

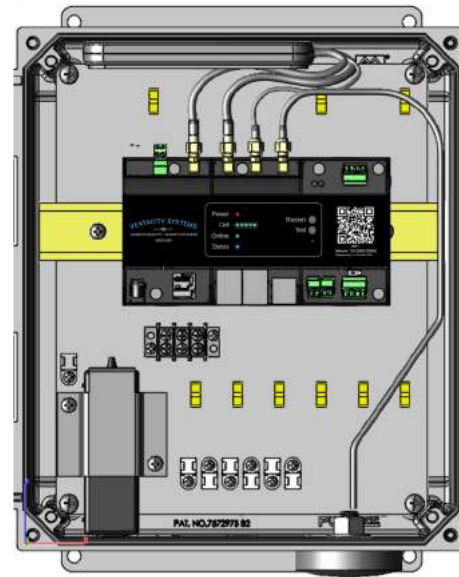


VENTACITY SYSTEMS INC.
THE FUTURE OF HEALTHY EFFICIENT BUILDINGS
Reinventing Fresh Air

WB&A
Hanover, MA
27 February 2019



VENTACITY SYSTEMS: WHO ARE WE?



Ventacity Systems

- Portland, OR Based
- In business since 2015
- Passive House certified HRVs & ERVs
- Next generation controls

Presenter

- John Davison



WHY VENTILATE

BETTER VENTILATION MEANS BETTER HEALTH

California Study of 168 Classrooms¹

Increasing classroom VRs from the California average (8.5 cfm per person) to the State standard of 15 cfm would decrease Illness Absences by 3.4%

Texas Study of 120 Classrooms²

Median CO2 levels were 28% higher than ASHRAE limit

Washington & Idaho Study of 434 Classrooms³

A 1000 PPM increase in CO2 was associated with a 10% - 20% increase in student absence

(1) Mendell et al (2013) "Association of Classroom Ventilation With Reduced Illness Absence..."

(2) Corsi et al (2002) "Carbon Dioxide Levels and Dynamics in Elementary Schools..."

(3) Shendell et al (2004) "Associations between classroom CO2 concentrations and student attendance..."

For full references, see www.ventacity.com/ahr



WHY VENTILATE

BETTER VENTILATION MEANS BETTER PERFORMANCE

Harvard Study⁴

On average, a 400 ppm increase in CO₂ was associated with a 21% decrease in cognitive function scores

70-school Study in Southwestern US⁵

Students' mean mathematics scores were increased by 0.5% per 2 cfm/person increase in ventilation rate within the range of 2 – 15 cfm

54-school Study across USA⁶

Math and Reading scores were 14% higher when VRs were greater than 10 cfm/student compared to scores when VRs were less than 5 cfm/student

(4) Allen, et al., Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures..."

(5) Shaughnessy, et al., Effects of Classroom Ventilation Rate and Temperature on Students' Test Scores..."

(6) Shaughnessy, et al., "A preliminary study on the association between ventilation rates in classrooms and student performance ..."

For full references, see www.ventacity.com/ahr

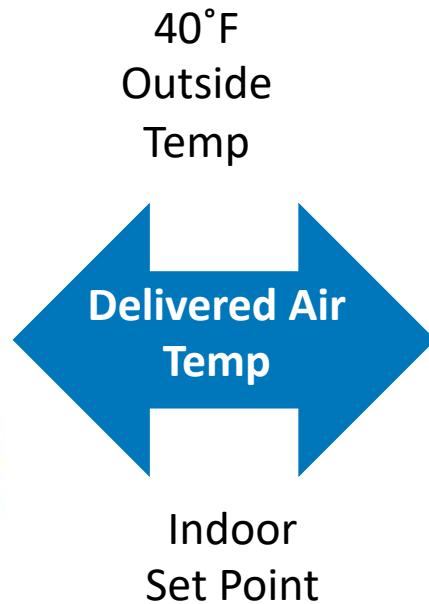


EFFICIENCY = COMFORT

65% Recovery



70°F



85% Recovery

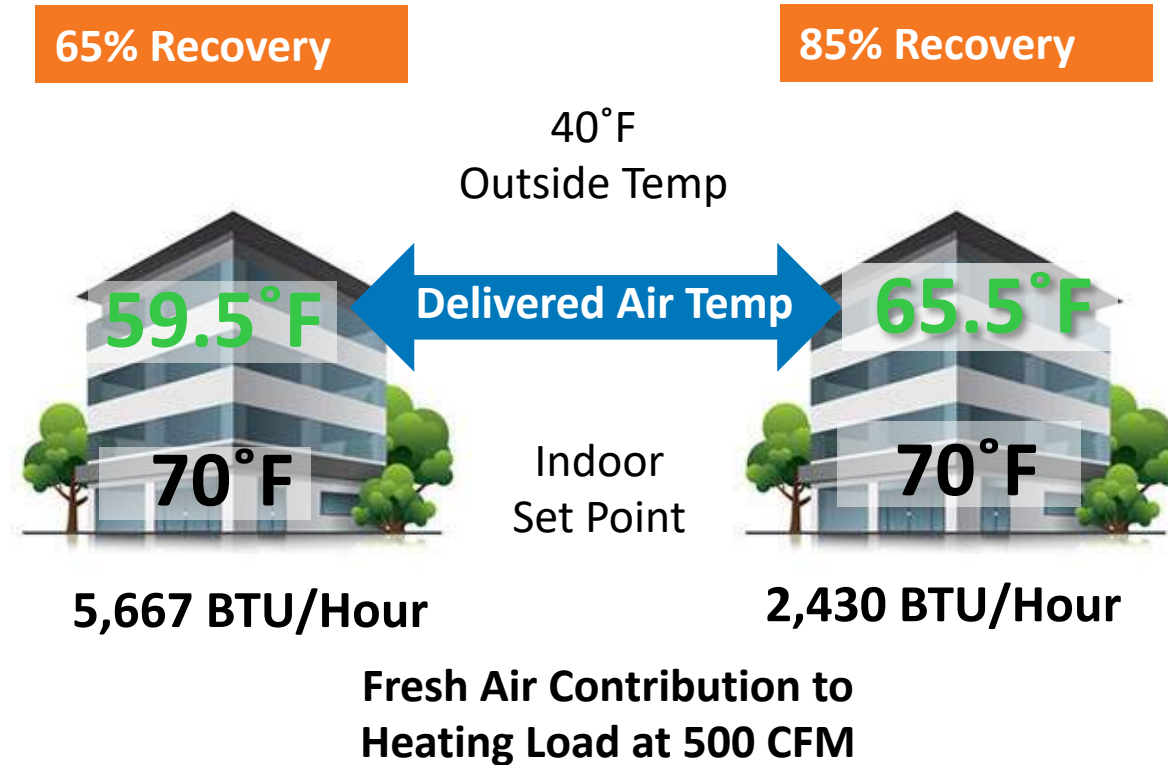


70°F

EFFICIENCY MATTERS

- COMFORT IS ENHANCED
- ENERGY EFFICIENCY IS SIGNIFICANTLY IMPROVED

ENERGY SAVINGS ARE SIGNIFICANT



EFFICIENCY MATTERS

- 20% INCREASE IN EFFICIENCY TRANSLATES TO MORE THAN 50% REDUCTION IN ENERGY USE



VS1000 RT



Recovery Efficiency	85%	70%	72%
Tempering Energy			
Incoming Air Temp	65.5°F	61°F	61.6 °F
BTUs/Hour	2,430	4,860	4,536
kBTUs/Year	21,286	42,573	39,735
Fan Efficiency			
CFM/WATT	2.9	1.3	1.6
Power Used	172	384	312
kWH/Year	1,507	3,364	2,733
Operating Cost			
Total kWH/Year	6,238	12,477	11,654
Yearly Cost	\$998	\$1,996	\$1,865

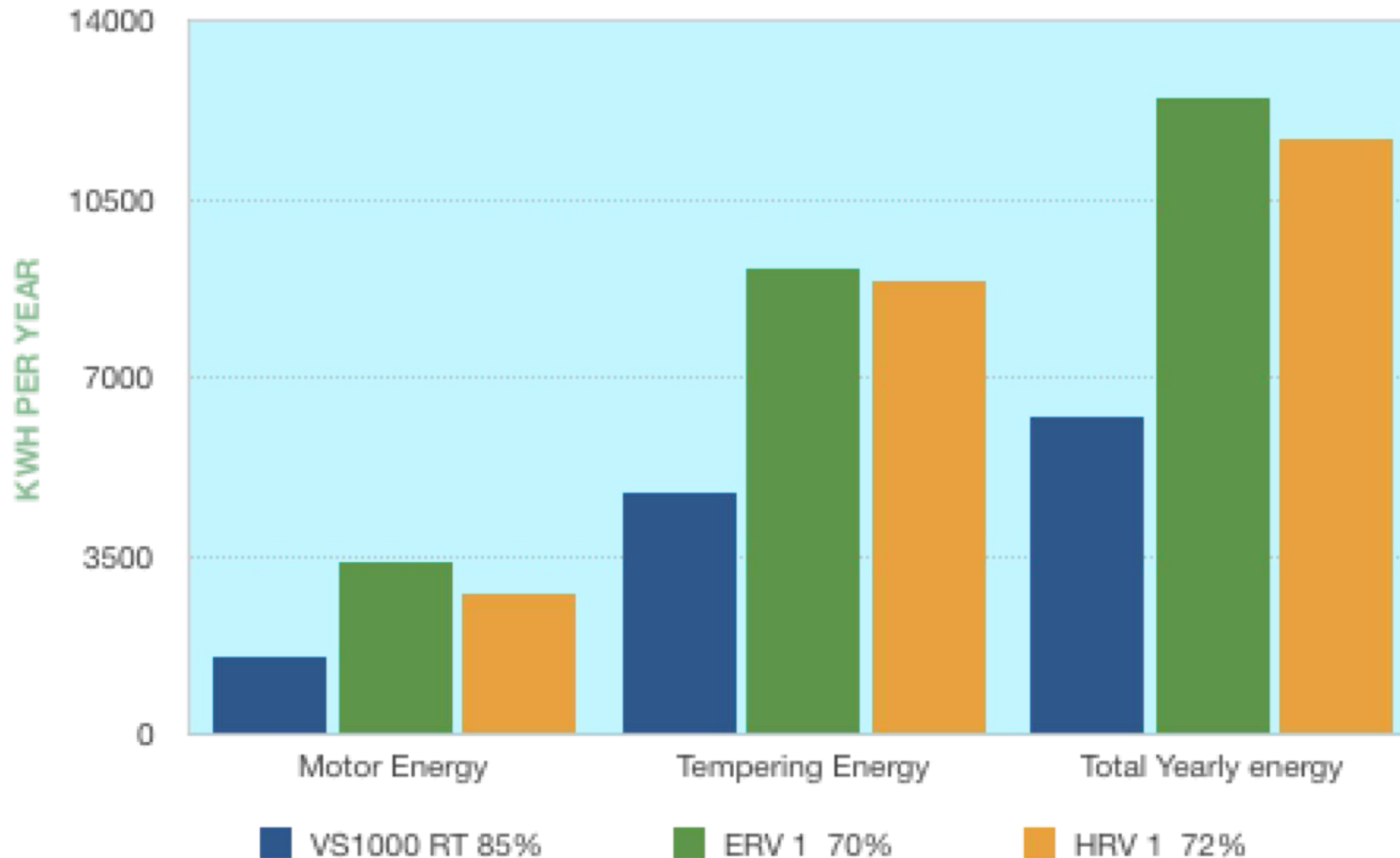
WITH HIGHER EFFICIENCY THE ROI IS IN MONTHS NOT YEARS

Using 500 cfm, average year-round delta T of 30F, and \$0.16/kWh



BIG ENERGY SAVINGS!

YEARLY ENERGY USE



VENTILATION ENERGY REDUCTIONS ARE SIGNIFICANT

- ASSUMING 500 CFM
- ASSUMING ΔT OF 30F
- 13-15% DIFFERENCE IN EFFICIENCY RESULTS IN NEARLY 100% DIFFERENCE IN ENERGY USE
- TRANSLATES IN TO SAVINGS OF +/- \$700 - \$800/YEAR AT \$.10/KWH

EFFICIENCY = SAVINGS

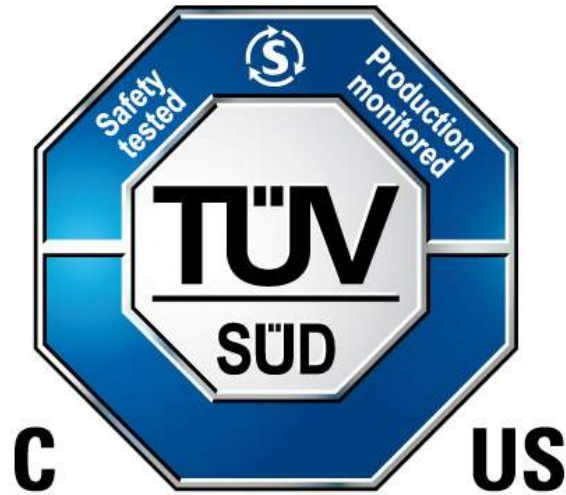
SPECIFICATON	PROPOSED
RENEWAIRE 1000 CFM (3)	VENTACITY VS1000 RT (3)
100 MBH GAS FIRED DUCT HEATERS NEEDED (3) TO MAINTAIN 55F SUPPLY AIR TEMPERATURE	PROVIDES SUPPLY AIR TEMPERATURE OF 61F AT DESIGN TEMPERATURE OF 5F, WITHOUT POST HEATING
ADD-ONS: OUTDOOR INSULATION PACKAGE, DAMPERS, BY-PASS	INCLUDED AS STANDARD

Winter Design Temperature = 5F Minimum Delivered Temperature = 55F

BRITISH COLUMBIA DAYCARE PROJECT

- HIGHER EFFICIENCY
- LOWER OVERALL COST

THE FIRST UL 1812, CSA, PASSIVE HOUSE CERTIFIED COUNTER FLOW HRV!



CERTIFIED AND TESTED

- TWO INDEPENDENT LABS TESTED (2)
- Listed UL1812
- Listed CSA
- **CERTIFIED PASSIVE HOUSE!**

THE FIRST PASSIVE HOUSE CERTIFIED COMMERCIAL ERV WORLDWIDE!



June 7, 2018
Airstage on Broadway
New York, NY

VENTACITY SETS NEW STANDARD

- **88 COMMERCIAL HRVS CERTIFIED BY PASSIVE HOUSE INSTITUTE AS OF 1.1.2019**
- **ONLY TWO ERVs ARE VS1000 RTe and VS3000 RTe**

PASSIVE HOUSE EFFICIENCY

BETTER METRIC, BUT LOWER EFFICIENCY NUMBER

Certificate

Certified Passive House Component
For cool, temperate climates, valid until 31 December 2016

Category: **Heat recovery unit**
Manufacturer: **Ventacity Systems, Inc.**
97201 Portland, UNITED STATES
Product name: **VS 1000 RT**

This certificate was awarded based on the following criteria:

Thermal comfort	$\Theta_{\text{supply air}} \geq 16.5 \text{ }^\circ\text{C}$ at $\Theta_{\text{outdoor air}} = -10 \text{ }^\circ\text{C}$
Effective heat recovery rate	$\eta_{\text{HR,eff}} \geq 75\%$
Electric power consumption	$P_{\text{el}} \leq 0.45 \text{ Wh/m}^3$
Performance number	≥ 10
Airtightness	Interior and exterior air leakage rates less than 3% of nominal air flow rate
Balancing and adjustability	Air flow balancing possible: yes Automated air flow balancing: yes ²⁾
Sound insulation	It is assumed that large ventilation units are installed in a separate building services room. Sound levels documented in the appendix of this certificate
Indoor air quality	Outdoor air filter F7 Extract air filter G4
Frostprotection	Frost protection required Different strategies mentioned in the appendix of this certificate

1) Available pressure difference with installed filter: **180 Pa**.
Additional components (e.g. heater coil) decrease the available pressure difference accordingly.
2) Only if the supply and return air streams are programmed to be balanced.
3) Recommended performance number is exceeded.

Further information can be found in the appendix of this certificate.

www.passivehouse.com xxxxxx

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
GERMANY

Certified for air flow rates of 500 - 1100 m³/h
At an external pressure of **228 Pa** ¹⁾
Requirements non residential buildings (Therewith device also applicable for residential building)

$\eta_{\text{HR,eff}}$ **82%**

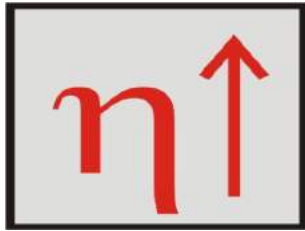
Electric power consumption 0.45 Wh/m³

Performance number 9.4 ³⁾

CERTIFIED COMPONENT
Passive House Institute

- NET RECOVERY EFFICIENCY
- POWER EFFICIENCY
- CROSS-FLOW TRANSFER/CONTAMINATION
- SOUND LEVEL

THE THREE FACTORS IN PERFORMANCE



heat recovery rate



power consumption

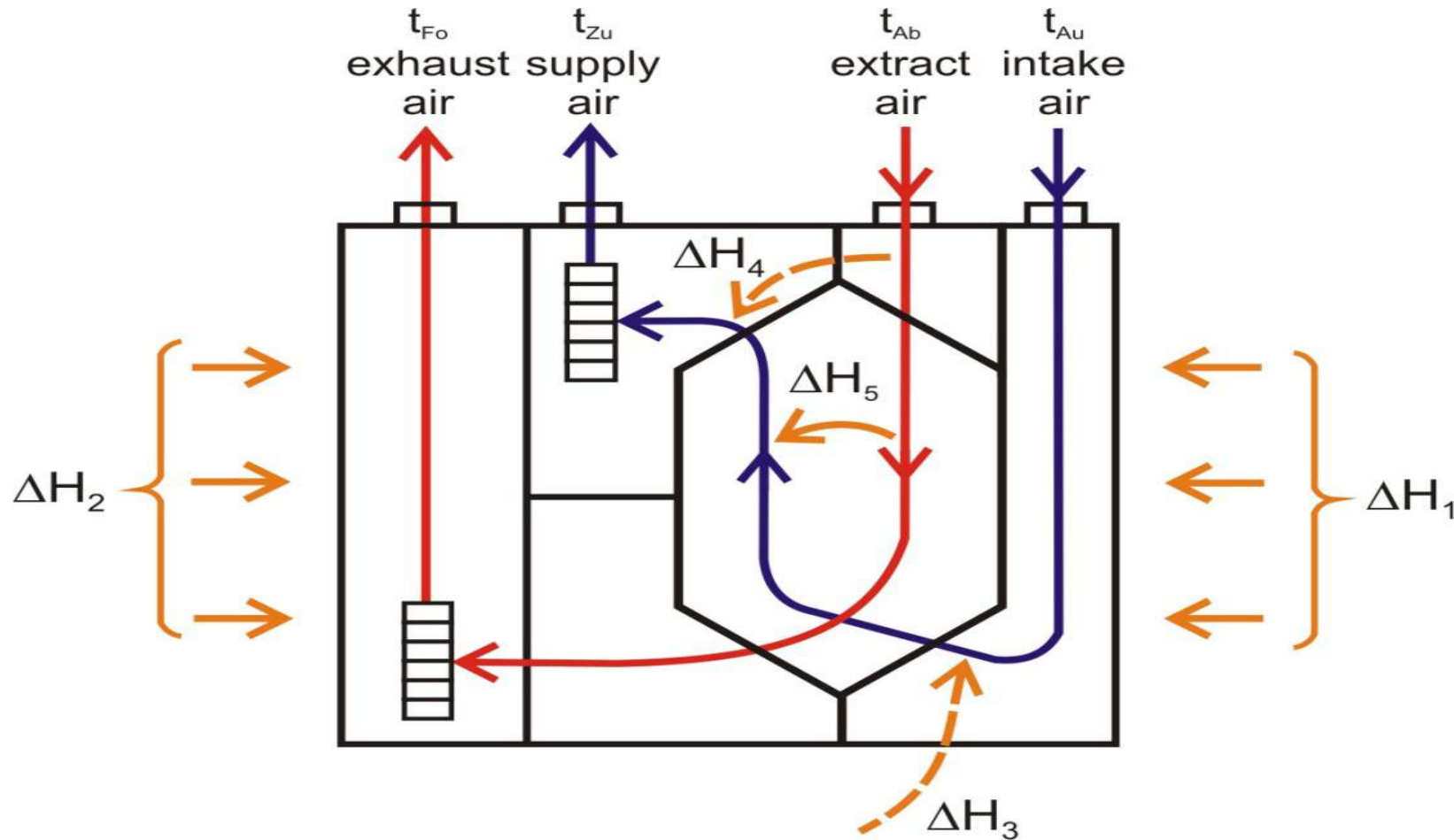


noise

IMPORTANT

- **RECOVERY RATE FOR EXHAUST AIR STREAM HAS MOST IMPACT ON ENERGY MODELING FOR BUILDING**
- **POWER CONSUMPTION IN WATTS/CFM – CAN ADD UP OVER COURSE OF A YEAR**
- **LOUD UNITS GET TURNED OFF!**

SUPPLY AIR STREAM HAS MANY INFLUENCES

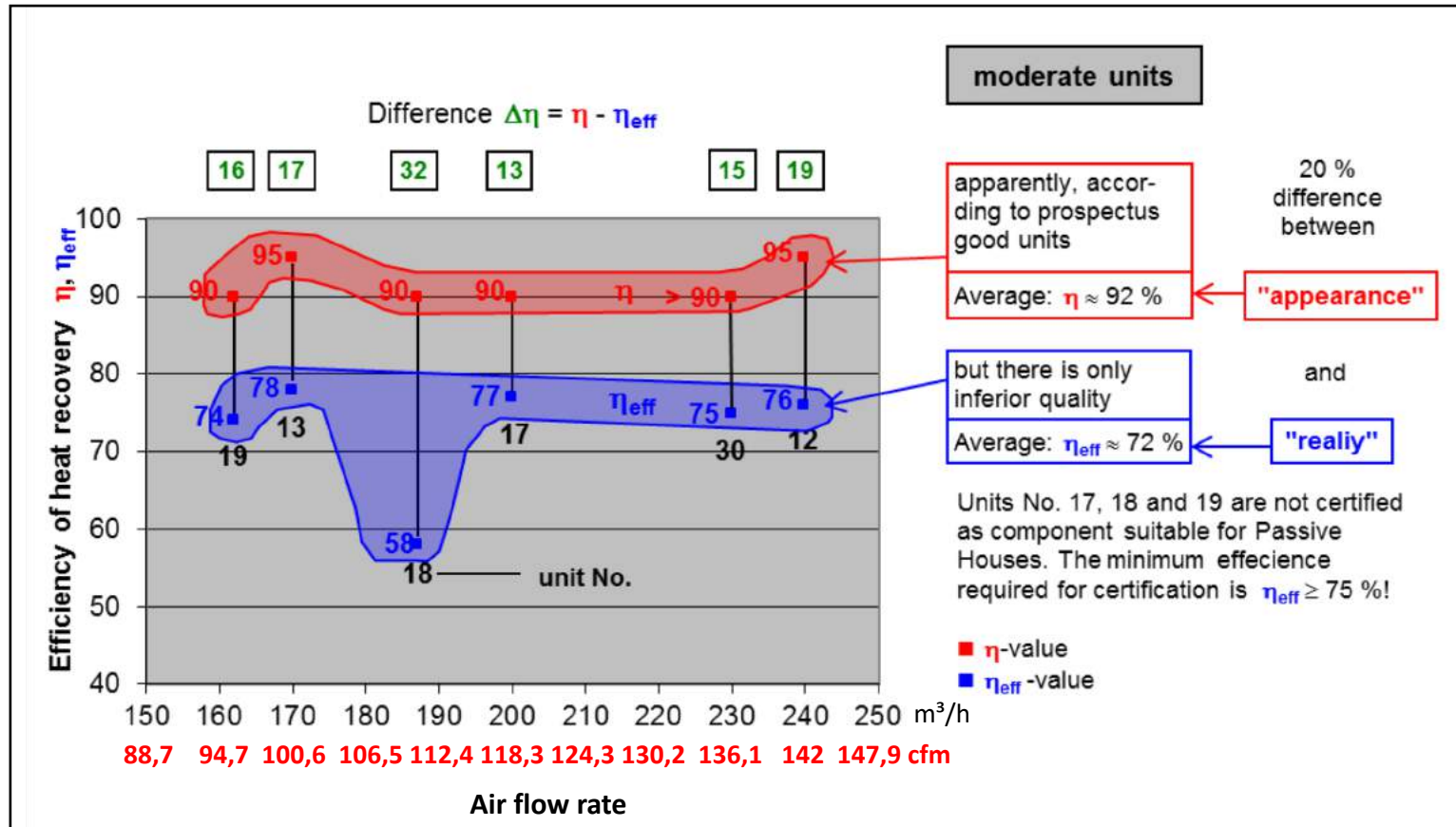


“REAL” EFFICIENCY ??

- CONDUCTION FROM ROOM
- CASE LEAKAGE
- CROSSFLOW LEAKAGE
- FAN ENERGY

DIFFERENT PROTOCOLS GET DIFFERENT RESULTS

ALL H/ERVs NOT CREATED EQUAL



- DISCREPANCY VARIES
- NO STANDARD CORRECTION
- MUST TEST TO HAVE RELIABLE RESULTS!

LOWER EFFICIENCY H/ERVs HAVE GREATER DISCREPANCIES OF HEAT RECOVERY:

η – based on supply air measured air heating (North American protocol)

(η_{eff} – based on extract air measured air cooling (Passive House Institute protocol)

VENTACITY FAMILY OF SMART VENTILATION™ PRODUCTS



VS500 SQ



VS1000 RT



VS3000 RT



INTRODUCING:

VS250 CM VS400 CM VS900 CM VS1200 CM

SMART IMPERATIVES

- HIGH EFFICIENCY VENTILATION
- SOPHISTICATED CONTROLS
- QUIET OPERATION
- SIMPLE INTERFACE

“WE MAKE SMART EASY”



ENGINEERED FOR MAXIMUM PERFORMANCE/EFFICIENCY

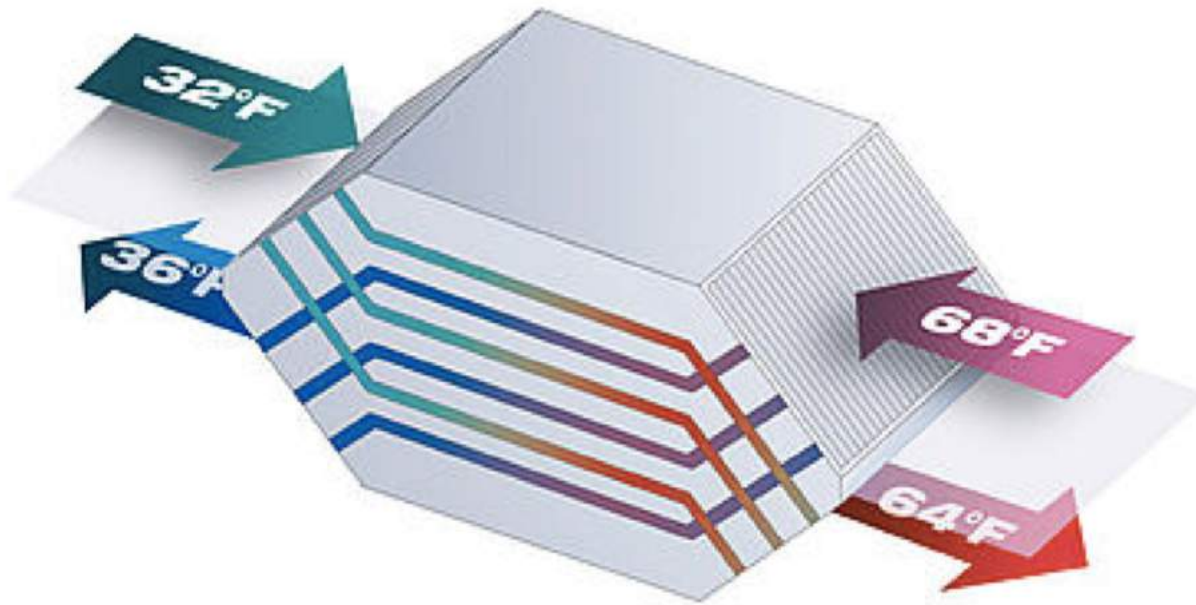


STANDARD FEATURES

- 1. COUNTER FLOW CORE WITH INTEGRATED BYPASS
- 2. AUTOMATED DAMPERS
- 3. ECM FAN MOTORS
- 4. INSULATED PANELS, NO THERMAL BRIDGES
- 5. CONTROL SYSTEM (BRAIN) AND SENSORS TEMP, PRESSURE, PRE
- 6. HEATER FOR COLD WEATHER OPERATION



HIGH EFFICIENCY COUNTERFLOW HEAT EXCHANGER



ULTRA EFFICIENT CORE

- COUNTERFLOW
- AIRTIGHT
- PLATE SURFACE GEOMETRY
- OPTIMIZED PLATE SPACING

BUILT-IN BYPASS FOR “ECONOMIZER”



FREE COOLING/ECONOMIZER

- INTEGRATED
- MANAGED TO A DELIVERED TEMPERATURE SETPOINT
- CONTINUOUSLY VARIABLE
- SCHEDULE FLEXIBILITY

ECM FAN MOTORS



ebmpapst

ECM FANS

- HIGHEST EFFICIENCY
- VARIABLE FLOWS
- AUTO ADJUSTING
- QUIET OPERATION
- DURABLE AND MAINTENANCE FREE

**VENTACITYSYSTEMS**
Making Buildings Healthy – Efficient – Smarter

SMART CONTROLS AND SENSORING



INTERNAL CONTROLS

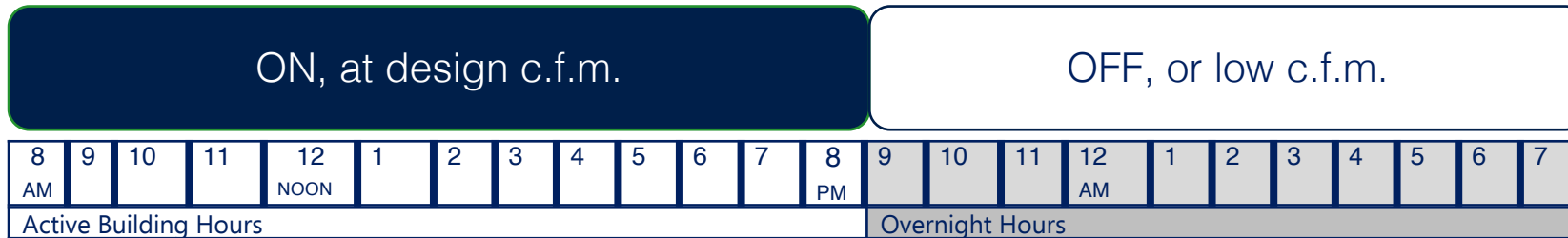
- VENTILATION MODE
- VENTILATION RATES
- SCHEDULING
- ECONOMIZING
- FIRE MODE
- FILTER MONITORING

CONNECTABLE TO BMS

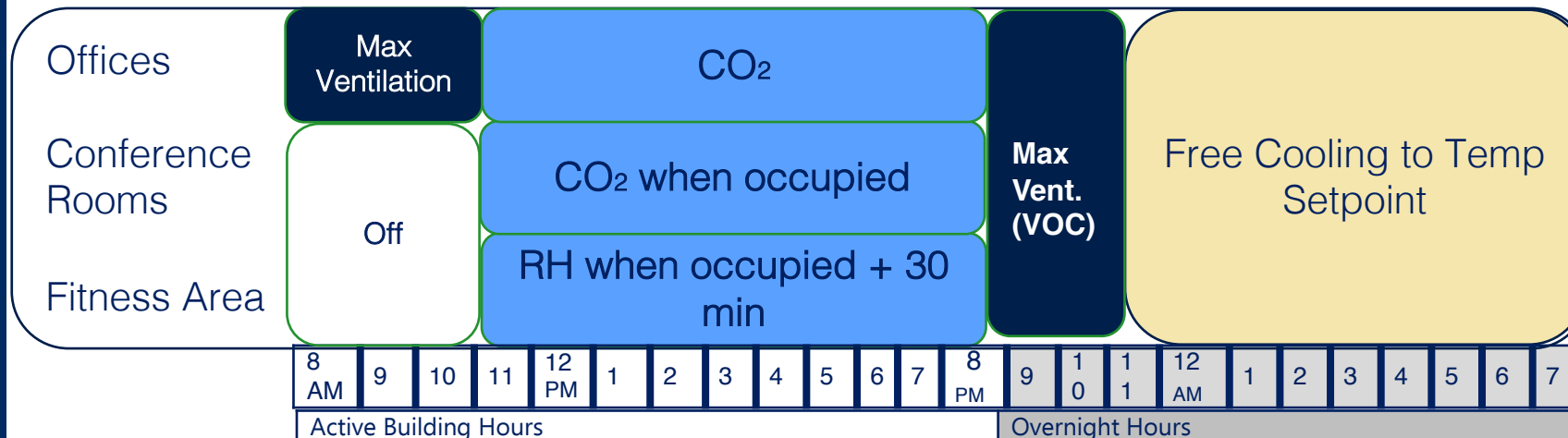
- MODBUS & BACnet IP

Intelligent Scheduling for System Optimization

Time-Based Only



Time + Environmental Response by Zone



TIME-BASED

- Time of Day
- Day of Week
- On; Off; and Specify Fan Speed

TIME + ENVIRONMENTAL RESPONSE, BY ZONE

- CO₂
- Temperature
- Relative Humidity
- VOCs
- “Economizer”
- Free cooling / bypass
- Energy bonus!



RT MODELS – ROOF-TOP READY



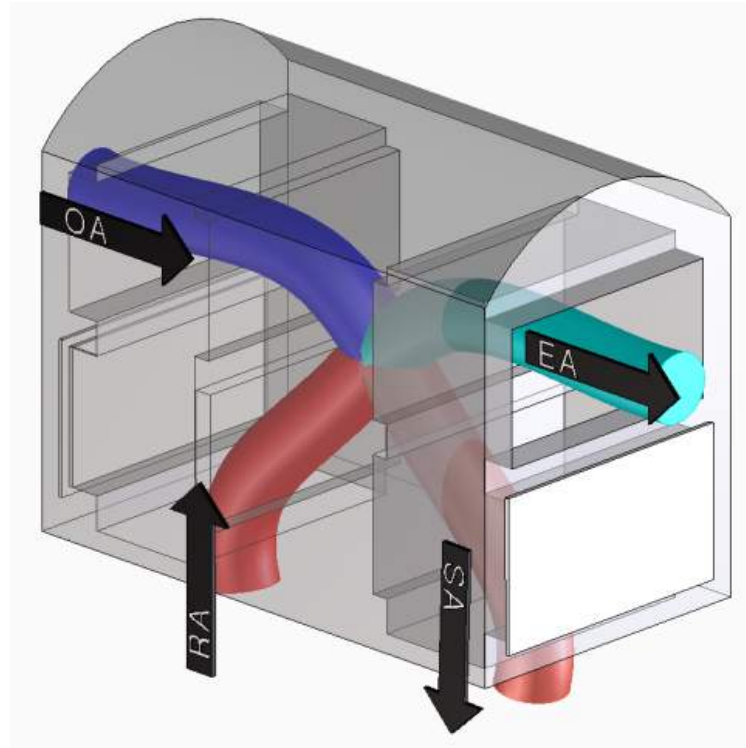
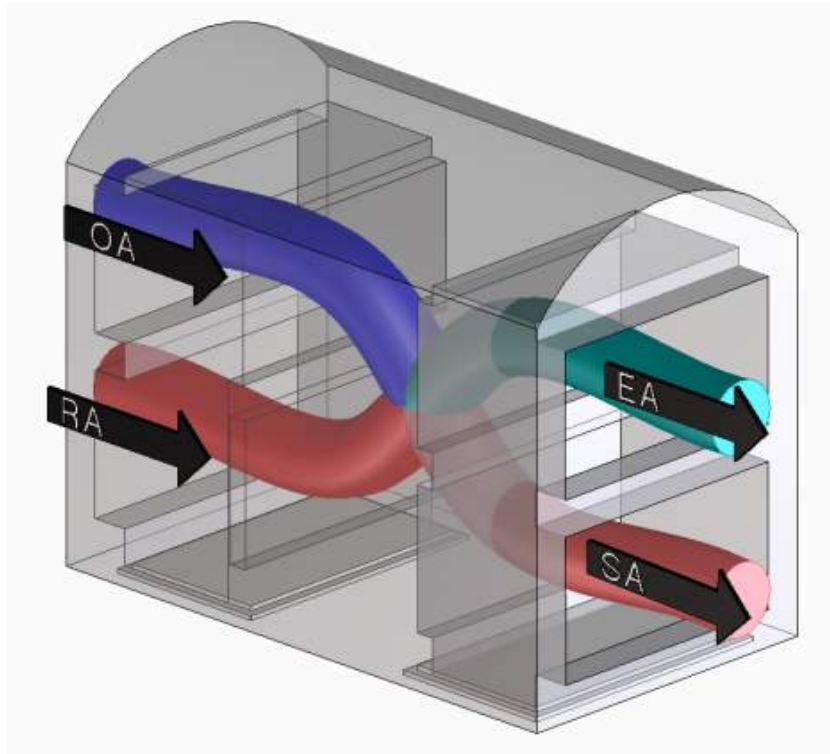
RT MODELS

- UL LISTED FOR OUTDOOR OPERATION
- CURB OR STAND MOUNTING
- DOMED ROOF FOR WATER SHEDDING
- 1000 CFM AND 3000 CFM MODELS



RT MODELS

FLEXIBLE DUCT CONFIGURATIONS



BUILT IN DUCT FLEXIBILITY

- BOTTOM DUCT
- END DUCT
- INTAKE AND EXHAUST ALSO DUCTABLE FOR INTERIOR MOUNTING LOCATIONS

VS500 SQ CLASSROOM VENTILATOR

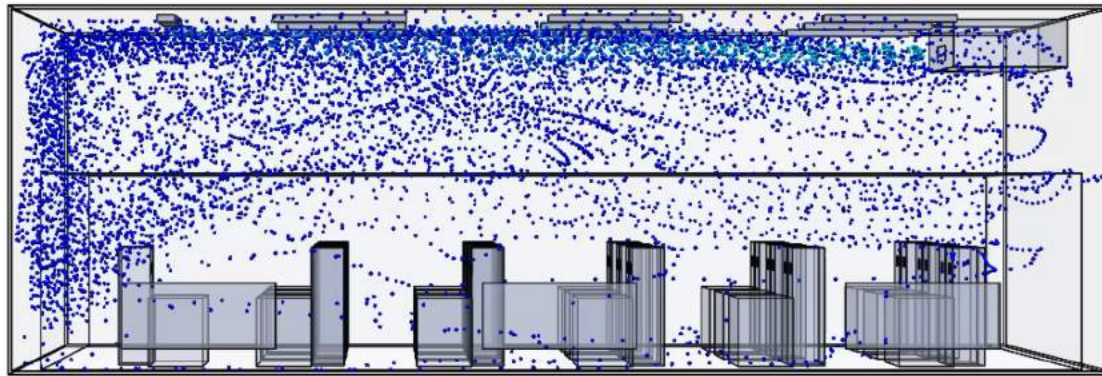


VS500 SQ UNITS

- EXPOSED OR SEMI-RECESSED CEILING MOUNTING
- NO INTERIOR DUCTWORK
- EXCEPTIONALLY QUIET OPERATION: 35 dB at 500 CFM
- CO2 SENSING FOR DEMAND CONTROL OPERATION
- EASY FILTER ACCESS
- MINIMIZES BUILDING DUCTWORK
- POST CONDITIONING AVAILABLE



VS 500 SQ: CLASSROOM VENTILATION



OPPORTUNITY FOR VRF OR SINGLE HEAD SYSTEM

SCHOOL OPPORTUNITIES

- **DISTRIBUTED VENTILATION**
- **NEW CLASSROOMS**
- **RETROFIT OLD CLASSROOMS**
- **AUTOMATIC CO2 MANAGEMENT**
- **QUIET < 35 DB**
- **COMFORT**
- **CENTRAL CONTROL WITH SBG**



INTERIOR CEILING MOUNTED UNITS



VS....CM UNITS

FOUR AVAILABLE SIZES:

- VS250 cm
- VS400 CM
- VS900 CM
- VS1200 CM

POST CONDITIONING MODULES

- ELECTRIC
- HYDRONIC CHANGE-OVER
- DX COIL

PHI CERTIFICATION PENDING

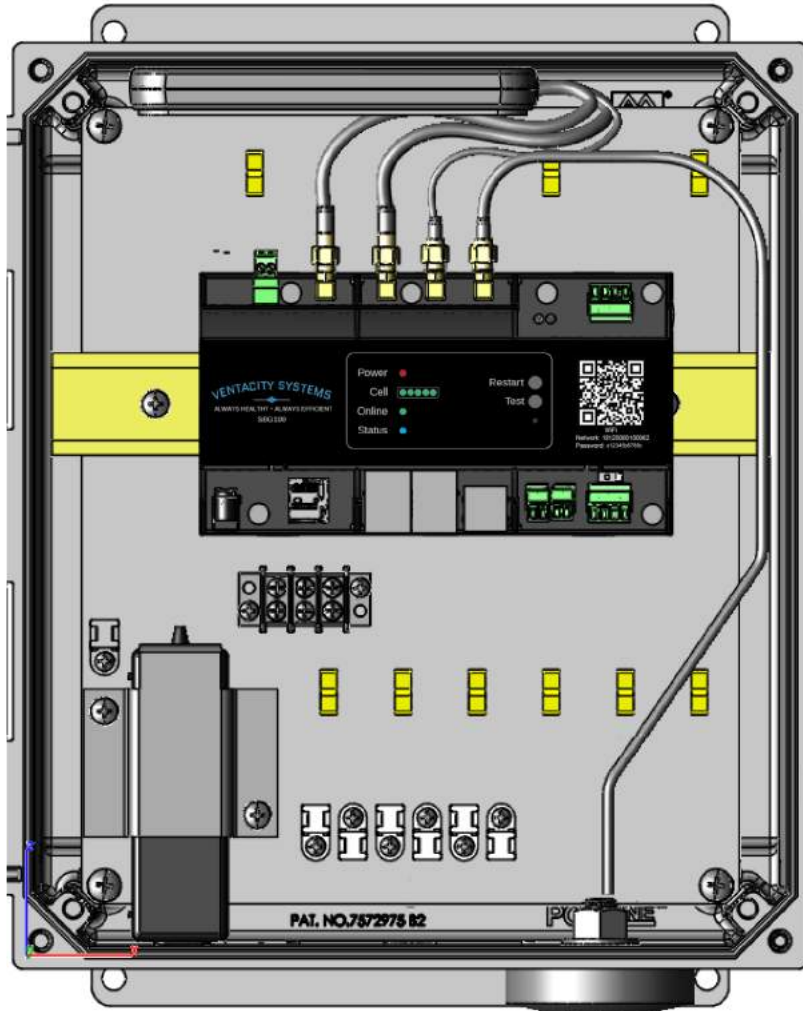


VENTACITYSYSTEMS

Making Buildings Healthy – Efficient – Smarter

DELIVERING BEYOND THE COMPETITION

SBC100 SMARTER BUILDING CONTROLLER



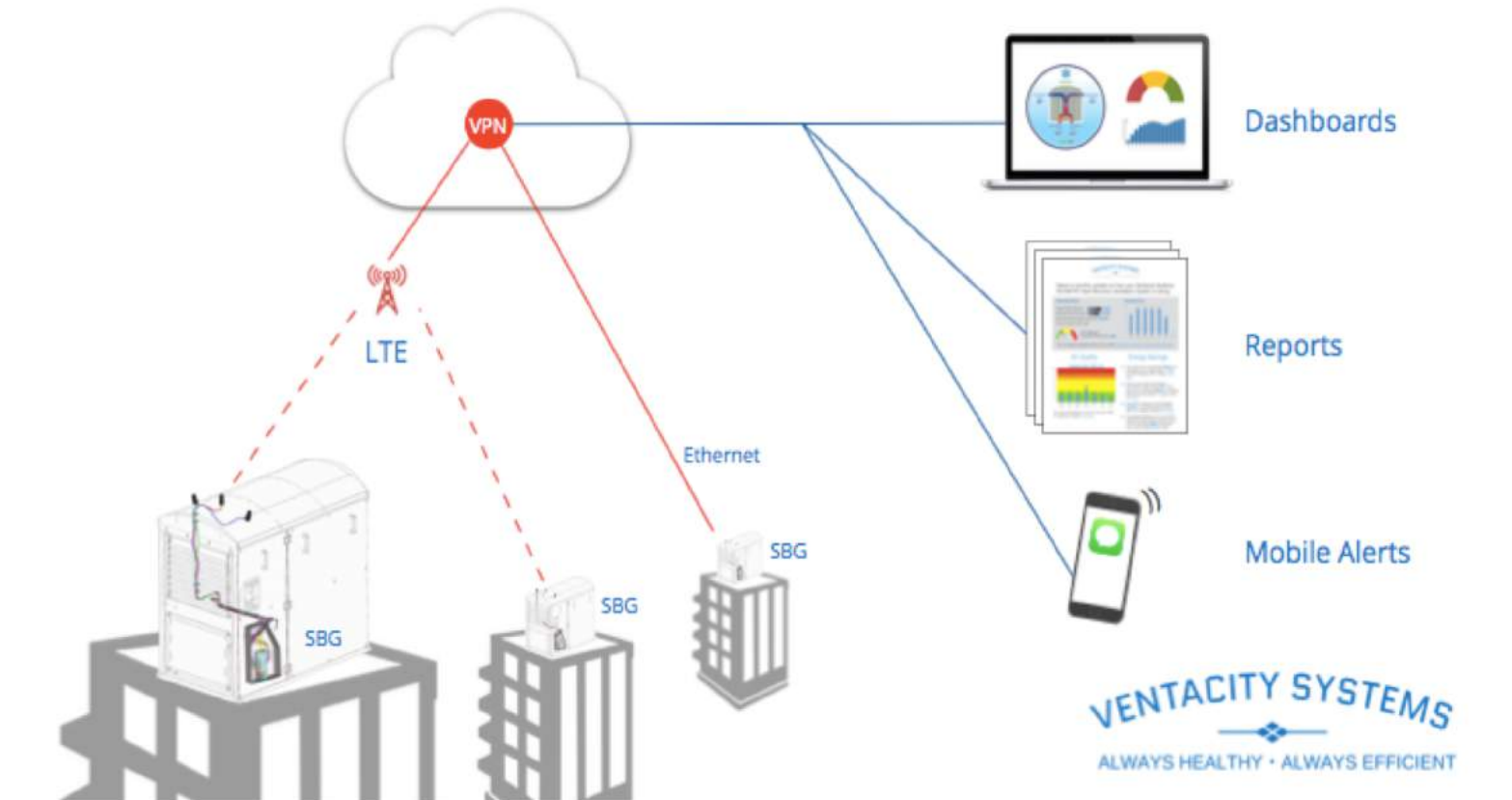
SBC100

A CLOUD-BASED SYSTEM FOR
THE CONTROLLING,
MONITORING, AND
OPTIMIZING OF VENTACITY
HIGH EFFICIENCY
VENTILATORS, FUJITSU
AIRSTAGE VRF EQUIPMENT
AND OTHER HVAC² CERTIFIED
EQUIPMENT


VENTACITYSYSTEMS
Making Buildings Healthy - Efficient - Smarter

DEFINING A NEW CLASS OF PRODUCT

Smart Building Gateway (SBG) + Smart Building Cloud Services (SBCS)



FOCUSED ON SMALL AND MEDIUM BUILDINGS

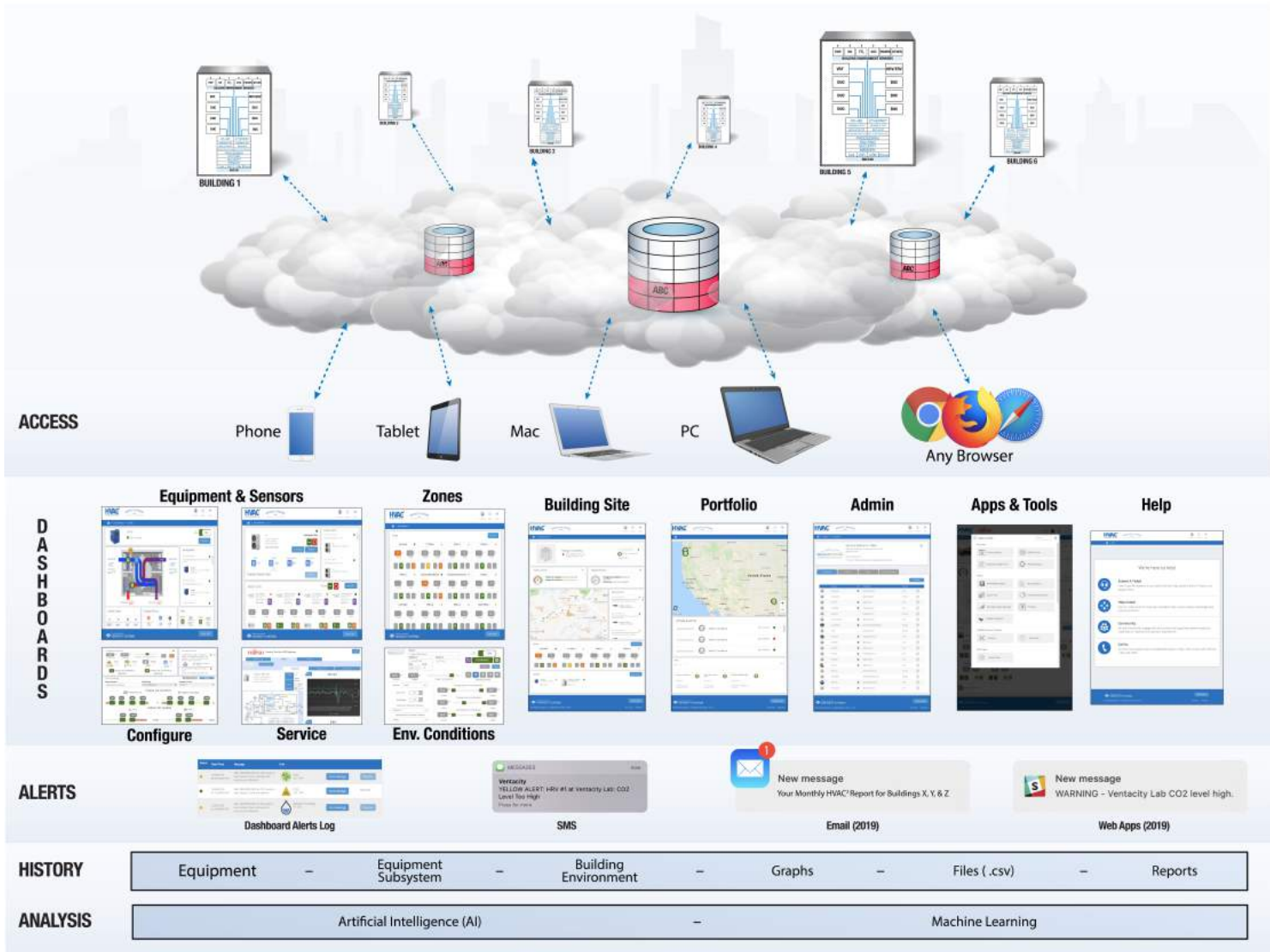
HVAC DISRUPTIVE

- MODERN ARCHITECTURE
- SECURE PRIVATE WIRELESS NETWORK WITH VPN
- CLOUD PROCESSING AND LOCAL EDGE PROCESSING
- CLOUD STORAGE AND LOCAL EDGE STORAGE
- DASHBOARDS
- REPORTS, ALERTS
- ANALYTICS
- MODBUS,
- CONTROL OR BE CONTROLLED
- LEARNING AI PLATFORM
- PRECONFIGURED
- DEVELOPED IN HOUSE
- PATENT PENDING

VENTACITYSYSTEMS
Making Buildings Healthy – Efficient – Smarter

HVAC² PLATFORM INFOGRAPHIC

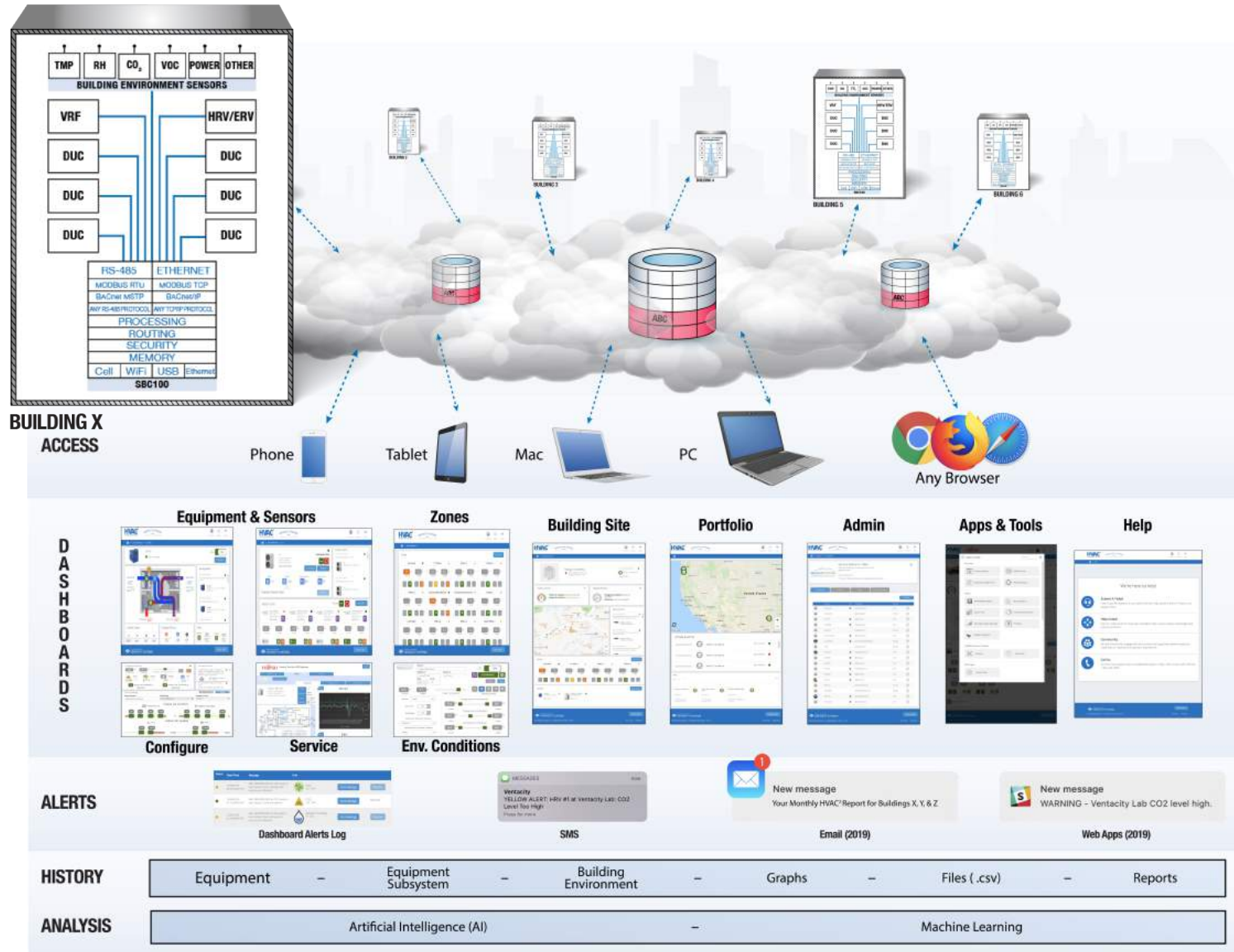
TOP 10 THINGS ABOUT HVAC² ARCHITECTURE



1. CLOUD+EDGE ARCHITECTURE
2. SECURITY, SECURITY!!!
3. GLOBAL SCALABILITY
4. INTUITIVE UI/UX
5. “DUC” CONNECTIVITY
6. DEEP INSIGHTS DASHBOARD
7. ALERTS (GREEN YELLOW RED)
8. HISTORY DATA RETENTION
9. ANALYSIS OPPORTUNITIES
10. CONTRACTOR CENTRIC



HVAC² PLATFORM INFOGRAPHIC



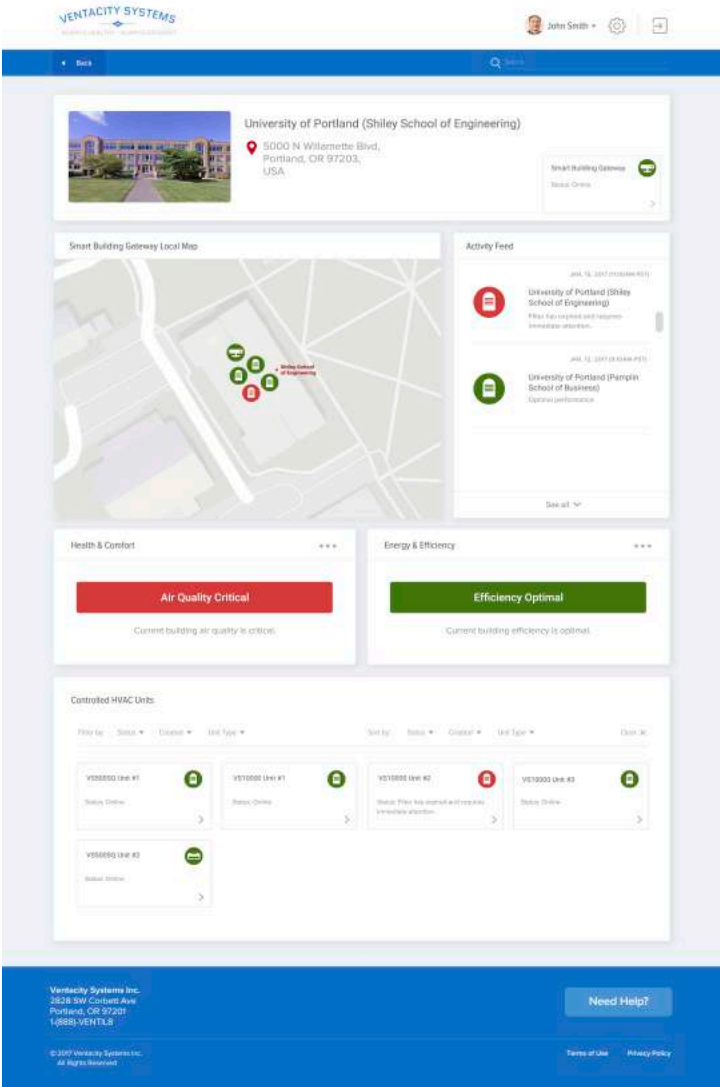
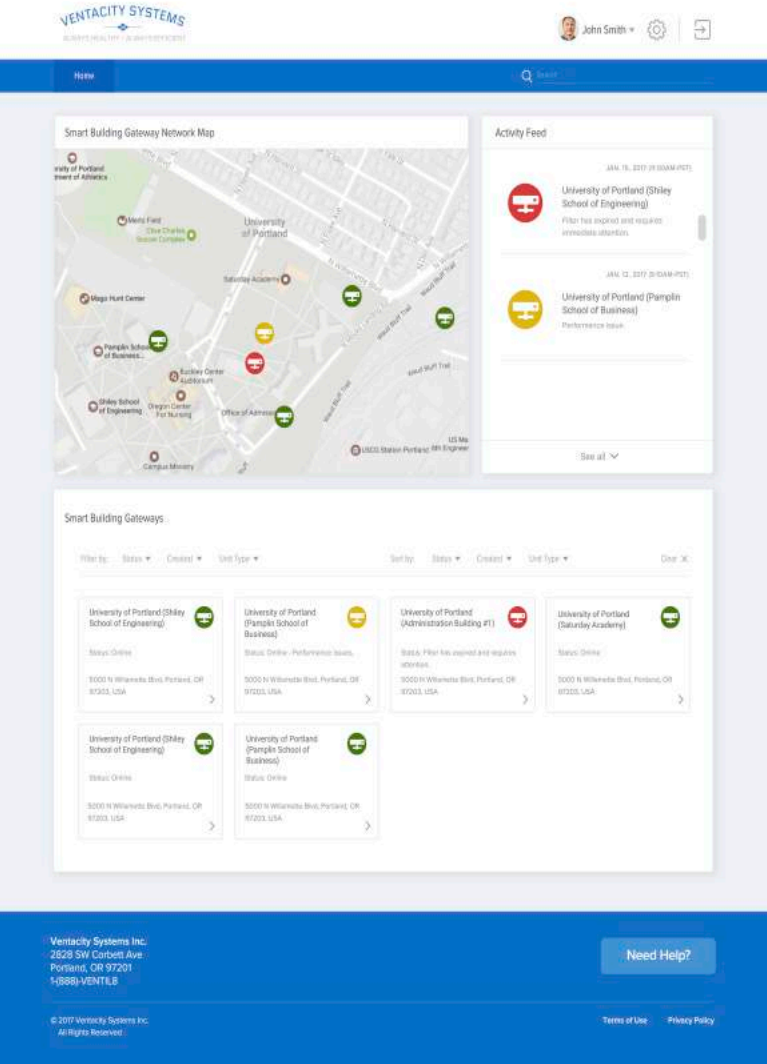
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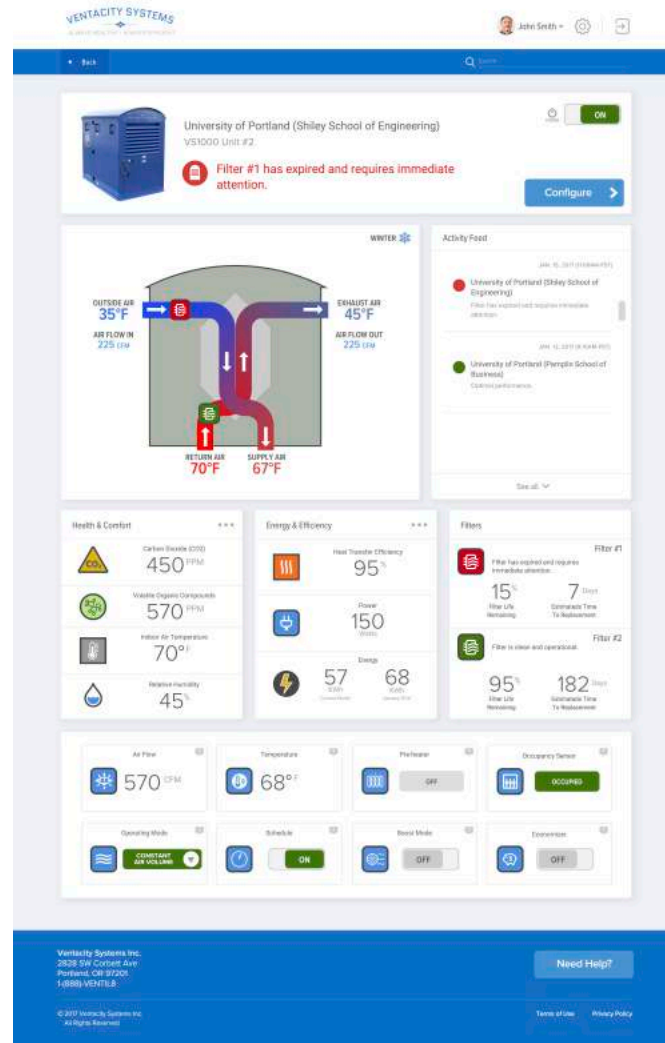
DASHBOARD: NETWORK & BUILDING MAP

INTERACTIVE AND REAL TIME IN THE CLOUD

1. MULTIPLE LOCATIONS
2. STATUS BASED ON COLOR
3. DASHBOARD FOR EASY ACCESS
4. INTUITIVE UI/UX
5. TABLET, SMART PHONE OR PC
6. DEEP INSIGHTS DASHBOARD
7. ALERTS (GREEN YELLOW RED)
8. HISTORY DATA RETENTION
9. ANALYSIS OPPORTUNITIES
10. CONTRACTOR CENTRIC



DASHBOARD: INDIVIDUAL PRODUCT VIEW



- MONITOR
- MANAGE
- OPTIMIZE

DELIVERING BEYOND THE COMPETITION

SBC100 SMARTER BUILDING CONTROLLER

SBC100



- FUJITSU AIRSTAGE VRF INCLUDING GROUNDBREAKING SERVICE TOOL 365
- WATTNODE ENERGY MONITORING SYSTEMS
- LABJACK SENSOR HUBS FOR IAQ MONITORING
- VAV DIFFUSER SYSTEMS IN PILOT TESTING
- EXPANDING HVC2 NETWORK OF DEVICES



VENTACITYSYSTEMS
Making Buildings Healthy – Efficient – Smarter

OPPORTUNITY ON ROOFS ACROSS AMERICA



AGING INSTALLATIONS

- Many aging gas packs
- Possible curb reuse



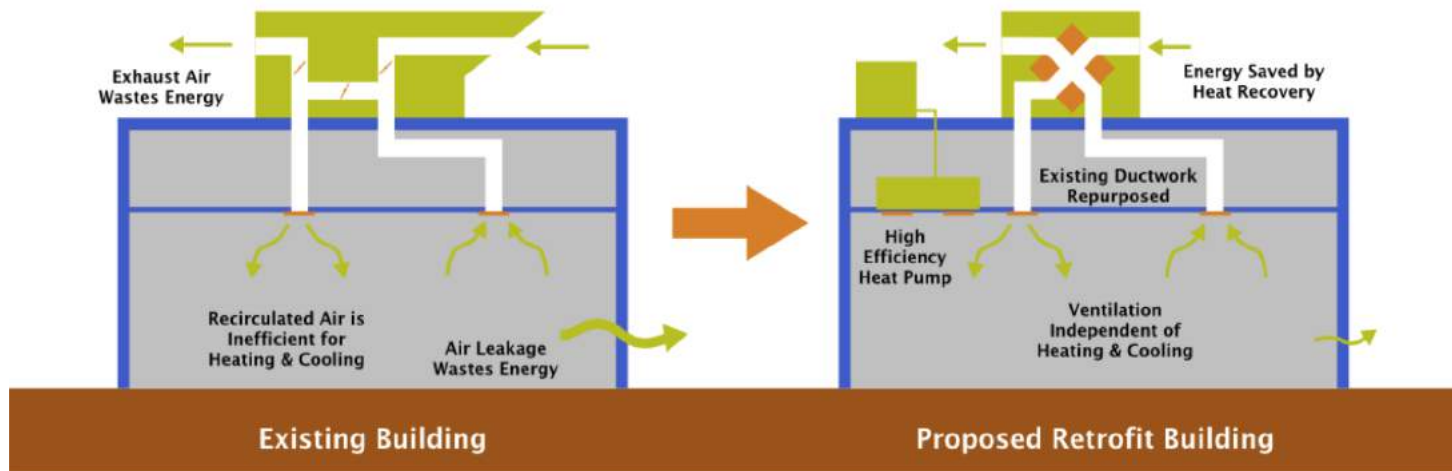
RTUS ARE EVERYWHERE

- Great Alternative
- Many Benefits

RTU REPLACEMENT PROGRAM

Retrofitting Existing Commercial Buildings to Achieve Significant Energy Savings & Better IAQ

RETROFIT PROCESS



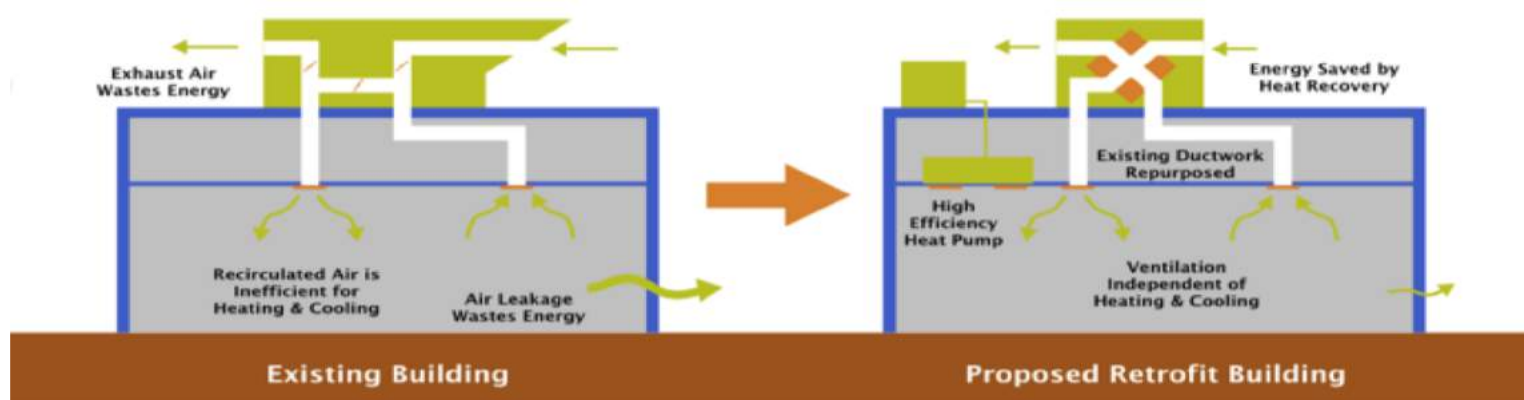
RETROFIT = SAVINGS

- Remove End-of-Life RTUs
- Replace with VS1000 RT

AND

- Fujitsu VRF System
- Re-Purpose Existing Ducts

MULTIPLE BENEFITS OF REPLACEMENT



- **Very Low Energy Savings (5% Typical)**
- **Same High Cost Maintenance**
- **15 Year Life Span**
- **Same H/C Loads, Resulting in 1:1 Replacement**
- **Same Noise Level**
- **Same poor IAQ**

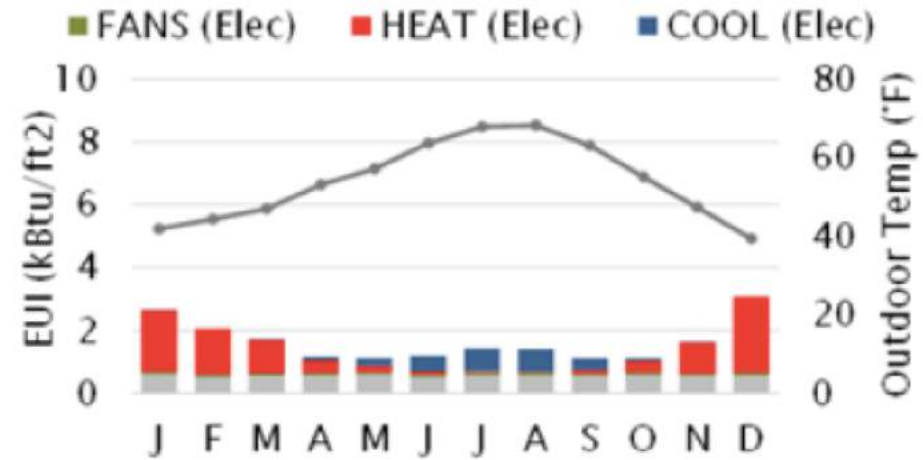
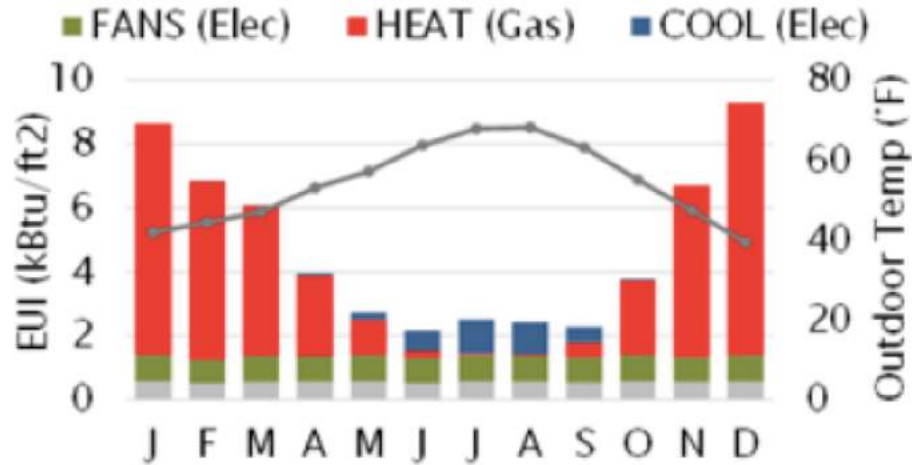
- **Significant Energy Savings (Proven 40-60+ %)**
- **50% + Reduction In Maintenance Costs**
- **25-30 Year Life Span**
- **Significant Reduction in H/C Loads, Reduced Equipment Sizing**
- **Improved Comfort & Quiet**
- **Great IAQ & Health**

POSITIVE RESULTS

- **Save Energy**
- **Save Money**
- **Lasts Longer**
- **Smaller Systems**
- **Quiet**
- **Better IAQ**
- **Better Comfort**

IMPRESSIVE RESULTS

REAL RESULTS

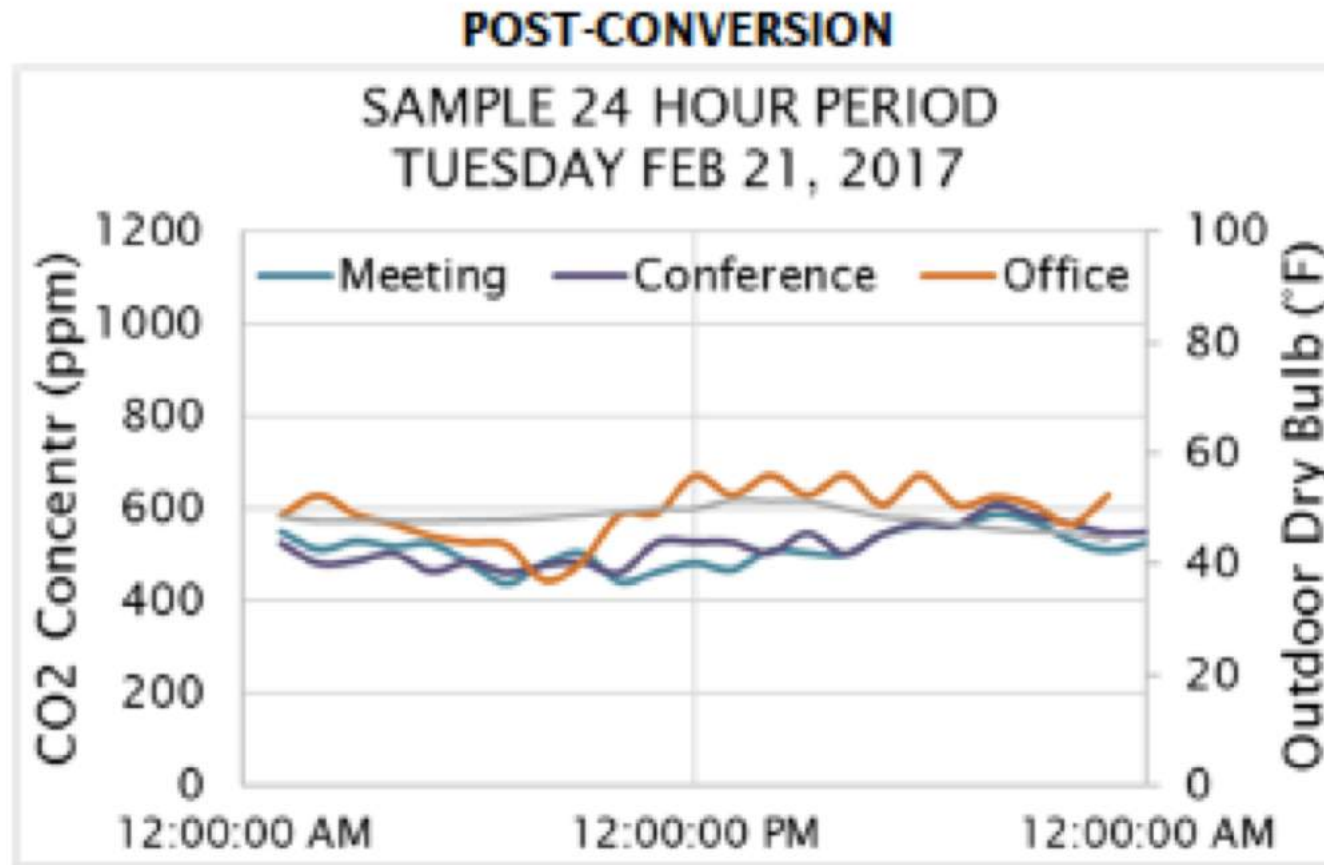


	ANNUAL EUI	---
Total:	57.4 kBtu/ft ²	---
Fans:	9.5 kBtu/ft ²	---
Heating:	37.6 kBtu/ft ²	---
Cooling:	3.6 kBtu/ft ²	---
HVAC:	50.7 kBtu/ft ²	---
Electricity:	19.8 kBtu/ft ²	---
Gas:	37.6 kBtu/ft ²	---

	ANNUAL EUI	ANNUAL SAVINGS
Total:	19.7 kBtu/ft ²	37.8 kBtu/ft ²
Fans:	1.0 kBtu/ft ²	8.5 kBtu/ft ²
Heating:	9.2 kBtu/ft ²	28.4 kBtu/ft ²
Cooling:	2.8 kBtu/ft ²	0.8 kBtu/ft ²
HVAC:	13.0 kBtu/ft ²	37.8 kBtu/ft ²
Electricity:	19.7 kBtu/ft ²	0.1 kBtu/ft ²
Gas:	0.0 kBtu/ft ²	37.6 kBtu/ft ²

CONSISTENT, HEALTHY IAQ

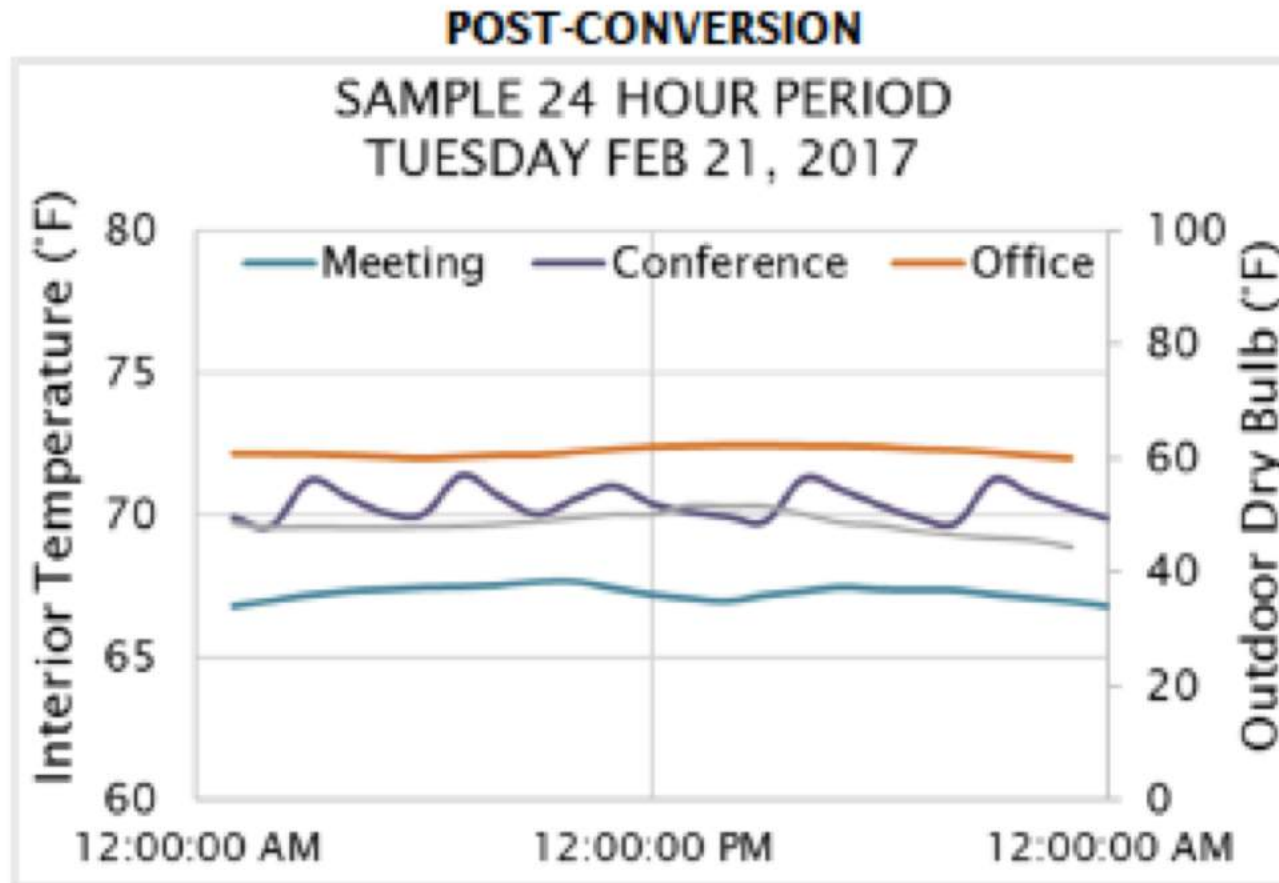
OCCUPANTS WIN



- Showing CO2 data from the conference room, a typical meeting room, and typical office.
- In general, good control of interior CO2 levels in occupied spaces.

CONSISTENT, COMFORTABLE SPACES

CONSISTENCY MATTERS



- Showing interior temperature data from the conference room, a typical meeting room, and typical office.
- In general, temperatures vary significantly between spaces.
- The owner changed setpoints on Dec 9, 2016.

STATE OFFICES, OREGON

PARTIAL RTU REPLACEMENT

Offices Case Study

GOVERNMENT OFFICE CLEANS AIR AND LOWERS BILL

Building Facts

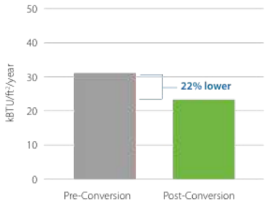
Building Construction Year	1940
Occupancy Type	Office
Number of Stories	1
Conditioned Area	13,200 sq.ft.
Ownership	Government Owned and Occupied

Partial Retrofit Still Reduces HVAC EUI By 22%

This Government Agency owns hundreds of buildings in the state of Oregon. With our help, they have modified 22% of one building as a test, working toward goals for a lessened energy footprint and carbon emissions. In short, 16 tons of heating/cooling capacity was replaced with 9 tons. This was done through a multi-zone ducted mini-split system, and the heat transferring powers of one VS1000 RT. Employees in the upgraded part of the offices report their workplace seems more comfortable and productive, while employees in the unaltered portion of the office report envy of their colleagues. Many visit the “fresh air” part of the building regularly. Three months of post-conversion summertime energy monitoring are following model projections closely, with the HVAC EUI at a 22% reduction



HVAC Energy Use Intensity



Interior CO2 Concentration, Temp Outdoor Pre and Post-Conversion



HVAC Facts

	PRE CONVERSION	POST CONVERSION
Fuel Source	H: Natural Gas; AC: Electricity	H: DMS, Ducted Fan Coils; AC: DMS, Ducted Fan Coils
HVAC System	(2) RTUs	(1) VS1000 RT; Mitsubishi MXZ-8C48NAHZ; (2) MVZ-A24AA4AH's
CFM	6,400	3,600
Tons	16	9

CS-OFFICE-GOV1-Jan2017



2828 SW Corbett Ave, Portland, OR 97201
1-(888)-VENTILR
ventacity.com

- Replaced Single RTU
- 22% of Space
- Reduced Building EUI by 22%
- “I want what they got!”



MIXED USE OFFICE, MONTANA

OFFICES AND GARAGE

Offices Case Study

ELECTRIC COOPERATIVE REDUCES HIGH CO2

Building Facts

Building Construction Year	1938
Occupancy Type	Office
Number of Stories	1
Conditioned Area	5,681 sqft
Ownership	Cooperative

Rural Cooperative Invests in Comfort and Health

Many progressive energy efficiency initiatives in the United States are conducted by member-owned utilities, often called "demand-side management" programs. This rural cooperative was formed to bring electricity to 117 farmers in 1938. It is now the second-largest utility provider in the state, serving 48,000 customers. In September 2016, a district office removed 2 "swamp coolers" and a poor-performing 7.5 ton RTU to install the Ventacity HRV and upgrade to a 4-ton ductless heat pump with 7 wall units for both heating and cooling. Early monitoring results shown below show a noticeable "step down" in CO2 concentrations immediately. During the first two weeks, CO2 was almost always between 400ppm and 600ppm, with one peak of 810ppm. Pre-conversion, there were regular spikes in all areas well above 1000ppm. Another welcome change in a garage (not shown) is temperatures typically about 70F instead of between 80 to 85F, relative to the same outdoor highs.

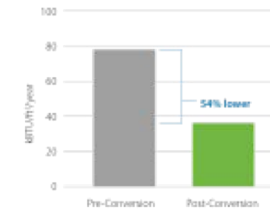
HVAC Facts

	PRE CONVERSION	POST CONVERSION
Fuel Source	H: Electricity; AC: Electricity	H: VRF Heat Pump + boiler; AC: VRF Heat Pump
HVAC System	2-stage electric boilers serving fan coils & radiators; packaged HRP RTU for cooling offices; (2) swamp coolers for storage/garage area	(1) VS1000 RT HRV (2) MKZ-8C48NAHZ, (3) MSZ-GE09NA-9, (3) MSZ-GE09NA-9; (1) MSZ-GE12NA-9, (2) MVZ-A24AA4 AH electric boiler back-up
CFM	est. 3,000	est. 1,600 (H & AC)
Tons	7.5	4

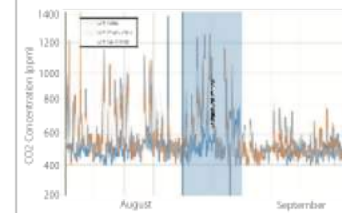
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HVAC Energy Use Intensity



CO2 Concentration Pre and Post-Conversion



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ventacity.com

- Mixed Use
- Improved IAQ Significantly
- 54% EUI Reduction

KING COUNTY AIRPORT, SEATTLE, WA

Public Spaces Case Study

AIRPORT IMPROVES AIR QUALITY AND REDUCES ENERGY

Installation Facts

Building Construction Year	1930
Occupancy Type	Airport
Number of Stories	2
Conditioned Area	26,000 sq.ft.
Ownership	County Government

Airport Reduces HVAC EUI By 81%

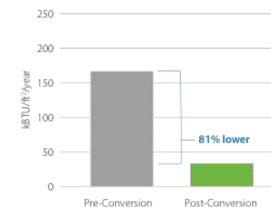
This historic airport handles 200,000 flights per year for helicopters, small commercial airlines, private and chartered jets, flight tests, as well as celebrities and dignitaries needing immediate access to the city. With the help of a local energy consultant, the airport is acquiring three VS1000 RT units to reduce its EUI by 86% in the modified area to around 30 kBtu/ft²/year. One could say its current EUI is as large and unwieldy as early commercial aircraft, and is now being transformed by 21st century HRV technology. A number of the airport's 5,209 employees will soon benefit from improved ventilation, in addition to lowered utility bill costs for an urban county government.

HVAC Facts

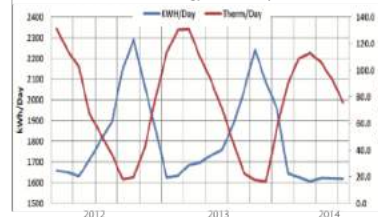
	PRE CONVERSION	POST CONVERSION
Fuel Source	H: Natural Gas; AC: Electricity	H: VRF Heat Pump; AC: VRF Heat Pump
HVAC System	(3) Multi-Zone Air Handlers	(3) VS1000 RT, (3) Mitsubishi VRF Heat Pumps (model TBD)
CFM	est. 4,200	TBD
Tons	est. 10.5	TBD



HVAC Energy Use Intensity



Pre-Conversion Energy Use Per Day



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HUGE IMPACT

- HVAC EUI Reduced by 81%
- Improved IAQ
- Activated Charcoal Filters Reduce Fine Particulates

KING COUNTY AIRPORT, SEATTLE, WA

BEFORE



“NOW THAT’S A BIG BOX!”

AFTER



“HONEY, I SHRUNK THE HVAC SYSTEM”

BIG CONTRAST

- 26,500 Sq Ft
- Airport Terminal & Offices
- Circa 1930
- HVAC EUI Reduction =

85%

AT LEAST 53% HVAC EUI REDUCTION

Location	Sq. Ft.	Use	HVAC Energy Reduction %
Corvallis, OR	2,600	Restaurant	54%
Portland, OR	12,000	Law Office	71%
Corvallis, OR	3,770	Government Office	72%
Seattle	26,000	Regional Airport	81%*
Seattle	5,911	3rd-Floor Offices	69%
Philadelphia	13,000	Multi-Family	64%*
Libby, MT	5,681	Office w/ Garage	54%*
Portland, ME	TBA	Multi-Family	TBA
Portland, OR	TBA	Church	TBA
8-Pilot Study (BetterBricks)		All of the above	53% Average
Location	Sq. Ft.	Use	HVAC Energy Reduction %

VERY IMPRESSIVE RESULTS

* Predicted HVAC EUI reduction using whole-building energy modeling.



NEW YORK RETROFIT

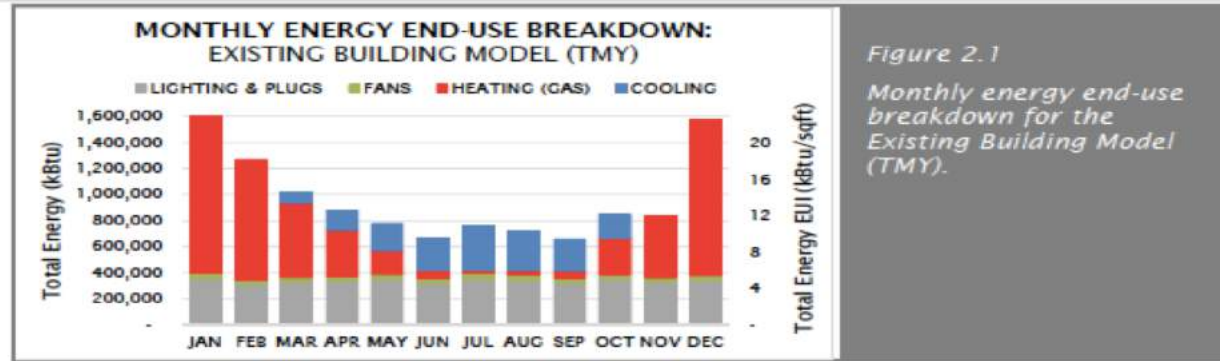


Figure 2.1
Monthly energy end-use breakdown for the Existing Building Model (TMY).

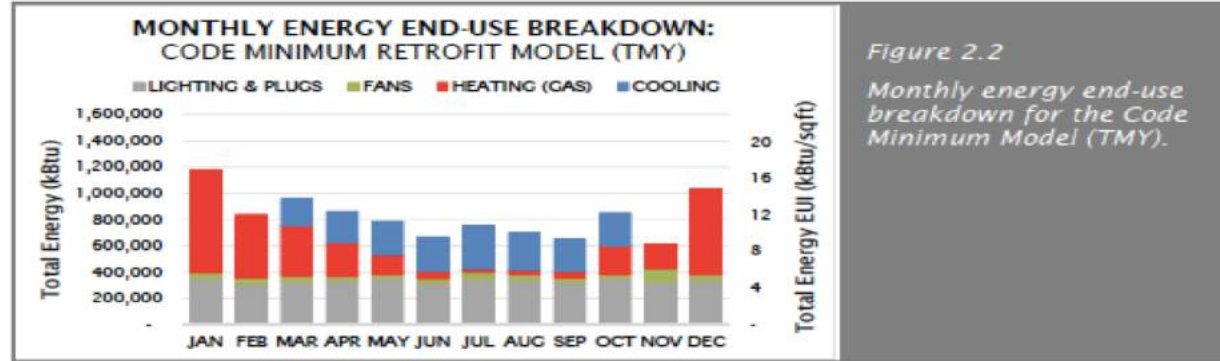


Figure 2.2
Monthly energy end-use breakdown for the Code Minimum Model (TMY).

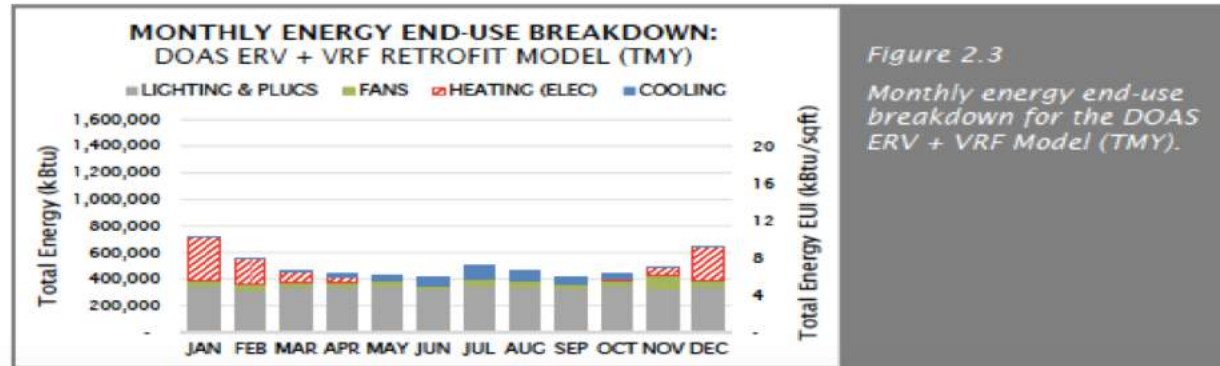


Figure 2.3
Monthly energy end-use breakdown for the DOAS ERV + VRF Model (TMY).

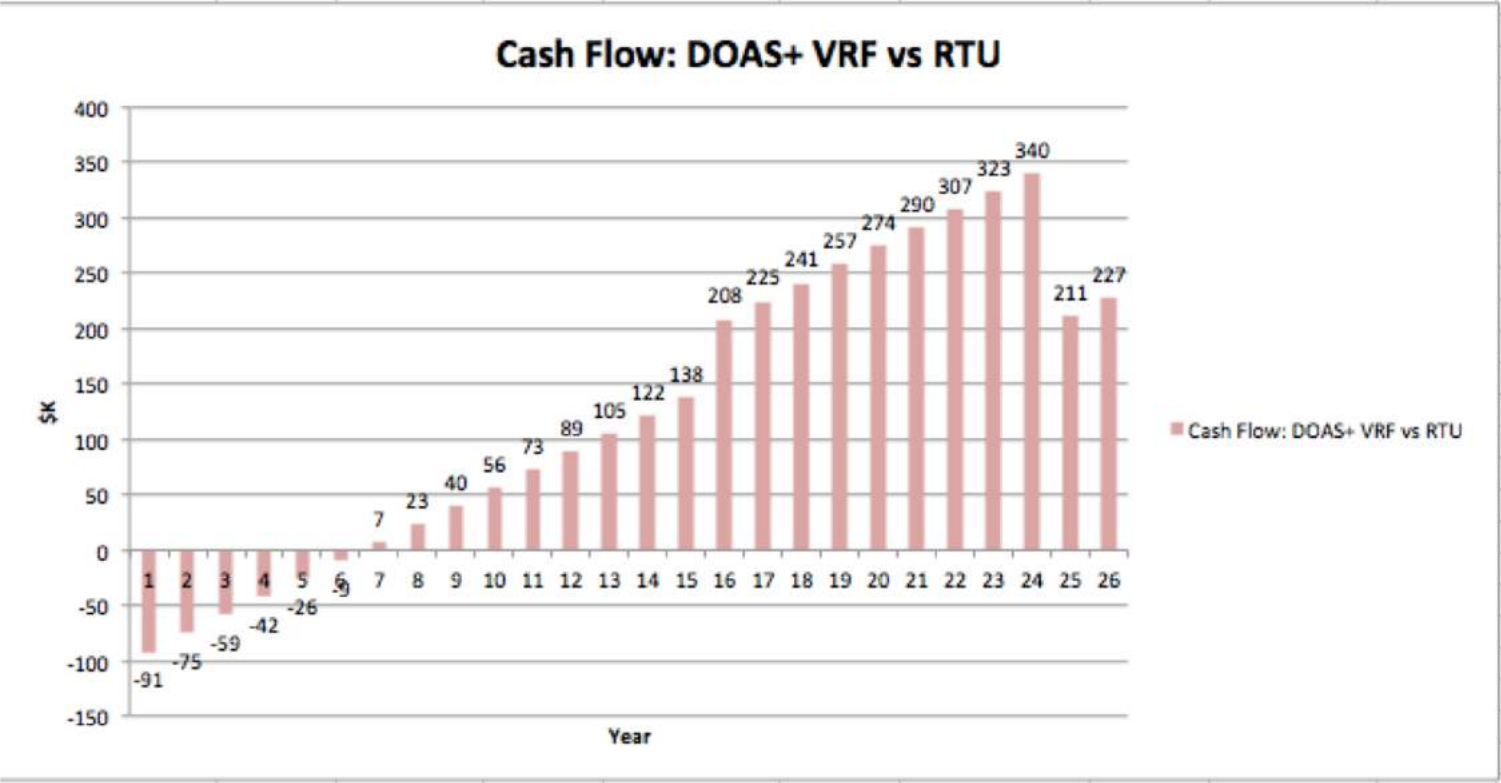
LARGEST PROJECT TO DATE

- 71,000 sq ft
- Four existing RTUs
- Replace with four ERVs, and VRF
- Model predicts 3 year payback
- Payback 18 months with incentives from utility

CALCULATING PAYBACK WITH THE RTU REPLACEMENT PROGRAM

ROI CALCULATOR

- Multiple Inputs Required
 - Dollars and Cents Not The Only Metrics of Return
1. IAQ & Health
 2. Building Value
 3. Carbon Savings



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PRESENTER

