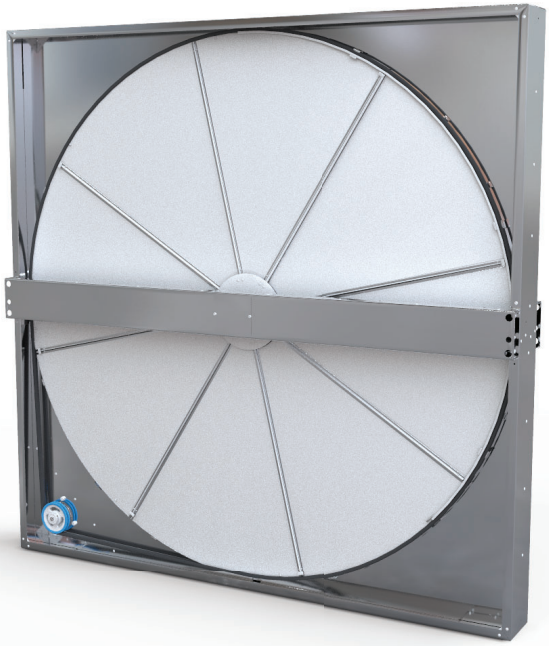
AIRXCHANGE

Understanding Efficiency of Energy Recovery Regional Climate Zones, AHRI / ASHRAE Standards & Maintaining Lifetime Energy Savings

APRIL 2020

TOTAL ENERGY EFFICIENCY

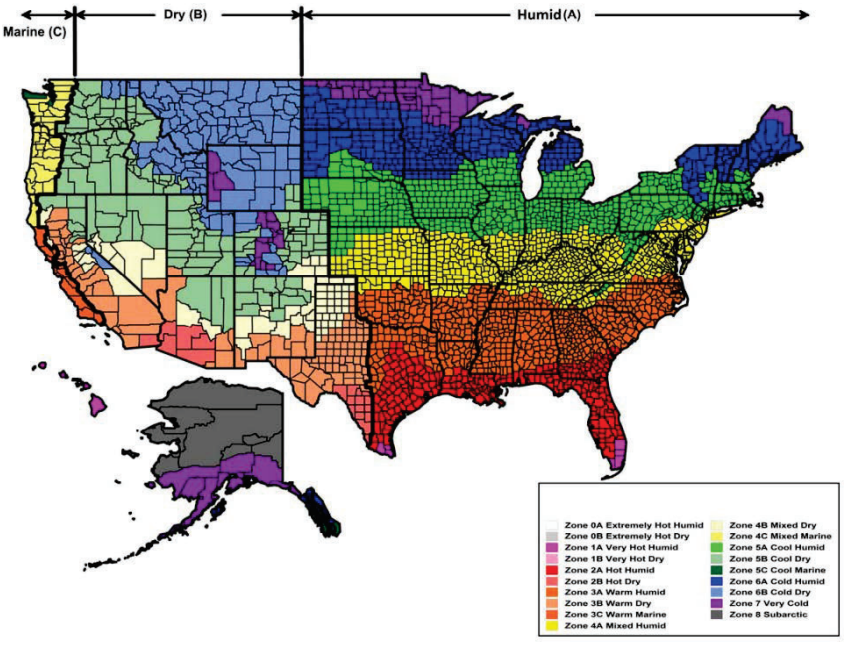
When designers are considering the use of energy recovery wheel options, they should consider multiple factors to provide the best overall fit to their budget. Those factors are **regional climate zone, energy recovery ratio at the design flow range, and the ability to maintain performance over the life of the equipment.**



CLIMATE ZONE

When **ASHRAE** developed the provisions for energy recovery in **STANDARD 90.1,** it considered the regional climate impacts on the use of energy recovery. Each climate zone has different energy recovery characteristics associated with its use.

Climate Zones and Representative Cities



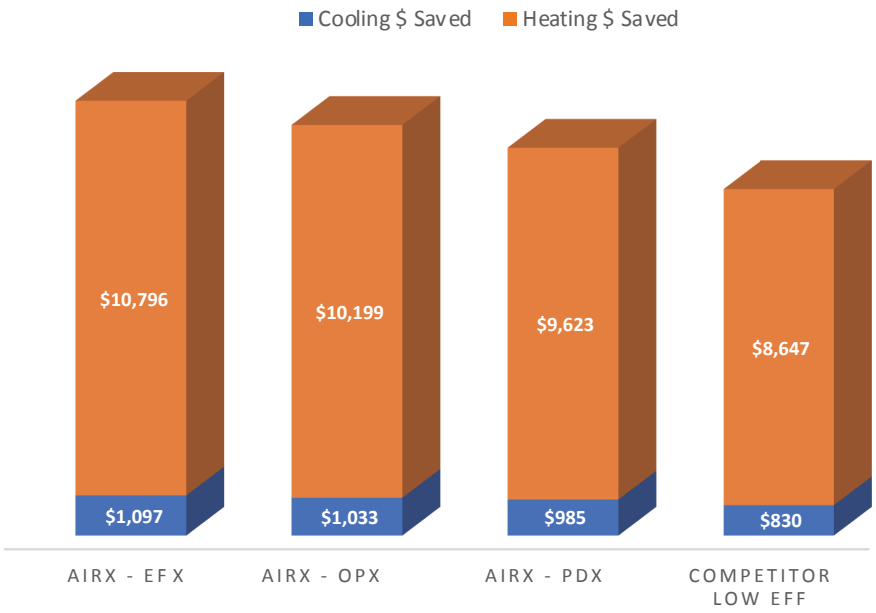
ASHRAE Standard 169-2013

Climate Zone	Climate Zone Name	Representative City
0A*	Extremely Hot Humid	Ho Chi Minh City, Vietnam
0B*	Extremely Hot Dry	Dubai, United Arab Emirates
1A	Very Hot Humid	Honolulu, HI
1B*	Very Hot Dry	New Delhi, India
2A	Hot Humid	Tampa, FL
2B	Hot Dry	Tucson, AZ
3A	Warm Humid	Atlanta, GA
3B	Warm Dry	El Paso, TX
3C	Warm Marine	San Diego, CA
4A	Mixed Humid	New York, NY
4B	Mixed Dry	Albuquerque, NM
4C	Mixed Marine	Seattle, WA
5A	Cool Humid	Buffalo, NY
5B	Cool Dry	Denver, CO
5C	Cool Marine	Port Angeles, WA
6A	Cold Humid	Rochester, MN
6B	Cold Dry	Great Falls, MO
7	Very Cold	International Falls, MN
8	Subarctic/Arctic	Fairbanks, AK

*Prototypes in non-U.S. climate zones were developed but not included in 90.1-2019 Progress Indicator.

In order to meet the needs of different climate zones, Airxchange has developed a wide range of performance models that allow designers to tailor their needs with the optimum wheel. Conversely, some of our competitors only make one possible performance profile limiting the amount of energy they can capture. The charts below provide a comparison of energy recovered by the range of Airxchange offerings versus a low efficiency competitor for three different representative climate zones. In addition, a net energy savings comparison chart summarizes the best overall performance for the range of wheels when accounting for fan energy losses due to air pressure drop (APD).

TOTAL ENERGY RECOVERED CHICAGO



Economic costs calculated using ASHRAE weather data and Airxchange economics software, www.airxweb.com.

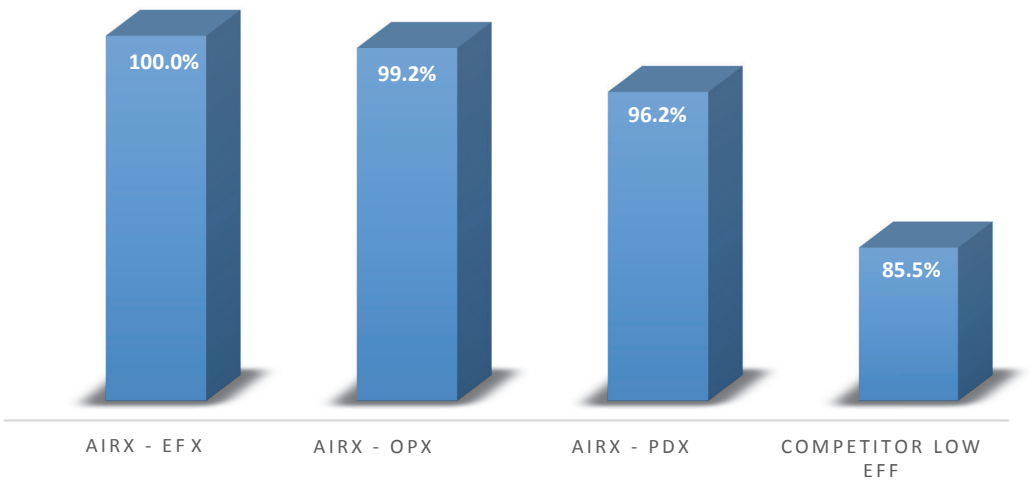
Chicago Represents Zone 5A

In this region, heating recovery dominates the energy savings profile

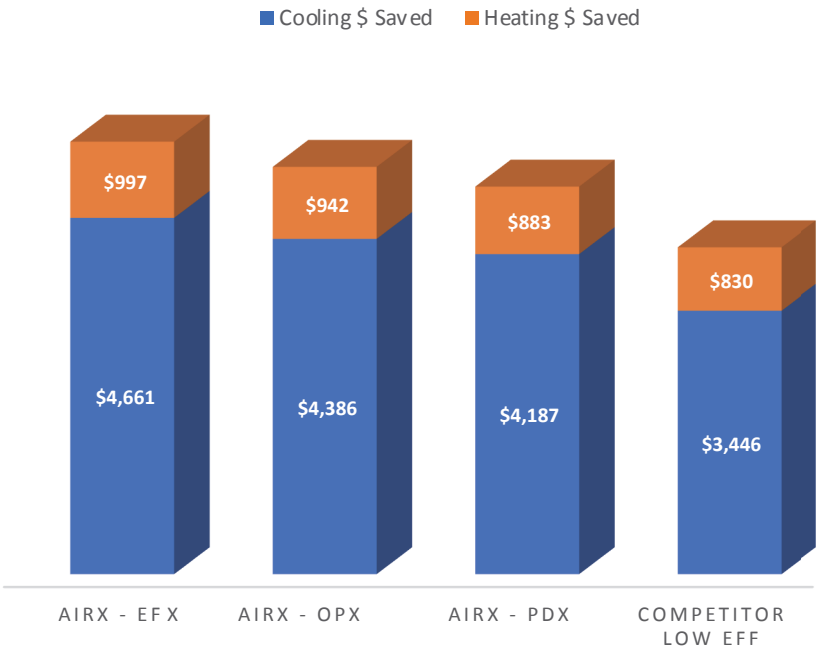
Best Performance Profile

The Airx EFX would have the Performance Profile that delivers the best overall savings. EFX Performance Profile has the Highest Enthalpy Recovery / Highest APD. The Airx EFX saves 15% more net energy per year than the Low Enthalpy Recovery Ratio / Low APD Competitor.

NET SAVINGS ACCOUNTING FOR FAN ENERGY CHICAGO



TOTAL ENERGY RECOVERED TAMPA



Economic costs calculated using ASHRAE weather data and Airxchange economics software, www.airxweb.com.

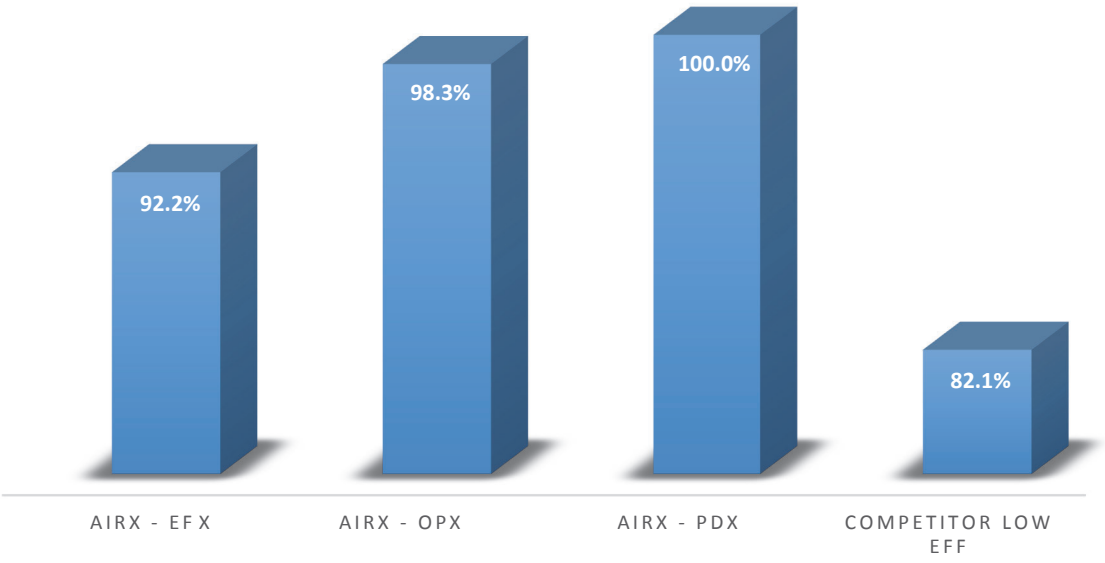
Tampa Represents Zone 2A

In this region, cooling energy recovery dominates the energy savings profile

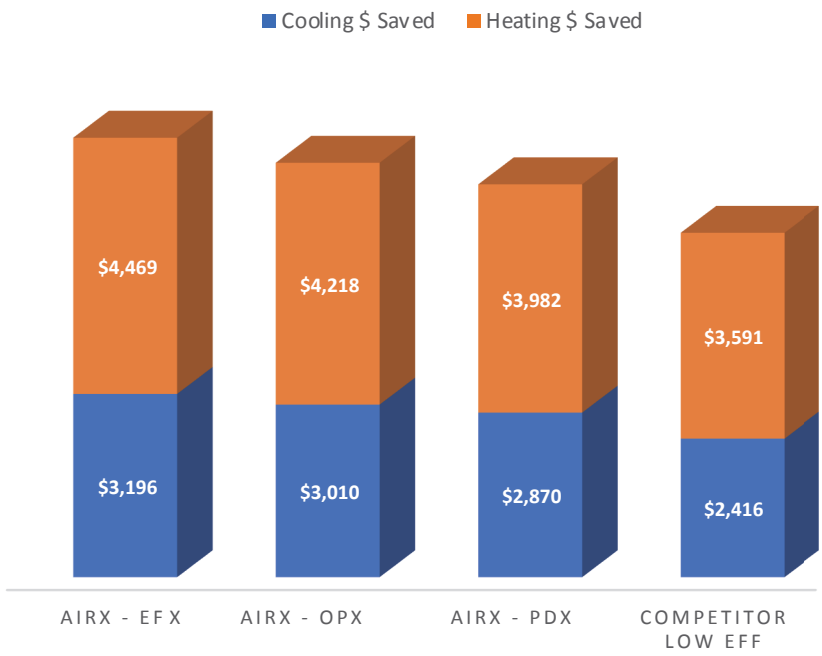
NET SAVINGS ACCOUNTING FOR FAN ENERGY TAMPA

Best Performance Profile

The Airx PDX would have the Performance Profile that delivers the best overall savings. PDX Profile has the Lowest APD / Good Enthalpy Recovery. The Airx PDX delivers 18% more energy savings than Low Enthalpy Recovery / Low APD Competitor.



TOTAL ENERGY RECOVERED DALLAS



Economic costs calculated using ASHRAE weather data and Airxchange economics software, www.airxweb.com.

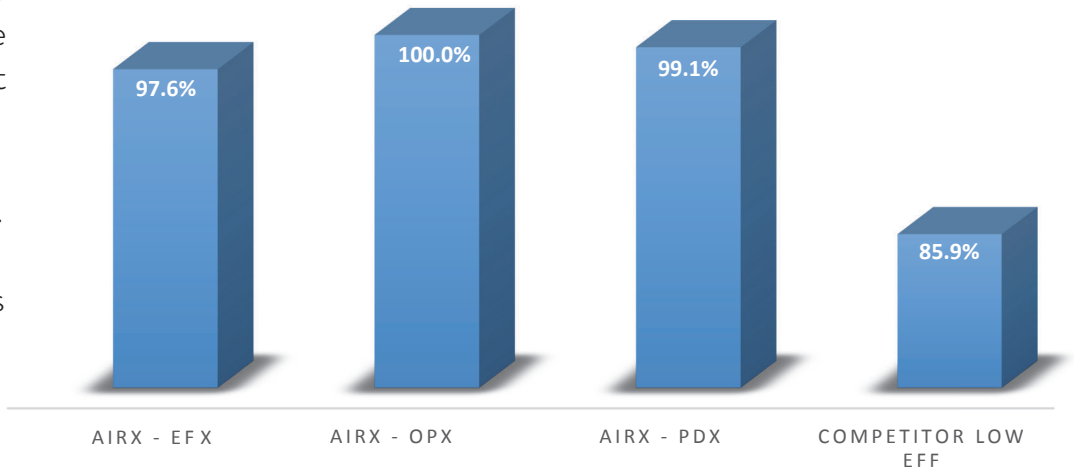
Dallas Represents Zone 3A

In this region significant amounts of both heating and cooling recovery are accounted for in the energy savings profile.

Best Performance Profile

The Airx OPX would have the Performance Profile that delivers the best overall savings. OPX Profile has a balance of Efficiency/Moderate APD. The Airx OPX delivers 14% more energy savings than Low Enthalpy Recovery / Low APD Competitor.

NET SAVINGS ACCOUNTING FOR FAN ENERGY DALLAS



ENTHALPY RECOVERY RATIO VS. EFFECTIVENESS

One factor that has led to confusion in the industry regarding thermal recovery is centered on the use of the term “Effectiveness”. Prior to 2019, both ASHRAE STD 90.1 and AHRI STD 1060 used the term "Effectiveness" when describing how much energy a device recycled. Yet, the two standards used different formulas to calculate the Effectiveness.

When calculating Effectiveness using the ASHRAE 90.1 formula the resultant value could be lower than a value calculated using the formula for Effectiveness from the AHRI 1060.

Starting in 2019, a new term was adopted by both AHRI 1060 and ASHRAE STD 90.1 called Enthalpy Recovery Ratio. This term uses the same formula in both standards to eliminate confusion. Enthalpy Recovery Ratio is the value that will be needed to comply with energy standards in ASHRAE 90.1.

Enthalpy Recovery Ratio will also allow designers to better understand the effects of imbalanced airflow on recovery. The ratio of exhaust to supply flow effects the total amount recovered energy by an enthalpy recovery device. For example, an exhaust/supply ratio of 0.90 will recover around 10% less energy than a system with a ratio of 1.0. Below is a chart which compares the values calculated for Effectiveness and Enthalpy Recovery Ratio, demonstrating how they are different as the Exhaust/ Supply Air Ratio changes. Most applications have an Exhaust/Supply Ratio less than 1.0.

Building codes require at least 50% Enthalpy Recovery Ratio for cooling and up to 60% for heating.

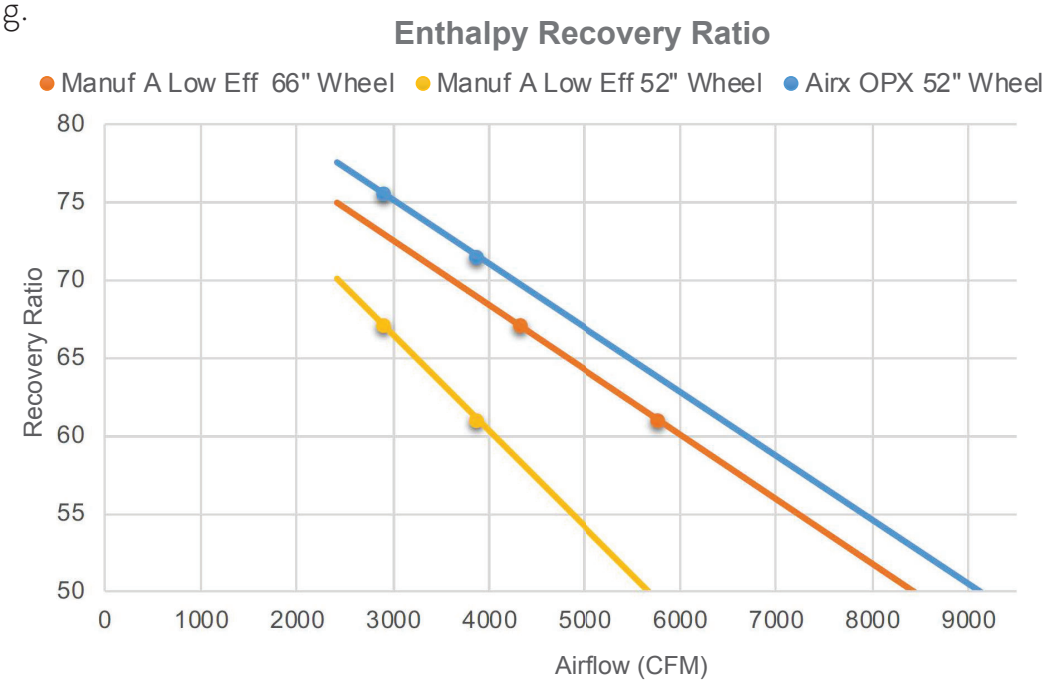
	Exhaust / Supply Ratio	AHRI 1060	ASHRAE Std 90.1
Effectiveness	1.0	65%	65%
Enthalpy Recovery Ratio	1.0	65%	65%
Effectiveness	0.90	72%	58.5% **
Enthalpy Recovery Ratio	0.90	58.5%	58.5%
			**Using Definitions Prior to 2019

WHEN HIGH EFFICIENCY TURNS OUT TO BE LOW EFFICIENCY

Comparing Enthalpy Recovery Ratio at the design airflow is key to selecting the best performance. When the ratio of Exhaust / Supply airflow equals 1.0, Effectiveness and Enthalpy Recovery Ratio values are the same. The chart below uses the term Enthalpy Recovery Ratio for consistency to updated ASHRAE 90.1 language which is used in building codes.

While AHRI 1060 lists thermal Effectiveness of wheels at a given flow rate there are several factors that design engineers need to understand. First, the Effectiveness listed in the directory at the rated flow is not uniform for all manufacturers. For example, Manufacturer A may rate their 52" wheel at 2,500 cfm with an effectiveness of 70% while Airxchange rates its 52" wheel at 5,500 cfm with an effectiveness at 65%. Effectiveness Rate is directly impacted by flow or more precisely face velocity. As the face velocity increases, the wheel's effectiveness decreases. With that understanding in this example, Manufacturer A is a much less efficient wheel than Airxchange. Furthermore, Manufacturer A will require a much larger diameter wheel to achieve the same performance as Airxchange.

Larger diameter wheels require larger air handling unit casings which dramatically increase overall unit cost. Therefore, it is incumbent to select wheels that are efficient at the design flow in order to avoid increasing total air handling or rooftop unit costs. Lastly, building energy codes require that the Enthalpy Recovery Ratio be no less than 50% for cooling and 60% for heating.



UNDERSTANDING ENERGY MEASUREMENT TERMS FOR ENERGY RECOVERY ERR / CEF/ RER

It's easy to understand how engineers and end users can get confused trying to figure out which energy recovery terms are the ones to use. Since both RER and ERR measure different attributes of an energy recovery component, is one better than the other in demonstrating a greater savings to the rest of the system?

Enthalpy Recovery Ratio (ERR) - A rating intended to measure the amount of energy recovered and used to precondition the outside air prior to the downstream HVAC system. ERR can be used for both enthalpy wheels and plates. It is used to comply with ASHRAE STD 90.1.

Recovered Efficiency Ratio (RER) – A rating to understand the energy recovered relative to the air pressure drop (APD) of an energy recovery component. RER can be used for both enthalpy wheels and plates. RER for enthalpy plates would eliminate wheel motor energy. It is not used to comply with ASHRAE STD 90.1

Combined Efficiency Factor (CEF) – A single point efficiency rating when combining both an energy recovery component and a downstream HVAC system.

CEF for 100% DOAS System

Unitary EER	ERR 50%	ERR 60%	ERR 70%	ERR 80%
14	19	21	23	26
17	22	25	27	31
20	25	28	31	35

25% Increase in CEF

50% Increase in CEF

CEF for 100 % DOAS System

Unitary EER	RER 50	RER 70	RER 90	RER 110
14	19	20	20	20
17	22	23	24	24
20	25	27	28	28

Tables Indicating CEF Improvement with Different ERR & RER

- Enthalpy Recovery Ratio (ERR) has a greater impact on improving system efficiency (CEF) than RER.
- DOAS systems can achieve at least 50% improvement over baseline CEF with 70% ERR but not with highest RER.
- Best CEF systems have at least 70% ERR and no more than 1.0 APD.
- Enthalpy plate systems eliminate wheel motor to achieve higher RER but with only small improvement in CEF. Since enthalpy plates have lower ERR than wheels, CEF would be lower for those systems.

TOTAL LIFETIME SAVINGS

Upgrading old, uncleanable aluminum wheels with Airxchange's fully cleanable and segmented polymer wheel.

In order to achieve lifetime savings, designers must consider the feasibility of being able to maintain recovered performance during lifetime operation. Two common application occurrences that impact performance over lifetime are exposure of recovery devices to smoke and smog. While its true that for all wheels, the counterflow of supply and exhaust airflow will purge dry dust and dirt. Oily substances that exist in smog and smoke will, over time, allow a microscopic accumulation of dust and dirt that cannot be overcome by the inherent effects of the rotating device. In our experience, owners of casinos, urban universities, dormitories and hospitals have been forced to replace their existing monolithic wheels with Airxchange fully cleanable and segmented polymer wheels even though the remaining air handling system still had many more years of useful operation. In some of our documented cases, owners experienced a 2-3% loss of efficiency per year for those systems which could not be sufficiently cleaned. Using a fully cleanable polymer wheel allows owners to easily maintain the recovery performance of wheels for the life of the equipment.

For questions, please contact us at contact_us@airxchange.com.