RESOURCE INNOVATION INSTITUTE

DEMYSTIFYING DEHUMIDIFICATION

FOR INDOOR HORTICULTURE ENVIRONMENTS

Harvesting Savings

Best practices on energy efficiency for indoor agriculture

IN COOPERATION WITH

ASHRAE

AHRI AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

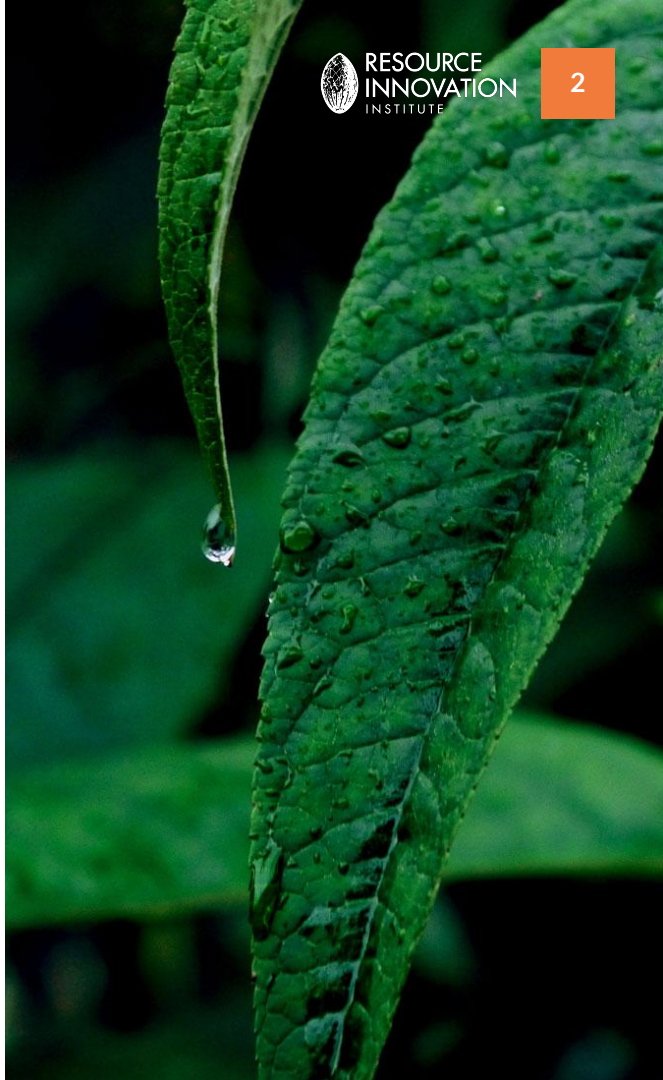
MODERATED BY

Efficiency Vermont

April 7, 2021

Agenda

Welcome	1:00 pm ET
About Resource Innovation Institute	
Purpose of Today's Workshop	
Technology Overview	1:15 pm ET
Equipment Evaluation	1:35 pm ET
Standards	
Certification	
Utility Efficiency Program Approaches	1:55 pm ET
Lessons Learned	
Data Visualization	



Breakout Rooms

Q&A	2:25 pm ET
Breakout Rooms	2:30 pm ET

Data

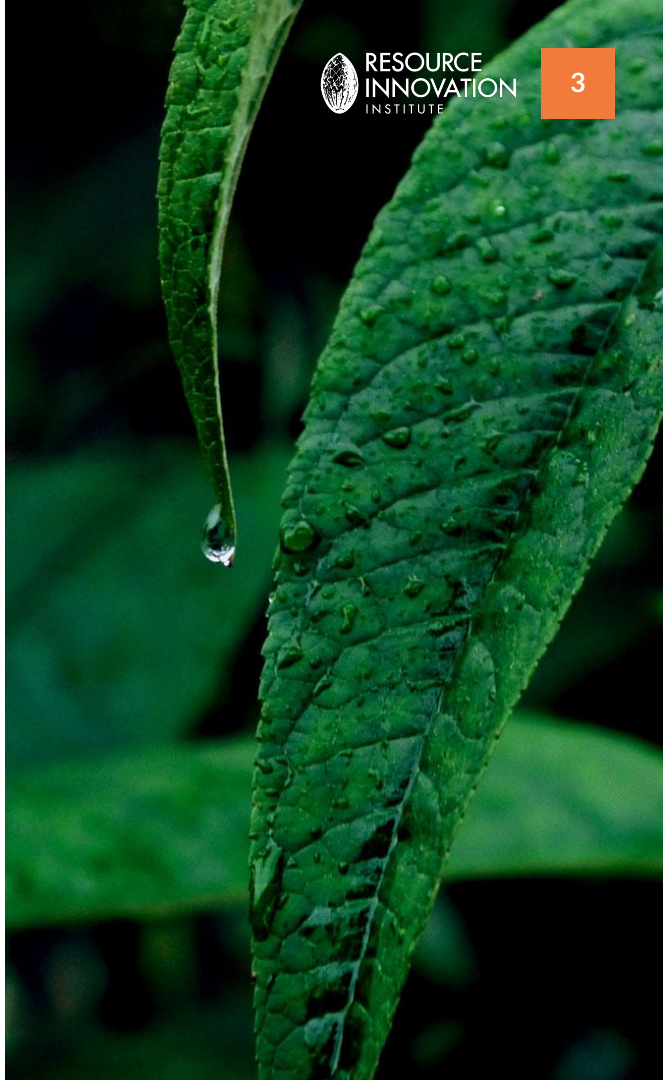
Developing a collaborative open source data access plan to enable consistent and defensible custom incentive calculations

Landscape

Identifying complementary policy and customer engagement approaches

Technology

Understanding dehumidification technology at a deeper level



SECTION 01

WELCOME

Your Host

Gretchen Schimelpfenig

TECHNICAL & OPERATIONS DIRECTOR

Gretchen Schimelpfenig leads RII's Technical Advisory Council activities, articulates RII's science-based positions, writes technical guidance on resource efficient cultivation, and supports PowerScore users with benchmarking analysis and reporting compliance.

gretchen@resourceinnovation.org

ABOUT US

What We Do

We bring stakeholders together to bring order to the nascent cannabis cultivation and CEA markets:

Measure

Resource Efficiency

- Key Performance Indicators
- Benchmarks
- Baselines

Inform

Govt, Utility, Industry

- Best practices
- Policies
- Programs
- Standards

Verify

Cultivation Processes

- Technologies
- Techniques

ABOUT US

About RII

- Objective, data-driven non-profit
- Founded 2016 in Portland, Oregon
- Expertise in climate policy, utility programs, green building certification, sustainable business, construction & indoor cultivation
- Expanding to non-cannabis crops and post-cultivation activities

ABOUT US

Our Network

USDA
DOER Massachusetts Department of Energy Resources

LANSING BWL
nationalgrid
EVERSOURCE

Efficiency Vermont
DNV

fifth season CONNECTION
SOLAR Sustainable cannabis.
LivWell ENLIGHTENED HEALTH

Grodan
FLUENCE BY OSRAM

ASHRAE
ASABE American Society of Agricultural and Biological Engineers

ABOUT US

2021 RII Members

USDA
E4 THE FUTURE — ENERGY • ECONOMY • EQUITY • ENVIRONMENT
ACEEE — American Council for an Energy-Efficient Economy
DOER — Massachusetts Department of Energy Resources
FLUENCE BY OSRAM
Grodan
DESERT AIRE — Est. 1978
D+R International
signify
TSRgrow™
anden
DLC
nationalgrid
EVERSOURCE
DNV
TRC
LATICRETE
Energy Solutions
CERES — GREENHOUSE SOLUTIONS
Nexant
oreon
QUEST
ARGUS — CONTROLS
rhythm
Efficiency Vermont
Seattle City Light
ri resource innovations
LANSING BWL — Hometown People. Hometown Power.
MEEA — MIDWEST ENERGY EFFICIENCY ALLIANCE
ers — energy & resource solutions
CALYX KING CONSULTING
LOWD
bios — SCIENTIFICALLY ENGINEERED
Agnetix
TONKON TORP LLP — Advocates & Advisors
IMEG
GS THERMAL SOLUTIONS
Strategic Energy Solutions
NAVITAS — SYSTEM INTEGRATION
microclimates™ — Integrate | Automate | Accelerate
GDS Associates, Inc. — ENGINEERS & CONSULTANTS
ANDERSON PORTER DESIGN
actual energy
HydroLogic — PURIFICATION SYSTEMS
Evergreen Consulting Group
SNOHOMISH COUNTY PUD — PUBLIC UTILITY DISTRICT NO. 1
Silver Bullet — TREATING WATER. BETTER.
root — ENGINEERS
TASMANIAN ENGINEERING — BOSTON, MA
ENERGY350
HANSEN-RICE
FRANKLIN ENERGY
CREATING A CLIMATE FOR GROWTH — PRIVA
OPERATIONS MANAGEMENT CONSULTING
InfiSense
grownetics
VLED
GroiQ
INSPIRE
DRAMM
SECURE ENERGY
TACOMA POWER — TACOMA PUBLIC UTILITIES
The GMP Collective
Greenbox — Architecture
SkyFoundry
pha
ERI — ENERGY RESOURCES INTEGRATION, LLC
PHG
EnSave
KOMET
NG-DG
DESIGN — Mechanical Contractors, Mechanical, Inc.
Triple M

ABOUT US

Technical Advisory Council

Multi-disciplinary body who aggregates knowledge to support producers and other stakeholders with objective and peer-reviewed data and curriculum on benchmarking resource efficiency

- **Guides** development of standards
- **Shapes** tools and resources to support best practices
- **Advocates** for informed policies, incentives and regulations

HVAC - Lighting - Utility - Water - Policy - Data - Controls

2021 *Emissions - Facility Design & Construction - Waste*

ABOUT US

PowerScore Benchmarking

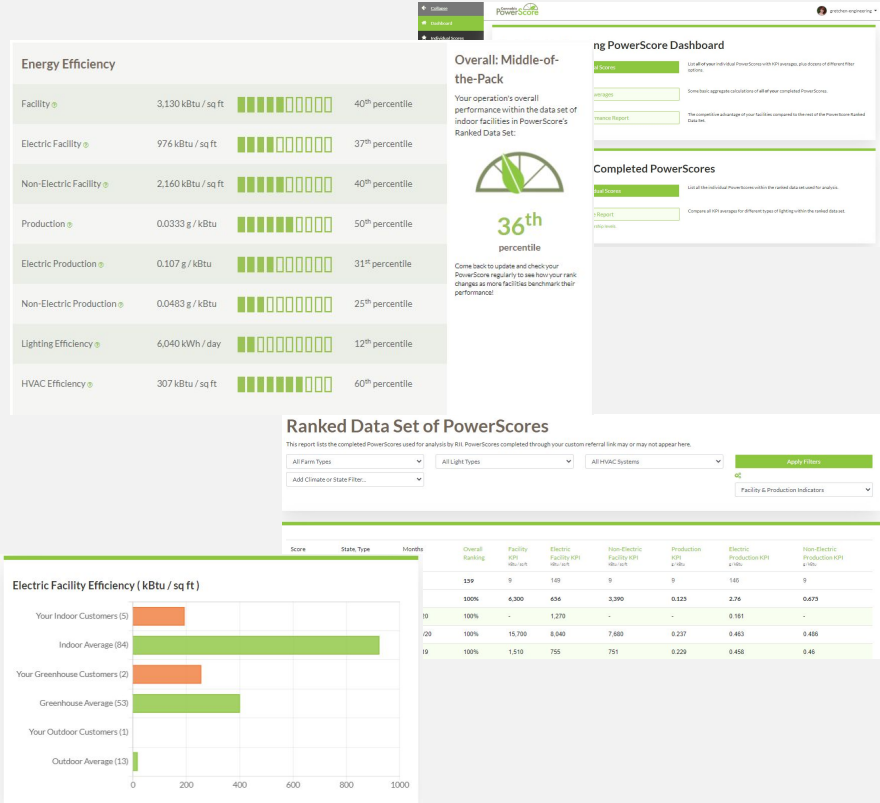
Specialized Key Performance Indicators

- Performance Benchmark Reports
  - HVAC & Lighting KPIs
- License PowerScore Pro
  - Portfolio management
  - Dashboard reports
  - Filters
  - Access Ranked Data Set

Measurement & Verification

- Pre- and post- efficiency and productivity
- Inform energy models
- Assess portfolios year over year
- Inform design discussions with forecasted KPIs

Cannabis PowerScore



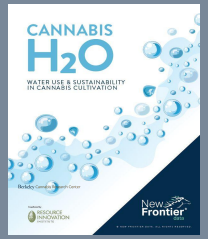
ABOUT US

Publications

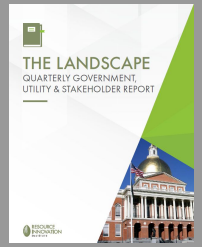
Best Practices Guides

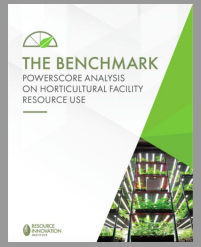
Primers*

Collaborative Reports on Resource Usage



Quarterly Reports*





*membership required to access

Training Curriculum

Producers	Efficient Yields Best practices on energy, water efficiency, and productivity	EnergyTrust of Oregon DOER Massachusetts Department of Energy Resources LANSING BWL SDGE
Utilities & Programs	Harvesting Savings Best practices on energy efficiency for indoor agriculture	MAEEP Massachusetts Energy Efficiency Partnership nationalgrid EVERSOURCE LANSING BWL
Design & Construction	Growing Efficiency Best practices on design and construction for horticulture	*Continuing Education Platform launching April 2021*

Subject Matter Addressed in Trainings

- Facility design & optimization
- Retrofits
- Commissioning
- LED lighting
- HVACD & energy recovery
- Automation & controls
- Demand management
- Water management
- Regulations using our policy roadmap
- PowerScore

ABOUT US

Services for Producers

- **Facility performance** benchmarking aligned with industry-standard KPIs on energy, water & waste
- **Portfolio-level** “digital” facility audits to enable comparative rankings of cultivation assets on efficiency and productivity for MSOs and investors
- **ESG reporting** support
- **Thought leadership** opportunities to be featured in case studies and conference presentations
- **Guidance on** how to maximize incentives and support from utilities and governments

Triple M | Plymouth, MA | Indoor

Efficiency | Demand reduction | Water reuse

Energy Efficiency		
Facility	2,510 kBtu / sq ft	
HVAC Efficiency	307 kBtu / sq ft	
Water Efficiency		
Water Facility	114 gal / sq ft	
Water Productivity	2.97 g / gal	
Waste Efficiency		
Waste Facility	1.45 lbs / sq ft	
Waste Production	235 g / lbs	

Purpose of Today's Workshop

- Increase market understanding of the available dehumidification technology
- Support efficiency program savings claims
- Drive standards development for dehumidification equipment specific to CEA
- Support certification bodies to enable creation of qualified product lists

Your Moderator

Lauren Morlino

EMERGING TECHNOLOGIES AND SERVICES MANAGER

Lauren researches and prototypes exciting, innovative, and efficient technologies and services for Vermont ratepayers. At Efficiency Vermont, Lauren designs initiatives for lighting, controls, refrigeration, consumer electronics, and controlled environment agriculture (CEA). She is an external advisor for VEIC on customer-centric program design and controlled environment agriculture.

lmorlino@veic.org

Efficiency Vermont

- Statewide energy efficiency utility
- Reduce the cost of energy for all Vermonters
- Helping families, businesses, and institutions understand and make better use of energy

Efficiency Vermont

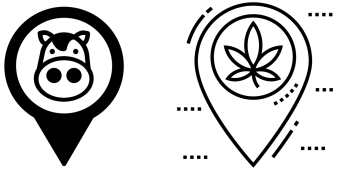
Direct support through incentives, training, and technical advice

Market transformation through supply chain engagement

Partnership with energy service providers

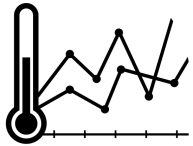
Why Programs Care: Efficiency Vermont

Cannabis legalization

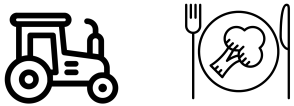


Transition of VT farms

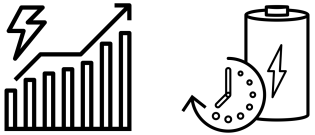
Food security



Climate resilience



Farm to Table movement



Utility needs/interests

Introducing Our Panelists

Chip Seidel

anden

Keith Coursin

Est. 1978 DESERT AIRE

Jesse Porter

INSPIRE

Craig Burg

ASHRAE

Bill Tristis

AHRI
AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

Fran Boucher

nationalgrid

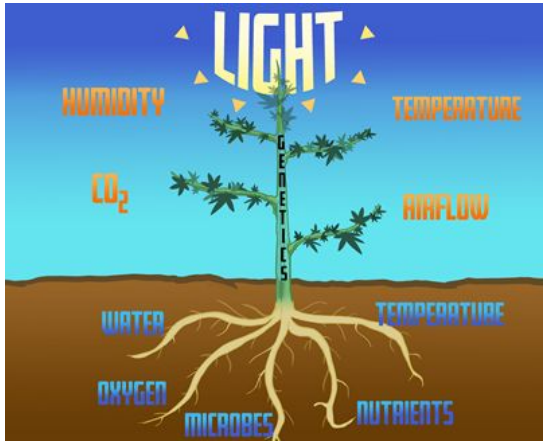
Nick Collins

DNV

SECTION 02

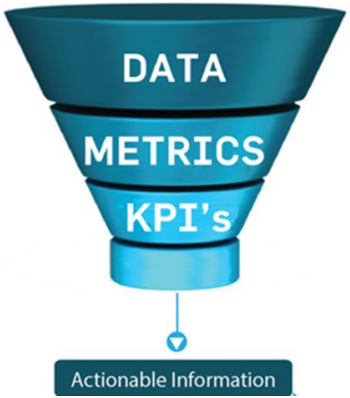
TECHNOLOGY OVERVIEW

High Performance Dehumidification From the Plant's Perspective



Key Performance Indicators

- Grams/sq ft, PPP, COA, VPD Control
- Grams/kBtu, Active compounds/kWh
- Cost of Production
- Moisture Removal Efficiency = gallons/hr/watt at setpoint



Why is dehumidification such a challenge for cannabis?

There is no best way to cultivate cannabis...yet.

Different Grow Techniques

Ventilated Greenhouse

- Uses ventilation air to control temperature
- Dehumidifiers use AHAM ratings for dark modes when greenhouse gets closed

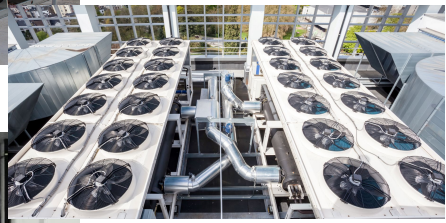
Sealed Greenhouse

- HVACD requirements also must include significant solar gain

Indoor Grow

- Needs HVACD solution
- Economizers not used because temperature and humidity must both be simultaneously used and CO_2 enrichment requirements

HVACD Choices



Air Conditioner with Standalone Dehumidifier

- Dehumidifiers use AHAM ratings

Ventilation with Heat Exchanger

- Limited climatic zone
- High efficiency heat exchanger eliminates outside air from getting into the zone

Integrated HVACD

- One system to handle cooling and dehumidification

Heat Recovery Chiller with 4-Pipe Air Handlers

- Could be gas chiller

Air Conditioner with Standalone Dehumidifier

Efficiency

- Standard Rooftop Air Conditioner
  - AHRI EER ratings
  - Could use several other type
    - Mini-Splits
    - VRF
    - Rooftop with hot gas reheat
- Dehumidifiers use AHAM ratings
  - Could be portables or fixed dehumidifiers with no cooling

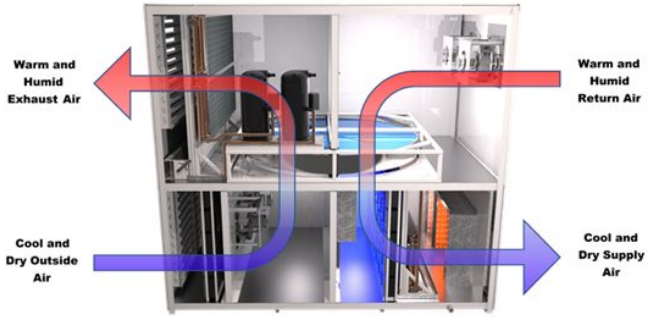
Comment

- Not all standalone dehumidifiers are equal- units specifically designed for grow applications deliver substantially better performance and efficiency
- A/C units must remove heat rejected by dehumidifier

Ventilation with Heat Exchanger

Efficiency

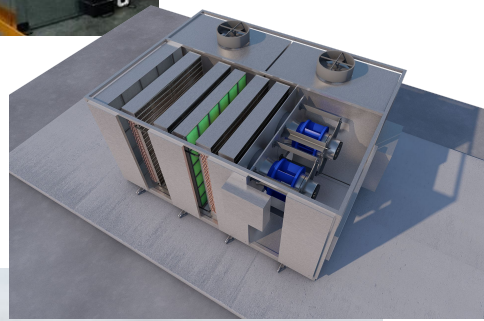
- No certification program for efficiency exists
- Provides both cooling and dehumidification for all climate zones
  - More efficient in dry climate zones
- Heat exchanger improves efficiency over baseline
  - Exchanger minimum efficiency should be >50%



Comment

- Some systems heat exchangers do not have a bypass so post cooling coils are required and are not as efficient

Integrated HVACD



Efficiency

- No certification program for efficiency exists
- Provides both cooling and dehumidification for all climate zones
- Uses variable hot gas reheat for site recovered energy to maintain balance between cooling load and dehumidification load

Comment

- Provides tight control of zones temperature and humidity levels
- D/X based designs
- Many configurations available

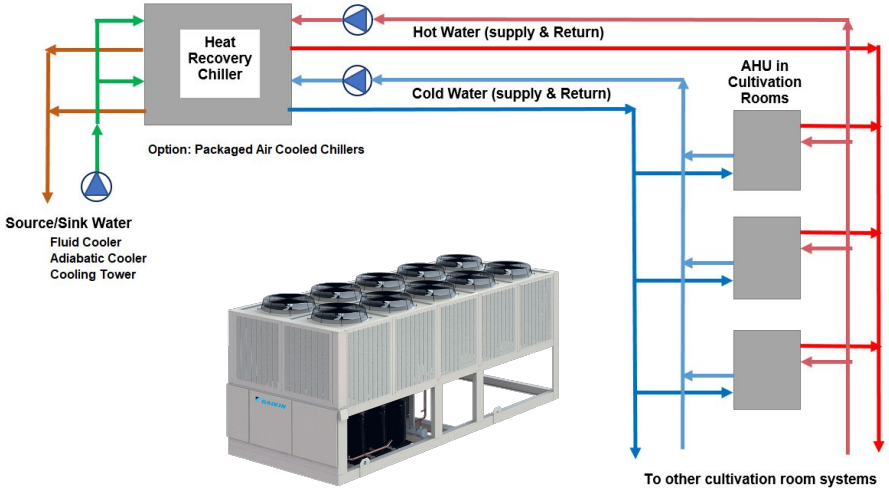
Heat Recovery Chiller with 4-Pipe Air Handlers

Efficiency

- AHRI chiller ratings - Integrated part load
- Many staging options
- Waterside economizer for winter operations available for northern climates
- Recovered heat options eliminate the need for new energy for reheat

Comment

- Air or water-cooled options



SECTION 03

ASHRAE CEA.MTG and INDUSTRY ACTIVITY

ASHRAE - Current Work and Objectives

MTG.CEA - Controlled Environment Agriculture

- Multi-disiplinary task group overseeing activities at ASHRAE related to the application.
- Ensures most important objectives are covered and limits overlap of efforts

Technical Committee 2.2 - Plant and Animal Environments

- Committed to developing more information for cognizant handbook chapter in HVAC Applications specific to today's CEA for cannabis.
- Sponsoring a Technical Program Track for HVAC&R for Indoor Plants & Animals at the 2021 Virtual Annual Conference June 28-30

Technical Committee 9.8 - Large Building Air Conditioning Applications

- Developing document that is intended to be a comprehensive handbook chapter or guideline on CEA application

ASHRAE - Current Work and Objectives

Research Project 1887 - Energy Usage in Indoor Plant Environments

- Past RTAR (Research Topic Acceptance Request) stage
- Work statement submitted
- Intends to review energy use of HVAC and lighting. Intent is to have several highly monitored environments to compare and contrast several technologies and interaction

Research Project 1901- Determination of Latent Loads for Controlled Environment Agriculture Crops

- RTAR accepted with comments
- Transpiration and evaporation focus
- Very detailed measurements over a variety of VPD and temperatures

ASHRAE - Current Work and Objectives

Research Projects in General

- Research funding issues currently
- Most projects will take 2-3 years from RTAR approval
- Finding qualified researchers and facilities can be difficult
- You can do your part by monitoring Research Activities Committee work as projects come out for bid and recommending researchers

Handbook and Guideline General

- Handbook chapters and revisions can generally be put in place quickly once done
- Work is done solely by technical committee volunteers, so development time frame can be lengthy

Industry Gaps in Efficiency Standards Development

What should be the scope?

- A whole facility?
- A room?
- A piece (or pieces) of equipment?

Should photo and dark period be considered? (Yes!)

- What should be the weighting be?

What are the rating conditions?

- Cannabis can thrive at generally high VPD and temperatures, but this is not the same for all crops or cultivars

Inclusion of Economizers

- Should there be some credit for the approach?
- Cross-contamination issues and measurements

Industry Gaps in Efficiency Standards Development

Over-Dehumidification issues

- Should there be a penalty for over-dehumidification?
- Equipment with ability to adjust the capacity and Sensible Heat Ratio (SHR) is available
- Different lighting technologies affect the room SHR

Other issues

- Accommodating different technologies in the same standard
  - Different conditions with different airstreams
  - Chilled water systems
  - Gas as an input source
- Laboratories capability for testing
- Determining a single metric for the multi-factor application (Cooling, dehumidification, air movement)

How Standard Development (Typically) Works

Manufacturers Speak to AHRI about Development of a Standard

- Work takes place in Task groups at AHRI to develop a standard

ASHRAE Special Project Committee Develops a Method of Test (MOT)

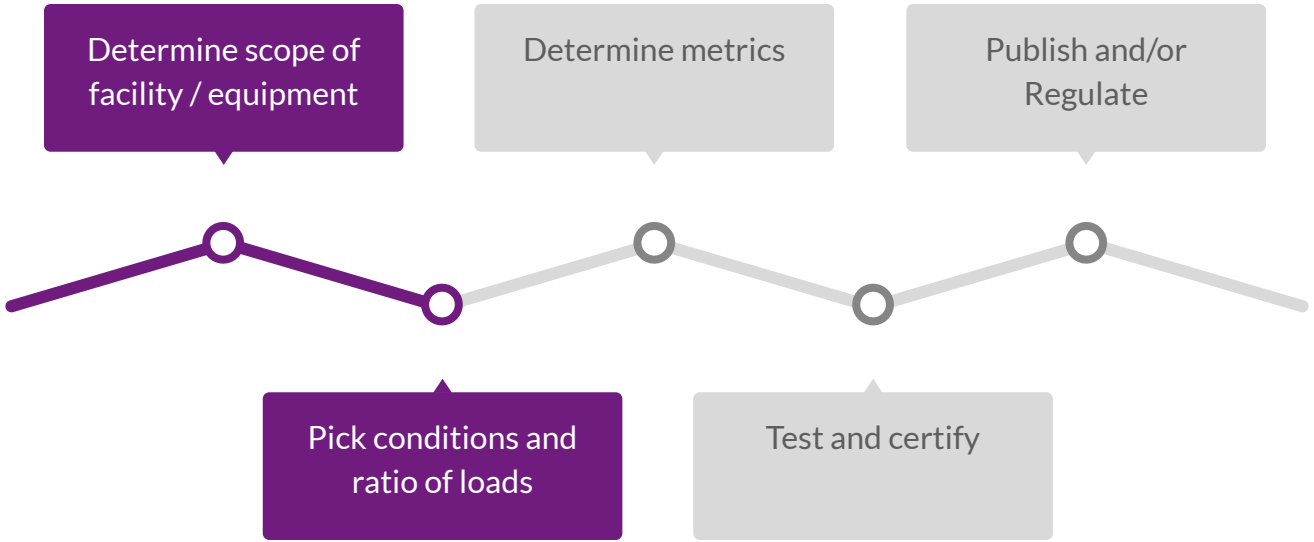
- An appendix in the AHRI standard may be developed concurrently with the standard that describes a MOT
- ASHRAE SPC ensures that all technical aspect of the MOT are correct and publishes and a ASHRAE/ANSI standard

AHRI Creates a Certification Program

- Equipment manufacturers join to help to develop and join in certification program

ASHRAE 90.1 Committee Determines if a Minimum Efficiency is Recommended in the ASHRAE 90.1 standard

Roadmap to Efficiency Standards



SECTION 04

CERTIFICATION PROGRAMS

Standards

- AHRI has published more than 100 standards and guidelines
  - Many in both I-P and SI
  - Majority are designated American National Standards by ANSI
- Regularly work with organizations and governments around the world to help them either adopt or harmonize standards
- Standards form the basis for AHRI's Certification Programs
- Standards are available free online at www.ahrinet.org

Certification

- 1000+ licensees, including more than 280 international
- Accredited to ISO Standard 17065 by SCC and COFRAC
- 3,000+ annual performance tests
- 100% of testing by independent third-party labs (ISO 17025-accredited)
- ENERGY STAR approved Certification Body
- Path of compliance for efficiency regulatory (MEPS) requirements

AHRI CERTIFIED®
www.ahridirectory.org
Globally Recognized. Industry Respected.

Equipment Certified By AHRI

- Air-Heating and Air-Cooling Coils
- Baseboard Heaters
- Central Station Air-Handling Units
- Chillers
- Commercial Refrigerators
- Direct Heaters
- Finned Tube Radiators
- Gas Purge Equipment for Use with Chillers
- Geo-Exchange Heat Pumps
- Energy Recovery Ventilators
- Ice-Makers/Ice Bins
- Indirect Fired Water Heaters
- Liquid-to-Liquid Heat Exchangers
- Pool Heat Pumps
- PTAC/PTHP
- Reclaimed Refrigerant
- Refrigerant Recovery/Recycling Equipment
- Residential & Commercial Water Heaters
- Residential & Commercial Boilers
- VRF Equipment
- Room Fan-Coils
- Refrigerant Testing Laboratory Certification
- Single Package Vertical ACs and Heat Pumps
- Truck/Trailer Refrigeration Units
- Unit Ventilators
- Unit Coolers
- Residential ACs and Heat Pumps
- Large Commercial ACs and Heat Pumps
- Variable Air Volume Terminals
- Variable Frequency Drives
- Water Source Heat Pumps

AHRI Performance Certification Programs

- Programs that verify performance of products
  - Capacity
  - Power Consumption
  - Energy Efficiency
  - Pressure Drop
- More than 60 years history
- Covers residential, commercial, and industrial products
- Globally recognized AHRI Certification Directory & Regulatory Reporting System

AHRI Program Strengths

- AHRI, not manufacturers
  - Selects which models to certify
  - Chooses laboratory for testing
  - Selects sample for testing
- Continuous testing; not one-offs
- Selection criteria: 20% + annually
- Penalties for inaccurate ratings

Third-Party Verification

1

Manufacturer performance ratings verified through testing at a third-party laboratory

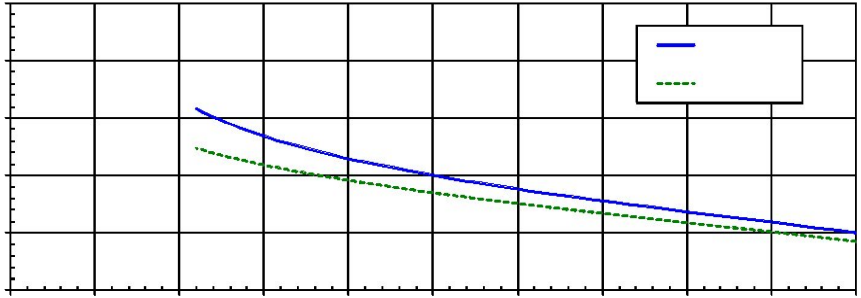
2

Holds manufacturers accountable

3

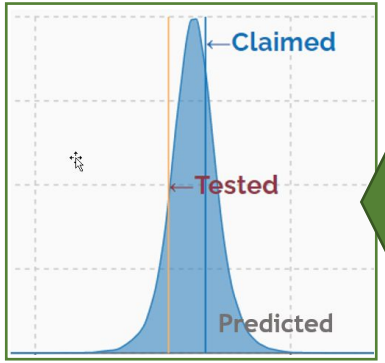
Provides consumers with confidence in performance of the product

Uncertainty: Published vs. Tested Performance



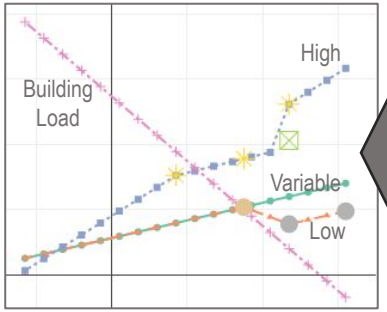
- AHRI verifies published performance based on testing
- Tested performance must match published performance within a tolerance as defined by each specific standard (e.g. +/- 5%) or test fails
- AHRI requires Manufacturer's to re-rate their published performance based on the failed test result

AHRI Analytics Suite



AHRI Analytics App

Executive Dashboard



AHRI/DOE Calculation App

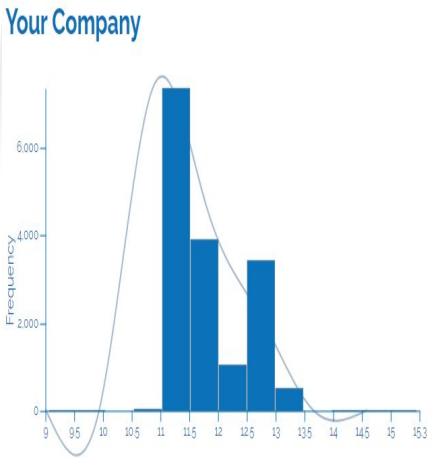
Selection Tool

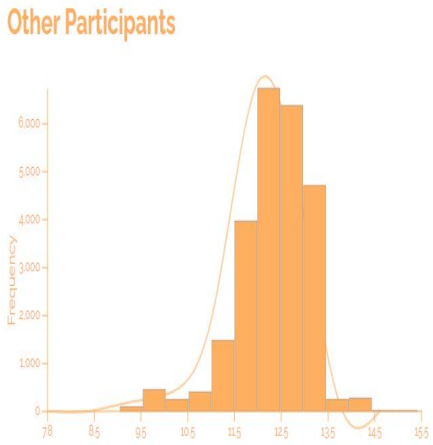
AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

we make life better®

AHRI Analytics App

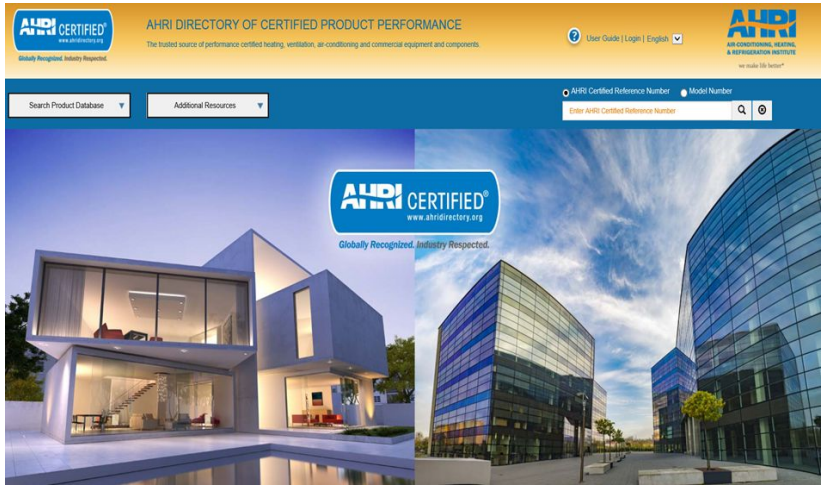
- Market surveillance by predictive analysis
- Industry Performance Comparison
- Engineering, Compliance, and Market intelligence





AHRI Certification Directory & Regulatory Reporting System

- Provides certified performance ratings for 7+ million residential, commercial, and industrial products
- Real-time data
- Meets FTC labeling requirements
- Identifies tax credit/rebate/Energy Star eligibility
- On-demand printout of certificates
- Source of data for all federal, state, and some international regulatory bodies



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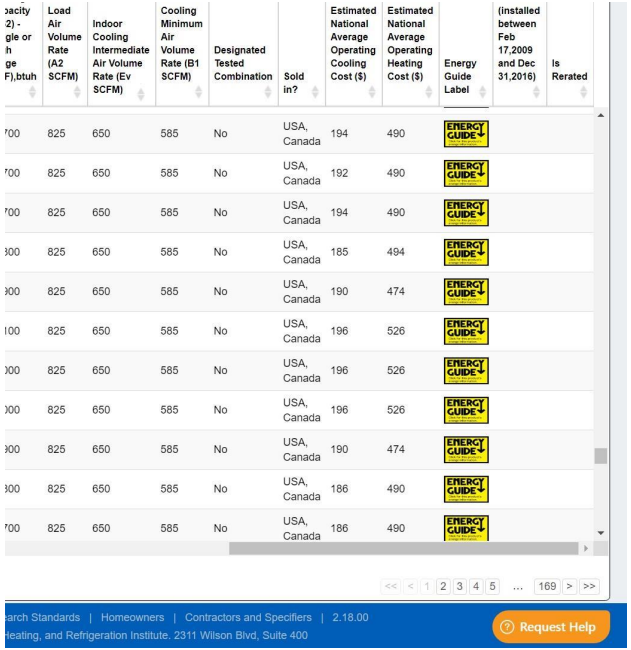
AHRI Regulatory Reporting System

- Accepted by
  - US Department of Energy
  - US EPA Energy Star Program
  - Energy Guide Labeling Program
  - California Energy Commission
  - Consortium for Energy Efficiency
  - Standards Council of Canada
  - India Bureau of Energy Efficiency
  - Saudi Arabian Standards Organization (SASO)
  - Australia/New Zealand Equipment Energy Efficiency (E3) Program



pacity 2) - gle or h ge F),btuh	Load Air Volume Rate (A2 SCFM)	Indoor Cooling Intermediate Air Volume Rate (Ev SCFM)	Cooling Minimum Air Volume Rate (B1 SCFM)	Designated Tested Combination	Sold in?	Estimated National Average Operating Cooling Cost ($)	Estimated National Average Operating Heating Cost ($)	Energy Guide Label	(installed between Feb 17,2009 and Dec 31,2016)	Is Rerated
700	825	650	585	No	USA, Canada	194	490			
700	825	650	585	No	USA, Canada	192	490			
700	825	650	585	No	USA, Canada	194	490			
300	825	650	585	No	USA, Canada	185	494			
000	825	650	585	No	USA, Canada	190	474			
100	825	650	585	No	USA, Canada	196	526			
000	825	650	585	No	USA, Canada	196	526			
000	825	650	585	No	USA, Canada	196	526			
300	825	650	585	No	USA, Canada	190	474			
300	825	650	585	No	USA, Canada	186	490			
700	825	650	585	No	USA, Canada	186	490			

Certificates of Performance

- Directory and Certificate of Product Ratings ensure accurate ratings to consumers and regulators
- AHRI Certificate of Product Ratings
  - Instantly generated and date stamped
  - Printout of all certified ratings
  - Identifies tax credit and/or rebate eligibility
  - Identifies product re-rates due to certification test failures
  - Identifies manufacturer and all associated brand names
  - Unique reference and certificate number

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This combination qualifies for a Federal Energy Efficiency Tax Credit when placed in service between 1/1/2015 and 12/31/2020.

Certificate of Product Ratings

AHRI Certified Reference Number : 7995405 Date : 01-25-2021 Model Status : Active

AHRI Type : HRCU-A-LB (Split System: Heat Pump with Remote Outdoor Unit-Air-Source)

Series : DZ14SA

Outdoor Unit Brand Name : DAIKIN

Outdoor Unit Model Number (Condenser or Single Package) : DZ14SA0361K*

Indoor Unit Model Number (Evaporator and/or Air Handler) : CHPF4860D6D*+MBVC2000**,1A*+TXV

The manufacturer of this DAIKIN product is responsible for the rating of this system combination.

Rated as follows in accordance with the latest edition of AHRI 210/240 with Addendum 1, Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Cooling Capacity (A2) - Single or High Stage (95F) , btuh : 36000

SEER : 15.00

EER (A2) - Single or High Stage (95F) : 12.50

Heating Capacity (H12) - Single or High Stage (47F) : 32600

HSPF (Region IV) : 8.50

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†"Active" Model Status are those that an AHRI Certification Program Participant is currently producing AND selling or offering for sale; OR new models that are being marketed but are not yet being produced. "Production Stopped" Model Status are those that an AHRI Certification Program Participant is no longer producing BUT is still selling or offering for sale.
Ratings that are Accompanied by RR(I) indicate an involuntary re-rate. The new published rating is shown along with the previous (i.e. RR(I) rating.

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CERTIFICATE VERIFICATION
The information for the model cited on this certificate can be verified at www.ahridirectory.org, click on "Verify Certificate" link and enter the AHRI Certified Reference Number and the date on which the certificate was issued, which is listed above, and the Certificate No., which is listed at bottom right.

AHRI AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

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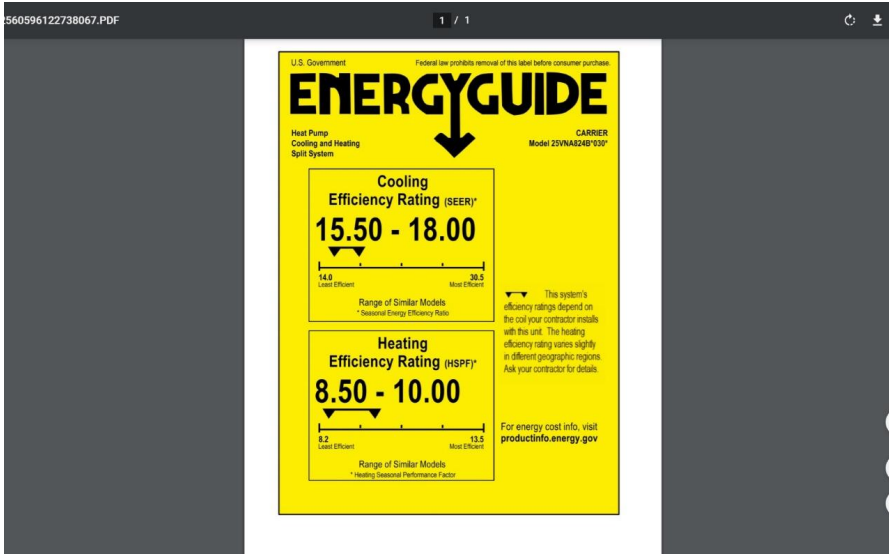
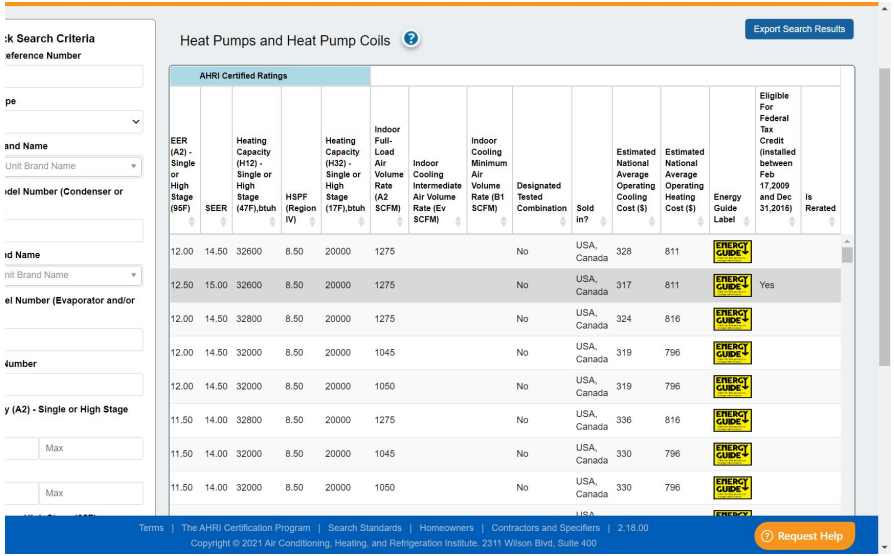
©2021 Air-Conditioning, Heating, and Refrigeration Institute

CERTIFICATE NO.: 1325806037170029004

ENERGYGUIDE Compliant Labels on Demand





EER (A2) - Single or High Stage (95F)	SEER	Heating Capacity (H12) - Single or High Stage (47F),btuh	HSPF (Region IV)	Heating Capacity (H32) - Single or High Stage (17F),btuh	Indoor Full-Load Air Volume Rate (A2 SCFM)	Indoor Cooling Intermediate Air Volume Rate (Ev SCFM)	Indoor Cooling Minimum Air Volume Rate (B1 SCFM)	Designated Tested Combination	Sold In?	Estimated National Average Operating Cooling Cost ($)	Estimated National Average Operating Heating Cost ($)	Energy Guide Label	Eligible For Federal Tax Credit (installed between Feb 17,2009 and Dec 31,2016)	Is Rerated
12.00	14.50	32600	8.50	20000	1275			No	USA, Canada	328	811			
12.50	15.00	32600	8.50	20000	1275			No	USA, Canada	317	811		Yes	
12.00	14.50	32800	8.50	20000	1275			No	USA, Canada	324	816			
12.00	14.50	32000	8.50	20000	1045			No	USA, Canada	319	796			
12.00	14.50	32000	8.50	20000	1050			No	USA, Canada	319	796			
11.50	14.00	32800	8.50	20000	1275			No	USA, Canada	336	816			
11.50	14.00	32000	8.50	20000	1045			No	USA, Canada	330	796			
11.50	14.00	32000	8.50	20000	1050			No	USA, Canada	330	796			

SECTION 05

EFFICIENCY PROGRAM APPROACHES

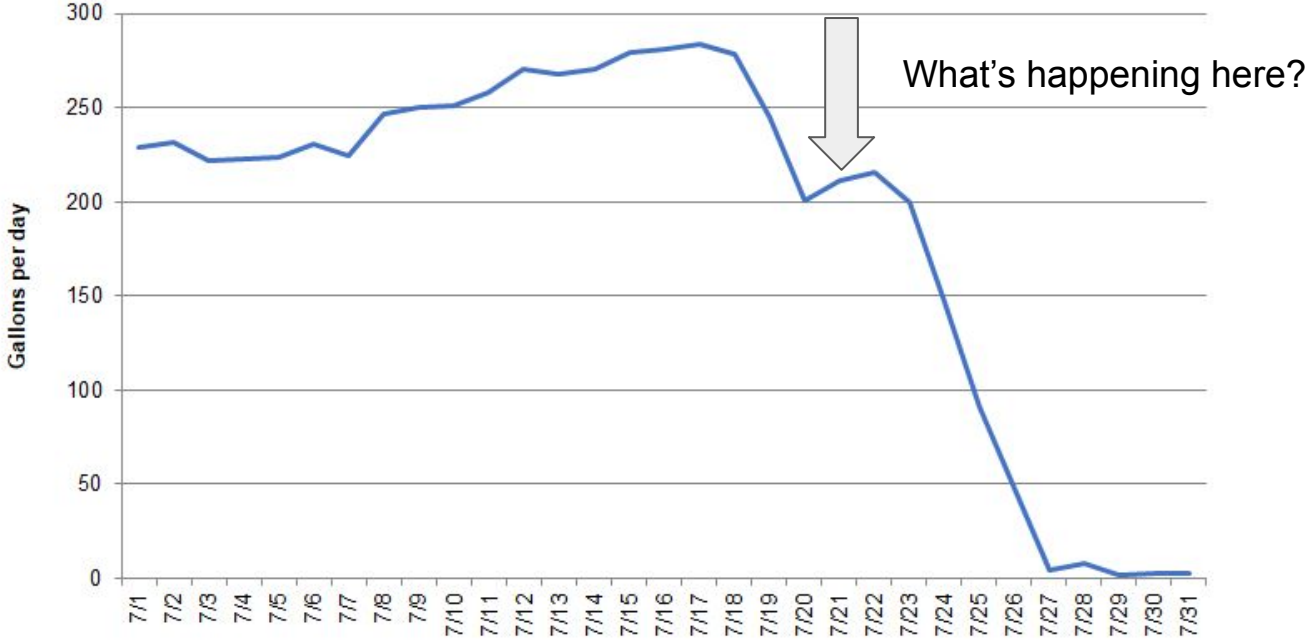
Dynamic Spaces

- Sealed cultivation spaces, particularly cannabis flower/bloom areas, generate substantial and dynamic loads
  - Loads shift dramatically every 12 hours, aligning with the light and dark photoperiods
  - Loads change throughout the course of a flowering cycle as plants mature and watering rates and temperature and humidity targets change based on cultivation methods

To design and operate efficient HVACD systems, we need understand what is happening in these spaces through the harvest cycle

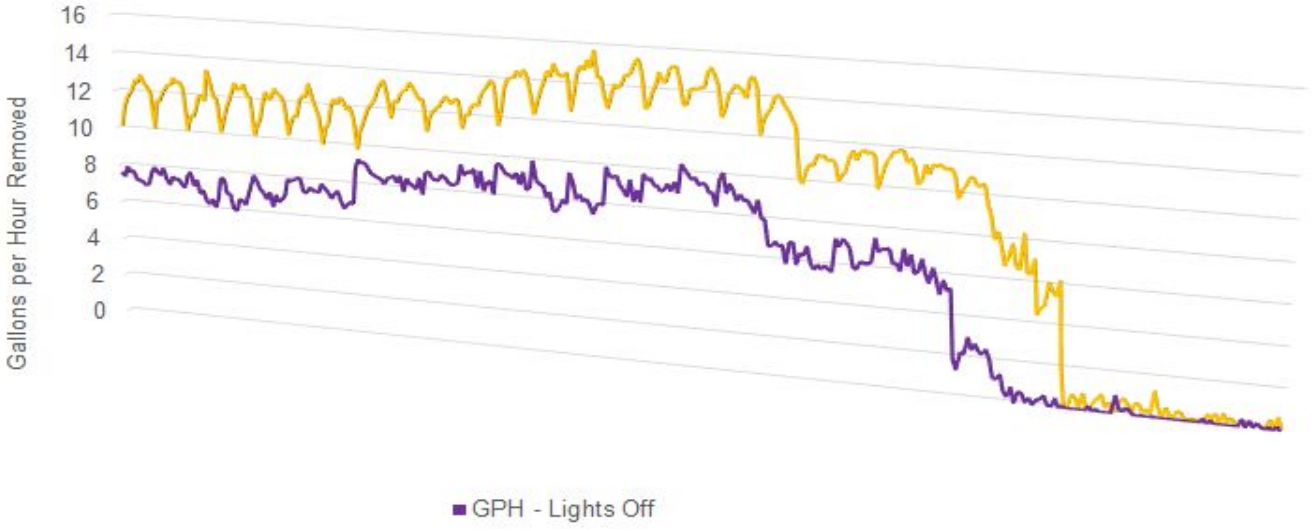
How much moisture are we trying to remove?

- Single Flower Room
- Approx 1,900 s.f.
- 40%-50% increase in latent load through the flower cycle



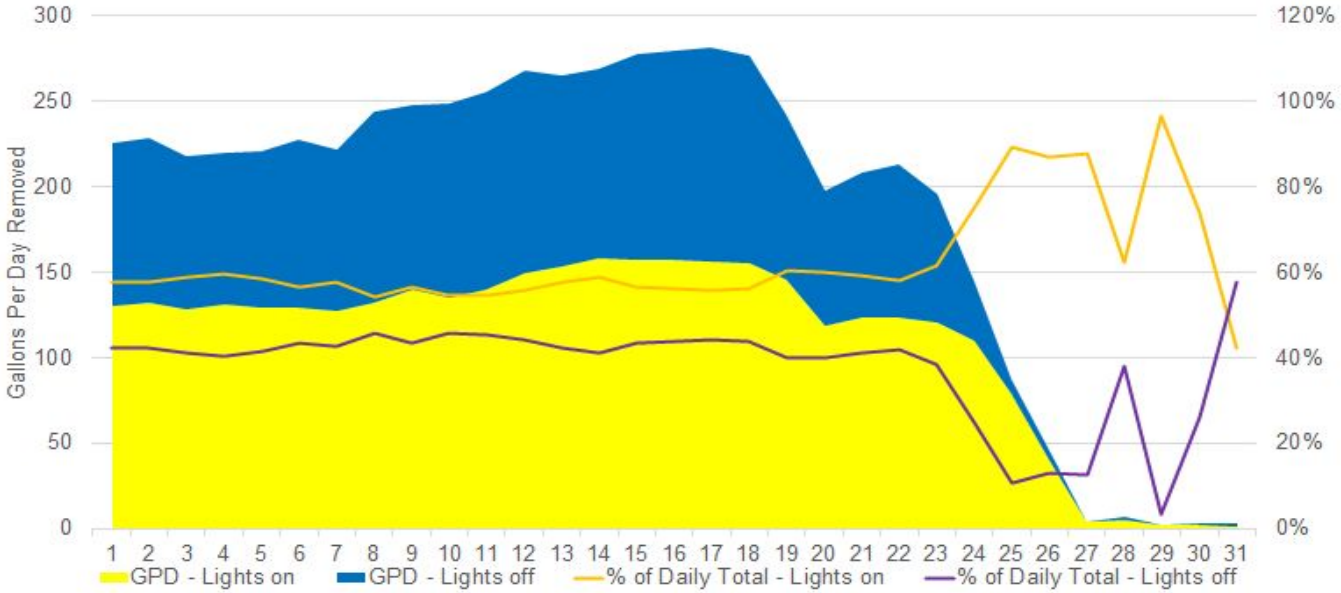
How Do Latent Loads Vary by Photoperiod?

- Lights on and lights off moisture removal
- How does this impact the loads of the space?



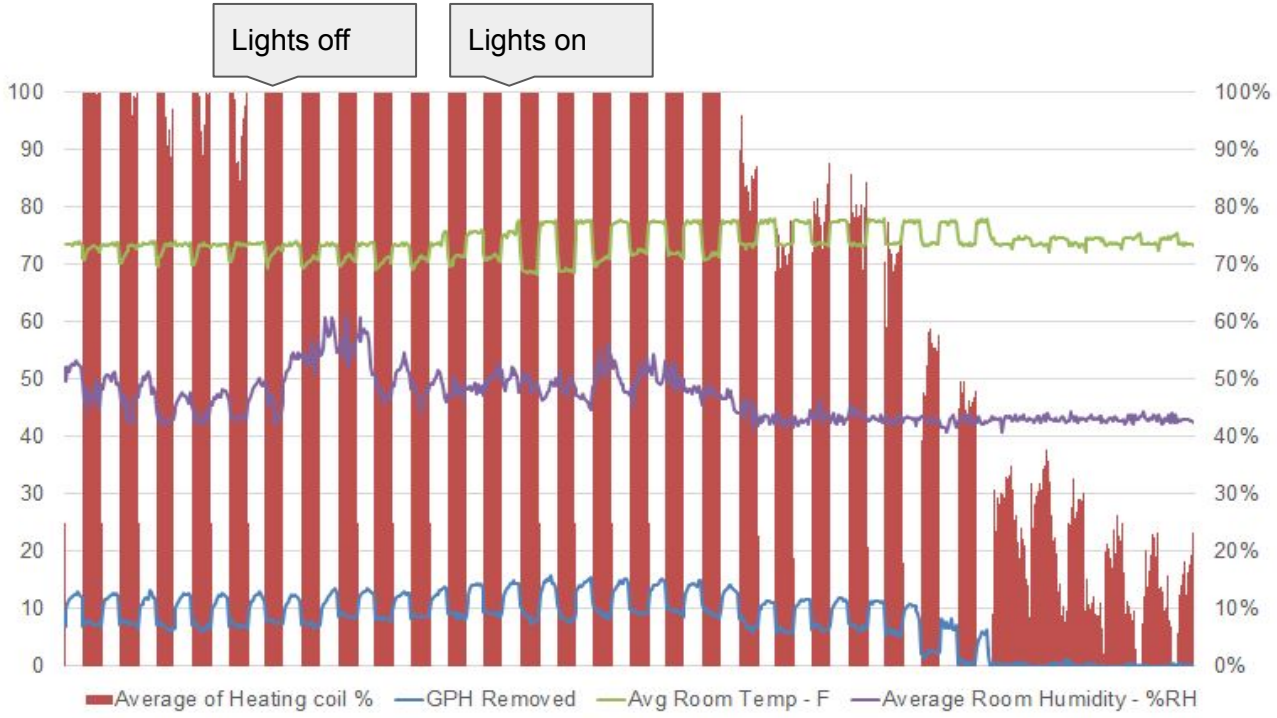
Total Moisture Removal by Photoperiod

- For *this* facility, approximately 60% of the total moisture removed in 24 hours occurs during the lights on photoperiod



What about HVAC energy use when lights are off?

- For *this* facility, electric resistance heaters run during the lights off periods.
- Why?



Common modeling complications

- Grow light dimming not accounted for in model

Solution: The PAs now ask about the grower's dimming plan early on and add a requirement to the incentive offer that will change the claimed savings if the dimming schedule is different than what was agreed to.

- Cycling vs. continuous dehumidification control can have a significant impact on modeled energy use.

Solution: The PAs now default to a cycling modeling approach which reduces the modeled cooling load associated with the lights-off period.

Common modeling complications

- High grower reported watering rates vs. lower actual dehumidification loads

Solution: The PAs have adopted a standard conservative value for plant transpiration load

- Growers initially indicate extremely cool and dry space environmental setpoints

Solution: Many growers will adjust environmental conditions throughout the growth cycle of the plants, the extreme design conditions may only exist for a few days towards the end of the flower cycle, we now specifically ask for average conditions rather than design conditions.

Continuous vs. Cycling Dehumidification

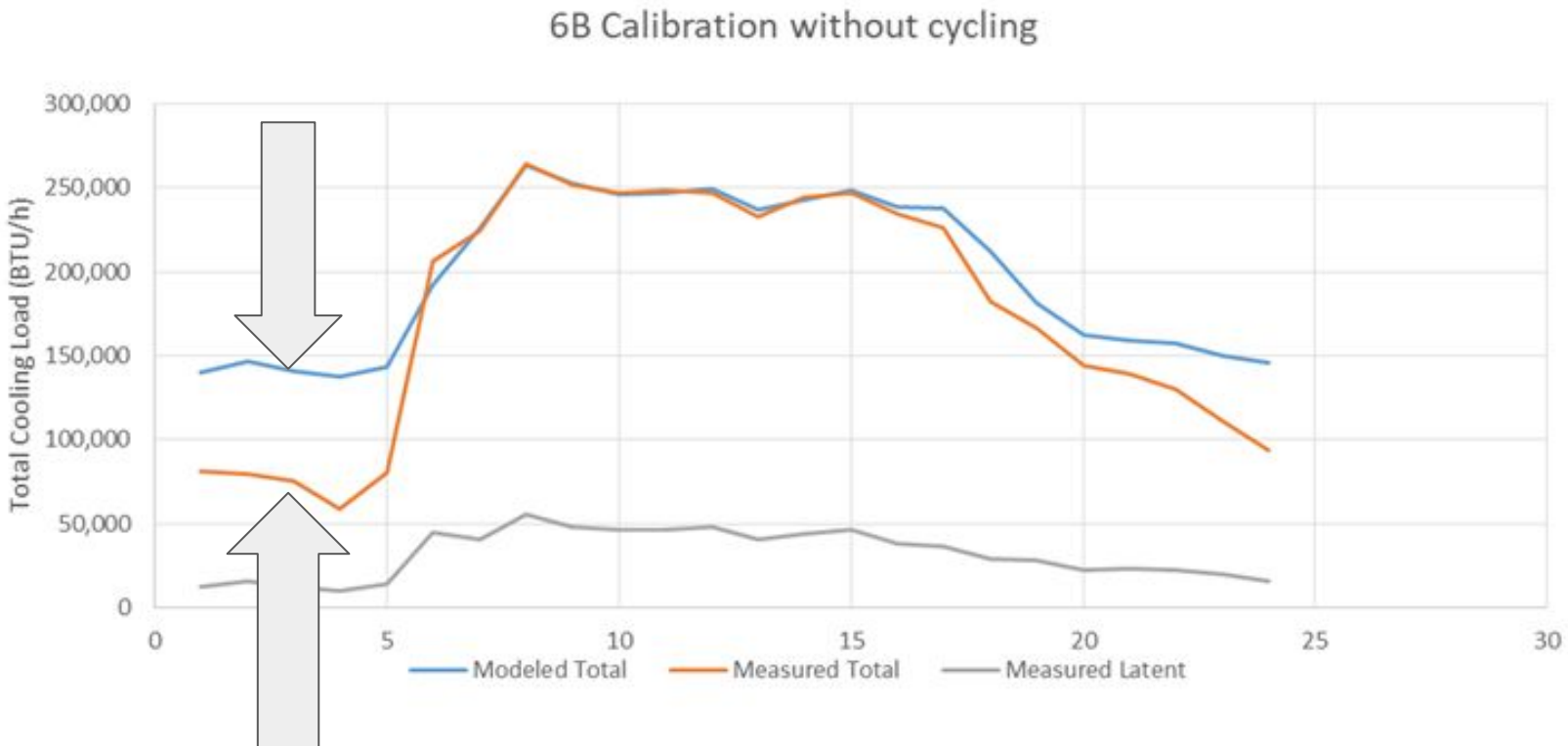
- Refrigerigeration based dehumidification systems cool air down below dewpoint temperature to dehumidify.

- During the lights off period, most of the sensible cooling is wasted energy since lights are off

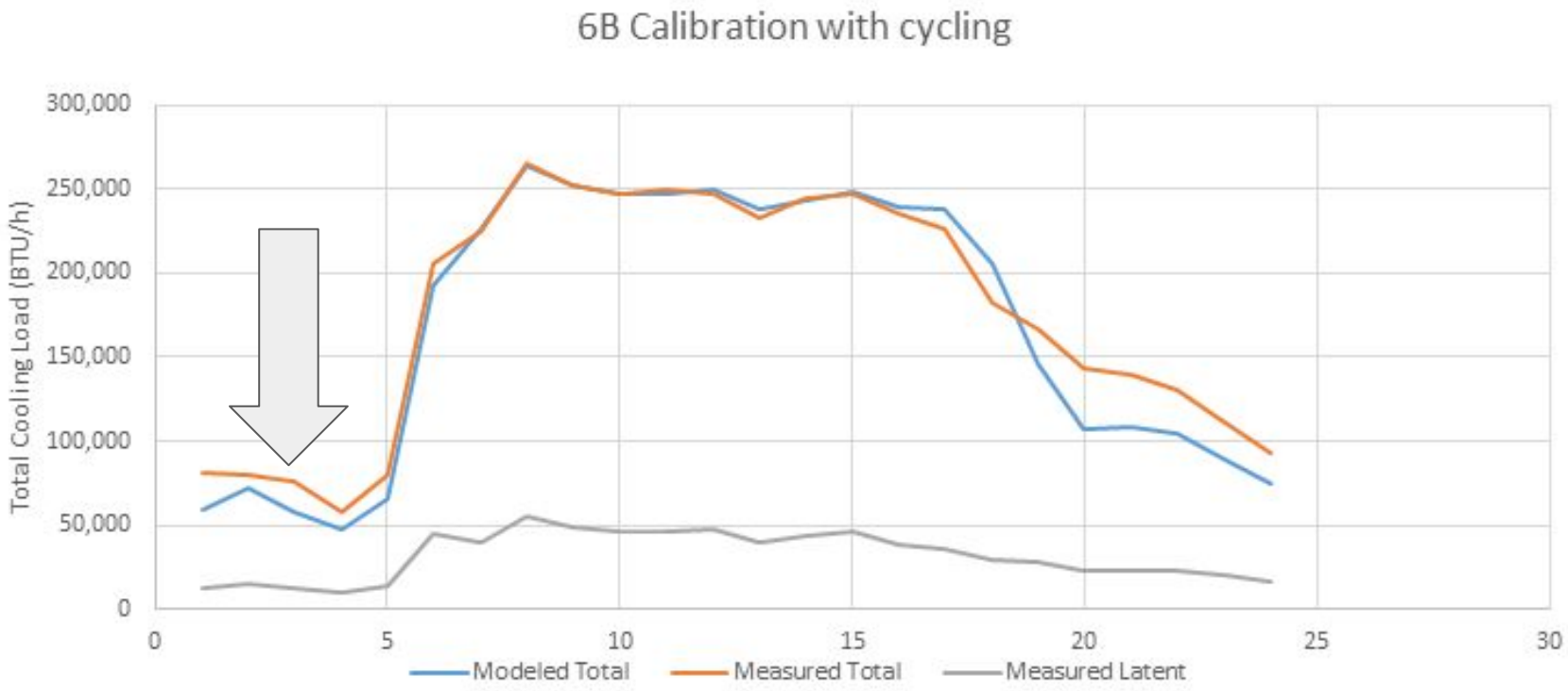
- Continuous, modulating dehumidification, such as with chilled water is inefficient when space sensible cooling loads are low. (Compares to labs with excess reheat)

Increasingly, specialty HVAC units use a dehumidification mode, where the coil will cycle on at a lower DAT reduce over cooling. This type of operation ensures the latent dominant load with less total cooling load for a given latent dehumidification load

M&V Issues with Continuous Dehumidification



M&V Example Cycling Dehumidification



Efficient Dehumidification Options

Several approaches to address variation in ratio of sensible vs latent load day to night

- Use of dedicated packaged dehumidifiers (common in smaller grows)
- Cycling dehumidification mode hunits (a few new to market)
- Wrap-around energy recovery (air to air, hydronic with refrigerant, popular with good incentives
- Variable airflow
    - Lights off air flow reduction (extremely cost-effective)
- Face and bypass dampers
- DX evaporator grid config (sequence compressors to meet load)

SECTION 06

Q&A & BREAKOUT ROOMS

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Thank you!

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