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Scoping Study: Electrifying New Homes in Dane County

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INTRODUCTION

Dane County's 2020 Climate Action Plan identifies accelerated adoption of heat pump technology as a key strategy for reducing Dane County's carbon footprint. The plan establishes goals for converting all existing propane and oil heat within the county to heat pumps by 2045, and for heat pumps to be used in all new residential construction by 2040. This study assesses the opportunity for all-electric new homes. By combining insights from interviews and energy and cost modeling, this study characterizes the current state of new homes and presents strategies to build momentum for constructing new high-performance all-electric homes in Dane County.

LAY OF THE LAND

Slipstream reviewed data on building permits issued, home starts, and Focus on Energy New Homes participation for a sense of residential single-family home new construction activity in Dane County. Interviews with builders and home performance raters active in the Dane County market provided insights on the awareness of heat pumps and barriers to using them in new homes.

MARKET DATA

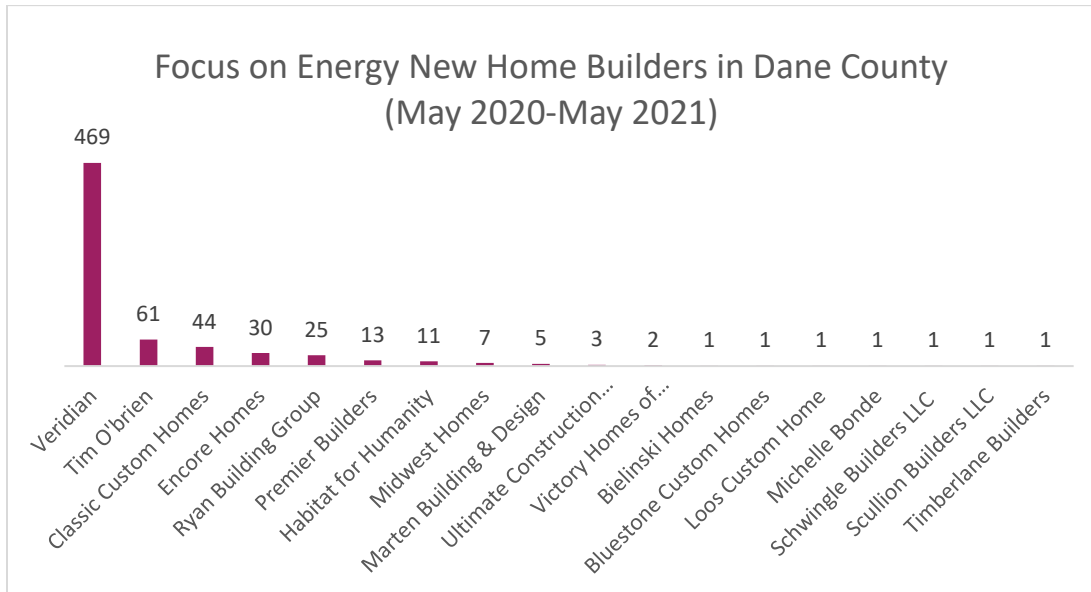
In 2020 there were 1,381 building permits issued for new single-family homes in Dane County.¹ MTD Marketing Services of Wisconsin calculated that there were 889 housing starts between April 2020 and April 2021.² Builders in Dane County participating in the Focus on Energy New Homes program constructed 677 homes between May 2020 and May 2021.³ Most of those homes were built by one local production builder (469). Focus on Energy new homes represent about 75 percent of the new homes started in Dane County between spring 2020 and 2021. However, they only represent about 50 percent of building permits issued.

¹U.S. Census Bureau. Building Permits Survey. <https://www.census.gov/construction/bps/> Accessed June 22, 2021.

² Mad City Dream Homes. Dane County Housing Starts. <https://www.madcitydreamhomes.com/housing-starts.php> Accessed June 22, 2021.

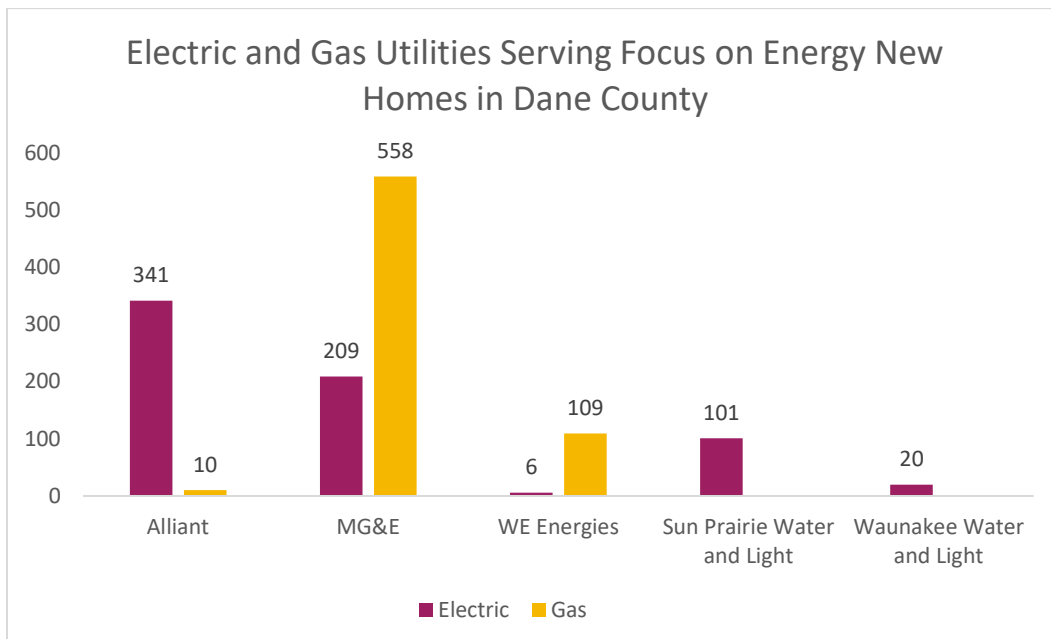
³ Data provided by Focus on Energy

Figure 1: Focus on Energy New Home Builders in Dane County (May 2020-May 2021)



All the homes built through the Focus on Energy New Homes program in Dane County use natural gas for space heating and water heating. Most of these homes are served by Alliant, Madison Gas & Electric (MGE), Sun Prairie Utilities, and Waunakee Utilities (electricity) and MGE and We Energies (natural gas).

Figure 2: Electric and Gas Utilities Serving Focus on Energy New Homes in Dane County



INTERVIEWS

Slipstream staff reached out multiple times to eight builders ranging from custom home builders to the two largest builders in Dane county and was able to conduct interviews with three. In addition, Slipstream staff contacted all five home performance raters working in the Dane County market and was able to conduct interviews with four.

Interviews with residential new home builders were designed to:

- Determine builder awareness and perception of heat pump technologies needed to support electrification.
- Identify perceived barriers, needs and or opportunities for increasing heat pump installation.
- Define who makes or influences decisions about selecting heating fuels and technologies.

Interviews with home performance raters were designed to:

- Gauge market readiness of heat pump space heating technology.
- Explore builder interest and aptitude (from the raters' perspective) for constructing all electric heat pump homes.
- Identify potential first movers in the market.

Interview results—new home builders

The new home builders we spoke with have an emerging awareness of air source heat pumps for water heating and are familiar with ductless mini splits. But few builders in Dane County have any significant experience with air source heat pumps used for space heating and perceive the technology as more costly to install and operate compared to gas appliances. Generally, they are not aware of the improvements that have been made in cold weather performance.

Beyond the lack of awareness of space heating applications for heat pumps, the primary impediment to converting to electric heating in new homes is the pervasiveness of natural gas infrastructure in Dane County. All the builders we spoke with said that it is the availability of natural gas that determines which fuel they use for space heating.

Related to the pervasive availability of natural gas is builders' reliance on their HVAC contractors to specify heating equipment for their homes. HVAC contractors are comfortably familiar with, and trust gas fired appliances (furnaces and water heaters) and are reluctant or resistant to adopting or offering a new technology, except under very limited applications.

Other insights from our interviews include:

- No recognition and very little consideration of the health impacts of using gas, particularly the direct household impacts of cooking with gas (PM 2.5 and

NOx production) though there is some realization that switching to electric could eliminate make-up air requirements and cooking with gas can become more of an issue as houses get tighter.

- No clear sense of the avoided costs to bring natural gas to the lot since this cost is embedded in the cost of the lot or in the developers' costs. Builders think the cost to bring natural gas from the curb to the building (cost to build) is minimal (perhaps \$1,000 to \$1,500).
- Dual fuel heating seen as bridge to all-electric homes that makes the transition better.
- The customer is the entity needed most to move the market forward and they need to be convinced that the costs are favorable to them.

Interview results—home performance raters

In comparison to builders, home performance raters in Dane County are familiar with air source heat pumps for space heating. Additionally, they expressed a confidence in the technology's ability to meet heating loads in this climate. However, they did comment that more information on heat pump performance in Dane County would be useful.

Dane County home performance raters are cautiously optimistic that installations of air source heat pumps for space heating will increase over the next five years. They do see several barriers that need to be overcome. These are:

- higher installation, operational and construction costs
- greater perceived (contractor/builder) risk
- need for back-up heat
- industry status quo

Dane County's home performance raters identified custom high-end builders or builders wanting to differentiate themselves and/or market themselves as cutting edge or eco-friendly as being most likely to embrace air source heat pumps for space heating applications. They also concurred with builders that HVAC contractors and customers need to be convinced to adopt air source heat pumps for space heating.

CONCLUSIONS

Air source heat pumps for space heating applications is a relatively unknown technology in the Dane County new construction marketplace. Add to that the pervasive availability of natural gas and relatively high electricity rates and builders have little incentive to switch to air source heat pumps.

COST ANALYSIS

Slipstream conducted a cost analysis to explore incremental costs of upgrading to an all-electric efficient home and avoiding natural gas line costs. The cost analysis also compared the

estimated operating costs of a conventionally built mixed-fuel home to a high-performance all-electric home. For the mixed-fuel homes, we assumed the space and water heating fuel to be natural gas since natural gas is pervasive across Dane County and all Focus on Energy New Homes Program participating homes the past year were heated with natural gas.

ENERGY MODELING METHODOLOGY

To compare costs of all-electric homes with mixed-fuel homes, we used a REM/Rate™ model and adjusted parameters to generate four hypothetical homes that are likely to be built in Dane County. The guiding reference we used was the New Homes Baseline and Market Characterization Study⁴ completed in 2017. The model assumed a 3800 square feet 3-bedroom Ranch house with a simple conditioned basement. To assess building envelope, air tightness was determined to range from 1.5 to 1.9 air changes per hour at 50 Pascals pressure differential (ACH 50). Whole house ventilation rate was modeled per ASHRAE 62.2. In the baseline mixed-fuel home, component specification and performance inputs were based on the characterization study and insights from 2020-2021 Focus on Energy data for Dane County homes. Below is a summary of the modeling parameters for each home:

Figure 3: Attributes of Mixed-Fuel Homes

Baseline Natural Gas Home		High Performance Natural Gas Home	
95% Annual Fuel Utilization Efficiency (AFUE)	Natural gas furnace	97% Annual Fuel Utilization Efficiency (AFUE)	Natural gas furnace
13 Seasonal Energy Efficiency Ratio (SEER)	A/C	13 Seasonal Energy Efficiency Ratio (SEER)	A/C
.68 Energy Factor	Natural gas water heater	.70 Energy Factor	Natural gas water heater
1.9 ACH50	Air tightness	1.5 ACH50	Air tightness
56% LED, 10% CFL and 34% incandescent	Lighting	100% LED	Lighting

Figure 4: Attributes of All-Electric Homes

High Performance Electric Home (Ducted ASHP)		High Performance Electric Home (Ductless ASHP)	
11.2 Heating Seasonal Performance Factor (HSPF)	ASHP	11.2 Heating Seasonal Performance Factor (HSPF)	ASHP
18.2 Seasonal Energy Efficiency Ratio (SEER)		19.7 Seasonal Energy Efficiency Ratio (SEER)	
3.5 Energy Factor	HPWH	3.5 Energy Factor	HPWH
1.5 ACH50	Air Tightness	1.5 ACH50	Air Tightness
100% LED	Lighting	100% LED	Lighting

⁴ Pigg, S. and Lord, M. 2017. New Homes Baseline and Market Characterization Study. Seventhwave.

COST COMPARISON

Concerns about increased cost of building and operating all-electric homes were common among raters and builders. We conducted an annualized cost analysis to investigate the differences. We obtained installed cost, incremental cost, and measure lifetime data from the Wisconsin and Illinois TRM and other sources where applicable. We applied measure lifetime data and the current U.S. mortgage interest rate of 2.5% to calculate annualized costs for each scenario. For the electric and gas-heated homes, we referenced envelope construction costs from a 2017 National Association of Home Builders (NAHB) study⁵ and cost of envelope upgrades reported in a recent study by Rocky Mountain Institute.⁶ Gas connection costs (\$6,400) came from a report on decarbonization in California.⁷ Annual energy costs came from the REM/Rate modeling using utility rates shown below:

Figure 5: Predominant Electric Rates in Dane County⁸

Electric Utility	Monthly fixed charge	Summer (per kWh June-Sept)	Winter (per kWh Oct-May)
Madison Gas & Electric	\$19.65	\$0.14	\$0.13
Alliant	\$14.80	\$0.12	\$0.12
Sun Prairie Water & Light	\$12.75	\$0.09	\$0.09

Figure 6: Predominant Natural Gas Rates in Dane County⁹

Gas Utility	Monthly fixed charge	Per therm charge
Madison Gas & Electric	\$21.59	\$0.67
WE Energies	\$9.90	\$0.9479

To report overall cost results, we selected MGE as the provider for both electricity and natural gas since we suspect most residents in Dane County are served by this utility. In this scenario, energy costs were slightly more expensive for the all-electric homes. Sun Prairie Water & Light electric customers benefit more from all-electric homes due to the lower electric rate. As shown in Figure 7, annual energy costs are lower for all-electric homes that are served by Sun Prairie Water & Light and are avoiding natural gas fixed charges from MGE.

⁵ Ford, Carmel (December 1, 2017). Cost of Constructing a Home. Available at: <https://www.nahbclassic.org/generic.aspx?genericContentID=260013>

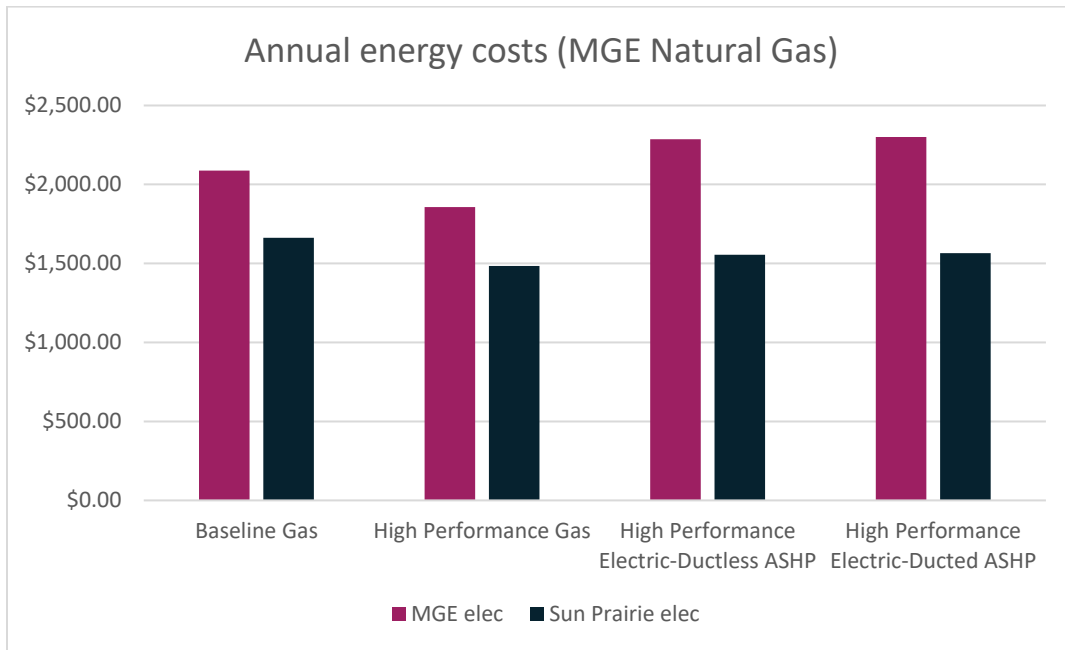
⁶ Petersen, Alisa; Gartman, Michael; Corvidae, Jacob. (2019) The Economics of Zero-Energy Homes: Single-Family Insights. Rocky Mountain Institute. Available at: www.rmi.org/economics-of-zero-energy-homes

⁷ Hopkins, Asa et al. 2018. Decarbonization of Heating Energy Use in California Buildings. Synapse Energy Economics, Inc. Available at: <https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf>

⁸ Electric rates were obtained May 2021.

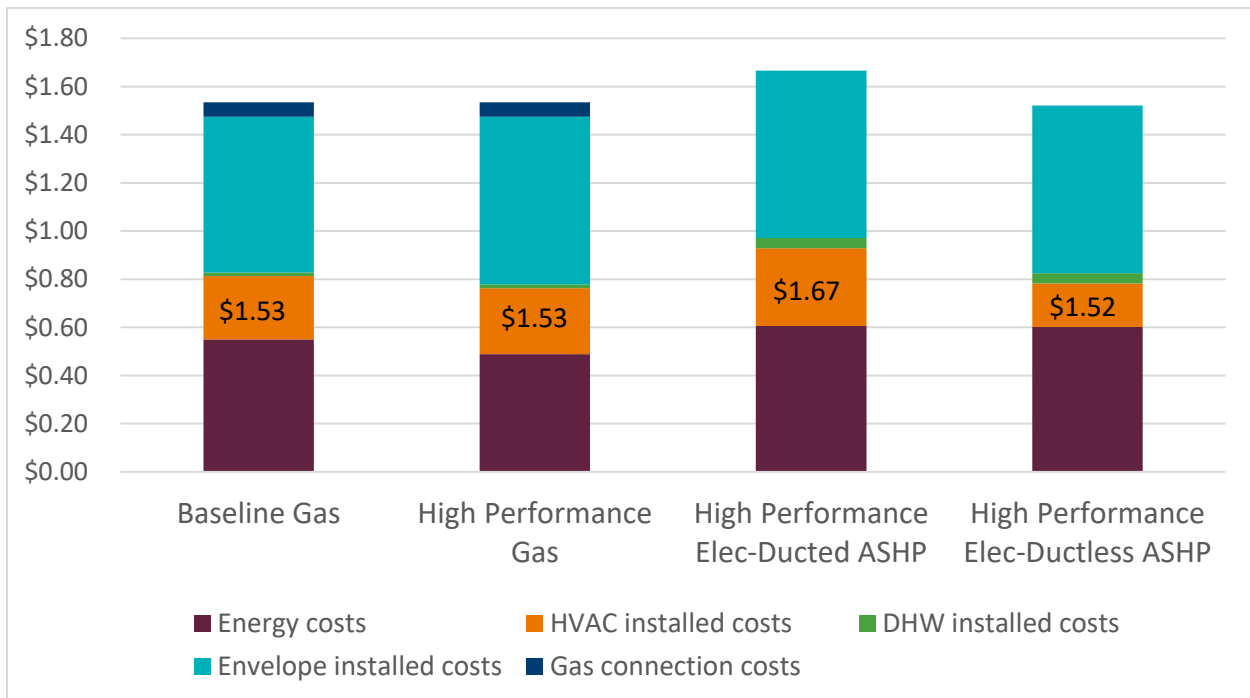
⁹ Natural gas rates were obtained May 2021.

Figure 7: Annual Energy Costs (MGE Natural Gas)



Total costs for each scenario are reported in the graph below and represent annualized costs/square foot.

Figure 7: Annualized costs per square foot (sf)



According to an online calculator,¹⁰ the total cost of construction is approximately \$120 per square foot in Dane County's area. This would equate to an annual carrying cost of \$4-\$8 per square foot under a 15-year or 30-year mortgage. The cost differentials (no more than \$0.14 per square foot) shown in our analysis are thus a small fraction of the total carrying and operating costs for new homes in Dane County.

We also find that a high performance all-electric home with a ductless heat pump has the lowest annualized cost per square foot. This is largely due to the avoided cost of installing ductwork in the home which a local contractor estimated could be in the ballpark of \$8,000.

While the results above show promise for all-electric homes, it is important to keep in mind the assumptions behind this cost comparison. On the positive side, we modeled a highly efficient baseline gas home but there may still be some less efficient homes built in the market today. On the negative side, heat pump performance in the field (and especially in cold climates) does not tend to align with nameplate energy efficiency ratings. For example, we used an assumption of 11.2 HSPF which translates to a coefficient of performance (COP) of 3.3. From our understanding of the field performance literature in cold-climates, seasonal heating efficiency of all-electric ducted heat pumps tends to be around a COP of 2 and all-electric ductless heat pump seasonal heating performance tends to be around a COP of 2.5. These 25% and 40% drops in heating efficiency would have a measurable impact on operating costs of all-electric homes. For a variety of reasons, heat pump water heaters are also likely to exhibit lower efficiency than what is indicated on their nameplate. Finally, our cost analysis focused only on the major appliances and omitted cooking and laundry equipment which are less consequential to the cost comparison.

PROGRAM APPROACH

To achieve its objective of using heat pumps for space heating and cooling in all new residential construction by 2040, Dane County needs to build awareness and acceptance of this technology. Slipstream suggests a multi-pronged awareness campaign that targets builders, HVAC contractors, and new home buyers. The components of this campaign could include the following.

Showcase the technology: Work with Veridian Homes, who provide the lion's share of new homes built in Dane County, to go all-electric and install an air source heat pump for space heating and cooling in a model home in one of their developments. This approach achieves three objectives: a) it increases builders' awareness of the technology, b) it builds awareness and comfort with the technology with the HVAC contractor, and c) it provides a showcase for prospective home buyers.

Veridian is a natural partner for Dane County since they embrace green building and represent nearly 70 percent of the homes built through the Focus on Energy New Homes program. Veridian is also already on the pathway to building all-electric given their recent commitment to

¹⁰ Home Building Cost Calculator Per Square Foot | Home-Cost: <https://app.home-cost.com/construction-cost-per-sf.html#try>

install heat pump water heaters in all spec homes. Tim O'Brien Homes, the second largest builder in Dane County, and also a green homes promoter, has started installing heat pump water heaters in their homes and can be a strong partner as well. Finally, other local builders with less of a heavy Dane County footprint could be partners for showcasing air source heat pumps for space heating and cooling.

Manufacturers of air source heat pump equipment such as Trane, Bryant, Daikin, Carrier, Mitsubishi, and Bosch and HVAC distributors could help Dane County by buying down equipment cost and providing technical support to the HVAC contractor to install air source heat pumps in the model home.

The primary outcome of this intervention is that all-electric homes are normalized for builders, contractors, and home buyers.

Intervene early to promote all-electric developments: We know the economics of all-electric homes is one of the biggest barriers. In a competitive construction market, avoided gas costs are passed along to the home buyer and can play a significant role helping favor the economics of all-electric homes. In the cost analysis, we used an estimate of \$6,400 to bring a gas connection and gas appliance piping to a home. However, another report has estimated the cost can range from \$1,000 to \$24,000.¹¹ Our interviews revealed local builders think the cost is as low as \$1,000-\$1,500 to bring gas from the curb to the building. One of the key factors driving this cost is a building's proximity to existing mains which depends on the state of the development. If gas lines are already extended to the curb, the avoided cost by going all-electric is lower.

If Dane County could intervene early to promote an all-electric development, the benefits could be significant since a collection of homes would be positioned to be all-electric and the entire development would be a showcase for the county. To do this, Dane County could identify specific local residential developments or developers and explore ways to facilitate or streamline the zoning or permitting process to expedite and reduce the costs of bringing electrified developments to market. Additionally, by committing to market to prospective homebuyers to spur demand, Dane County could reduce risk to developers who are open to all-electric developments but ultimately focused on the bottom-line and concerned they may not sell the lots if they launch an all-electric development.

Develop pilot programs and case studies: Dane County could work with WPPI and MGE to develop a pilot program promoting air source heat pumps for space heating and cooling in new homes. Focusing first on WPPI member utilities (Sun Prairie Water and Light and Waunakee Water and Light) would be beneficial because their electric rates are lower making the cost more favorable. However, MGE provides natural gas to 82 percent of the Focus on Energy new homes built in 2020 so a pilot program moving new homes in their gas service territory to all-electric is needed. For pilot participants to experience better cost-effectiveness, it would help for electric rate innovations to be advocated for by Dane County, and ultimately adopted, such as a lower all-electric heating rate.

Due to the challenging economics of all-electric new construction, Dane County may also want to consider a bridge approach in a pilot program that acknowledges that not all new construction will go all-electric immediately but that there is an immediate compelling opportunity within the

¹¹ Billimoria, Sherri et al. The Economics of Electrifying Buildings. 2018. RMI. Available at: <https://rmi.org/insight/the-economics-of-electrifying-buildings/>

next five years to partially electrify space heating. There are a few benefits to this approach. First, the incremental equipment cost compared to central AC is quite low for many single-stage and two-stage heat pumps sized for cooling (~\$400-\$1,000). Second, the heat pump will be able to compete more effectively on an operating cost basis since the efficiency of the heat pump will be higher because it is operating at more moderate temperatures. Third, more homeowners will see how well air source heat pumps operate and can serve as case studies and will be likely to convert themselves to all-electric heat pumps at the time of equipment replacement by 2035-2040.

This “AC-replacement” strategy is a compelling one that is being advocated for in an AC phase-out federal policy proposal.¹² Rather than a top-down approach, Dane County could promote bottom-up market transformation by ensuring builders and HVAC contractors understand that it does not make sense to install “one-way air conditioners” anymore. Heat pumps are no longer a question. The question is whether you go with dual-fuel heating or all-electric heating in your heat pump selection for a given home. This strategy is bolstered by the fact that Focus on Energy no longer offers rebates on Central AC equipment and offers a \$1,000 rebate for a dual-fuel heat pump that displaces natural gas.

Pilot participants provide an easily accessible source for Dane County to develop case studies. Builders could be another source by providing their showcase home or referring a homebuyer to Dane County. Whether the case studies come from pilots, identifying a couple early case studies will benefit Dane County in its outreach and make all-electric homes feel more achievable in the eyes of homebuyers.

Accelerate Focus on Energy heat pump program for new homes: The Focus on Energy New Homes program recently added prescriptive incentives on top of the incentives based on levels of certification. Heat pump water heaters receive an extra \$200 in a prescriptive incentive and inclusion of this measure can increase the overall incentive level by increasing the level of certification. Builders have taken note and as described above; heat pump water heaters are becoming more commonly installed in new homes in Dane County.

Dane County could benefit by working with Focus on Energy to phase out the prescriptive rebate for 98 percent efficient gas furnaces and add a rebate for cold climate air source heat pumps. Further aligning the available statewide incentives to promote electrification and dissuade gas-heated homes provides an important lever to improve the economics of all-electric new homes.

Tackle HVAC contractor resistance: Builders’ subcontractors hold substantial influence over the equipment installed in new homes. To ensure the next generation of HVAC contractors are familiar with air source heat pumps and their applicability for space heating in cold climates, Dane County could work with Madison College’s HVAC program to highlight the improved cold-climate performance of air source heat pumps and share local case studies of all-electric homes in Dane County. To influence existing HVAC contractors, Dane County could create a climate champions program to recognize businesses that embrace technologies and strategies that address the goals in Dane County’s 2020 climate action plan. In concert with a climate champions program, Dane County would benefit by developing a process for identifying HVAC

¹² Pantano, Stephen et al. 2021. 3H ‘Hybrid Heat Homes’ An Incentive Program to Electrify Space Heating and Reduce Energy Bills in American Homes, CLASP, <https://www.clasp.ngo/research/all/3h-hybrid-heat-homes-an-incentive-program-to-electrify-space-heating-and-reduce-energy-bills-in-american-homes/>

contractors with expertise in air source heat pumps to distinguish those contractors in the market. Recognition for HVAC contractors could take the form of a “heat pump badge” on a trade ally list that Dane County could host or encourage the local utilities or statewide Focus on Energy program to host.

On an individual basis, specifically targeting Dave Jones, Inc and providing them with information on air source heat pumps could pay dividends since Veridian primarily works with them.

To support training and education of HVAC contractors, Dane County could host or co-host a manufacturer’s heat pump roundtable where each manufacturer is offered a chance to discuss their heat pump solution. Local distributors could be a helpful partner in this venture and Dane County could further benefit by leveraging the distributor relationships held by Focus on Energy’s Midstream program which already includes heat pump water heaters and ductless mini-split heat pumps as incentivized measures.

PARTNERS AND ALLIES

Partner/Ally	Role
Focus on Energy	Promote ASHPs through their new homes program, support trade ally education and outreach
Sustainability Leaders Collaborative	Leverage ideas and resources
Madison Area Builders Association	Promote ASHPs to the builder community
Madison College HVAC Program	Teach the next generation of HVAC contractors about ASHPs
Better Buildings, Better Business Conference	Teach HVAC contractors and builders about ASHPs
HVAC manufacturers and distributors	Provide donations for model homes and teach HVAC contractors
WI Local Government Climate Coalition	Leverage ideas and resources
Builders/developers	Showcase ASHP technology, enact all-electric development
Raters	Advocates for ASHP technology with builders and HVAC contractors
New home homeowners with ASHPs	Provide material for case studies
MadiSUN Program	Pair all-electric value proposition with on-site solar value proposition.
Local utilities	Develop pilots

BUDGET SCENARIOS

Limited Resource Awareness Campaign	Deep Awareness Campaign
Convince 1-3 builders to use all-electric model home	Convince 1-3 builders to use all-electric model home
Accelerate Focus on Energy heat pump program for new homes	Accelerate Focus on Energy heat pump program for new homes

Outreach to Madison College and co-host manufacturer's lightning round featuring heat pumps	Early builder/developer intervention to encourage all-electric development
Develop 2 case studies, including one on dual fuel	Develop pilot with local utilities on residential all-electric new construction
Early builder/developer intervention to encourage all-electric development	Develop 3-4 case studies, including one on dual fuel.
	Create climate champions program for existing HVAC contractors, co-host manufacturer's lightning round featuring heat pumps, and conduct outreach to Madison College.
One-Year Budget	One-Year Budget
\$15,000	\$60,000

The limited resource awareness campaign focuses on specific outreach activities that Dane County can pursue in the community to impact the market for all-electric new homes. A major success for Dane County would be if it could convince a handful of builders to begin using all-electric model homes since this would result in increased exposure to new homebuyers and serve as a signal that all-electric homes are normal and can make sense.

For the deeper awareness campaign, Dane County would need to invest more in training and education of HVAC contractors. Creation of a climate champions program that entices HVAC contractors to participate could be a valuable lever of influence. Careful consideration would be needed to determine how to craft a value proposition for HVAC contractors. To be most successful, the program would ideally help participating HVAC contractors get more business. The deep awareness campaign also carves out a role for Dane County to spearhead development of a pilot with local utilities. To both make a pilot happen and to amplify results will require more substantial resources.

IMPACT SCENARIOS

Impacts of the limited resource awareness campaign include the following:

- Increased local builder awareness surrounding all-electric homes and heat pumps
- Increased visibility of all-electric homes to new home buyers.
- Focus on Energy incentives benefit all-electric homes.
- Better local HVAC contractor familiarity with heat pump technology, understanding of quality application and installation practices
- Higher HVAC contractor motivation to install heat pumps.
- Benefits of all-electric developments better understood by developers such that new all-electric development is proposed in Dane County.
- For new homes not ready to go all-electric, builders and HVAC contractors ensure that no more central ACs are installed and instead dual-fuel air source heat pumps become the “go to” alternative to an all-electric heating system.



The estimated impacts above would be a clear direct result of Dane County's community outreach. Indirectly, the ideal impact would be a sustained increase in the number of all-electric new homes constructed in Dane County up to the point where all-electric becomes the norm and by 2040 100% of new construction in Dane County is all-electric. While this change will not happen overnight, if Dane County can successfully spur the market for all-electric new construction, momentum will only be easier to build. As the local grid's emissions intensity declines over the coming years, the emissions benefits will also increase.

Additional impacts of the deep awareness campaign include the following:

- An informed and educated local HVAC contractor workforce where new contractors receive substantial exposure to heat pumps in their schooling and existing contractors receive recognition (that ideally translates into more business) for their proven heat pump knowledge.
- An all-electric homes pilot provides robust real-world data on the cost and performance of all-electric new homes and how they compare to mixed-fuel homes.

By successfully encouraging a pilot study on all-electric new homes, Dane County will have unlocked key data that can convince builders to go all-electric. The cost study we completed for this project relied on broad assumptions on installed costs as well as performance of the heat pumps. More robust real-world data would likely hold more weight in the eyes of many builders. An investment in the local market of HVAC contractors is likely to not only impact new homes but also heat pump retrofits. Promoting quality training and recognizing heat pump installers for their knowledge and experience could help transform the market to ensure heat pumps are always the first choice for heating. Builders signaled how they lean on HVAC contractors for the equipment selected for the home. HVAC contractors are perhaps the most impactful market actor in encouraging electrification but as of today stand as the biggest barrier.

FUNDING OPPORTUNITIES

The most immediate potential sources of funding for the effort described above would include local electric utilities that stand to make more from selling more electricity, Focus on Energy, and the Office of Energy Innovation. As one example of a local heat pump effort, we are aware that WPPI Energy is already planning to create an air source heat pump video for customers and contractors in their member utilities' territories. Finally, the Department of Health Services Climate and Health Program could be another source of funding within the state.

Outside of Wisconsin, the Department of Energy's new E3 Initiative¹³ could potentially be another source of funding. This Initiative focused on "advancing the research, development, and national deployment of clean heating and cooling systems that include heat pumps, advanced

¹³Energy, Emissions and Equity (E3) Initiative: <https://www.energy.gov/eere/buildings/energy-emissions-and-equity-e3-initiative>

water heaters, low-to-no global warming potential refrigerants, and smarter HVAC diagnostic tools in residential and commercial buildings.”

Foundations might also be a source of funding for this work such as the McKnight Foundation, Energy Foundation, Joyce Foundation, or Madison Community Foundation. The Beneficial Electrification League¹⁴ recently awarded a number of grants focused on electrification and may be another source of funding if future grant opportunities emerge.

CONCLUSIONS

While all-electric new homes promise significant decarbonization benefits in Dane County, they face a number of barriers to wider adoption. Our interviews revealed that air source heat pumps are still a relatively unfamiliar technology to builders and that they hold outdated perceptions on their performance in cold climates. Also, the pervasiveness of natural gas infrastructure in Dane County makes it so that builders default to natural gas space heating, water heating, and cooking equipment. The builder perception that all-electric heating is more expensive to install and operate was shown by our cost analysis to not always be true. Still, low natural gas rates and relatively high electricity rates in Dane County do present challenges to the economics of all-electric homes.

Our analysis did not consider all-electric homes with rooftop solar which would be an additional valuable comparison, especially as the cost for solar goes down over time and presents a homeowner with lower cost electricity. Our analysis also did not consider the scenario of dual-fuel heating which could serve as a bridge to all-electric homes for scenarios when natural gas infrastructure costs are already sunk, and a homebuyer is not quite ready to completely forego gas for heating.

As next steps, we recommended two levels of awareness campaigns that could be undertaken depending on funding. In this early stage of the market for all-electric new homes, building awareness among key market actors and providing reasons to shift their behavior will help spur progress in transforming the market of residential new construction in Dane County.

¹⁴ Beneficial Electrification League. <https://be-league.com/>