



**TRANE**®

# Engineering Bulletin

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## IntelliPak™ 20-130 Ton Rooftops Energy Recovery Wheel

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# Introduction

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## Preface

This manual presents the concept and application of energy recovery wheels with the IntelliPak Rooftops.

Energy wheels (also called heat wheels, enthalpy wheels, energy recovery ventilators, or heat recovery) have become more and more popular since the first designs were introduced in the 1950s. Energy wheel technology has evolved through its initial broad application in the 1980s to widespread acceptance in the 1990s. The substrate and the coating used to effect the energy transfer have been improved, and there have been fundamental enhancements to the components associated with the energy wheels. These improvements have resulted in energy wheels that can be more specifically targeted to the individual applications in today's marketplace.

## Introduction

Trane in Clarksville offers an integrated energy wheel that can be used in 100% outside air or partial outside air applications. This engineering bulletin provides an overview of the energy wheel module features and benefits and application considerations.



# Benefits

Table 1 describes the features and benefits of Trane's energy wheel module/section. The primary advantage is the improvement of indoor air quality (IAQ). The IntelliPak Energy Recovery Wheel

can also dramatically reduce energy consumption, while running reliably year after year. The rooftop equipment can be downsized confidently because these energy wheels are certified to comply with ARI Standard 1060-2000.

**Table 1. Energy wheel module/section features and benefits**

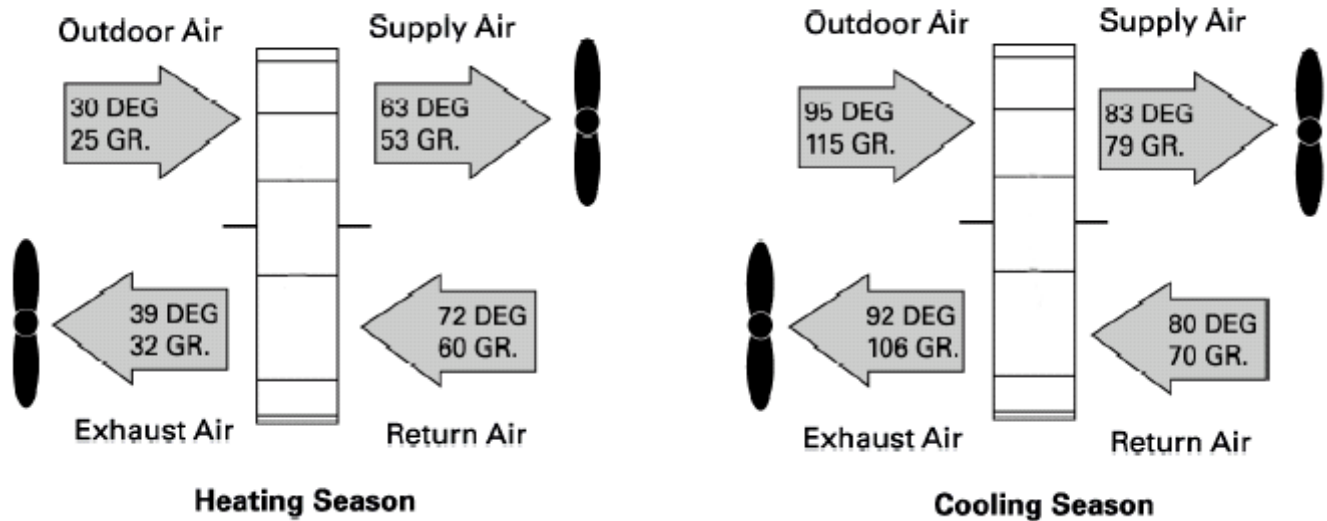
<b>Feature/Benefit</b>	<b>Description</b>
<b>Pre-engineered solution</b>	Trane's energy wheel offering is engineered specifically for each project. Where other suppliers typically provide just the energy wheel, Trane provides a system solution optimized for the application.
<b>Flexibility</b>	The wheel can be designed for partial outside air or 100% outside air.
<b>Confidence</b>	Backed by extensive testing and years of experience, the Trane energy wheel offering can be chosen with utmost confidence.
<b>Accessibility</b>	Under normal conditions and in most applications, the wheel is self-cleaning. However wheel sections are removable to allow for easy service access.
<b>Certification</b>	Energy wheel sections are certified by ARI 1060-2000. ARI 1060 certification means that the performance of the wheels have been verified by a reputable organization through independent tests.

# Technical Overview

An energy wheel acts as an intermediary device that operates within and between two air streams in the rooftop. As the wheel rotates between the outdoor and return air streams, the higher temperature air stream transfers its sensible energy (temperature) to the wheel media surfaces. This energy is then transferred from the media core to the cooler air stream during the second half of the rotation.

Latent energy (moisture) is transferred via the desiccant coating, which has a strong affinity for water vapor. Because the opposing air streams have different temperatures and moisture contents, their vapor pressure differ. The vapor pressure differential and temperature change provide the driving force necessary for the transfer of water vapor (see Figure1).

**Figure 1. Energy Recovery in an IntelliPak Rooftop**





# Technical Overview

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## Energy Recovery Important in all Seasons

The ability to recover latent energy is important in both the heating and cooling seasons. During cooling season, when the latent load can be greater than the sensible load, the outdoor air is dehumidified. During the heating season, the humidification load is reduced through moisture recovery.

Latent energy recovery allows for sizable reductions in unit capacity, which can help offset the initial cost of the energy wheel module/section.

A 100 percent outside air, or dedicated, system gives your customer the opportunity to pretreat the outside air using recovered sensible and latent energy from the exhaust air stream.

## Unit Configuration Using 100 Percent Outside Air

In a 100% outside air unit, return air enters the unit through the return air opening, passes through the energy wheel, and is exhausted from the energy wheel section by the energy wheel exhaust fan. While the return air is flowing through the energy wheel section, the outside air enters the unit through the back side of the energy wheel section, passes through the filters, and through the energy wheel, drawn through by the supply fan.

Note: Wheel sizes should be chosen for the outdoor air ventilation requirement.

## Unit Configuration Using Partial Outside Air

A partial flow outside air system is typically used when the required outside air is less than 100 percent.

In a partial flow outside air unit, the supply fan is staged on with the energy wheel circuit.

The IntelliPak rooftop unit monitors the outside air set points (set in the rooftop human interface) to check for suitable economizer operation. If the conditions are suitable to economize, the unit will modulate the economizer dampers open. Once dampers open, the energy wheel will be disabled through an end switch on the economizer actuator. If the conditions are not suitable to economize, the economizer damper will remain at minimum, and the energy wheel will remain energized.

The air flow path through the energy wheel will be identical to the 100% outside air module.

# Module/Section Construction

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## General Energy Wheel Specifications

### 1. Cassette Components

The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive belt.

### 2. Coatings and Desiccants

The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded by a patented and proprietary process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

### 3. Sensible Wheel Characteristics

Sensible energy recovery wheels shall be constructed of lightweight polymer and shall be provided without desiccant coating. Sensible-only wheels shall be constructed in the same fashion as the total energy recovery wheel.

### 4. Wheel Layers

The wheel shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.

### 5. Removable Segment Wheels

Wheels greater than 30 inches in diameter shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

### 6. Seals and Belts

All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

### 7. Standards Compliance

The energy recovery cassette shall be an Underwriters Laboratories (UL) Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84-1991, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060-2000, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the ARI Certified Products Directory and bear the ARI Certified Product Seal.

Due to a policy of continuous product improvement, specifications for *Energy Recovery Components are subject to change without notice.*



# Application Considerations

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## Typical Applications

- Schools, universities, dormitories
- Offices, condominiums, apartments
- Nursing homes, day care centers
- Hotels, motels, department stores
- Breweries
- Convention centers, airports, prisons
- Maintenance facilities

## Inappropriate Applications

**! WARNING**

**TOXIC HAZARDS!**

Do not use an energy wheel in an application where the exhaust air is contaminated with harmful toxins or biohazards, which could result in death or serious injury.

Although cross leakage between air streams in a rooftop with an energy wheel is minimal, there are some applications where cross leakage poses a significant health risk to the building occupants.

These applications are not appropriate for energy wheel technology:

- Specialized hospital treatment wings, such as tuberculosis units
- Some retail establishments, such as restaurants, whose menus include grease - or smoke-producing selections
- Some industrial applications, such as concentrated smoke from welding operations
- Laboratories where hood exhaust fumes are involved in the project analysis

For applications where the air streams within the rooftop must be isolated, consider using alternative technologies, such as coil loops, that guarantee separation of the air streams.

**Important Note:** Do not use energy wheels in applications where even a minor mixing of the air streams presents a health risk.

## Filtration Requirements

For rooftop units, minimal filtration is provided prior to the energy wheel near the outside air. Small size particles may still pass through the heat exchange matrix due to the laminar flow of air within the wheel. If larger particles do impact onto the wheel, they are generally blown off by the reversing airflow as the wheel passes into the opposing air stream. Downstream supply air rooftop unit filters can catch any particle that is self-cleaned in this manner.

Return air filtration is not generally required and is not provided as a standard feature of the energy wheel. However in an industrial application or in applications where the return/exhaust air is contaminated with large particles such as lint, the air should be filtered upstream of the energy wheel.

Note: If return/exhaust air filters are applied due to application requirements, the additional static must be considered for unit selection.

# Application Considerations

## Frost Prevention

1. Moisture condenses on an energy wheel when its surface temperature is below the air stream dew point temperature. Due to cold outdoor air temperatures during the winter months, the surface temperatures of an energy wheel can be below freezing, causing frost on the wheel. The contributors to frost formation are the winter return air relative humidity, return air dry bulb, and outdoor air temperature. The main contributor is the return air relative humidity.
2. Trane energy wheels are total energy wheels, meaning that at the nominal speed of the wheel, the sensible and latent effectiveness is close to equal. On the psychrometric chart (Figure 2), each air stream follows a straight line path between the outside air and return air. When the line crosses the saturation line, condensate or frost occurs. In Figure 2, frost does not occur at condition 1, but does occur at condition 2.

## Determining Frost Conditions

To determine the minimum outside air temperature where frosting will not occur:

1. Plot the return air dry bulb and percent RH on the psychrometric chart.
2. Draw a line from this return air point to the tangent on the saturation line. (This point is shown as the 'frost point' in the Figure 2 example.)
3. Drop straight down from the tangent intersection point to find the minimum outside air dry bulb temperature.

Note: Outdoor air temperatures below freezing do not necessarily mean frost will form on the energy wheel. The Figure 2 example shows that frost control is not needed if the winter design condition for the outdoor air temperature does not drop below 0° F and the indoor relative humidity does not exceed 30% at 70° F.

## Frost Prevention Methods

If frost prevention is necessary, the following are possible recommendations:

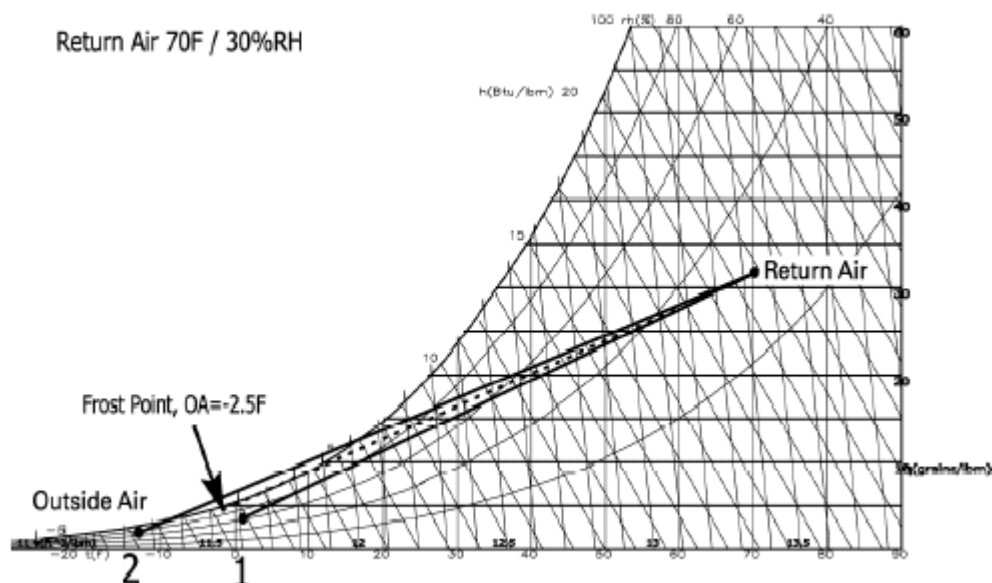
1. Preheat the outside air.
2. Turn the wheel off and on.
3. Use a bypass damper.

### Preheat the Outside Air

Preheating the outside air produces the best result and allows for the most energy to be recovered. It prevents the exhaust air stream from reaching frost conditions by raising the outdoor air temperature above the frost point temperature.

For continuous operation below the frost threshold temperature, the electric preheat will be installed in the outdoor air stream before the outdoor air enters the energy wheel.

Figure 2. Determining Frost Conditions



# Application Considerations

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## Turn the Wheel Off and On

For intermittent ventilation below the frost threshold temperature, a temperature control can be provided to shut off the energy wheel and fans when the outdoor temperature drops to a control set point (as determined by the frost threshold temperature). Operation may be automatically restored when the outdoor air temperature rises above the thermostat set point. The thermostat should be located in the outdoor air intake. On/Off frost control should only be used if:

- The temperature falls below the frost threshold for a limited number of hours, resulting in a buildings highest natural ventilation rate because of the maximum indoor/outdoor temperature differential.
- Temperatures below the winter design temperature usually occur during periods of darkness lasting 1-6 hours. Depending on the application, these low temperatures may only occur during unoccupied periods when ventilation is not required.

Note: Turning the wheel off during frost conditions is a reliable method of preventing the wheel from frosting; however, it does not allow for any reduction in the heating equipment.

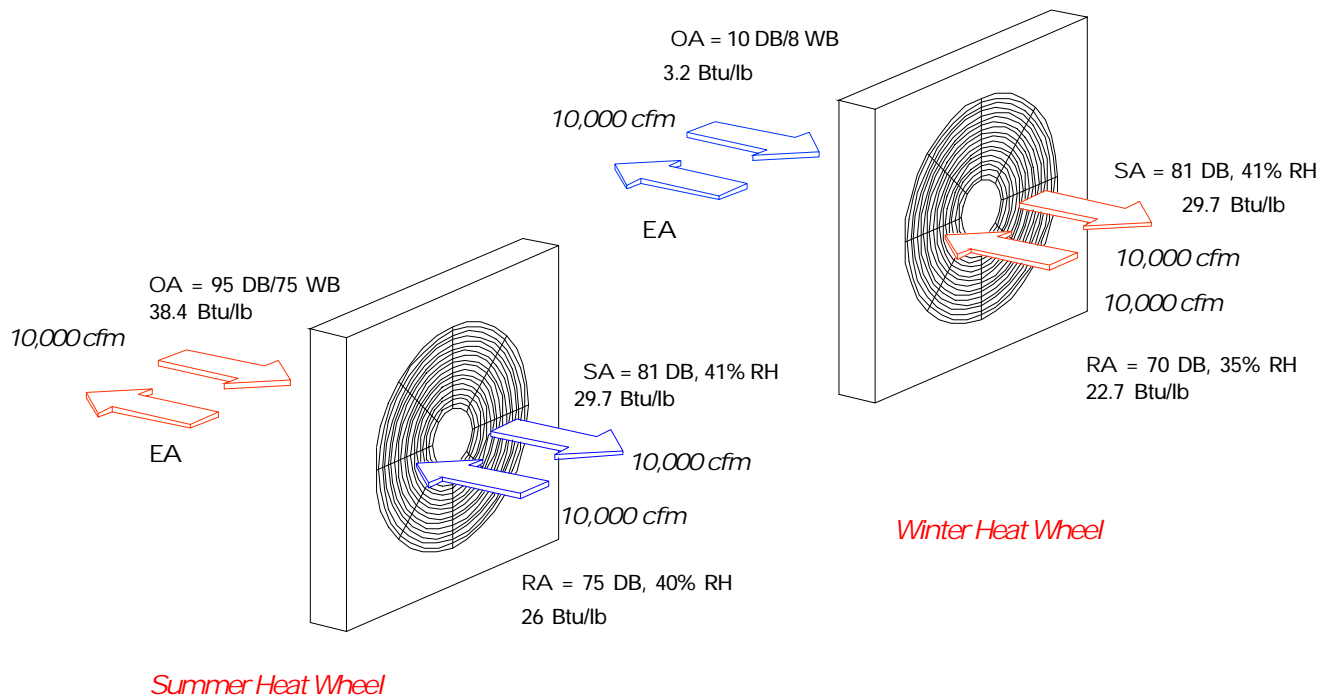
## Use a Bypass Damper

Using a bypass damper prevents the exhaust air from being cooled down below saturation. Best used when frosting conditions exist at the extreme winter design. To reduce the amount of energy recovered from the exhaust air stream, outside air is bypassed around the wheel. Frosting conditions are avoided by preventing the energy wheel temperature to drop below the exhaust air dew point temperature. The exhaust set point temperature is maintained by modulating the outside air bypass dampers. The indoor air humidity has the greatest affect on the exhaust air set point temperatures.

Note: Some defrost options may not be available on every IntelliPak unit.

# HVAC System Capacity Reduction

A significant benefit of enthalpy energy recovery is the ability to reduce the size and cost of the rooftop unit. The following example shows the power of enthalpy in reducing the size of the unit.



## Capacity Reduction, Summer Cooling

$$\begin{aligned} \text{Btuh} &= 4.5 \times \text{SCFM} \times (\text{H}_{\text{oa}} - \text{H}_{\text{sa}}) \\ &= 4.5 \times 10000 \times (38.4 - 29.7) \\ &= 391,500 \text{ Btuh} \end{aligned}$$

$$\begin{aligned} \text{Tonnage} &= 391,500 / 12,000 \\ &= 32.6 \text{ tons} \end{aligned}$$

## Capacity Reduction, Winter Heating

$$\begin{aligned} \text{Btuh} &= 4.5 \times \text{SCFM} \times (\text{H}_{\text{sa}} - \text{H}_{\text{ra}}) \\ &= 4.5 \times 10000 \times (29.7 - 22.7) \\ &= 630,000 \text{ Btuh} \end{aligned}$$

$$\begin{aligned} \text{HP} &= 630,000 / 33,470 \\ &= 18.8 \text{ hp} \end{aligned}$$



# Ordering Considerations

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## Unit and Wheel

Select a wheel. Based on the job requirement, select a wheel with the energy wheel selection program from AirXchange. For free Selection CD's, go to <http://www.airxchange.com/>

Now select the unit. Use the new entering coil temperatures from the energy wheel selection to run the rooftop unit selection.

If you have any questions about the selection procedure, contact Applications in Clarksville.

Important Notes:

1. Some factory options are not available with the energy wheel option.
2. If the rooftop unit has heat (electric, gas, or hydronic), make sure the minimum heating airflow requirements are met. (See catalog or selection program for requirements.)
3. The 100% Outside Air Energy Wheel Option can have single point power, if you order the IntelliPak Rooftop exhaust fans.
4. There is a special curb adapter that must be purchased if the rooftop unit is placed on a curb.
5. The IntelliPak Rooftop is UL approved.
6. All components that are used in the energy wheel section have UL approval.

## Get a Quote

Price quotes are requested through the sales office to the Clarksville design specials team for the wheel modifications only.

Please fill in the on-line pricing form at the below address for a quote.

<http://tranenetck1/common/helpdesk/forms/energyrecoverywheel.asp>

## Order

### Sales Offices Only:

To order the energy wheel option, fax a copy of the wheel selection to the design specials group Attn.: Sandra Jones @ fax #931-648-5901.

### Support

Please call the Clarksville Marketing and Sales Support or Technical Service any questions you may have regarding the Energy Wheel.



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Stocking Location	TRANENET EAGLE

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