LARGER THAN RESIDENTIAL VENTILATION STRATEGIES AND DESIGN

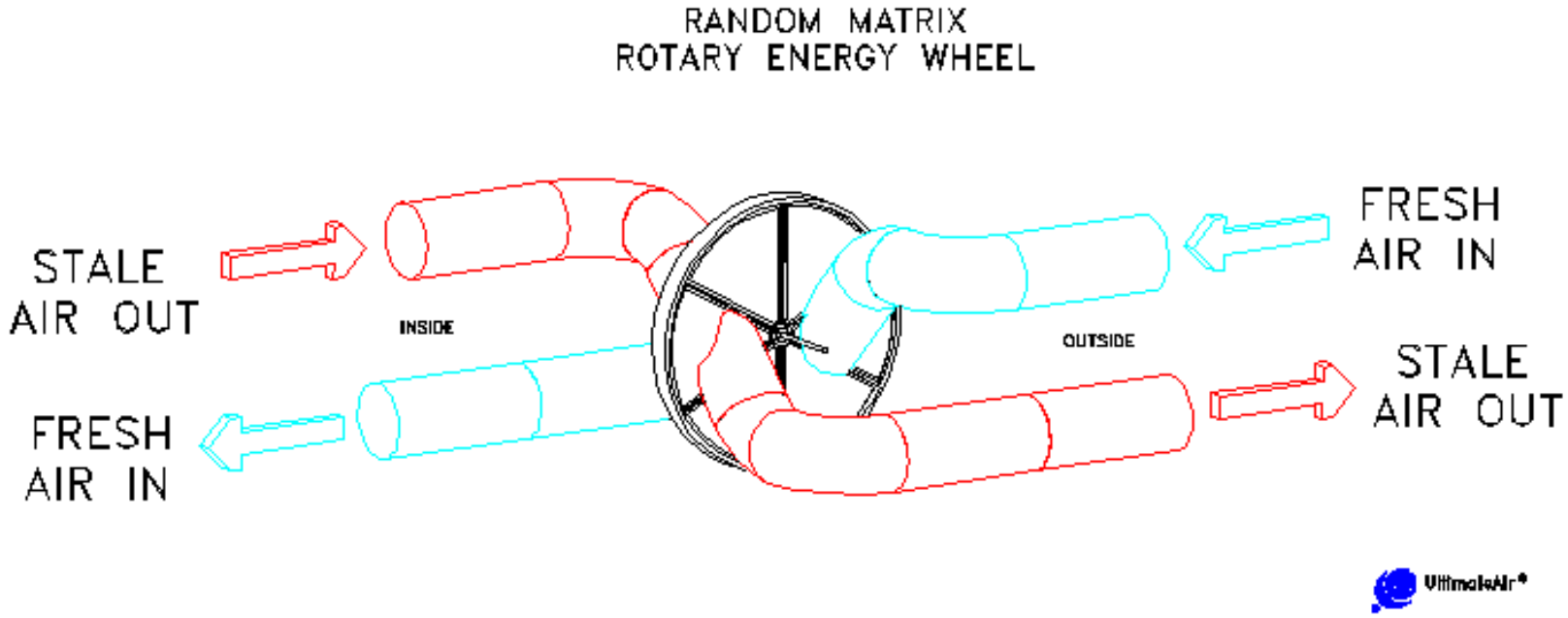
Jason Morosko
jmorosko@ultimateair.com
UltimateAir Inc
Athens, Ohio

COMMERCIAL ERV DESIGN & ACCESSORIES

TOPICS

- Some background topics
- Motor efficiency
- Heat exchange efficiency
- Unit Insulation
- Service
- Air Filtration
- Installation details
- Zoning
- Controls
- Maintenance

PRINCIPLE OF OPERATION



ERV vs. HRV

In most applications it is better have moisture transfer

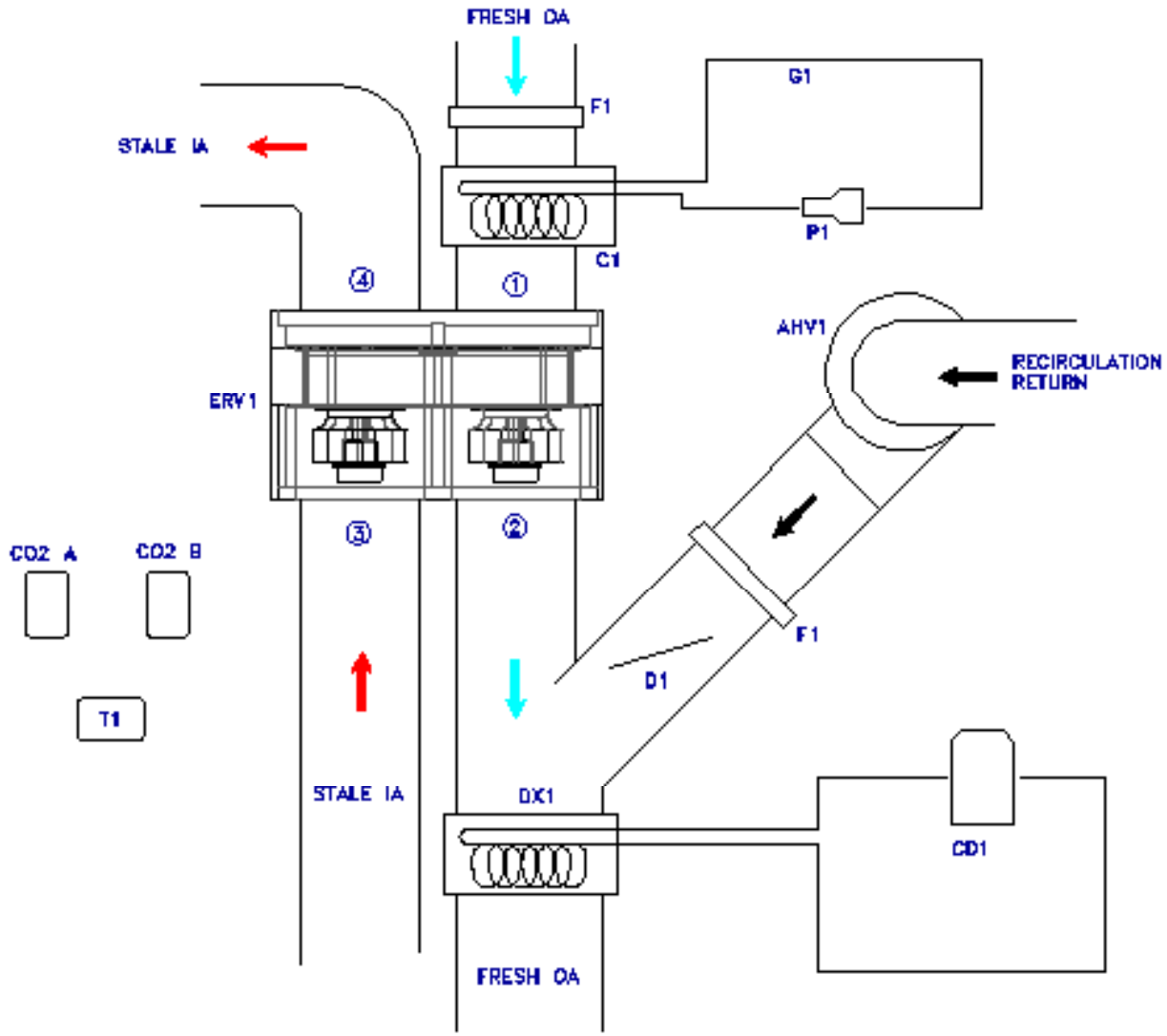
1. Hot humid outside condition: remove humidity from the incoming air = ERV
2. Cold outside – dry inside: return as much humidity as possible to the inside = ERV
3. Cold outside – excessively humid inside: exhaust some humidity, but not all = ERV

If you always want to move all humidity from the outside to the inside, or from the inside to outside, or if the humidity inside and outside are always favorable = HRV

SPECIFICATION - Commercial

Model	RecoupAerator 2000DX Energy Recovery Ventilator (ERV). Includes patented energy transfer/filtration material, fans, controls, and motors.
Airflow Capacity	~200 – 1800 CFM
Apparent Sensible Efficiency	95%
Total Recovery Efficiency	44%
Heat Exchange Type	Patented rotary random matrix polymer
Filtration	Energy transfer/filtration material 95% effective at 1.8 microns (MERV 12), washable/replaceable
Electrical Ratings	1@ 120 VAC – 5amp, 50/60hz : 1@200-277VAC – 20amp, Single phase, 50/60hz
Dimensions	64 in. H x 64 in. W x 42 in. D
Connections	4 – 18” Diameter Duct connections
Maintenance	Routine clean/service approximately every 8 months

SAMPLE INSTALL



C1	GROUND COIL
P1	GROUND COIL PUMP
D1	POWER DAMPER
AHV1	AUXILARY VARIABLE SPEED FAN
DX1	DX COIL
G1	GROUND LOOP
F1	AIR FILTER
CO2A	CO2 MONITOR LOCATION A
CO2B	CO2 MONITOR LOCATION B
T1	THERMOSTAT (TEMP + HUMIDITY)
ERV1	ENERGY RECOVERY VENTILATOR
CD1	OUTSIDE CONDENSER FOR DX1

1800 CFM ERV *wheel assembly*

1800 CFM ERV *exterior*

1800 CFM ERV *exterior*

1800 CFM ERV *reverse curve EC DC fan*

24x48 COIL *for commercial application*

- Applications include Pre and Post conditioning of the air
- Considerations

    1. Design for the end goal – what you want to achieve
    2. Installation
        a. Transitioning from the coil to the duct
        b. Filtration – for IAQ and/or equipment protection
        c. Condensate drain

- Design Considerations

    1. Insulated, thermally broken housing
    2. Pressure drop (fan power)
    3. Coil efficiency
    4. Fluid

24x48 COIL *data for pre cooling*

Test	Inlet Water	Water Flow	Air Flow	Inlet Air	Inlet Air	Outlet Water	Outlet Air		Capacity Btu/Hr		
	F	*GPM*	*CFM*	*DB F*	*WB F*	*F*	*WB F*	*DB F*	*Total*	*Sensible*	*Latent*
Options For Pre Cooling and Dehumidifying											
1	60	2.0	500	95	85	76.6	65.3	64.7	16578	16578	0
2	60	6.0	500	95	85	76.2	61.3	61.6	49065	18561	30503
3	60	12.0	500	95	85	68.3	59.6	60.2	50385	19031	31354
4	60	2.0	1000	95	85	81.8	75.0	75.3	21627	21627	0
5	60	6.0	1000	95	85	82.6	70.5	70.6	66990	27188	39802
6	60	12.0	1000	95	85	73.8	65.8	66.4	82076	31357	50719
7	60	2.0	2000	95	85	86.5	80.2	82.9	26492	26492	0
8	60	6.0	2000	95	85	75.9	76.1	73.3	47643	47643	0
9	60	12.0	2000	95	85	79.7	72.3	72.7	117200	48886	68314
10	60	2.0	1500	95	85	85.0	78.3	79.9	24961	24961	0
11	60	12.0	1500	95	85	77.5	69.4	70.0	104207	41147	63060
12	60	6.0	1000	95	85	81.5	70.7	71.0	64663	26307	38356

24x48 COIL *exterior*

24x48 COIL *assembly*

COST COMPARISON *Dayton, OH – 1000 CFM*

Local Variables		
Indoor Temp	68	*F*
Location	Dayton, OH	
Air Flow	1000	*CFM*
Unit A. ASE	92	*%*
Unit A Power	0.8	*Watt/CFM*
	800	*Watt*
Unit B. ASE	82	*%*
Unit B Power	1.2	*Watt/CFM*
	1200	*Watt*

Global Variables		
Electric Cost	0.09	/kWh
Heating COP (est)	2.5	
Cooling SEER (est)	16	
Cp air	0.24	btu/lb.
Air Density	0.0764	lb./cu.ft. @ 60F

Month	Ave. Daily Temp	BTU/day Loss	BTU/day Gain	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-cool / month	Cost to re-cool / month	Operational Cost / month	Operational Cost / month
	F	*BTU*	*BTU*	*No heat recovery*	*Unit A*	*Unit B*	*No heat recovery*	*Unit A*	*Unit B*	*Unit A*	*Unit B*
Jan	34.9	873967.1	0.0	$ 285.85	$ 22.87	$ 51.45	$ -	$ -	$ -	$ 53.57	$ 80.35
Feb	38.8	770992.1	0.0	$ 252.17	$ 20.17	$ 45.39	$ -	$ -	$ -	$ 53.57	$ 80.35
Mar	50.5	462067.2	0.0	$ 151.13	$ 12.09	$ 27.20	$ -	$ -	$ -	$ 53.57	$ 80.35
Apr	62.8	137300.0	0.0	$ 44.91	$ 3.59	$ 8.08	$ -	$ -	$ -	$ 53.57	$ 80.35
May	73.8	0.0	153142.3	$ -	$ -	$ -	$ 7.83	$ 0.63	$ 1.41	$ 53.57	$ 80.35
June	82.9	0.0	393417.2	$ -	$ -	$ -	$ 20.11	$ 1.61	$ 3.62	$ 53.57	$ 80.35
July	86.4	0.0	485830.7	$ -	$ -	$ -	$ 24.83	$ 1.99	$ 4.47	$ 53.57	$ 80.35
Aug	84.7	0.0	440944.1	$ -	$ -	$ -	$ 22.53	$ 1.80	$ 4.06	$ 53.57	$ 80.35
Sept	78.4	0.0	274599.9	$ -	$ -	$ -	$ 14.03	$ 1.12	$ 2.53	$ 53.57	$ 80.35
Oct	65.7	60728.8	0.0	$ 19.86	$ 1.59	$ 3.58	$ -	$ -	$ -	$ 53.57	$ 80.35
Nov	52.3	414540.3	0.0	$ 135.58	$ 10.85	$ 24.40	$ -	$ -	$ -	$ 53.57	$ 80.35
Dec	40.1	736667.1	0.0	$ 240.94	$ 19.28	$ 43.37	$ -	$ -	$ -	$ 53.57	$ 80.35
Annual HDD	4057.9	Yearly		**$ 1,130.43**	**$ 90.43**	**$ 203.48**	**$ 89.33**	**$ 7.15**	**$ 16.08**	**$ 642.82**	**$ 964.22**
Annual CDD	2052.2										

COST COMPARISON *Dayton, OH – 1000 CFM*

Assumptions	
Location	Dayton, OH
Unit A. ASE %	92
Unit A. W/CFM	0.8
Unit B. ASE %	82
Unit B. W/CFM	1.2
Heating COP	2.5
Cooling SEER	16
HDD	4057.9
CDD	2052.2
Air Flow (CFM)	1000

Cost to re-heat / re-cool without heat recovery	$ 1,219.76

Yearly Savings	Due to ASE	Due to W/CFM	Total
Better Unit	$ 121.98	$ 321.41	$ 443.38

Unit A. Cost	$ 13,500.00
Unit B. Cost	$ 11,000.00
Years to Payback unit A vs unit B	5.6

COST COMPARISON *Portland, OR – 1000 CFM*

Local Variables		
Indoor Temp	68	*F*
Location	Portland, OR	
Air Flow	1000	*CFM*
Unit A. ASE	92	*%*
Unit A Power	0.8	*Watt/CFM*
	800	*Watt*
Unit B. ASE	82	*%*
Unit B Power	1.2	*Watt/CFM*
	1200	*Watt*

Global Variables		
Electric Cost	0.09	/kWh
Heating COP (est)	2.5	
Cooling SEER (est)	16	
Cp air	0.24	btu/lb.
Air Density	0.0764	lb./cu.ft. @ 60F

Month	Ave. Daily Temp	BTU/day Loss	BTU/day Gain	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-cool / month	Cost to re-cool / month	Operational Cost / month	Operational Cost / month
	F	*BTU*	*BTU*	*No heat recovery*	*Unit A*	*Unit B*	*No heat recovery*	*Unit A*	*Unit B*	*Unit A*	*Unit B*
Jan	45.3	599367.2	0.0	$ 196.03	$ 15.68	$ 35.29	$ -	$ -	$ -	$ 53.57	$ 80.35
Feb	50.9	451505.7	0.0	$ 147.67	$ 11.81	$ 26.58	$ -	$ -	$ -	$ 53.57	$ 80.35
Mar	55.9	319486.5	0.0	$ 104.49	$ 8.36	$ 18.81	$ -	$ -	$ -	$ 53.57	$ 80.35
Apr	60.4	200669.2	0.0	$ 65.63	$ 5.25	$ 11.81	$ -	$ -	$ -	$ 53.57	$ 80.35
May	67.1	23763.5	0.0	$ 7.77	$ 0.62	$ 1.40	$ -	$ -	$ -	$ 53.57	$ 80.35
June	73.9	0.0	155782.7	$ -	$ -	$ -	$ 7.96	$ 0.64	$ 1.43	$ 53.57	$ 80.35
July	79.9	0.0	314205.7	$ -	$ -	$ -	$ 16.06	$ 1.28	$ 2.89	$ 53.57	$ 80.35
Aug	80.2	0.0	322126.8	$ -	$ -	$ -	$ 16.46	$ 1.32	$ 2.96	$ 53.57	$ 80.35
Sept	74.5	0.0	171625.0	$ -	$ -	$ -	$ 8.77	$ 0.70	$ 1.58	$ 53.57	$ 80.35
Oct	63.9	108255.7	0.0	$ 35.41	$ 2.83	$ 6.37	$ -	$ -	$ -	$ 53.57	$ 80.35
Nov	52.5	409259.5	0.0	$ 133.86	$ 10.71	$ 24.09	$ -	$ -	$ -	$ 53.57	$ 80.35
Dec	45.5	594086.4	0.0	$ 194.31	$ 15.54	$ 34.98	$ -	$ -	$ -	$ 53.57	$ 80.35
Annual HDD	3177.5	Yearly		**$ 885.17**	**$ 70.81**	**$ 159.33**	**$ 49.25**	**$ 3.94**	**$ 8.87**	**$ 642.82**	**$ 964.22**
Annual CDD	1131.5										

COST COMPARISON *Portland, OR – 1000 CFM*

Assumptions	
Location	Portland, OR
Unit A. ASE %	92
Unit A. W/CFM	0.8
Unit B. ASE %	82
Unit B. W/CFM	1.2
Heating COP	2.5
Cooling SEER	16
HDD	3177.5
CDD	1131.5
Air Flow (CFM)	1000

Cost to re-heat / re-cool without heat recovery	$ 934.42

Yearly Savings	Due to ASE	Due to W/CFM	Total
Better Unit	$ 93.44	$ 321.41	$ 414.85

Unit A. Cost	$ 13,500.00
Unit B. Cost	$ 11,000.00
Years to Payback unit A vs unit B	6.0

COST COMPARISON *Miami, FL – 1000 CFM*

Local Variables		
Indoor Temp	68	*F*
Location	Miami, FL	
Air Flow	1000	*CFM*
Unit A. ASE	92	*%*
Unit A Power	0.8	*Watt/CFM*
	800	*Watt*
Unit B. ASE	82	*%*
Unit B Power	1.2	*Watt/CFM*
	1200	*Watt*

Global Variables		
Electric Cost	0.09	/kWh
Heating COP (est)	2.5	
Cooling SEER (est)	16	
Cp air	0.24	btu/lb.
Air Density	0.0764	lb./cu.ft. @ 60F

Month	Ave. Daily Temp	BTU/day Loss	BTU/day Gain	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-cool / month	Cost to re-cool / month	Operational Cost / month	Operational Cost / month
	F	*BTU*	*BTU*	*No heat recovery*	*Unit A*	*Unit B*	*No heat recovery*	*Unit A*	*Unit B*	*Unit A*	*Unit B*
Jan	67.1	23763.5	0.0	$ 7.77	$ 0.62	$ 1.40	$ -	$ -	$ -	$ 53.57	$ 80.35
Feb	68.4	0.0	10561.5	$ -	$ -	$ -	$ 0.54	$ 0.04	$ 0.10	$ 53.57	$ 80.35
Mar	71.6	0.0	95053.8	$ -	$ -	$ -	$ 4.86	$ 0.39	$ 0.87	$ 53.57	$ 80.35
Apr	75.2	0.0	190107.6	$ -	$ -	$ -	$ 9.72	$ 0.78	$ 1.75	$ 53.57	$ 80.35
May	78.6	0.0	279880.7	$ -	$ -	$ -	$ 14.30	$ 1.14	$ 2.57	$ 53.57	$ 80.35
June	81.3	0.0	351171.1	$ -	$ -	$ -	$ 17.95	$ 1.44	$ 3.23	$ 53.57	$ 80.35
July	82.6	0.0	385496.1	$ -	$ -	$ -	$ 19.70	$ 1.58	$ 3.55	$ 53.57	$ 80.35
Aug	82.8	0.0	390776.8	$ -	$ -	$ -	$ 19.97	$ 1.60	$ 3.59	$ 53.57	$ 80.35
Sept	81.9	0.0	367013.4	$ -	$ -	$ -	$ 18.76	$ 1.50	$ 3.38	$ 53.57	$ 80.35
Oct	78.3	0.0	271959.6	$ -	$ -	$ -	$ 13.90	$ 1.11	$ 2.50	$ 53.57	$ 80.35
Nov	73.6	0.0	147861.5	$ -	$ -	$ -	$ 7.56	$ 0.60	$ 1.36	$ 53.57	$ 80.35
Dec	69.1	0.0	29044.2	$ -	$ -	$ -	$ 1.48	$ 0.12	$ 0.27	$ 53.57	$ 80.35
Annual HDD	27.9	Yearly		**$ 7.77**	**$ 0.62**	**$ 1.40**	**$ 128.73**	**$ 10.30**	**$ 23.17**	**$ 642.82**	**$ 964.22**
Annual CDD	2957.4										

COST COMPARISON *Miami, FL – 1000 CFM*

Assumptions	
Location	Miami, FL
Unit A. ASE %	92
Unit A. W/CFM	0.8
Unit B. ASE %	82
Unit B. W/CFM	1.2
Heating COP	2.5
Cooling SEER	16
HDD	27.9
CDD	2957.4
Air Flow (CFM)	1000

Cost to re-heat / re-cool without heat recovery	$ 136.50

Yearly Savings	Due to ASE	Due to W/CFM	Total
Better Unit	$ 13.65	$ 321.41	$ 335.06

Unit A. Cost	$ 13,500.00
Unit B. Cost	$ 11,000.00
Years to Payback unit A vs unit B	7.5

COST COMPARISON *Duluth, MN – 1000 CFM*

Local Variables		
Indoor Temp	68	*F*
Location	Duluth, MN	
Air Flow	1000	*CFM*
Unit A. ASE	92	*%*
Unit A Power	0.8	*Watt/CFM*
	800	*Watt*
Unit B. ASE	82	*%*
Unit B Power	1.2	*Watt/CFM*
	1200	*Watt*

Global Variables		
Electric Cost	0.09	/kWh
Heating COP (est)	2.5	
Cooling SEER (est)	16	
Cp air	0.24	btu/lb.
Air Density	0.0764	lb./cu.ft. @ 60F

Month	Ave. Daily Temp	BTU/day Loss	BTU/day Gain	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-cool / month	Cost to re-cool / month	Operational Cost / month	Operational Cost / month
	F	*BTU*	*BTU*	*No heat recovery*	*Unit A*	*Unit B*	*No heat recovery*	*Unit A*	*Unit B*	*Unit A*	*Unit B*
Jan	7.2	1605353.5	0.0	$ 525.06	$ 42.00	$ 94.51	$ -	$ -	$ -	$ 53.57	$ 80.35
Feb	12.4	1468053.5	0.0	$ 480.15	$ 38.41	$ 86.43	$ -	$ -	$ -	$ 53.57	$ 80.35
Mar	24.4	1151207.4	0.0	$ 376.52	$ 30.12	$ 67.77	$ -	$ -	$ -	$ 53.57	$ 80.35
Apr	38.5	778913.3	0.0	$ 254.76	$ 20.38	$ 45.86	$ -	$ -	$ -	$ 53.57	$ 80.35
May	50.7	456786.4	0.0	$ 149.40	$ 11.95	$ 26.89	$ -	$ -	$ -	$ 53.57	$ 80.35
June	59.7	219151.9	0.0	$ 71.68	$ 5.73	$ 12.90	$ -	$ -	$ -	$ 53.57	$ 80.35
July	66.0	52807.7	0.0	$ 17.27	$ 1.38	$ 3.11	$ -	$ -	$ -	$ 53.57	$ 80.35
Aug	63.7	113536.5	0.0	$ 37.13	$ 2.97	$ 6.68	$ -	$ -	$ -	$ 53.57	$ 80.35
Sept	54.1	367013.4	0.0	$ 120.04	$ 9.60	$ 21.61	$ -	$ -	$ -	$ 53.57	$ 80.35
Oct	43.7	641613.3	0.0	$ 209.85	$ 16.79	$ 37.77	$ -	$ -	$ -	$ 53.57	$ 80.35
Nov	28.4	1045592.1	0.0	$ 341.98	$ 27.36	$ 61.56	$ -	$ -	$ -	$ 53.57	$ 80.35
Dec	12.9	1454851.6	0.0	$ 475.83	$ 38.07	$ 85.65	$ -	$ -	$ -	$ 53.57	$ 80.35
Annual HDD	10983.3	Yearly		**$ 3,059.68**	**$ 244.77**	**$ 550.74**	**$ -**	**$ -**	**$ -**	**$ 642.82**	**$ 964.22**
Annual CDD	0										

COST COMPARISON *Duluth, MN – 1000 CFM*

Assumptions	
Location	Duluth, MN
Unit A. ASE %	92
Unit A. W/CFM	0.8
Unit B. ASE %	82
Unit B. W/CFM	1.2
Heating COP	2.5
Cooling SEER	16
HDD	10983.3
CDD	0
Air Flow (CFM)	1000

Cost to re-heat / re-cool without heat recovery			$ 3,059.68
Yearly Savings	**Due to ASE**	**Due to W/CFM**	**Total**
Better Unit	$ 305.97	$ 321.41	$ 627.38

Unit A. Cost	$ 13,500.00
Unit B. Cost	$ 11,000.00
Years to Payback unit A vs unit B	4.0

COST COMPARISON *Duluth, MN – 20K CFM*

Local Variables		
Indoor Temp	68	*F*
Location	Duluth, MN	
Air Flow	20000	*CFM*
Unit A. ASE	92	*%*
Unit A Power	0.8	*Watt/CFM*
	16000	*Watt*
Unit B. ASE	82	*%*
Unit B Power	1.2	*Watt/CFM*
	24000	*Watt*

Global Variables		
Electric Cost	0.09	/kWh
Heating COP (est)	2.5	
Cooling SEER (est)	16	
Cp air	0.24	btu/lb.
Air Density	0.0764	lb./cu.ft. @ 60F

Month	Ave. Daily Temp	BTU/day Loss	BTU/day Gain	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-cool / month	Cost to re-cool / month	Operational Cost / month	Operational Cost / month
	F	*BTU*	*BTU*	*No heat recovery*	*Unit A*	*Unit B*	*No heat recovery*	*Unit A*	*Unit B*	*Unit A*	*Unit B*
Jan	7.2	32107069.4	0.0	$ 10,501.17	$ 840.09	$ 1,890.21	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Feb	12.4	29361070.1	0.0	$ 9,603.05	$ 768.24	$ 1,728.55	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Mar	24.4	23024148.5	0.0	$ 7,530.45	$ 602.44	$ 1,355.48	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Apr	38.5	15578265.6	0.0	$ 5,095.14	$ 407.61	$ 917.13	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
May	50.7	9135728.6	0.0	$ 2,988.00	$ 239.04	$ 537.84	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
June	59.7	4383037.4	0.0	$ 1,433.55	$ 114.68	$ 258.04	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
July	66.0	1056153.6	0.0	$ 345.43	$ 27.63	$ 62.18	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Aug	63.7	2270730.2	0.0	$ 742.68	$ 59.41	$ 133.68	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Sept	54.1	7340267.5	0.0	$ 2,400.76	$ 192.06	$ 432.14	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Oct	43.7	12832266.2	0.0	$ 4,197.02	$ 335.76	$ 755.46	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Nov	28.4	20911841.3	0.0	$ 6,839.58	$ 547.17	$ 1,231.12	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Dec	12.9	29097031.7	0.0	$ 9,516.69	$ 761.34	$ 1,713.00	$ -	$ -	$ -	$ 1,071.36	$ 1,607.04
Annual HDD	10983.3	Yearly		**$ 61,193.52**	**$ 4,895.48**	**$ 11,014.83**	**$ -**	**$ -**	**$ -**	**$ 12,856.32**	**$ 19,284.48**
Annual CDD	0										

COST COMPARISON *Duluth, MN – 20K CFM*

Assumptions	
Location	Duluth, MN
Unit A. ASE %	92
Unit A. W/CFM	0.8
Unit B. ASE %	82
Unit B. W/CFM	1.2
Heating COP	2.5
Cooling SEER	16
HDD	10983.3
CDD	0
Air Flow (CFM)	20000

Cost to re-heat / re-cool without heat recovery			$ 61,193.52
Yearly Savings	**Due to ASE**	**Due to W/CFM**	**Total**
Better Unit	$ 6,119.35	$ 6,428.16	**$ 12,547.51**

Unit A. Cost	$ 40,000.00
Unit B. Cost	$ 32,000.00
Years to Payback unit A vs unit B	**0.6**

COST COMPARISON *Duluth, MN – 20K CFM*

[lower ASE & w/cfm]

Local Variables		
Indoor Temp	68	*F*
Location	Duluth, MN	
Air Flow	20000	*CFM*
Unit A. ASE	92	*%*
Unit A Power	0.8	*Watt/CFM*
	16000	*Watt*
Unit B. ASE	75	*%*
Unit B Power	1.5	*Watt/CFM*
	30000	*Watt*

Global Variables		
Electric Cost	0.09	/kWh
Heating COP (est)	2.5	
Cooling SEER (est)	16	
Cp air	0.24	btu/lb.
Air Density	0.0764	lb./cu.ft. @ 60F

Month	Ave. Daily Temp	BTU/day Loss	BTU/day Gain	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-heat / month	Cost to re-cool / month	Cost to re-cool / month	Operational Cost / month	Operational Cost / month
	F	*BTU*	*BTU*	*No heat recovery*	*Unit A*	*Unit B*	*No heat recovery*	*Unit A*	*Unit B*	*Unit A*	*Unit B*
Jan	7.2	32107069.4	0.0	$ 10,501.17	$ 840.09	$ 2,625.29	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Feb	12.4	29361070.1	0.0	$ 9,603.05	$ 768.24	$ 2,400.76	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Mar	24.4	23024148.5	0.0	$ 7,530.45	$ 602.44	$ 1,882.61	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Apr	38.5	15578265.6	0.0	$ 5,095.14	$ 407.61	$ 1,273.79	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
May	50.7	9135728.6	0.0	$ 2,988.00	$ 239.04	$ 747.00	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
June	59.7	4383037.4	0.0	$ 1,433.55	$ 114.68	$ 358.39	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
July	66.0	1056153.6	0.0	$ 345.43	$ 27.63	$ 86.36	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Aug	63.7	2270730.2	0.0	$ 742.68	$ 59.41	$ 185.67	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Sept	54.1	7340267.5	0.0	$ 2,400.76	$ 192.06	$ 600.19	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Oct	43.7	12832266.2	0.0	$ 4,197.02	$ 335.76	$ 1,049.25	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Nov	28.4	20911841.3	0.0	$ 6,839.58	$ 547.17	$ 1,709.90	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Dec	12.9	29097031.7	0.0	$ 9,516.69	$ 761.34	$ 2,379.17	$ -	$ -	$ -	$ 1,071.36	$ 2,008.80
Annual HDD	10983.3	Yearly		**$ 61,193.52**	**$ 4,895.48**	**$ 15,298.38**	**$ -**	**$ -**	**$ -**	**$ 12,856.32**	**$ 24,105.60**
Annual CDD	0										

COST COMPARISON *Duluth, MN – 20K CFM*

[lower ASE & w/cfm]

Assumptions	
Location	Duluth, MN
Unit A. ASE %	92
Unit A. W/CFM	0.8
Unit B. ASE %	75
Unit B. W/CFM	1.5
Heating COP	2.5
Cooling SEER	16
HDD	10983.3
CDD	0
Air Flow (CFM)	20000

Cost to re-heat / re-cool without heat recovery			$ 61,193.52
Yearly Savings	**Due to ASE**	**Due to W/CFM**	**Total**
Better Unit	$10,402.90	$ 11,249.28	**$ 21,652.18**

Unit A. Cost	$ 40,000.00
Unit B. Cost	$ 32,000.00
Years to Payback unit A vs unit B	**0.4**

UltimateAir®

…..Raising your IAQ
Thanks….

Contact
Jason Morosko
Vice President, Engineering
UltimateAir, Inc.
178 Mill Street
Athens, Ohio 45701 USA
800.535.3448
740.594.2277
740.592.1499
www.ultimateair.com
jmorosko@ultimateair.com