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Impacts Of Legacy And Next Generation Cooling Technologies On Power Demands And Environmental, Social And Governance Strategies

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SCTE CABLE-TEC EXPO®22
SEPTEMBER 19-22 • PHILADELPHIA, PA

2022 Fall Technical Forum
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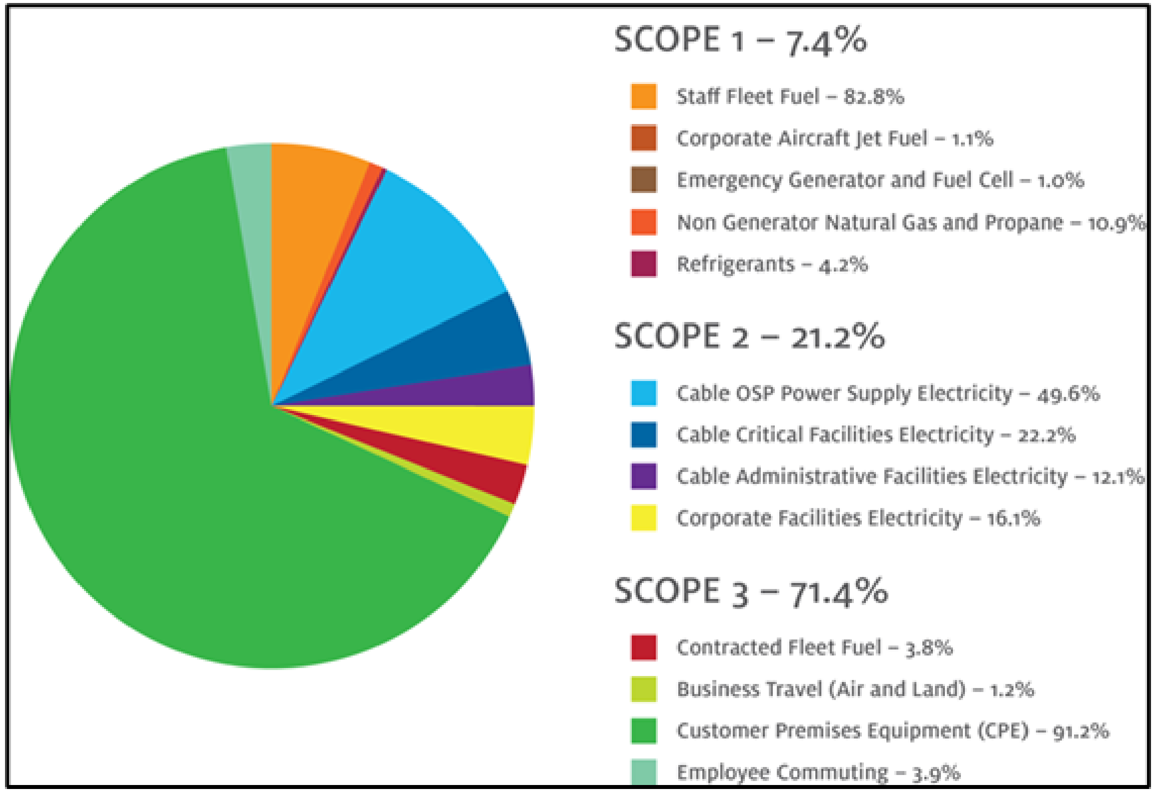
Cooling Technology and ESG

- Energy use is a key component of the Environmental element of ESG.
- For Cable Operators energy use for critical facilities operation represents one of, if not the largest operating expense. HVAC (Heating, Ventilation and Air Conditioning) systems typically account for 35% to 45% of the cable facility energy use.
- The Information Technology Equipment (ITE) heat loads represent approximately 45% to 50% and miscellaneous lighting is +/- 5%.
- By achieving reductions in energy use, related Greenhouse Gas (GHG) emissions can be reduced resulting in an improved ESG score.

Footprint of a Typical Cable Operator

From SCTE 208 2021– Cable Operator Greenhouse Gas Emissions Data Collection Recommended Practices



- Scope 1 (Direct Emissions), Refrigerants – 4.2%
- Scope 2 (Indirect Electricity Emissions), Cable Critical Facilities Electricity of 22.2%
- Due to variations between operators' approach to preventive maintenance (ie. internal or external business partners) and operators not having readily available emissions data for purchased goods, Scopes 1 & 3 impacts are not considered in this presentation

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Refrigerants, Scope 1 (Direct Emissions), Affect of Scope 2

- The main concern is during installation and possible leaks
- This is covered in detail by the Environmental Protection Agency (EPA) in: Greenhouse Gas *Inventory Guidance: Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases.*
- Refrigerants used in Heating, Ventilating and Air Conditioning (HVAC) systems affects their efficiency and therefore can have an effect on *Scope 2 (Indirect Electricity Emissions)*.

Cable Critical Facilities Electricity

GHG Scope 2, Cable Critical Facilities Electricity - 22.2%

- PUE, Cooling Systems and their performance are significant contributors

Types of Cooling Systems

- “Legacy” cooling Systems, over 10 years old
- Cooling Systems Today
- Next Generation Cooling Systems

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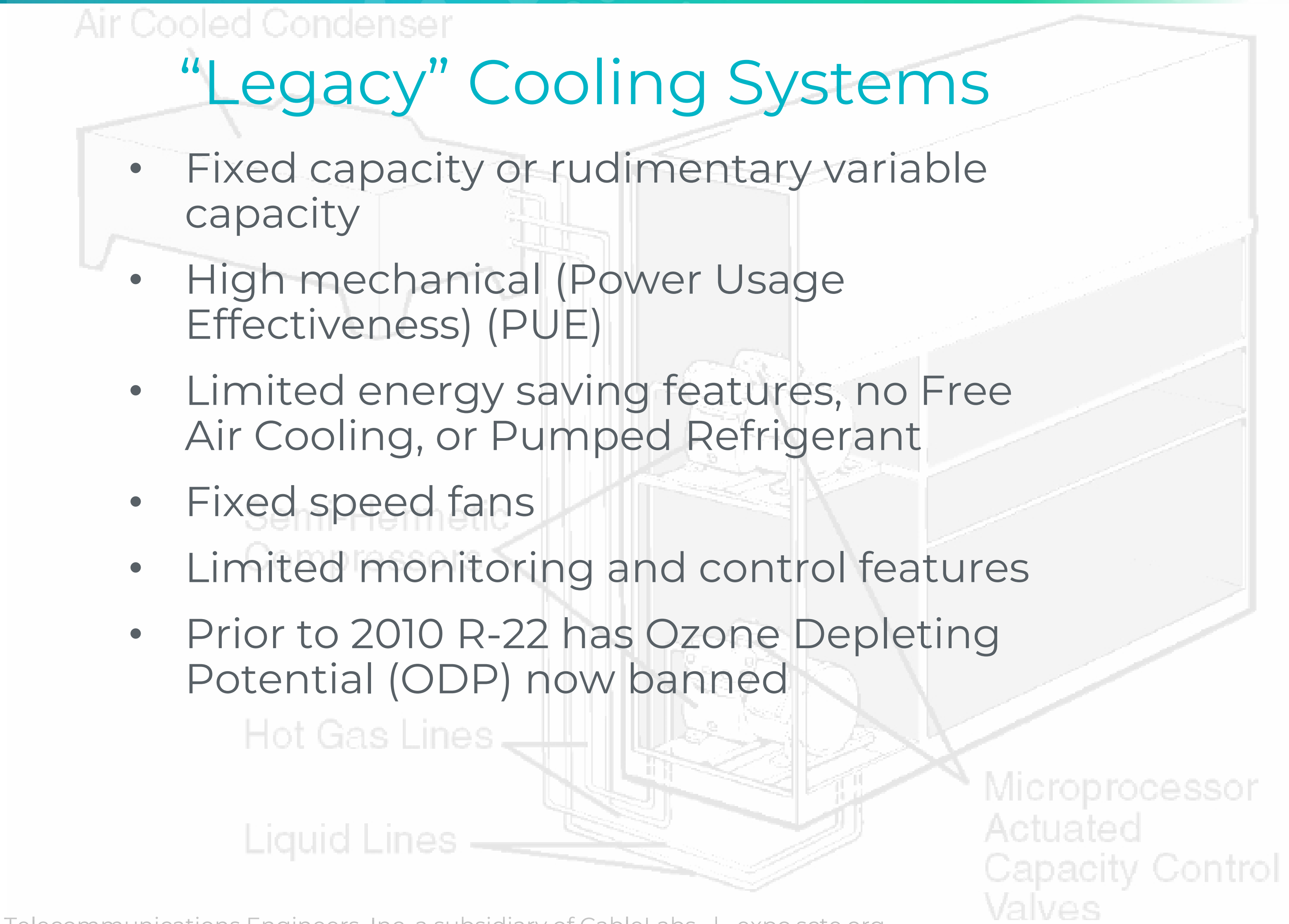
"Legacy" Cooling Systems

- Fixed capacity or rudimentary variable capacity
- High mechanical (Power Usage Effectiveness) (PUE)
- Limited energy saving features, no Free Air Cooling, or Pumped Refrigerant
- Fixed speed fans
- Limited monitoring and control features
- Prior to 2010 R-22 has Ozone Depleting Potential (ODP) now banned



Cooling Systems Today

- Variable capacity
- Mechanical PUE much lower as capacity matches heat load
- Electronically Commutated (EC) fans
- Energy saving features, including Free Air Cooling, or Pumped Refrigerant
- Sophisticated monitoring and control features
- Refrigerants all zero ODP

Cooling System Improvements – Legacy/Existing

SCTE Documents

Improving air flow management – resulting in less air flow required and higher return air temps – **SCTE Journal SCTE-EM-V5N1 – Rightsizing Network Cooling – Getting Ready for 10G**

Increase in set points – **SCTE 253 2019 Cable Technical Facility Climate Optimization Operational Practice: Understanding Set Point Values, Part 1**

Control Systems and Networking cooling units- **SCTE 184 SCTE Energy Management**

Air containment – **SCTE 274 2021 Cable Operator Critical Facility Air Containment Operational Practice**

Operational Practice to improve air flow and climate conditions in Critical Facilities – **SCTE 219 2021 – Technical Facility Climate Optimization Methodology**

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Cooling Systems – Energy Conservation Measures (ECM)

Set Point Adjustments

Average Savings = up to 20%

- 10 sites over a 30-day soak period
- Raising the control temperatures from 68F/20C to 75F/24C allows the HVAC to run less.

Blanking Panels

Average Savings = 12%

- 7 sites
- Install BP's in open rack spaces to block openings that allow hot & cold air to mix.
- Increases HVAC efficiency.

Economizers on HVAC

Average Seasonal 5 mos savings = 38% per device

- 10 sites
- Recorded HVAC equipment with ability to use cold outside air to assist with space cooling when ambient temperatures allow.
- Reduces compressor run times and decreases energy use.

Airflow Optimization

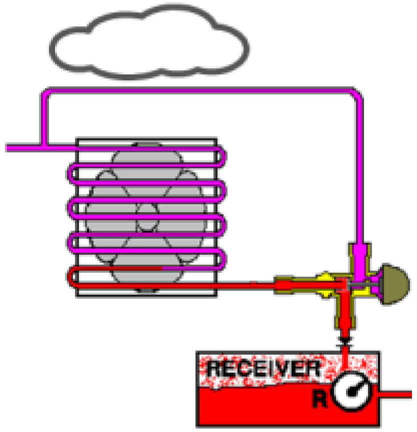
Estimated Annual Savings per site = 15% - 20%

- Measures to improve conditioned airflow distribution to racks and maintain separation of return air to HVAC equipment.
- Elements include containment curtains or doors, ductwork relocation, blanking panels and rack gap fillers.

Cooling System Improvements Legacy/Existing

Cooling Systems – Floating Head

- Variable condensing and head pressure
- Replace R22 with R407C



Floating Head Retrofit - example			
Cooling Units	**2 - Liebert DH290; 1 - Liebert DS105**		
	Pre-Retrofit	**Post-Retrofit**	**Reduction**
Cooling Power kW	67	34	33
Cooling Energy (kWh)	585,416	299,201	286215
Energy Cost ($0.12/kWh)			$34,346
CO2 Equvialence			
Refrigerant Removal (kg)			211.47
Refrigerant Removal (lbs)			466.2
C02 Equivalence Reduction			**Metric Tons**
	Due to kWh avoided		203
	Due to refrigerant removal		383
	Total		**586**

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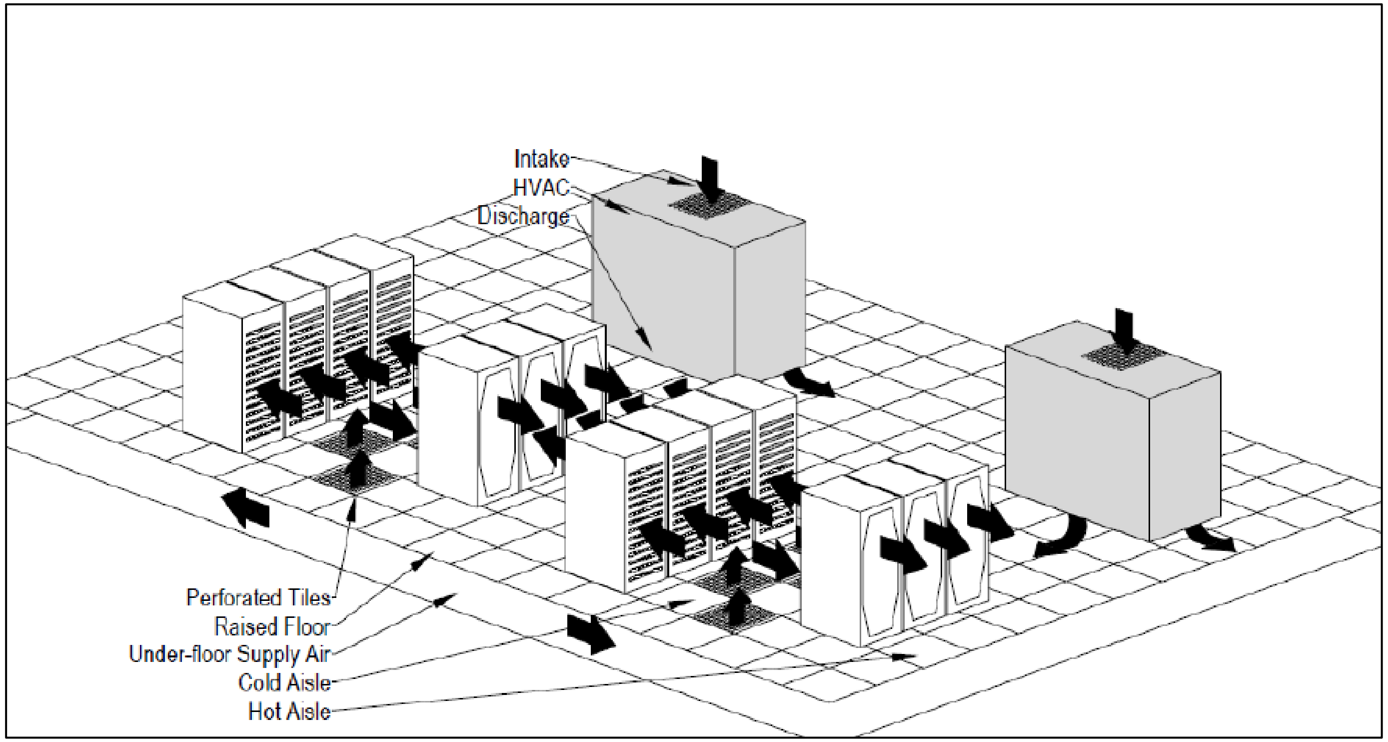
Cooling Systems – Room/Perimeter

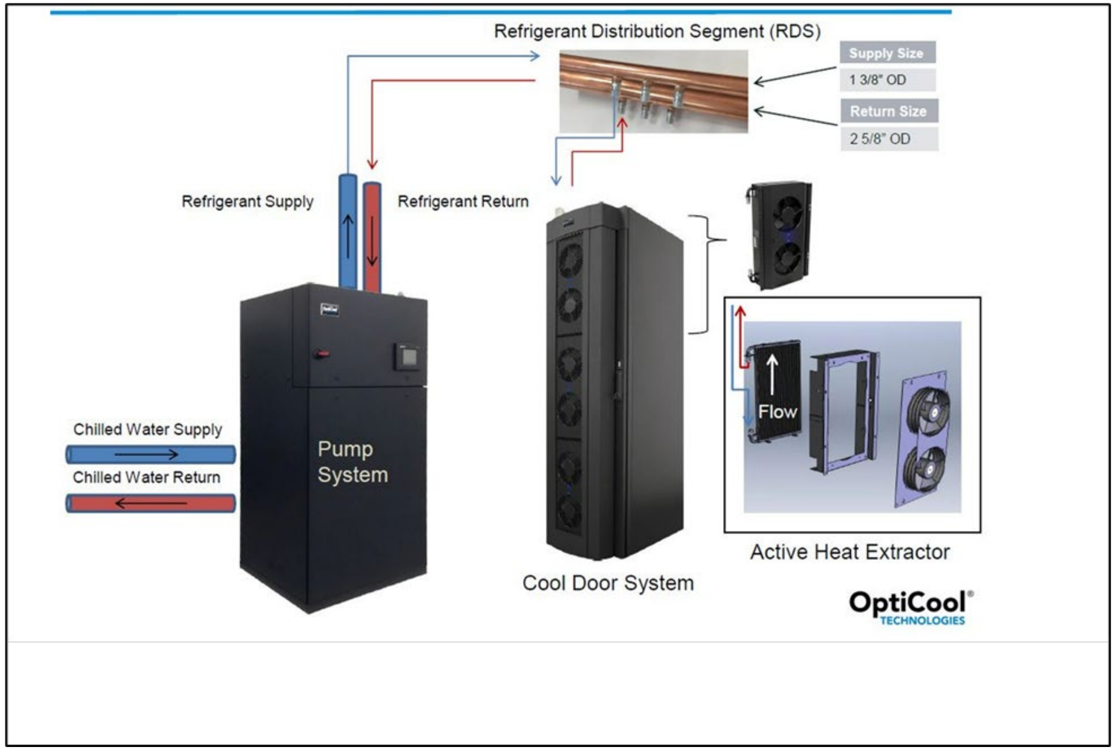
- Bulk air delivery are inefficient
- Hot and cold air mixing
- High bypass air
- Often over provisioned to compensate



Cooling Systems – In-Row Cooling

- Multiple smaller HVAC units
- Containment provides more control of air movement
- Uses server space

Cooling Systems – In-Rack (Close Coupled Cooling)



Reduce
- Carbon Footprint: Up to 90%
- Energy Usage: Up to 90%
- Floor Space: Up to 60%
- Noise Levels: Down to 53 dBa
- Operating Costs

Eliminate
- Cooling the Entire Room
- CFD Airflow Modeling
- Return Air Plenum
- Troublesome Hot Spots
- Raised Floor
- High Maintenance Costs

Increase
- Energy Rebates: Up to 30%
- Rack Densities: Grow to 45kW+
- Cooling Efficiency with Superior Heat Capture
- In-Rack Redundancy: Up to N+2

Future-Proof
- Capacity
- Scalability
- Modularity
- Space efficiency
- Adaptability

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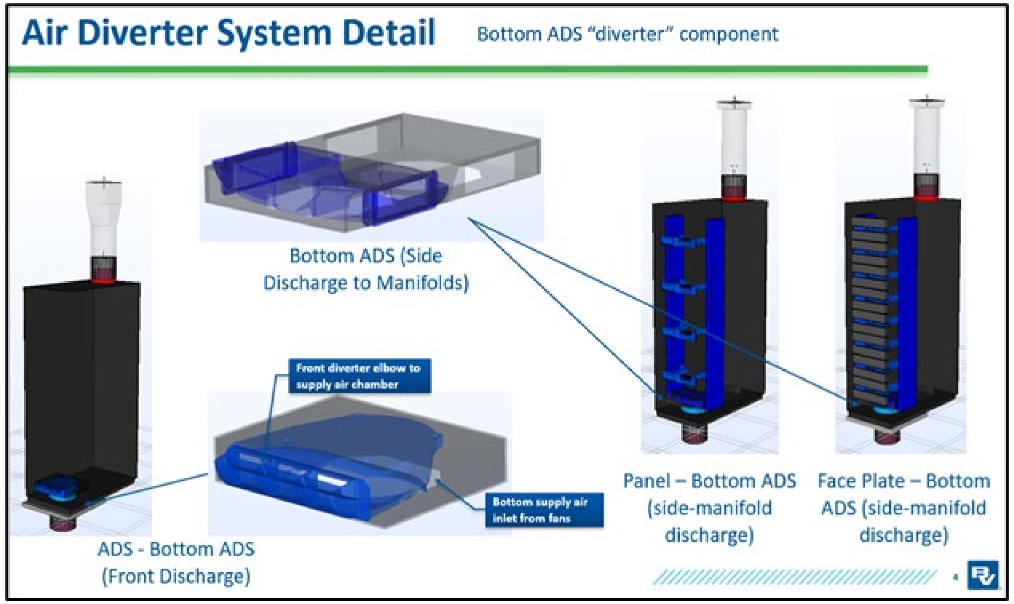
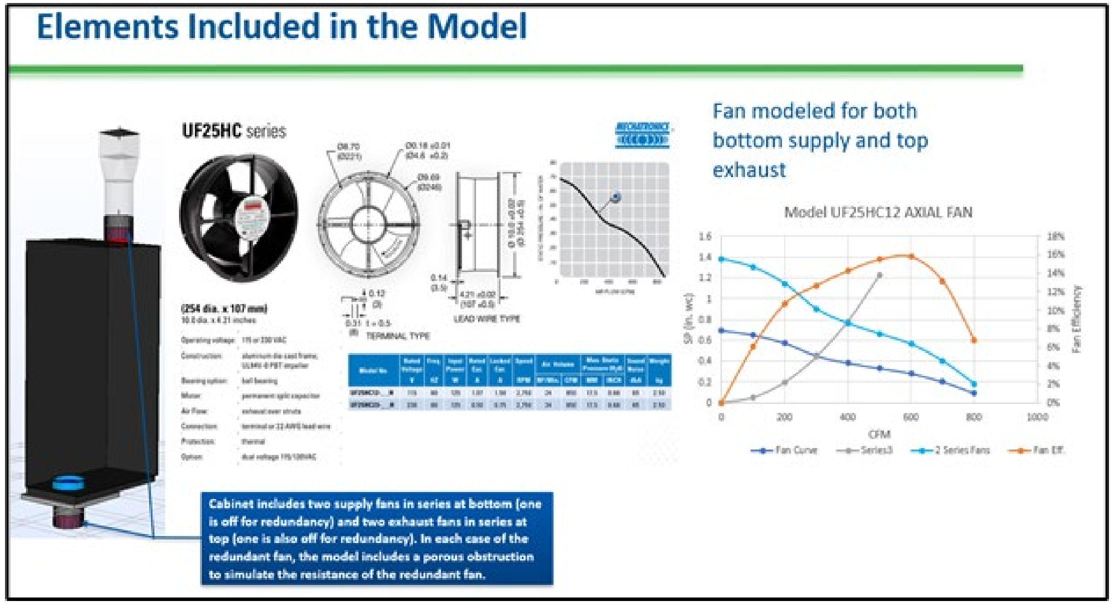
Cooling Systems – Replace Server fans with Bulk Fans





(Courtesy of Chillirack)

Cooling Systems – Why not CO_2?

Advantages	Disadvantages
Refrigeration capacity is high, approximately 5 times that of R404A (smaller compressor displacement but the same motor size)	Operating and standing pressures are high with resulting higher leak potential. Components specific to R744 required
Pressure drops in pipes allowing longer lines	Compressors are R744 specific, steel, or stainless-steel welded fittings required
Evaporators and condensers have high heat transfer	System complexity resulting in higher costs
System pressure drops, compression ratios all result in higher system efficiency	Complexity can result in poor performance and reliability because commissioning and operation need to be done correctly
Thermosyphoning of the refrigerant is possible reducing compressor run time.	Not suitable for high ambient temperature areas
R744 is inexpensive to manufacture, has low toxicity so release, often just by venting, or leakage is not an issue as there are no disposal restrictions	Listed as an asphyxiant so leak detection is required in small, enclosed spaces and release needs to be in well ventilated areas.

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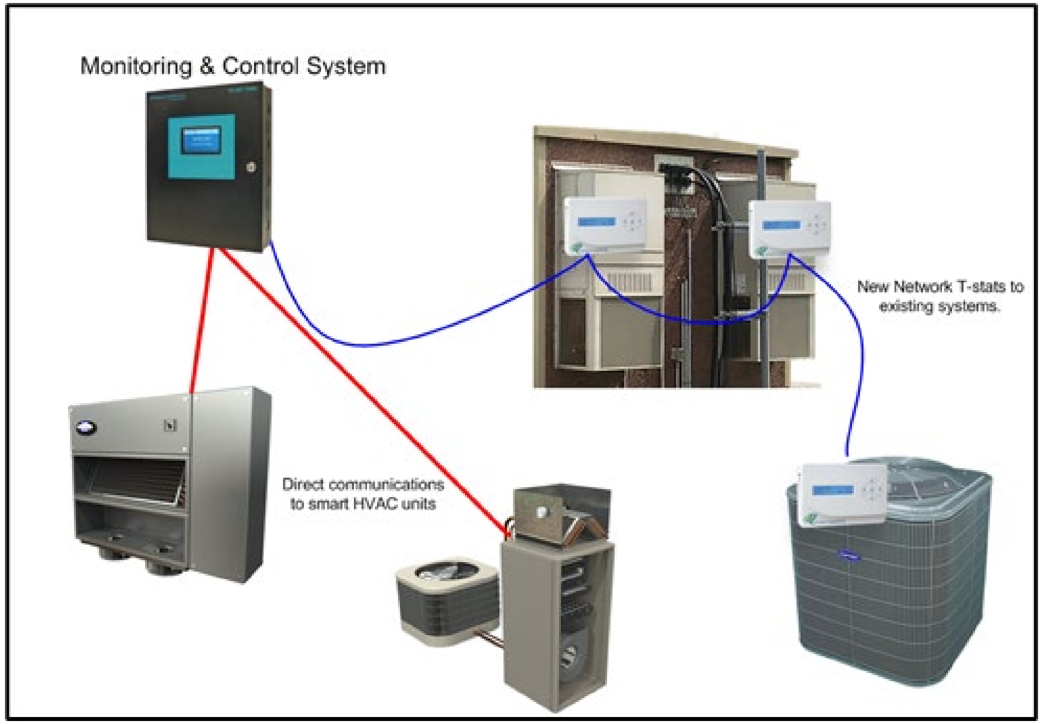
Monitoring and Control

- From Thermostat to Building Management System (BMS)
- Data Aggregation
- Data Analytics
- Next Gen Control Technologies
- Impact on Carbon



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Monitoring and Control

Tie to Carbon

Intelligent controls are able to take advantage of alternate cooling methods such as outdoor economization to further reduces compressor run time.

Examples

- Charter Communications, Inc. "evaporative free-cooling avoided over 5,700 MWh[1] " or CO_2 reduction of 4,039 Metric Tons[2].
- Another MSO has recently completed a free air economization proof of viability at a Northeast facility reduction in compressor run time provided a savings of approximately 19,162kWh/13.6 Metric tons CO_2 during a five-month period available for economization use. This will yield a CO_2 reduction of 13.6 metric tons.

[1] Charter-2021-ESG-Report.pdf, https://corporate.charter.com/esg-report
[2] Carbon reduction calculated using the EPA calculator. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

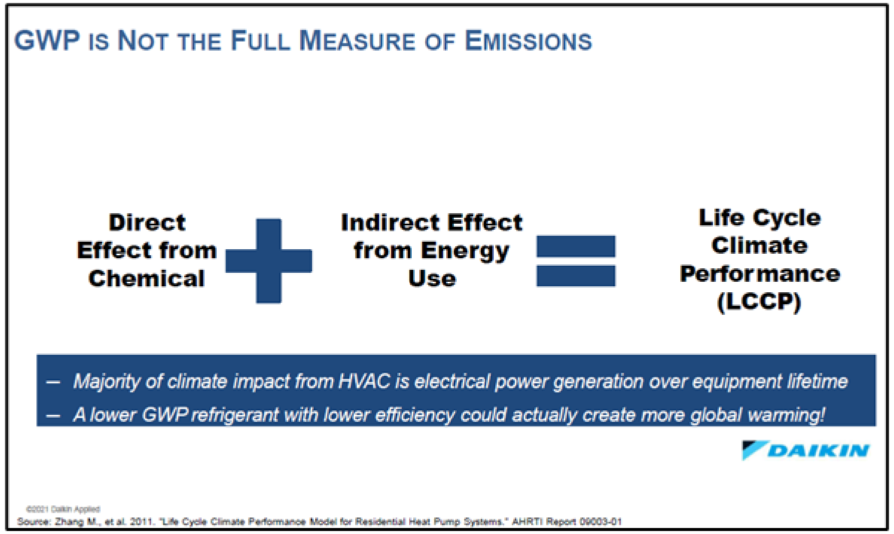
Next Generation Refrigerants and Cooling Systems

Refrigerants
- Designed to have low Global Warming Potential (GWP)
- Properties affect efficiency of HVAC
- This in turn can adversely affect the energy used by the HVAC to cool a give ITE heat load

Cooling Systems
- Use of Phase Change Material (PCM) reduce compressor run time
- Liquid Cooling
- Immersion Cooling
- Internal server cooling

Conclusions

- Critical facilities will have increasing energy requirements through capacity augmentation and higher energy density ITE.
- Their carbon footprint need not track those increases.
- The source of the electrical power being a key factor in the critical facility
- Climate performance consideration must be given to reduce that impact through use of microgrids, Distributed Energy Resources (DER) and other solutions for greener energy.



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