No Really, RTU Gas Efficiency is a Decarbonization Strategy

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ABSTRACT

While many utilities, energy efficiency organizations, and manufacturers are scrambling to respond to electrification policies and decarbonization buzz, the US continues to sell hundreds of thousands of commercial gas rooftop units (RTUs). RTUs are responsible for heating and cooling 60% of the US commercial building floor area, representing about a fifth of total commercial building energy use. (DOE 2017). Gas RTUs are the most common commercial heating technology in the US—70 to 90% of the RTU market is still gas-fired—yet they remain one of the least-transformed products over the last several decades in terms of energy efficiency. While these gas RTUs will remain in buildings for the next 20–30 years and will be slow to electrify, gas RTUs continue to get sold with minimal heating efficiency improvements.

This paper will describe often-ignored RTU features that can save significant gas heating energy, and therefore carbon emissions, including low leakage dampers, improved insulation, heat or energy recovery, dual fuel heat pump RTUs, and condensing furnaces. For example, current metrics completely ignore interactive effects between component furnaces, heat pumps, and energy recovery. We will share energy modeling, lab testing, and field study results that demonstrate the carbon emission and gas heating savings achievable from these features and how current and upcoming metrics fail to capture the consumption impacts of these features. We will share market insights from manufacturer and distributor interviews and program considerations when planning for gas RTU measures.

Introduction

Rooftop units (RTUs) are responsible for heating and cooling 60% of the U.S. commercial building floor area, representing about a fifth of total commercial building energy use (DOE 2017). For the purposes of this paper, RTUs are defined as outdoor packaged commercial heating and cooling equipment that provides both space conditioning and ventilation. Historically, RTU efficiency was defined either by its cooling metric [Seasonal Energy Efficiency Ratio (SEER2)[1] or Integrated Energy Efficiency Ratio (IEER)[2]] or its heating metric [Thermal Efficiency (TE) or Annual Fuel Utilization Efficiency (AFUE)[3]].

New RTU performance rating metrics in the U.S.—Thermal Efficiency 2 (TE2) for gas furnaces, Integrated Ventilation and Heating Efficiency (IVHE) for heat pumps, and Integrated Ventilation Economizing and Cooling (IVEC) for commercial unitary air conditioners—have

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[1] SEER2 is the DOE regulated metric based on Air Conditioning, Heating, and Refrigeration Institute (AHRI) test procedure AHRI 210/240-2020. (AHRI 2023)

[2] IEER is the current DOE-regulated metric for commercial unitary equipment based on AHRI 340/360-2022 (AHRI 2022).

[3] TE is the current DOE regulated metric for warm-air furnace (CFR. 2015a) based on CSA/ANSI Z21.47. (CSA 2003)

improvements over their predecessors. (EERE 2022a) However, these new metrics do not account for all features that impact gas and electric energy consumption, like cabinet insulation and dampers. These metrics, therefore, still create an incomplete picture of RTU performance, particularly for gas heating energy, which is a critical part of reducing carbon.

As national and regional decarbonization and energy efficiency goals evolve, it becomes increasingly important to utilize all available strategies, and improving gas efficiency is one of many options. The US continues to sell hundreds of thousands of commercial gas RTUs despite recent decarbonization efforts to convert natural gas-fueled products to electric. Gas RTUs are the most common commercial heating technology in the US compared to heat pump or electric resistance RTUs—70 to 90% of the RTU market is still gas-fired—yet they remain one of the least-transformed products over the last several decades in terms of energy efficiency. While these gas RTUs will remain in buildings for the next 20–30 years and will be slow to electrify, gas RTUs continue to get sold with minimal heating efficiency improvements.

The Northwest Energy Efficiency Alliance (NEEA), in partnership with electric and gas utilities, RTU manufacturers, and efficiency organizations, has researched gas heating efficiency opportunities and developed an approach that reduces significant RTU gas heating energy. This paper will describe often-ignored RTU features that can save significant gas heating energy, and therefore carbon emissions, including low leakage dampers, improved insulation, heat or energy recovery, dual fuel heat pump RTUs, and condensing furnaces. The paper will describe:

1. How consumers currently select RTUs
2. The factors that impact energy consumption
3. Current and upcoming RTU metrics and their attributes and limitations
4. Non-energy benefits associated with energy-saving features
5. Challenges associated with the RTU landscape
6. Recommendations for utility programs and efficiency organizations to include gas heating efficiency in future initiatives

Current RTU System Selection

The HVAC industry and efficiency community generally associate an “efficient RTU” with a unit that has a high cooling rating (e.g., SEER2 or IEER). Manufacturers market their units as standard and high efficiency based on cooling ratings, and this terminology passes through to distributors, contractors, and building owners. Organizations like ENERGY STAR® set efficiency targets for air conditioners and heat pumps (ENERGY STAR 2023), and utilities offer rebates based on the cooling rating. Even the size of a unit is usually referred to in tonnage (e.g., a 5-ton unit), which refers to the nominal cooling capacity. While cooling efficiency certainly matters, it is an incomplete picture of the potential for energy savings in RTUs, particularly in climates with moderate to high heating loads. Historically, heating energy efficiency has only focused on improving a unit’s TE; however, the average RTU has not improved much beyond the current U.S. standard of 81% TE, which is a large, missed opportunity when considering decarbonization strategies.

If the HVAC and energy efficiency industry wants to help consumers meet decarbonization goals, opportunities exist to redefine what it means to purchase an efficient RTU in a way that includes heating. Fortunately, several RTU characteristics improve both heating and cooling energy consumption that could be included in future metrics, utility energy efficiency programs, or product marketing.

Fuel costs and infrastructure upgrades are other factors end users consider when pursuing decarbonization goals. Evaluating the short-term and long-term energy costs can help the end-user when deciding between different RTU fuel options. For example, the cost per Btu of natural gas is around 30% of the cost of electricity, based on data from the U.S. Energy Information Administration that compares the average of the cost per Btu of delivered energy in the United States from 2018 to 2022 (EIA 2022). Additionally, upgrading the electrical service in existing buildings can be cost prohibitive and disruptive. Where gas service is already installed, a customer may prefer to use the existing gas piping but choose a more efficient gas RTU system that reduces carbon footprint as a decarbonization strategy.

Based on one RTU manufacturer's reported sales over the past five years, nearly 80% of commercial product sales include a form of heat. Of that 80%, 75% are gas furnaces and 25% are electric resistance heat. While the percentage of RTUs with a form of electric heat have grown over the past five years, gas furnaces are still a large portion of the market.

RTU Characteristics that Reduce Energy Consumption

Generally, RTUs are composed of three major components: a cooling component (typically an integrated refrigeration system[4]), a heating component (typically a gas furnace), and a supply air fan. These three components are also the three main energy consumers of the system—using either electricity or natural gas for the heating component. In addition, many auxiliary components and features will also impact how efficiently the equipment operates. Efficiency opportunities derive from three primary opportunities:

1. Increasing operational efficiency
2. Reducing RTU heat loss
3. Designing RTUs as a system

1. Increasing Operational Efficiency

Operational efficiency is improved when a piece of equipment provides the same amount of output capacity with less energy (i.e., fuel) input. The Department of Energy Advanced Rooftop Unit Challenge (DOE 2019), ENERGY STAR (ENERGY STAR 2023), and traditional utilities programs have focused on ways to increase RTU operational efficiency of the cooling, heating, and fan components.

- **Higher efficiency cooling,** at both full and part-load conditions, characterized by high cooling ratings such as SEER2 and IEER. (AHRI 2023)
- **Higher efficiency gas furnace**, designated by a higher TE or AFUE rating, such as a condensing furnace (>90% TE2). (CSA 2003)
- **Electric or dual fuel heat pump** use, because electric heating is more efficient on a BTU basis.
- **Higher efficiency fans**, which include higher efficiency motors, improved fan blade design, and/or variable speed capability.

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[4] The refrigeration system in a heat pump is also used for heating when in heat pump mode.

2. Reducing RTU Heat Loss

Reducing heat losses[5] can have a significant impact on seasonal energy consumption and seasonal efficiency, particularly in the heating season. Strategies include:

- **Enclosure insulation**, increasing R-value of the cabinet insulation or the furnace jacket, which reduces conduction and solar radiation.
- **Enclosure sealing** to reduce conditioned air leakage from the walls of the unit.
- **Damper sealing,** reducing air leakage from the outside air damper, decreasing heat loss during unoccupied hours or when economizers are off.
- **Exhaust air energy recovery** and level of recovery effectiveness, transfers energy from exhaust air to the incoming fresh-air stream using energy recovery ventilators (ERVs) or heat recovery ventilators (HRVs).
- **Isolation dampers**, on the supply and return duct that close when the unit is not operating at night.

3. Designing RTUs as a System

Designing and evaluating RTUs from a system perspective ensures they provide the exact amount of energy (heating, cooling, airflow) needed in the conditioned space. A system perspective considers not just individual component performance (i.e., furnace efficiency, fan efficiency), but how the RTU is controlled as a part of a larger HVAC system and how it interacts with the building. A unit with very high component efficiency can fail to achieve expected savings if it is designed to provide more conditioning or airflow than the space requires. RTU design strategies that consider system-level performance include:

- **Economizers** that use outside air to provide cooling to the building when conditions allow.
- **Variable capacity heating or cooling** using variable speed compressors.
- **Variable speed fans** using electronically commutated motors or variable frequency drives.
- **Right-sizing** airflow and heating/cooling capacity.
- **Commissioning**, which ensures the system is operating as designed.
- **Ventilation right-sizing**, balanced with indoor air quality.
- **Advanced controls**, which can include demand-control ventilation, fan control, temperature setbacks, reset logic, self-diagnostics, connectivity with building systems or manufacturer support.

Another factor that influences overall system energy use that is not always captured in component metrics is energy consumption during standby operation, as opposed to point-in-time efficiency. Many of the features that save energy during active operation also contribute to lower energy use or lower standby losses but do not get credit in existing performance metrics.

Energy-saving opportunities related to whole system performance—equipment selection, commissioning, and operation—are more difficult (but not impossible) to influence at the manufacturing or distribution level because they relate to how components are used. However,

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[5] Heat loss means the transfer of usable heat outside the system through conduction, convection, or radiation. For RTUs, this means either hot air or cold air that is lost to the outside air, which necessitates additional fuel being used to make up for the losses.

efficiency advocates can work to ensure equipment has specific capabilities that are verifiable at the equipment level for variable speed fans, variable capacity cooling, and economizers.

Modeled Energy Reduction Potential of RTU Characteristics

NEEA and Cadeo conducted an energy modeling study in five climate zones and five building types of key technology options for RTUs that save gas heating: condensing furnaces, increased cabinet insulation, low leakage dampers, and heat or energy recovery ventilators (HRV/ERV). NEEA found the TE metric only accounts for the impact of condensing furnaces even though the other measures can save as much or more gas energy. NEEA's energy modeling results (shown in Figure 1) demonstrate gas heating energy represents the majority of a gas RTU's total energy consumption in climates with both heating and cooling.

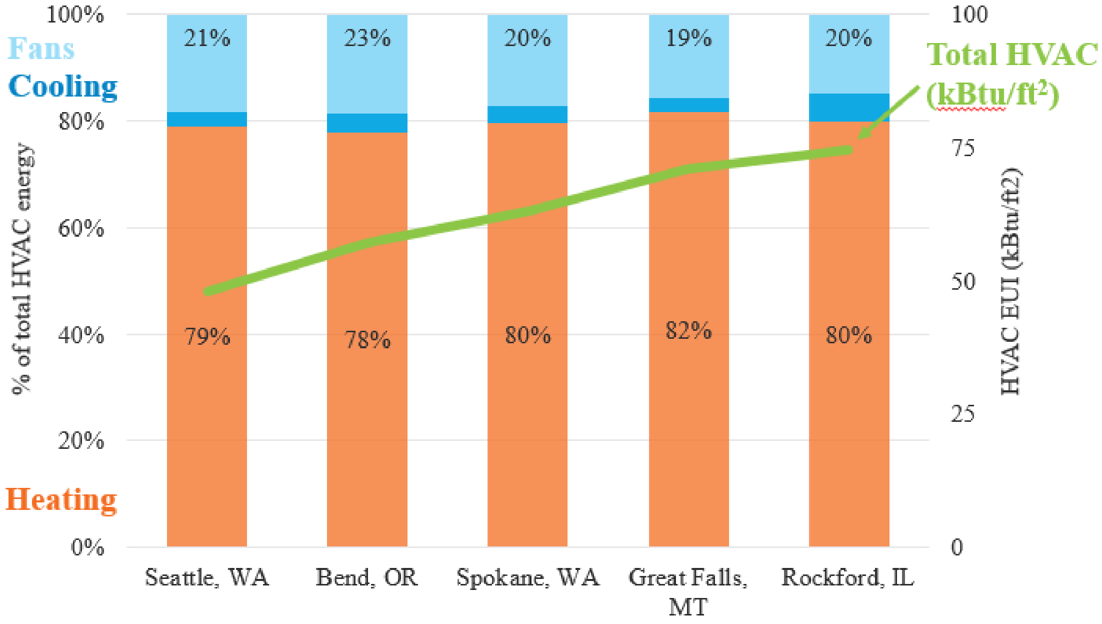

Figure 1. RTU heating, cooling, and fan energy consumption as a percentage of total consumption. (NEEA 2022)

Figure 2 shows that condensing equipment reduces HVAC energy use intensity (EUI) by an average of 10% over a baseline RTU, the combination of increased insulation and dampers save 6%, and an HRV/ERV saves 24% on average (NEEA 2022). The majority of these savings (more than 95%) are gas heating savings, with minimal impacts to electric fan energy and cooling energy.

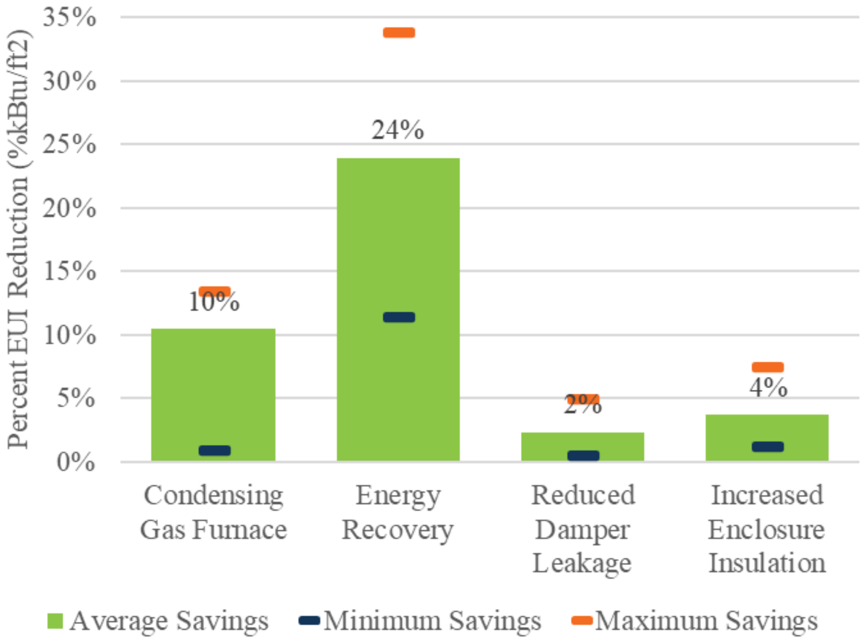

Figure 2. Annual HVAC savings (Electric and Gas) from RTU energy efficiency measures (NEEA 2022)

In a 2022 Commercial Warm Air Furnace (CWAF) standard proposed determination (EERE 2022c), DOE noted that moving to a condensing level standard (92% TE) in the US would result in 2.1 quads of primary energy savings over 30 years. Comparing NEEA's savings estimates of 10% condensing savings, 6% savings for insulation and dampers, and 24% savings for HRV/ERV against DOE's energy analysis shows the relative energy savings potential of these features—1.2 quads for insulation and dampers, and more than five quads for HRV/ERV. These numbers are certainly significant by DOE's standards, and yet these components are not being considered as energy-saving features by codes, standards, and utility programs because they are not included in the scope of DOE's CWAF test procedure and the TE or TE2 metrics.

Current and Upcoming RTU Metrics

Efficiency metrics are used to rate the energy efficiency of a variety of equipment, including RTUs. Because each type of equipment is different, each test procedure and efficiency metric used for rating is also different. The goal of test procedure and metric design is to make sure that equipment that uses less energy gets a better rating and that each test procedure is representative of how equipment operates in real life.

Metrics that do not account for all characteristics impacting RTU energy consumption can be confusing for customers prioritizing energy conservation, lower utility bills, or decarbonization goals. Consumers can become frustrated if they purchase a unit that has a high efficiency metric rating but underperforms because the metric did not account for all the performance characteristics. Conversely, if RTUs have energy-saving features that performance metrics do not account for, consumers are less likely to choose those units as efficient options.

More than ten existing and upcoming metrics are used to rate the efficiency of an RTU. Current and upcoming U.S. test procedures and performance metrics capture some, but not all, of the characteristics that affect RTU energy consumption described above. RTUs (and makeup air units and dedicated outside air systems) are regulated based on two of the three major RTU components previously discussed—the cooling component and the heating component.[6,7]

Table 1 shows the RTU characteristics that impact energy consumption and how current and upcoming performance metrics include or exclude their impact. Upcoming metrics improve upon past metrics by capturing more characteristics that impact energy consumption; however, those improvements are focused heavily on cooling metrics, with heating metrics still excluding many key energy consumption characteristics.

Table 1. RTU characteristics and coverage in current and future metrics

RTU Feature/Metric	Heating Metrics		Cooling Metrics		
	TE	TE2*	EER	IEER	IVEC*
Operational Efficiency					
Full load efficiency	Yes	Yes	Yes	Yes	Yes
Part load efficiency	No	Yes	No	Yes	Yes
Dual fuel interactive effects	No	No	No	No	No
Supply fan energy	No	No	Partially	Yes	Partially
Heat Loss					
Furnace jacket losses	No	Yes	No	No	No
Cabinet insulation	No	No	Partially	Partially	Partially
Cabinet leakage	No	No	Partially	Partially	Partially
Damper leakage	No	No	No	No	No
Heat or energy recovery credit	No	No	No	No	No
System Design					
Seasonal energy use weighting	No	No	No	Yes	Yes
Economizing ability (free cooling)	No	No	No	No	Yes
Energy saving control methods	No	No	No	No	No
Controls verification procedure	No	No	No	No	No

* Indicates an upcoming future metric.

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[6] Gas RTUs will commonly include a direct expansion (DX) cooling system along with a gas furnace. Other (non-gas) configurations of RTUs can include only DX cooling, a heat pump (DX heating and cooling) or electric resistance heating, but these are not the focus of this paper. The regulated metrics that apply to an RTU depends on the year of manufacture, capacity, component configuration, electric service, and dehumidification ability.

[7] Efficiency metrics for fans also exist, such as the FEI metric, but packaged RTU are excluded from proposed DOE requirements for fans because fan performance is already included in the regulated cooling metrics.

Heating Performance Metrics

The gas heating component of an RTU is subject to DOE's CWAF product regulation (EERE 2022b). The current CWAF heating efficiency test procedure references ANSI Z21.47[8] (CFR 2015a) and the regulated metric is TE. Gas RTU test procedures and efficiency requirements have changed little in over two decades even though gas RTUs have a large market share and are a huge opportunity for energy savings.

Currently, most commercial packaged rooftop furnaces have a TE of 80% to 81%. While it is possible to achieve a higher TE for indoor split systems and air handlers (up to 97%) with a condensing furnace, the application of condensing furnaces in package rooftop units is not widespread. Some drawbacks to using condensing furnaces in package units are the high pressure drop associated with the secondary heat exchanger which negatively affects performance during fan only, cooling, or heat pump only operation, and management of the corrosive condensate in conditions below freezing.

DOE updated the regulated CWAF metrics, now TE2, in 2023 with a test procedure final rule for gas furnaces (EERE 2023a) and a proposed rule for heat pumps (EERE 2023b). Manufacturers are not required to test equipment to these metrics until a new standard is set, which is expected in the next DOE cycle (2027-2029). TE2 has notable improvements over its predecessor but still does not fully represent the seasonal heating energy consumption and heating energy saving potential of an RTU.

The CWAF test procedure and TE2 metric only account for a single source of RTU inefficiency: heat lost through the flue (combustion inefficiency). Furthermore, the current test procedure is only applied to equipment operating at full fire, which represents a small portion of the total run time of an RTU operating under typical service conditions.[9]

TE2 is improved over TE as it includes furnace jacket losses; however, the furnace jacket losses are not equivalent to the total enclosure losses for the following three reasons. First, the CWAF testing is not in a conditioned chamber, so testing is not in a representative winter condition. Temperature differential has a big impact on enclosure losses. Testing at room temperatures (e.g., 65°F (18°C)) means the metric does not account for temperature differentials between 20°F and 60°F (-6.7°C to 15.5°C). Second, the furnace component is not required to be tested inside the RTU it will be sold in, so the physical environment surrounding the furnace (i.e., components inside the RTU box, insulation levels, sealing, thermal bridging) may not be representative of real-world conditions. Third, heat loss during standby or recirculation modes is not accounted for because the testing is only during active furnace operation (full and part load). NEEA's energy modeling of RTUs showed that units are in standby most of the time (upwards of 90%) and that this is where most heating season enclosure losses happen (NEEA 2021a).

Energy modeling performed by NEEA (NEEA 2022) has shown that mitigating heat losses from thermal transmittance (conduction), air leakage (convection), and exhaust air can save more than 10% gas energy, but only reduced combustion heat loss through the flue (such as using a condensing furnace) will have any impact on the TE2 rating. Conduction, air leakage, and exhaust air will also impact the electric consumption of an RTU for the cooling system (heat gains during the cooling season) or for the heating system if the RTU has a heat pump or hybrid

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[8] CSA/ANSI Z21.47-21/CSA 2.3 | Gas-Fired Central Furnaces

[9] For example, energy modeling done in support of the development of CSA P.8 estimates that less than 5% of the heating season operating hours are spent in full fire in a typical Canadian climate. (NEEA 2021a)

system[10]. When considering efficiency more broadly as the amount of space conditioning that occurs for a given amount of energy input (a system approach), it becomes clear that the current metrics do not tell the whole story.

Many in the industry continue to pursue whole-box test procedures. NEEA, along with NRCan, efficiency advocates, manufacturers, consumer advocates, testing lab representatives, and AHRI worked together on the development of CSA P.8-2022, which is a consensus-based test procedure that builds on existing test methods for gas furnaces (CSA 2022). Key improvements in the P.8 approach include seasonal weighting of six operating modes, heating season fan energy, damper leakage, cabinet insulation, energy recovery, and furnace efficiency. The impacts of these features are then combined in a new metric: the Heating Season Total Coefficient of Performance (TCOPHS). The P.8 test procedure and TCOPHS metric are not yet required by U.S. or Canadian codes and standards, but they can be used in voluntary programs or could serve as a concrete example of how to incorporate improvements to DOE's current metrics.

Cooling Performance Metrics

Gas RTUs are subject to DOE's Commercial Unitary Air Conditioning (CUAC) product regulation if they include direct expansion cooling. Theoretically if cooling metrics include features that save heating or gas energy, cooling metrics could be used as a performance indicator for heating efficiency. The DOE employs a more comprehensive cooling metric for CUAC, the Integrated Energy Efficiency Ratio (IEER), than the heating metrics described previously (CFR 2015b). While IEER is not a completely representative metric, it does include testing in a conditioned chamber, a weighted average efficiency of multiple load points, and accounts for all sources of electric energy use (e.g., fan energy) and not just the cooling system.

In 2023, the DOE proposed a new metric, IVEC, to regulate CUAC/HP with a proposed test procedure rule for commercial unitary cooling and heat pumps. (EERE 2022a) The IVEC metric builds on the current IEER metric framework by increasing fan energy impacts, adding economizer benefits, reweighting the load points based on updated national energy modeling, and adding crankcase heater energy use. While the IVEC metric is an improvement, it still only partially includes the impacts from enclosure characteristics. Testing takes place in a conditioned chamber, so insulation levels and enclosure leakage will impact the results (ratio of input fuel to delivered capacity), but enclosure losses in standby or fan-only recirculating modes are not accounted for because the units are only tested in active cooling modes.

Additional Regulatory Gaps

In addition to the limitations described above, other factors, including outside air dampers, the use of heat or energy recovery, and the use of a dual fuel heat pump, are not captured in current or upcoming metrics.

Outside Air Dampers. The AHRI test procedure that is used for both the IEER and IVEC metrics stipulates that outside air openings (such as economizers) are blocked off during testing. Because of this, air leakage from the dampers will have no impact on the rating, and testing essentially assumes no damper leakage. Similarly, on the heating side, damper leakage

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[10] Hybrid in this case refers to a heating system that uses both a heat pump and a gas furnace. often the gas furnace is a backup or supplementary heat for the colder days.

and total enclosure impacts are not accounted for because the TE and new TE2 metrics only rate the furnace component and not the entire RTU. Dampers are blocked off during testing because some units are sold by the manufacturer without dampers installed. Instead, dampers are purchased from third-party vendors and installed on site. In those scenarios, the dampers are not available during testing. This market dynamic is important to consider for future improvements to test methods, but it does not mean there is no path forward to account for damper leakage in efficiency testing.

NEEA and NRCan lab testing found that units without a certified leakage rating had significantly higher leakage than units with a certified leakage rate. (NRCan 2022) The base model unit in this 2021 study had a tested damper leakage rate that was 30 times that of the units with low leak dampers. This study found that, for a baseline or typical replacement unit, outside air dampers are the largest source of leakage and heat loss compared to enclosure leakage and thermal transmittance. NEEA's research (both lab testing and energy modeling) has shown that: (1) there is significant variation in the performance of dampers on commercially available RTUs and (2) damper leakage has a significant impact on energy consumption. Unfortunately, damper leakage is not considered in any efficiency testing for RTUs.

HRV/ERV. HRV/ERVs are not considered in DOE current or upcoming test procedures and metrics that cover 0-90% outside air equipment, even though HRV/ERVs are the largest opportunity for energy savings in gas RTUs. DOE's DX-DOAS test procedure, which references AHRI 920, does account for the benefits of HRV/ERVs[11]. The DX-DOAS test procedure is a DOE precedent that could be leveraged in the future to adopt a similar approach to incorporating HRV/ERVs in the CUAC and CWAF metrics.

Heat Pumps and Dual Fuel Heat Pumps. If an RTU includes a heat pump as the heating component, the heat pump is rated separately from the gas furnace even if they are included in the same packaged RTU. A packaged dual fuel heat pump is triple regulated if the cooling requirement is considered separate from the heat pump's heating requirement. This is an issue because when product components are regulated separately it is likely that operational interactive effects between the units' components are either not captured or not weighted appropriately. Dual fuel RTUs can include efficient controls that maximize the use of the heat pump to save energy, but the regulatory framework does not give any credit for this feature. Additionally, the test procedure does not provide any way to validate or refute control-based efficiency claims.

Light Commercial Equipment. The CWAF rulemaking (TE) currently sets requirements for furnaces that have a capacity of 225,000 Btu/hr or more, and the consumer furnaces rulemaking (AFUE) sets requirements for single phase units with a capacity less than 225,000 Btu/hr. This leaves a conspicuous regulatory gap for smaller capacity three-phase units, despite many RTUs falling in this category.

Non-energy Benefits of Energy Performance Characteristics

Several of the energy-saving features described in the previous sections have additional non-energy benefits that contribute to an overall higher quality product or can be selling points for a customer. This section describes the benefits of two of those features, enclosure insulation and HRV/ERVs.

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[11] DX-DOAS documentation often refers to HRV/ERVs as Ventilation Energy Recovery System.

Enclosure Insulation. As previously discussed, enclosure insulation reduces heat loss through the RTU, particularly when the RTU is in standby or not in operation. Increasing insulation to 2-in. (50 mm) foam insulation (R-12) provides decreased heat loss over typical 1-in. (25 mm) fiberglass insulation and provides more structural rigidity, which increases cabinet stability and product longevity. Manufacturers with 2-in. (50 mm) foam insulation often use this material because it increases resistance to hail or hurricanes and can resist warping when being lifted by a crane. Foam insulation is also lighter weight than fiberglass, eliminates the risk of fiberglass in the airstream, and can be easier to clean. Additionally, one manufacturer who has made the switch to foam filled panels has noted lower production costs compared to fiberglass insulation. They found lower assembly costs compared to gluing fiberglass insulation and that the structurally rigid foam panels allowed the use of thinner, lower cost sheet metal elsewhere in cabinet construction.

HRV/ERVs. The use of an HRV or ERV on an RTU can recover valuable heat from the return or exhaust air resulting in significant energy savings even in applications using less than 100% outside air. The use of HRV/ERVs can improve indoor air quality by allowing a unit to increase ventilation without high energy impacts. Additionally, ERVs can improve occupant comfort by maintaining indoor humidity in the winter and providing dehumidification in the summer.

HRV/ERVs also play an important role in HVAC system resiliency during extreme weather events and in reducing the energy needed to heat extremely cold or cool extremely hot outside air. An HRV/ERV with a high recovery effectiveness may allow downsizing of the primary heating and cooling components because of reduced heating and cooling load.

Conclusion

Developing test procedures and metrics takes time and effort industry-wide, so overhauling existing metrics toward a whole-box method that incorporates heat loss and other factors would be a large undertaking. Additionally, while there are benefits to improving metrics to account for energy consumption characteristics of RTUs, there are barriers to developing a more representative RTU test procedure:

1. Cost: Conditioned chamber testing is more expensive and complex than component testing at room temperatures, which can increase the test burden on manufacturers.
2. Physical size: Testing a packaged RTU requires test labs and chambers large enough to house the entire RTU, which can have a large footprint and volume. However, RTUs are already tested as a whole-box for cooling test procedures, so this barrier could be relatively small.
3. Testing iterations: Whole-box testing would require many more tests to cover the many possible RTU configurations as compared to individual component testing.
4. Total regulatory burden: Burden on HVAC manufacturers from multiple changes to testing metrics (IVEC and TE) and refrigerant phase out.

Even with the known barriers many in the industry continue to pursue a whole-box test procedure, but in the meantime, regional energy codes, utility energy efficiency programs, manufacturers, and the design community have an opportunity to focus on the features that save energy that are not captured in existing metrics.

Utilities, energy efficiency organizations, codes, and building performance standards have an opportunity to save significant gas energy and carbon by prioritizing gas heating efficiency as a decarbonization strategy. NEEA has created an efficient RTU specification (NEEA 2024) that includes the use of higher insulation, low leakage dampers, heat or energy recovery, or condensing technology. Several manufacturers have products available today that meet the specification. The industry has an opportunity to create efficient RTU program measures that target gas and carbon-saving features as one tool in the decarbonization strategy toolbox.

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