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FMD Facility Maintenance Decisions

Data Center Cooling 2015 - Moving at Warp Speed

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Today's Moderator

Edward Sullivan

Editor

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David Roden

Cooling Business Development Manager, Schneider Electric

David has been in the data center cooling industry for 13 years with roles in Engineering, Product Management, Sales and Business Development. He began his career with Schneider Electric (then APC) as an application engineer supporting the global sales force for precision cooling units and then advancing to other roles.

In 2007 David joined Coolcentric, a start up company focused on liquid cooling for data centers, responsible for leading the inside sales and sales engineering teams. He returned to Schneider Electric in 2011 and currently manages the eastern region of the US and Canada.

Prior to Schneider Electric, David served as a combat engineer officer in the United States Army. He received a Bachelors degree in mechanical engineering from Rensselaer Polytechnic Institute in Troy, NY and is a member of ASHRAE.

Learning Objectives:

- Analyze data center business trends
- Identify factors that impact economizer mode operation
- Evaluate room cooling vs. air handling units
- Understand how to compare economizer modes

To Ask Questions:

Please use the question and answer panel on the right-hand side of the screen, and send to all panelists.

Presentation Handouts

All participants will receive an e-mail by the end of the day with a link to download a PDF copy of today's presentation slides.

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June 2015

David Roden
Cooling Business Development Manager

Schneider Electric

Agenda

> Data Center Business Trends
> "Age" of the Economizer
> Room Cooling vs. Air Handling Units
> Economizers – which one is right for my Data Center?
> Conclusions

Data Center segmentation has changed from business size to business purpose

Server deployments in Cloud & Colo will increase by 2.5x by 2020 (2)

Enterprise
Data Center as an Enabler

PAM: $15.1B (1)
3% - 4% Growth

Cloud & Colo
Data Center as a Business

PAM: $4.9B (1)
15% - 20% Growth

HPC
Data Center as an Investment

PAM: $2.0B (1)
7% - 9% Growth

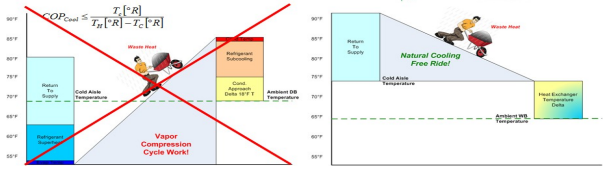
(1) PAM for Current yoy. Source Tier1 & ITB internal estimates

(2) Cloud & Colo server deployments will represent 43% by 2020; up from 18% in 2011 IDC

Influence of the Market

Industry Standards & Certifications driving technology & testing requirements

Economization



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NEW Technologies are emerging for very specialized applications

Water/Liquid Cooled Servers

LiquidCool SOLUTIONS

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Voice of customers

My problem in the Data Center is……

- How to reduce my Data Center OPEX
- Maximizing ROI and using capital efficiently
- How to deal with new standards of increasing temperatures
- First cost over other initiatives (efficiency and outsourcing)
- Ensuring predictability of the Cooling system
- Looking for education on how to design a Data Center to fit my needs
- Flexibility to adapt the physical IT space to dynamic operational demands
- Adapting to different building types, existing site constraints, and lack of outdoor space

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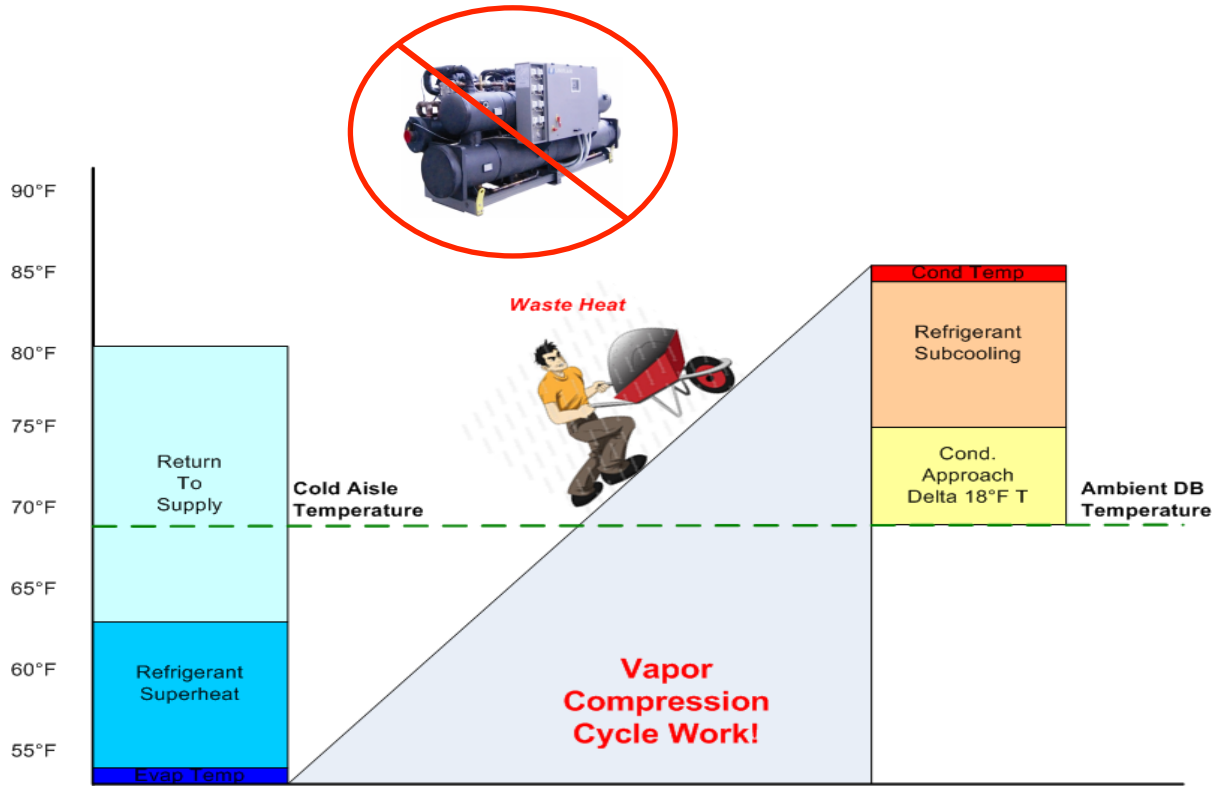
An Overview of the Economizer Mode

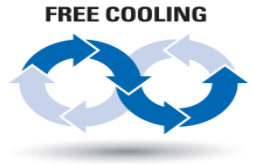
Operating in economizer mode saves energy

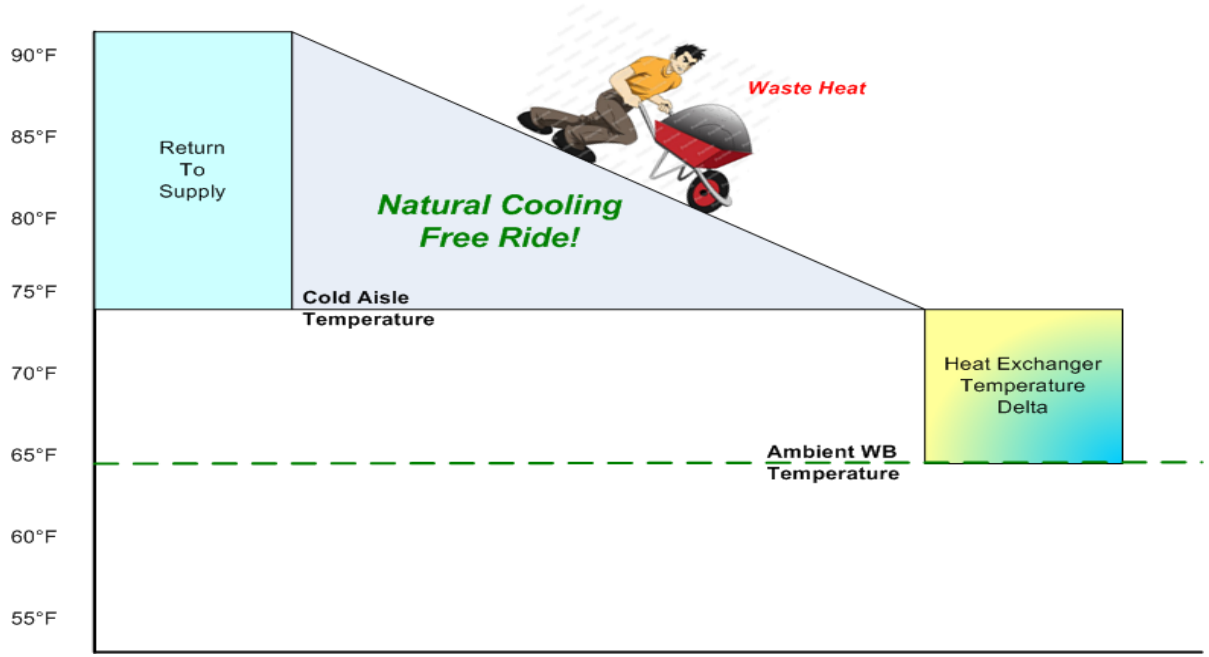
It is often a requirement in meeting efficiency targets

A greater demand to conserve energy

Economization – Will Minimize/Eliminate Vapor Compression Work





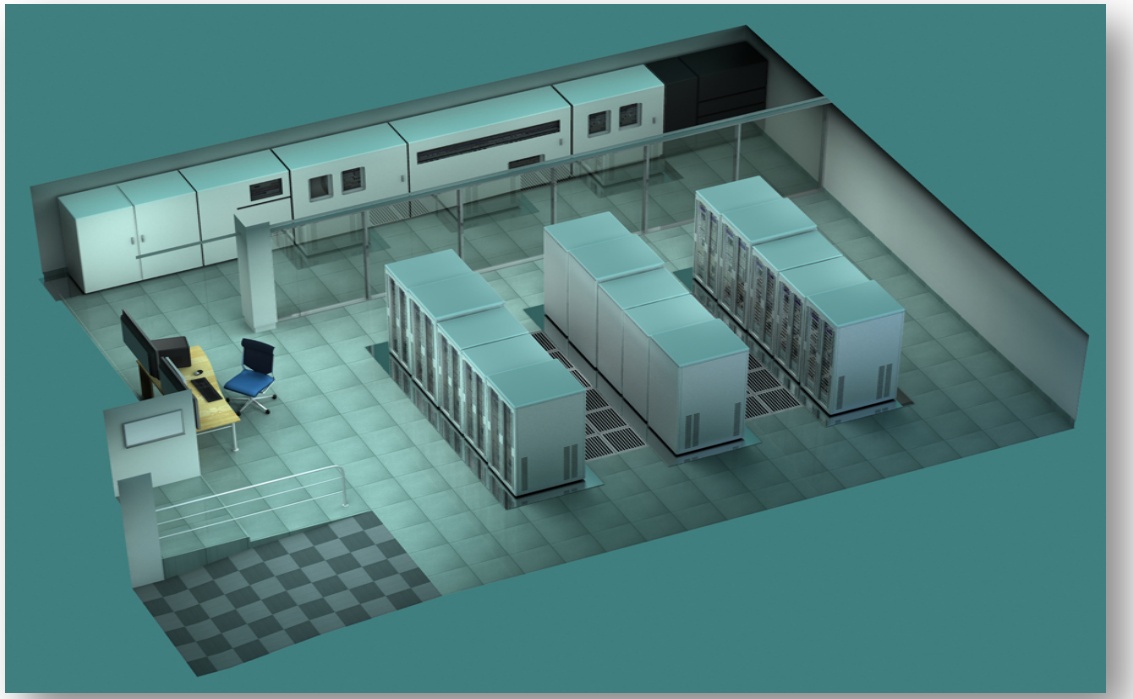


Energy Reuse???

Factors that Impact Economizer Mode Operation

- Geographic location
- Cooling system set points
- Separation of hot and cold air streams

Increased Interest in Economizers



> Operation at partial loads increases economizer mode benefits

> Trend toward higher IT air return temperatures increases % of time operation is possible

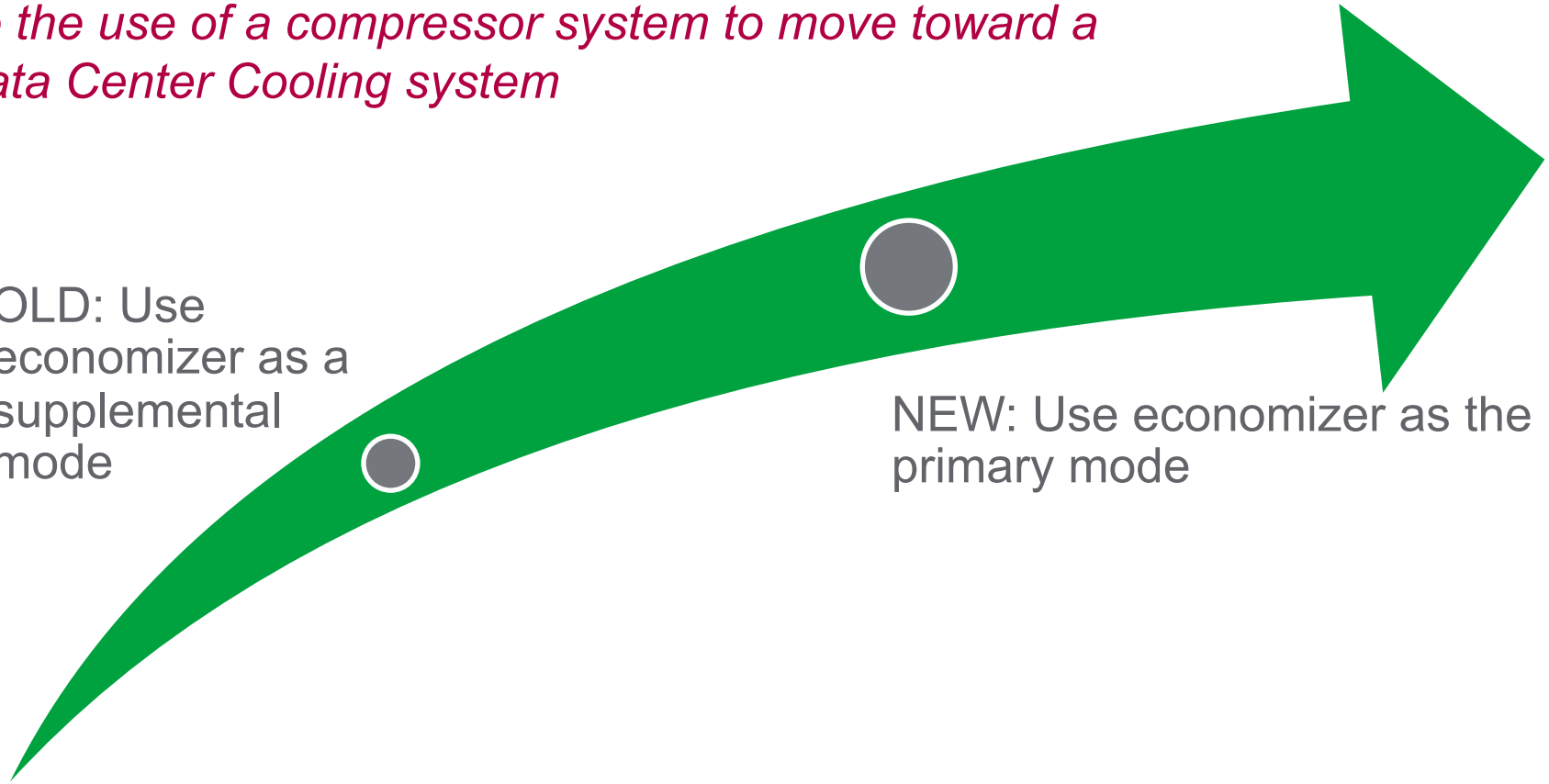
> Most new systems can operate in a partial economizer mode

> Tools for quantifying energy saved is improved and can predict ROI

> Real-world experience with these modes and improved systems has increase confidence

Paradigm Shift: Economizer to Become PRIMARY Mode of Operation

Reduce/eliminate the use of a compressor system to move toward a highly efficient Data Center Cooling system



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Room Cooling Segmentation

CRAC/CRAH

- Placed inside Data Center
- Heat rejection is external (ex. Chiller, Air-Cooled DX, etc.)
- Capacities up to 400kW per unit
- Typically standardized, w/ some level of customization
- Distributed approach
- Some free Cooling options
- May be less efficient when under-loaded

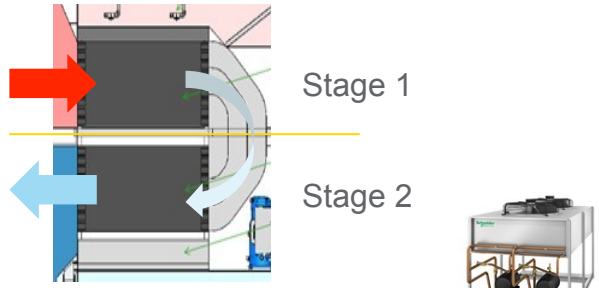
Air Handling Unit (AHU)

- Placed outside Data Center
- Heat rejection is 'self-contained'
- Capacities up to 1MW per unit
- Typically highly customized
- Larger fans provide some gain in efficiency (ex. 2-4%)
- Multiple free Cooling options
- Piping for liquid distribution is reduced
- Ducting for air distribution is increased
- May be more efficient when under-loaded due to larger coil face

Innovation in the market

Multi-Phase Indirect Air Economizer Solutions

- Increased efficiency, improved water consumption, optimized perimeter IT room interface

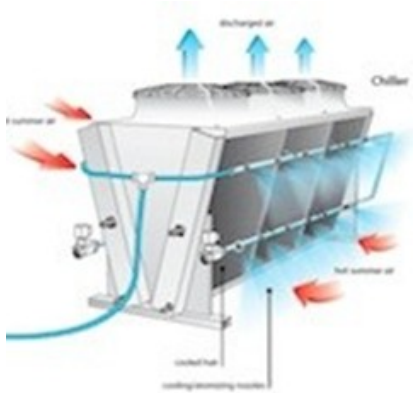


Refrigerant Economizer

- Improved efficiency and simplified economization for Air cooled DX solutions

Adiabatic / Evaporative Air Cooled Chillers

- Expands free Cooling hours improving efficiency



Room Cooling Selection Considerations

- Financial
  - First Cost
  - Operating Cost
  - 3-Year TCO (Operating + First Cost)
  - *Day one budget vs. Pay as you grow*
- Facility Constraints (Existing Data Centers)
  - Out of Capacity
  - Stranded Capacity
  - Out of Space
- Qualitative Criteria
  - Reliability / Availability
  - Flexibility
- Regional considerations and tweaks related to economization

Financial Comparison

- Data Center Sizes – 60, 120, 480, 1200 kW
- Rack Density – 3, 6, 12, 20 kW per Rack (120 CFM/kW)
- Raised Floor Air Distribution for Room Cooling – 100 Euro/ m2 ($8/ft2)
  - Raised Floor Pricing range from 30 Euro / m2 to 400 Euro / m2($50/ft2)
  - Does not consider fire suppression under floor ($4-$10/ft2)
- Drop Ceiling for Room Cooling Hot Aisle Containment – 36 Euro / m2 ($4/ft2)
  - Based on RSMeans Cost Works Data Base – Typical Drop Ceiling
  - Does not consider fire suppression in drop ceiling range ($4-$10/ft2)
- Active Floor for Room Cooling with CAC and raised floor for high density (12 and 20 kW per rack)
- Piping costs based on RSMeans Cost Works Data Base – Steel Piping
- Cost of Energy = 0.1 Euro / kWh
- EcoStream Analysis Tool used to determine airflow required for each scenario

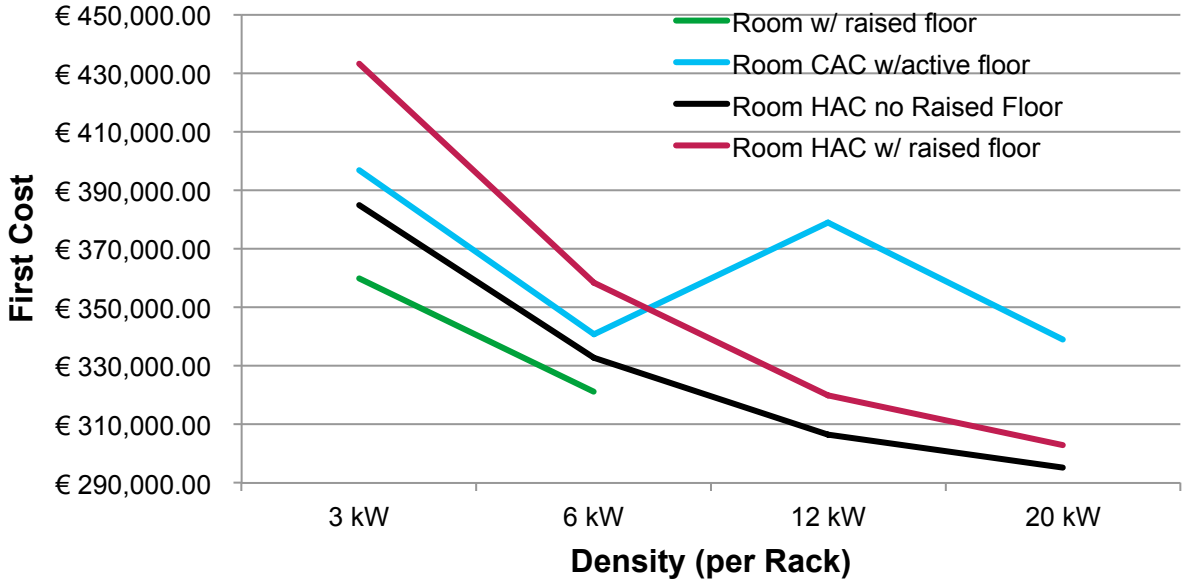
Benefits of Containment–Room Cooling

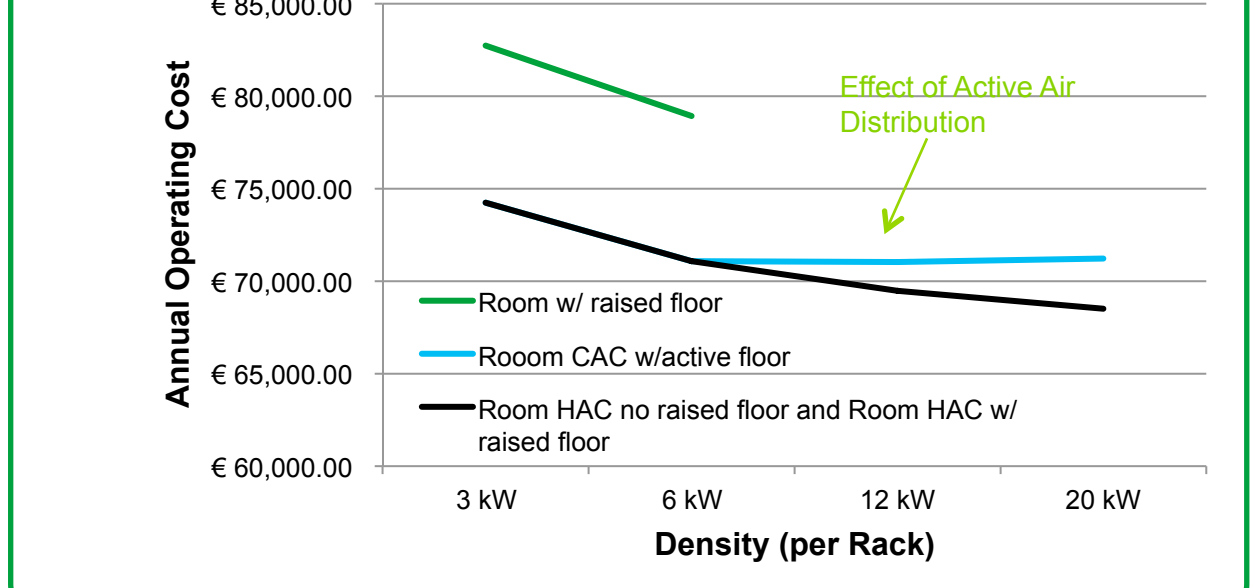
First Cost

- Higher first cost of adding containment to room Cooling
- Room Cooling with no raised floor and Hot Aisle Containment (HAC) most cost effective solution.

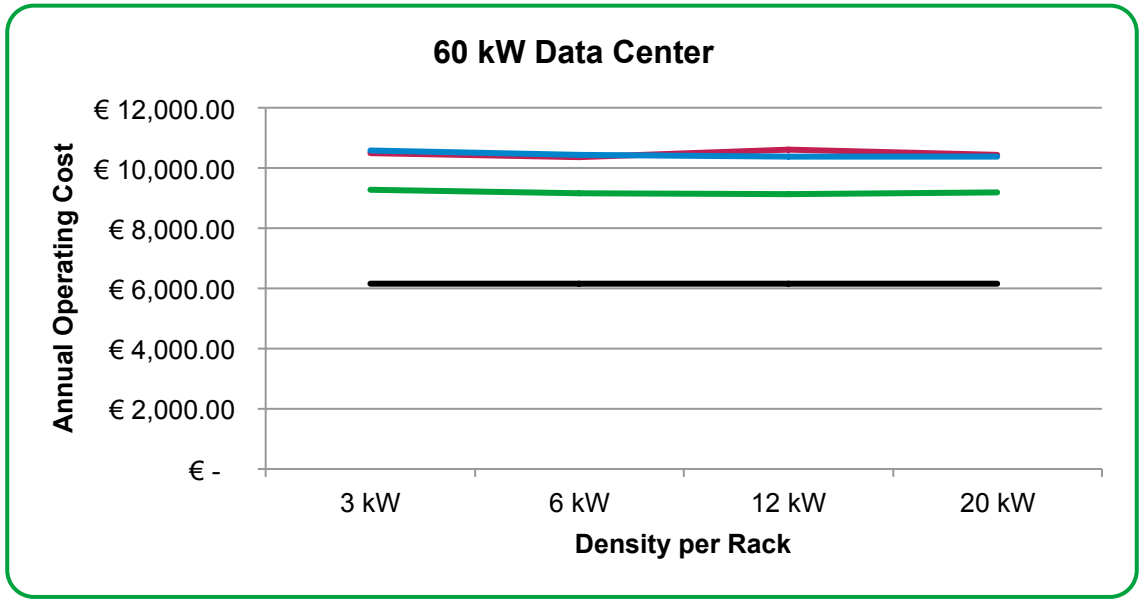
Operating Cost Improvement

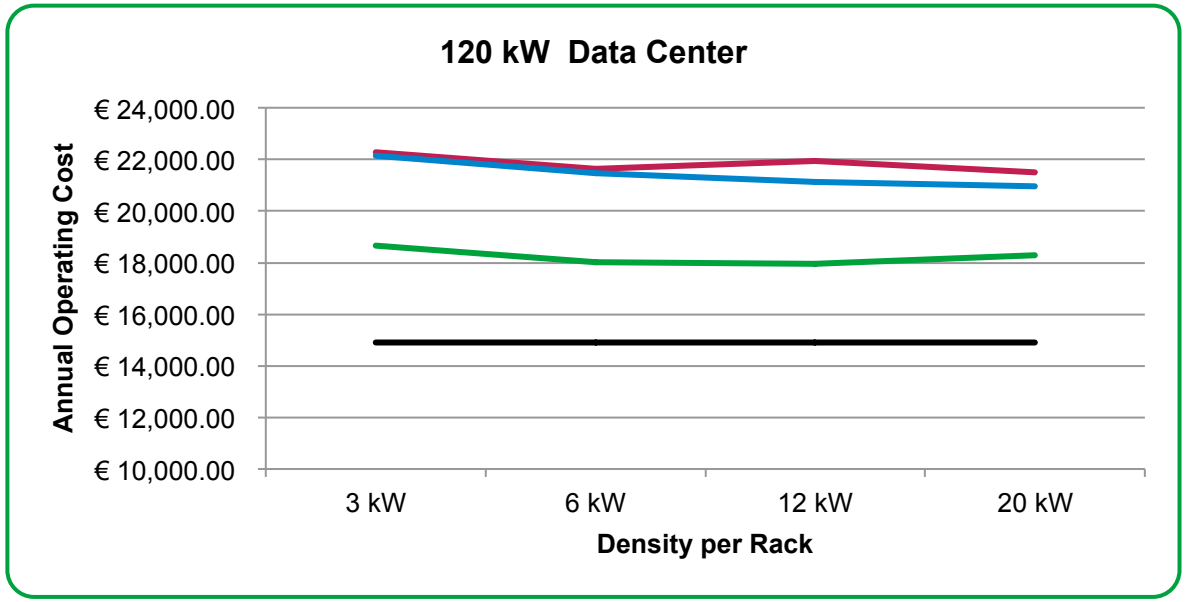
- HAC no raised floor ROI over raised floor
  - 3 kW per Rack = 3 years
  - 6 kW per Rack = 1.5 years
- CAC with raised ROI over raised floor
  - 3 kW per Rack = 4.3 years
  - 6 kW per Rack = 2.5 years

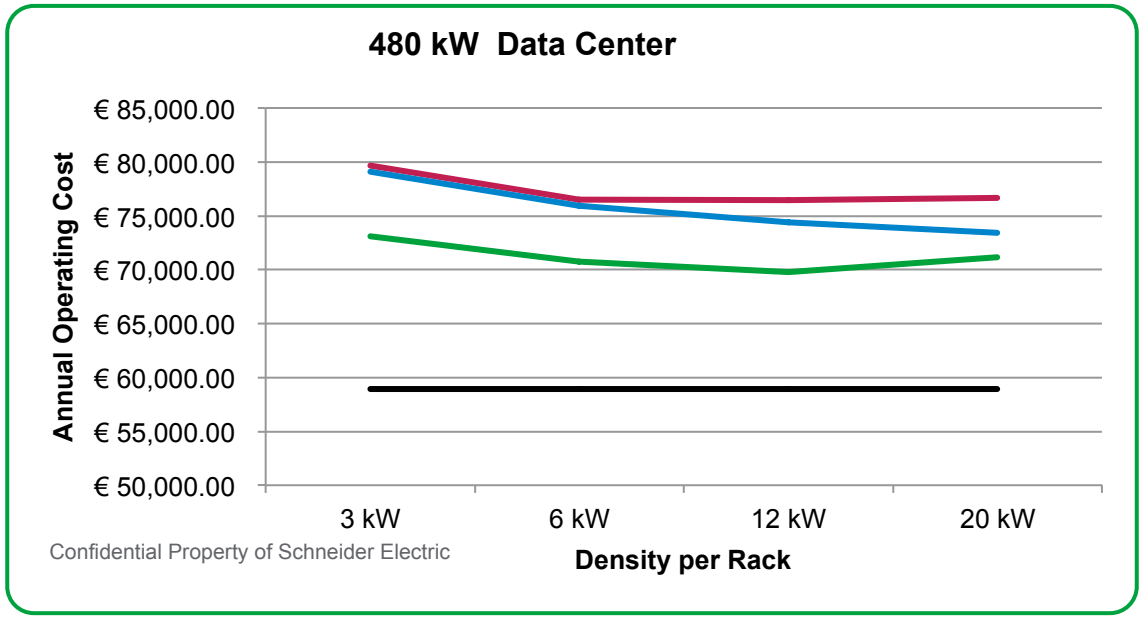


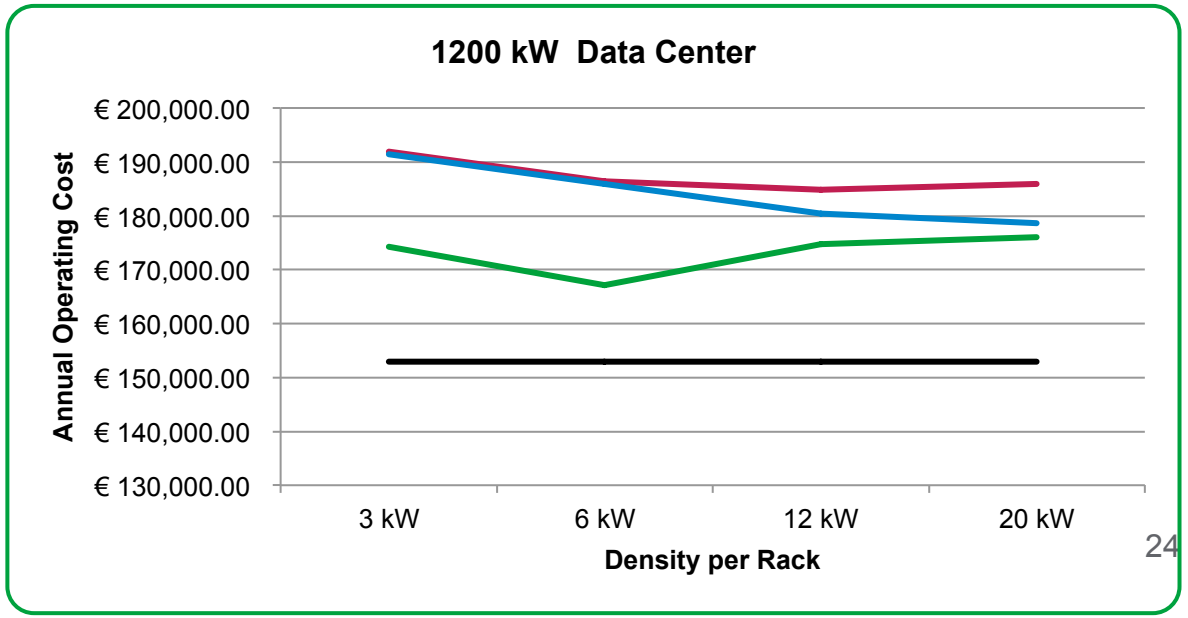


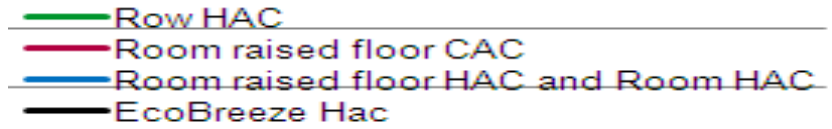
Annual Operating Costs











3-Year Cost Model

	IT Deployment / Data Center Size	
Density per Rack	Medium (201-999kW)	Large (1MW and Over)
3 kW	CRAH w/ HAC	AHU w/ HAC
6 kW	CRAH w/ HAC	AHU w/ HAC
12 kW	CRAH w/ HAC	AHU w/ HAC
20 kW	CRAH w/ HAC	AHU w/ HAC

- Some scenarios are very close
  - Region
  - Small price variations

Summary

> CRAHs well suited for Data Centers 200kW – 1MW

> AHUs better suited for Data Centers +1MW

> Using Containment is a mandate for efficiency optimization

> First cost of AHUs is moderately higher, but payback can be achieved in 3 years or less

> Highly customized units tend to have more quality/reliability issues than those having some level of standardization

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Comparison of Economizer Modes

15 Economizer Modes

6 economizer modes in ***extreme hot*** outdoor conditions, should at least partially depend on a ***refrigerant-based mode***

Partial Economizer Mode

Evaporative Assist

Qualitative Comparison of Economizer Modes

	Air Economizer Modes			Water Economizer Modes		
Economizer Mode Attribute	Air conditioner bypass via direct fresh air (w/ evap assist)	Air conditioner bypass via air heat exchanger (w/ evap assist)	Air conditioner bypass via air heat wheel (w/ evap assist)	Chiller bypass via heat exchanger	Packaged chiller bypass via evaporative cooler [3]	CRAC compressor bypass via second coil (w/ evap assist)
Building shell compatibility	May require building shell modification	May require building shell modification	May require building shell modification	No issue with building shell	No issue with building shell	No issue with building shell
Ability to retrofit	Not logical to retrofit into existing system	Not logical to retrofit into existing system	Not logical to retrofit into existing system	Practical if space available	Practical if space available	Requires swapping out CRAC unit
Complexity of controls	Fewer devices to control	Fewer devices to control	Fewer devices to control	Most devices to control	Moderate number devices to control	Moderate number devices to control
Data Center humidity control	Dependent on outdoor humidity	Independent of outdoor humidity	Independent of outdoor humidity	Independent of outdoor humidity	Independent of outdoor humidity	Independent of outdoor humidity
Life expectancy	20-40 years on heat exchanger	20-40 years on heat exchanger	20-40 years on heat exchanger	10-15 yrs on plate heat exchanger	10-20 years on evaporative cooler	10-20 years on Cooling unit
Availability risks -loss of Cooling water - poor air quality - fire suppression	Highly susceptible to outdoor air quality Shutdown required with clean agent suppression	Low downtime risk due to water loss. No risk due to poor air quality, or fire suppression	Low downtime risk due to water loss. No risk due to poor air quality, or fire suppression	Downtime due to loss of make-up water for Cooling tower	No downtime due to water loss, poor air quality, or fire suppression	No downtime due to water loss, poor air quality, or fire suppression
Footprint	0.41 ft^2 / kW 0.038 m^2 / kW	0.788 ft^2 / kW 0.073 m^2 / kW	1.72 ft^2 / kW 0.16 m^2 / kW	1.94 ft^2 / kW 0.18 m^2 / kW	3.34 ft^2 / kW 0.31 m^2 / kW	2.02 ft^2 / kW 0.19 m^2 / kW
Need for backup refrigerant mode	Fully sized backup in case of poor outdoor air quality	Partially sized for extreme climates	Partially sized for extreme climates	Partially sized for extreme climates	Partially sized for extreme climates	Partially sized for extreme climates

Qualitative Comparison of Economizer Modes

	Air Economizer Modes			Water Economizer Modes		
Economizer mode attribute	**Air conditioner bypass via direct fresh air (w/ evap assist)**	**Air conditioner bypass via air heat exchanger (w/ evap assist)**	**Air conditioner bypass via air heat wheel (w/ evap assist)**	**Chiller bypass via heat exchanger**	**Packaged chiller bypass via evaporative cooler [5]**	**CRAC compressor bypass via second coil (w/ evap assist)**
Annual water consumption	100 gal 379 L	1,262,000 gal 4,777,000 L	257,000 gal 973,000 L	7,000,000 gal 26,000,000 L	128,000 gal 485,000 L	128,000 gal 485,000 L
Capital cost of entire Cooling system	$2.2 / watt	$2.4 / watt	$2.8 / watt	$3.0 / watt	$2.3/ watt	$2.0 / watt
Annual maintenance cost of entire system	75%	75%	83%	100%	100%	92%
Total Cooling energy	737,506	340,365	377,625	589,221	736,954	960,974
Annual hours - full economizer mode	5,723	7,074	5,990	4,705	5,301	4,918
Annual hours - partial economizer mode	0	1,686	2,770	3,604	1,773	3,800
Est. annual PUE	1.34	1.25	1.26	1.31	1.34	1.39

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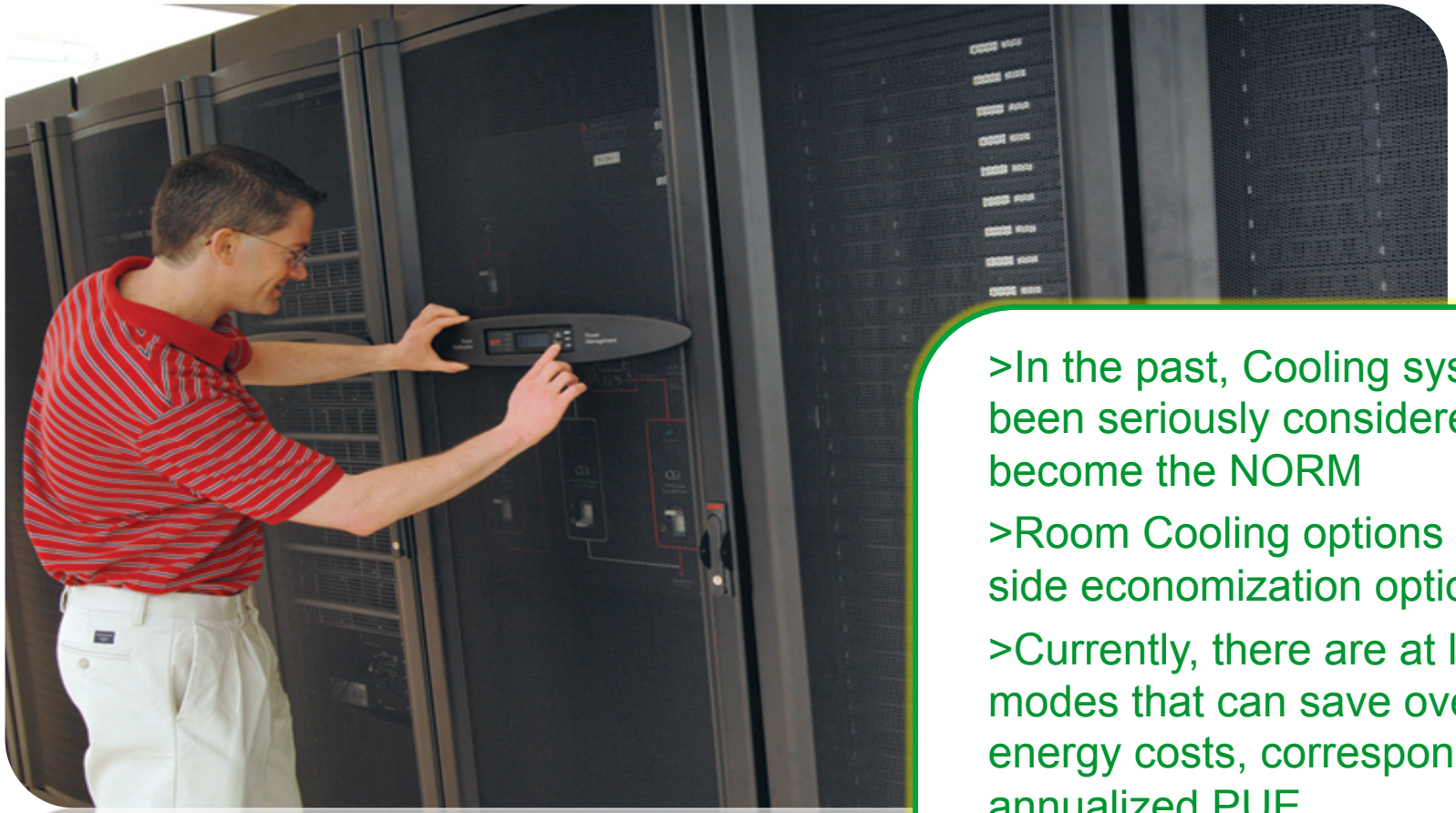
Conclusions



>In the past, Cooling system economizer modes have not been seriously considered in most Data Centers but will now become the NORM

>Room Cooling options are numerous. Water-side and Air-side economization options exist for a variety of applications.

>Currently, there are at least 15 different types of economizer modes that can save over 70% in annual Cooling system energy costs, corresponding to a 15%+ reduction in annualized PUE

Resources List

The Different Types of Air Conditioning Equipment for IT Environments
Data Center Science Center White Paper 59

Hot-Aisle vs. Cold-Aisle Containment for Data Centers
Data Center Science Center White Paper 135

Economizer Modes of Data Center Cooling Systems
Data Center Science Center White Paper 132

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