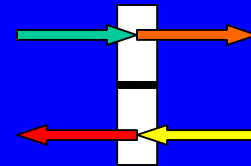




# Energy Recovery Ventilators

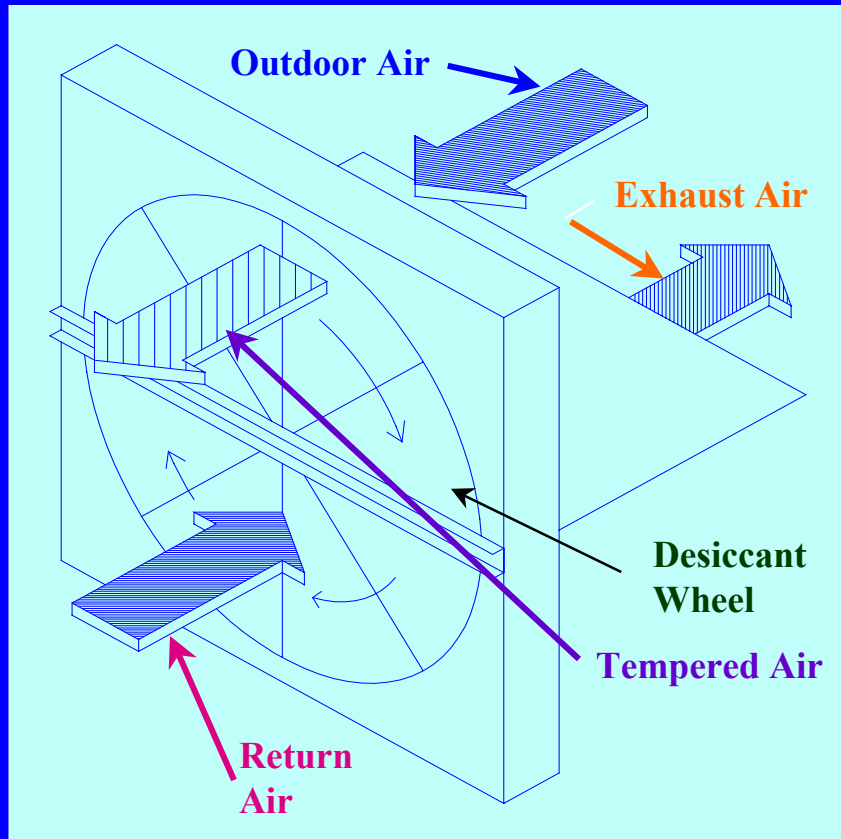
by

## Rooftop Systems Inc.



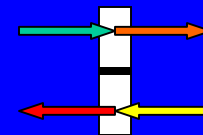


# Enthalpy Wheels



- Wheel Rotates between the Return Air and the Outdoor Air Airstreams.
- Return Air Temperature and Humidity is absorbed onto the Desiccant Wheel.
- Outdoor Air is PreHeated or PreCooled as it crosses the Wheel.
- Outdoor Air Humidity is Lowered or Raised as it crosses the Wheel.

*Energy Recovery Ventilators*

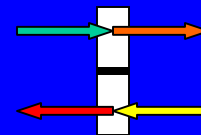




# ERV Terminology

- Energy Recovery Ventilator - Equipment used to recover exhaust air energy from a conditioned space.
- Unitized Energy Recovery Ventilator - ERV that is coupled with a package air conditioning unit to provide optimal comfort conditions.
- Enthalpy Wheel - The ERV component used to provide energy recovery of both the sensible and latent exhaust air.
  - **Warms the outside air in winter, and cools it in the summer.**
  - **Lowers the outside air humidity when it is high, and recovers exhausted humidity in arid conditions.**

*Energy Recovery Ventilators*





# ARI Certification Terminology

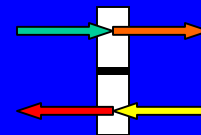
**Exhaust Air Transfer Ratio (EATR)** - Percentage of Tempered Air that originated as return air (measured by using tracer gas).

**Outdoor Air Correction Factor (OACF)** - Difference in airflow (CFM) measured between the entering Outdoor Air and the Tempered Air, presented as a ratio.

**Net Effectiveness** - The measured energy recovery effectiveness adjusted to account for that portion of the Tempered Air after removing the **EATR** from the percentage.

**Application Effectiveness** - The measured energy recovery effectiveness that is not adjusted to account for Exhaust Air Transfer.

*Energy Recovery Ventilators*





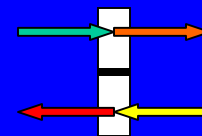
## What is Application Effectiveness?

Application (measured) “**Effectiveness**” is the percentage of total heat recovered between the two airstreams in the ERV.

**Example:** If Return =  $75^{\circ}$  and Outside =  $20^{\circ}$  then the difference =  $55^{\circ}$ . At 70% Effectiveness the Recovered Energy would be  $38.5^{\circ}$  ( $70\% \times 55^{\circ}$ )

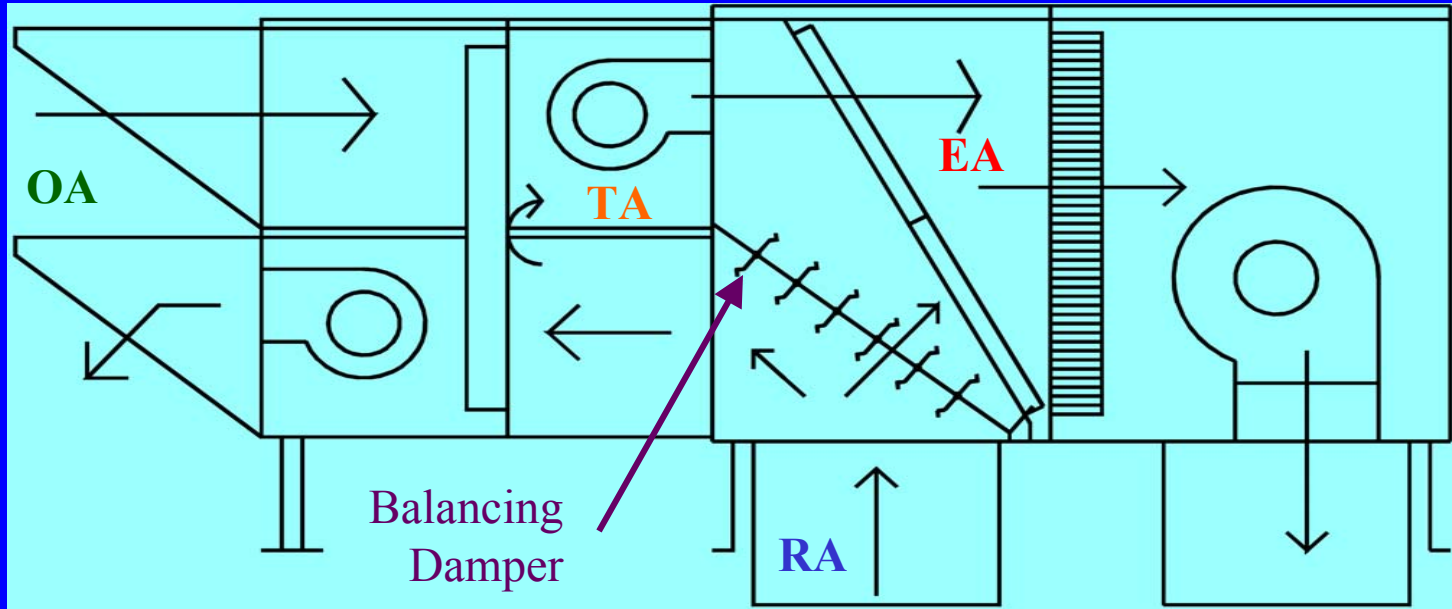
**The Tempered Air would be  $58.5^{\circ}$  ( $20^{\circ} + 38.5^{\circ}$ ).**

*Energy Recovery Ventilators*





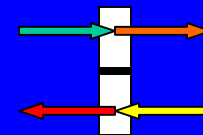
# Tempered Air (TA)



$$TA = ((RA^{\circ} - OA^{\circ}) * Effectiveness) + OA^{\circ}$$

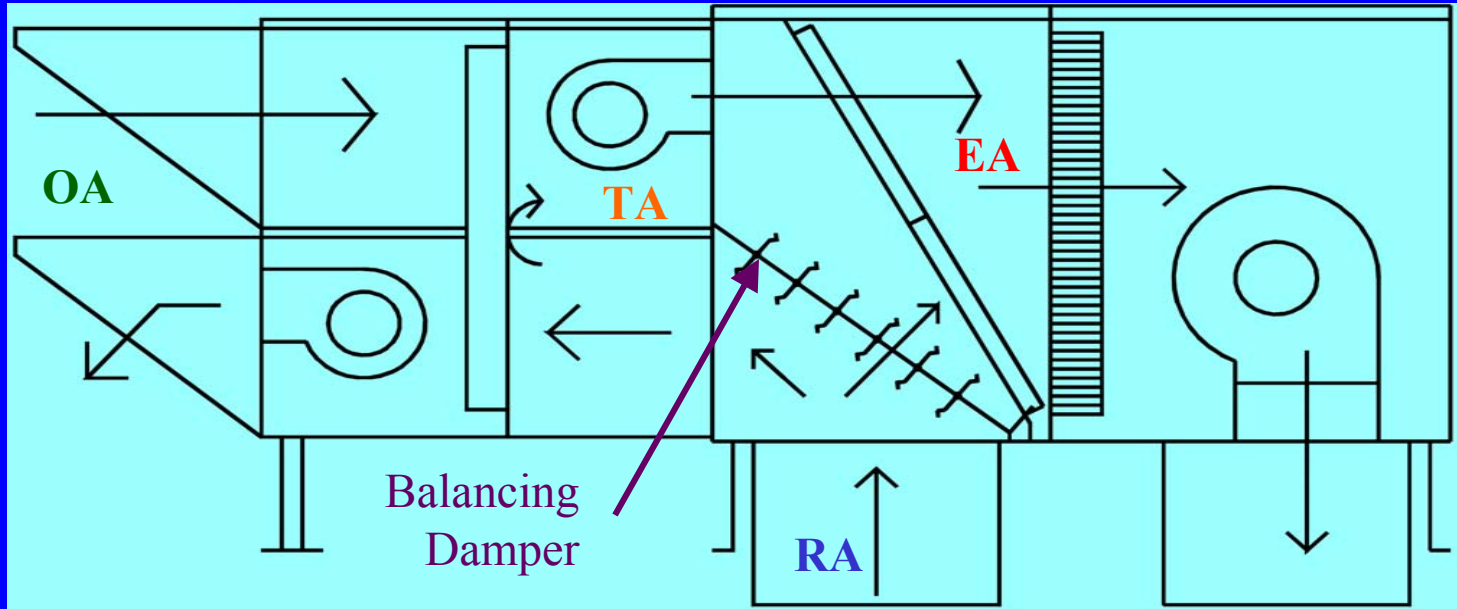
Example:  $TA = ((75^{\circ} - 20^{\circ}) * 70\%) + 20^{\circ} = 58.5^{\circ}$

*Energy Recovery Ventilators*





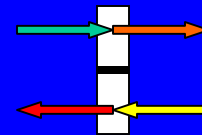
# Entering Air (EA)



$$EA = (RA\% * RA^\circ) + (TA\% * TA^\circ)$$

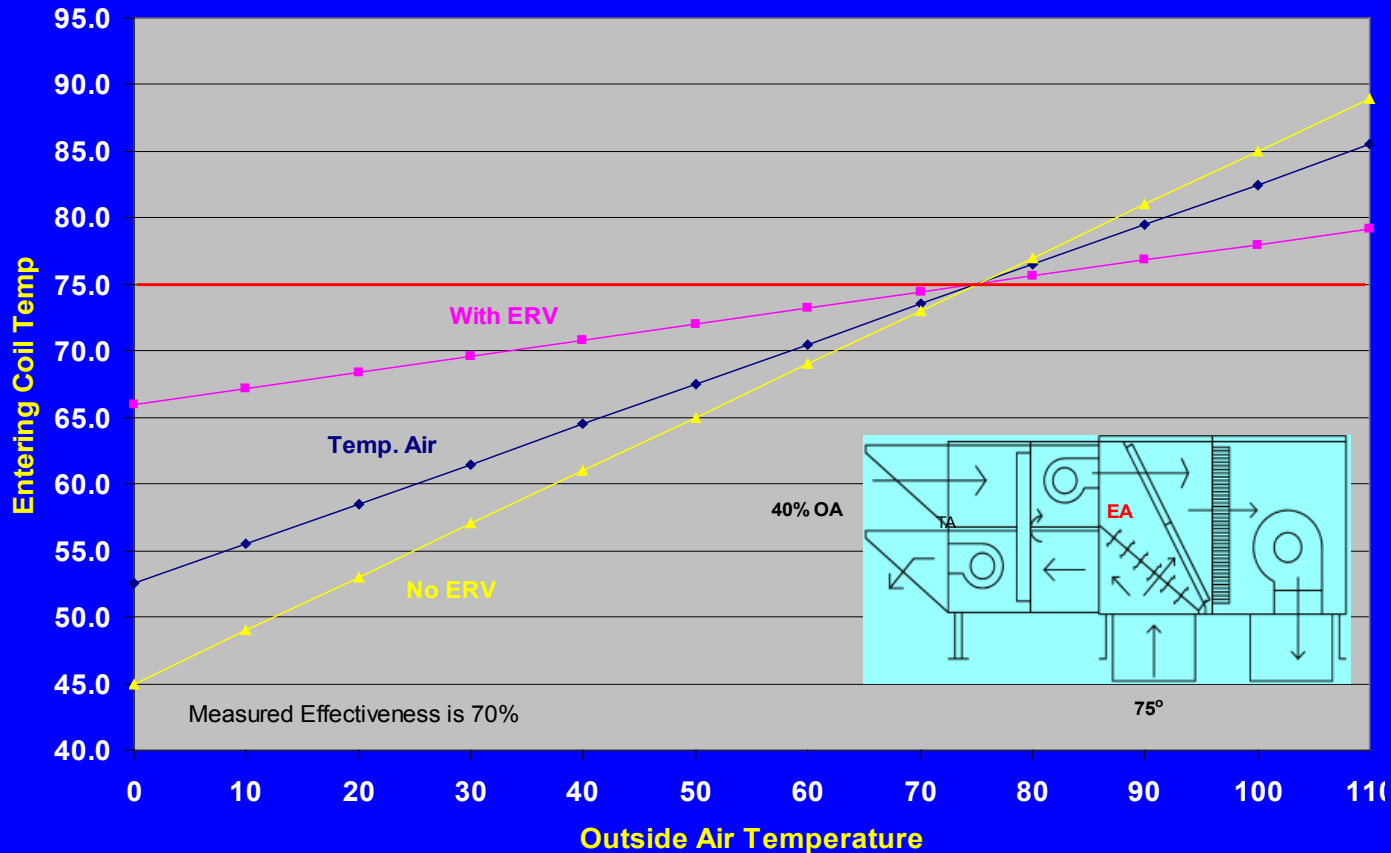
Example:  $EA = (60\% * 75^\circ) + (40\% * 58.5^\circ) = 68.4^\circ$

*Energy Recovery Ventilators*

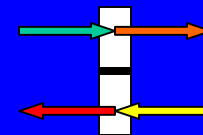




# Entering Air Temperature (EA) at 40% Outside Air and 75° Return Air

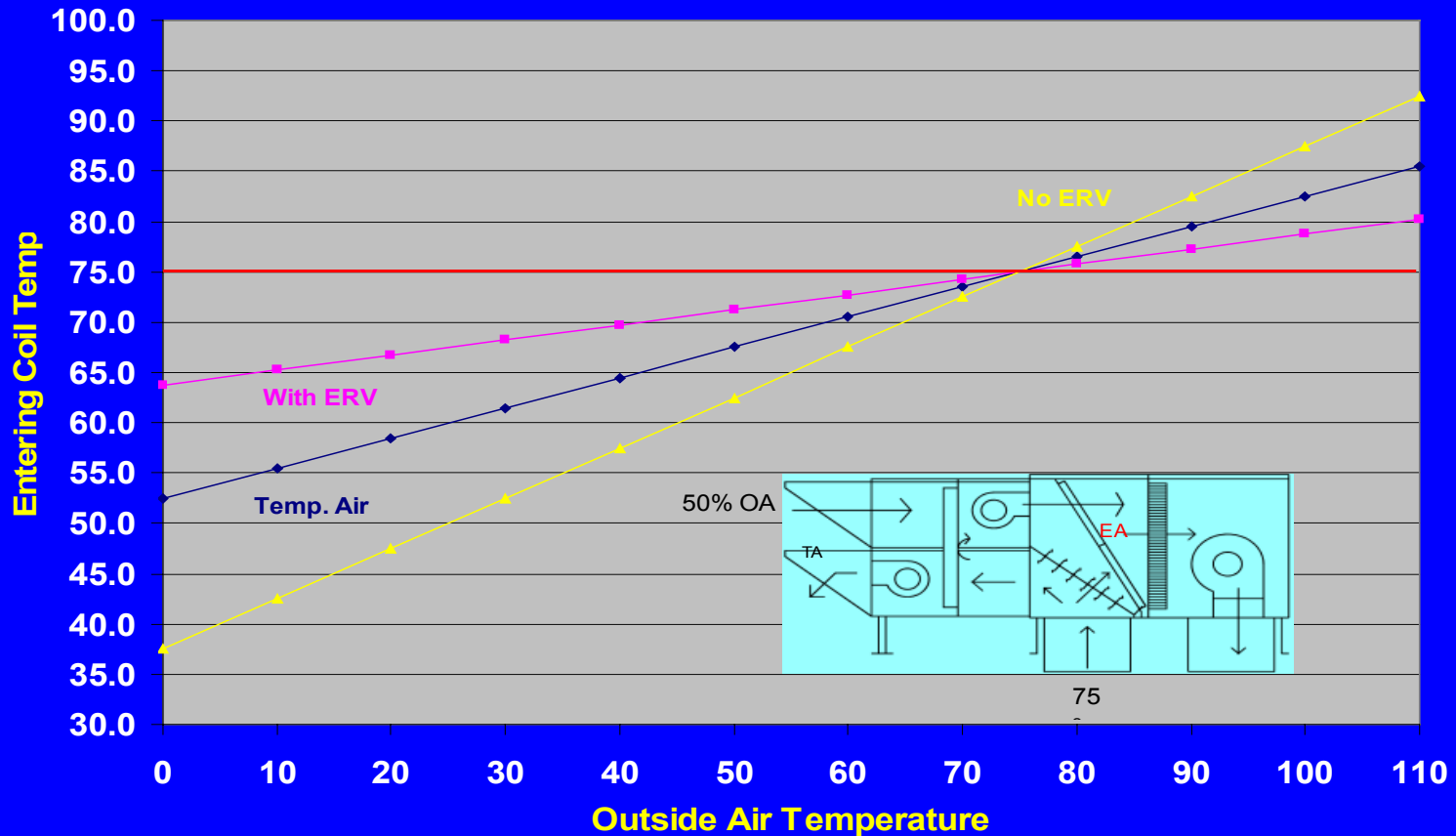


*Energy Recovery Ventilators*

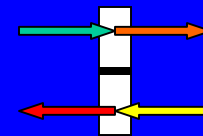




# Entering Air Temperature (EA) at 50% Outside Air and 75° Return Air

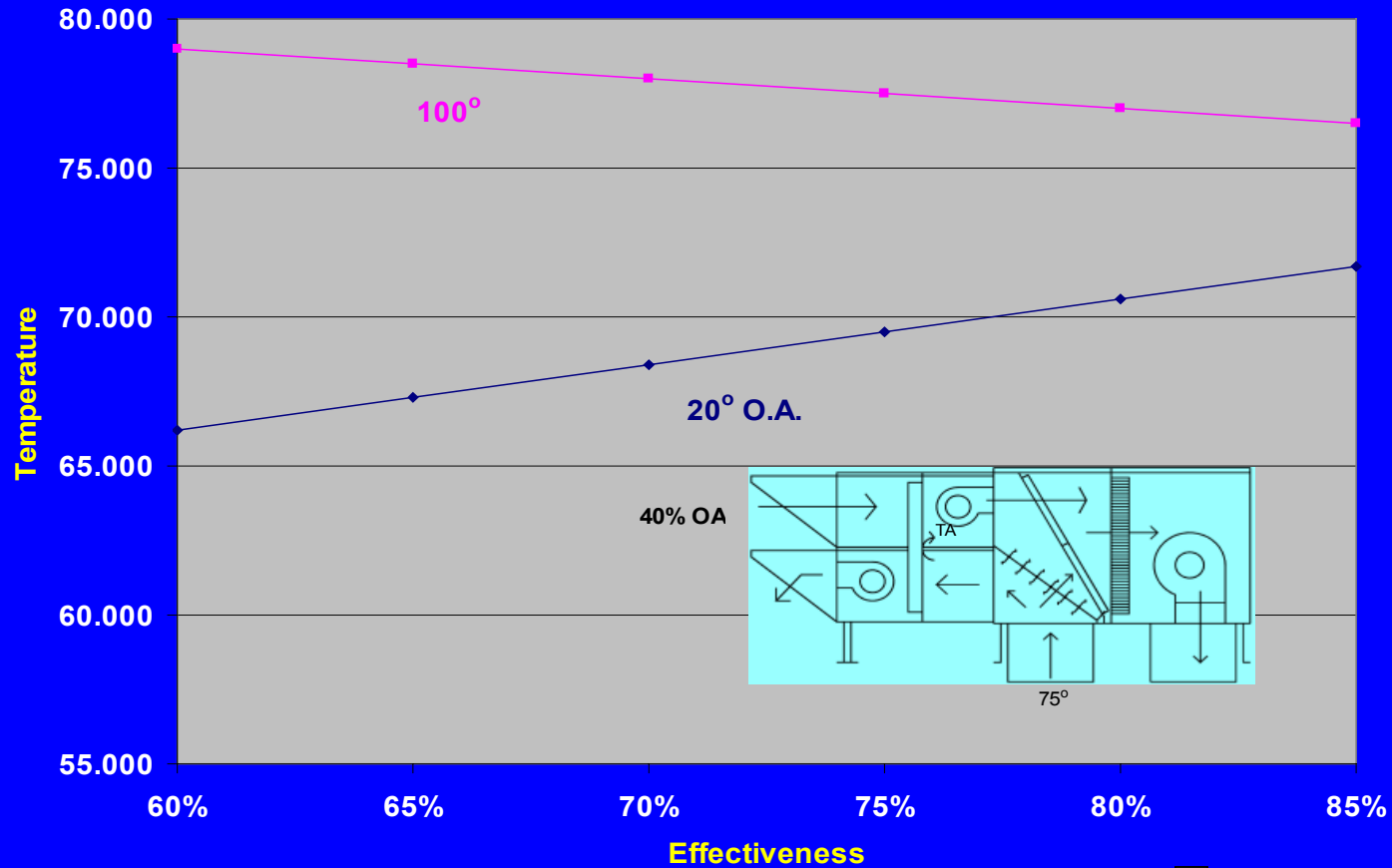


*Energy Recovery Ventilators*

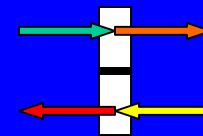




# Entering Air (EA) Temperature Change as Effectiveness Changes

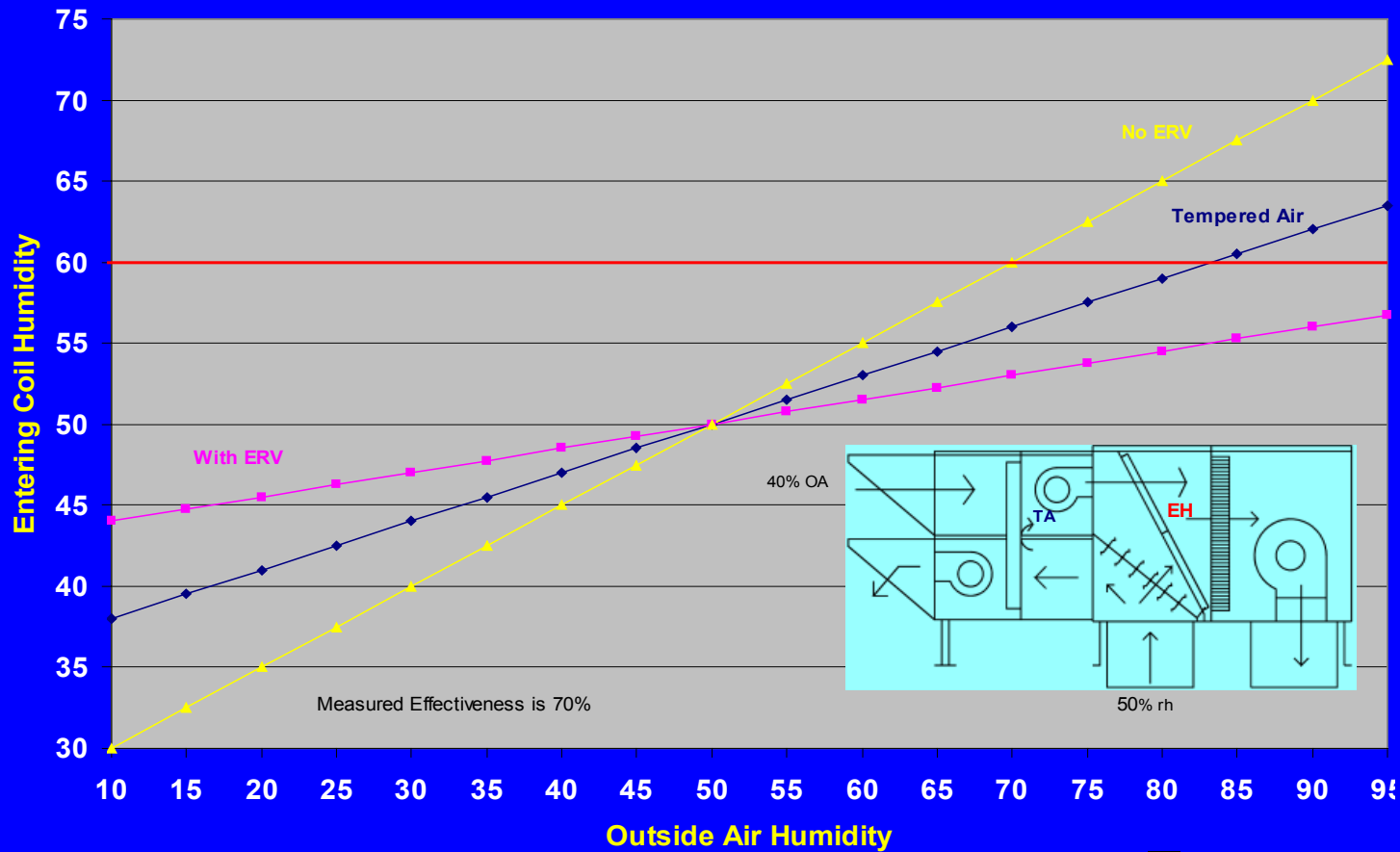


*Energy Recovery Ventilators*

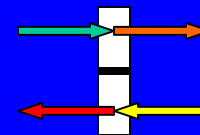




# Entering Air Humidity (EH) at Varying Outside Air Humidity Levels

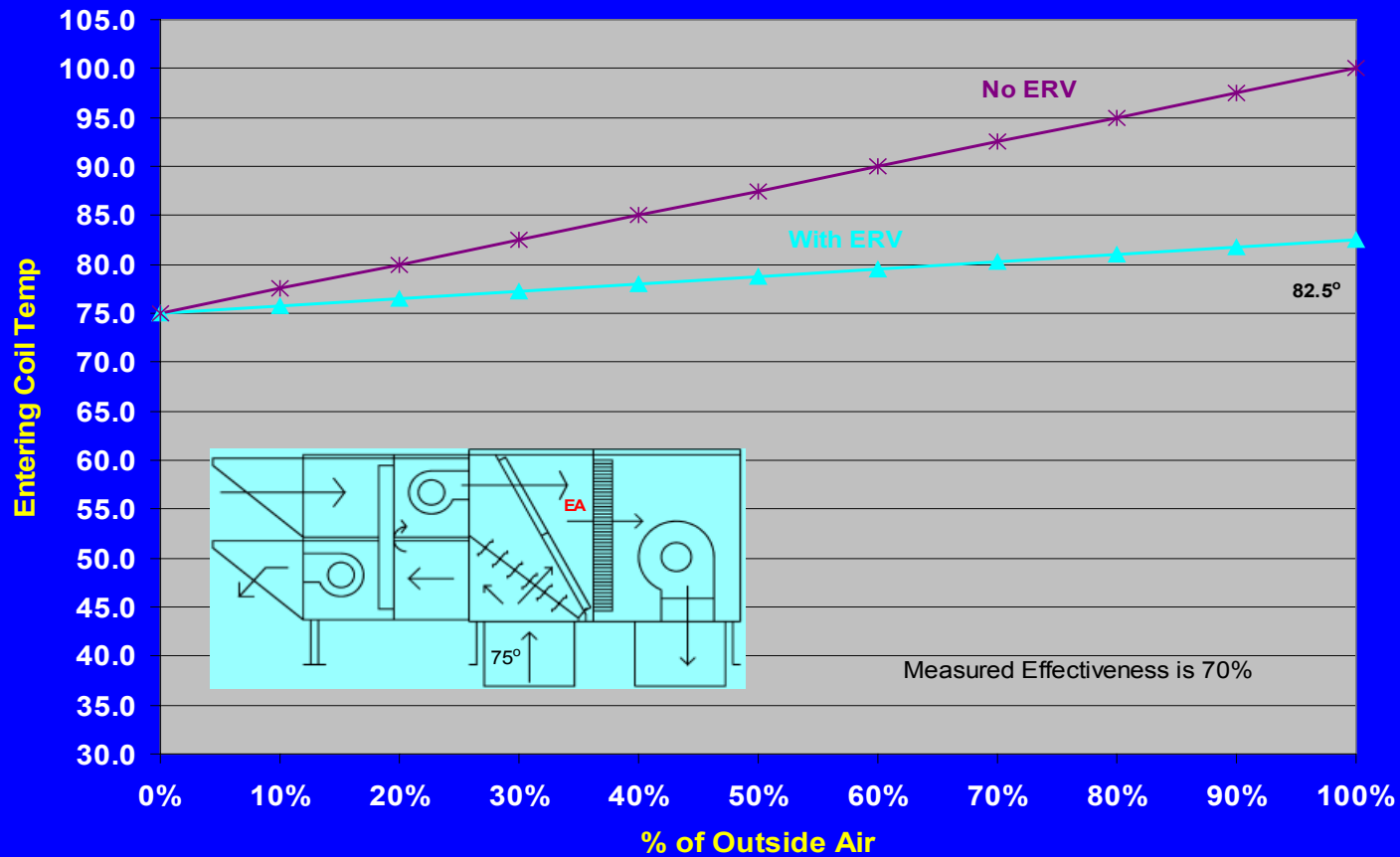


*Energy Recovery Ventilators*

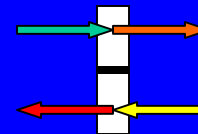




# Entering Air Temperature (EA) at 100° OA and Varying % of Outside Air

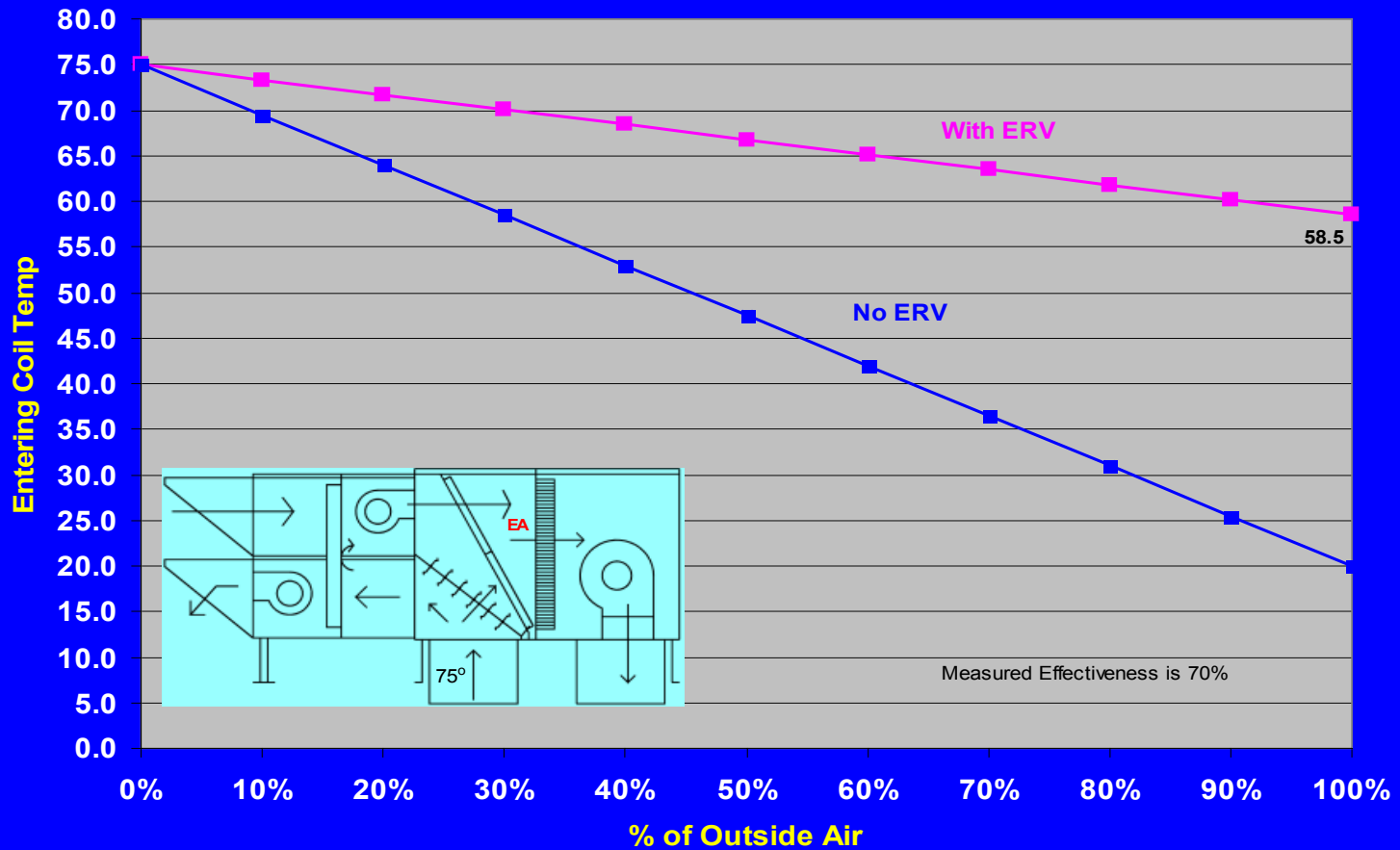


*Energy Recovery Ventilators*

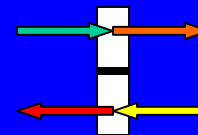




# Entering Air Temperature (EA) at 20° OA and Varying % of Outside Air



*Energy Recovery Ventilators*





## Old vs. New ARI Ratings

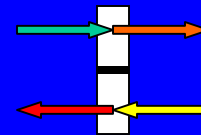


**Apples**  
or  
**Oranges**



- Old Rating System (pre ARI) for Effectiveness had higher ratings with exhaust air transfer included in the data
- New ARI Rating System for Effectiveness has lower ratings without exhaust air transfer included in the data

*Energy Recovery Ventilators*





## Old vs. New ARI Ratings

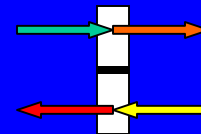


- Manufactures *that do not Certify* with ARI will claim higher Effectiveness numbers by using the Old Ratings System



Manufactures *that do Certify* with ARI will have lower **Net Effectiveness** than the Old Ratings System, but similar Application Effectiveness numbers.

*Energy Recovery Ventilators*





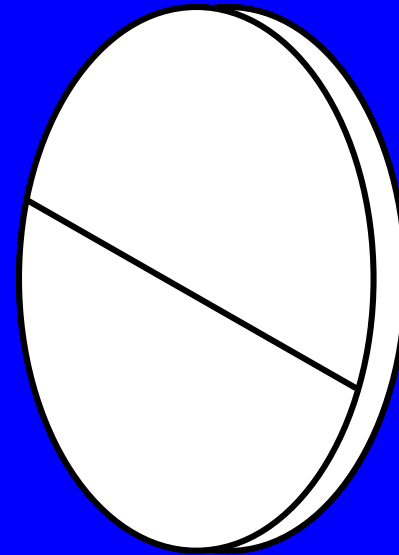
# Beware of the Ratings Game!

Ratings are a function of

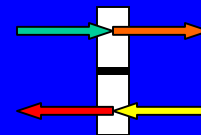
***VELOCITY!***

The higher the ***velocity***,  
the lower the rating!

Some manufacturers have  
their ratings based on  
lower airflow than the  
actual application usage.



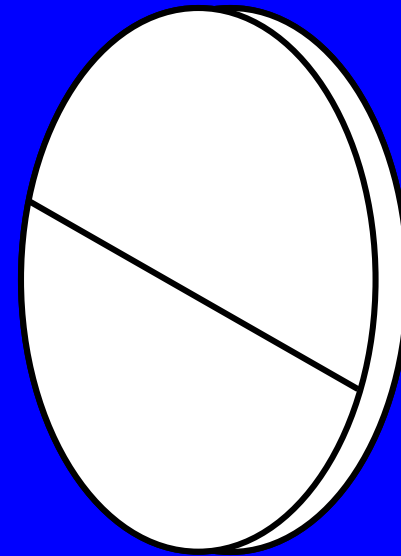
*Energy Recovery Ventilators*



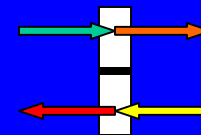


# Beware of the Ratings Game!

- *Ratings are based on 1 scfm setpoint* (not a range of scfm)
  - *The setpoint is specified by the wheel manufacturer*
- A wheel with a range of 1,500 to 3,000 scfm, can be rated at any point within that range
  - *At 2,000 scfm the rating would be much higher than at 3,000 scfm*

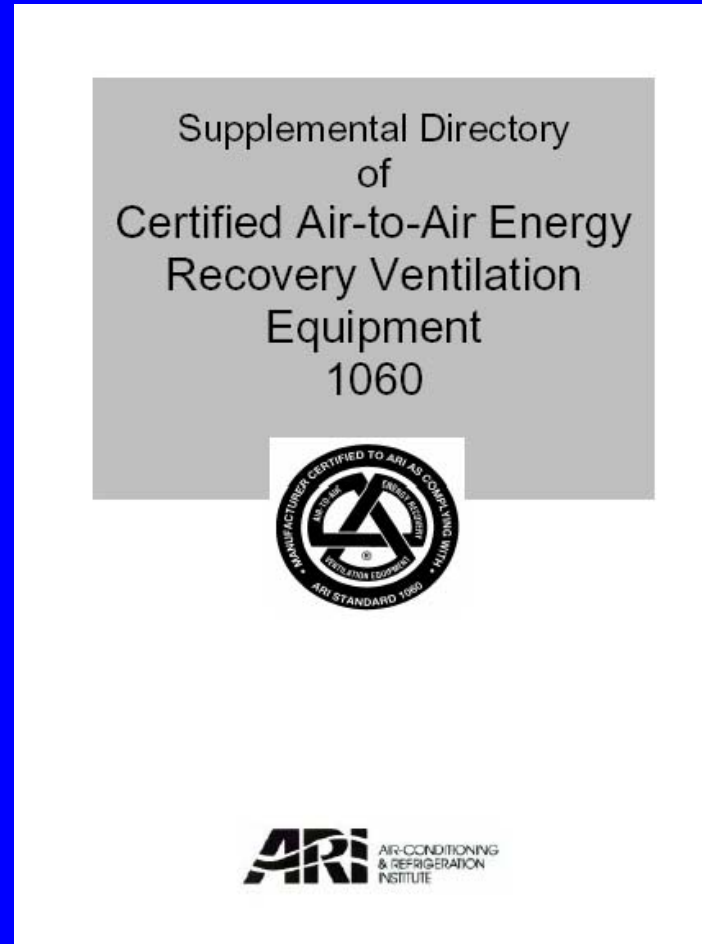


*Energy Recovery Ventilators*

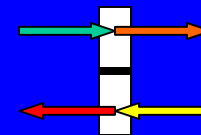




ARI  
Certified  
Components



*Energy Recovery Ventilators*

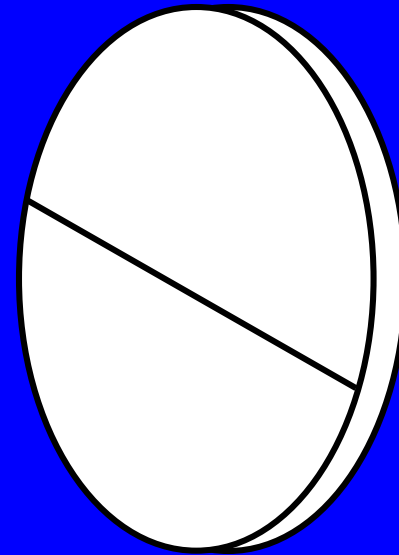




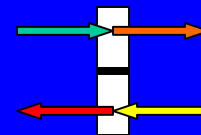
## *Rotary Wheel Manufacturers* with Certified ARI Ratings

- Airxchange
- Desiccant Rotors Int'l
- Innergy Tech
- Novelaire
- Venmar

(as of March 21, 2002)



*Energy Recovery Ventilators*





# ARI Certified Components

Unit Manufacturer: ROOFTOP SYSTEMS INC.

Type: WHEEL Nominal Airflow: 900 scfm

Tilt Angle (Heating/Cooling) N / A Deg

Pressure Drop: 1.00 inches

### Leakage Ratings

	Pressure Differential	EATR	QACF	Purge Angle or Setting
Test 1:	-1.00 inches	0.3%	0.97	N/A
Test 2:	0.00 inches	0.7%	1.19	N/A
Test 3	1.00 inches	0.0%	1.34	N/A
Optional Add'l Test(s):	Inches			

### Thermal Effectiveness Ratings at 0" Pressure Differential

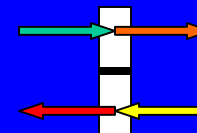
	Sensible	Latent	Total
100% Airflow Heating Condition:	76%	68%	73%
75% Airflow Heating Condition:	81%	73%	78%
100% Airflow Cooling Condition:	76%	68%	72%
75% Airflow Cooling Condition:	81%	73%	76%
	Net Sensible	Net Latent	Net Total
100% Airflow Heating Condition:	76%	68%	73%
75% Airflow Heating Condition:	81%	73%	78%
100% Airflow Cooling Condition:	76%	68%	72%
75% Airflow Cooling Condition:	81%	73%	76%

Trade Name: ROOFTOP SYSTEMS INC. Model Number: 50-R11-30

Trade Name: ROOFTOP SYSTEMS INC. Model Number: 50-R11-31

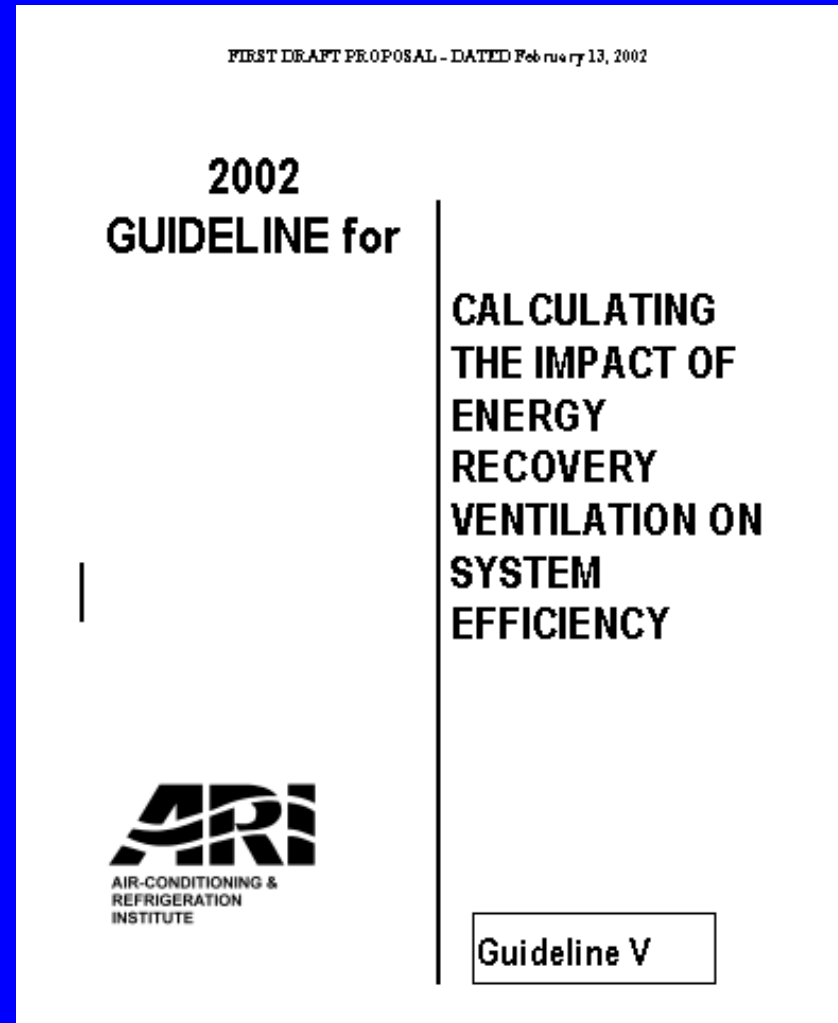
Trade Name: ROOFTOP SYSTEMS INC. Model Number: 50-R11-36

*Energy Recovery Ventilators*

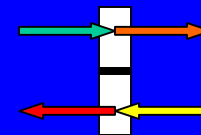




Recovery  
Efficiency  
Ratio (RER)



*Energy Recovery Ventilators*





Performance  
Software

## AIRX ERC

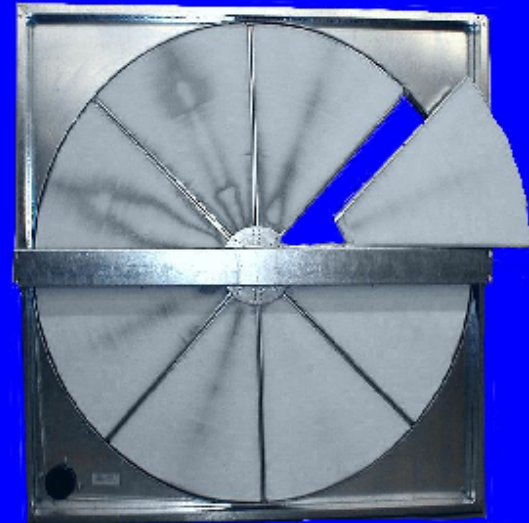
Version 3.0.5(I-P and SI)

© Copyright Airchange 1997, 1998, 2001, and 2002

*Selection, Performance, and  
Energy Analysis Software*

Description

Go to  
Calculations



Rooftop Systems Inc.

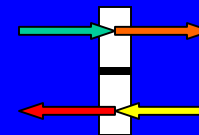
2405 McIver Lane  
Carrollton, Texas 75006

tel: 972-247-7447  
fax: 972-243-0940

<http://www.rooftopsystems.com>



*Energy Recovery Ventilators*





# Performance Software

**AIRX Inputs**  
File Options Go to Help

**Schools for Learning** Current File: Detroit Sample.erp

Project Information **Unit Selections** Design Conditions Utilities Schedules

Total Number of Units in Project **0**

Suggested MIN Airflow, cfm **300** Suggested MAX Airflow, cfm **550**

Choose Selection Method

- Select from list of all available units
- Select based on airflow
- Select based on effectiveness

Unit Tag (Optional) **RTU-1**

Net Outdoor Airflow Rate, cfm **450**

Net Exhaust Airflow Rate, cfm **450**

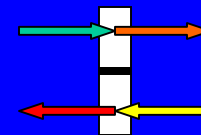
Fan/Motor Efficiency, % **40**

**Add Unit** **R06 ERC1906 300-550**

**Delete Unit** **1** Single-click to select a unit to delete

No.	Tag	Model	Sup cfm	Exh cfm	Fan/Mot Eff.	Supply dP	Return dP	EATR	DACF
1	RTU-1	ERC-1906	450	450	40	0.46	0.46	8.1	1.07
2	RTU-2	ERC-2511	1000	1000	40	0.89	0.89	6.7	1.02
3	RTU-3	ERC-3628	2800	2800	40	0.92	0.92	4.7	1.01
4	RTU-4	ERC-5262	6000	6000	40	0.92	0.92	3.2	1.01

## Energy Recovery Ventilators





# Performance Software

**AIRX Outputs**

File Go To Specifications Help

**Design Point Performance** | Annual Energy Analysis | Economic Summary | System EER Analysis

**Schools for Learning**

*DESIGN CONDITIONS*

		SUMMER		WINTER	
		outdoor	indoor	outdoor	indoor
Dry Bulb Temperature, F		90.00	75.00	0.00	72.00
Wet Bulb Temperature, F		73.00	63.00	-1.00	54.00
Enthalpy, Btu/lb		36.94	28.74	0.57	22.71
Total Effectiveness, %		Meas. 69.3	Net 66.5	Meas. 72.0	Net 69.1

Select one or all units

Unit No. Model No. of Units in Project

1 (RTU-1) ERC-1906 4

Calculate View Diagram

This Unit Report Summary Report

Net Outdoor Airflow, cfm 450

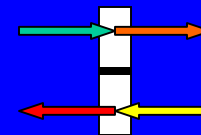
Net Exhaust Airflow, cfm 450

No frost control is used

---SUPPLY AIR CONDITIONS---					-----DESIGN LOADS-----				
(including the effect of return air leakage)					OA	OA	OA	Total	Net OA
	Tdb, F	Twb, F	Enthalpy, Btu/lb	rh, %	Sensible Btu/h	Latent Btu/h	Total Btu/h	Recovered Btu/h	Load Btu/h
Summer	79.01	66.29	31.27	51.9	6,946	8,870	15,816	10,559	5,257
Winter	50.93	41.11	15.86	41.8	35,484	9,965	45,450	30,249	15,201

SYSTEM CAPACITY SAVED: COOLING, TONS 0.88 HEATING, Btu/h 30,249

## Energy Recovery Ventilators





# Performance Software

**AIRX Outputs**

File Go To Specifications Help

Design Point Performance **Annual Energy Analysis** Economic Summary System EER Analysis

**Schools for Learning**

SELECT A UNIT FOR ANNUAL ANALYSIS OR SELECT "ALL UNITS" FOR ENTIRE PROJECT

**Calculate Energy**

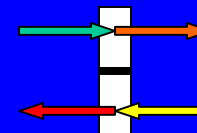
Unit No. Model No. Units in Project Weather Conditions

1 (RTU-1) ERC-1906 4 Detroit, Michigan

Dry Bulb	MCWB	Annual	Enthalpy	Ventilation	Recovered	Net Vent.	
F	F	Hours	Btu/lb	Load, MBtu	Load, MBtu	Load, MBtu	
97.50	78.00	1	41.81	18	12	6	
92.50	74.00	12	37.86	214	143	71	
87.50	72.87	45	36.90	708	469	239	
82.50	69.41	157	33.86	1,552	1,024	527	
77.50	66.12	276	31.16	1,292	839	453	
72.50	63.04	265	28.80				
67.50	59.26	256	26.18	-19	-14	-5	
62.50	54.26	245	22.94	-170	-146	-24	
57.50	50.37	246	20.65	-977	-742	-235	
52.50	45.79	229	18.17	-2,000	-1,429	-571	
47.50	42.14	187	16.35	-2,295	-1,620	-676	

**Print This Table**

## Energy Recovery Ventilators





# Performance Software

**AIRX Outputs**

File Go To Specifications Help

Design Point Performance Annual Energy Analysis **Economic Summary** System EER Analysis

**Schools for Learning**

Weather Conditions  
Detroit, Michigan

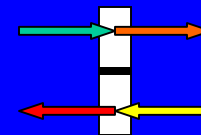
**Calculate Economics**

Unit No.	Model	Supply cfm	Exhaust cfm	Coolg Saved, MBtu	Cooling \$ Saved	Heatg Saved, MBtu	Heati
1	ERC-1906	450	450	2,487	92	24,008	154
2	ERC-2511	1000	1000	5,875	218	56,522	362
3	ERC-3628	2800	2800	14,534	540	140,912	903
4	ERC-5262	6000	6000	30,967	1,151	300,531	1,926
SUMMARY							
All Units		10250	10250	53,863	2,002	521,973	3,346

**Print This Table** **Print Entire Report**

Note: Summer utility rates are assumed to apply from May through October

## Energy Recovery Ventilators





# Performance Software

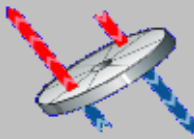
**AIRX Outputs**

File Go To Specifications Help

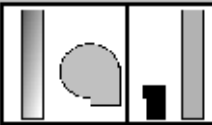
Design Point Performance Annual Energy Analysis Economic Summary **System EER Analysis**

**Schools for Learning**

Airxchange Component



Unitary Equipment



\* Confirm that unitary equipment size is based on the reduced load with the addition of the ERV component (see Help for details)


This analysis calculates the recovery efficiency ratio (RER) for the ERV component and combines it with the EER of a unitary packaged air conditioner to provide a calculated efficiency for the combination (System EER)

Select a Unit: 4 (RTU-4) Name or Model Number: RTU-4

EER: 9

Unitary Capacity \*: 360000 Btu/h

**Calculate**



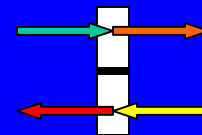
To print, EER Calculations must be completed

Unit	ERV RER	Unitary Model	Unitary Cap.	Unitary EER	ERV Cap.(Y), %	Syst. EER
1 (RTU-1)	45.48	RTU-1	36000.0	9.00	23	11.00
2 (RTU-2)	38.02	RTU-2	72000.0	9.00	26	11.20
3 (RTU-3)	36.70	RTU-3	180000.0	9.00	26	11.15
4 (RTU-4)	38.14	RTU-4	360000.0	9.00	27	11.32

**Print Selection**

**Print All**

## Energy Recovery Ventilators





# Payback Savings Estimator

<b>Rooflop Systems Inc.</b>			
<b>UERV Payback Analysis Estimator</b>			
<b>Job Description</b>			
Job Name:	Schools for Learning	City/State:	Detroit, MI
Contractor:	Billy Bob Mechanical	Contact:	Billy Bob
Engineer:	Prime Engineers	Contact:	I. B. Good
Quote Date:	3/15/02	Quote Number:	1234
<b>Energy Savings Data Generated from Airxchange 3.01 Software</b>			
Total Cooling \$ Saved:	\$	2,002.00	
+ Total Heating \$ Saved:	\$	3,346.00	
- Total Fan \$ Spent:	\$	1,922.00	
= Total \$ Saved:			\$3,426.00
<b>Job Tonnage Savings Information</b>			
Total Cooling Tonnage Saved: (from Airxchange Software)		19.08	
X Installed A/C \$ Cost per Ton: (includes A/C units, duct, grills, etc.)		\$1,000.00	
= Total \$ Savings on Tonnage:			\$19,080.00
<b>Total Savings due to UERV's:</b>			<b>\$22,506.00</b>
<b>Job Costing Information</b>			
Estimated Installed Cost for UERV's:	\$	30,750.00	
<b>Saving Payback (in years) for UERV's:</b>			<b>1.37</b>
<b>Total UERV CFM:</b>		10,250.00	
<b>Total Installed UERV Cost per CFM:</b>			<b>\$3.00</b>

*Energy Recovery Ventilators*

