% below 2010 levels by 2050.



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

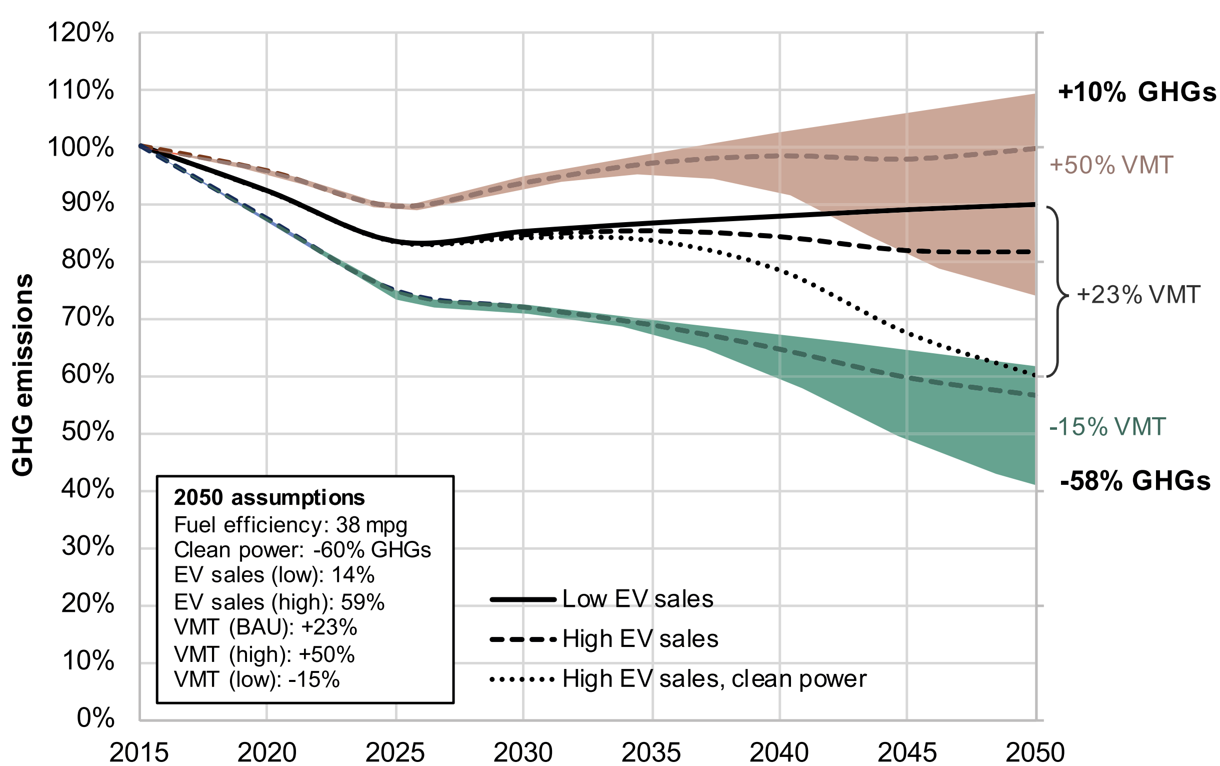


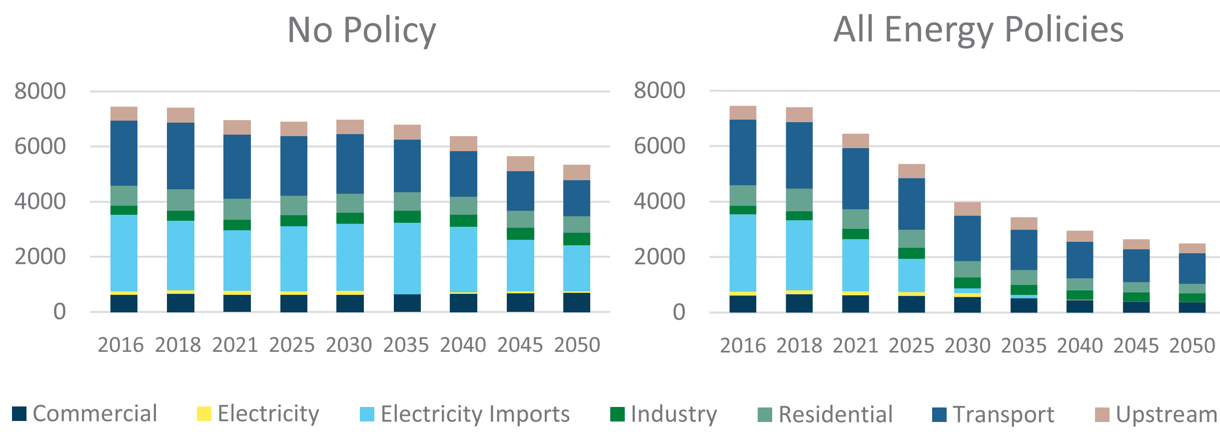
the more important vehicle efficiency (EVs are much more efficient than gasoline) and a clean electricity supply are.

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

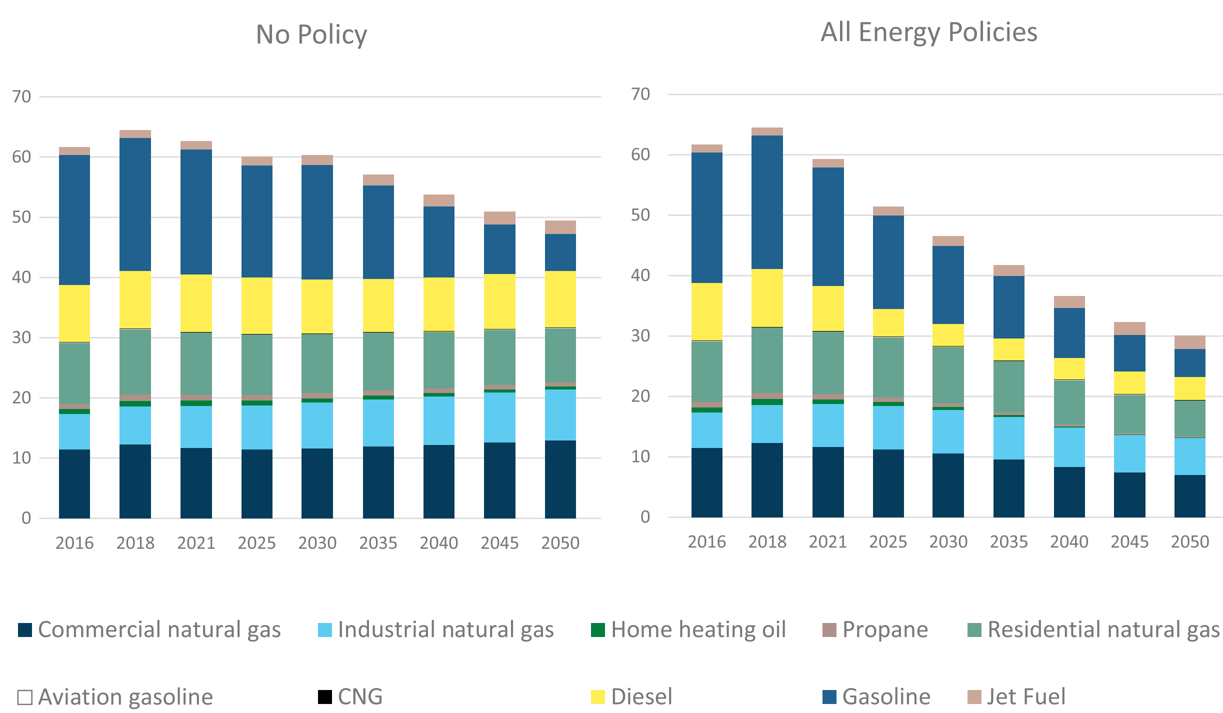




▲ **Fig. 8.9:** Energy-related GHG emissions (thousand metric tons CO_2-equivalent). Post-2050, remaining major sources of emissions are:

- 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



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.

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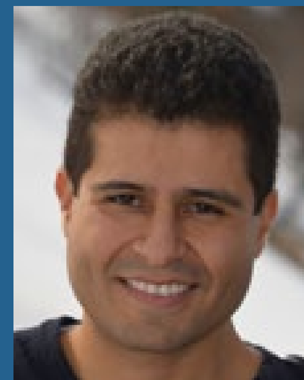
Assistant Scientist in Biological Systems Engineering at University of Wisconsin-Madison



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.

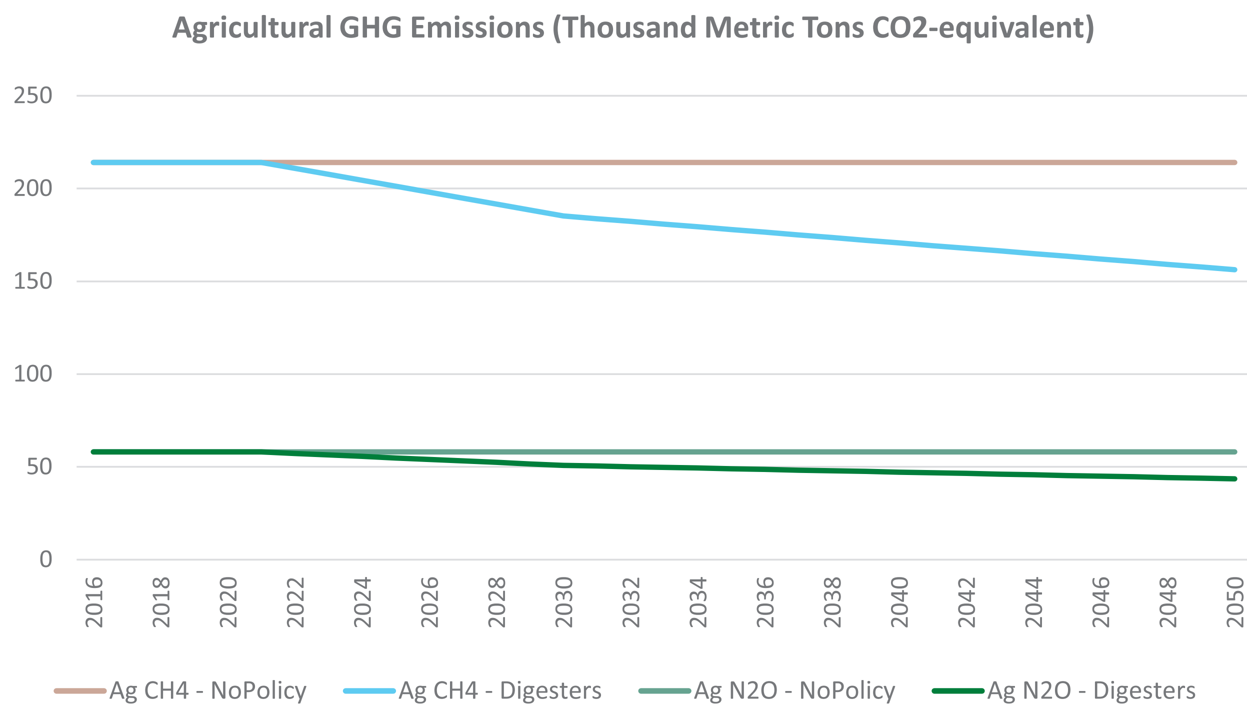


Fig. 8.12: Digester policy: half of all manure is digested by 2030 and all by 2050. The policy reduces agricultural emissions by about one quarter by 2050. Method: manure is responsible for 27% of ag methane and 25% of N_2O. Starting in 2022, these emissions are linearly reduced, reaching half of their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

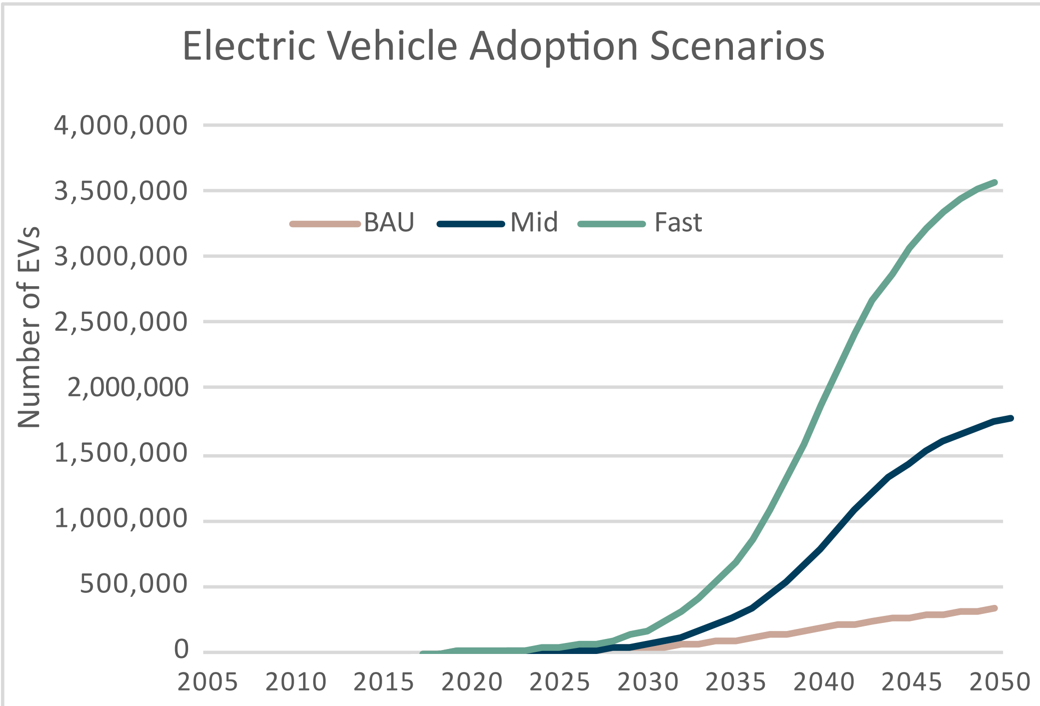
Demand-side Policies Several of the policy areas increase efficiency – the energy efficiency program increases the efficiency of electricity and gas, as do the advanced building standards, and the primary water recommendation increases the efficiency of water use. Because the model tracks electric generation, 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.

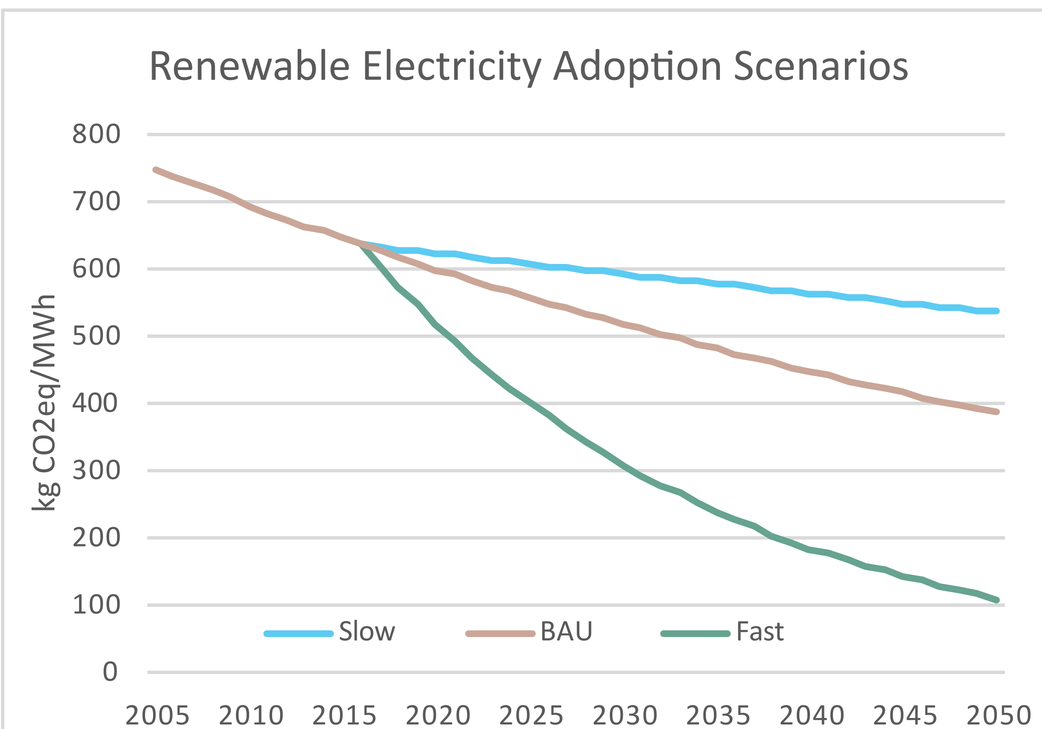
The model tells us that the reduced electricity, natural gas, and water use save all residents and businesses an average of $35 million per year in their electricity fuel and water bills by 2030, and $225 million per year by 2050.

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





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.