High-Performance RTU Market Transformation Plan

Center for Energy and Environment

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Minnesota Efficient Technology Accelerator

Minnesota Efficient Technology Accelerator (ETA) is a statewide market transformation program that accelerates deployment and reduces the cost of emerging and innovative efficient technologies, bringing lower energy bills and environmental benefits to Minnesotans. ETA is a partnership funded by the state's investor-owned utilities (IOUs), administered by the Minnesota Department of Commerce, Division of Energy Resources (DER), and implemented by Center for Energy and Environment (CEE).[1]

The ETA program has set four overarching goals:

- Create a strategic process to accelerate market deployment of key technologies.
- Employ effective strategies to leverage market forces.
- Become a hub for collaboration among stakeholders.
- Achieve cost-effective energy savings and other benefits for utilities and Minnesotans.

The ETA program develops individual market transformation initiatives for a handful of targeted technologies and approaches, often starting at an early stage of development. The ETA approach involves working closely with market partners and other key stakeholders. Initiatives move through four stages of a life cycle that includes: 1) concept development; 2) program development; 3) market development; and 4) long-term monitoring and tracking. Most efforts and resources are applied during the market development stage, which is the "implementation" stage that involves intensive market engagement. Before moving from one stage to the next, an initiative must be vetted and approved by a coordinating committee consisting of the DER and the utilities funding ETA.

Purpose of this plan

The Market Transformation Plan is the culmination of the program development stage, where extensive research and planning is done to prepare the initiative for market launch. This plan summarizes key contextual information, lay out the basic program logic and desired end state that informs our market strategy, and present the fundamental market support activities necessary for success. The plan will then guide the development of specific activities each year during the market development phase. By being transparent in our objectives and strategies as much as possible, we hope to better facilitate stakeholder engagement and alignment on strategy with key stakeholders, so we can coordinate and succeed in achieving common goals. Supporting and informing this plan are the Market Characterization Report and the Energy Savings and Evaluation Plan (Appendices A and B).

[1] Minnesota Statutes § 216B.241 subd. 14 created the framework for the ETA program, which is funded by Xcel Energy, CenterPoint Energy, Minnesota Energy Resources, Minnesota Power, and Otter Tail Power.

Summary of our approach

This section contains a summary of our approach, including our theory for transforming the market for commercial rooftop units (RTUs). RTUs provide an all-in-one solution for heating, ventilation, and air-conditioning (HVAC) for commercial and industrial buildings. Given this utility, it is the most common equipment choice for meeting commercial HVAC needs. While the cooling load is usually electric, the heating fuel type of Minnesota RTUs is generally natural gas (97% of RTUs as of 2017)[2]. Even though it is the most common commercial HVAC choice, the RTU industry has remained stagnant for more than 30 years, with RTU heating efficiency only improving by 1% over that time.[3]

In the state of Minnesota, there are approximately 21,000[4] buildings that rely on RTUs for space conditioning (heating, cooling, ventilation), which represents 80%[5] of the commercial buildings in the state. The average age of these units is 13 years, which means they are approaching the end of their expected 15-year lifetime and are operating below federal minimum standards for efficiency.

This presents a huge opportunity for energy and emissions savings, because commercial HVAC accounts for more than 60% of the energy use in commercial buildings in Minnesota.[6] So, it will be imperative to increase the efficiency and reduce the emissions of the most common commercial HVAC equipment: RTUs. The two technologies that can reduce energy use from RTUs the most are heat pumps and energy recovery ventilators (ERVs), so these technologies will be the focus of this initiative, but each come with their own market barriers and opportunities.

Our market research showed that there is low awareness and product confidence for both technologies. As discussed, this is a slow-evolving market, so market actors hesitate to adopt new technologies. Specifically, contractors and distributors aren’t interested in selling ERVs because they are perceived as problematic, expensive, and not delivering on their energy savings claims. These false perceptions have propagated throughout the industry and created a bias against installing them. It will be key to build confidence in this product and show the energy savings that it can deliver.

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[2] Schuetter et al. 2017. *Commercial Roof-top Units in Minnesota Conservation Applied Research & Development Final Report*. Minnesota Department of Commerce Conservation Applied Research & Development. https://www.cards.commerce.state.mn.us/CARDS/security/search.do?method=showPoup&documentId=%7BAC3FB94A-9598-4A9C-BF02-967BFAC28FF3%7D&documentTitle=386204&documentType=6

[3] Federal minimum standards for RTUs increased from 80% to 81% starting in 2024. This is the first change in minimum efficiency standards since 1994.

[4] Ibid

[5] Ibid

[6] Parker, Andrew, et al. 2023. *ComStock Reference Documentation*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5500-83819. https://www.nrel.gov/docs/fy23osti/83819.pdf

Dual fuel heat pumps are a product category that has low market awareness, limited product availability, and long lead times. Most manufacturers have at least one dual fuel heat pump option, but product development is currently focused on the refrigerant transition, new federal performance minimums, and new UL standards for RTUs, which limits their ability to focus on bringing more heat pumps to market in the near term. Despite this, manufacturers are excited about the opportunity for heat pump RTUs and expect this market to grow. Based on conversations with manufacturers, we expect to see more product offerings and improvements in heat pump performance over the next 2–10 years.

We will overcome these barriers and leverage market opportunities by implementing market support strategies. These strategies will require deep engagement and partnership with various market actors including building owners, contractors, distributors, and manufacturers. We will build confidence with these stakeholders through field research that is already underway and will expand in 2024. As CEE works with more stakeholders, this research will showcase the benefits of this technology and we will better understand what value to bring to each stakeholder based on their needs and interests. This research will be leveraged to develop case studies and market resources that will be used to build market awareness, confidence, and develop market partnerships.

A key opportunity for this initiative is the fact that these technologies (heat pumps and ERVs) have the potential to reduce commercial HVAC energy use by 50%. However, RTUs are an overlooked strategy for reducing energy use since this market has largely not changed for the last 30 years. Building awareness for high-performance RTUs as a 'plug and play' opportunity for building owners to reduce their energy use and emissions will be key.

There are many commercial building owners, including cities and corporations, that own many buildings with RTUs and aim to reduce their energy use and emissions[7]. We will engage with these stakeholders and raise the profile of high-performance RTUs as a key strategy to achieve sustainability goals. Working with these stakeholders to commit to high-performance RTUs on their buildings will send a clear demand signal to manufacturers, leading to more product development, availability, and decreased lead times for these products.

By building awareness, confidence, and demand for high-performance RTUs, the market will grow and they will eventually become the most common choice in the industry.

[7]Victor, David G. and Yanosek, Kassia. 2022. *How Big Business Is Taking the Lead on Climate Change*. McKinsey Sustainability https://www.mckinsey.com/capabilities/sustainability/our-insights/sustainability-blog/how-big-business-is-taking-the-lead-on-climate-change

PRODUCT INFORMATION

Product description

RTUs provide cooling and heating for the entire building by delivering conditioned air through ductwork to various zones or spaces. RTUs also provide ventilation, circulating fresh air and exhausting stale air. Commercial RTUs present an easy all-in-one solution for HVAC needs in commercial and industrial buildings, which makes them the most common equipment choice in the commercial sector.

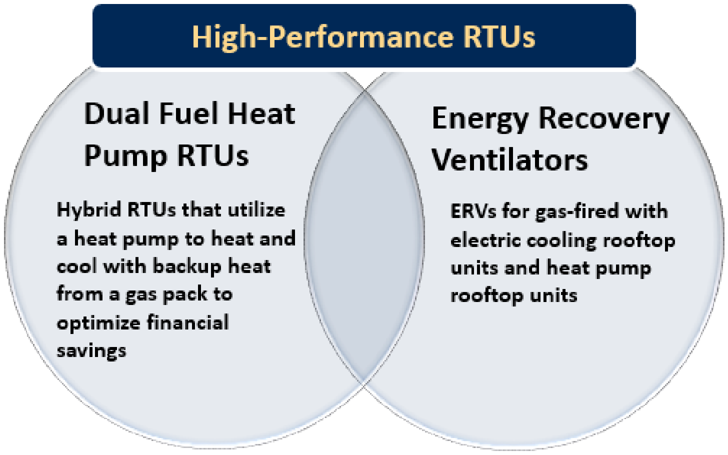
This initiative plans to transform this market by making high-performance RTUs the most common choice in this industry. To accomplish this, high-performance needs to be defined. Unfortunately, current test procedures evaluate efficiency through metrics for individual components rather than the efficiency of the whole box. This approach leads the market to undervalue holistic efficiency components like improved box insulation and air-leakage, as well as ERVs, because RTUs are selected, specified, and rebated using the individual efficiency metrics for the heating and cooling components of the RTU rather than considering the efficiency of all the components together. The lack of a whole-box efficiency metric has led to very little product development and efficiency improvements for whole-box measures, as there is no market incentive or efficiency metric to define these benefits. This issue is compounded by the fact that the heating efficiency of RTUs has not significantly improved in over 30 years, so we have only seen product development and efficiency improvements in the cooling components of RTUs.

Given the current state of this market and the lack of whole-box efficiency metrics, we decided to launch this initiative by focusing on accelerating the adoption of the components of an RTU that can deliver the largest impact and most energy savings. During the program development phase, we completed research to identify these components, and found that dual fuel heat pumps and ERVs had the most potential. This initiative will focus on accelerating the adoption of these two technologies as it launches.

As we accelerate the adoption of dual fuel heat pumps and ERVs, we plan to evaluate opportunities to improve the efficiency metrics used in this industry, which will help highlight the benefits of ERVs, heat pumps, and other whole-box improvements. Strategies for improving these metrics and additional efficiency components will be folded into the program as they arise through further research and evaluation.

A more in-depth description of the two products we are focused on is provided in the following.

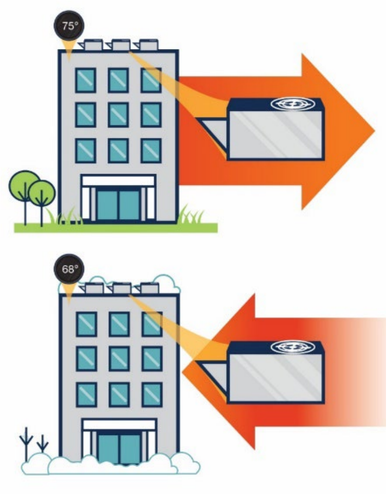
Figure 1. High-performance RTU technologies



Dual fuel heat pump RTUs

A dual fuel heat pump RTU can provide both heating and cooling to a building using one refrigeration system. These systems are similar to a traditional air conditioning RTU but can reverse the flow of refrigerant to move heat from the outside environment into the building. Heat pumps are much more efficient than gas furnaces because they move heat from one location to another instead of generating heat by combusting natural gas. Heat pumps can operate well in cold outdoor temperatures but lose efficiency and experience capacity limitations at very low temperatures. Dual fuel heat pump RTUs are equipped with a gas heat exchanger that can provide heating at low ambient temperatures as necessary. Utilizing a gas heat exchanger at low temperatures can optimize bill savings because the heat pump doesn't operate when it is least efficient. However, the heat pump can still offset most of the heating load, which can greatly reduce energy use and carbon emissions.

Figure 2. Dual-fuel heat pump RTU (rooftop unit) diagram



The high-performance RTU product definition includes two levels of products for dual fuel heat pumps. The two-level system was created to capture the two different types of dual fuel heat pumps available in the market. The first level consists of the more common dual fuel heat pumps equipped with staged compressors. Additionally, there are premium dual fuel heat pumps that use variable speed compressors, which increases the efficiency and capacity at lower temperatures. There are currently very few of these systems and they are sold at a premium. The premium products are captured in level 2 and the standard products are captured in level 1 of the product definition.

Energy recovery ventilators (ERVs)

Rooftop units provide more than just heating and cooling to buildings, as they also provide fresh outdoor air to occupied spaces. To maintain good indoor air quality, commercial buildings have fresh outdoor air requirements. This prevents the buildup of harmful gases like carbon monoxide in the indoor environment. RTUs transfer fresh outdoor air into the building while exhausting indoor air that has collected VOCs, pollutants, and dirt. While this is necessary, it comes with a significant energy penalty if an ERV is not used. The ERV acts as a passive heat exchanger between the incoming fresh outdoor air and exhausted indoor air. By conditioning the incoming fresh air, an ERV saves energy by reducing the amount that the RTU needs to condition (heat or cool) the fresh air that enters the building. ERVs also possess a few non-energy benefits such as improving comfort by balancing humidity, circulating fresh outdoor air to the building, and potentially reducing the required HVAC tonnage for a building.

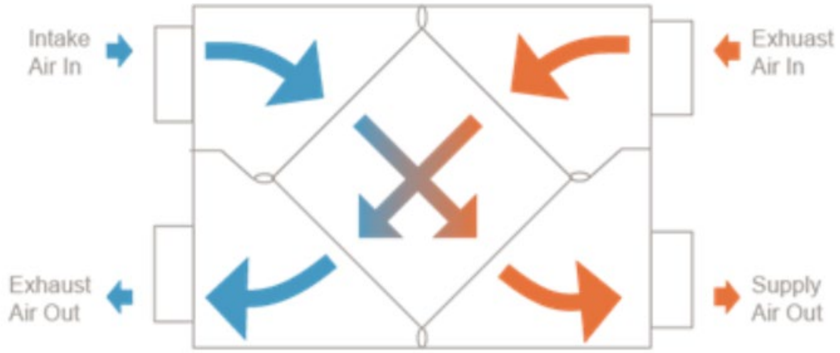
ERVs and heat recovery ventilators (HRVs) are often compared when considering energy recovery. They are the two different types of recovery ventilators. Both types can save a significant amount of energy but have slight differences. ERVs can transfer sensible (related to temperature change) and latent heat (related to moisture), while HRVs can only transfer sensible heat. The key difference between these two energy recovery systems is the material that it is made of — ERVs have a membrane that can transfer both sensible and latent heat. This program is focused on ERVs because Minnesota has a humid climate (lots of latent energy), which means ERVs can produce more energy savings.

There are different types of ERVs. One is a fixed-plate ERV that acts as a passive heat (and moisture) exchanger, only exchanging heat and not directly mixing the indoor and outdoor air streams. The exhaust air entering the heat exchanger transfers heat to the fresh incoming outdoor air. Each air stream has its own passageway through the membrane. This type of ERV does not require a motor and is passive. Some RTUs have a motor-driven ERV wheel that is called an energy recovery wheel (ERW) or enthalpy wheel. The ERW rotates, absorbing and emitting heat like the passive heat exchanger. In this scenario, the two separate air streams pass over the same membrane, resulting in heat and moisture transfer.

We are focused on the following energy recovery types with at least 50% effectiveness:

- Rotating energy recovery wheel or enthalpy wheel
- Fixed membrane
- Bolt-on or integrated

Figure 3. Example fixed membrane energy recovery ventilation (ERV) diagram[8]



Application types and focus

The high-performance RTU initiative focuses on equipment that is 25 tons or less, which spans the commercial sector and applies to new construction, retrofit, and replacement markets. Units above 25 tons enter the range where other technologies may be more applicable and the HVAC equipment is often created specifically for a building's application and are made to order, unlike common off-the-shelf rooftop units. The 25-ton and larger rooftop units will have different pathways to purchase and barriers than the tonnage range we are focused on.

Commercial dual fuel heat pump RTUs have a variety of applications and can be installed on any building that currently has an RTU. They are the most common HVAC equipment on commercial buildings that have ductwork and are typically mounted on the roof. Roof curbs connect the RTU to the building's ductwork. Since dual fuel RTUs use the same fuel source (electricity and gas) they can replace existing RTUs without requiring large infrastructure changes, although roof curb adjustments may be needed. Conversely, all-electric RTUs may require electrical upgrades, roof reinforcement, and roof curb adjustments. The most common building types for dual fuel RTUs are retail, education, grocery, municipalities, hospitals, warehouses, and restaurants.

Similarly, energy recovery ventilators have a wide application and should be applied to any building that has outdoor air requirements of 10% or higher (the vast majority of commercial buildings).[9] An ERV can operate in all applications a typical RTU can and provide year-round benefits. In fact, within certain temperature ranges, the ERV can meet the building's load through recovery, eliminating the need for heating or cooling at that temperature. ERVs can be applied to an RTU in two ways. The ERV can either be bolted onto a new or an existing RTU, post-manufacturing, or it can be integrated into the box by the manufacturer. Bolt-on ERVs are

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[8] Kessler, Nicole, and Josh Quinnell. 2017. *Energy Recovery in Minnesota Commercial and Institutional Buildings: Expectations and Performance*. Minnesota Department of Commerce Conservation Applied Research & Development. *https://www.mncee.org/energy-recovery-minnesota-commercial-and-institutional-buildings-closed*

[9] Every building type listed in this section, except warehouses, has a median outdoor air requirement above 10% according to data from CBECS.

externally mounted to the RTU, typically after the RTU has been installed on the roof. Integrated ERVs are built into the RTU cabinet by the manufacturer, so no additional labor is required by the contractor. In the long-term, we would like more manufacturers to integrate ERVs into their cabinet design. This would reduce the complexity of procurement and installation as there would be no additional coordination for the arrival and installation of the RTU and ERV.

ERVs deliver more energy savings in buildings that have higher fresh outdoor air-requirements (ventilation requirements). Based on Commercial Building Energy Consumption Survey (CBECS) data, we expect the largest ERV savings from education buildings such as primary and secondary schools. Restaurants and retail/strip malls also have high energy savings potential due to their high outdoor air requirements. We plan to focus on these building types in the near term, but there is energy savings potential in most commercial building types.

The target building types for the high-performance RTU program will be:

- Municipalities
- Universities
- Schools
- Hospitals
- Commercial retail
- Grocery
- Small commercial buildings three stories or less (offices)
- Industrial buildings/warehouses
- Restaurants

Product specification

There are certain specifications and standards that can help determine the suitability of commercial rooftop units for specific buildings or efficiency programs, whether they are heat pump or traditional electric/gas-fired units. Key performance metrics for commercial dual fuel heat pump RTUs include:

- Energy efficiency ratio (EER): EER measures the cooling efficiency of the rooftop unit under full load cooling conditions. It is a measured ratio of output cooling energy to input electrical energy at full load operation and is measured in Btus/hr. Higher EER values indicate more efficient cooling performance.
- Heating capacity: Gas-fired rooftop units as well as dual fuel heat pumps should have adequate heating capacity to meet the building's heating demands. This is measured in Btus/hr.
- Integrated energy efficiency ratio (IEER): IEER measures the cooling efficiency of commercial rooftop units. IEER is calculated by considering the cooling capacity and power consumption at four specific load points: 100%, 75%, 50%, and 25% of the unit's rated capacity. These load points represent different operating conditions that an RTU may encounter during its normal operation. It considers the unit's energy consumption across different operating conditions over a typical cooling season.

- Seasonal energy efficiency ratio (SEER): SEER is defined as the cooling output during a typical cooling season divided by the total electric energy input during the same period. This rating represents the performance of the unit over a typical cooling season.
- Cooling capacity: Cooling capacity refers to its ability to remove heat from the indoor space and provide a cool space. This is measured in Btu/hr. or tons of refrigeration (12,000 Btu/hr. per ton).
- Combustion efficiency – AFUE: Average fuel utilization efficiency (AFUE) is a ratio measure of useful energy output to energy input expressed as a percentage. For gas-fired units, combustion efficiency measures how effectively the unit burns fuel. Higher combustion efficiency values indicate better fuel utilization.
- Coefficient of performance (COP): COP is a measure of the heat pump's heating efficiency. It indicates the ratio of heat produced to energy consumed. Higher COP values indicate better heating performance. COP is measured for two different outdoor ambient temperature test points, 47°F and 17°F. This metric is used specifically for commercial heat pumps above or equal to 65,000 Btu/hr.
- Whole-box efficiency: As the industry moves toward whole-box efficiency, we expect to see a standard focused on a consistent method of measuring whole-box efficiency. Currently, the United States does not have a standard, but we can look to the CSA P.8 standard as a reference point for measuring whole-box efficiency. The Canadian standard takes a holistic view of the energy efficiency of a packaged furnace.
- Heat seasonal performance factor (HSPF): HSPF is used to measure the efficiency of air source heat pumps below 5.4 tons. This is defined as the ratio of heat output measured in Btus over the heating season to power used measured in Watt-hours and has a unit of Btu/W-h.

To define the technologies that are relevant to our initiative, we have assigned a prescriptive and performance requirement for both dual fuel heat pumps and ERVs. These are draft metrics that focus on products that are currently available in the market and are outlined in Table 1 and Table 2.

Table 1. High-performance RTU product definition – Dual fuel heat pumps

Dual Fuel Heat Pump RTUs		
Level	**Prescriptive**	**Performance**
Level 1	Multi-stage compressor Dual fuel	ASHRAE 90.1 2019 (2024 MN Code Minimum) Detailed in Table 3

Level 2	Cold climate capable Variable speed compressor Dual fuel	≥60% capacity at 5°F or ENERGY STAR cold climate minimum Provide heating down to 5°F **<65,000 Btu/hr. (three phase)** 8.5 HSPF 16 SEER 12 EER **≥65,000 Btu/hr.** 1.7 COP at 5°F 2.3 COP at 17°F 3.5 COP at 47°F 11.5 EER 18 IEER

Table 2. High-performance RTU product definition – ERVs

Energy Recovery Ventilators		
Level	**Prescriptive**	**Performance**
Level 1	Enthalpy wheel Plate heat exchanger Membrane heat exchanger Bolt on or integrated For heat pump and AC RTUs	ASHRAE 90.1 2019 minimum ≥50% effectiveness

There are two distinct levels of dual fuel heat pump RTUs in the market, so we specified those. Level one captures most dual fuel products in the market. These products are above federal minimum performance requirements, operate efficiently, and can displace a large portion of the heating load traditionally met by the gas burner. These products are also more readily available, cost less overall due to the simplicity of the technology and controls, and are similar to install.

The second level captures what are known as the premium models available in the market. These products have variable speed compressors, fans, and advanced controls used to modulate the heat pump and gas heat system at low ambient temperatures. These products also often have increased cabinet insulation and options for integrated ERVs. Products with these features come at a premium price and are often custom made for a specific application.

Defining two levels of product allows the program to showcase the benefits and accelerate the adoption of both product categories.

ERVs have a single level system that covers all the typical ERVs in the market. The performance requirement for ERVs is based on ASHRAE 90.1 2019 (MN code minimum), with at least a 50% effectiveness. Our goal is to increase the adoption of any ERV, as they are not typically considered in most applications but offer substantial benefits. These systems can be added to existing RTUs or new construction and replacements.

State of the product

Dual fuel heat pumps

Currently, the market offers a range of dual fuel heat pump RTUs available for purchase. Manufacturers have been actively working to release new products, especially in response to the updated performance minimum requirements set by the Department of Energy for 2023. Most major manufacturers offer a heat pump option across their product lines, demonstrating their commitment to providing energy efficient solutions. However, there are still a few larger manufacturers that could introduce dual fuel heat pump options, as the market currently offers limited choices in this category. Recognizing the increasing demand for electrification, manufacturers are focused on developing new high-efficiency products and expanding their offerings with dual fuel solutions.

The production landscape is adapting to meet the growing demand for heat pump RTUs. This year, we observed a promising trend with the introduction of more dual fuel products. Manufacturers are actively working to expand their product portfolios to cater to different customer needs and preferences. This reflects the industry's recognition of the importance of offering diverse and efficient HVAC solutions.

However, the commercial HVAC market still lags the residential market, with very few manufacturers offering Level 2 RTUs with variable speed compressors, designed for cold-climate performance. Manufacturers have instead focused on designing equipment with low-GWP refrigerant (to meet upcoming federal requirements) and navigating supply chain issues caused by the pandemic that have led to long lead times for their large volume code-minimum products. CEE plans to work with manufacturers to accelerate product development activities by showing them the opportunity and demand for dual fuel heat pump RTUs.

Energy recovery ventilators

ERVs have traditionally been manufactured and sold by third-party vendors that RTU manufacturers work with to ensure that the ERV is compatible with their product. There has been little interest from RTU manufacturers to integrate ERVs into their product until recently. The market has very low uptake of ERVs, so the manufacturers don’t see any value in bringing development for these products in-house. We have heard through our market characterization research that a few manufacturers are considering developing integrated ERVs as the industry moves toward energy savings solutions for RTUs.

Future growth

In summary, there are some high-performance RTUs available in the market and manufacturers are working on new products, but their focus is on meeting upcoming changes to federal minimum standards. New dual fuel heat pump RTU products and ERVS will be released, but this is not a core component of their business. We will work with the industry to focus more on energy efficiency and electrification to drive further advancements in the market, and work with manufacturers to continuously introduce new high-efficiency products and expand their offerings.

Efficiency specifications

The federal minimum standards for RTUs, including dual fuel heat pumps are regulated by the Department of Energy. These standards focus on energy efficiency and overall performance is measured by COP, EER, and IEER for 5.4 tons and above. Units smaller than 5.4 tons use HSPF, EER, and SEER. The DOE minimum efficiency requirements for heat pumps can be found below in Table 3.

Table 3. Federal minimum performance requirements for unitary heat pumps

Air-Cooled Electrically Operated Unitary Heat Pumps: Minimum Efficiency Requirements			
Size Category	**Heating Section Type**	**Subcategory or Rating Condition**	**Minimum Efficiency**
<65,000 Btu/h	All	Split system	14.3 SEER2 7.5 HSPF2
		Single package	13.4 SEER2 6.7 HSPF2
≥65,000 Btu/h and <135,000 Btu/h	Electric resistance (or none)	Split system and single package	14.1 IEER
	All other	Split system and single package	13.9 IEER
		47°F db/43°F wb outdoor air	3.40 COP_H
		17°F db/15°F wb outdoor air	2.25 COP_H
≥135,000 Btu/h and <240,000 Btu/h	Electric resistance (or none)	Split system and single package	13.5 IEER
	All other	Split system and single package	13.3 IEER
		47°F db/43°F wb outdoor air	3.30 COP_H
		17°F db/15°F wb outdoor air	2.05 COP_H
≥240,000 Btu/h	Electric resistance (or none)	Split system and single package	12.5 IEER
	All other	Split system and single package	12.3 IEER
		47°F db/43°F wb outdoor air	3.20 COP_H
		17°F db/15°F wb outdoor air	2.05 COP_H

The table above aligns with the heat pump minimum efficiency requirement outlined in the Minnesota commercial code that follows ASHRAE 90.1 2019 section 6.8.1-2 guidelines. There are currently no code requirements for dual fuel heat pumps on commercial buildings.

Utility rebates

Commercial rebates for direct expansion cooling RTUs have existed for years. These rebates depend on meeting the size, EER, and IEER requirements outlined by the utility, which is also used to calculate the rebate amount. A few utilities have tried rebating high-efficiency heating

RTUs with condensing gas burners, but these efforts have led to low participation and ultimately cancelled programs, as this technology faces many barriers.

Until 2024, prescriptive rebates for dual fuel commercial heat pump RTUs have not existed in Minnesota. However, this will change as Xcel Energy's 2024–2026 Energy Conservation and Optimization (ECO) plan includes prescriptive rebates for dual fuel heat pump RTUs. Minnesota Energy Resources Corporation (MERC) also added a new prescriptive measure for RTUs in their 2024–2026 ECO Plan that will mainly apply to RTUs with integrated ERVs.

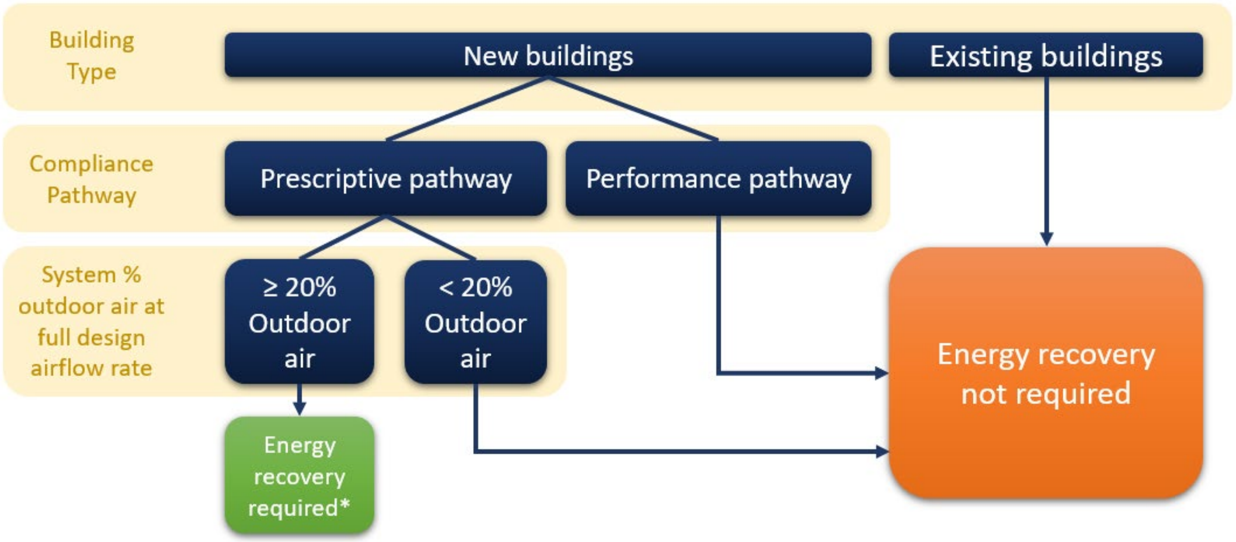
Some electric and gas utilities offer prescriptive rebates for ERVs. CenterPoint Energy added the measure back to the company's prescriptive rebate offerings for ventilation on air handling units in 2024. CenterPoint Energy's rebate is $0.50/CFM outside air through the device. Xcel Energy offers rebates of $1 per CFM heating and $1 per CFM cooling on ERVs installed with 60% total cooling effectiveness and 60% total heating sensible effectiveness. MERC's 2024–2026 plan introduces a new prescriptive rebate for ERVs, offering a maximum rebate of $500 per unit, with a rate of $50 per 100 CFM in their program.

Code requirements

Outside federal minimum efficiency requirements, commercial code is only applicable for ERVs and not dual fuel heat pumps. For new construction, builders can follow a prescriptive pathway that requires energy recovery for systems that exceed the supply airflow and percentage of outdoor air described in section 6.5.6 (Table 4 below). For code compliance, builders can alternatively choose the performance pathway that does not require ERVs according to the ASHRAE guidelines. These energy recovery requirements do not apply to alterations of existing buildings (i.e., RTU replacements).

It should be noted that the 2024 Minnesota commercial code includes an amendment to the ERV requirement that weakens the requirements stated by both the ASHRAE 90.1 2019 and 2016 guidelines. This amendment results in ERVs only being required for new buildings that follow the prescriptive path and have outdoor air requirements above 20%. The figure below shows the large ERV savings opportunity available given the limited path for which they are currently required by code.

Figure 4. Compliance pathway for MN commercial code



***Although energy recovery can only be required for systems with ≥ 20% outdoor air, the requirement also depends on other system factors shown in Table 4 below.**

Table 4. Minnesota Rules, Chapter 1323- 6.5.6.1.2 – ERVs required if design supply airflow exceeds values listed

Climate Zone	% Outdoor air at full design airflow rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
	Design supply fan airflow rate							
6A	NR	≥16,000	≥5,500	≥4,500	≥3,500	≥2,000	≥1,000	≥120
7	NR	≥4,000	≥2,500	≥1,000	≥140	≥120	≥100	≥80

Competitive landscape

High-performance RTUs are one choice of many commercial HVAC solutions. Though RTUs are the most common solution for commercial buildings, there are competing products that can take their place. For our program to be successful, we need to clearly understand the competition in the market and how it can be an opportunity or a barrier. The table below details competing RTU products and how they compare to dual fuel RTUs.

Table 5. Competitive products and characteristics

Competitive product, practice, or service	Commercially available?	Comparable cost (without considering incentives)	Energy savings	Comments/notes
Electric AC RTU paired with natural gas or propane furnace	Yes	Lower	None	Most common RTU available. Usually, lowest cost and lowest efficiency. Can include outdoor air options.
Heat pump with electric resistance backup heat	Yes	Higher	Lower	Very common heat pump configuration, especially for southern regions where heating demand is low. Little to no bill savings compared to gas furnace — costs could increase.
Variable refrigerant flow (VRF) systems	Yes	Higher	Higher	High cost due to installation and equipment, especially for retrofit applications, thus challenging for existing buildings. Most applicable to new construction. Requires separate equipment for ventilation.

Air conditioner RTUs with a gas furnace are the traditional choice for commercial buildings. These are the main competitors for dual fuel heat pump RTUs as they provide heating and cooling to the building and are the most familiar product. Dual fuel heat pump RTUs are a drop-in replacement for these products, but customers and contractors will need to see a benefit to switch product types.

Heat pumps that have electric resistance as backup heat are also a competitor in this space. These types of products are primarily used in southern regions but are also a drop-in replacement option for traditional RTUs with a gas furnace. However, the electric resistance backup heat could require updated electric infrastructure and increase customers' bills, so applications are limited as well. Customers interested in electrification, may want to go all-electric and choose this option over a dual fuel heat pump RTUs.

Variable refrigerant flow (VRF) systems are a more sophisticated option for specific applications that do not have ductwork. VRFs are used for retrofit or new construction applications where ductwork does not exist, or fresh air ventilation and cooling/heating are decoupled. This can be a competing product as it provides similar electrification and efficiency benefits as heat pump RTUs.

MARKET DESCRIPTION

Market summary

The commercial market is the primary area of focus for the initiative. Table 6 below shows some general aspects of the target market for this technology including the focus sectors for the ETA initiative, whether the initiative will focus on existing buildings, new construction, or both, the current market size, and energy savings potential to provide a sense of opportunity scale.

Table 6. High-performance RTU target market summary

Sector (e.g., residential, commercial, industrial, etc.)	Commercial
Building Type	Existing and new construction building, including: ■ Municipal ■ Universities ■ Schools ■ Hospitals ■ Commercial retail ■ Grocery ■ Small commercial buildings three stories or less (offices) ■ Industrial buildings/warehouses ■ Restaurants
Current market size	Commercial buildings in Minnesota: 20,700 Number of Existing RTUs in state: 132,427 Percentage of RTUs that use gas furnaces for heating: 97%
Technical savings potential[10]	-1,610,000 MWh 21,210,000 Dth 15,710,000 MMBtu (net savings)

[10] Further details are provided in the savings potential section and Appendix B.

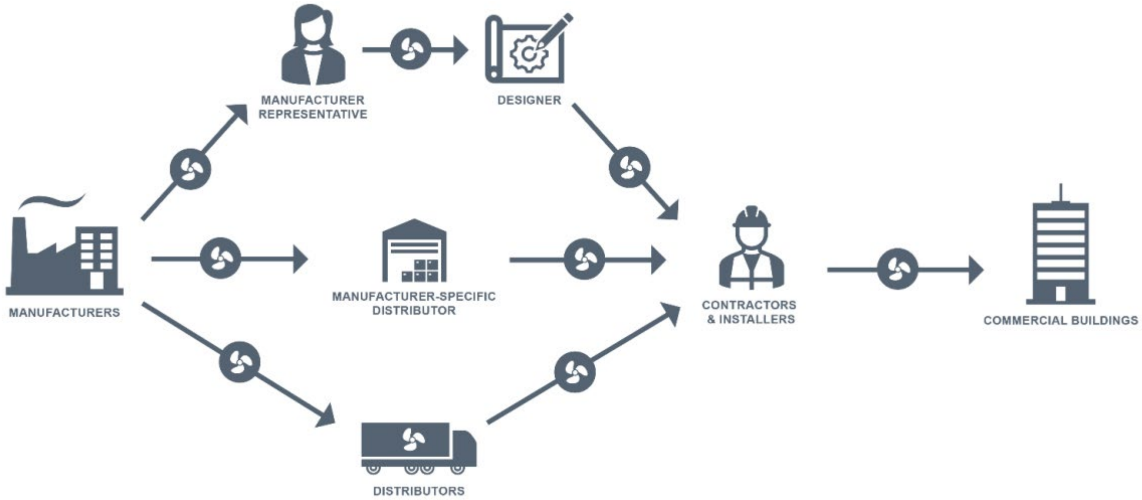
Market dynamics and path to purchase

The commercial HVAC supply chain has a few different avenues to deliver product to the customer. Depending on the application and product type, we can see the following paths:

- Manufacturer-specific distributors who only represent one brand of equipment for all product types or specific equipment types — deliver equipment to contractors.
- Manufacturer representatives and designers work together to provide a recommendation for a specific piece of equipment. This is the least common path, representing less than 10% of the market.
- Distributors stock products they have purchased in wholesale from various manufacturers. These products are usually the baseline standard efficiency products.

All these market actors help influence contractors and installers, who recommend equipment to their customers.

Figure 5. Simplified RTU market map[11]

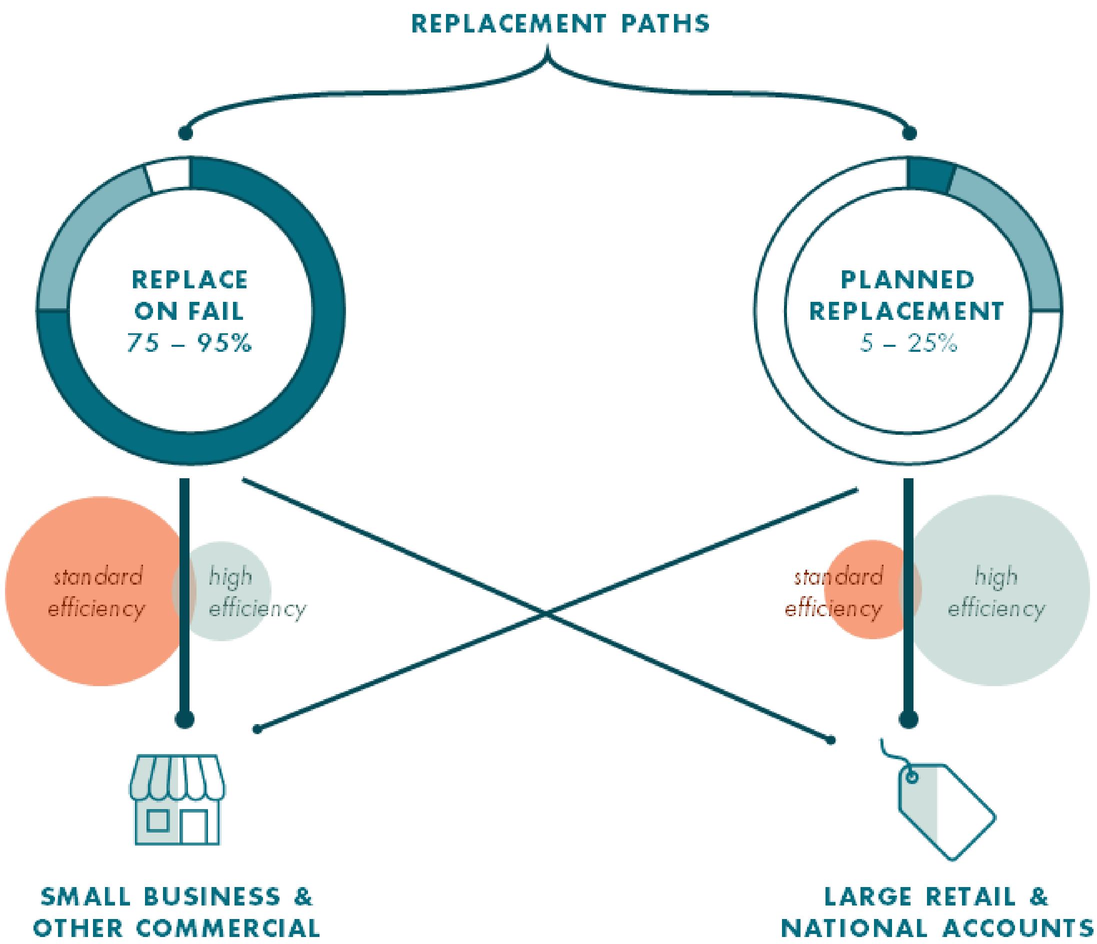


The replace-on-fail market for RTUs refers to a situation in which units are typically replaced only when they fail or reach the end of their operational life. In this scenario, building owners (or operators) defer replacing their RTUs until they experience a breakdown or significant malfunction. This approach to replacing RTUs dominates the market because it is a reactive strategy, where replacements are initiated in response to a system failure, rather than as part of a proactive, planned upgrade. This model of replacement often results in a higher demand for standard, less energy efficient units, as building owners primarily focus on restoring

[11] Dulane Moran, Rebecca Hovey, Bretnie Eschenbach, Julianne MacLennan, Jessica Walter. 2023. *High-Performance RTU Market Characterization*. Center for Energy and Environment. https://www.etamn.org/sites/default/files/research-papers/Final%20RTU%20Market%20Characterization.pdf

functionality rather than the long-term efficiency or emissions. The figure below outlines this market dichotomy and includes an estimate of the market share for replace on fail compared to planned replacement.

Figure 6. Estimate of market pathways for equipment replacement[12]



In addition, if customers ask for and purchase high-efficiency RTUs, this only refers to the efficiency of the cooling performance. Since the heating efficiency in this market hasn't changed in over 30 years,[13] efficiency only refers to cooling efficiency. All of this affects how the customers and contractors perceive the equipment and their choice of replacement when

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[12] Dulane Moran, Rebecca Hovey, Bretnie Eschenbach, Julianne MacLennan, Jessica Walter. 2023. *High-Performance RTU Market Characterization*. Center for Energy and Environment. https://www.etamn.org/sites/default/files/research-papers/Final%20RTU%20Market%20Characterization.pdf

[13] Federal minimum standards for RTUs increased from 80% to 81% starting in 2024. This is the first change in minimum efficiency standards since 1994.

these situations arise. To encourage more high-efficiency heating equipment choices, we need more training and education for customers and contractors.

PROGRAM LOGIC

Long-term vision

The high-performance RTU initiative will implement several market support strategies to achieve the desired end state. If successful, we expect to see high-performance RTUs widely available, making up the majority of market share in Minnesota and encouraged by building code. Customers and contractors will have all the resources they need to support high-performance RTU installation, maintenance, and service. The desired end state is for high-performance RTUs to be the most common choice in the industry.

Market barriers and opportunities

Multiple barriers inhibit the adoption of this technology. However, a few significant opportunities can help overcome the obstacles these products face. In this section of the market transformation plan, we have distilled the key and most pronounced barriers and opportunities in this market. These barriers and opportunities were informed by our market characterization research and our experience with commercial HVAC programs and research to date. Market support strategies will either be designed to overcome the most critical barriers listed below or leverage the opportunities identified to help the market accelerate faster.

High-performance RTU key barriers:

1. Lack of product availability and long lead times

Stakeholders often encounter challenges in procuring high-performance RTUs due to limited manufacturer offerings, product availability, and long lead times. Extended lead times for these technologies can cause delays in projects, leading to reluctance in adopting ERVs and dual fuel heat pumps. This is especially true because the majority of the market replaces equipment when it fails and seek a quick replacement. If high-performance equipment isn't readily available, they will purchase whatever is available. This lengthy procurement timeline acts as a barrier to broader adoption, as well as the perception of equipment scarcity.

2. Historically slow evolving market with established biases and misconceptions

Dual fuel heat pumps and ERVs encounter resistance to adoption due to a historically slow-evolving market that maintains established biases and misconceptions. These technologies face challenges from existing industry perceptions and long-standing biases that favor conventional systems, mostly because conventional systems are familiar and therefore easy to install and well understood. The market's bias was highlighted in the market characterization research, where they found that efficient equipment only describes efficient cooling performance and not heating performance. So, when a customer asks for and purchases an efficient RTU, they are only receiving efficient cooling, not heating. The market's reluctance to embrace new technologies partially stems from the lack of change in this equipment over time. The heating performance of RTUs has not changed in over 30 years, so there has been no need to learn about and adopt new technologies. This has entrenched beliefs in this industry, making it difficult to shift mindsets toward the advantages offered by ERVs and dual fuel heat pumps.

3. Increased system complexity, installation, and control challenges

ERVs utilize sophisticated controls to regulate airflows, manage energy transfer, and maintain indoor air quality. The complexity of these control systems can be overwhelming for some HVAC technicians, contractors, or building operators, leading to a lack of confidence or expertise in optimizing ERV performance. In addition to controls, the initial installation and setup of ERVs can be a challenge for inexperienced technicians, leading to poor performance from the day the unit is installed. ERV maintenance adds another layer of complexity to the already misunderstood system, leading to challenges for technicians.

Dual fuel heat pumps can also have control challenges due to their system complexity compared to typical cooling RTUs. With added components like a reversing valve, the system has additional control considerations, especially during troubleshooting. Other complexities with the controls can include determining the switchover temperature (if allowed) for the dual fuel heat pump to switch over to gas heat. Supply fan airflows are typically different for heating and cooling modes and have additional settings to consider.

4. Low awareness and product confidence

High-performance RTUs face a significant barrier to adoption due to low awareness and confidence in the product. This often leads to inflated costs because contractors are unfamiliar with the product, may be hesitant to install it, and fear potential callbacks. Many stakeholders including contractors, building owners, and end users don't understand the value these technologies provide because they have limited experience with the benefits and functionalities of ERVs and dual fuel heat pumps. This lack of awareness leads to a lack of confidence in the performance and reliability of these technologies, hindering widespread adoption. Though ERVs and heat pumps have been used for many years, their efficacy in cold climates has yet to be widely understood.

High-performance RTU key opportunities:

1. Manufacturers expect the heat pump market to grow and are evaluating market opportunities

Manufacturers anticipate growth in the heat pump market and its associated market opportunities, presenting an opportunity to spur change in this stagnant market. The industry is taking note of electrification policies and evaluating opportunities to gain market share. These planning and product development efforts can be leveraged to vastly improve the performance of RTUs. We can show them the potential demand for high-performance RTUs from key market actors like large corporations and building owners/end users. This change in the industry and potential demand can prompt manufacturers to invest in research, development, and production scalability for dual fuel heat pumps and ERVs. As manufacturers jockey for heat pump market share, we expect manufacturers to refine and promote these systems, creating opportunity to enhance their affordability and availability. Enhanced opportunities like this contribute to increased consumer[14] awareness, accessibility, and confidence in adoption.

2. Increasing effort to reduce energy use and carbon emissions among large commercial building owners (e.g., corporations, federal and local government, etc.)

This effort from large commercial building owners including corporations and governmental entities, to curtail carbon emissions and reduce energy consumption, presents a significant opportunity to drive the adoption of dual fuel heat pumps and ERVs. These stakeholders who are committed to sustainability seek innovative solutions to reduce their carbon emissions and enhance their energy efficiency. Dual fuel heat pumps and ERVs offer a solution to meet these objectives. This problem solving can be leveraged to increase awareness and confidence in these technologies. By highlighting the energy savings and bill impacts of these technologies, we can encourage building owners to embrace them as essential to their sustainability goals.

3. Heat pumps and ERVs offer a substantial energy and emissions savings opportunity for commercial buildings

HVAC accounts for over half the energy use in commercial buildings nationwide.[15] High-performance RTUs with dual fuel heat pumps and ERVs have the potential to reduce HVAC energy use by more than 50%. By emphasizing the substantial energy savings and emissions-reducing capabilities of dual fuel heat pumps and ERVs, stakeholders can be encouraged to prioritize these technologies in their RTU selection process. Further, these technologies can deliver bill savings to the consumer and can be an easy plug and play replacement for existing equipment. Raising awareness of the ease and effectiveness of this technology presents a huge opportunity.

Market support strategies

To leverage the opportunities that exist in the market and overcome known barriers, we've identified a comprehensive selection of key market support strategies, outlined in this section. Many are informed by the market characterization research and CEE's previous efforts and experience with existing programs.

[14] Note, consumer is a broad term meant to encompass building decision makers, purchasers, end user, and other appropriate parties.

[15] U.S. Energy Information Administration. 2023. *Use of Energy Explained.* U.S. Energy Information Administration https://www.eia.gov/energyexplained/use-of-energy/commercial-buildings.php

As the team embarks on market support strategies, we will learn more about the market, the impact of the strategies, and how the market itself may be evolving or shifting independently. To optimize the initiative's impact, the team will adapt and potentially shift market support strategies over time. These changes will be carefully considered, documented, and brought to the coordinating committee annually.

1. Generate and leverage field studies, pilots, and data to create case studies and market resources that build market awareness and confidence

We aim to recruit diverse pilot partners, including business owners, contractors, distributors, and manufacturers, to facilitate field demonstrations. These pilots will provide crucial data supporting energy modeling efforts to showcase the tangible benefits, such as energy and cost savings and return on investment, associated with dual fuel heat pumps and ERVs. Utilizing this field data, we'll develop compelling case studies and educational tools and resources that demonstrate energy savings potential and illustrate the direct impacts on customer bills, effectively highlighting the advantages of these technologies. These tools, resources, and data will be used to generate market awareness and build confidence in selling and installing this product.

2. Partner with manufacturers and distributors to expand product availability, decrease product lead time, and increase product development

CEE will build these partnerships by working with manufacturers and distributors on field demonstrations and pilots, training activities, resource development, and national engagement opportunities. We will connect with them to showcase the market potential and business opportunity for high-performance RTUs. Through our field research and market engagement, we will bring market insights to manufacturers to drive product development and deliver a better customer experience. We will also collaborate with distributors to optimize stocking practices and connect distributors with interested building owners and contractors. These partnerships will drive demand and create a better, more widely available product.

3. Create, leverage, and deliver market education and training in collaboration with market actors

We will create tailored marketing, education, and training resources for trade partners, contractors, distributors, and manufacturers within Minnesota's HVAC distribution network. We will work with market partners to understand the intricacies of the distribution dynamics and identify educational gaps that exist today. The goal is to generate useful training and resources that fill market gaps, generate awareness and confidence in the market opportunity for high-performance RTUs, and build proficiency in selling, installing, maintaining, and repairing the product. This education will help create market leaders that drive the sales of this product, and we will help develop the training, tools, and resources to do so.

4. Create and leverage resources and conduct targeted consumer[16] outreach to build awareness and demand

This strategy will leverage field demonstrations and case studies to showcase the energy savings, emissions reductions, and ROI that high-performance RTUs offer. These real-world examples will help build awareness and confidence in this technology among consumers. Additionally, education and training materials will be developed that showcase these benefits, streamline product selection, and make it easy for building owners to find contractors that install high-performance RTUs.

These resources and materials will be delivered to business owners or associations that either reach many building owners or those building owners who own a large number of buildings. This outreach could include one-on-one relationship building with corporations and municipalities or presentations and materials for business associations. These efforts will also target large organizations or associations with sustainability goals, so we can showcase how high-performance RTUs can help them achieve these targets. Our goal is to have these organizations commit to buying high-performance RTUs by providing training, education, and tools that showcase the benefits and value high-performance RTUs provide. These commitments will build demand for this product, while providing further confidence for other owners and large entities to do the same.

5. Engage with utilities on program opportunities and tools to highlight commercial rate options and bill impacts

We will work with utilities to develop pilots and programs that support and incentivize high-performance RTUs. Our market research, field studies, and modeling can provide utilities with the information they need to develop robust program offerings, which will lower the upfront cost for equipment. Once programs are launched, we will collaborate with utilities and market partners to drive participation in these programs.

Additionally, we will collaborate with utilities and market partners to develop accessible tools and resources that clarify commercial rate options, empowering market actors to effectively navigate complex rate structures. These tools and resources will highlight the bill impacts from installing high-performance RTUs and inform proper equipment selection, controls, and setup to maximize savings.

6. Collaborate with national partners to create a unified voice and align high-performance RTU specifications, efficiency standards, and test standards

We will work with national partners (e.g., ENERGY STAR, NEEA, NEEP, etc.) to align high-performance RTU specifications and testing standards (e.g., whole-box efficiency and

[16] Note, consumer is a broad term meant to encompass building decision makers, purchasers, end user, and other appropriate parties.

combined heating specifications). We will leverage our partnerships to convene a national cohort to discuss the opportunity for high-performance RTUs and create a space for shared learning on program implementation, market research, and field or lab demonstrations. This collaboration will highlight the collective demand for high-performance RTUs and communicate product development needs to manufacturers. This alignment and unified voice will provide clear communication and demand signals to the supply chain.

7. Develop strategies and work with appropriate entities to advance state and federal codes and code compliance

This strategy involves engaging in collaborative efforts with code stakeholders to explore avenues for advancing code requirements and compliance practices. This involves assessing retrofit possibilities and enhancing overall compliance strategies. To support these initiatives, we will compile and present comprehensive field data, along with energy savings and cost information, tailored specifically for code stakeholders, facilitating informed decision-making and potential code enhancements. This work will advance codes that encourage the selection of high-performance RTUS.

PARTNERS AND ROLES

For this work, CEE will build partnerships with local and national stakeholders to establish a trusted voice in the market and influence change.

Utility stakeholders

Minnesota utilities funding Minnesota's Efficient Technology Accelerator (ETA) are key stakeholders that serve on the ETA Coordinating Committee. Representatives of these utilities are also invited to serve on the Evaluation and Cost-Effectiveness Advisory Committee and the Market Strategy Advisory Committee. These utilities include:

- Xcel Energy
- Minnesota Power
- Otter Tail Power
- CenterPoint Energy
- Minnesota Energy Resources

Since this initiative technology is part of both the natural gas and electric market, all listed utilities benefit from this initiative.

CEE collaborates with these utilities to create cost-effectiveness assessments, deliver details on savings and costs, compile and present data on rebate participation, conduct training for contractors, and complement and standardize program offerings across Minnesota as much as possible. Some of the activities that will involve our utility partners are listed as follows.

- Support the creation of rebate programs with eligibility requirements that align with high-performance RTU product specifications. These may include prescriptive rebates offered directly to customers or midstream rebates encouraging distributors and contractors to endorse and market high-performance RTUs.
- Collaborate on creating educational materials for consumers[17] and distribute them across utility contractor networks.
- Support the creation of pilot programs or campaigns that specifically target the adoption of high-performance RTUs.
- Conduct or jointly organize training sessions for contractors focused on the value of high-performance RTUs and available program opportunities.

Supply chain market actors

Supply chain actors will be a critical partner for the program. ETA is well positioned to develop a strong relationship with RTU supply chain market actors. We have connections with local RTU manufacturers and distributors, as well as others across the nation. ETA also has existing relationships with other key supply chain actors in the state that will bolster the programs opportunities.

Key supply chain partners are:

- Contractors and trade partners
- Manufacturers
- Distributors
- Consumers
- Developers and builders

NEEA

CEE began working with Northwest Energy Efficiency Alliance (NEEA) on commercial rooftop unit research in 2022. We leveraged their extensive experience with market transformation and their Efficient Gas Rooftop Unit[18] initiative to inform our logic model development. Capitalizing on over 25 years of experience with market transformation, CEE will work closely with NEEA to strategically prioritize and align engagement with manufacturers when needed to advance this initiative's goals.

[17] Note, consumer is a broad term meant to encompass building decision makers, purchasers, end user, and other appropriate parties.

[18] NEEA. 2024. *Efficient Gas Rooftop Units.* Betterbricks. https://betterbricks.com/solutions/efficient-rooftop-units?__hstc=85581830.a29853e5b909106ee7e818ec7d80a952.1704924167832.1704924167832.1704924167832.1&__hssc=85581830.2.1704924167832&__hsfp=1654019965

National partnerships and stakeholders

Achieving scale is crucial in the program's market transformation plan, and this scale extends beyond the Minnesota market. Therefore, coordinating with national partners is integral to the program's plan. Below is a summary of each group and CEE's involvement.

- **Consortium for Energy Efficiency** is a nonprofit member organization that largely consists of utility members from across the country. They bring together their members and industry experts to set metrics for efficiency measures, including heat pump RTUs. Working with the Consortium will help achieve national collaboration and alignment on RTU specifications and keep all participating parties attune to market trends and establish relationships that support high-performance RTUs.
- **Northeast Energy Efficiency Partnerships (NEEP)** is a nonprofit composed of funding members in the northeast as well as national-level subscribers. They created the first extensive list of cold-climate residential ASHPs and they have started a list of commercial VRF systems. We will engage with them on the opportunity and needs for the RTU market. Partnering with NEEP will support national collaboration and engagement for this initiative.
- **ENERGY STAR** is administered by the United States Environmental Protection Agency and delivers cost-saving energy efficiency solutions that protect the climate, improve air quality, and protect public health. Products that fall under ENERGY STAR like commercial heating and cooling reduce energy waste and help consumers save on utility bills. The program sets performance minimums for both heating and cooling products. CEE collaborates with ENERGY STAR on market transformation strategies, as well as program and messaging alignment.
- **California MTA** California Public Utilities Commission (CPUC) established a market transformation framework in 2019. This framework provides funding for CalMTA to support market transformation initiatives to increase energy efficiency and reduce greenhouse gases by driving market adoption of selected technologies and practices. RTUs are an early focus area for CalMTA and we will engage with them on collaboration and alignment opportunities.

SAVINGS POTENTIAL

This initiative has significant savings potential. Technical potential represents the total achievable savings if we were able to influence the market to a maximum effect. The estimated total technical potential for the high-performance RTU initiative is 15.7 million MMBtu (million British thermal units) of combined savings.

To project technical potential, we had to understand the number of RTUs in the state as well as their tonnage. Referencing a 2017 CEE CARD study,[3] we were able to break down the RTUs by tonnage, found below.

Table 7. Breakdown of RTU tonnage ranges

Cooling Capacity (Ton)	Number of RTUs 2017	Number of RTUs 2024	Number of RTUs 2044	% of Total
<5.4	62,200	71,563	98,317	51.4%
≥5.4 to <11.3	35,200	40,499	55,639	29.1%
≥11.3 to <20	12,000	13,806	18,967	9.9%
≥20 to 25	5,700	6,558	9,010	4.7%
>25 to <63.3	3,900	4,487	6,165	3.2%
≥63.3	1,900	2,186	3,003	1.6%
Total	120,900	139,100	191,100	100%

Next, an energy model was created to estimate overall energy savings for each of the tonnage ranges listed above. The energy model is based on manufacturer-provided performance data for a dual fuel heat pump and a switchover temperature of 20°F[19]. This performance data and switchover temperature were plugged into the energy model for each tonnage range to calculate savings. Finally, the number of RTUs was extrapolated over the next 20 years to account for new construction buildings.

There were two calculations performed, one for dual fuel heat pumps and one for energy recovery ventilators. For our calculation, there were four tonnage ranges selected that represent units in our product definition. These ranges are less than 5.4, 5.4 to 11.3, 11.3 to 20, and 20 to 25 tons. The dual fuel heat pump and ERV savings were calculated using a unit tonnage set at the midpoint of each range. All ERV savings were calculated with the assumption that the ERV was connected to a dual fuel heat pump RTU. The results from the energy models are summarized in Table 8 below. Further details on how this calculation was completed and the associated energy savings for high-performance RTUs can be found in Appendix B, the Energy Savings and Evaluation plan.

Table 8. High-performance RTU Technical Potential

	Energy Efficiency Savings			Efficient Fuel Switching Savings			Total
	Electric Peak Demand (kW)	Electric Cooling Savings (MWh)	Gas (Dth)	Electric (MWh)	Gas (Dth)	Net Energy Savings (MMBtu)	Energy Savings across fuel types (MMBtu)
Statewide Technical Potential	320,000	550,000	2,720,000	-2,060,000	17,640,000	10,610,000	15,200,000
RTU ERVs	290,000	480,000	2,720,000	n/a	n/a	n/a	4,350,000
RTU HPs	30,000	70,000	n/a	-2,060,000	17,640,000	10,610,000	10,850,000

19 The heat pump RTU performance data is based on existing Tier 1 equipment, so the technical potential is conservative estimate as equipment performance should improve over time.

RISK MITIGATION PLAN

Risks are inherent to any project. However, we have identified key anticipated risks and developed mitigation strategies. These are described in Table 9 below.

Table 9. High Performance RTU risk mitigation matrix

"IF" this happens	"THEN" this will occur (impact)	Probability (H/M/L)	Impact (H/M/L)	Risk response: (Accept, avoid, mitigate, transfer)	Response plan
Contractors increase the price of installation costs disproportionately compared to traditional RTUs because it is a technology they are not familiar with.	Customers may not realize the value proposition for high-performance RTUs if traditional heating RTUs have a much lower initial cost.	H	M	Mitigate	Educate contractors and building owners on the ease of installation and value proposition to build demand.
Manufacturers are not receptive to program support on market engagement.	Manufacturers will not promote high-performance RTUs and prioritize this technology for their product development roadmaps.	L	M	Mitigate	Engage manufacturers to show market demand and opportunity through collaboration.
Utilities do not launch programs centered around dual fuel heat pumps.	Consumers[20] will have difficulty justifying the incremental cost of dual fuel RTUs, resulting in continued low awareness and familiarity with the product.	L	M	Mitigate	Work with utilities on incentive programs to show energy savings potential, bill impacts, and benefits of technology.

[20] Note, consumer is a broad term meant to encompass building decision makers, purchasers, end user, and other appropriate parties.

“IF” this happens	“THEN” this will occur (impact)	Probability (H/M/L)	Impact (H/M/L)	Risk response: (Accept, avoid, mitigate, transfer)	Response plan
Manufacturers and consumers prefer all-electric heat pumps vs. dual fuel.	Fewer dual fuel options will be available, and adoption will be slow.	L	M	Mitigate	Highlight dual fuel value propositions related to bill savings, ease of install, and resiliency.
Lack of stocked product and lead times remain long.	Procuring high-performance RTUs will remain difficult, especially for the replacement market.	M	H	Mitigate	Work with manufacturers to identify issues leading to long lead times. Work to create purchase agreements to increase demand for products.

TRANSITION PLAN

The high-performance RTU team will track metrics to monitor the initiative’s progress and re-evaluate strategic interventions as necessary. The high-performance RTU logic model will be updated periodically during the Market Development phase, removing barriers and opportunities based on the evolution of the market. Interventions will be adjusted to ensure sustained acceleration of market adoption, leading to the ultimate impact: high-performance RTUs are widely available, make up the majority of market share, and are encouraged by code.

Once the market development strategies have been deployed for several years and achieve their desired impact, the team will monitor market share, market progress indicators, and the code and standards landscape to determine the right time for the program to pull back market development activities. This will include transitioning critical functions to the market and a move into the Long-Term Monitoring and Tracking (LTMT) phase where sales will be tracked and analyzed to measure savings, but market support activities are discontinued. Determining readiness for transition from market development, a resource-intensive phase, to LTMT, a resource-light phase, will require careful monitoring and assessment for optimal timing. The ETA coordinating committee will review and approve the transition to LTMT.

Appendix A. Market Characterization Report

See High-Performance RTU Market Characterization Report

APPENDIX B. ENERGY SAVINGS AND MARKET EVALUATION

See High-Performance RTU Energy Savings and Market Evaluation Plan (Includes complete logic model)