Adiabatic Solutions for Data Centers

June 2024

Speaker Bios

William Truong

Business Development Manager

William serves as the North American Business Development Manager for Data Centers at Condair. He specializes in integrating adiabatic technologies, including evaporative media and atomizing nozzle systems, into both new and retrofit data centers and products.

William holds a Bachelor’s degree in Mechanical Engineering from the University of Ottawa and currently chairs ASHRAE TC 5.7 - Evaporative Cooling

Sean Barlett

Water Chemical Engineer

Sean has had various engineering, project management and leadership roles in the water treatment industry supporting customers in the power, semiconductor, and oil and gas markets. His knowledge includes water chemistry, system design, and operations optimization.

Before Sean joined Condair, he worked as a facilities chemical engineer with Meta Platforms supporting critical cooling systems at multiple data center campuses.

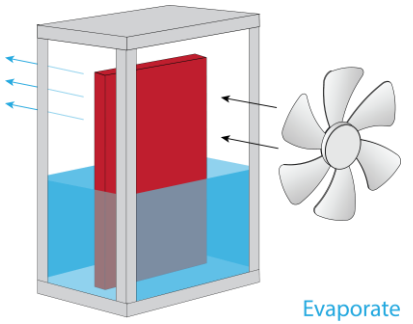
Sean earned his bachelor's degree in chemical engineering from Northeastern University and a Masters in Environmental Engineering from John’s Hopkins University and is currently the workstream lead for Open Compute’s Direct Evaporative Cooling Best Practices workstream.

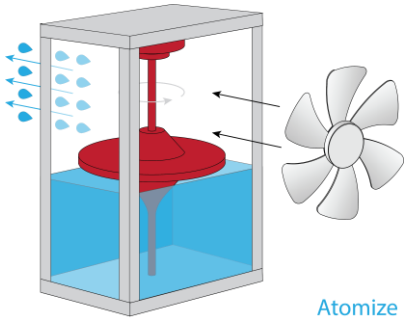
Agenda

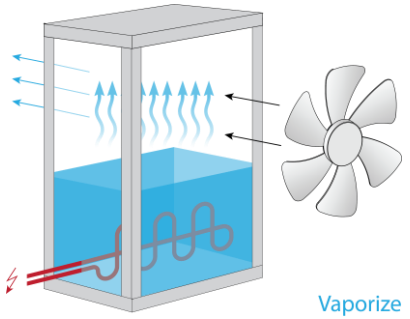
1. Methods of Humidification and Evaporative Cooling
2. Types of Data Centers and Use of Evaporative Cooling
3. Use of Economization and Evaporative Cooling
4. Adiabatic Technologies
5. Case Study – Weatherite Telecoms Direct Evaporative Cooling

Methods of Humidification and Evaporative Cooling

Methods of Air Humidification and Evaporative Cooling







Adiabatic

Energy comes from the air

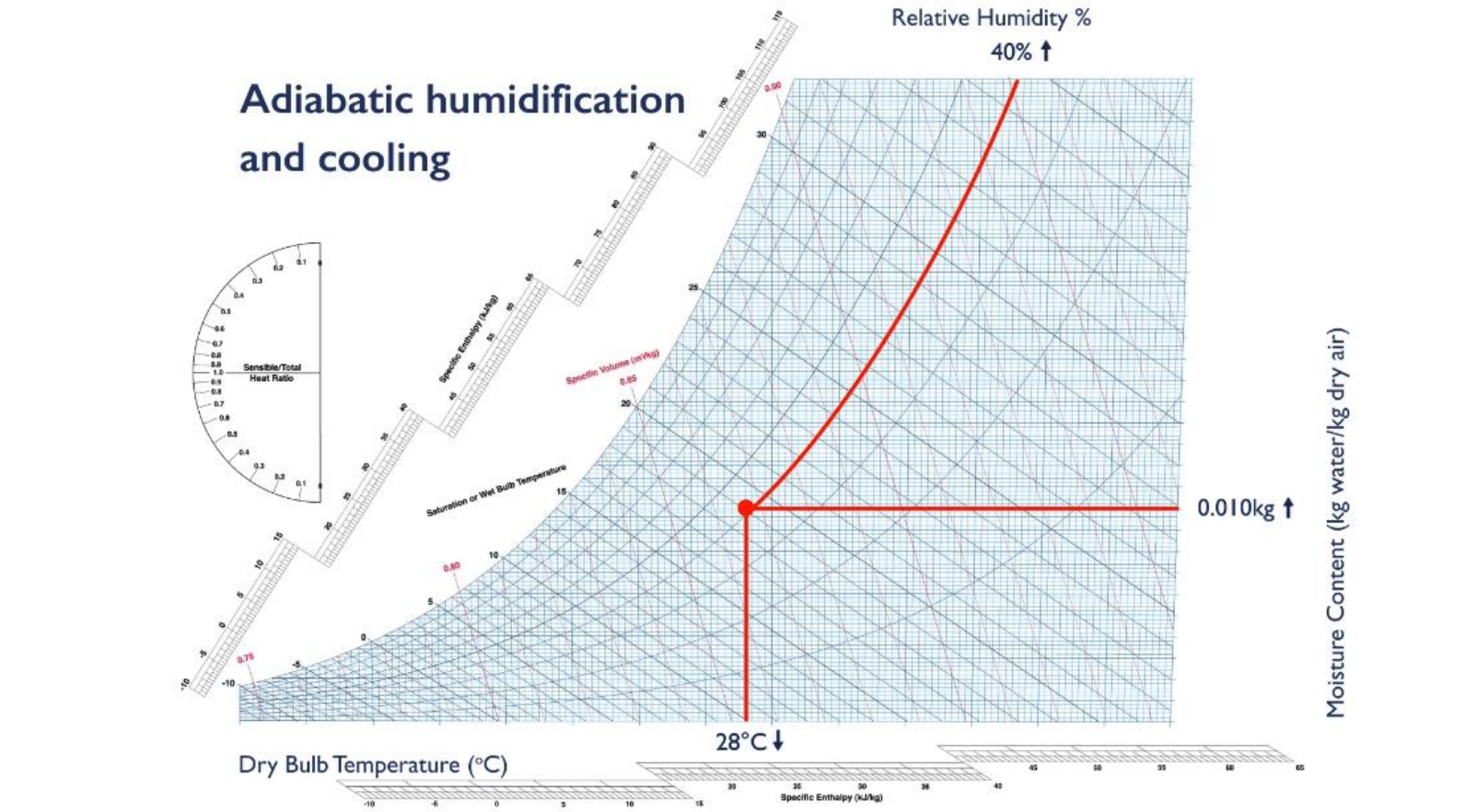
Isothermal

Heat of Evaporation:
970 – 1075 BTU/lb
2257 - 2500 kJ/kg

Psychrometrics

Adiabatic Humidification

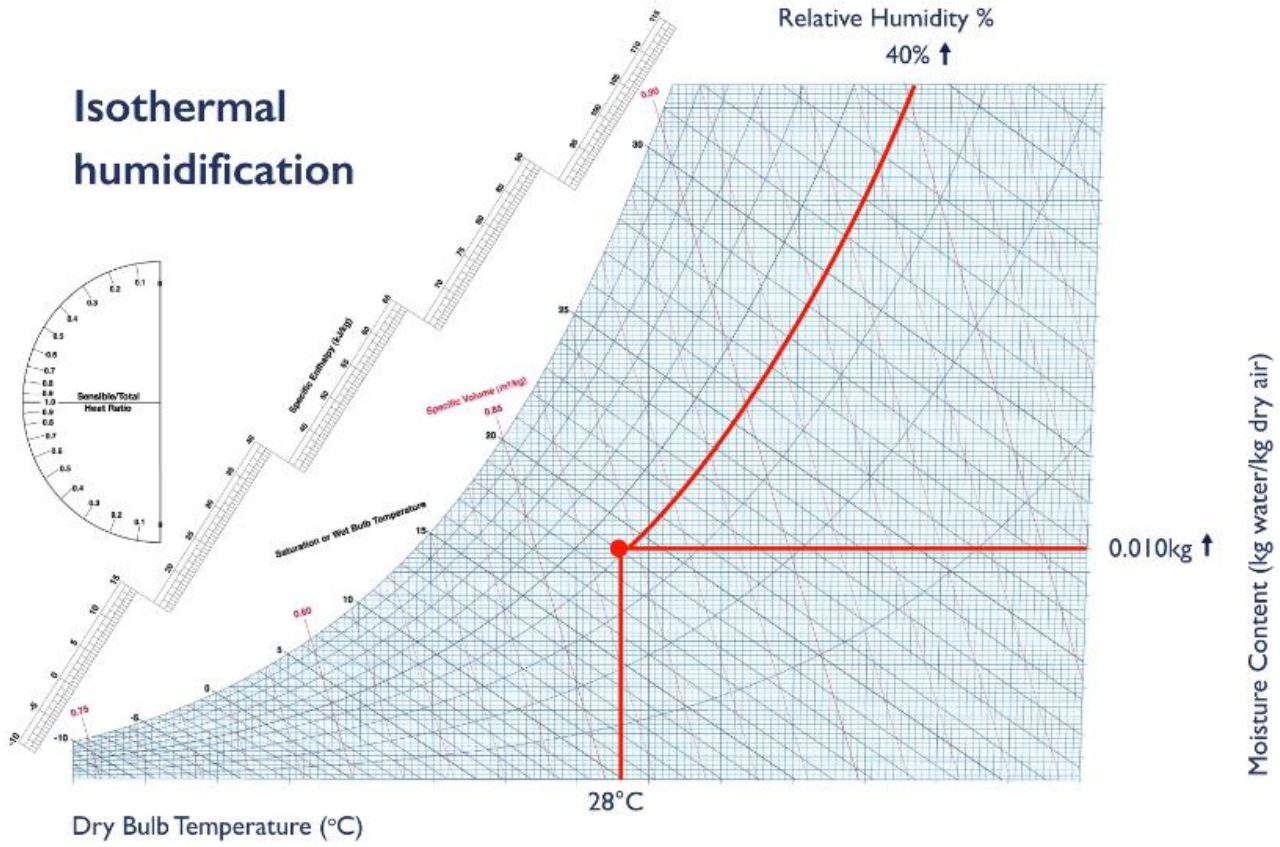
- The same amount of energy is required as for an isothermal humidifier
- However, for adiabatic humidifiers, this energy is taken from the air in the form of heat which results in a temperature decrease



Psychrometrics

Isothermal Humidification

- We add energy to water to get it to change state from liquid to vapor
- For steam humidifiers, this energy typically comes from the electricity or gas being used to boil the water



Adiabatic vs Isothermal Humidification

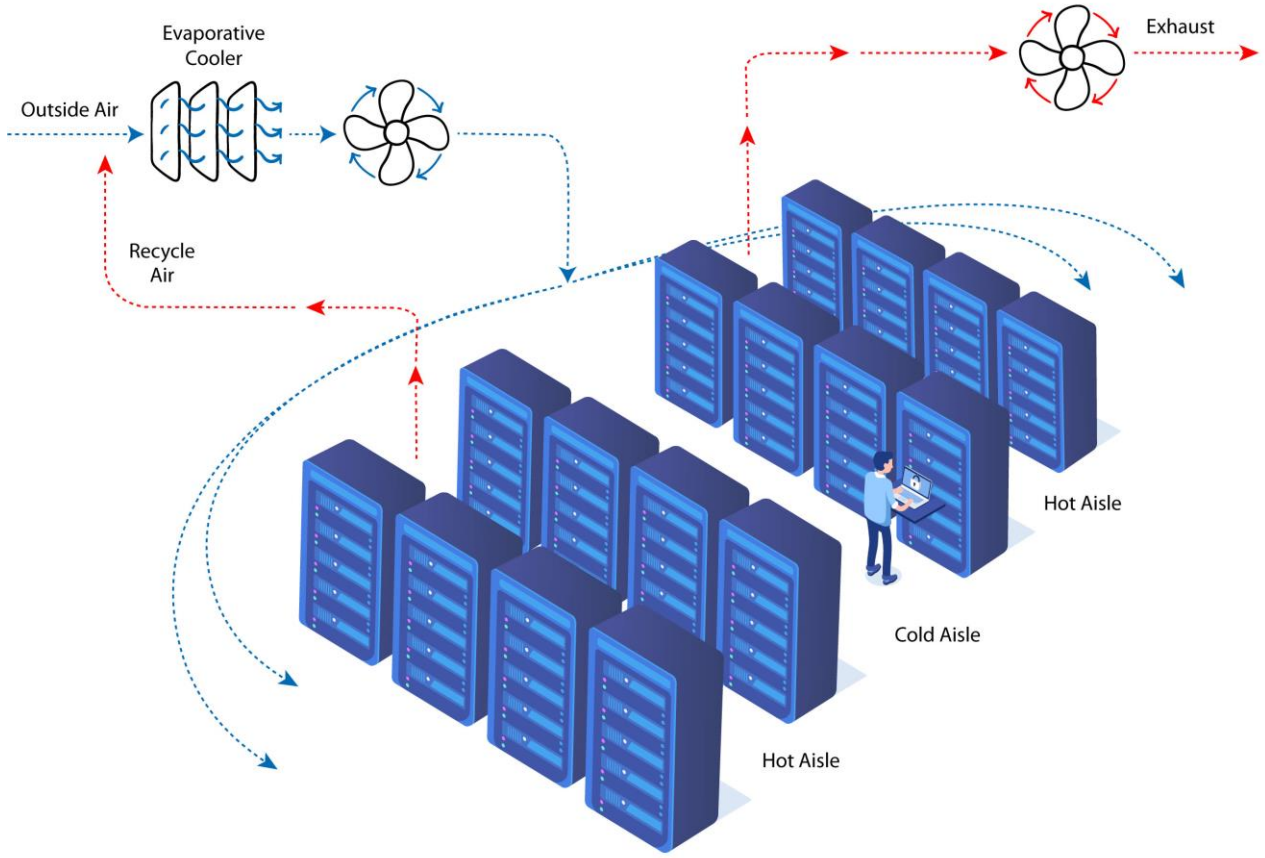
Evaporative Media – <0.3 kW
(up to 2,200 lbs/hr water evaporated)

Electrode Boiler - 74.8 kW
(200 lbs/hr water evaporated)

Types of Data Centers

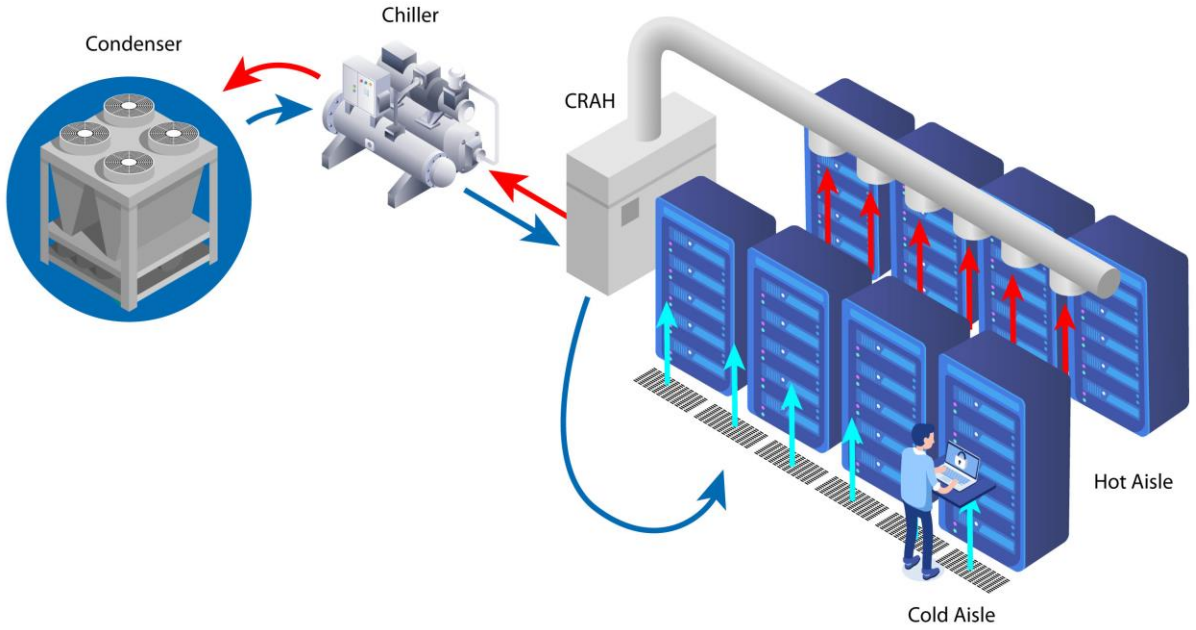
Hyperscale Data Centers

- Large purpose-built facilities designed to house a large number of servers
- Often standardized servers/rack enclosures, electricity, and cooling systems to streamline installations and reduce costs
- Many operators build their own servers and operate at a wide temperature and humidity range.
- Typically designed for the maximization of free cooling to reduce power consumption
- Small efficiency gains can lead to significant savings



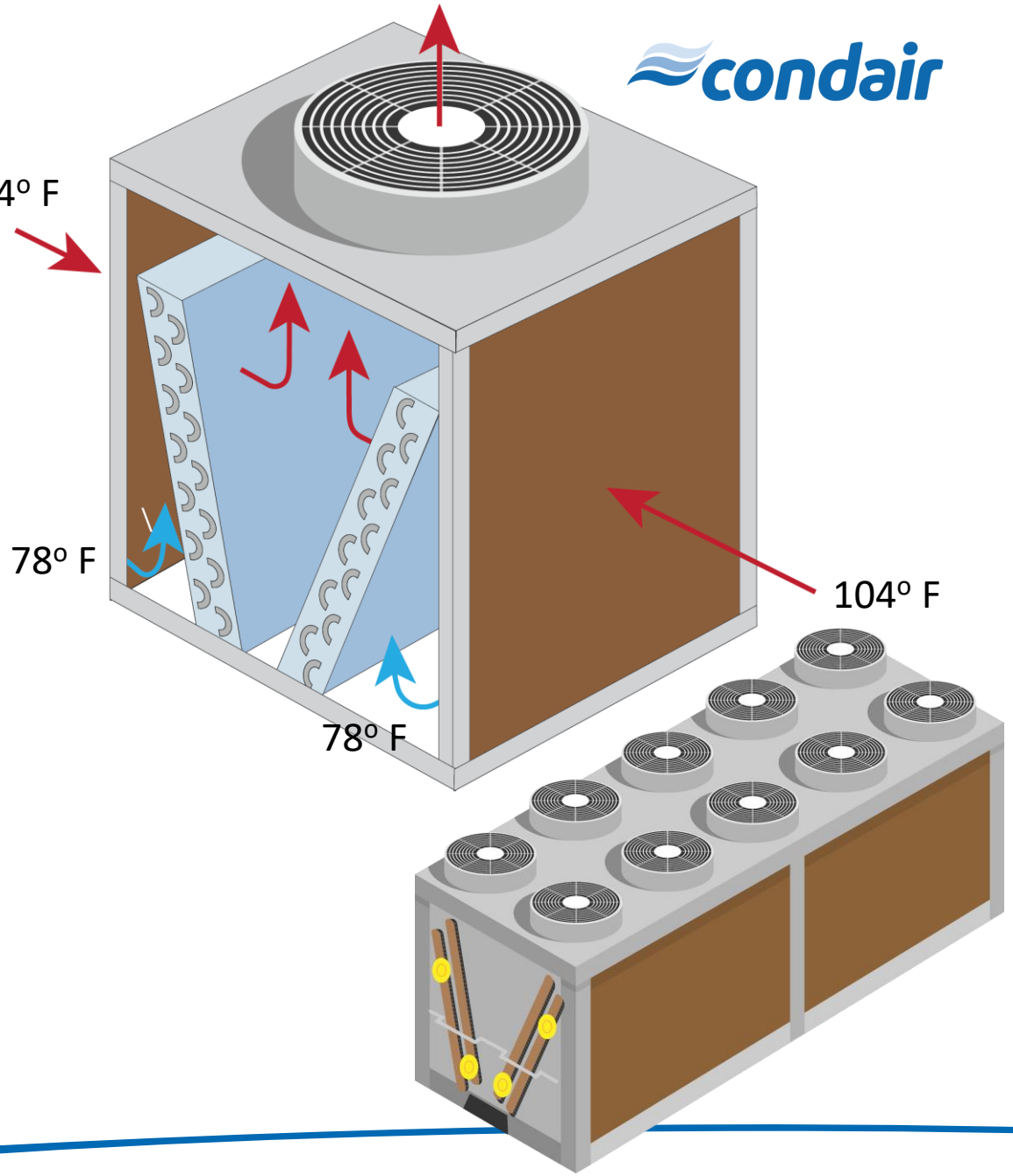
Colocation Data Centers

- Large data centers but generally not as large as Hyperscale
- Colocation companies typically rent cage space (owner supplies racks) or cloud-based processing (colo owned servers)
  - End user owns servers / applications
  - High availability with redundant connectivity paths
- Temperature and humidity control are critical and defined under a service level agreement (SLA)
  - Potentially wide variety of equipment with different requirements
- Limited use of evaporative cooling today, except for the large colocation facilities



Pre-Cooling

- Air-cooled equipment cools to dry bulb temperature.
- Dry bulb air temperature is typically higher than the wet bulb temperature.
- Air-cooled equipment can cool to the wet bulb if the air entering the system is cooled and humidified.
- Cooling and humidification can be selectively turned on and off based on ambient conditions to maximize water and energy conservation.
- Pre-cooling systems can be added to existing chillers/coolers by adding prefabricated wet sections.



Other Data Centers

- **Enterprise Data Centers**
  - Efficiency is important but high availability, high reliability is more important
  - Humidity and temperature control is critical
  - Limited use of evaporative cooling (generally large facilities)

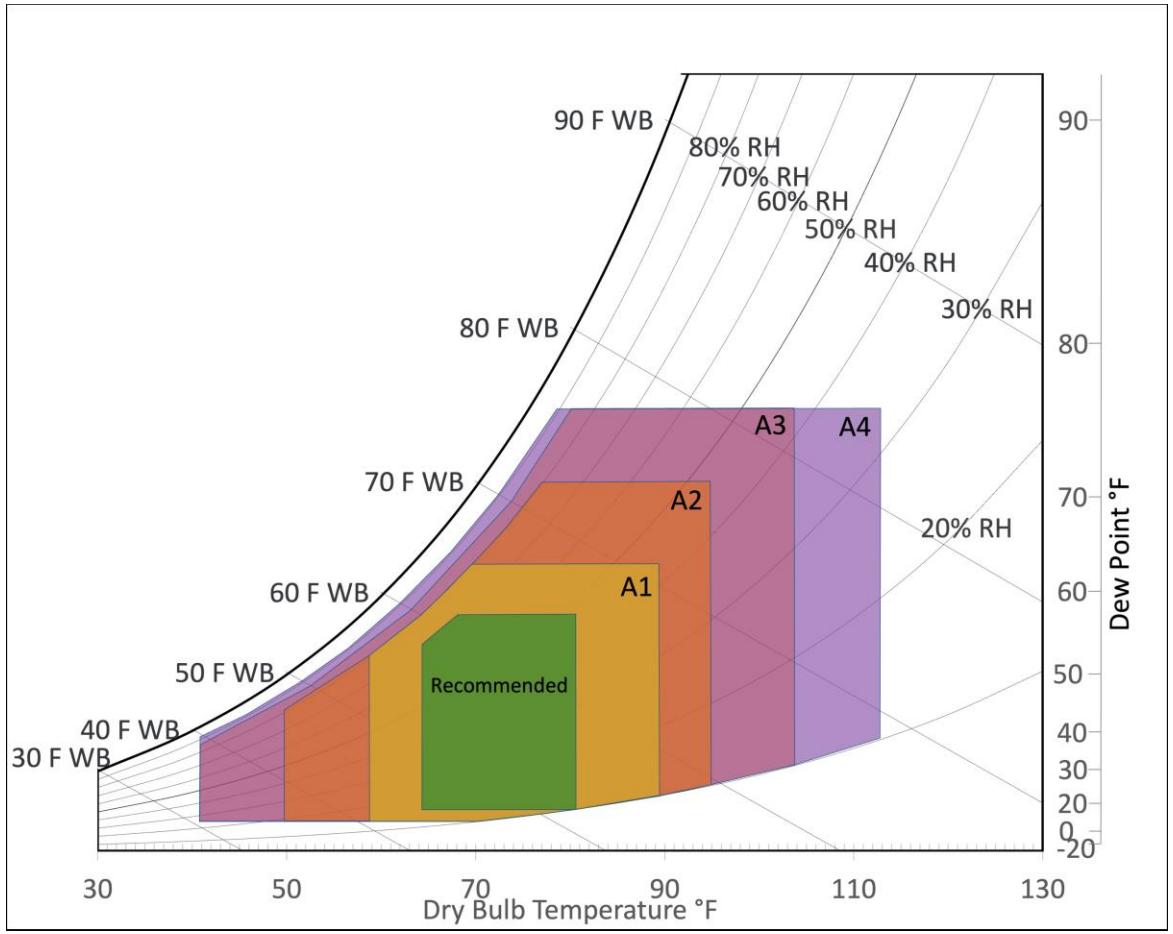
- **Edge Data Centers**
  - Small rooms, closets, remote sites
  - Connectivity to the rest of the network, typically containing network switching
  - Evaporative cooling and humidification not applicable

- **Containerized Data Centers**
  - Remote locations with limited water supply
  - Limited use of evaporative cooling and humidification

Economization

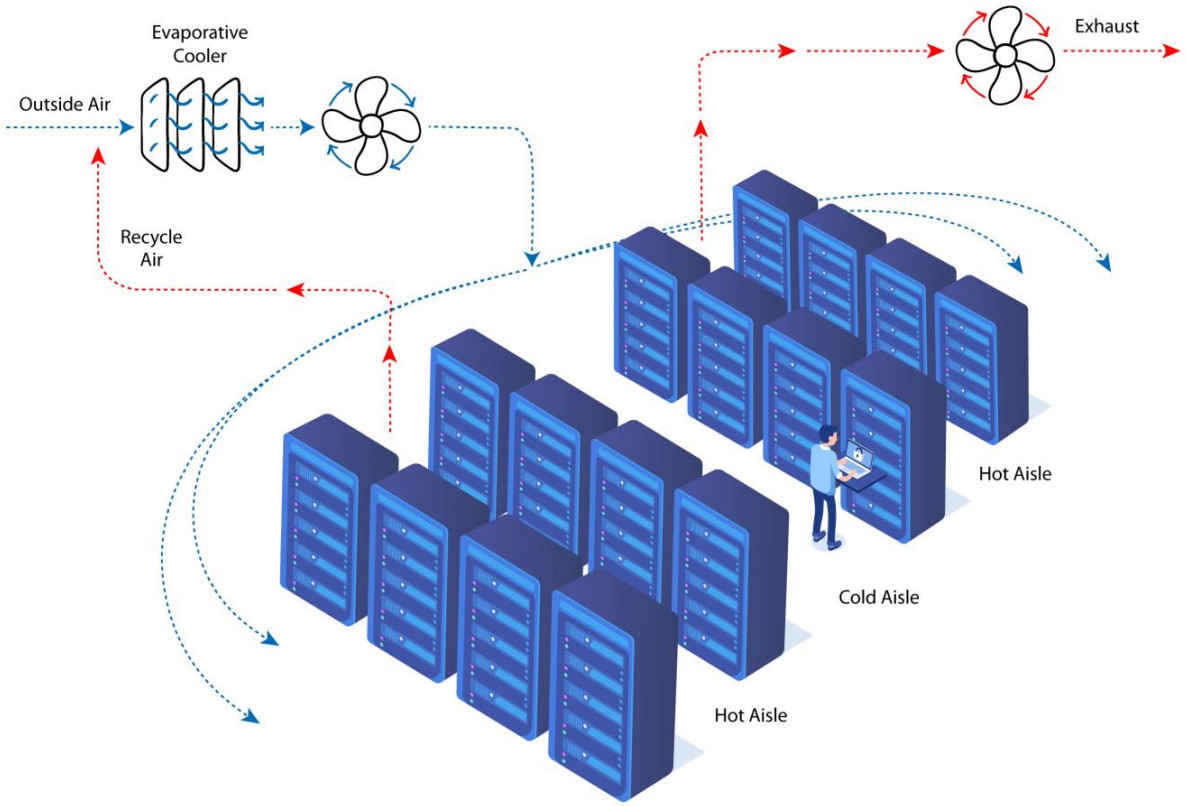
ASHRAE TC 9.9 Thermal Guidelines

- 2015 expanded the humidity envelope
- 8% RH for A1 and A2 classes
- 15.8 F dew point
- 2021 added pollutants as a factor
- Low levels of pollutants > recommended humidity limit
- High levels of pollutants < recommended humidity limit
- 2021 added high-density envelope

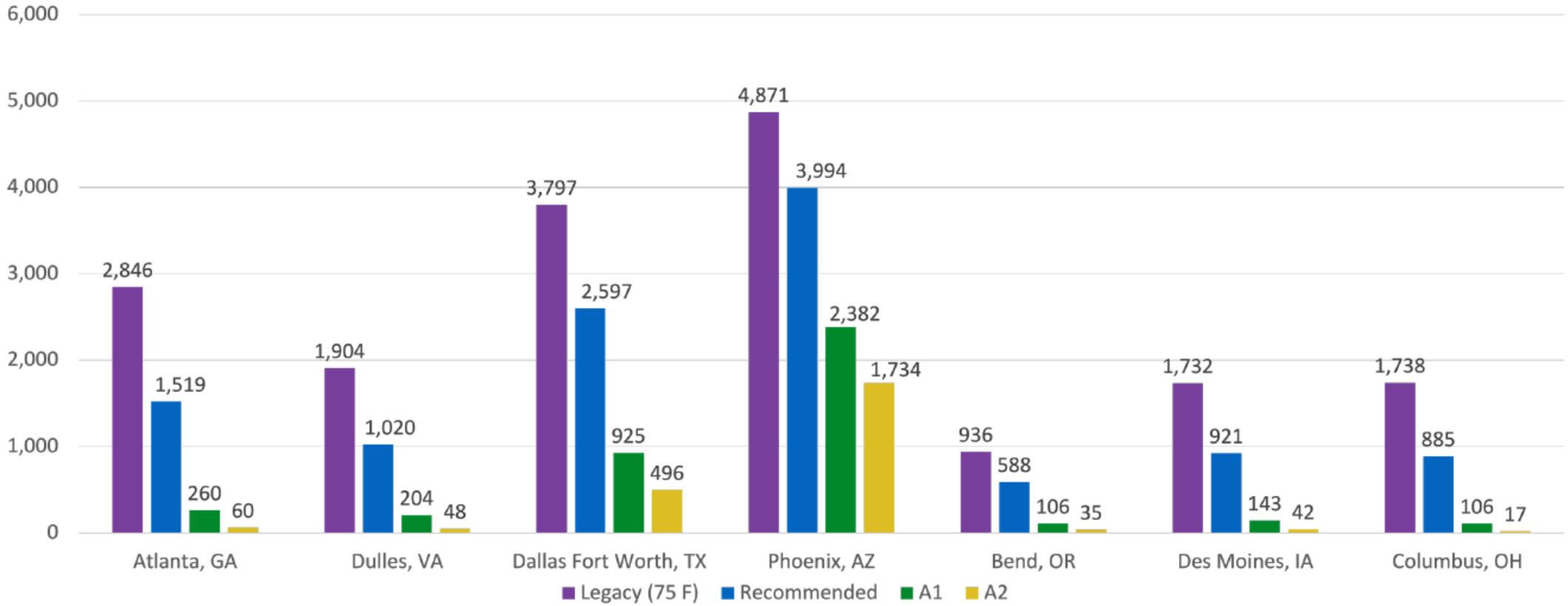


Economization

- Not a piece of equipment
- Mode of operation that allows a part of the cooling system to reduce load
- Air-side: Outdoor air is brought directly into the data hall
- Water-side: Chilled water by-passes the mechanical cooling equipment and rejects heat directly to equipment such as a fluid cooler or cooling tower.
- Refrigerant-based: Refrigerant in a system is used to complete the refrigeration cycle without the use of mechanical compression.



Evaporative Cooling Hours/Year with Airside Economization



Adiabatic Technologies

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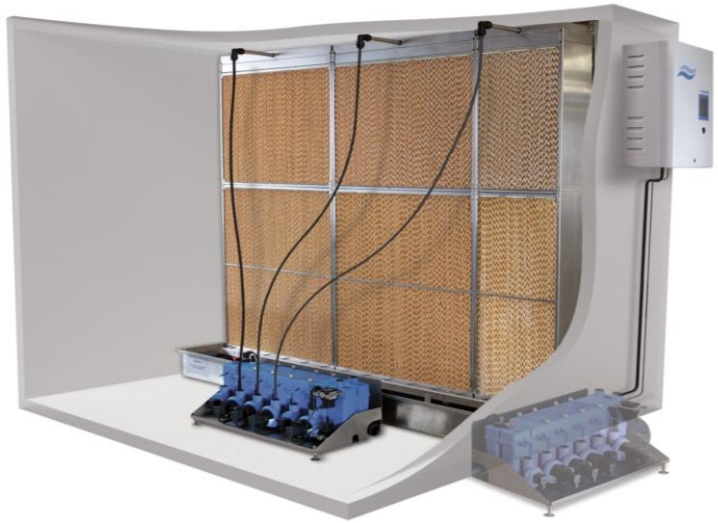
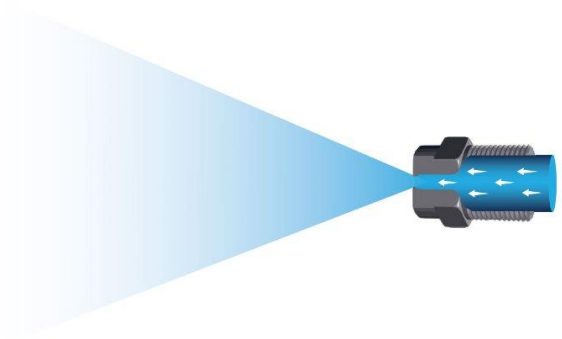
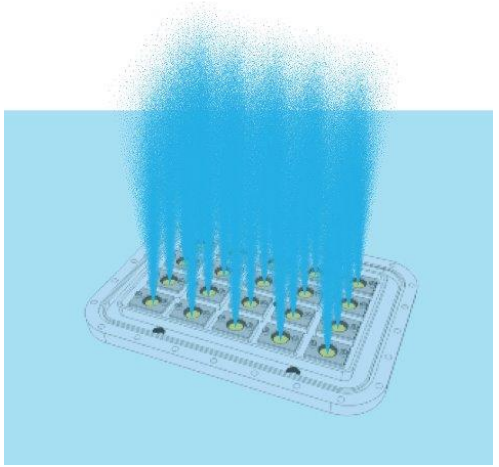


Wetted Media



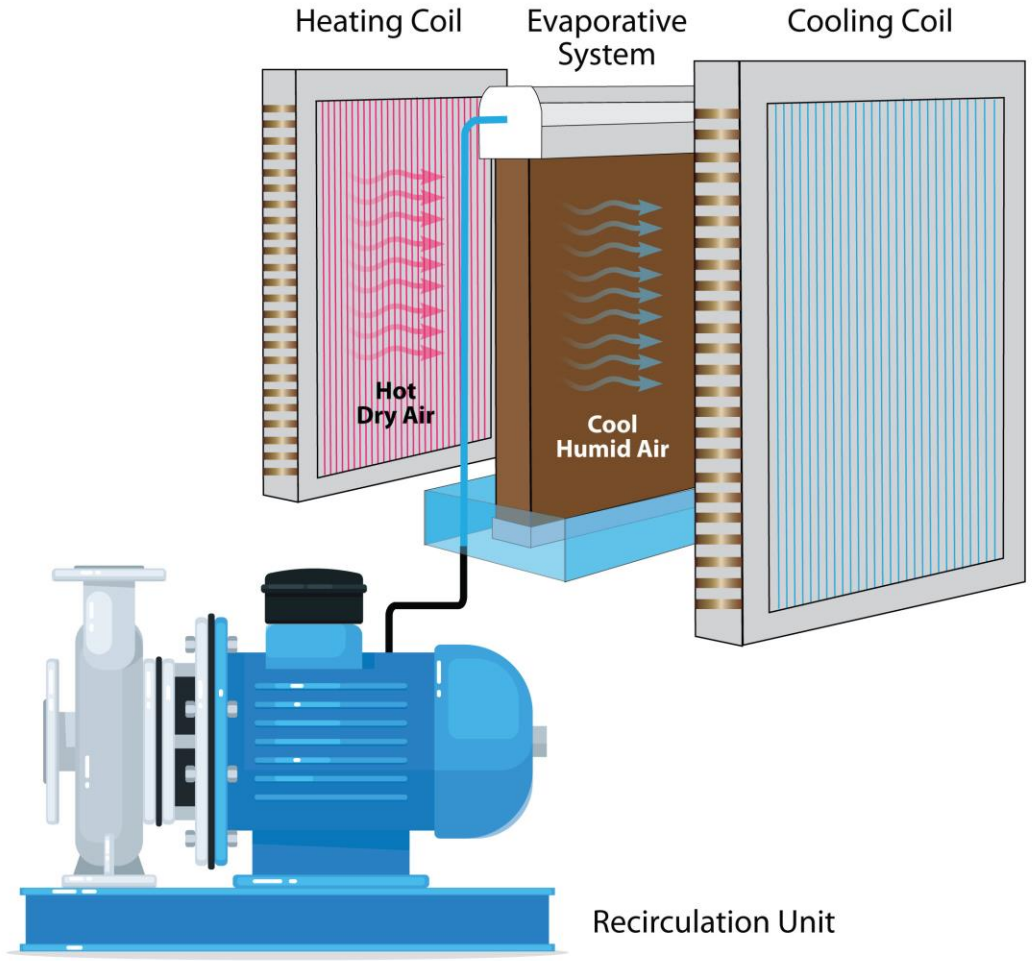
Atomizing Nozzles



Ultrasonic Nebulizers

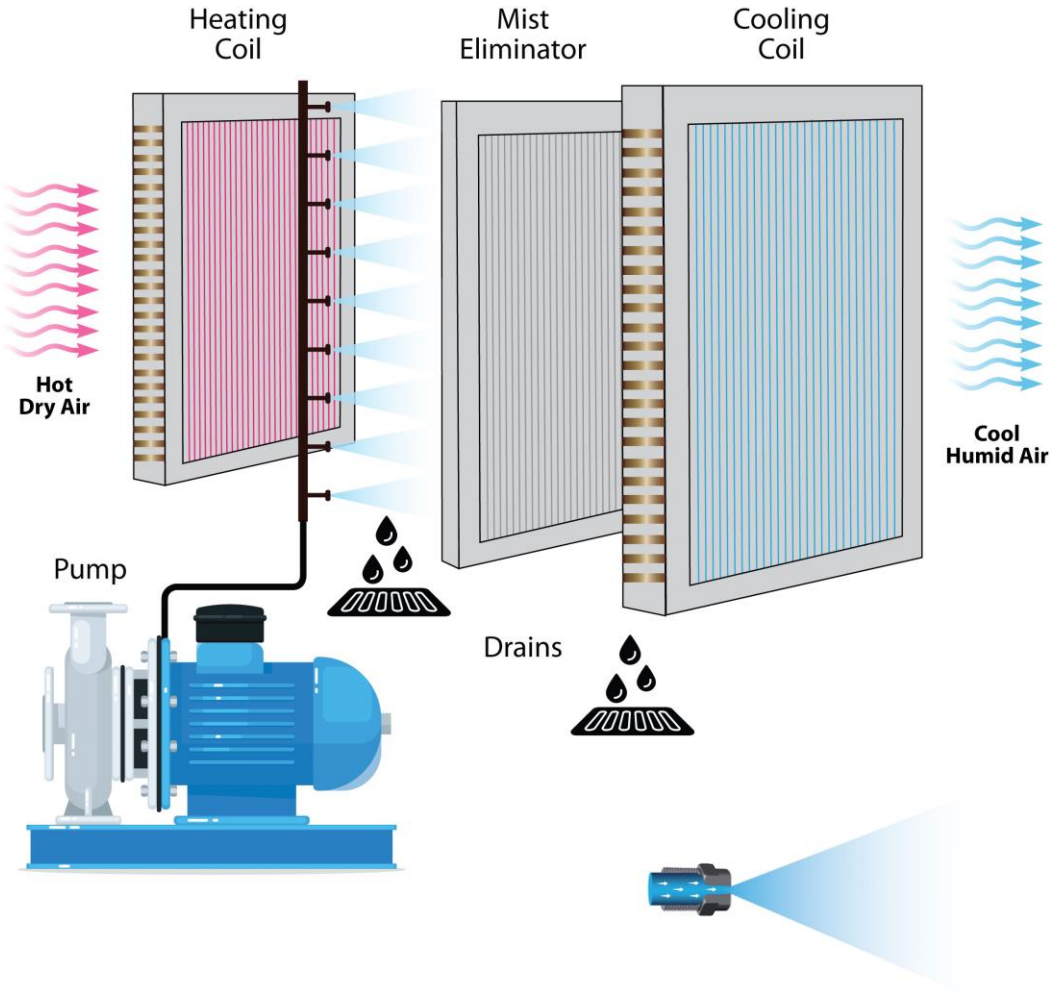
Wetted Media Systems

- Evaporative media is saturated with water
  - All evaporation takes place within the depth of the media
- Water is typically recirculated over the media and periodically drained
- High-capacity outputs and scalable
- Does not require treated water
  - Water quality will impact media life
- Easy to retrofit into existing systems
- Limitation on control accuracy (without additional control schemes)



High Pressure Atomizing Systems

- Water is pressurized to ~1000 psi (70 bar) and sprayed into the air stream through as series of nozzles
  - Droplet size of 10-40 microns
  - Typical absorption distance 3-5 ft.
- Requires treated water (RO/DI)
  - Unevaporated water is not recirculated within the system (hygiene)
- High-capacity outputs and scalable
  - A single pump system can supply multiple zone
- High control accuracy (+/- 2%) with options for N+1 redundancy



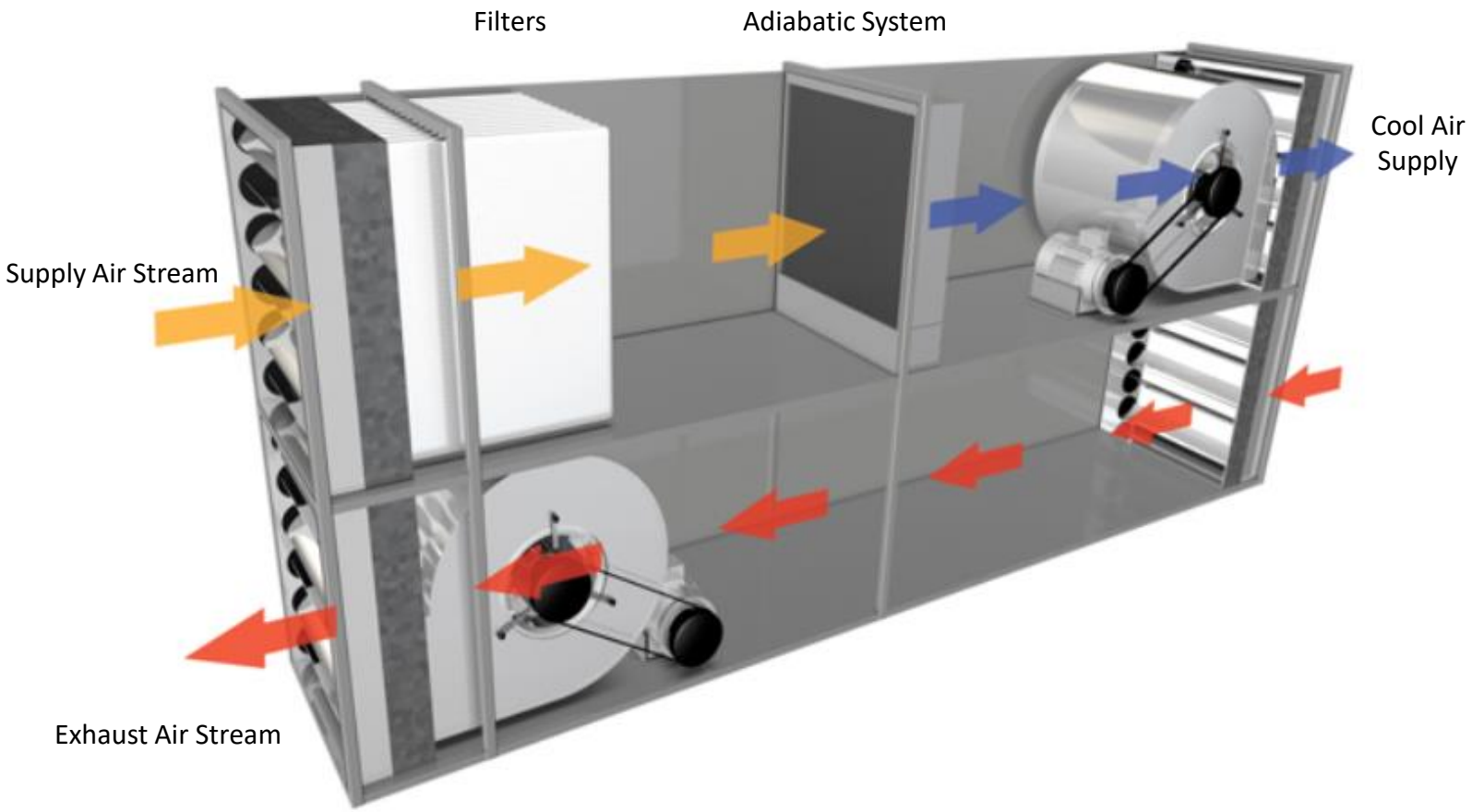
Direct Evaporative Cooling

Benefits

- Delivers high volume of cooling (0.68kW/kg)
- Provides humidification of air
- Ideal for hot dry climates

Limitations

- Requires high ventilation rates
- Not suitable for humid climates
- Consideration for filtration



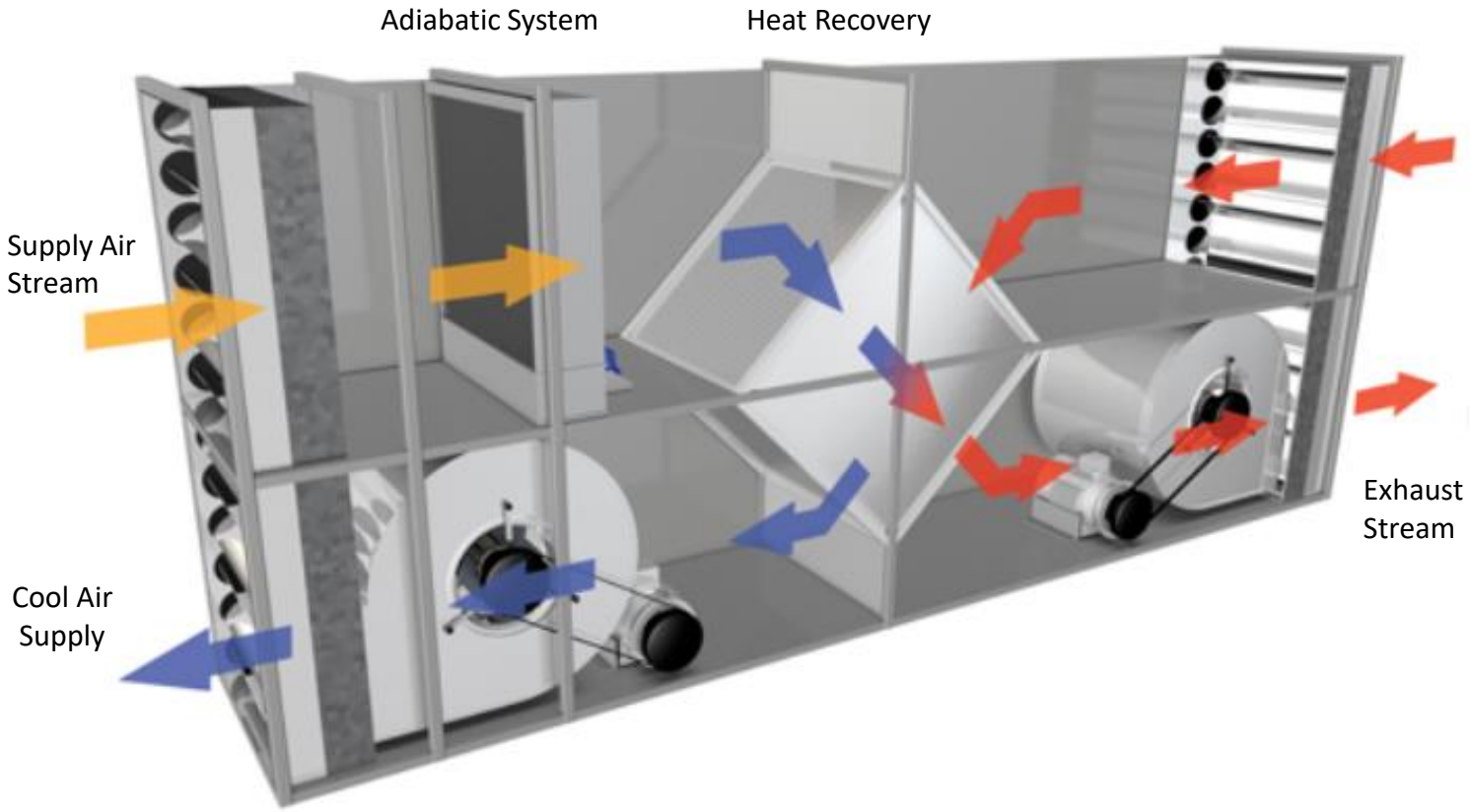
Indirect Evaporative Cooling

Benefits

- Does not mix airstreams, ideal for secure buildings
- Volume of cooling increased by circulating more air
- No moisture addition
- Not limited to air extraction/fresh air rate

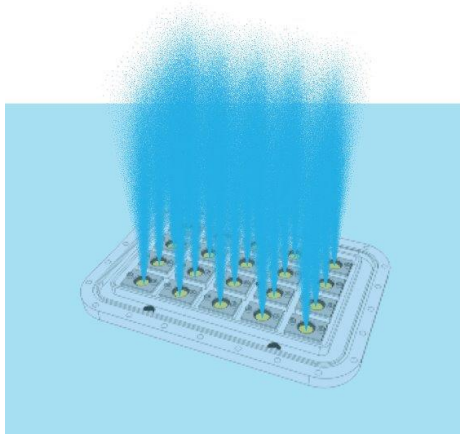
Limitations

- Volume of cooling depends on efficiency of heat recovery (lower efficiency than direct evap)



Ultrasonic Systems

- Piezo electric transducers cause cavitation in the water releasing an ultra fine mist
  - Droplet size of 1-3 microns
- Ideal for lower capacity humidification applications
  - 5-40 lbs/hr
- Requires treated water (RO/DI)
- Commonly installed in-space
  - Some systems can be installed in a duct/AHU
  - Absorption distances 10-15 ft.
- Meets California's Title 24 Humidification Energy requirements (adiabatic humidification only in computer rooms and data centers)



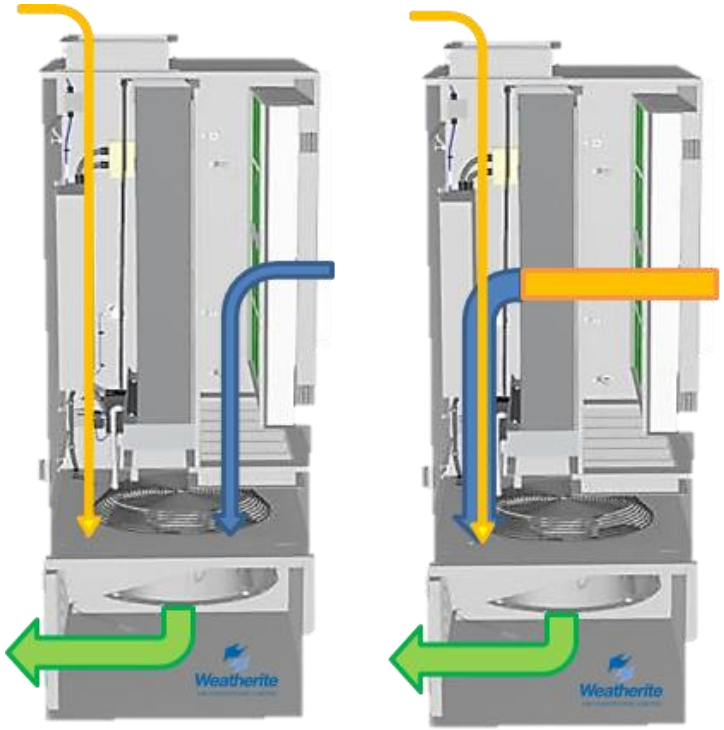
Case Study

Direct Evaporative Cooling Case Study

Weatherite Telecoms

Objective

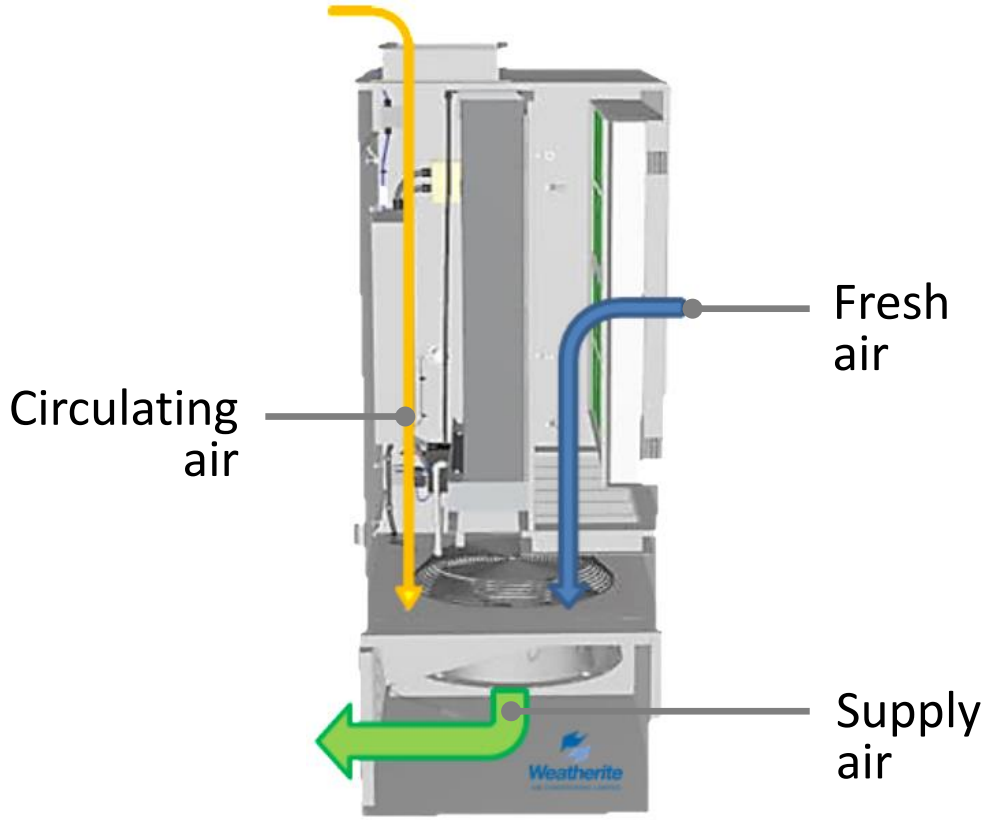
To replace existing compressor driven cooling systems with a refrigerant free, energy efficient solution for all low to medium heat density telecoms rooms throughout the UK for a leading telecoms provider



Direct Evaporative Cooling Case Study

Weatherite Telecoms

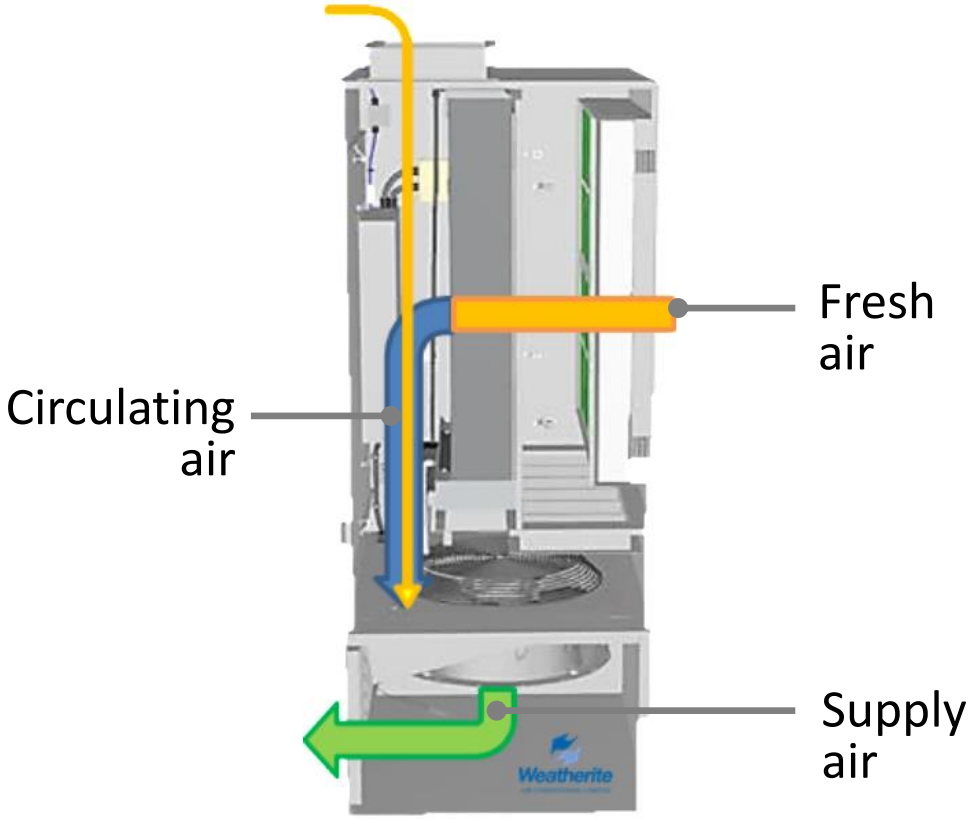
Mode 1:
Free cooling only,
bypass, damper open



Direct Evaporative Cooling Case Study

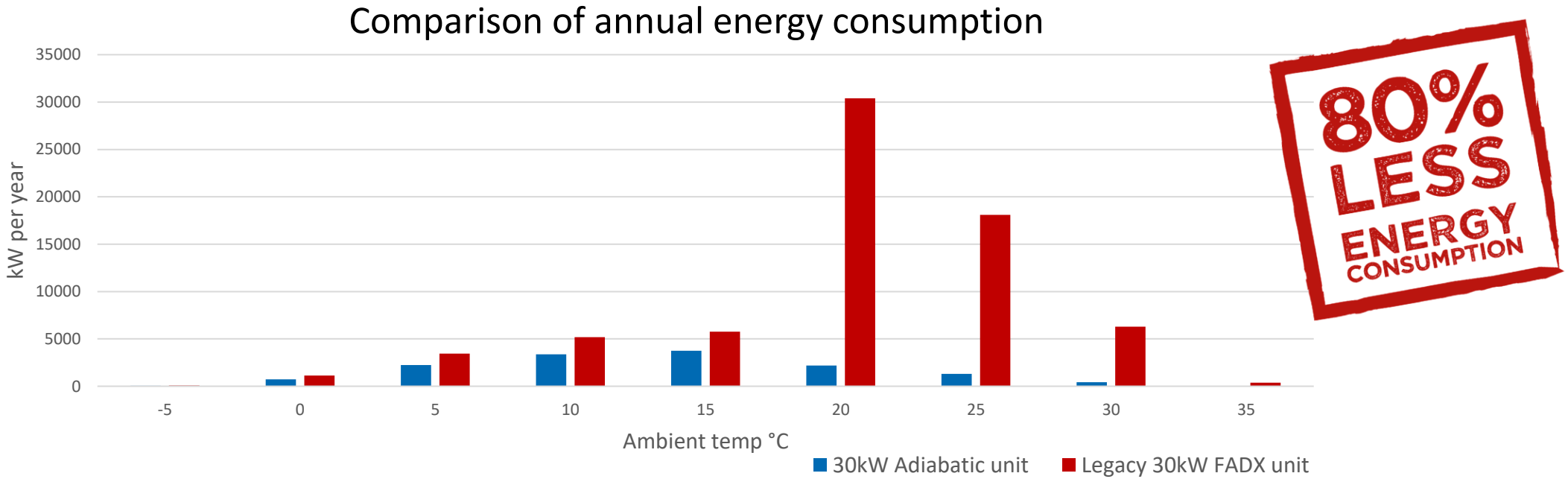
Weatherite Telecoms

Mode 2:
Adiabatic cooling, bypass damper closed; air flows through the humidifier



Direct Evaporative Cooling Case Study

Weatherite Telecoms



	Free Cooling Only					Adiabatic or DX Cooling				
Ambient DB °C	**-5°C**	**0°C**	**5°C**	**10°C**	**15°C**	**20°C**	**25°C**	**30°C**	**35°C**	**Total kWh**
30kW Adiabatic Unit [kWh]	57	734	2,237	3,370	3,742	2,195	1,306	422	25	**14,088 kWh**
Legacy 30kW FADX Unit [kWh]	88	1,132	3,450	5,196	5,770	30,406	18,101	6,299	372	**70,814 kWh**
Difference [kWh]	**31**	**398**	**1,212**	**1,826**	**2,028**	**28,211**	**16,795**	**5,878**	**347**	**56,726 kWh**

Additional Resources

Full Case Study

Previous Webinar

Website

LinkedIn

Questions?