EFFICIENT TECHNOLOGY ACCELERATOR

HPW Energy Savings and Market Evaluation Plan

Center for Energy and Environment

Fall 2023

CONTENTS

Background and Summary of Potential

Minnesota Efficient Technology Accelerator

The Efficient Technology Accelerator (ETA) is a statewide market transformation program to accelerate deployment and reduce the cost of emerging and innovative efficient technologies, bringing lower energy bills and environmental benefits to Minnesotans. The ETA is funded by the state's investor-owned utilities (IOUs),[1] administered by the Minnesota Department of Commerce, Division of Energy Resources (DER), and implemented by Center for Energy and Environment (CEE). Savings generated by the program will be claimed by the funding utilities to help meet state goals.

As a market transformation program, ETA will work to overcome market barriers, leading to greater market adoption of targeted technologies, and ultimately, energy savings. In the initial years of a market transformation program, energy savings can be small as it can take time to grow the market. In addition, the savings methodology for counting savings from market transformation initiatives (described further in this document) is more involved than is typically the case for utility rebate programs. Therefore, a careful evaluation plan is a complementary endeavor to estimating savings from market transformation programs because it can provide additional evidence of the effectiveness of programmatic efforts to break down barriers and support the estimation and claiming of energy savings.

Within the overall ETA program, individual market transformation initiatives (a programmatic effort around a specific technology or approach) are developed. This Energy Savings and Market Evaluation Plan focuses on the high-performance windows initiative. We attempt here to provide a well-thought-out plan for both the estimation of savings, and for measuring market progress, in advance of launching our initiative in the market. As we learn more about the market through additional research and through our market engagement, we will continue to refine and update our approach.

High-performance windows

Summary

Windows are the largest source of energy loss in the building envelope[2], and therefore present a huge opportunity for energy savings and optimizing HVAC performance. While the window market has stagnated over the past 25 years, recent technology advancements are creating a

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[1] Specifically, electric and natural gas IOUs with more than 30,000 customers as specified in Minnesota Statutes § 216B.241 subd. 14, which includes Xcel Energy, Minnesota Power, Otter Tail Power, CenterPoint Energy, and Minnesota Energy Resources.

[2] Partnership for Advanced Window Solutions, "Now is the Time for Advanced Window Solutions." Available here. Windows account for only 8% of the building envelope but are responsible for 45% of envelope heat transfer according to this source.

timely opportunity to shift the market towards high-performance windows. However, these high-performance products face several market barriers including lack of industry and consumer awareness, lack of a manufacturing business case, a busy commodity market with upward pressure on costs and labor, complex product selection, and a new construction market driven by first cost and code. To overcome these barriers, there are a number of opportunities to leverage including national and regional policies related to energy efficiency or electrification, the pronounced non-energy benefits of windows, a new ENERGY STAR specification (Version 7.0), and ongoing technology innovations. Given these barriers and opportunities, the market is ripe for intervention, and ETA plans to lead multiple market support strategies to enhance adoption of high-performance windows (HPW). Anticipated market support strategies include:

1. Creating case studies and pilots to demonstrate value proposition to market actors.
2. Creating or co-creating marketing and educational materials and plans with market actors
3. Training and educating market actors
4. Engaging with national above-code programs and tax credits to ensure HPW specifications are included
5. Engaging utilities and local entities to incorporate HPW into program offerings, incentives, and policies
6. Participating in North American collaboration to build scale, share costs, influence codes, and amplify market demand signal
7. Contributing to advancement of ENERGY STAR specification to promote HPW
8. Engaging with state energy code development to promote the inclusion of HPW

For more information about barriers, opportunities, and market support strategies, please see the Market Transformation Plan.

Product description

High-performance windows include low U-factor (equivalent to high R-value) fenestration products used in single-family, multifamily, and some commercial buildings. These products improve the energy performance of a building by improving the thermal insulation, air leakage, and solar heat gain components of a building's envelope to optimize HVAC performance. These products also offer an impressive line-up of non-energy benefits including improved comfort, noise reduction, and health benefits.

For this initiative, we will classify high-performance windows as those with a U-Factor of ≤ 0.22[3] and a window air leakage rating of ≤ 0.3 cfm/ft^2. This aligns with the ENERGY STAR Version 7.0 Northern zone prescriptive specification, which goes into effect on October 23, 2023. While this is our current program definition, this definition will evolve over time as we work to promote lower U-Factor products.

[3] U-Factor is the inverse of R-value, so a U-Factor 0.22 is equivalent to 1/0.22 or R-4.5.

Application focus

For this initiative, we are focusing strictly on residential applications. We are including all single-family applications, and multifamily applications where residential style window products are used. We will also be focusing on both new construction and retrofit markets, which split the current window sales relatively evenly as found in market characterization.

Energy savings potential

To understand a technology's savings potential, we can consider both the absolute maximum amount of savings possible with the technology (the technical potential) and, more realistically, the savings the program may expect to achieve (program potential).

Technical potential is the theoretical maximum amount of energy use (first-year savings) that could be displaced by the measure with consideration of engineering constraints. It is a snapshot in time, assuming immediate implementation of the technology across all buildings and applications where it is feasible. In other words, if we were to change out all existing technology in our building stock with this technology, including projected new construction, the savings of that transition would be our technical potential.

The technical potential is helpful to compare savings across initiatives and provide an order of magnitude of savings potential. Technical potential assumes that all possible retrofit opportunities and all new construction opportunities over a 20-year timeframe are fully captured.

The program potential is a smaller subset of the technical potential that considers both broader factors like turnover rates, workforce limitations, and other market barriers, as well as program implementation constraints.

The technical potential estimates are described below. Program potential will be estimated over the next year as more data become available.

Technical potential

To project technical potential, we first identified per window (unit) savings. This was done through normalizing scenario modeling completed by Lawrence Berkeley National Laboratory to be representative of the full state, accounting for all heating types and climate variation throughout the state.[4] Through this process, ETA anticipates HPW per unit savings to be 12.4 kWh and 3.13 therms when compared to a Minnesota code window.

These per-unit savings were then applied to the entire existing building stock and new construction potential to create estimates of the technical potential. The technical potential represents the total achievable savings if we were to replace every window in Minnesota with the HPW specification and use them in every home built for the next 20 years. For this initiative,

[4] These calculations are outlined in Appendix A.

this includes an assumption of 15 windows per home[5] for each of the 1.8 million existing homes in Minnesota (including detached and attached single-family homes and 2–4 unit apartments, from EIA 2020 RECS data[6]), and a new construction projection of 19 million windows, resulting in a technical potential estimate of roughly 13 million MMBTU (Table 1). It should be noted that the realized savings would be much higher because this only considers the energy savings above code. These results reflect the savings that can be claimed through a traditional energy efficiency program, but most customers will experience a higher energy savings amount. See Appendix A for further details on the technical potential calculation.

Table 1: HPW Technical Potential

	Electric (MWh)	Gas (Dth)	Combined (MMBTU)
Statewide Technical Potential	**470,000**	**11,800,000**	**13,300,000**
New Construction	130,000	3,300,000	3,700,000
Retrofit and Replacement	340,000	8,500,000	9,600,000

LOGIC MODEL

Market transformation programs are different than traditional energy efficiency programs (i.e., resource acquisition programs) in that savings do not occur necessarily at the same time as activities. Market transformation relies on removing barriers in the market to increase product adoption and eventually achieve savings, so it is important to document the theory of market progress that will lead to energy savings. The program theory is derived from carefully documenting market barriers and opportunities, identifying activities to leverage opportunities and overcome barriers, and describing intended outcomes in the market, which will ultimately lead to energy savings. This theory draws a through line of logic from the current market conditions, to what we plan to do, and how we think the market will change as a result. Given that the market will take time to develop and absorb these changes before energy savings are fully realized, ETA will rely on other market progress indicators (MPIs) to show intermediate progress.

To document the program theory and identify MPIs, ETA engaged in a logic modeling process, with support from NEEA. The logic model is a visual flow chart representation of the program theory, showing the key barriers and opportunities; ETA's market support strategies; the immediate results of ETA's market support strategies (outputs); and the short-, medium-, and long-term market outcomes that we anticipate being the market result from these support

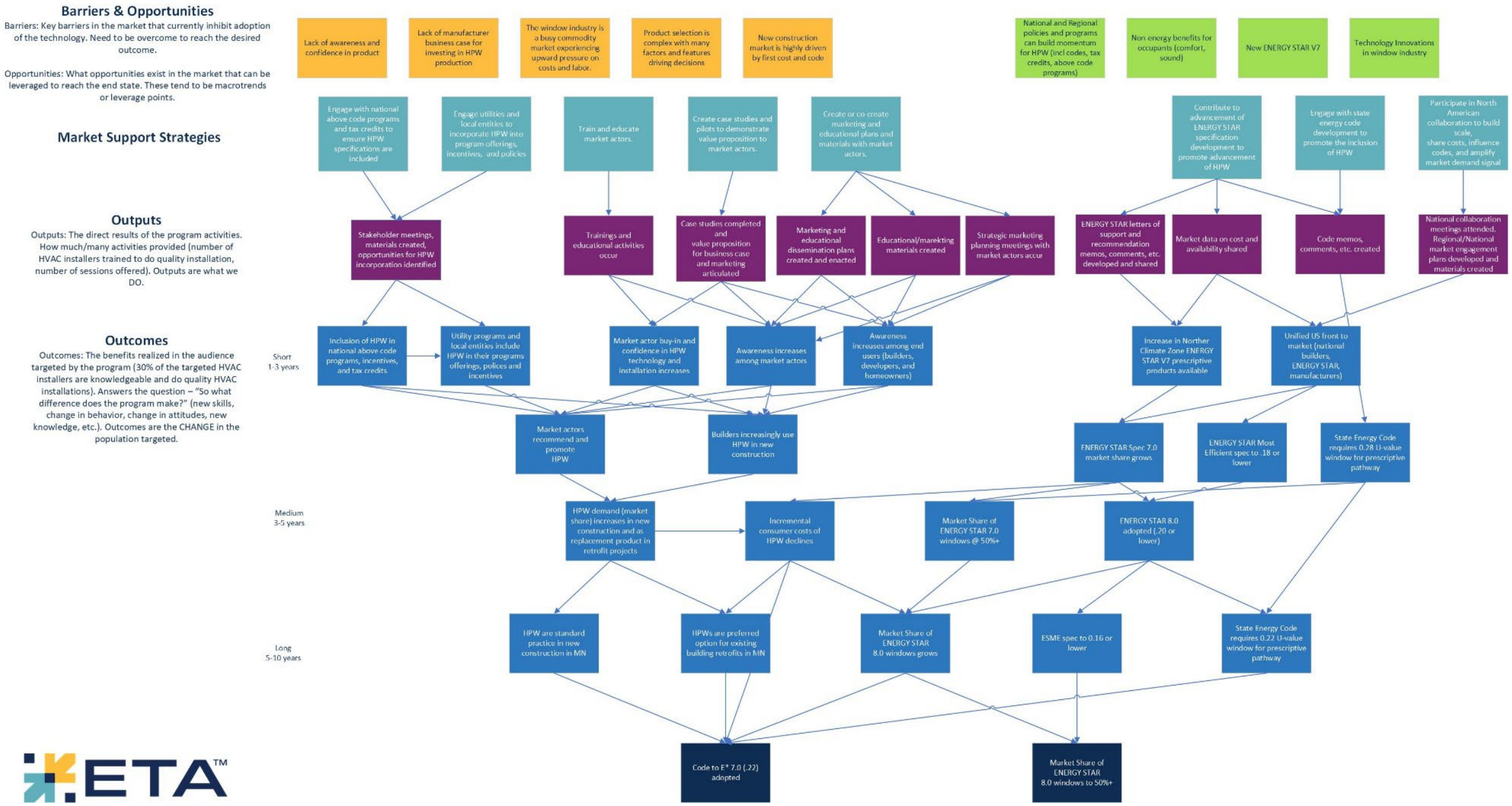
[5] Center for Energy and Environment, "Window Retrofit Technologies" (2015). Report prepared for and funded by CARD. Available here.

[6] U.S. Energy Information Administration, "2020 RECS Survey Data." Available here.

strategies. All these lead to the overarching, long-term impact that we hope to make at the end of our market intervention work. Market progress indicators are then derived from the outcomes indicated in the logic model, and outputs will also be tracked to document that the market support strategies are implemented. For more details about market support strategies, please see the Market Transformation Plan.

The logic model serves as a guiding document for the program and is used as a check for specific market activities to ensure alignment with the intended plan. We anticipate reviewing the logic model periodically to ensure the program theory remains sound and to adjust for new barriers and opportunities that arise. The logic model and identified MPIs will also serve as a basis for market progress evaluation, benchmarking the progress the initiative has made in the outlined program theory. The current logic model for the HPW initiative is shown in Figure 1.

Figure 1: HPW Logic Model



Evaluation efforts

Various data, in addition to energy savings inputs, will need to be collected and tracked to understand the market and the initiative's progress. Output tracking will help show that we are implementing the outlined market support strategies, indicating implementation progress and completion of important milestones. Market progress indicators will show the state of the market and whether we are achieving the intended outcomes from our work. For more information about data sources and collection, see the Data collection plan section.

Outputs

Outputs are the direct result of ETA's actions and are therefore largely something we can measure and/or document internally or on a collective partner level depending on the market support strategy. The metrics used to assess outputs are essentially to show that the strategy is being implemented and the expected outputs and milestones are occurring , not that the market is changing, which is captured through outcomes and MPIs. Unlike with some market outcomes where the goal may be to achieve a year over year increase in a specific metric (MPI), outputs and associated metrics do not necessarily result in continued increases. Rather, they indicate how we anticipate reporting on our activities. For example, an output-based metric may be the number of trainings held. We may do four trainings one year, and only two the next as we are focusing on other strategies. That difference is acceptable; we will simply plan on reporting the number of trainings held and qualitative details about the trainings each year.

In other times, we may want to focus our strategies and subsequent outputs on quality over quantity, though quality may require more resources and outside market actor perspectives to effectively gauge. We intend to focus resources and market actor time on MPI tracking rather than output tracking as MPIs are more critical to showing market progress. When quality can be proxied via internally trackable metrics, we will denote those metrics. For example, we may include the number of individuals contacted and number of times we engaged with those individuals; we may only engage with a small number of key market actors, but engage with them deeply through numerous encounters, which is a proxy for quality engagement.

The market support strategy, output, and metric to measure the output are listed in the table below (Table 2). Outputs will be tracked and documented on an ongoing basis by program staff.

Table 2: Market support strategies and associated outputs and metrics

Strategy	Output	Metric
Engage with national above-code programs and tax credits to ensure HPW specifications are included (MSS 4)	O1. Stakeholder meetings, materials created, opportunities for HPW incorporation identified	# of stakeholder meetings, meeting notes, materials exist, opportunities identified
Engage utilities and local entities to incorporate HPW into program		

Strategy	Output	Metric
offerings, incentives, and policies (MSS 5)		
Train and educate market actors (MSS 3)	O2. Training materials are developed; Trainings and educational activities occur	Training materials are developed # of trainings and educational activities (incl. conference presentations and events), # of trainees, level of satisfaction with training
Create case studies and pilots to demonstrate value proposition to market actors (MSS 1)	O3. Case studies completed and value proposition for business case and marketing articulated	# of case studies completed, # of pilot programs implemented/launched
Create, or co-create, marketing and educational materials and dissemination plans with market actors (MSS 2)	O4. Strategic marketing planning meetings with market actors occur	# of meetings, # of market actors engaged
	O5. Marketing and educational dissemination plans created and enacted	Marketing plans exist, # of people reached through marketing
	O6. Educational/marketing materials created	Materials created
Contribute to advancement of ENERGY STAR specification development to promote advancement of HPW (MSS 7)	O7. Market data on cost and availability shared	Market data shared
	O8. ENERGY STAR letters of support and recommendation memos, comments, etc. developed and shared	Meeting notes, letters of support developed and signed, additional documentation provided
Engage with state energy code development to promote the inclusion of HPW (MSS 8)	O9. Code memos, comments, etc. created	Meeting notes, recommendation memos, comments, etc. exist
Participate in North American collaboration to build scale, share costs, influence codes, and amplify market demand signal (MSS 6)	O10. National collaboration meetings attended O11. Regional/National market engagement plans developed and materials created	# of meetings attended, engagement plans created, materials created

Market progress indicators

Outcomes are the anticipated *market* result of the market support strategy implementation. As they are a market result, they rely on market actors to come to fruition and are not fully within

ETA's control. Thus, they require evaluation of indicators (MPIs), which are tracked via external data sources or primary data collection. The logic model outcomes, MPIs, associated metrics, and data sources are listed below. A single outcome may require measuring multiple MPIs to assess progress. Conversely, progress toward multiple outcomes might be tracked via the measurement of a single MPI. Table 3 lists all outcomes and their respective MPIs, so there may be duplicative MPIs listed. Similarly, multiple strategies can lead to the same outcome, or conversely, one strategy can lead to multiple outcomes, so strategies are not included in the table for simplicity. However, one can review the logic model to see the connection between strategies and associated outcomes. Table 3 also includes anticipated data sources to gather information about MPIs; these are discussed in more detail in the Data collection plan section.

As MPIs also relate to short-, medium-, and long-term outcomes, not all MPIs will be tracked initially or concurrently. We anticipate evaluating the time relevant MPIs every one to three years, depending on how quickly ETA can implement market support strategies and how frequently market insights are needed to guide strategies.

Table 3: Logic model outcomes and associated MPIs

Logic Model Outcome	MPI	Data source
Inclusion of HPW in national above-code programs, incentives, and tax credits	A. Inclusion of HPW in national above-code programs and incentives	Program documentation
	B. Inclusion of HPW in federal tax credits	Program documentation
Utility programs and local entities include HPW in their programs offerings, polices, and incentives	C. Utility programs include HPW	Program documentation
	D. Local entity (e.g., city, county) programs and/or policies include HPW	Communication with local entities
Market actor buy-in and confidence in HPW technology and installation increases	E. Installers report greater preparedness/confidence in installing HPW	Training surveys, installer survey
	F. Suppliers/installers increasingly report a favorable opinion of HPW	Training surveys, installer/supplier survey
	G. Suppliers/installers increasingly report willingness to promote HPW	Training surveys, installer/supplier survey
	H. Manufacturers increasingly report a favorable opinion of HPW	Manufacturer survey
Awareness increases among market actors	I. Market actor awareness increases	Training surveys, installer/supplier survey
Awareness increases among end users (builders,	J. End user awareness increases (builders, MF developers, and homeowners)	Builder and MF developer survey, consumer survey

Logic Model Outcome	MPI	Data source
MF developers, and homeowners)		
Increase in Norther Climate Zone ENERGY STAR Version 7.0 prescriptive products available	K. Increase in qualified products	ENERGY STAR Version 7.0 QPL
Unified U.S. front to market (national builders, ENERGY STAR, manufacturers)	L. Co-signed comment letters to EPA or DOE	Partnership for advanced windows (PAWS)
Market actors recommend and promote HPW	M. Suppliers' sales of HPW qualified products increase	Sales data - Ducker report, RESNET
	N. Installers increasingly recommend HPW	Mystery shopping
	O. Installers/suppliers/raters increasingly report recommending HPW	Installer/supplier survey, rater survey
	P. HPW are included on installer/supplier and manufacturers websites and marketing materials	Web search Manufacturer survey
	Q. HPW are included in sales training	Manufacturer survey
Builders increasingly use HPW in new construction	R. Builders increasingly report using HPW	Builder survey RESNET
	S. HPW installations in new construction increases	RESNET, Permit data
ENERGY STAR Version 7.0 market share grows	T. Increase in ENERGY STAR Version 7.0 market share	ENERGY STAR shipment data report, installer/supplier survey
ENERGY STAR Most Efficient (ESME) spec to U-factor ≤ 0.18	U. ENERGY STAR Most Efficient Spec reduced to U-factor ≤ 0.18	ENERGY STAR Most Efficient Windows spec
State Energy Code requires ≤ 0.28 U-factor window for prescriptive pathway	V. State Energy Code reduced to ≤ 0.28 U-factor window for prescriptive pathway	Minnesota residential energy code
HPW demand (market share) increases in new construction and as	W. Increase in the share of HPWs installed in new homes.	RESNET, Permit data
	X. HPW installations in new construction increases	RESNET, Permit data

Logic Model Outcome	MPI	Data source
replacement product in retrofit projects	Y. Increase in the share of HPWs installed in existing homes	Sales data - Ducker report, utility rebate data
	Z. HPW installations in retrofits increases	Sales data - Ducker report, RESNET
Incremental consumer costs of HPW declines	AA. Decrease in average incremental unit cost	Supplier/installer survey, builder survey
Market Share of ENERGY STAR Version 7.0 windows @ 50%+	AB. Increase in ENERGY STAR Version 7.0 market share	ENERGY STAR shipment data report, installer/supplier survey
ENERGY STAR Version 8.0 adopted (.20 or lower)	AC. ENERGY STAR Version 8.0 Adopted	ENERGY STAR Version 8.0 spec
HPW are standard practice in new construction in Northern zone	AD. 75% of builders agree HPW is standard practice	Builder survey, rater survey
HPWs are preferred option for existing building retrofits	AE. 75% of installers/suppliers agree HPW are standard practice for retrofits	Installer/supplier survey
Market share of ENERGY STAR Version 8.0 windows grows	AF. Increase in ENERGY STAR Version 8.0 market share	ENERGY STAR shipment data report, installer/supplier survey
ESME spec to U-factor ≤ 0.16	AG. ESME Spec reduced to U-factor ≤ 0.16	ESME Windows spec
State Energy Code requires ≤ 0.22 U-factor window for prescriptive pathway	AH. U-factor ≤ 0.22 Minnesota Code requirements	Minnesota residential energy code

Energy savings methodology overview

As outlined in the ETA filing, ETA will apply an approach consistent with how savings are estimated for traditional CIP programs.

In its most basic form, energy savings are estimated using the following equation:

[market transformation savings] = [number of units] x [savings per unit]

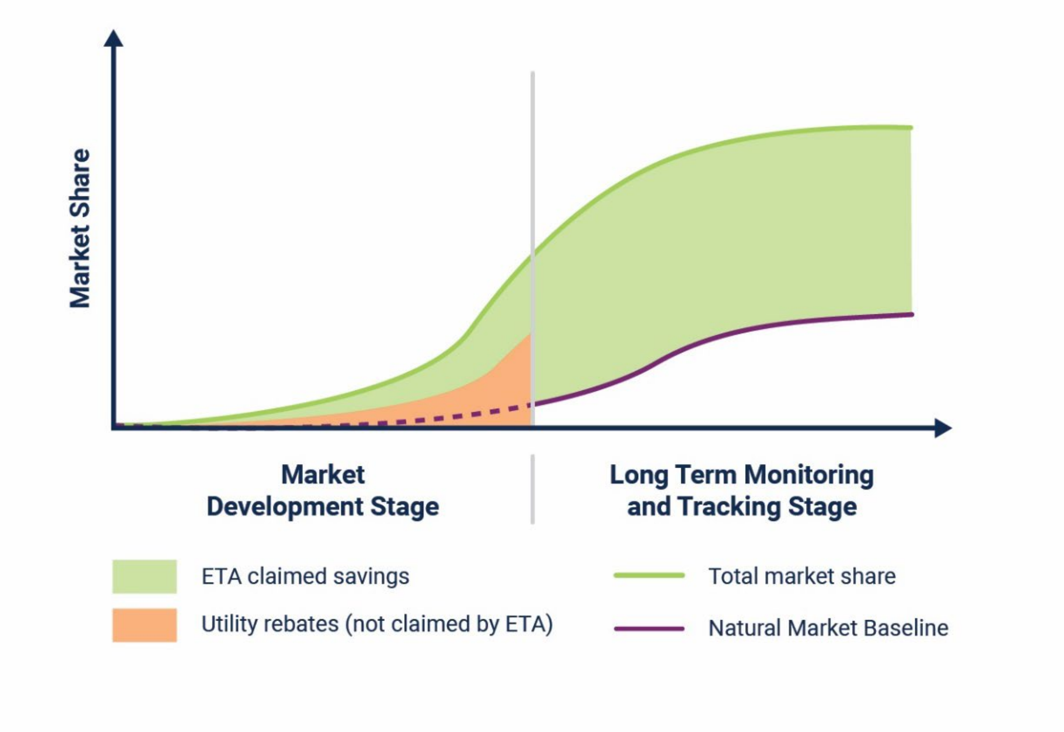
However, there are some key differences in approach and additional adjustments that are made to estimate market transformation savings, which were described in the filing and approved in the ETA final order. In summary, the approach involves three basic steps:

1. **Counting total statewide savings from market sales data.** For market transformation, the number of units is counted at the whole market level, rather than at the individual customer level. This is because the market support strategies influence the whole market, not just a single customer's decision. Thus, because the program will not be collecting site-level data for the whole state, the program will use an average statewide savings number across all applicable customer sites, and multiply that by data typically collected at the manufacturer, distributor, or retailer level.[7] In traditional CIP programs, savings accuracy depends on precisely capturing customer site information, while in market transformation it is more important to accurately characterize the whole market.
2. **Adjusting the total savings to account for utility rebates.** Frequently, at least a portion of a market transformation initiative's life cycle will overlap with rebates offered by a traditional CIP program, as entities work together to advance the adoption of energy efficient products and practices in the market. Savings from this type of joint program effort are referred to as co-created savings because both programs contribute to the total savings and to the market transformation effects. However, these savings should not be double counted in savings claimed through ETA. Therefore, when rebates are provided by a traditional CIP program during the course of a market transformation initiative, the savings claimed through these rebates will be subtracted from the total market transformation savings to avoid double counting.
3. **Adjusting for a natural market baseline during the Long-Term Monitoring and Tracking Stage.** The natural market baseline is a forecast of the future in which no utility-funded intervention exists (CIP or ETA). It is a counterfactual, hypothetical forecast that allows us to recognize that there is some current market adoption, albeit very minimal, and that market adoption may change on its own. Minnesota, however, does not require the subtraction of

[7] We note that distributors could provide product to contractors in Minnesota that may install them in other states. A similar situation can occur for retail products sold directly to customers. In this case, an adjustment to account for this leakage to adjacent states may be needed. NEEA has developed methodologies for accounting for this leakage, and we would follow best practices in making those adjustments.

the natural market baseline from the statewide savings data during the Market Development Stage, as it is a gross savings state (Figure 2). However, it is appropriate to adjust for the natural market baseline in the Long-Term Monitoring and Tracking Stage, per the filing (Figure 3).

Figure 2: Market Development and Long-term Monitoring and Tracking savings accounting

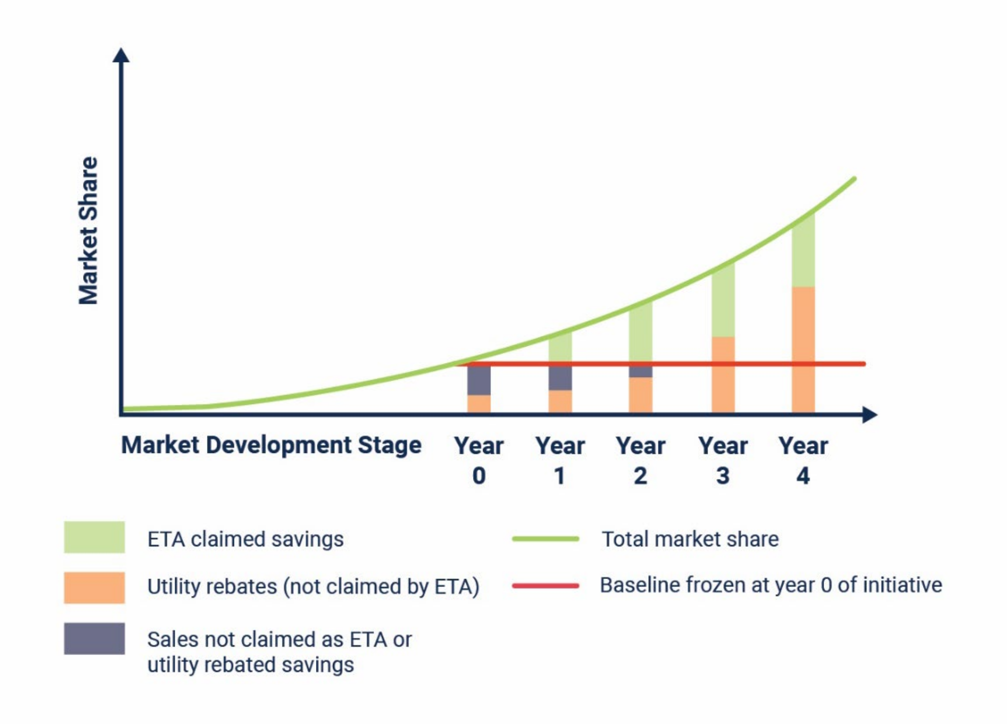


Modification for simplified baseline approach

While it is not a regulatory requirement to account for the natural market baseline during the Market Development Stage, there are currently commercially available products that meet our product definition in the market with a small portion of sales prior to ETA strategy implementation. Therefore, we plan to modify the approach outlined in the filing and follow a more conservative, simplified baseline approach to adjust for some naturally occurring sales during the Market Development Stage. This will be accounted for by freezing a baseline at the total market share of the product in the year prior to the Market Development Stage (Figure 3). Trendlines or averages may also be considered if we believe the year before contained anomalies (e.g., supply chain shortages, COVID-19).

With this simplified baseline approach, ETA will only claim savings for sales above the initial frozen baseline. In early years, rebate participation may be below the simplified baseline (e.g., yr. 1 and 2). Therefore, there is no need to subtract the rebated savings from ETA savings since they are already accounted for within the simplified baseline. Once utility rebate amounts cross the simplified baseline amount, we will simply subtract utility savings instead of the baseline. Utility rebate participation will likely grow over time, and while we anticipate having positive influence on volume of rebated sales, we plan to only count ETA savings above the rebated amount, so it is possible that ETA savings may temporarily shrink over time until reaching Long Term Monitoring and Tracking (e.g., yr. 3–4 in Figure 5).

Figure 3: Simplified baseline approach for savings calculations in market development stage



The simplified baseline approach is more conservative than claiming all gross savings, as is allowable in statute, and requires less evaluation spend than a full NMB. The NMB is also hypothetical and uncertain, and this approach relies on a more tangible sales figure. We will, however, still provide NMB projections and use the NMB in the Long-Term Monitoring and Tracking Stage.

For the windows initiative, we will plan to freeze sales estimates based on the upcoming 2023 report from Ducker Carlisle, NA LLC (referred to as the Ducker report). After five years, the program will review the baseline assumptions to account for unforeseen market disruptions or new data to inform the baseline adoption, and we may adjust the baseline accordingly.

Inputs for savings calculations

Each input used to calculate energy savings and complete the necessary adjustments is discussed in more detail below. The value of these inputs is based on our current understanding of the technology and market and may shift if different data become available.

Savings per unit

Currently, there is no HPW measure outlined in the Minnesota Technical Reference Manual (TRM), which is often used as a guideline for savings calculations. However, Lawrence Berkeley National Labs (LBNL) conducted modeling to identify per-unit savings for window scenarios in

Minnesota. The modeling performed by LBNL produced savings estimates for two window upgrade scenarios (over code and over market), across four locations in Minnesota, with four HVAC scenarios. These values were normalized to produce statewide gas and electric energy savings on a per-window basis, summarized in Table 4 below. At this time, we anticipate using only the more conservative over-code factors, even though in some cases, our market support efforts may trigger early replacement where an over-market savings factor would be more appropriate. For more information about calculations, please see Appendix A.

Table 4: Normalized Gas and Electric Savings per Window

Total weighted savings	Electricity (kWh)	Gas (Therm)
HPW over code (U-factor 0.32)	12	3.1
HPW over market* (U-factor 0.44)	74	7.1

***Market indicates existing windows in current building stock.**

If the TRM adopts a high-performance window measure, the initiative may switch to using TRM data for energy savings.

Statewide sales estimates

Window sales are difficult to track across a complicated path to purchase and obtaining actual sales data for a whole market is never feasible. However, we will be able to acquire initial sales data estimates for both HPW (ENERGY STAR Version 7.0 for the Northern Climate Zone or better) and non-HPW from a Ducker report that is currently underway. This will provide us with both whole category window sales estimates and HPW sales estimates. As our definition of HPW follows only the prescriptive path for ENERGY STAR Version 7.0 based on a U-factor of ≤ 0.22, the proportion of windows meeting the prescriptive path vs. a tradeoff option with a higher u-factor and solar heat gain coefficient will also be assessed in the Ducker report.

While the Ducker report will generate Minnesota-specific estimates in 2023, their typical reporting only includes regional estimates, thus it does not include the level of granularity needed to continually produce annual sales data. Therefore, this data will be further supported with RESNET data, which includes a database of installed windows in Minnesota, and includes their U-factor and SHGC. RESNET data however is typically only for new construction, (described in more detail in the Data collection plan section). As this is also an imperfect data source, we will work with supply chain actors to strengthen the accuracy of market data over time. This may include developing partnerships and getting data directly from manufacturers if possible.

Utility rebate data

At the start of this initiative, windows had not historically been included in rebate programs. However, four of the five funding utilities have filed for replacement windows rebate programs in their most recent triennial plans (for 2024–2026). Proposed incentives range from $15–$75 per window and include both trade ally incentives and homeowner or consumer incentives. We will work with these funding utilities to track window rebates and subtract them from the total savings if they rise above the simplified baseline sales amount. Similarly, utilities offer new construction programs ranging from performance based to prescriptive rebates. We will work these utilities to share the applicable data and properly account for these savings.

We will also work with DER and non-funding consumer-owner utilities (COUs) to identify additional rebate programs and amounts.

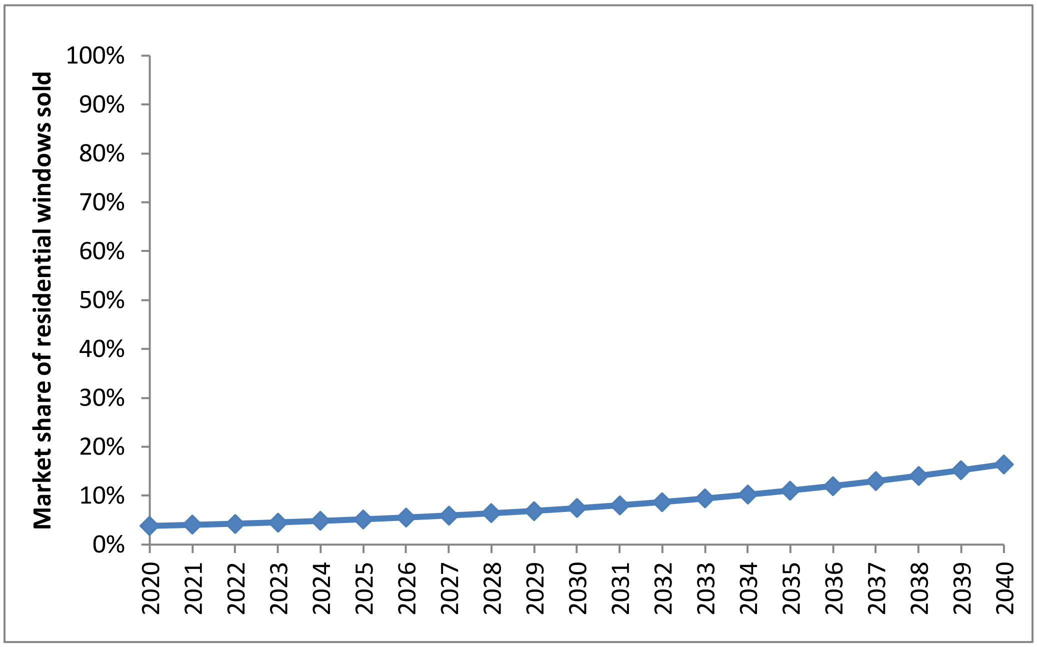
Simplified baseline sales

Minnesota-specific sales estimates from the Ducker report should be available fall 2023, which will serve as the simplified baseline until further review. This data will estimate the ENERGY STAR Version 7.0 window sales for 2022, how many of those windows meet the specification for the prescriptive path (≤ 0.22 U-factor), and the approximate share of the market for both ENERGY STAR and ≤ 0.22 U-factor windows.

Natural market baseline

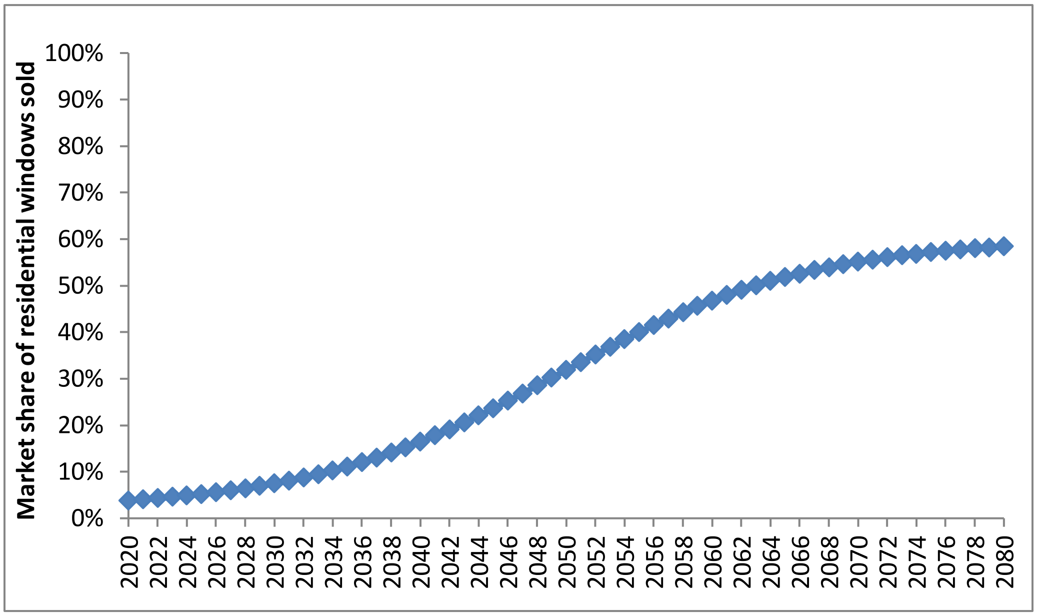
The natural market baseline is created using a methodology developed by NEEA, and it results in an s-curve shaped model of the projected market adoption for HPWs if the ETA did not intervene in the market. Since these are hypothetical models, a large amount of uncertainty around estimated figures exists. However, market characterization, expert opinion on future projections, and current understandings of market inform the natural market baseline inputs. They will be refined over the next year as the program launches and reviewed periodically to confirm the assumptions are still appropriate. Based on our current understanding of the market, we anticipate the natural market baseline curve over the program lifetime of 20 years to be similar to that shown in Figure 4 below.

Figure 4: HPW natural market baseline over the 20 year program life



The curve is extrapolated further, beyond the program life to see the broader trajectory of this NMB (Figure 5).

Figure 5: HPW natural market baseline beyond program lifetime

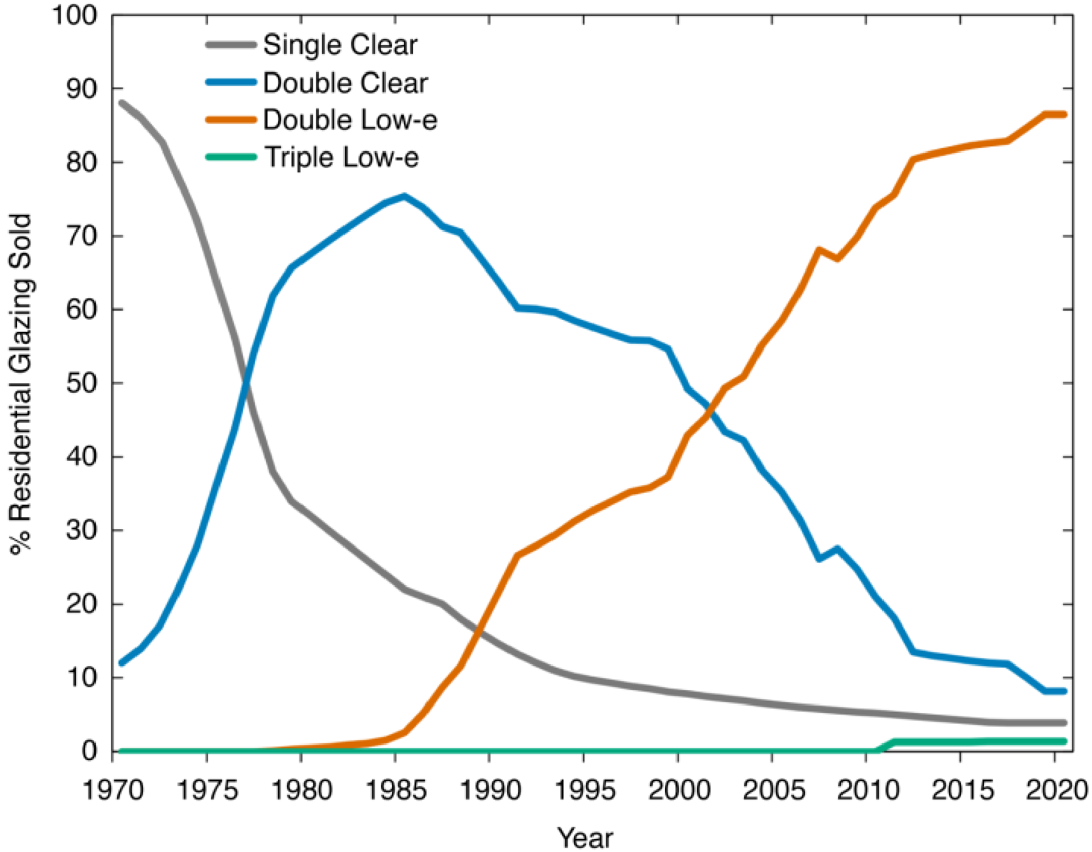


Rationale

The 2022 DOE report; Pathway to Zero Energy Windows: Advancing Technologies and Market Adoption illustrated that triple pane low-e windows have maintained 2% market share since

2010, as outlined in Figure 6. A recent NEEA market transformation study on Thin Triple Pane Windows also estimated that triple glazed window products account for 2% of sales. We believe the Minnesota market is similar and set our initial market share is around 2%. This will be confirmed by data in the Ducker report. While we realize this excludes double pane windows capable of meeting the specification, it is acknowledged that most products that currently meet the HPW requirement are triple pane, so the market share of triple pane products is the best indicator of HPW market share. This product category has largely remained stagnant due to persistent market barriers and low demand, indicating that progress will remain limited unless market support occurs.

Figure 6: Market share by glazing type



Source: 2022 DOE report; Pathway to Zero Energy Windows: Advancing Technologies and Market Adoption

In addition, MN Residential Energy Code has a history of slow adoption. The current residential energy code has been in place since 2015, with plans underway to adopt an updated residential energy code expected to take effect in 2026. Without market intervention to support accelerated code adoption, it is reasonable to assume that the next residential energy code update will take effect 11 years after the current update is complete. This projects the next residential update will occur in 2037. The current code update will be based on IECC 2021, which prescribes a maximum U-factor of 0.30. This is far below the HPW window requirement. If the subsequent code update steps down maximum window U-factor requirements at the same increment (0.02), the 2037 code update will prescribe a maximum U-factor of 0.28, which aligns with a double-pane low-e product. This requirement for low-e double pane products could push HPW into the efficient offering space in the window market, which could trigger an increase in demand at that point in time.

Thus, we anticipate a growth period starting around 2037. If we assume the growth period is similar to that of the double low-e product, we anticipate roughly 25 years before growth tapers off. Market share will eventually reach market saturation after this point, which we predict to be around 60% of market share.

Even as the market evolves and codes advance, we anticipate that HPW products will never reach market penetration consistent with its double-pane low-e competitor, which has reached close to 90% market saturation. We anticipate energy codes in other states to be adopted even more slowly than the MN code cycle, with double pane products remaining available, especially since the southern window market does not require low U-factor products, since solar heat gain is more important to energy savings in the south. However, due to the non-energy benefits that HPWs produce, coupled with the fact that once manufacturers switch some of their lines to produce these windows production ramp up will be easier, we believe market share will increase. We estimate that without market intervention activities, the product would eventually achieve a relatively high market share of 60%. This is slightly lower than the peak market penetration of the double clear window product in 1985.

While we anticipate the market share for HPW will be lower than the double-pane low-e product due to the market barriers previously identified, we anticipate the time period of growth would be more similar to the double-pane low-e product rather than other technologies. This is because triple-pane technology is an incremental increase in efficiency and mainly benefits the northern part of the country, much like low-e coatings. Code and utility programs are the biggest drivers of adoption for this type of technology. Absent interventions advocating for advanced window requirements and supporting rebates, it is estimated that the market penetration for HPW will remain stagnant and have slow adoption.

Utility savings allocation

The allocation of statewide savings to individual utilities is based on their level of funding. Under this approach, statewide savings are allocated based on an individual utility's total fuel-specific funding as a percentage of total initiative funding. Funding and savings for this initiative is thus 88% by gas utilities and 12% from electric utilities. The 2023 funding allocations are listed in Table 5 below. Funding percentages will be reviewed on an annual basis for adjustments in funding (e.g., updated triennial plans, additional utilities voluntarily contributing).

Table 5: Funding and savings percentages for the HPW initiative

Utility	% of funding/savings
Electric utilities	
Xcel Energy (electric)	10.6%
MN Power	0.9%
Otter Tail Power	0.5%
Electric total	**12.0%**
Gas utilities	
CenterPoint Energy	48.2%
Xcel Energy (gas)	24.2%
MERC	15.6%
Gas total	**88.0%**
Total	**100.0%**

ETA savings attribution

While ETA plans to claim savings only above and beyond the simple baseline and utility rebates, we anticipate that ETA activities will increase product demand in a way that will benefit utility rebate programs, which should be partially attributed to ETA when the program is evaluated. When the state evaluates the program, we anticipate highlighting co-created savings, which is a mixture of utility rebated savings and ETA claimed savings, as an overall indicator of ETA's effectiveness. We will also work with the third-party evaluator to determine any additional adjustments necessary to account for these activities as they arise.

Post code/standard adoption plan

Energy codes or appliance standards are often the endpoint of market transformation efforts. A given market transformation initiative helps accelerate the technology's adoption into the code or standard, and savings can continue to accrue from the ETA initiatives after they have been adopted into a code or standard. The method to calculate savings post-code adoption is well established nationally and involves adjusting the savings by an attribution rate[8] to account for the degree to which the market transformation effort influenced the code or standard. Thus, the basic savings equation for market transformation initiatives post code or standard adoption is as follows:

[8] The attribution rate is initiative-specific and determined as an outcome of the evaluation. It is an estimate of the extent to which market transformation efforts influenced the savings (considering other factors) and is typically expressed as a percent.

[market transformation savings] = [number of units] x [savings per unit] x [attribution rate]

The number of years after the code or standard is adopted that the program can claim savings must also be determined. NEEA generally claims savings from energy codes for 10 years, while savings claimed from appliance standards vary more based on the extent to which earlier standards were adopted due to market support activities. Therefore, we plan to claim savings for 10 years for energy codes, while standards changes will be based on an estimate by an independent evaluator of how much earlier the standard was adopted. The attribution rate will be determined based on an evaluation completed by an independent evaluator after the code or standard has been adopted.

For this initiative, we anticipate engaging with state energy code development to promote the inclusion of HPW into Minnesota's Residential Energy Code. This will be a stepped approach, but the ultimate goal will be to require a ≤ 0.22 U-factor prescriptive pathway. Thus, we plan to continue to count savings for 10 years after code adoption.

NET BENEFITS

Calculation and allocation of net benefits

In addition to energy savings, we will calculate net benefits, which are the total benefits of an efficiency measure minus the total costs over its lifetime. They are used to assess the cost-effectiveness of programs and as inputs to calculate the financial incentive mechanism for the IOUs. All net benefits will be allocated to utilities based on funding level, following the same formula for attributing energy savings.

The inputs needed to calculate net benefits can be divided into measure-level inputs, utility inputs, and DER-specified inputs, and vary based on fuel type. The HPW initiative will use both gas and electric inputs. All inputs are outlined in Appendix B. In general, DER-specified inputs are set by the DER and publicly available, and we will work with utilities to gather utility input data, including confidential trade secret data. For the windows initiative, we anticipate the following measure-level values and data sources (Table 6).

Table 6: HPW measure-level input values and sources

ELECTRIC INPUTS	
Measure-level Inputs	**Data source**
Utility Project Costs (Program costs)	ETA program costs
Incremental cost	$54/window PAWS memo
Project Life	40 years PAWS memo
Energy Savings/Unit	12.4 kWh

Capacity Savings/Unit[9]	N/A
Number of Units	Est. of annual sales data
Load Shape	NREL or similar
GAS INPUTS	
Measure-level Inputs	**Data source**
Utility Project Costs (Program costs)	ETA program costs
Incremental Costs	$54/window PAWS memo
Project Life	40 years PAWS memo
Avg. Dth/Unit Saved	0.313 Dth
Number of Units	Est. annual sales data

MARKET PROGRESS REPORTING

To monitor progress, we will create an annual status report, referred to in the filing as the Energy Savings and Market Progress Reports.

The content of each of these reports will include:

1. Output tracking and MPI progress
2. Total savings and net benefits
3. Savings and net benefit allocations to individual utilities

Some outputs and MPIs may not be appropriate to track initially or annually based on when we focus on particular market support strategies and whether the outcome is intended to be a short-, medium-, or long-term outcome. Thus, every report will include an update of outputs and MPIs, however, the particular metrics reported will be tailored to include only those that are most appropriate at that time. Savings and net benefits, as well as utility allocations, will be included in each annual Energy Savings and Market Progress Measurement Report. The reports will fully document the final methodology and data sources used to calculate energy savings and net benefits.

These reports will continue throughout the Market Development and Long-term Monitoring and Tracking stages. When the initiative switches into the Long-Term Monitoring and Tracking, the Energy Savings Report will include the same contents listed in 1–3 and will periodically assess the need for market re-entry (i.e., additional Market Development work). Re-entry to the market

[9] Note that windows are not yet a measure in the Minnesota TRM, but if they are included, we would use calculations consistent with the TRM in future years.

may be justified if market indicators show that progress and increased market share, or diffusion, are not proceeding as anticipated.

We will periodically assess the right time to sunset long-term monitoring and tracking of an initiative. For initiatives with an end goal that includes an energy code or standard, the initiative often continues to accrue savings for many years after the technology or practice is included in that code or standard. The methodology for calculating savings from the ETA initiatives after a technology is adopted into codes or efficiency standards is covered in the Post code/standard adoption plan.

DATA COLLECTION PLAN

There are many different data types and sources discussed throughout this document. These are compiled in Table 7 to provide a comprehensive view of how we plan to collect or access data for this initiative. We also acknowledge that this data landscape represents our current understanding of potential data availability, which may change in the future as other data sources are discovered or become available. We will also plan to work with third party evaluators to collect supplemental data and review approaches and assumptions as necessary.

Table 7: Evaluation data purpose, type, and sources

Purpose	Data type	Data source
Market support outputs tracking	Output tracking	Internal data documents: Engagement plans Meeting records and documented communications Activity records Additional documents as relevant
MPI measurement – secondary data sources	Building stock and permitting data	RESNET Census data
	ENERGY STAR shipment data	ENERGY STAR shipment data report
	Dichotomous outcome confirmation	Web searches/literature review Communication with utilities and local entities ENERGY STAR v7.0 QPL PAWS ENERGY STAR Most Efficient Window's specification ENERGY STAR v8.0 specification

Purpose	Data type	Data source
		Minnesota residential energy code
	Sales data	Ducker report (both retrofit and new construction) RESNET (new construction) Manufacturer and/or distributor data (both retrofit and new construction) Utility program data (primarily retrofit)
MPI measurement – primary qualitative data collection	Primary survey/interview data for appropriate MPIs (see Table 3)	Rater survey Builder survey Consumer survey Installer/Supplier survey Training surveys Mystery shopping
Energy savings	Whole category market data	Ducker report
	Sales data for HPW	Ducker report RESNET
	Per-unit savings	LBNL modeling
	Utility rebate data	Utilities and DER database
Net benefits	DER global inputs	DER guidance
	Utility data	Utility data transfers, IRPs, filings and other data sources
	Measure level inputs (see Table 6)	LBNL modeling NREL Utilities

Sales data

Sales data is used primarily to calculate energy savings and for some MPI measurement. Currently, the Ducker report and RESNET data will serve as the baseline and annual tracking source for sales data. However, both sources present data limitations and additional data exploration will happen in 2024 and beyond to further refine our sales estimates by utilizing a variety of data sources.

Ducker report data

We will estimate our initial HPW Minnesota statewide sales data, as well as whole market data, via the Ducker report, which provides estimates of both efficient (ENERGY STAR Version 7.0) and nonefficient windows. As our definition of HPW follows only the prescriptive path for ENERGY STAR Version 7.0 based on a U-factor of ≤ 0.22, the proportion of windows meeting the prescriptive path vs. a tradeoff option with a higher U-factor and solar heat gain coefficient will also be assessed to inform HPW calculations.

It is important to understand that this report creates sales *estimates* from a sampling of sales data rather than reporting the *actual* total sales or shipment data. This estimation approach is typical of most sales data available, as sales data are closely guarded by retailers and distributors and, in order to see the full picture, you would need all retailers and distributors to contribute. Additionally, in typical years, it provides regional data rather than state-specific data, though we have created a separate contract to receive Minnesota-specific estimates for 2023. Given these limitations, we will also want to leverage additional data sources to triangulate this information.

RESNET data

For triangulation, we plan to use data from RESNET, which largely consists of data used to generate the Home Energy Rating System (HERS) index, primarily for new construction single-family homes. The dataset provides a U-factor and solar heat gain coefficient (SHGC) for windows in rated homes. A recent study showed that 59% of new construction homes in Minnesota receive the HERS index,[10] and given that our recent market characterization work with Cadeo indicated new construction comprises between 50-60% of the target market, the RESNET data should provide U-factor and SHGC for approximately a third of the window market. This will allow us to see how many windows currently, and historically, meet the ≤ 0.22 U-factor, and how many may be meeting ENERGY STAR Version 7.0 through performance path tradeoffs rather than the prescriptive ≤ 0.22 U-factor. This can then be used as both a starting condition and as an annual proxy for new construction window sales, though there may be a lag in sales compared to installation and entry into the system.

This data also has some limitations, mainly: it is mostly relevant to new construction, not retrofit applications; it represents primarily single-family homes and includes few multifamily buildings; it is biased toward the metro area as there are fewer HERS raters and ratings in Greater MN; and it may skew toward representing larger volume builders who are more likely to apply for utility rebate programs using HERS ratings.

[10] Ryan Meres, "Trends in HERS Rated Homes – A Statistical Abstract" (May 2023). Available here.

Supply chain data

Given the limitations of both currently available datasets, we also plan to work with manufacturers and distributors to receive sales or shipment data. This process has not been initiated, but we are collaborating with NEEA on plans to set up data sharing agreements with manufacturers. NEEA successfully leveraged this tactic in their previous window initiative and we believe that collaborating on this approach will garner positive responses from manufacturers.

Utility data

Data from utilities will also be used for a variety of purposes including energy savings, net benefits calculations, and additional benefits tracking. More specifically, we will request a variety of data from funding utilities including:

- Utility rebate data
- Measure-level inputs for net benefits calculations (e.g., project costs, incentive amounts, load shapes)
- Utility-level inputs for net benefits calculations (e.g., avoided energy costs, avoided emissions)

Given that these data span a wide range of utility functions, we will work with each funding utility to determine the appropriate person for each data point to ensure smooth data transfer. We will also use existing documentation, such as Integrated Resource Plans and filings to glean appropriate information.

We will also connect with non-funding COUs for these data points to ensure statewide representation, though we recognize data collection efforts and quality may vary based on utility, and not all metrics are needed from COUs. We will also work with DER to utilize their Energy Savings Platform database to glean additional information entered by COUs.

Output tracking – internal data documents

Most logic model outputs, or results of our market support activities, will be tracked through internal sources. This may include records of trainings, participant lists, meeting notes, engagement or strategy plans, and materials created. We plan to utilize an adapted version of SalesForce to track market engagement and will have documents saved on our internal systems to share with future evaluators. Specific tracking processes for each output will be developed as the market support activities are rolled out.

MPI secondary data sources

Building stock and permitting data

Building stock and permitting data will be used to understand the market share, penetration, and potential of HPWs. Permitting data will provide an estimate for new construction housing units in the state, which will supplement the data from RESNET. Building stock data will largely be used to understand the market potential and penetration of HPWs.

ENERGY STAR data

Data from ENERGY STAR will be used in few different ways. The ENERGY STAR Version 7.0 qualified products list will outline the manufacturers and product lines that meet the prescriptive and performance paths of ENERGY STAR Version 7.0. This will provide insight into product availability, market positioning, and product development.

Energy Star also collects shipment data at a regional level. This can provide insights for regional trends and market share data for ENERGY STAR Version 7.0. This data will supplement the Minnesota-specific data collected from other sources.

Dichotomous outcome confirmation

There are several dichotomous MPIs that rely on proof that something happened or is in existence. It either happens or it doesn't. These include outcomes like ENERGY STARspecifications being adopted or codes being changed to a particular standard. These outcomes have a variety of data sources but are relatively easy to track as most are publicly available, and proof of achievement is only needed once.

MPI primary data collection

Many MPIs will need to be measured outside of sources that currently exist. In general, this will be done using surveys, interviews, focus groups, or other data collection options. Most often, this will involve a third-party evaluator. However, in areas where ETA has extensive knowledge and skillsets, we may undertake research in-house and in some situations have a third-party review the results. We anticipate the following groups will be important to engage with data collection:

- Builders and developers
- Consumers
- Installers/Suppliers
- Raters
- Manufacturers

More details about the specific primary data collection plans will be included in our annual work plan as research questions are solidified and adjusted each year.

Net benefits

For information about net benefits inputs and data sources, please see Appendix B.

Appendix A. Savings potential calculations

Data sources

2019 New Residential Construction Permits (Census)

Census data was used to estimate the volume of new construction in the West North Central region. These values were then used to distribute the new construction window sales volume among the seven West North Central states to provide an estimate for Minnesota.

Minnesota HPW Window Modeling by LBNL

Through the partnership for advanced window solutions (PAWS), Lawrence Berkeley National Lab (LBNL) provided modeling to support MN utilities in the development of HPW programs. This modeling estimated the energy use of a model home with two window replacement scenarios that were utilized in this savings calculation. The model included permutations for four different HVAC scenarios across four Minnesota locations.

EIA Residential Energy Consumption Survey (RECS) 2020 Dataset

The number of existing homes value (including single family attached, detached, and 2-4-unit apartments) is used to calculate the technical potential for the retrofit market.

Methods

Window savings

The modeling performed by LBNL produced savings estimates for two window replacement scenarios, across four locations in Minnesota, with four HVAC scenarios[11]. Three window models were used; a home with market baseline windows, a home with code minimum windows and a home with high-performance windows. The market baseline window model assumed a U-factor, Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) of 0.44, 0.57 and 0.90 respectively. The code minimum window model assumed a U-factor, SHGC and VT of 0.32, 0.28 and 0.81 respectively. The high-performance window model assumed a U-factor, SHGC and VT of 0.22, 0.28 and 0.73 respectively. Each model calculated whole home energy use so that they could be compared to analyze energy savings of a high-performance replacement scenario over a code and market baseline. The modeling results are summarized Table 1.

Table 8: Energy savings per 3'x5' window for ENERGY STAR Version 7.0 window replacement

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[11] The modeling software used was EnergyPlus 9.5. The model used the residential prototype home model developed by PNNL with a floor area of 2400SF, a window area of 288SF, R-11 walls and R-19 roof. Windows were distributed evenly for each orientation (N, S, E, W) with no shading. The HVAC scenarios assumed 81% AFUE for Gas Heating, 99% eFAF, single speed ccASHP with seasonal COP's of 2H/4C, A/C Cooling with COP of 3, and thermostat setpoints of 70/74 (H/C).

HVAC Scenario	Electric heat		Gas Heating, no AC		Gas Heating, with AC		Heat Pump w/ electric resistance backup	
Savings over MN Energy Code Baseline								
MN Location	Electricity (kWh)	Gas (therms)	Electricity (kWh)	Gas (therms)	Electricity (kWh)	Gas (therms)	Electricity (kWh)	Gas (therms)
Minneapolis	83	0.0	2	3.4	0	3.6	69	0.0
Rochester	91	0.0	3	3.7	2	3.7	77	0.0
Duluth	104	0.0	3	4.2	1	4.2	88	0.0
Bemidji	86	0.0	3	4.4	2	4.3	87	0.0
Savings over Market Baseline								
MN Location	Electricity (kWh)	Gas (therms)	Electricity (kWh)	Gas (therms)	Electricity (kWh)	Gas (therms)	Electricity (kWh)	Gas (therms)
Minneapolis	264	0.0	6	6.3	70	7.3	279	0.0
Rochester	353	0.0	9	8.3	63	10.0	357	0.0
Duluth	350	0.0	11	14.3	47	14.6	351	0.0
Bemidji	319	0.0	10	14.0	63	12.6	333	0.0

To summarize these values into a single savings number, for each baseline, that represents the average savings per window in the state, these estimates need to be weighted to represent the housing stock and climate zones in the state. The following steps were taken for both baseline scenarios. The data was first weighted by HVAC type for each location.

Data from the 2018 Minnesota Potential Study was used to estimate a weighted, statewide HVAC breakdown that aligns with the HVAC categories modeled. The Potential Study estimates the percentage of housing stock broken out separately by cooling and heating type. This data is listed in Tables 2 and 3.

Table 9: Minnesota housing stock by cooling type

Cooling Type	
No AC	33%
ASHP Cooling	2%
Central AC	40%
Room AC	25%

Table 10: Minnesota housing stock by heating type

Heating Type	
Natural Gas heating	71%
Electric heating	11%
Bottled, tank, LP gas	13%
Oil	2%
Wood	3%

This data was then transposed to align with the modeling categories used in the LBNL analysis. To do this, the 71% "Natural Gas heating" fraction was split between the "Gas Heating, no AC" and "Gas Heating, with AC" categories. The 40% "Central AC" fraction was assigned to the "Gas Heating, with AC" category, so the remainder of the 71% (31%) was assigned to "Gas Heating, no AC". Next, the 11% "Electricity Heating" fraction was distributed between the "Electric heat" category and the "Heat Pump" category. The 2% "ASHP cooling" fraction was assigned to "Heat Pump", so the remainder of the 11% (9%) was assigned to the "Electric heat" category. The remainder of heating fuel categories; "Bottled, tank, LP gas", "Oil" and "Wood" were all combined into the "OTHER" category. This results in the following housing stock HVAC breakdown that aligns with the modeling categories, summarized in Table 4.

Table 11: Minnesota housing stock by modeled HVAC scenario

HVAC Scenario	MN Housing Stock
Electric forced-air furnace	9%
Gas Heating, no AC	31%
Gas Heating, with AC	40%
Heat Pump	2%
OTHER	18%

Because these values are used to estimate a weighted per unit savings value that represents the entire state, and there is only modeling data for the four HVAC scenarios listed, the "OTHER" category was removed from the total and the remaining categories were weighted and scaled to 100%, as shown in Table 5. These are the values used to weight the energy savings data by HVAC scenario:

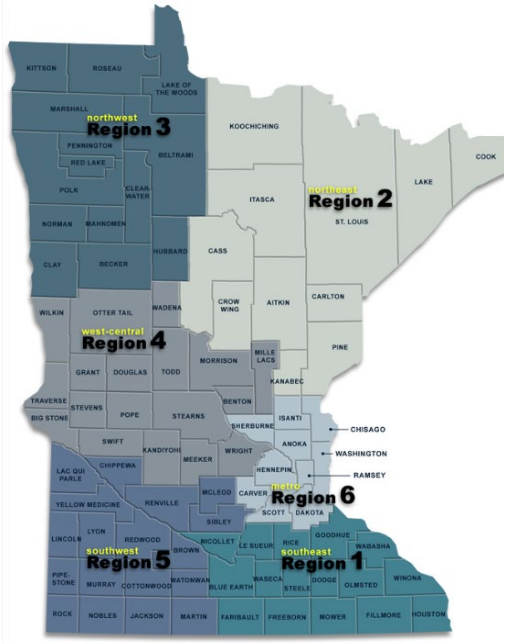
Table 12: Minnesota sousing stock by modeled HVAC scenario - weighted to exclude "Other"

HVAC Scenario	MN Housing Stock
Electric forced-air furnace	11%
Gas Heating, no AC	38%
Gas Heating, with AC	49%
Heat Pump	2%

Using these values the savings were weighted by HVAC type for each location, with the results shown in Table 6.

Table 13: Energy savings weighted by HVAC type

	HPW over code baseline		HPW over market baseline	
MN City	Electricity (kWh)	Gas (Therms)	Electricity (kWh)	Gas (Therms)
Minneapolis, MN	12	3.0	72	5.9
Rochester, MN	14	3.2	81	8.0
Duluth, MN	15	3.6	74	12.6
Bemidji, MN	14	3.8	78	11.4



Next, to adapt these climate-specific values into a number representative of the climate throughout the entire state, the cities were weighted based on the population in their region. This was done using the regions[12] shown in the figure to the right and each region was assigned to a city based on location and climate. The results are shown in Table 7.

Table 14: Model city region assignments and population distribution

MN City	MN Region(s)	County population within region(s)	Population distribution
Minneapolis	6,4	3,984,615	70%
Rochester	1,5	965,944	17%
Duluth	2	450,577	8%
Bemidji	3	269,336	5%

This population distribution was then applied to the HVAC weighted savings values listed in the previous table. The results produced the statewide weighted per unit savings for HPW over the two baselines scenarios. Results are shown Table 8.

Table 15: Weighted energy savings per 3'x5' window

Total Weighted Savings	Electricity (kWh)	Gas (Therms)
HPW over code baseline	12	3.1
HPW over market baseline	74	7.1

[12] MN Department of Health, "Planning for climate and health impacts: Emergency management considerations." Available here.

Estimating Technical Potential

We followed the definition of technical potential that was outlined in the Minnesota Potential Study and described below.

Technical potential: Technical potential is the (theoretical) maximum amount of energy use that could be displaced by the measure. This equates to the total market, as defined below, multiplied by the savings per unit. This is the energy savings that is technically achievable if the measure were implemented in every possible scenario over the 20 year program life.

Technical Potential

The technical potential calculation was separated into two categories (new construction and replacement). The formula for calculating the technical potential for new construction is:

$$Technical\ potential_{new\ cx} = [annual\ new\ cx\ sales] \times [HPW\ over\ code\ savings] \times [20\ yrs]$$

The formula for calculating the technical potential for the replacement market is:

$$Technical\ potential_{retrofit} = [total\ \#\ of\ existing\ windows] \times [HPW\ over\ code\ savings]$$

Where the total number of existing windows is calculated by multiplying the total number of existing homes in MN (1,803,378[13]) by 15 windows per home[14].

The technical potential for the replacement market is a conservative estimate because it only includes the energy savings over a code baseline. This reflects the technical potential that utilities may be able to claim through a traditional energy-efficiency program, which typically only count savings over a code baseline. This approach underestimates the energy savings that would actually be experienced by a customer who received a HPW upgrade. These savings would be much higher, as illustrated in the table above outlining the energy savings over a market baseline.

The approach described throughout results in the technical potential summarized in table 9:

Table 16: Technical Potential for new construction and replacement

	Electric (MWh)	Gas (Dth)	Combined (MMBTU)
Statewide Technical Potential	**470,000**	**11,800,000**	**13,300,000**
New Construction	130,000	3,300,000	3,700,000
Replacement	340,000	8,500,000	9,600,000

[13] U.S. Energy Information Administration, "2020 RECS Survey Data." Available here. Estimated number of detached and attached single-family homes and 2-4 unit apartments in Minnesota, from EIA 2020 RECS data.

[14]Center for Energy and Environment and Minnesota Department of Commerce, Division of Energy Resources, "Window Retrofit Technologies" (March 2015). Available here. It is estimated that the typical house has 15 windows, averaging 15 sq. ft. each.

APPENDIX B. NET BENEFITS MEMO

TECHNICAL MEMORANDUM

Draft methodology for calculating ETA net benefits

September 13, 2023

Authors: Chidinma Emenike, Isaac Smith, Carl Nelson, Maddie Hansen-Connell

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Purpose

ETA statute requires the calculation and allocation of net benefits as well as energy savings. This document lays out a draft methodology for calculating net benefits from ETA initiatives. This methodology will be included as part of the Market Transformation Plan documents to be approved by the ETA Coordinating Committee prior to launching ETA initiatives.

Net benefits are used for assessing program cost-effectiveness and as inputs for calculating utility financial incentives. As with other CIP programs, net benefits for ETA will be reported when there are savings from specific initiatives to be claimed. Once ETA initiatives are approved and launched, CEE will file annual ETA Energy Savings Reports (similar to an individual utility's Status Report) of total savings and net benefits for each participating utility.

Background

The ETA filing approved by DER provides some overall guidance on calculation of net benefits[15]. As described in the filing, ETA net benefits calculations differ from other CIP programs in several key respects, as outlined in Table 1 below.

Table 17: ETA net benefits calculations compared to traditional CIP program savings calculations

ETA net benefits	CIP program net benefits
Calculated on a statewide basis	Calculated by individual utility territory
Allocated based on financial contribution to ETA (same as ETA savings)	Calculated based on each individual utilities' spending and savings

[15] Center for Energy and Environment. "Minnesota Efficient Technology Accelerator Program Proposal" (2022). Submitted to Minnesota Department of Commerce, Division of Energy Resources. Docket No. E,G999/CIP-21-548. P. 21-34.

ETA net benefits will be calculated based on the primary approved cost-effectiveness test (Minnesota Test) and all other secondary approved cost-effectiveness tests (Societal, Utility, and Ratepayer Impact Tests). Consistent with the approved filing, we will not calculate participant net benefits[16]. Participant cost-effectiveness is a more impactful metric earlier in the program cycle (i.e., when considering program rebates, as opposed to reporting net benefits), and is already considered as part of the ETA initiative selection process.

Included impacts for calculating net benefits

Table 2 below shows a list of various impacts (benefits and costs). Per DER guidance, these impacts will be included in each of the four cost-effectiveness tests. Shaded cells indicate values that are currently not quantified and/or do not have an approved estimation methodology[17].

Table 18: DER-approved cost-benefit impacts (non-quantified impacts in grey)

Utility	Category	Impact	MN Test	Societal Test	Utility Test	RIM
Electric Utility	Generation	Energy Generation	X	X	X	X
		Capacity	X	X	X	X
		Environmental Compliance	X	X	X	X
		RPS Compliance	X	X	X	X
		Market Price Effects	X	X	X	X
		Ancillary Services	X	X	X	X
	Transmission	Transmission Capacity	X	X	X	X
		Transmission System Losses	X	X	X	X
	Distribution Costs	Distribution Costs	X	X	X	X
		Distribution System Losses	X	X	X	X

[16] The participant test is designed to assess cost-effectiveness from a participant's perspective, considering rebates provided by the program. As described in the filing, this test is not as meaningful for ETA initiatives (which may intervene in the market prior to a technology being cost-effective, and do not provide rebates).
Center for Energy and Environment. "Minnesota Efficient Technology Accelerator Program Proposal" (2022). Submitted to Minnesota Department of Commerce, Division of Energy Resources. Docket No. E,G999/CIP-21-548.

[17] DER Decision. "In the Matter of 2024-2026 CIP Cost-Effectiveness Methodologies for Electric and Gas Investor-Owned Utilities" (March, 31, 2023). Docket No. E,G999/CIP-23-46.

Utility	Category	Impact	MN Test	Societal Test	Utility Test	RIM
	General	Program Incentives[18]	X	X	X	X
		Program Administration Costs	X	X	X	X
		Utility Performance Incentives	X	X	X	X
		Utility Revenue Impacts				X
		Credit and Collection Costs	X	X	X	X
		Risk	X	X	X	X
		Reliability	X	X	X	X
		Resilience	X	X	X	X
Gas Utility	Commodity / Supply	Fuel and Variable O&M	X	X	X	X
		Capacity and Storage	X	X	X	X
		Environmental Compliance	X	X	X	X
		Market Price Effects	X	X	X	X
	Transportation	Transportation	X	X	X	X
	Delivery	Delivery	X	X	X	X
	General (same as Electric)	Program Incentives[18]	X	X	X	X
		Program Administration Costs	X	X	X	X
		Utility Performance Incentives	X	X	X	X
		Credit and Collection Costs	X	X	X	X
		Risk	X	X	X	X
		Reliability	X	X	X	X
		Resilience	X	X	X	X
Non-Utility System	Other Fuels	Other Fuels	X	X		
	Participant	Participant Costs		X		
		Participant Benefits		X		
Societal	Societal Impacts	GHG emissions	X	X		
		Criteria air emissions	X	X		
		Other environmental	X	X		

[18] Note that ETA is not expected to have any costs in this category as ETA initiatives do not provide customer rebates.

Utility	Category	Impact	MN Test	Societal Test	Utility Test	RIM
		Economic and Jobs (Macroeconomic)	X	X		
		Energy Security	X	X		
		Energy Equity	X	X		

Basic methodology – electric utilities

Below we outline the methodology plan to employ to calculate these impacts for the ETA. In general, this is very similar to calculating net benefits for an individual utility, with the exception of calculating the time value of avoided energy for electric utilities, as described below.

Step 1: Calculate total annual energy and capacity savings. This is based on energy savings calculation methodology, discussed in the Energy Savings and Evaluation plans (generally, it will be total units * energy savings/unit or capacity savings/unit). To the extent possible, savings will be consistent with the most recent TRM.

Step 1a (electric utilities only): DER guidance provides for calculating the benefits of avoided energy by each hour of the year (8760 hours) for each year of measure life, resulting in a high level of data granularity that is needed to calculate net benefits. It is reasonable to expect that we might be able to get this level of granularity of data from ETA-participating utilities; but data for the rest of the state will be challenging. Thus, a simplified method will be used for calculating the time value of efficiency, by breaking down the year into periods, and estimating the $/kWh value for each time period. Savings from measure-specific load shapes will also allocated to these discrete time periods.

For illustrative purposes, Table 3 shows the time periods used for calculating energy savings in the 2018 Minnesota Potential Study. We will base the actual time periods and percentage allocations used for ETA net benefits calculations according to what makes the most sense based on the data that is received.

Table 19: Potential Study energy time periods, for calculating time value of electric energy savings

Period	Period definition	% of year
Summer on-peak	Jun-Aug: weekdays 9 a.m. – 10 p.m.	10%
Summer off-peak	Jun-Aug: weekdays 10 p.m. – 9 a.m.	8%
Winter on-peak	Nov-Mar: weekdays 8 a.m. – 10 p.m.	17%
Winter off-peak	Nov-Mar: weekdays 10 p.m. – 8 a.m.	12%
Shoulder on-peak	Apr-May & Sep-Oct: Weekdays 7 a.m. – 11 p.m. + All weekend days 9 a.m. – 11 p.m.	33%

Period	Period definition	% of year
Shoulder off-peak	Apr-May & Sep-Oct: Weekdays 11 p.m. – 7 a.m. + All weekend days 11 p.m. – 9 a.m.	20%

Step 2: Multiply energy and capacity savings by the appropriate values. Energy savings will be multiplied by each relevant $/kWh value (value of avoided energy, value of avoided emissions, etc.), for each period shown in Table 3. Capacity savings will be multiplied by each relevant $/KW value (value of avoided capacity, value of avoided T&D, etc.) per year of measure life. Calculate total benefits by adding together all resulting dollar amounts for each value.

Step 3: Discount benefits in future years by the appropriate discount rate. The ETA would use the discount rates provided by DER guidance, with some extrapolation needed to calculate statewide values for the utility test, as described in a below section.

Step 4: Calculate total net costs, in keeping with current DER methodology. If available, these inputs will be sourced from the most recent TRM. If costs occur beyond year one (e.g., O&M costs), they will be subtracted from the benefits in the year in which they occur.

Step 5: Calculate net benefits (total benefits minus total costs).

Electric inputs

Table 4 shows the inputs needed to calculate net benefits for electric utilities (Table 4). These inputs are divided into three categories:

1) *Measure-level inputs*. These will be different for each ETA initiative. The method for estimating these inputs will be defined in the Energy Savings Plan for each initiative.
2) *Utility-specific inputs*. These are inputs that are specific to each utility; as described in the "calculating statewide inputs" section below, load-weighted statewide averages will be calculated for these values. Some utility-specific inputs utilize DER-specified values for individual utilities – refer to the footnotes for more information about these values. The statewide average will be based on DER-specified inputs where possible (not available for all utilities).
3) *Global inputs*. These are inputs that apply statewide and are provided by DER.

Utility-specific inputs and global inputs are largely derived from Triennial Plan filings and associated decisions. See the Relevant Filings section for specific filing references.

Table 20: Benefit-cost inputs for electric-saving measures

Measure-level Inputs	Utility-specific Inputs	Global Inputs
Utility Project Costs	Avoided Energy Costs	Participant Discount Rate (residential customers)
Project Life	Avoided Emissions	Societal Discount Rate

Measure-level Inputs	Utility-specific Inputs	Global Inputs
Energy Savings/Unit	Avoided T&D[19]	Environmental Compliance
Capacity Savings/Unit	CIP Utility Discount Rate[20]	Non-gas Fuel Cost
Number of Units	Participant Discount Rate (non-residential customers)[21]	Non-gas Environmental Damage Factor
Load Shape		Non-Gas Fuel Loss Factor
Incremental Costs		Avoided Capacity Costs
Electric Non-Energy Benefits		
Variable O&M		

Basic methodology - gas utilities

The gas utility methodology follows DER guidance.

Step 1: Calculate total annual energy savings. This is based on energy savings calculation methodology, discussed elsewhere (generally, it will be total units * energy savings/unit). To the extent possible, savings will be consistent with the most recent TRM.

Step 2: Multiply energy savings by the appropriate values. Energy savings will be multiplied by each relevant $/Dth value (value of avoided energy, value of avoided emissions, etc.). Calculate total benefits by adding together all resulting dollar amounts for each value.

Step 3: Discount benefits in future years by the appropriate discount rate, as provided by DER.

Step 4: Calculate the total net costs, in keeping with DER methodology. If available, these inputs will be sourced from the most recent TRM.

Step 5: Calculate net benefits (total benefits minus total costs).

Gas inputs

Table 5 shows the gas inputs that will be used to calculate net benefits, divided into the categories described above in the electric section.

[19] DER-approved annual values per utility.

[20] Specified by DER in their order, for each investor-owned utility (IOU).

[21] Same as the CIP utility discount rate.

Table 21: Benefit-cost inputs for gas-saving measures

Measure-level Inputs	Utility-specific Inputs	Global Inputs
Utility Project Costs	CIP Utility Discount Rate[22]	Participant Discount Rate (residential customers)
Project Life	Participant Discount Rate (non-residential customers)[23]	Societal Discount Rate
Energy Savings/Unit	Gas Retail Rate[24]	Environmental Compliance
Number of Units	Demand Cost[25]	Gas Environmental Damage Factor
Incremental Costs		Gas Escalation Rate
Variable O&M		Gas Commodity Cost
		Peak Reduction Factor

Relevant filings

Utility-specific inputs are filed every three years in the utility Triennial Plans and approved by the DER. The 2024-2026 Triennial Plans include:

- Minnesota Department of Commerce. "Decision in the Matter of Xcel Energy's 2024-2026 Energy Conservation and Optimization Triennial Plan" (December 1, 2023). Docket No. G,E002/CIP-23-092.
- Minnesota Department of Commerce. "Decision in the Matter of Minnesota Power's 2024-2026 Energy Conservation and Optimization Triennial Plan" (December 1, 2023). Docket No. E015/CIP-23-093.
- Minnesota Department of Commerce. "Decision in the Matter of Otter Tail Power Company's 2024-2026 Energy Conservation and Optimization Triennial Plan" (December 1, 2023). Docket No. E017/CIP-23-094.
- Minnesota Department of Commerce. "Decision in the Matter of CenterPoint Energy's 2024-2026 Energy Conservation and Optimization Triennial Plan" (December 1, 2023). Docket No. G008/CIP-23-095.

[22] Specified by DER for each IOU.

[23] Same as the CIP utility discount rate.

[24] Per DER, this is calculated using each utility's currently approved tariffed non-natural gas margin (using a weighted average if multiple customer classes are participating), demand cost, and the DER-specified gas commodity cost.

[25] Per DER, this value is sourced from the utility's March 2023 Purchased Gas Adjustment filing.

- Minnesota Department of Commerce. "Decision in the Matter of Minnesota Energy Resources Corporation's 2024-2026 Energy Conservation and Optimization Triennial Plan" (December 1, 2023). Docket No. G011/CIP-23-098.

DER specified inputs and global inputs are noted in the Minnesota Department of Commerce Decision on the 2024-2026 CIP Cost-Effectiveness Methodologies for Electric and Gas Investor-Owned Utilities (Docket No. E,G999/CIP-23-046; filed March 31). All filings can be found on the State of Minnesota's Public Utilities Commission electronic docket system, eDockets available here.

Calculating statewide inputs

Measure-level inputs will be estimated based on the methodology outlined in each ETA initiative's Energy Savings Plan. Global inputs will be per the latest DER guidance.

To estimate statewide values for utility-specific inputs (as shown in Tables 4 and 5 above), CEE will calculate a load-weighted statewide average using values from ETA utilities, as well as from non-ETA utilities when available. Other statewide data source may supplement utility-specific data. This follows the methodology employed in the 2018 Minnesota Potential Study. Data sources will include:

- NREL's Cambium data sets (to estimate the value of avoided energy and avoided emissions)
- Confidential data requests for trade secret utility-specific data points
- Appropriate proxies (co-op borrowing rates, muni bond rates, etc.) to determine the value of benefits occurring outside of ETA funder utility service areas and calculate load-weighted statewide average