Better Buildings
Space Conditioning Technology Team

National Renewable Energy Laboratory

March 07, 2019, 1-2 PM EST

Agenda

- Introductions
- HVAC Research Team updates
- Speakers
  - Michael Deru, NREL
  - Marwa Zaartari, enVerid
- Discussion

Better Buildings Summit 2019

https://betterbuildingsinitiative.energy.gov/summit

HVAC Research Team Updates

- Advanced RTU Campaign Recognition Awards
  - Winners announced at the PRSM conference on April 30!
- New HVAC Reports from GSA Proving Grounds
  - Cooling tower water treatment technologies (5 technologies)
  - High-efficiency circulator pumps
  - High-efficiency RTUs
  - High-efficiency chiller
- Reports coming soon (Spring 2019)
  - High-efficiency smart motors for refrigeration condenser fans
  - RTU AFDD landscaping study
  - enVerid gaseous air cleaner
  - Chemical free cooling tower water treatment
- New and ongoing projects
  - RTU AFDD – performance data collection
  - RTU coordination evaluation

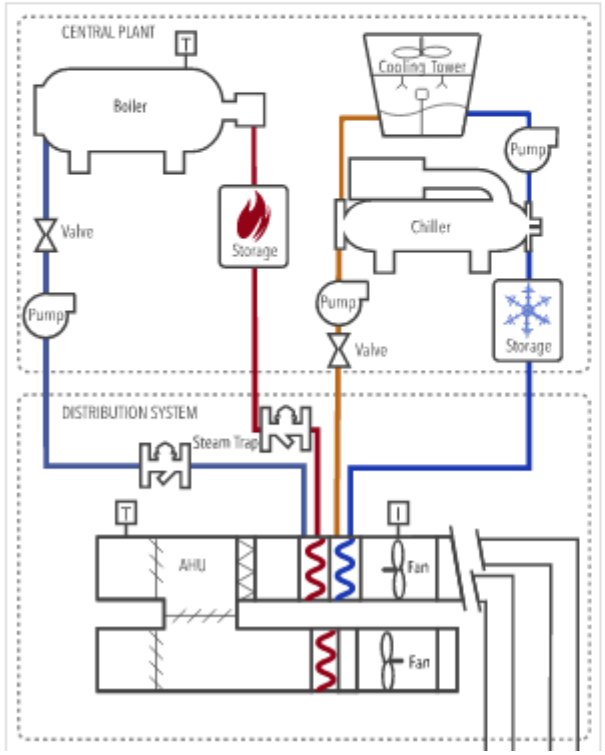
HVAC Resource Map

Better Buildings U.S. DEPARTMENT OF ENERGY

www.HVACresourcemap.net

HVAC Home | Central Plant | Distribution | Space Loads | Contributors

HVAC Resources



What is this resource?

The Central Plant Resource Map is an intuitive graphical interface that provides quick access to a broad array of quality information on operations and maintenance best practices and energy and water efficiency measures. The resources cover the central plant, distribution systems, and zone systems. The primary audiences for this resource are facility managers, operations staff, and design engineers who are looking to improve central plant and distribution efficiency but don't have time to search for these resources.

This Resource Map is not a repetition of guidance provided in codes and standards. It should not be used in lieu of professional engineering services.

Explore HVAC Resources

Use the horizontal navigation above or the interactive diagram to dive into resources on different HVAC components.

The resources listed on this site have been carefully selected to help narrow your search for helpful information.

AHR Expo Technology Award Winners

- January 14-16, 2019 in Atlanta GA
- Over 45,000 attendees and 1,800 exhibiting companies
- https://ahrexpo.com

2019 AHR Expo Technology Award Winners

- Automated Logic Corporation (Building Automation)
  - OptiFlex™ Virtual Integrator - data monitoring across diverse building systems
- Johnson Controls, Inc. (Cooling)
  - YORK YZ Magnetic Bearing Centrifugal Chiller with R-1233zd (GWP = 1)
- Regal (Heating)
  - Genteq® Ensite® EC motor for furnaces
- CPS Products, Inc. (Indoor Air Quality)
  - IAQ SmartAir™ air monitoring system
- Anvil International (Plumbing)
  - AnvilPress™ Copper, Copper Press Fittings and Coupling Systems

2019 AHR Expo Technology Award Winners

- Emerson (Refrigeration)
  - Copeland Scroll™ fractional-horsepower, low-temperature compressors
- Taco Comfort Solutions (Software)
  - Taco Tags featuring eLink™ is a cloud-based support program
- Dwyer Instruments, Inc. (Tools & Instruments)
  - Series 490W Wireless Hydronic Balancing Kit
- Energy Wall, LLC (Ventilation)
  - Energy Wall Universal ERV energy recovery ventilator
- enVerid Systems (Green Building)
  - HVAC Load Reduction® (HLR) indoor air scrubber

Product of the Year!

Marwa Zaatari, enVerid

enVerid HLR Technology

U.S. DEPARTMENT OF ENERGY

Mission: Improve Energy Efficiency and Indoor Air Quality in Buildings Worldwide

enVerid
Energy savings. Air quality.

Our Market

- Commercial, education, and government buildings
- US, China, Middle East

Our Expertise

- Chemistry
- Electronics
- Software
- Indoor air quality
- One third of employees have PhD/Masters degree

Shaping the Industry

- ASHRAE
- USGBC

ASHRAE

U.S. GREEN BUILDING COUNCIL MEMBER

Generating Value for Global Clients

enVerid
Energy savings. Air quality.

Google

TESLA

CISCO

HARVARD UNIVERSITY

Morgan Stanley

bxp Boston Properties

MIAMI

THE UNIVERSITY OF TENNESSEE CHATTANOOGA

The DIPLOMAT BEACH RESORT

AZRIELI GROUP

CBRE

Hines

Air Liquide
creative oxygen

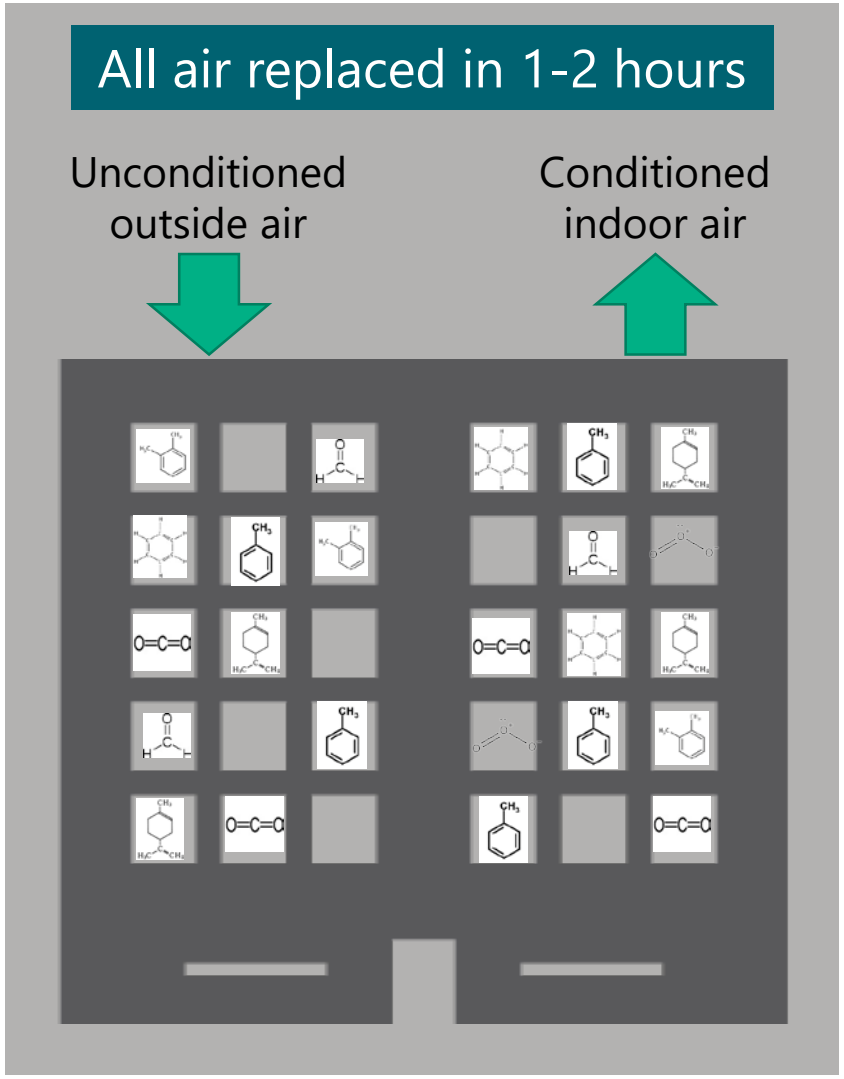
ArcBest

GSA

CEIBS

And widespread support and endorsement

Ventilation to Maintain Indoor Air Quality (IAQ)



- Ventilation decreases concentration of indoor gas contaminants:

- But… dilution is not a good solution

- HVAC capacity
- Energy usage
- Water consumption
- Maintenance

- And outside air is often polluted…

“Fresh air” is Not So Fresh

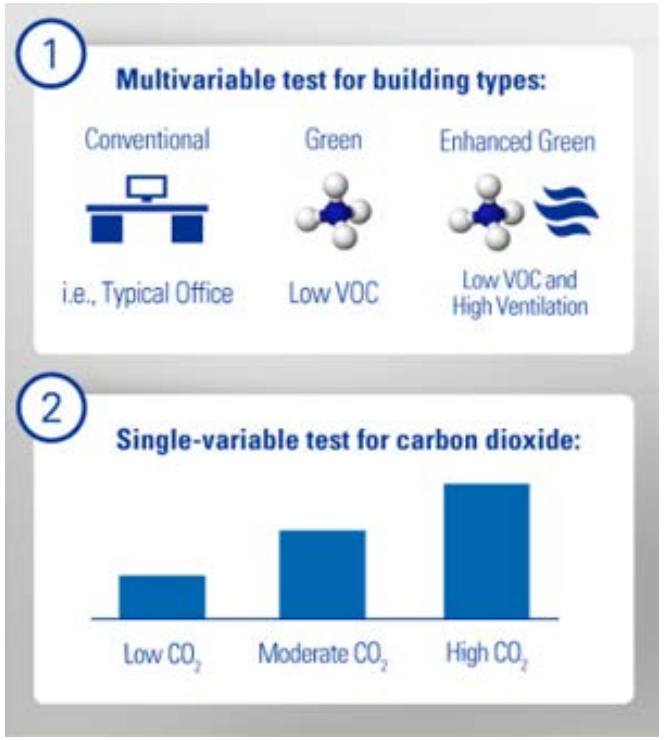
	American Lung Association		EPA
Outside air ratings	**24-Hour Particle Pollution**	**Ozone Grade**	**8-Hr Ozone Classification**
Boston-Worcester-Providence, MA-RI-NH-CT	B	F	
Chicago-Naperville, IL-IN-WI	F	F	Nonattainment
Dallas-Fort Worth, TX-OK	B	F	Nonattainment
Houston-The Woodlands, TX	C	F	Nonattainment
New York-Newark, NY-NJ-CT-PA	F	F	Nonattainment
Miami-Fort Lauderdale-Port St. Lucie, FL	B	C	
Washington-Baltimore-Arlington, DC-MD-VA-WV-PA	C	F	Nonattainment

Buildings are wasting energy and money to bring polluted air inside

The Challenge

Indoor Air Quality (IAQ)

Satish et al., LBL, 2012
Allen et al., Harvard School of Public Health, 2015

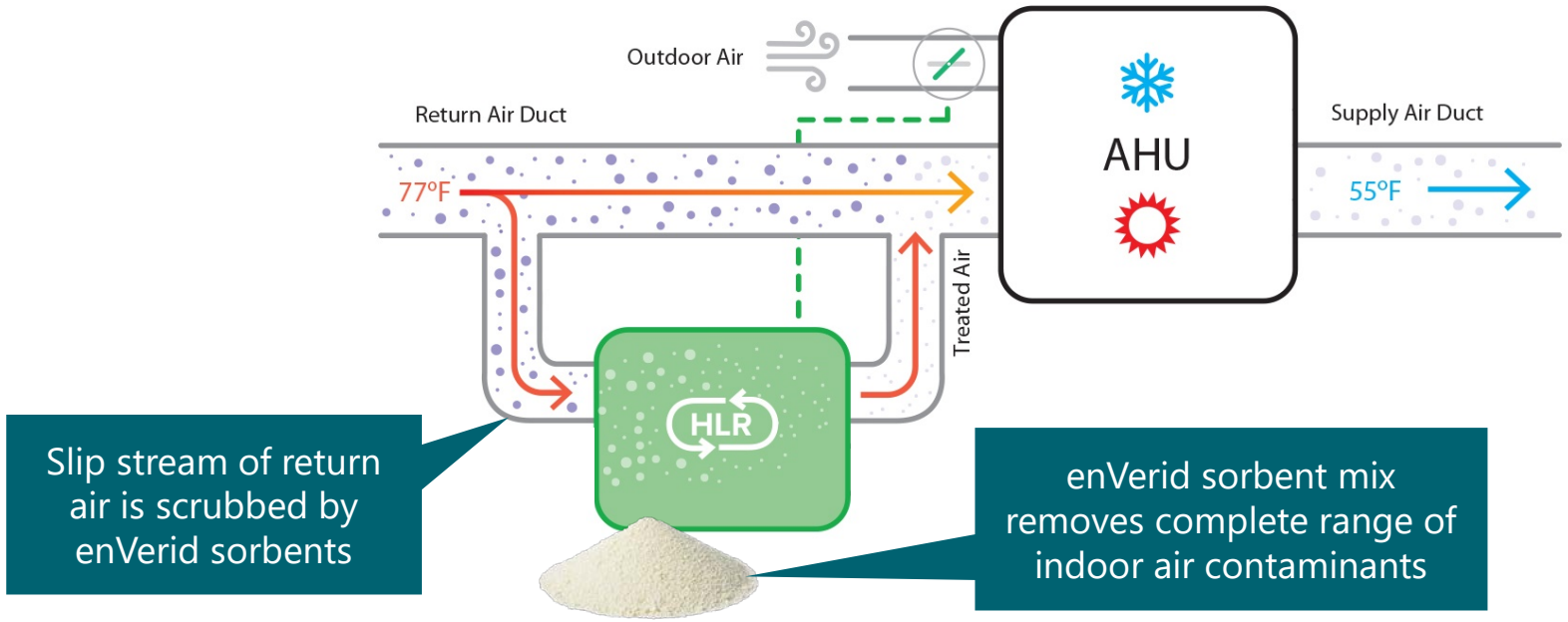


Elevated CO_2 has a <u>direct and negative</u> effect on productivity

Gain of $6,500 per year per employee

Maintaining IAQ with Molecular Cleaning

- ASHRAE Standard 62.1 = **performance based approach IAQP** + Air Cleaning:
  - Can be implemented as an energy conservation measure: less ventilation is needed to maintain IAQ
  - Decrease the intake of outdoor-generated pollutants indoors



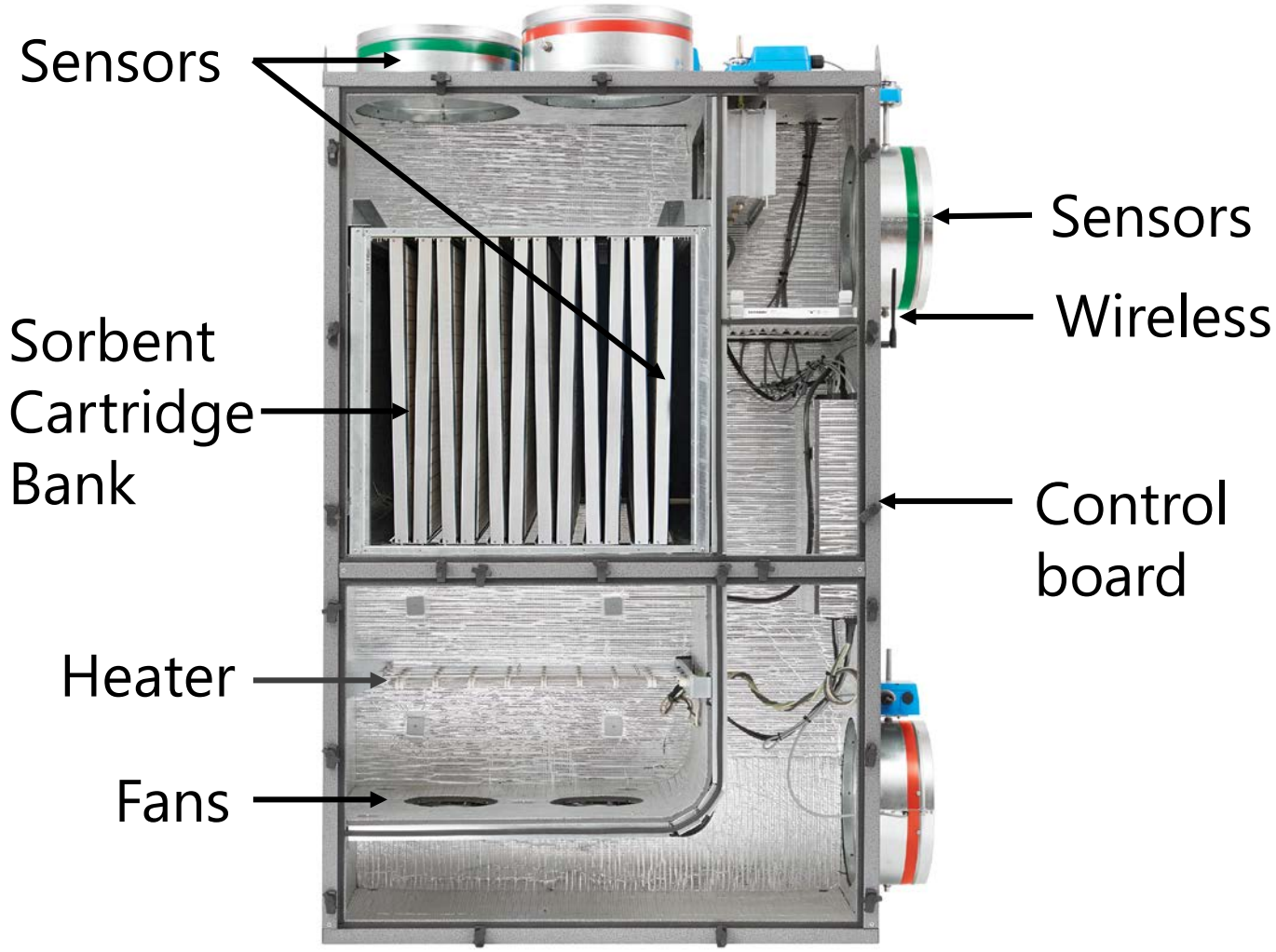
enVerid HVAC Load Reduction® (HLR®) module reduces required outside air by 60-80%

Use Cases

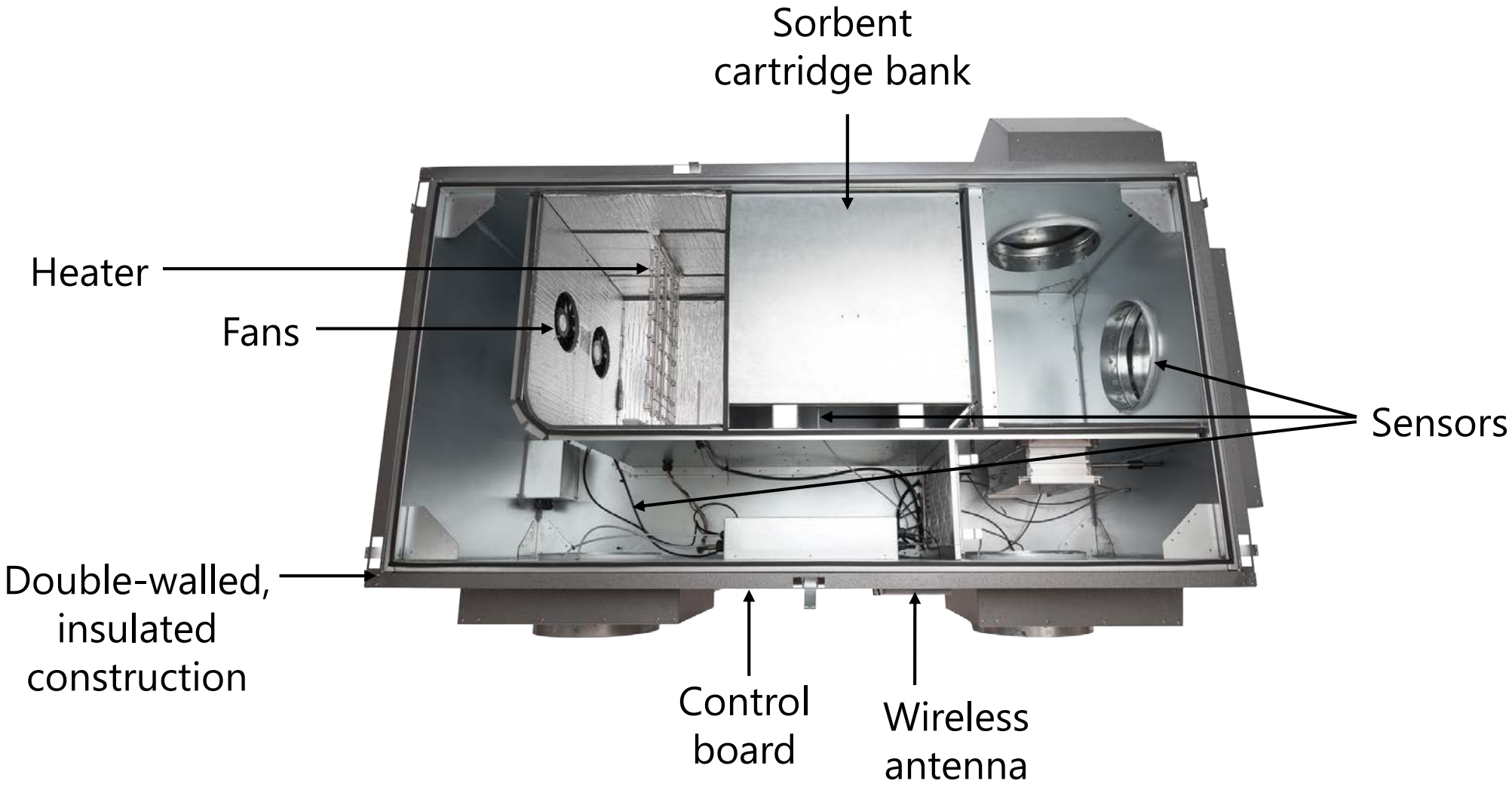
1. New construction
2. HVAC replacement / upgrade
3. Delay replacement of aging HVAC system
4. Simplify tenant finish-out
5. Accommodate increased occupant density
6. Avoid DOAS/ERV replacement
7. Energy retrofit
8. IAQ retrofit

HLR Operation Summary

HLR Module: What's Inside



Rooftop HLR Module: What's Inside



Adsorption Mode: Adsorption of Contaminants

Clean Air
(to AHU or plenum)

Indoor Air
(from return duct or plenum)

1,000 CFM

- Captures:
  - Carbon Dioxide
  - VOCs
  - Formaldehyde
  - Ozone
- Zero by-products

Each HLR 1000E module typically addresses 15,000 – 25,000 ft^2 of occupied space

Regeneration Mode: Heat and Release

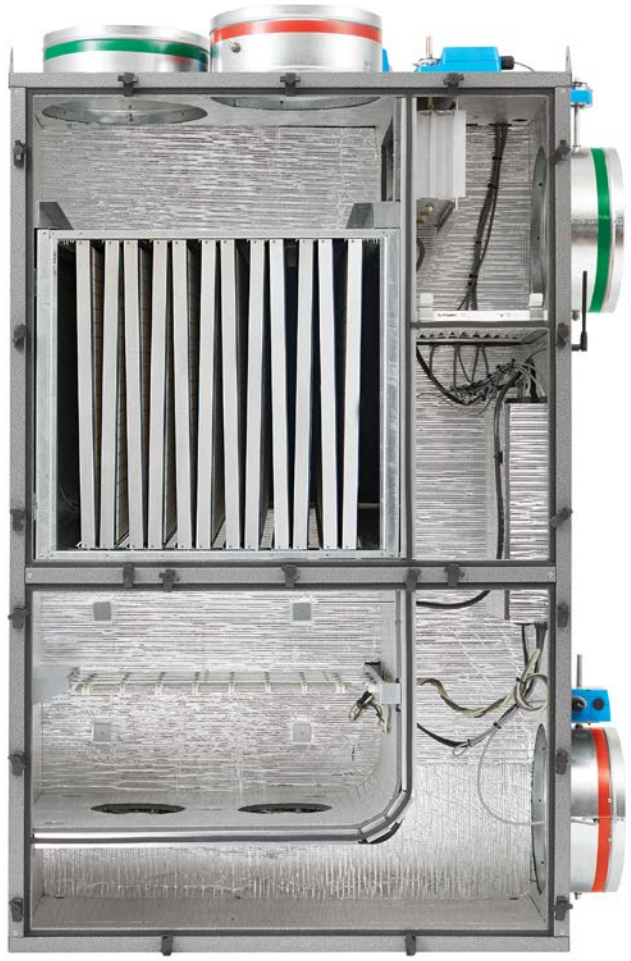
Vent Contaminants Outside

- Air heated to 130-150 ˚F
- Regeneration dampers opened

Comprehensive Sensing

Clean Air Sensor
- Temperature
- Humidity
- CO_2

Cartridge Bank Sensor
- Temperature
- Pressure



Indoor Air Inlet Sensor
- Temperature
- Humidity
- CO_2
- Total VOC (TVOC) - Optional

Connections (direct or via BMS):
- OA damper position monitoring (optional)
- Air handling unit (AHU) status

Fire signal dry contact

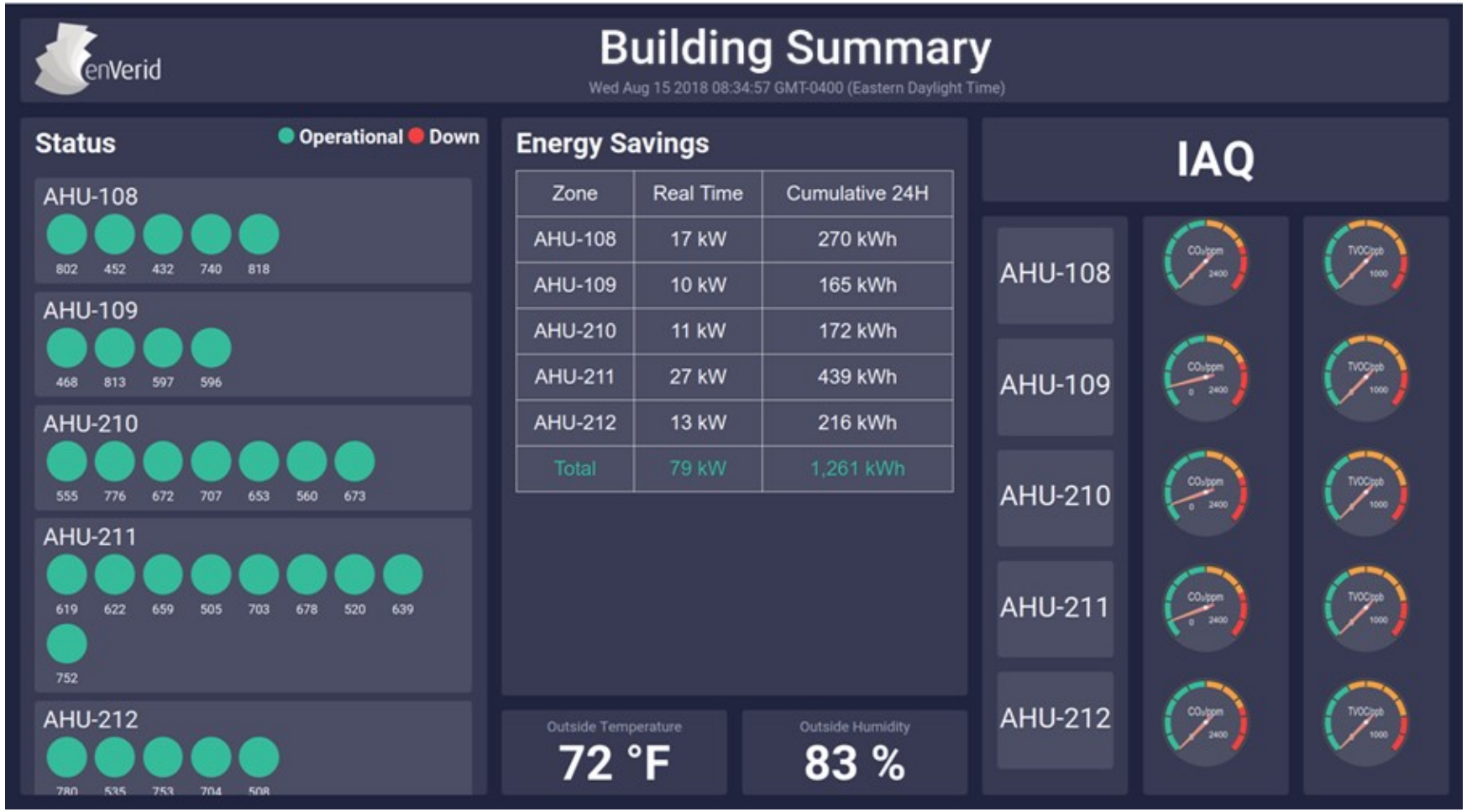
AHU Supply duct sensor (optional)
- Temperature
- Humidity

Outside Air Sensor (optional)
- Temperature
- Humidity

Note: BACnet integration to BMS eliminates need for optional sensors & connections

Advanced algorithms use sensor data to optimize energy savings & IAQ

enVerid Cloud: 24/7 Monitoring



Monitor HLR status, energy savings, and IAQ – Anywhere, Anytime

Michael Deru, NREL

enVerid Field Validation

U.S. DEPARTMENT OF ENERGY

Test Site Criteria

- OA flow rates and building air balance are known
- Adequate OA reduction available
- OA dampers are operable and can be controlled by HLRs
- No building ventilation or IAQ problems
- Adequate space for HLR installation
- Hours of operation and climate support energy savings

Test Sites

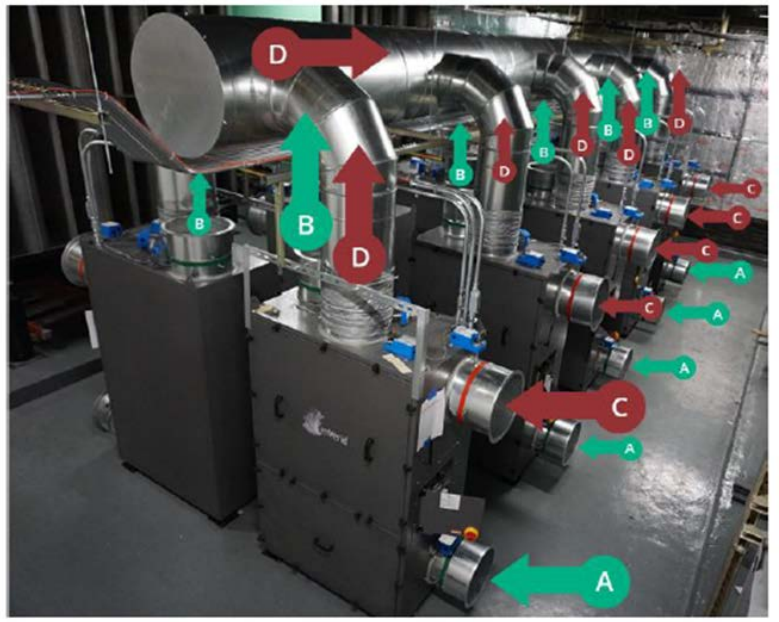
- Multiple sites were reviewed for installation – all retrofits
- HLR technology deployed at six sites
  - Performance data collected from two sites
  - One site had cooling capacity issues that were resolved by HLRs
  - Three sites had ventilation system problems and were not included in the final testing

University of Miami Wellness Center

- 60,000 ft^2 fitness and wellness center
- 3 HLRs installed in return air duct path
- Data for summers from 2015 to 2017
- Weekly on-off operation
- Damper operation challenges reduced some data collection

Morgan Stanley HQ, New York City

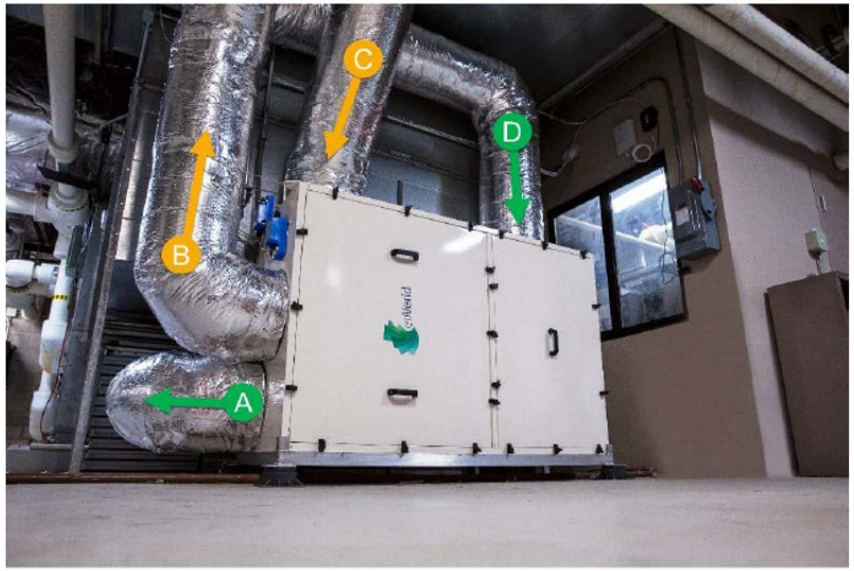
- 42 story, 1.3 million ft^2 office building
- 40 HLR units installed in return air plenums on two floors
- Data from 2017 summer
- Weekly on-off operation
- Exhaust challenges prevented winter operation
  - Corrected and now operates during heating season



A Return air from Plenum
B Clean air from HLR returned to Plenum
C Plenum air for regeneration
D Regeneration exhaust from HLR

ArcBest HQ, Fort Smith, AR

- 190,000 ft^2 5-story office building
- Occupancy was 17% over design
- 10 HLRs were installed June 2016



Results – UMH Wellness Center

Energy

Year	Data Collection Period	Chilled Water Savings	Comments
2015	September	10%	OA damper #2 was stuck open
2016	8/14 – 9/14	28%	
2017	6/22 – 9/27	36.8%	

Indoor Air Quality

Contaminants of Concern	Below Limit
Formaldehyde	4 locations pass, 2 slightly over
Acetaldehyde	Pass
Limonene	Pass
Toluene	Pass
Xylenes	Pass

Results – Morgan Stanley HQ

Energy

Year	Data Collection Period	Chilled Water Savings	Comments
2017	7/17 – 9/28	5%	• High internal and envelope loads, ventilation is small fraction of cooling load • Limited data and variable damper control increased uncertainty in results

Indoor Air Quality

Contaminants of Concern	Below Limit
Formaldehyde	Pass
Acetaldehyde	Pass
Toluene	Pass
Xylenes	Pass
Ozone (outdoor source)	Pass
$PM_{2.5}$ (outdoor source)	Pass
PM_{10} (outdoor source)	Pass

Results – ArcBest HQ

- Operation pre-HLR did not meet IAQ requirements

  ➔Baseline could not be established
- HLR operation met IAQ requirements and avoided costly upgrade to chilled water plant and AHUs
- Indoor temperature and RH improved – fewer hot/cold calls
- Energy and water savings
- Extended life of OA filter in AHUs

Conclusions

- The HLR technology removes gaseous contaminants from indoor air and allows for a reduction in OA
- Energy savings are highly dependent on the OA reduction, hours of operation, and climate
- Best with long cooling (hot humid), long heating, or mix of cooling and heating climates
- Works well for areas with poor OA quality
- Retrofits: Need to know OA flow rates and air balance
- New Construction: May allow for smaller HVAC system

Thank you

Questions
New challenges
New project results
Topics for next call

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