THE PLAN

- Very aggressive program
- Buildings primary target for savings
- Retrofitting existing buildings key to significant savings
- City buildings targeting Passive House or NZE by 2030
AGGRESSIVE TARGETS FOR BUILDINGS

80 x 50 Roadmap (MtCO₂e)

- **Transportation**
- **Waste**
- **Buildings**

*GHG emissions from electricity production (Energy) is included in Buildings and Transportation*
A Roadmap to 80 x 50, in Million Metric Tons of Carbon Dioxide Equivalent (MtCO$_2$e)

- Pre-2014 Policies
- One City Built to Last Policies
- TWG Energy Conservation Measures
- Performance-based Energy Code
- Deep Energy Retrofits, including high efficiency electric technologies for heat and hot water
- Low Carbon Intensity Electric Grid

-2%
- Zero Waste
- Net Zero Wastewater Treatment Plants

-20%
- Pre-2014 Policies
- Shift away from Personal Vehicles
- Low Carbon Fuels and Vehicles
- Improved Network Efficiency
- Improved Freight Efficiency
- Low Carbon Intensity Electric Grid

-46%

2005 Baseline
2014
Waste
Transportation
Buildings
Energy Supply

11.8
Citywide 80x50 Target

*All percent reductions are relative to the 2005 citywide baseline
<table>
<thead>
<tr>
<th>Buildings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement cost-effective upgrades in existing buildings to improve energy efficiency in the near-term</td>
<td></td>
</tr>
<tr>
<td>Scale up deep energy retrofits that holistically address heating systems, cooling systems, and building envelopes and transition buildings away from fossil fuels</td>
<td></td>
</tr>
<tr>
<td>Expand distributed solar energy and install 1,000 MW of solar capacity by 2030</td>
<td></td>
</tr>
<tr>
<td>Ensure building decision-makers have access to building energy use information</td>
<td></td>
</tr>
<tr>
<td>Provide assistance to the private sector to accelerate adoption of energy efficiency and clean energy</td>
<td></td>
</tr>
<tr>
<td>Streamline regulatory processes for building energy efficiency and clean energy</td>
<td></td>
</tr>
<tr>
<td>Ensure building owners can finance energy efficiency projects</td>
<td></td>
</tr>
<tr>
<td>Achieve exceptional energy performance for new buildings and substantial renovations</td>
<td></td>
</tr>
<tr>
<td>Lead by example in City-owned buildings</td>
<td></td>
</tr>
<tr>
<td>Prepare New York City's workforce to deliver high performance buildings</td>
<td></td>
</tr>
<tr>
<td>Position New York City as a global hub for energy efficiency and clean energy technology</td>
<td></td>
</tr>
</tbody>
</table>
Buildings Use About 40% of Total Energy in North America

OPPORTUNITY
- Up to 70% in NYC and other large cities
- OA is increasing in importance
- LEED points for extra OA
- The “Forgotten” component in EE
Outside Air (Ventilation) Accounts for 30-40% of Building Energy Use

OPPORTUNITY
- Even more in high performance buildings
- Unrecognized by most energy modelers
- Will increase with more focus on IAQ and health in buildings
That Means That OA in Buildings Accounts for **12-16%** of All Energy Use In North America!

**OPPORTUNITY**
- Unrecognized
- Huge Opportunity
- Misunderstood
- Crucially important to EE conversation
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/
WHY VENTILATE
BETTER VENTILATION MEANS BETTER PERFORMANCE

Harvard Study\(^4\)
On average, a 400 ppm increase in CO\(_2\) was associated with a 21% decrease in cognitive function scores

70-school Study in Southwestern US\(^5\)
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 USA\(^6\)
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
WHY VENTILATE?
HEALTHIER CONDITIONS

- Lawrence Berkeley National Laboratory study of California classrooms
- Increasing ventilation from 8 CFM/student to 15 CFM/student
- Reduced sickness related absenteeism by almost 4%

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WHY VENTILATE?
BETTER PERFORMANCE

SURPRISING RESULTS

• Harvard/Syracuse study of cognitive function in office workers:
  • Green days 61% better
  • Green+ days 101% better
  • Most effected categories were crisis response, information usage, and strategy
THE MODEL FOR TRANSMOGRIFICATION

- Highly Insulated
- Superior verified air-sealing
- Thermal bridges eliminated
- Low u-value windows
- Efficient heating & AC systems
- VHE Heat Recovery Ventilation (HRV)
WHAT’S HAPPENING IN THE TRANSMOGRIFIER?

• Remove Fossil Fuels (Electrification)
• Radically reduce fan energy
• Significantly reduce outside air penalty
• Introduce Advanced to provide HVAC where needed, when needed, at optimum efficiency
IMPRESSIVE RESULTS  

REAL RESULTS

---

### Annual EUI

<table>
<thead>
<tr>
<th>Component</th>
<th>EUI (kBtu/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>57.4</td>
</tr>
<tr>
<td>Fans</td>
<td>9.5</td>
</tr>
<tr>
<td>Heating</td>
<td>37.6</td>
</tr>
<tr>
<td>Cooling</td>
<td>3.6</td>
</tr>
<tr>
<td>HVAC</td>
<td>50.7</td>
</tr>
<tr>
<td>Electricity</td>
<td>19.8</td>
</tr>
<tr>
<td>Gas</td>
<td>37.6</td>
</tr>
</tbody>
</table>

### Annual Savings

<table>
<thead>
<tr>
<th>Component</th>
<th>Savings (kBtu/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>37.8</td>
</tr>
<tr>
<td>Fans</td>
<td>8.5</td>
</tr>
<tr>
<td>Heating</td>
<td>28.4</td>
</tr>
<tr>
<td>Cooling</td>
<td>0.8</td>
</tr>
<tr>
<td>HVAC</td>
<td>37.8</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.1</td>
</tr>
<tr>
<td>Gas</td>
<td>37.6</td>
</tr>
</tbody>
</table>

---

September 2019 © Ventacity Systems, Inc.
ELECTRIFICATION DONE RIGHT!

LARGEST PROJECT TO DATE

- 71,000 sq ft Office Building
- Four Floors
- Retrofit Done While Occupied
- 50% Complete on April 1, 2019

Savings 4 Months

1. $49,854
2. 126,200 kWh
3. 622.32 kW Demand Reduction
4. 38,800 Therms Gas Reduction (modeled)
STEP BY STEP

WORKSHOP

• Introduce contractor to the model

• Provide insight and information to share with building owner

• Gain knowledge of HVAC systems involved in the retrofit
STEP BY STEP

ENERGY ANALYSIS

- HVAC comparison
- Model savings
- Determine payback and scope of project
# STEP BY STEP ENERGY ANALYSIS

<table>
<thead>
<tr>
<th>Bill Period</th>
<th>Electricity Usage</th>
<th>Gas Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Date</td>
<td>End Date</td>
<td># of Days</td>
</tr>
<tr>
<td>12/5/16</td>
<td>1/4/17</td>
<td>30</td>
</tr>
<tr>
<td>1/4/17</td>
<td>2/3/17</td>
<td>30</td>
</tr>
<tr>
<td>2/3/17</td>
<td>3/7/17</td>
<td>32</td>
</tr>
<tr>
<td>3/7/17</td>
<td>4/5/17</td>
<td>29</td>
</tr>
<tr>
<td>4/5/17</td>
<td>5/3/17</td>
<td>28</td>
</tr>
<tr>
<td>5/3/17</td>
<td>6/2/17</td>
<td>30</td>
</tr>
<tr>
<td>6/2/17</td>
<td>7/3/17</td>
<td>31</td>
</tr>
<tr>
<td>7/3/17</td>
<td>8/2/17</td>
<td>30</td>
</tr>
<tr>
<td>8/2/17</td>
<td>8/31/17</td>
<td>29</td>
</tr>
<tr>
<td>8/31/17</td>
<td>10/2/17</td>
<td>32</td>
</tr>
<tr>
<td>10/2/17</td>
<td>10/31/17</td>
<td>29</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>330</td>
</tr>
</tbody>
</table>
STEP BY STEP INCENTIVES

- Utilities
- EE Organizations
- Usually a custom program application

Commercial & Industrial Efficiency Program Application
Prescriptive and Custom Incentives

We offer incentives for installing energy-efficient electric and gas equipment and technologies. Energy efficiency can help improve your bottom line by reducing your energy use and maintenance costs while increasing your operating efficiencies. These upgrades can also help protect the environment.

HOW TO APPLY

CHECK PROJECT AND EQUIPMENT ELIGIBILITY
All installed equipment must meet or exceed program requirements described in the program manual.

SUBMIT APPLICATION PACKAGE
An application package is required for all projects and includes the following items:
- Completed program application
- Con Edison Tool or custom analysis
- Cut sheets or technical support details as specified by the program manual
- W-9 of the incentive recipient

SIGN PRELIMINARY INCENTIVE OFFER LETTER (IOL)
Please identify a contact person who will be present during the pre-inspection site visit, and return the completed IOL document to Con Edison within 30 days.

PRE-INSPECTION
Con Edison will inspect the pre-existing condition of your site.

NOTICE TO PROCEED
Wait until you receive your Notice to Proceed before starting your project.

INSTALL EQUIPMENT OR PERFORM PROJECT WORK
The Notice to Proceed allows 90 days to complete your project and submit your completion paperwork. Contact the program team if you think your project will require more than 90 days. Submit your completion paperwork as soon as your project is completed. The completion paperwork includes:
- Signed completion form
- Final project invoices and receipts for custom projects. (Prescriptive projects require invoices only upon request)

POST INSPECTION
Con Edison will inspect the new condition of your site.

RECEIVE INCENTIVE PAYMENT
Once your energy savings and incentives are finalized by the program team, an incentive check will be mailed to you or your Market Partner. Only designated Market Partners in good standing may receive incentive payments.
STEP BY STEP
THE TEAM!

• Contractor
• Manufacturer’s Engineer
• Manufacturers’ Rep
• Distributor
STEP BY STEP

- Heat pumps - Outside Units
- Transition from Existing RTUs to Heat Pumps
- While building is occupied
- Lots of planning!

September 2019 © Ventacity Systems, Inc.
STEP BY STEP

INSTALLATION!

• Heat pumps - Inside Units

• Added control and diversity for better comfort

• While building is occupied

• Lots of planning!
Retrofitting Existing Commercial Buildings To Achieve Significant Energy Savings & Better IAQ

- Many aging gas packs
- Possible curb reuse
Retrofitting Existing Commercial Buildings To Achieve Significant Energy Savings & Better IAQ

RETROFIT PROCESS

Existing Building

- Exhaust Air Wastes Energy
- Recirculated Air is Inefficient for Heating & Cooling
- Air Leakage Wastes Energy

Proposed Retrofit Building

- Energy Saved by Heat Recovery
- High Efficiency Heat Pump
- Existing Ductwork Repurposed
- Ventilation Independent of Heating & Cooling
MANY BENEFITS

- 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
EFFICIENCY, EFFICIENCY, EFFICIENCY!

NET EFFICIENCY MATTERS!

- Building load reduction
- High comfort level
- No need to reheat
- Simple controls
- High return (COP)
- Economizer a bonus

CoP = Coefficient of Performance (AHRI 1060 Standard test @ 50% capacity)
EFFICIENCY = COMFORT

- Comfort is enhanced
- Energy efficiency is significantly improved

65% Recovery

40°F Outside Temp

59.5°F

Delivered Air Temp

65% Recovery

70°F

Indoor Set Point

65.5°F

70°F
EFFICIENCY MATTERS

• Comfort is enhanced

• Energy efficiency is significantly improved

EFFICIENCY = COMFORT

65% Recovery
40°F Outside Temp

59.5°F

70°F

5,667 BTU/Hour

Delivered Air Temp

85% Recovery

Indoor Set Point

65.5°F

70°F

2,430 BTU/Hour

Fresh Air Contribution to Heating Load at 500 CFM

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# Total Savings Significant

<table>
<thead>
<tr>
<th></th>
<th>VHE</th>
<th>STD</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="VS1000_RT" alt="Image" /></td>
<td><img src="STD" alt="Image" /></td>
<td><img src="STD" alt="Image" /></td>
<td></td>
</tr>
<tr>
<td>Recovery Efficiency</td>
<td>85%</td>
<td>70%</td>
<td>72%</td>
</tr>
<tr>
<td>Tempering Energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incoming Air Temp</td>
<td>65.5°F</td>
<td>61°F</td>
<td>61.6°F</td>
</tr>
<tr>
<td>BTUs/Hour</td>
<td>2,430</td>
<td>4,860</td>
<td>4,536</td>
</tr>
<tr>
<td>kBTUs/Year</td>
<td>21,286</td>
<td>42,573</td>
<td>39,735</td>
</tr>
<tr>
<td>Fan Efficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CFM/WATT</td>
<td>2.9</td>
<td>1.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Power Used</td>
<td>172</td>
<td>384</td>
<td>312</td>
</tr>
<tr>
<td>kWh/Year</td>
<td>1,507</td>
<td>3,364</td>
<td>2,733</td>
</tr>
<tr>
<td>Operating Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total kWh/Year</td>
<td>6,238</td>
<td>12,477</td>
<td>11,654</td>
</tr>
<tr>
<td>Yearly Cost</td>
<td>$998</td>
<td>$1,996</td>
<td>$1,865</td>
</tr>
</tbody>
</table>

*With Higher Efficiency

The ROI Is In Months Not Years

CALCULATED AT 500 CFM

30 DEGREE DELTA T

.25 INCHES STATIC PSI

$0.18 KW

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BIG ENERGY SAVINGS!

VENTILATION ENERGY REDUCTIONS ARE SIGNIFICANT

- Assuming 500 CFM
- Assuming ΔT of 30F
- 13-15% difference in results in nearly 100% reduction in energy use
- Translates into savings of +/- $700 - $800/year at $0.10/kWh
MWH OF POWER SAVED!

VERY SIGNIFICANT YEARLY SAVINGS

- Assuming +/- 115,000 Commercial H/ERVs sold every year
- Assuming ΔT of 30°F
- 13-15% difference in results in nearly 100% reduction in energy use
- Adoption of Passive House level of efficiency would result in closing power plants
### EFFICIENCY = SAVINGS

<table>
<thead>
<tr>
<th>SPECIFICATION</th>
<th>PROPOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td>STD 1000 CFM ERVs (3)</td>
<td>VHE HRVs (3)</td>
</tr>
<tr>
<td>100 MBH GAS FIRED DUCT HEATER (3) TO MAINTAIN 55°F SUPPLY AIR TEMPERATURE</td>
<td>NOT NEEDED, PROVIDES SUPPLY AIR TEMPERATURE AT DESIGN TEMPERATURE</td>
</tr>
<tr>
<td>ADD-ONS: OUTDOOR INSULATION PACKAGE, DAMPERS, BY-PASS</td>
<td>INCLUDED AS STANDARD</td>
</tr>
</tbody>
</table>

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

### BRITISH COLUMBIA DAYCARE PROJECT

- Higher efficiency
- Lower overall cost
**OFFICES**

**Indoor Air Quality Affects Productivity & Cognition**

The connection between indoor air quality and its impact on crisis response, strategy and information usage in office workers is indisputable. Improving office ventilation with units from Ventacity Systems:

- Reduces CO₂ levels and high concentrations of VOCs, thereby improving IAQ and resulting in higher worker cognition and productivity
- Improves comfort
- Decreases energy usage, lowering operating costs
- Provides sentient, intelligent and secure ventilation management with the Smart Building Gateway

**Building Retrofit**

**Separate Ventilation from Heating and Cooling**

**Install New VRF or DMS System**

**Remove Aging RTUs**

**Install New VS1000 RT HRV**

Building is now Healthy and Efficient

**Building Facts**

- Building Construction Year: Circa 1900
- Occupancy Type: Office
- Number of Stories: 3
- Conditioned Area: 12,000 sqft.
- Ownership: Private

**Practicing Financial and Environmental Stewardship While Practicing Law**

Ventacity regards an early adopter as a flagship customer; a law practice working above retail spaces in a 1909 historic warehouse. In completing a quiet remodel, the owners eagerly removed nine aging RTUs and replaced them with four Ventacity VS1000 RTs and one VRF system. By upgrading lights, windows, and air tightness, the office’s overall EUI is expected to drop from 61.4 to 28 kBtu/ft²/year HVAC EUI. In particular, it is expected to drop 71%, a large impact compared with incremental HVAC improvements. Taking the historic energy conservation approach also enabled the law firm to receive some ratepayer funded rebates on non-Ventacity items. Ventacity staff was present on record 100° summer days, yet the incoming, pre-cooled air from the recovery core was an ideal 80°F.

**HVAC Facts**

<table>
<thead>
<tr>
<th>Pre Conversion</th>
<th>Post Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Source</td>
<td>VRF Heat Pump, AC</td>
</tr>
<tr>
<td>HVAC Systems</td>
<td>RTUs</td>
</tr>
<tr>
<td>CFM</td>
<td>14,000</td>
</tr>
<tr>
<td>TEMS</td>
<td>180</td>
</tr>
</tbody>
</table>

“I was surprised by how much our energy bill dropped”—Building Owner

**LAW FIRM REDUCES HVAC EUI BY 71%**
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.
GOVERNMENT OFFICE CLEANS AIR AND LOWERS BILL

Building Facts

- Building Construction Year: 1940
- Occupancy Type: Office
- Number of Stories: 2
- Conditioned Area: 12,380 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 reduced 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 power of one V5 1000 FT. 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 Facts

<table>
<thead>
<tr>
<th>Pre Conversion</th>
<th>Post Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Source</td>
<td>Natural Gas, AC Electricity</td>
</tr>
<tr>
<td>HVAC System</td>
<td>Ducted Fan Coils, V5 Mini-Split, 1000 FT.</td>
</tr>
<tr>
<td>CSM</td>
<td>6.4 KEB</td>
</tr>
<tr>
<td>Total</td>
<td>160</td>
</tr>
</tbody>
</table>

“I want what they got!”

September 2019 © Ventacity Systems, Inc.
MIXED USE OFFICE, MONTANA

ELECTRIC COOPERATIVE REDUCES HIGH CO2

Building Facts

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

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 2019, a district office removed 2 “sweat coolers” and a poor-performing 7.5 ton RTU to install the Ventacity HRAs and upgrade to a 4-ton dual-duct heat pump with 7 R-410A units for both heating and cooling. Early monitoring results shown below show a noticeable drop down in CO2 concentrations immediately. During the first two weeks, CO2 was almost always between 400ppm and 500ppm, with one peak of 800ppm. 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
  - Fuel Source: H, Electricity, AC, Electricity
  - HVAC System: 2 stage electric boiler, serving fan coil, radiators supplied by H, R-410A for cooling, 2 systems: one for garage, one for rest of building
- Post Conversion
  - Fuel Source: H, HW Pump, biomass, AC, HW Heat Pump
  - HVAC System: 1 stage HW boiler, HW pump, HRA, 2 systems: one for garage, one for rest of building

CO2 Concentration Post and Pre-Conversion

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KING COUNTY AIRPORT, SEATTLE, WA

AIRPORT IMPROVES AIR QUALITY AND REDUCES ENERGY

Installation Facts

<table>
<thead>
<tr>
<th>Building Construction Year</th>
<th>Pre-Conversion</th>
<th>Post Conversion</th>
<th>HVAC Energy Use Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC EUI Reduced by 85%</td>
<td>85%</td>
<td></td>
<td>HVA Energy Use Intensity</td>
</tr>
<tr>
<td>HVAC System</td>
<td>Pre-Conversion</td>
<td>Post Conversion</td>
<td>HVAC Energy Use Per Day</td>
</tr>
</tbody>
</table>

• HVAC EUI Reduced by 85%
• Improved IAQ
• Activated Charcoal Filters Reduce Fine Particulates

KING COUNTY AIRPORT, SEATTLE, WA
HUGE IMPACT

Installation Facts

Building Construction Year: Pre-Conversion
Occupancy Type: Post Conversion
Heating: HVAC Energy Use Intensity
Cooling: HVAC Energy Use Per Day

(KING COUNTY AIRPORT, SEATTLE, WA)

September 2019 © Ventacity Systems, Inc.
KING COUNTY AIRPORT, SEATTLE

BEFORE

“NOW THAT’S A BIG BOX!”

AFTER

“HONEY, I SHRUNK THE HVAC SYSTEM”

BIG CONTRAST

• 26,500 Sq Ft
• Airport Terminal and offices
• Circa 1930
• HVAC EUI Reduction 85%

September 2019 © Ventacity Systems, Inc.
## MINIMUM 54% EUI REDUCTION

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

**WORST CASE 54% REDUCTION!**

- Predicted HVAC EUI reduction using whole-building energy modeling.
Can we electrify our schools?

OPPORTUNITY

• Ventilation in need of improvement

• Existing solutions use fossil fuels

• A new approach is doable
THE PATH TO NET ZERO?

NEW ENGLAND HIGH EFFICIENCY SCHOOLS

• Ventilation energy buried in HVAC numbers

• RTUs do not allow for Demand Control Ventilation

• Cut HVAC load in half, how many solar panels saved to get to Net Zero?
TYPICAL NUMBERS FOR CONVENTIONAL APPROACHES TO HVAC

FANS STAND OUT

- Fans drive high energy use
- Systems do not allow for Demand Control Ventilation
- Large air volumes require very large ducts
## THE SOLUTION

<table>
<thead>
<tr>
<th>Item</th>
<th>DIU</th>
<th>CB</th>
<th>VAV</th>
<th>VRF/ERV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>$4,680,253</td>
<td>$5,007,280</td>
<td>$4,201,338</td>
<td>$2,084,083</td>
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<tr>
<td>Ductwork</td>
<td>$1,921,788</td>
<td>$1,755,648</td>
<td>$2,290,754</td>
<td>Included</td>
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<tr>
<td>Piping</td>
<td>$2,456,280</td>
<td>$1,948,199</td>
<td>$1,344,529</td>
<td>Included</td>
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<tr>
<td>Seismic</td>
<td>$25,777</td>
<td>$48,202</td>
<td>$22,350</td>
<td>$50,000</td>
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<tr>
<td>Other</td>
<td>$573,694</td>
<td>$550,201</td>
<td>$521,808</td>
<td>$600,000</td>
</tr>
<tr>
<td>Electrical</td>
<td></td>
<td>$200,000</td>
<td>$200,000</td>
<td></td>
</tr>
<tr>
<td>Gen Constr</td>
<td>$1,075,590</td>
<td></td>
<td>$70,300</td>
<td>Included</td>
</tr>
<tr>
<td>Total</td>
<td>$10,733,382</td>
<td>$9,309,530</td>
<td>$8,651,079</td>
<td>$2,934,083</td>
</tr>
<tr>
<td>Total Cost/SF</td>
<td>$178.89</td>
<td>$155.16</td>
<td>$144.18</td>
<td>$48.90</td>
</tr>
</tbody>
</table>
### THE SOLUTION

<table>
<thead>
<tr>
<th></th>
<th><strong>Energy</strong></th>
<th><strong>Consumption</strong></th>
<th></th>
<th><strong>Energy</strong></th>
<th><strong>Cost</strong></th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Electricity</strong></td>
<td><strong>Natural Gas</strong></td>
<td><strong>Total</strong></td>
<td><strong>Electricity</strong></td>
<td><strong>Natural Gas</strong></td>
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<tr>
<td></td>
<td>kWh</td>
<td>therms</td>
<td>mBtu</td>
<td>$/Year</td>
<td>$/Year</td>
</tr>
<tr>
<td>DIU</td>
<td>475,338</td>
<td>12,303</td>
<td>2,852.7</td>
<td>$136,714</td>
<td>$13,678</td>
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<tr>
<td>CB</td>
<td>479,746</td>
<td>12,506</td>
<td>2,888.0</td>
<td>$139,760</td>
<td>$13,903</td>
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<tr>
<td>VAV</td>
<td>400,746</td>
<td>10,124</td>
<td>2,380.1</td>
<td>$131,942</td>
<td>$11,255</td>
</tr>
<tr>
<td>VRF/ERV</td>
<td>351,685</td>
<td>0</td>
<td>1,500.0</td>
<td>$115,789</td>
<td>$0</td>
</tr>
</tbody>
</table>

**VRF/ERV YEARLY SAVINGS**  **$16,153**
## THE SOLUTION

### TOTAL COST REDUCTIONS FOR VRF/VHE HRV SYSTEM

**VS**

### VAV (BEST OPTION FROM 2016 STUDY) HVAC SYSTEM

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Cost Reductions</td>
<td>$ 5,716,996</td>
</tr>
<tr>
<td>Structural Cost Reduction <em>(BASED ON 4 FT REDUCED BUILDING HEIGHT)</em></td>
<td>$ 2,000,000</td>
</tr>
<tr>
<td>Annual Energy Savings</td>
<td>$ 16,153</td>
</tr>
</tbody>
</table>

### WIN, WIN, WIN

- First Cost is lower
- Un-planned savings and benefits
- Improved IAQ and health an significant added benefit
QUESTIONS?

BARRY STEPHENS
BARRY@VENTACITY.COM
603-498-9005