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LU-VE GROUP

leadership with passion

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CLOSE CONTROL AIR CONDITIONERS

DATA CENTERS DESIGN SIDE NOTES

P series G series R series F series

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DATA CENTER NEEDS

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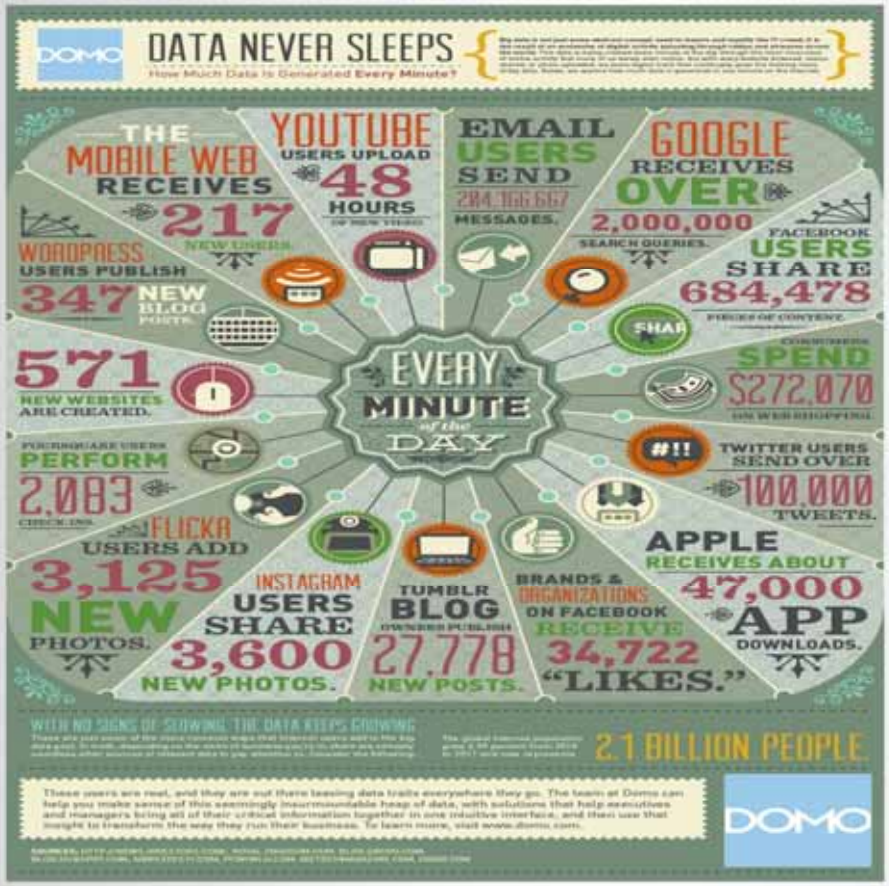
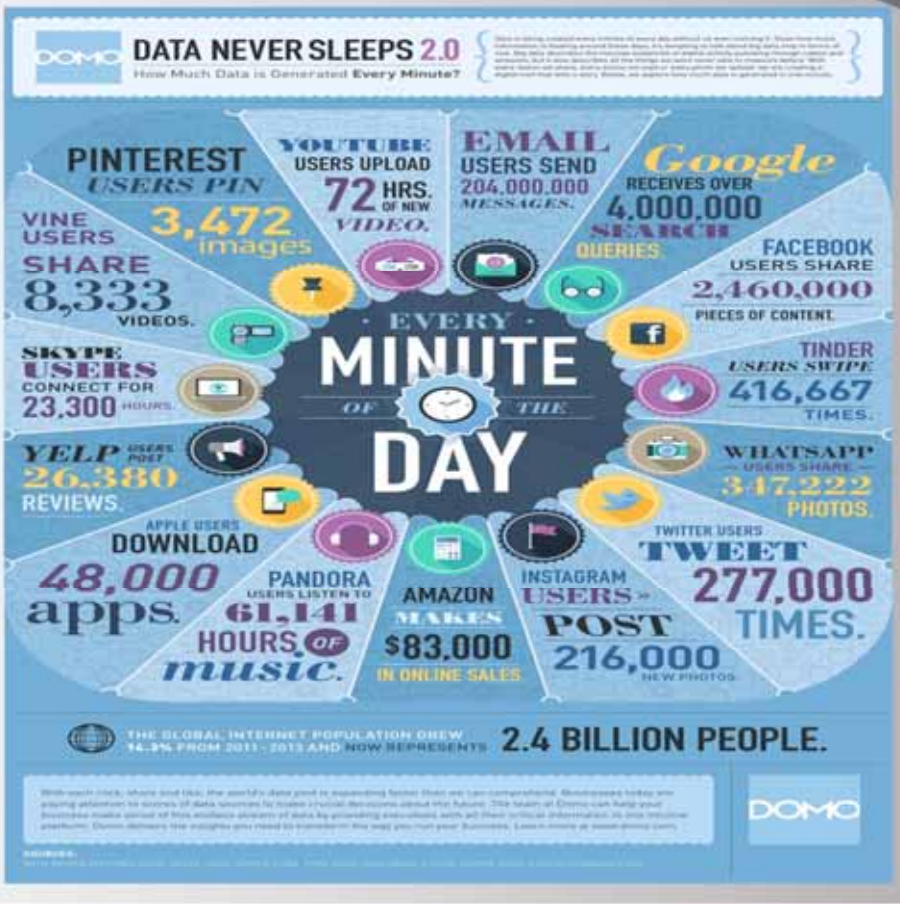
A MINUTE IN THE LIFE OF INTERNET

Evolving technology has created the necessity for ever greater exchange of data, increasing exponentially the concentration of electronic equipment inside Data Center





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A DAY IN THE LIFE OF CLOUD

How often do you use the cloud? Maybe More than you think?
The timeline below provides examples of when you may not realize you're using cloud based technology

6:00 A.M.

Wake up to your IPhone alarm clock playing a song from your ITunes playlist.

Apple's 125 million ICloud users have access to 28 million songs.

7:00 A.M.

Check your work email on your phone and respond to a few messages while drinking your morning cup of coffee.

68% of people check their work emails before 8:00 a.m.

8:00 A.M.

Before your company commute, VPN into your company's network to submit your expense reports to HR on time.

By 2016, at least 43% of the USA labor force will work from home at least occasionally.

9:00 A.M.

Arrive at work and turn on your computer as your antivirus software is updated and your files are backed up automatically.

60% of companies say cloud computing has reduced their need for their IT team to maintain infrastructure.

10:00 A.M.

Save work documents to the virtual server for your teammate in another country to edit next.

5GB of data storage in the cloud equals roughly 71,000 word documents.

12:00 P.M .

At lunch, use your mobile device to check your Facebook news feed and upload a photo.

10.4 million photos are uploaded to Facebook each hour.

2:00 P.M.

Conduct a virtual meeting with the global team in sixteen different countries around the world.

A five person meeting in-person is nearly 3 times as expensive as a video conference.

5:00 P.M.

Add gathered customer information from the workday to the CRM using your smartphone before heading home.

At year-end 2016, more than 50% of global 1000 companies will have stored customer sensitive data in the public cloud.

7:00 P.M.

Pull up the recipe you pinned to Pinterest for dinner tonight.

70% of pinterest account holders cite cooking and recipes as the top item they pin.

9:00 P.M.

Catch up on your favorite TV shows on Hulu.

73% of people who use Hulu only watch television shows.

11:00 P.M

Check your synced work/home calendar at night to prepare for the next day.

19% of internet users spend time organizing their life online daily.

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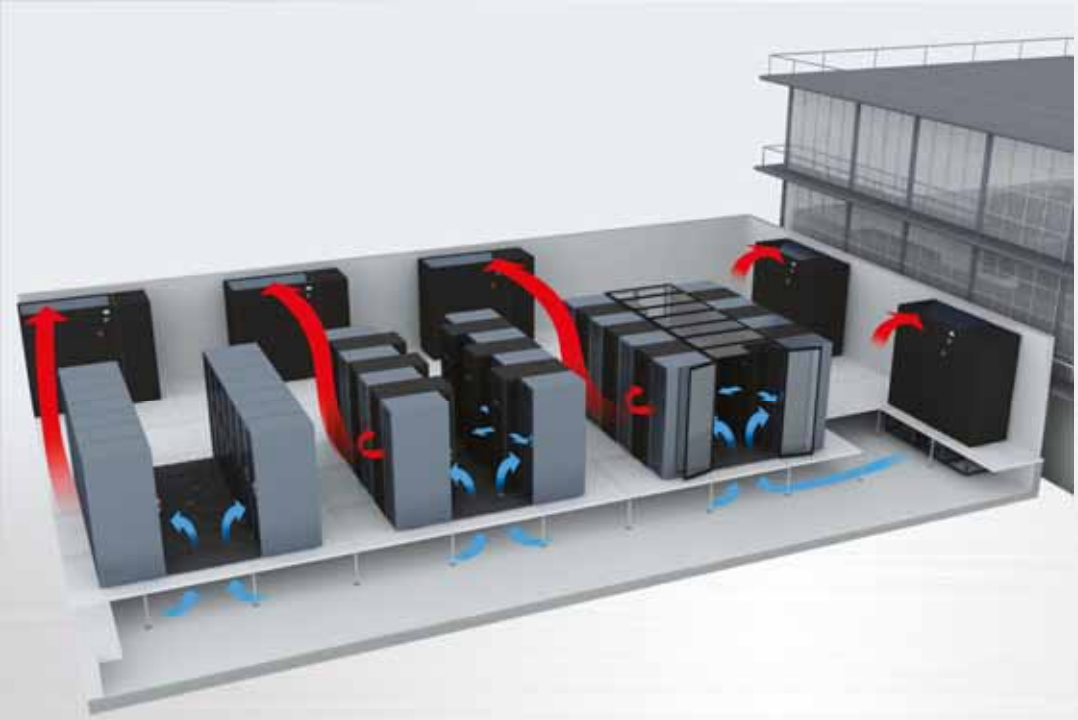
MAIN FEATURES OF DATA CENTERS



- Occupants of most facilities are people; the occupants in these facilities are software applications.
- Load is more volatile and transient since software additions and changes can take place very rapidly.
- Computer hardware is the major equipment, and equipment upgrades are often measured in months rather than years. This results in upgrade/life cycle mismatches between hardware and facility power/cooling.
- Often data centers have a connected power/cooling load density 10 times or more that of a typical office building.

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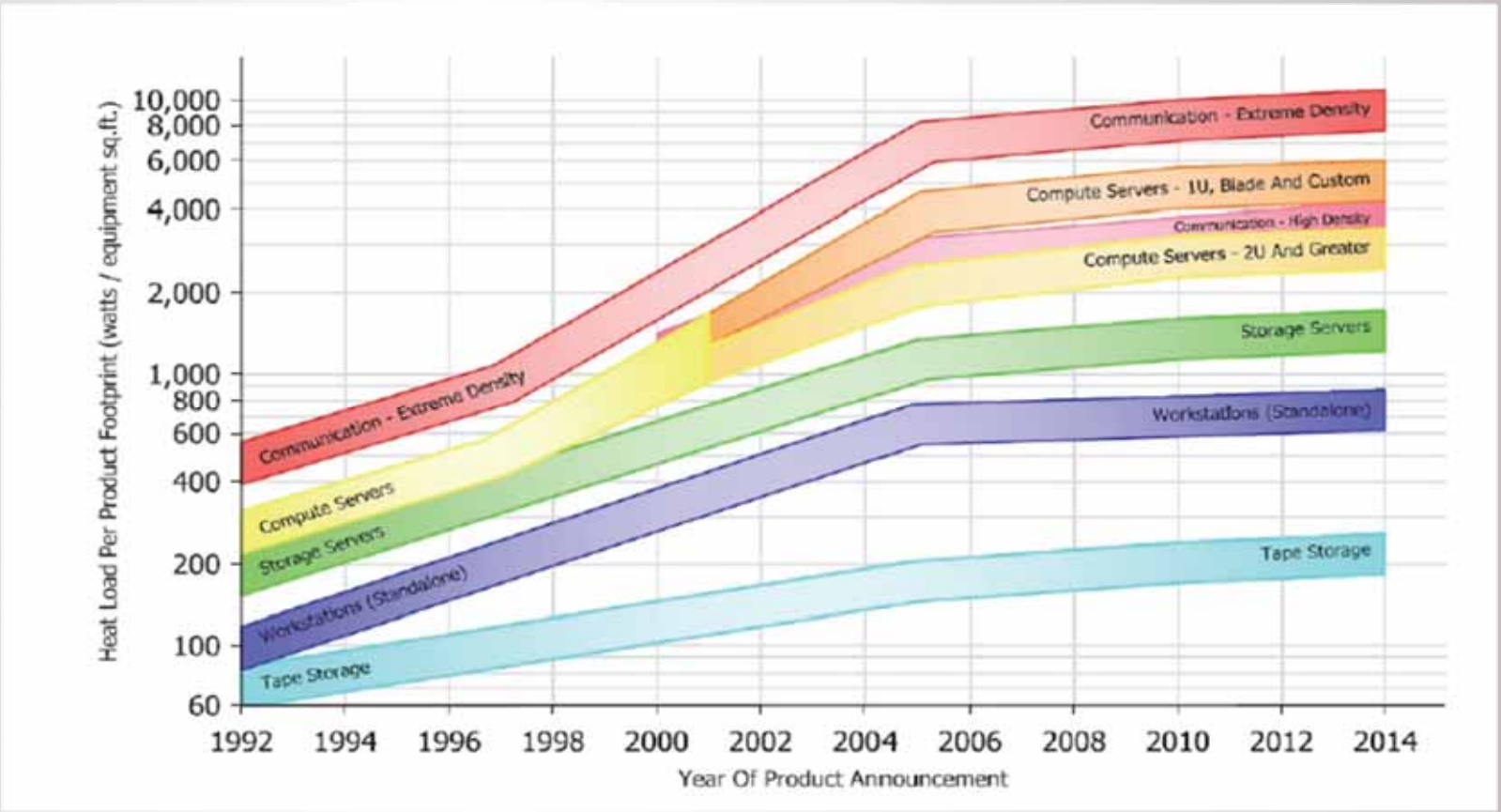
DATACOM EQUIPMENT LOAD TREND (ASHRAE)



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DATA CENTER POWER DENSITIES

Description	Heat load per Rack kW	Power Density (W/m^2)	Typical cooling medium	Cooling systems
Low density	1-7	500-900	Air	CRAC or CRAH units. All air systems
Medium density	8-10 10-14	900-1500	Air	Hot or cold aisle containment. CRAC or CRAH units. All air systems
High density	15-24	5000+	CW/Refrigerant/Carbon Dioxide	Hot or cold aisle containment. Containment or in-row liquid cooling
High density plus	25+	8000+	CW/Refrigerant/Carbon Dioxide	Cabinet/rear door liquid cooling
CRAC: Computer room air conditioning; CRAH: Computer room air handling ; CW: Chilled water				

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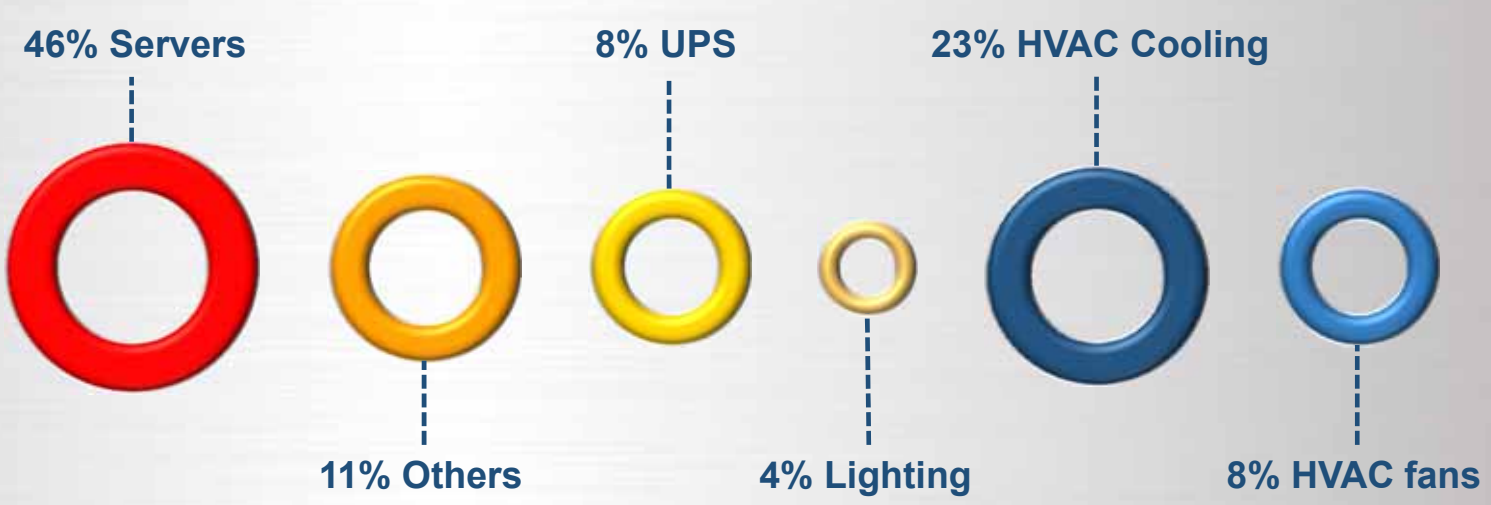
AVERAGE DATA CENTRE POWER ALLOCATION



Power consumption breakdown in a typical Data Center (ASHRAE)

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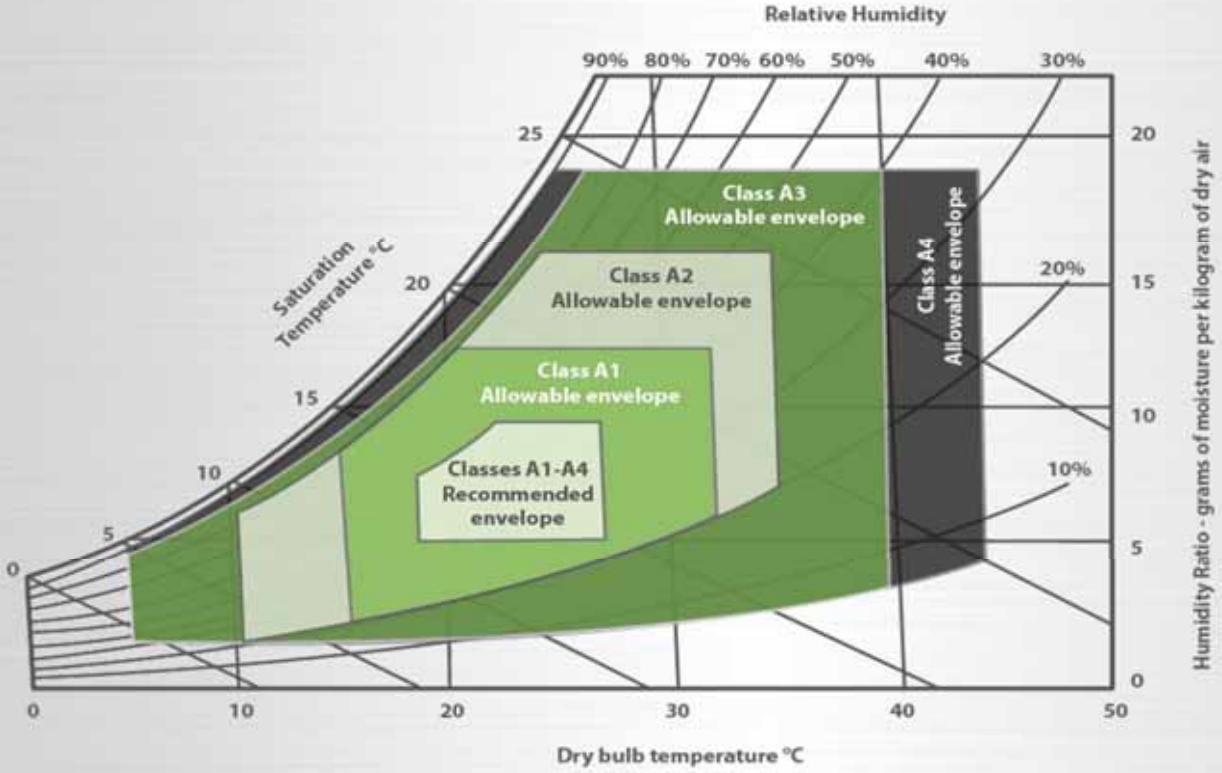
ASHRAE RECOMMENDED AND ALLOWABLE INLET AIR CONDITIONS TO SERVERS



Class A1: data centers with tightly controlled environmental parameters (dew point, temperature, and relative humidity); typically housing enterprise servers and storage products.

Class A2/A3/A4: information technology spaces with some control of environmental parameters (dew point, temperature, and relative humidity); types of products typically designed for this environment are volume servers, storage products, personal computers, and workstations.

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ASHRAE RECOMMENDED AND ALLOWABLE INLET AIR CONDITIONS TO SERVERS

Working Zone	Temperature Control	Humidity Control	Typical Application	Hardware	Average pPUE CW	Average pPUE DX
Tight Control	21°C to 25°C	45% to 55% RH	Legacy DC with supply temp. Control and High Precision control on Humidity	All Servers	1,25	1,35
ASHRAE Recommended	18°C to 27°C	5.5ºC DP to 60% RH and 15ºC DP	Current DC with return or supply temp. control and humidity control	All Servers	1,24	1,27
A1	15°C to 32°C	20% to 80% RH	Data Center with focus on Energy Savings and reduced limits on Hum.	Enterprise servers, storage products	1,19	1,24
A2	10°C to 35°C	20% to 80% RH	Information and Technology Space or Office	Volume servers, storage products, pc, workstations	1,15	1,19

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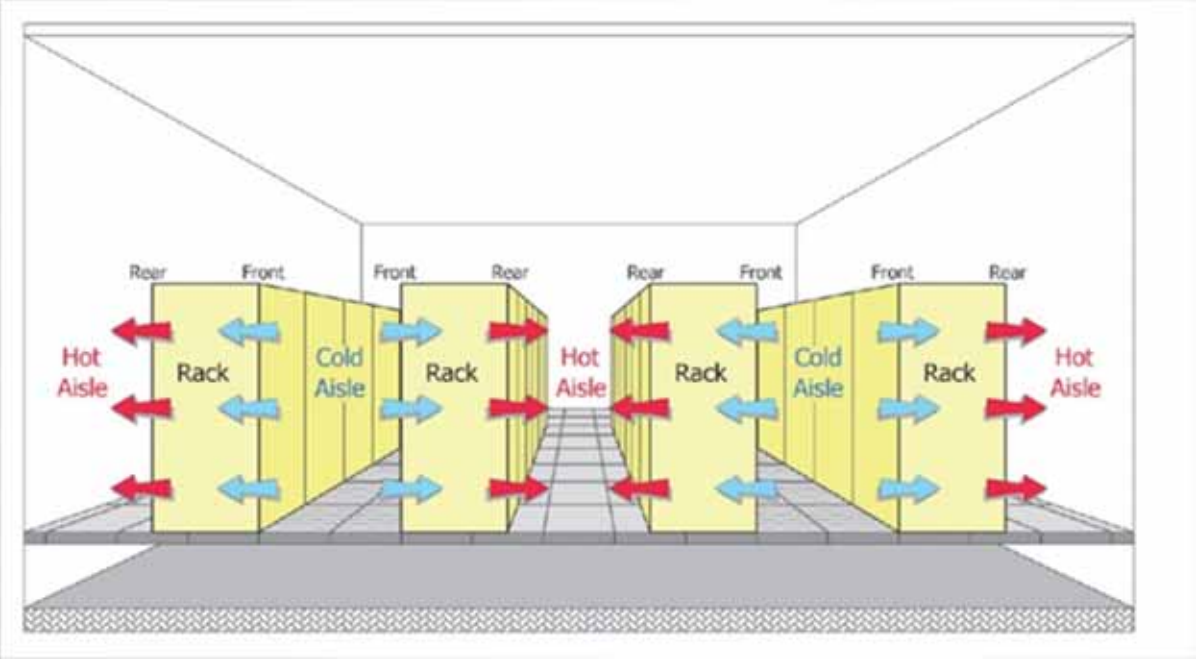
EQUIPMENT PLACEMENT HOT AISLE/COLD AISLE CONCEPT



EQUIPMENT INTAKES FACE THE COLD AISLE; AIR IS DRAWN INTO THEM, AND IS EXHAUSTED FROM THE REAR OF THE EQUIPMENT INTO THE HOT AISLE.

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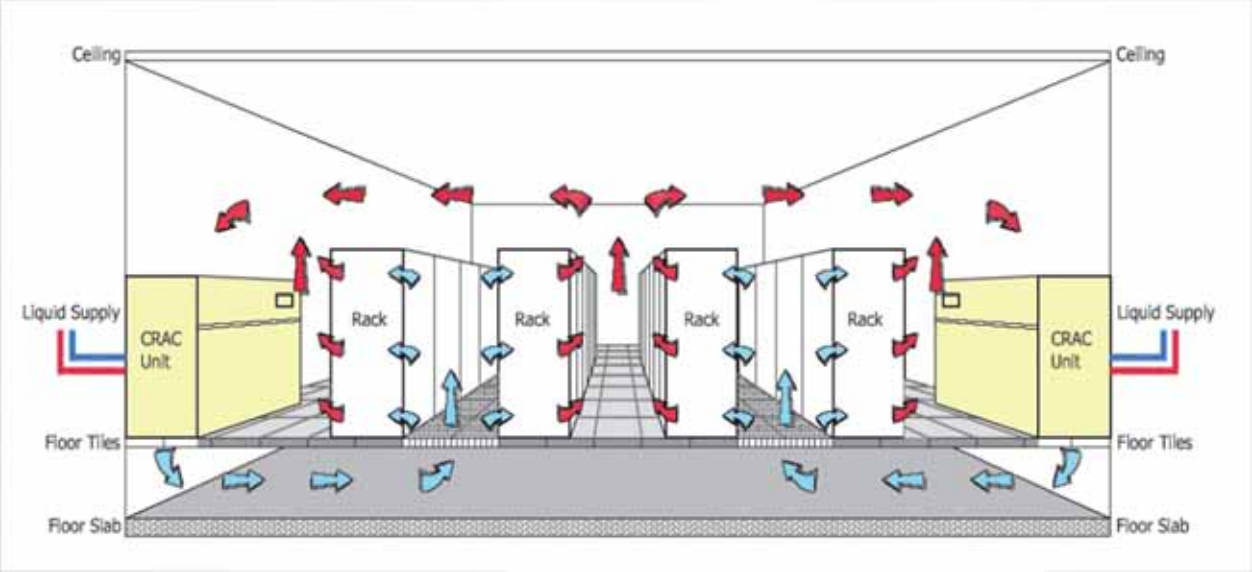
AIR DISTRIBUTION- UNDERFLOOR



PRO:

- Flexibility in equipment configuration
- Lower fan energy use

CON:

- Risk of air distribution disuniformity due to pressure variations in underfloor plenum

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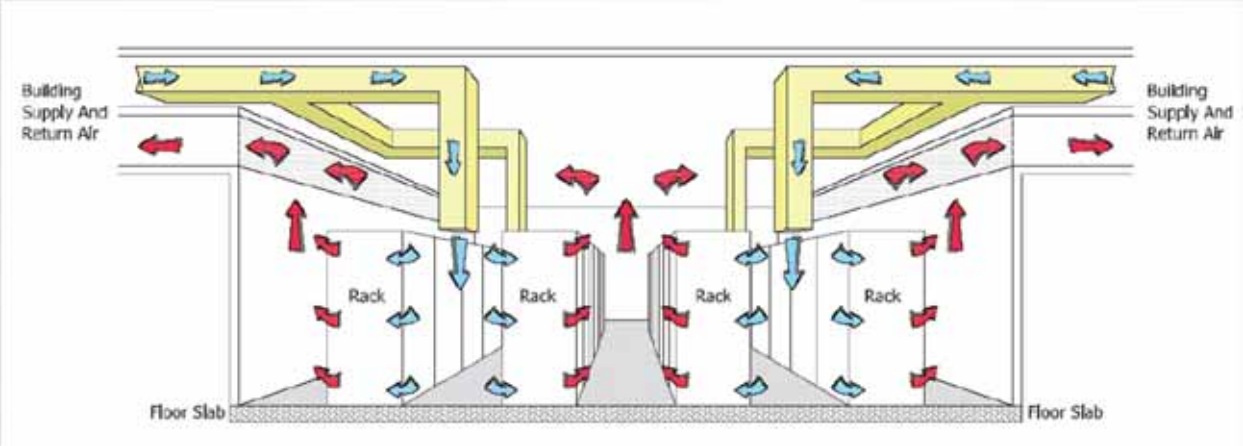
AIR DISTRIBUTION- OVERHEAD



PRO:

- Better air flow balancing
- Lower or no underfloor space needed

CON:

- Higher fan energy use
- Ductwork in ceiling and Datacom space

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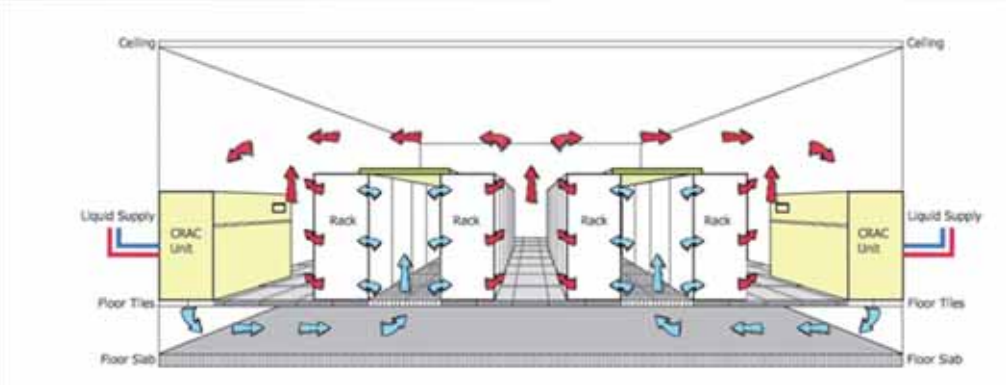
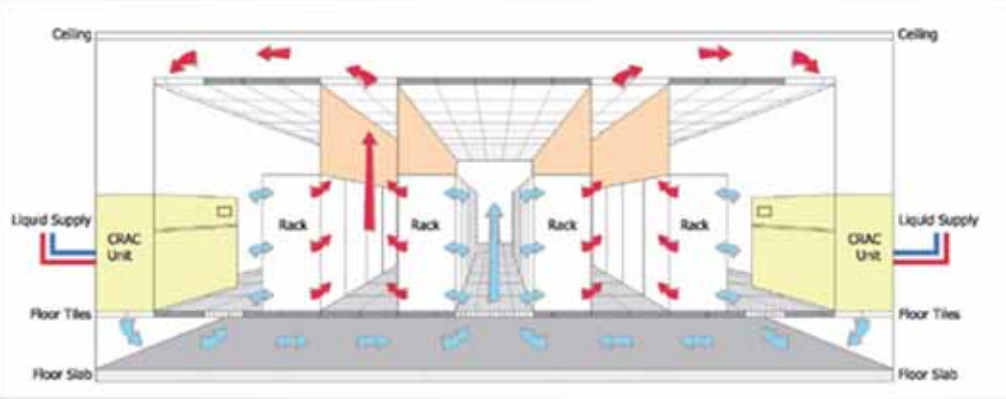
AIR DISTRIBUTION- OVERHEAD



Cold aisle containment schematic (ASHRAE)



Hot aisle containment schematic (ASHRAE)

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WHICH SOLUTION IS BETTER?

Characteristic	CACS	HACS	Comment
Ability to set work environment temperature to 24° C (standard indoor design temperature	NO	YES	With HACS, cooling set point can be set higher while still maintaining a work environment temperature of 24° C , and benefiting from economizer hours. Increasing CACS cooling set points results in uncomfortably high data center temperatures. This promotes a negative perception when someone walks in a hot data center
Take advantage of potential economizer hours	NO	YES	The number of economizer hours with CACS is limited by the maximum work environment temperature in the hot aisle (the work environment) and by temperature limitations of non-racked IT equipment
Acceptable temperature for non-racked equipment	NO	YES	With CACS, because the cold aisles are contained, the rest of the data center is allowed to become hot. Perimeter IT equipment (i.e. tape libraries) outside contained areas would have to be evaluated for operation at elevated temperatures. Risk of overheating perimeter IT equipment increases with decreased cold air leakage.
Ease of deployment with room cooling	YES	NO	CACS is preferred for retrofitting a data center with raised floor, room-level cooling with flooded return (draws its warm return air from the room). A HACS without row-oriented cooling or dropped ceiling would require special return ductwork.
New data center designs	NO	YES	The cost of building a new data center with CACS or HACS is nearly identical. Specifying HACS for a new data center will improve the overall efficiency, work environment and overall operating costs.

Both improve the efficiency of the HVAC equipment by preventing mixing of cold supply and hot exhaust air.

The pros and cons of the two solutions are summarized in the following table.

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AIR COOLING EQUIPMENT FOR DATACOM ROOMS

- Direct expansion units - CRAC (Computer Room Air Conditioners).
- Chilled water units - CRAH (Computer Room Air Handlers).
- Specifically designed for Datacom equipment room applications. Built and tested in accordance with ANSI/ASHRAE Standard 127, Available for underfloor or overhead air supply.
- Sized to supply air to IT equipment at 18 to 27° C, DT = 11 K.
- Recirculated room air continuously filtered with G4 filters (ANSI/ASHRAE Standard 127).
- For outdoor air G4 + F7 filtering required (EN 10339).

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DX OR CHILLED WATER?

Direct expansion systems		Chilled water systems	
Pros	**Cons**	**Pros**	**Cons**
Unitary equipment can be sized for the load to run at its best efficiency.	Impractical for large data centers	Large-capacity systems can produce cooling at the lowest EER	Impractical for small data centers.
Advances in displacement compressor technology has improved small system energy efficiency.	Increased maintenance due to multiple compressors, fans, and controls.	Water-side economizers can be added for cool-weather energy savings.	Winterization and freeze protection costs could negate energy savings.
Efficiency improves for air-cooled DX systems in cooler dimates.	Can have higher energy consumption than chilled-water systems, especially at larger cooling capacities.	Maintenance is minimized on the data center floor.	Water-cooled chillers require more building infrastructure.

If chilled water is chosen, hydraulic circuits should be loop type with multiple connection for supply reliability. Precautions against damages due to pipe leakage are mandatory.

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AUTOMATIC CONTROLS FOR DATACOM HVAC EQUIPMENT

The two fundamental values which must be controlled are air temperature and air flow. They must be controlled independently:

- Air temperature should be controlled at server inlet or at CRAC and CRAH supply. Return air temperature control MUST be avoided as much as possible.
- Air flow rate is best controlled depending on underfloor plenum pressure, which should be kept at a value of 10÷20 Pa.

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OPERATING COSTS

CAPEX (CAPital EXpenditure) – INDEX OF INITIAL INVESTMENT

The optimization of the design process and the selection of the air conditioning plant permit significant savings to be made in the implementation phase which greatly help to increase this index

OPEX (OPerating EXpenditure) – INDEX OF OPERATING COSTS

The selection of an air conditioning plant with a high degree of efficiency and sustainability enables very high OPEX index levels to be achieved

pPUE (Partial Power Usage Effectiveness) – INDEX OF ENERGY EFFICIENCY

An air conditioning plant with reduced energy consumption and advanced energy saving systems dramatically reduces the pPUE index.

DCiE (Data Centre Efficiency) – INDEX OF EQUIPMENT EFFICIENCY

As with PUE, an increase in DCiE is directly related to the efficiency of the air conditioning plant.

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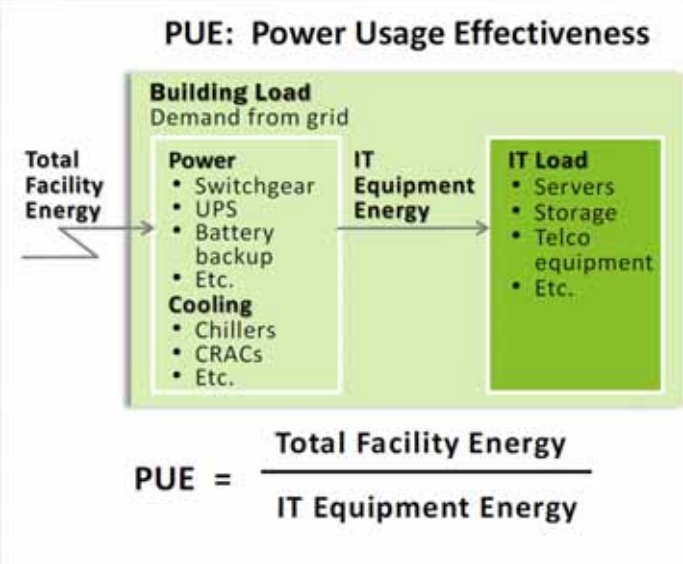
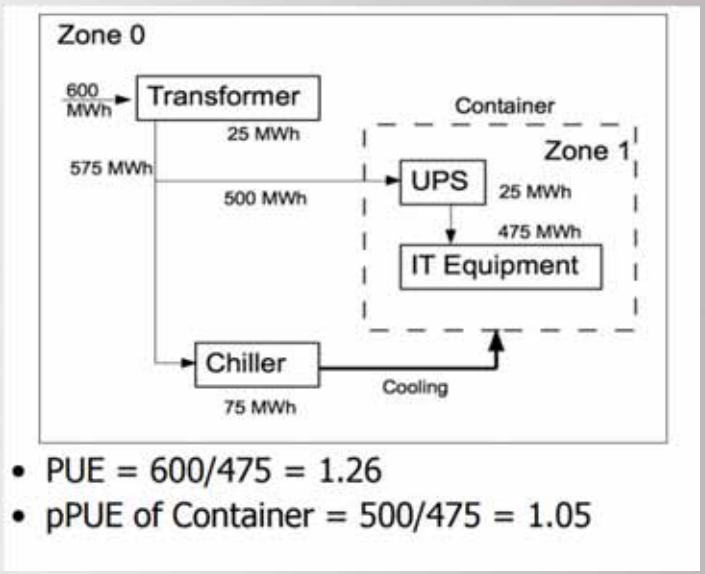
DEFINITION OF PUE/PPUE (POWER USAGE EFFECTIVENESS)



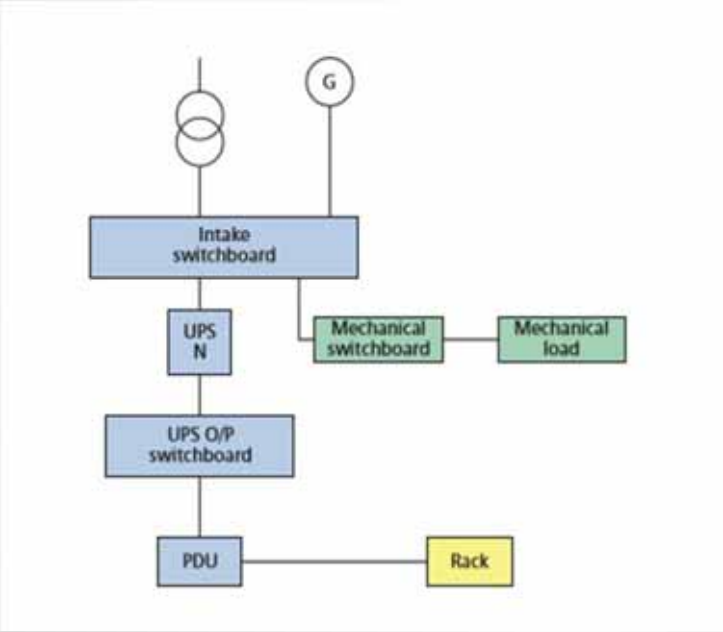


PUE is defined as the ratio of total facility energy to IT equipment energy.

Partial PUE is the total energy inside a boundary divided by the IT equipment energy inside the boundary.

TIER CLASSIFICATION – TIER 1

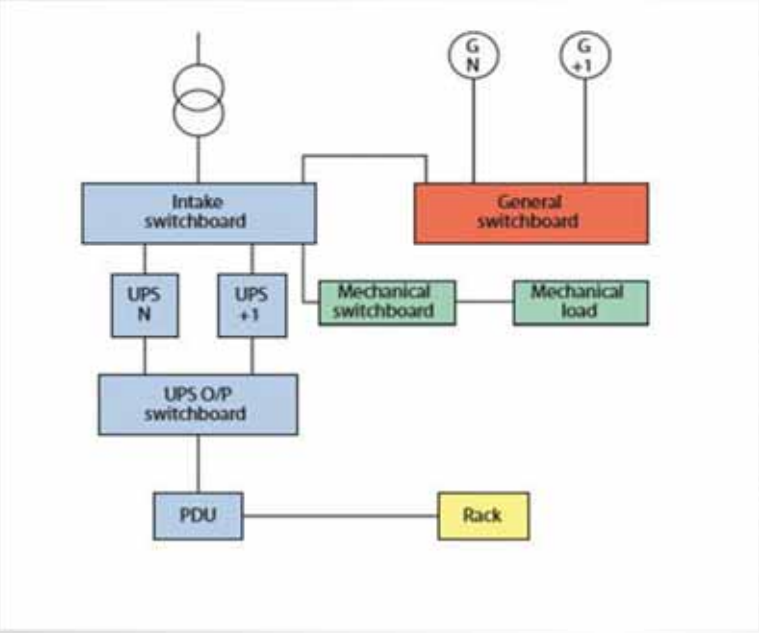
The standard Tier Classification System was created by the Uptime Institute in the USA to consistently evaluate various data center facilities in terms of potential site infrastructure performance, or uptime.
Each Tier incorporates the requirements of all the lower Tiers.



Tier 1: Basic Capacity.

A Tier 1 data center provides dedicated site infrastructure to support information technology beyond an office setting.

TIER CLASSIFICATION – TIER 2



Tier 2: Redundant Capacity Components.

Include redundant critical power and cooling components to provide select maintenance opportunities and an increased margin of safety against IT process disruptions.

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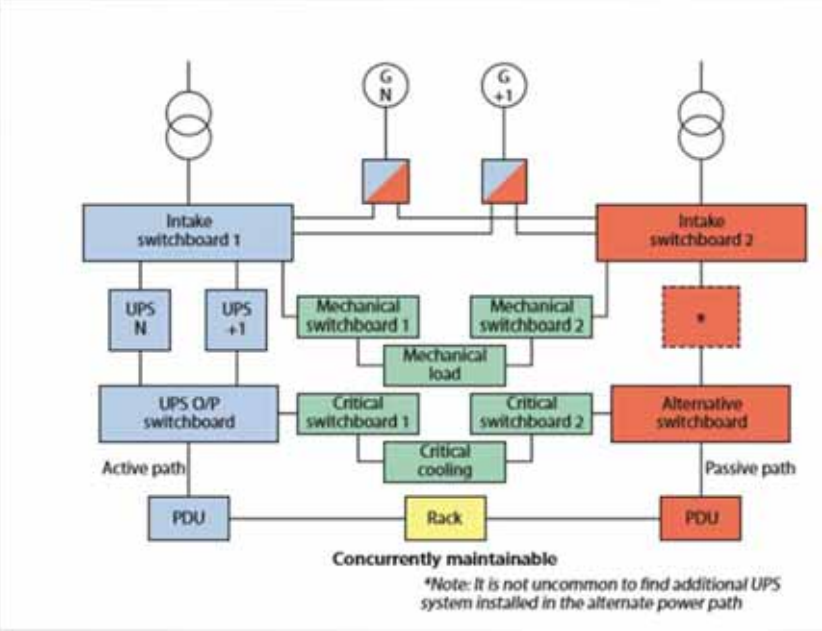
TIER CLASSIFICATION – TIER 3



Tier 3: Concurrently Maintainable.

A Tier III data center requires no shutdowns for equipment replacement and maintenance.

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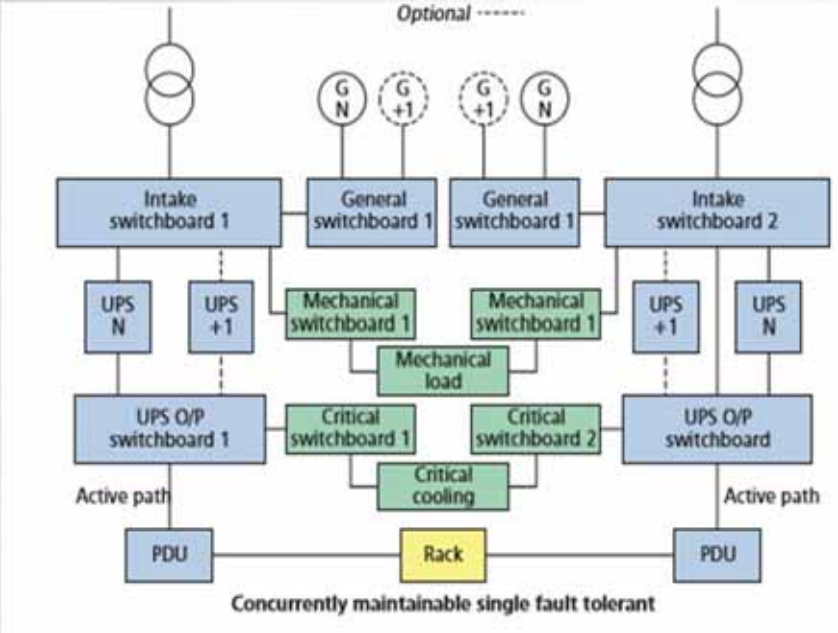
TIER CLASSIFICATION – TIER 4



Tier 4: Fault Tolerance.

When individual equipment failures or distribution path interruptions occur, the effects of the events are stopped short of the IT operations.

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ENERGY SAVING TIPS

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TIPS FOR ENERGY SAVINGS IN DATA CENTERS

Data center power density is up to 100 times that of an office building, and they operate 24 hours a day, 7 days a week (about three times the annual operating hours of a typical office building). It is very important to adopt design solutions and select mechanical and electrical HVAC equipment which is very energy efficient.

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TIPS FOR ENERGY SAVINGS IN DATA CENTERS

1. Do not oversize the HVAC system, but match it to the actual load as much as possible. Modular solutions, which allow increasing of the cooling capacity as equipment is added, are preferable.

2. Optimize supply air temperature:

   - Annual operating hours can be extended with direct or indirect free-cooling.
   - Improved efficiency If DX equipment is used.
   - With CRAH, higher chilled water temperatures can be used, with higher chiller EER.

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TIPS FOR ENERGY SAVINGS IN DATA CENTERS

3. Improve CRAC unit controls as follows:

- Use server inlet or discharge, and not return, air temperature for unit control.
- if humidity control is required use a single CRAC unit only or, In any case control room air dew point rather than relative humidity.
- If CRAC units have variable-speed fans, fan speed should be controlled by the static pressure in the raised-floor plenum, which should be kept constant between 10 and 20 Pa.

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TIPS FOR ENERGY SAVINGS IN DATA CENTERS

4. Separate hot and cold airstreams as follows:

- Organize IT equipment to support a hot-aisle/cold-aisle arrangement.
- Locate floor diffusers/grilles (or overhead supply grilles) in cold aisles only; seal any floor tile cutouts.
- Use blanking panels in unused IT equipment rows and racks.
- Contain either hot aisles or cold aisles through installation of partitions and ceilings.

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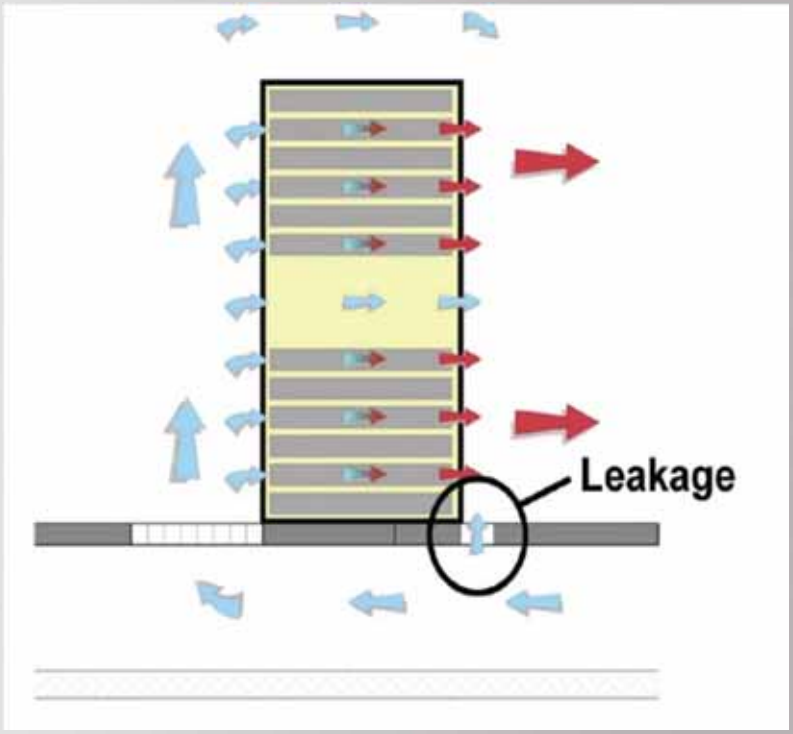
TIPS FOR ENERGY SAVINGS IN DATA CENTERS

5. Minimize underfloor air leakage. Leakage from the raised-floor air distribution plenum can cause inadequate cooling supply air quantities to be delivered to the IT equipment.



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TIPS FOR ENERGY SAVINGS IN DATA CENTERS

6. Increase CRAC/CRAH unit efficiency by selecting units with efficient energy-saving features, for example:

- units with brushless EC fan motors.
- for DX units, adopt compressors with brushless DC Inverter technology.
- for DX units, adopt electronic expansion valves.

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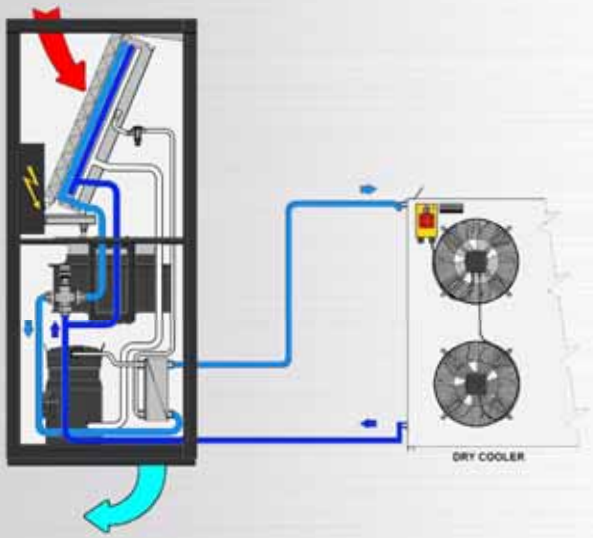
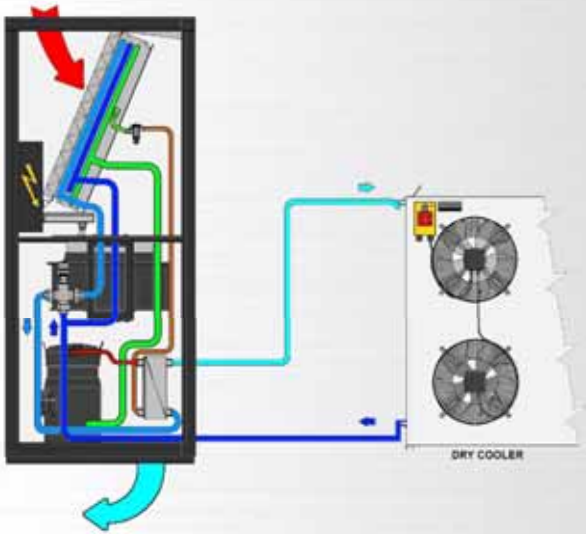
TIPS FOR ENERGY SAVINGS IN DATA CENTERS

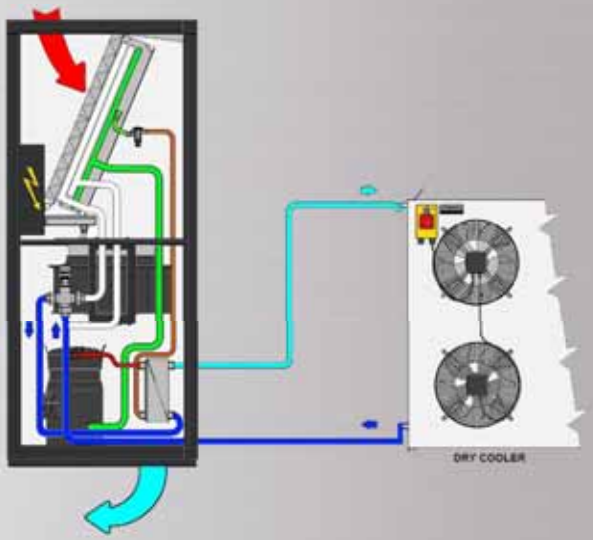
7. provide DX units with remote coolers which can work in free-cooling mode, whenever ambient air conditions allow. With these units, three different operation modes are possible:



Total free cooling mode



Partial free cooling mode



No free cooling mode

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TIPS FOR ENERGY SAVINGS IN DATA CENTERS

8. With CRAH chilled water units:

- Adopt 2-way instead of 3-way valves on cooling coils
- Use the highest possible DT across the coils
- Use Inverter-driven variable-speed pumping to serve the loads
- Consider using primary-only rather than primary-secondary circuits. Possible savings are:
  - Total annual plant energy: 2% to 5%
  - First cost: 4% to 8%
  - Life-cycle cost: 3% to 5%

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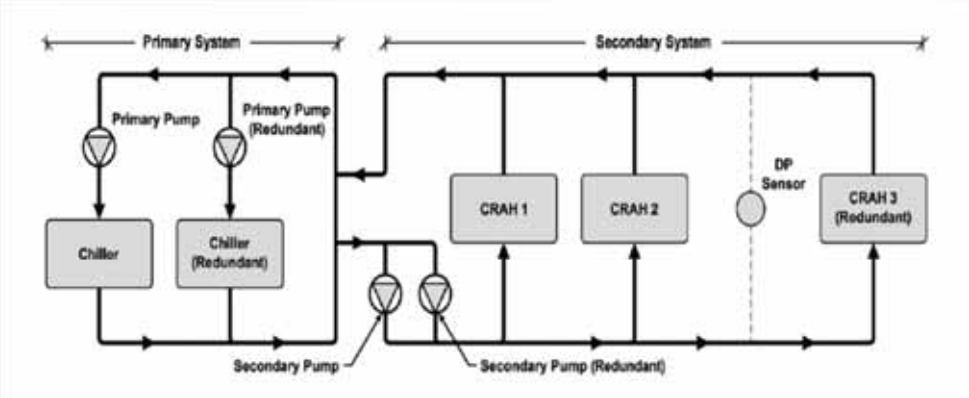
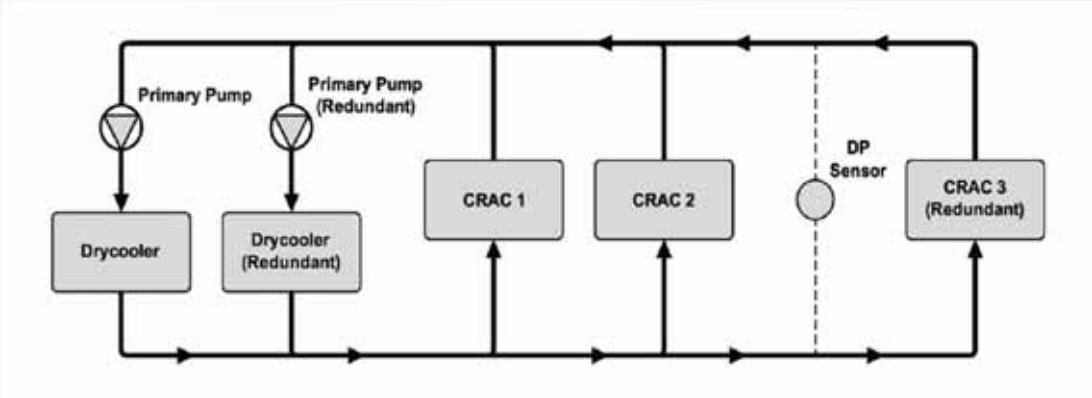
TIPS FOR ENERGY SAVINGS IN DATA CENTERS



Primary-secondary circuit



Primary only circuit

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DATA CENTERS SUSTAINABILITY

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WHAT IS SUSTAINABILITY?

Sustainability is defined as “providing for the needs of the present without detracting from the ability to fulfill the needs of the future”

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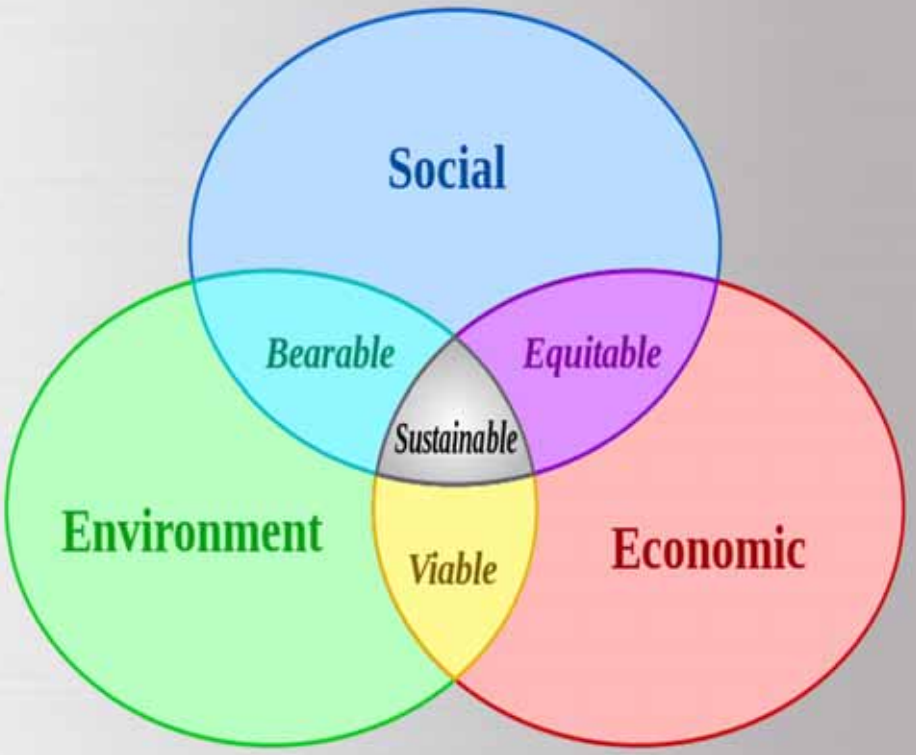
THE THREE COMPONENTS OF SUSTAINABILITY

- Environmental: The capacity of valorizing the main features of the territory, while guaranteeing custody and renewal of natural resources
- Economic: The capacity of an economic system to generate a lasting growth of economic indicators
- Social: The capacity of guaranteeing human well being (security, health, instruction) and to distribute it uniformly among all classes of people



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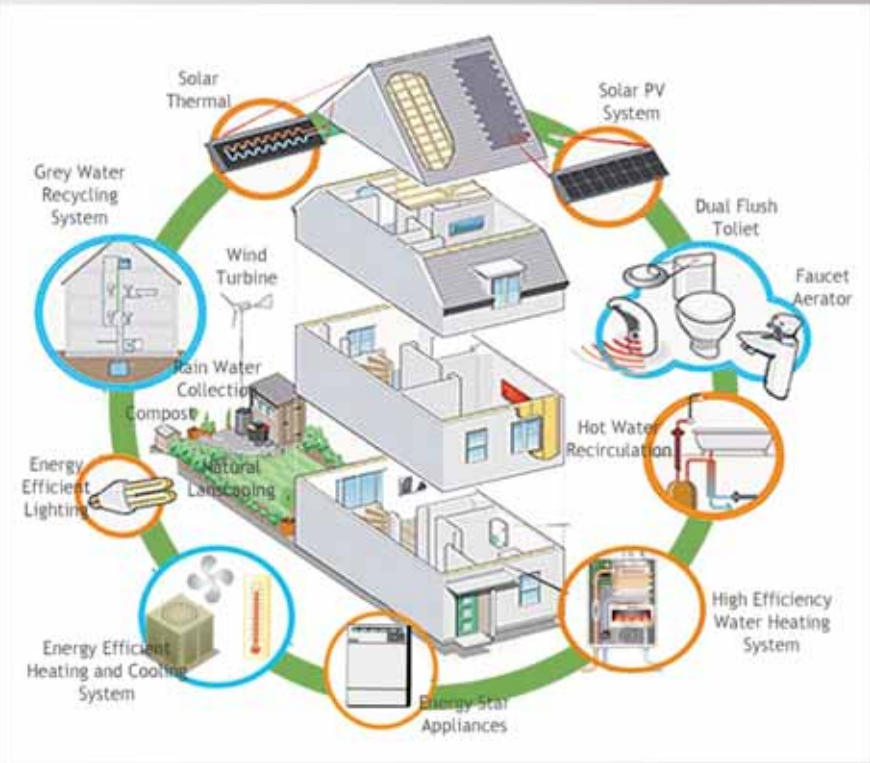
FACTORS INFLUENCING SUSTAINABILITY

- Growth and movement of population
- Availability of food
- Control of diffusion of pathologies
- Availability of energy resources
- Material availability and management
- Potable and non-potable water resources
- Air and water pollution
- Solid and liquid waste disposal
- Use of territory



THE MOST WIDELY USED CERTIFICATION PROTOCOLS

- BREEAM (Building Research Environmental Assessment Method) was introduced in1990 by BRE (Building Research Establishment), then a government organization, now a private one. It is used throughout the world, especially in the UK and countries with a British cultural heritage (Middle and Far East)

- LEED (Leadership in Energy and Environmental Design was developed by the US Green Building Council, which is a bob-profit US organization, founded in 1998. It is used worldwide.

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LEED SCORING AND CERTIFICATION LEVELS

- 100 base points
- + 10 points for innovation in design and regional properties
- 4 certification levels

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LEED CERTIFICATION FOR DATA CENTERS

The latest version of LEED (v. 4) considers data centers as a specific type of building.

The certification level depends on the overall score out of a total of 110 points: the levels are:

- Certified (40-49 points)
- Silver (50-59 points)
- Gold (60-79 points)
- Platinum (80+ points).

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CATEGORIES AND SCORES OF LEED CREDITS

- Integrated Design Process (1 point)
- Location and Transportation (16 points)
- Sustainable Sites (10 points)
- Water Efficiency (11 points)
- Energy and Atmosphere (33 points)
- Materials and Resources (13 points)
- Pilot Credits (16 points)
- Innovation in Design (6 points)
- Regional Priorities (4 points)

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LEED SCORE CARD FOR DATA CENTERS

LEED for New Construction for Data Centers (v4)

		POSSIBLE: 1
Credit	Integrative process	1
LOCATION & TRANSPORTATION		**POSSIBLE: 16**
Credit	LEED for Neighborhood Development location	16
Credit	Sensitive land protection	1
Credit	High priority site	2
Credit	Surrounding density and diverse uses	5
Credit	Access to quality transit	5
Credit	Bicycle facilities	1
Credit	Reduced parking footprint	1
Credit	Green vehicles	1
SUSTAINABLE SITES		**POSSIBLE: 10**
Prereq	Construction activity pollution prevention	REQUIRED
Credit	Site assessment	1
Credit	Site development - protect or restore habitat	2
Credit	Open space	1
Credit	Rainwater management	3
Credit	Heat island reduction	2
Credit	Light pollution reduction	1
WATER EFFICIENCY		**POSSIBLE: 11**
Prereq	Outdoor water use reduction	REQUIRED
Prereq	Indoor water use reduction	REQUIRED
Prereq	Building-level water metering	REQUIRED
Credit	Outdoor water use reduction	2
Credit	Indoor water use reduction	6
Credit	Cooling tower water use	2
Credit	Water metering	1
ENERGY & ATMOSPHERE		**POSSIBLE: 33**
Prereq	Fundamental commissioning and verification	REQUIRED
Prereq	Minimum energy performance	REQUIRED
Prereq	Building-level energy metering	REQUIRED
Prereq	Fundamental refrigerant management	REQUIRED
Credit	Enhanced commissioning	6
Credit	Optimize energy performance	18
Credit	Advanced energy metering	1
Credit	Demand response	2
Credit	Renewable energy production	3
Credit	Enhanced refrigerant management	1
Credit	Green power and carbon offsets	2

MATERIAL & RESOURCES		**POSSIBLE: 13**
Prereq	Storage and collection of recyclables	REQUIRED
Prereq	Construction and demolition waste management planning	REQUIRED
Credit	Building life-cycle impact reduction	5
Credit	Building product disclosure and optimization - environmental product declarations	2
Credit	Building product disclosure and optimization - sourcing of raw materials	2
Credit	Building product disclosure and optimization - material ingredients	2
Credit	Construction and demolition waste management	2
PILOT CREDITS		**POSSIBLE: 16**
Prereq	Minimum IAQ performance	REQUIRED
Prereq	Environmental tobacco smoke control	REQUIRED
Credit	Enhanced IAQ strategies	2
Credit	Low-emitting materials	3
Credit	Construction IAQ management plan	1
Credit	IAQ assessment	2
Credit	Thermal comfort	1
Credit	Interior lighting	2
Credit	Daylight	3
Credit	Quality views	1
Credit	Acoustic performance	1
Prereq	GO Pilot ACP: ETS Control for Projects in Japan	REQUIRED
INNOVATION		**POSSIBLE: 6**
Credit	Innovation	5
Credit	LEED Accredited Professional	1
REGIONAL PRIORITY		**POSSIBLE: 4**
Credit	Regional priority	4
TOTAL		110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM

TECNAIR LV

THANK YOU!