CIBSE ASHRAE Group

Data Centre Energy Efficiency: Who, What, Why, When, Where & How

CIBSE

DIGITAL REALTY

dbassociates consulting engineers

ASHRAE

Presenters

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Digital Realty

Bio's

Don Beaty has over 30 years experience in consulting engineering and founded DLB Associates Consulting Engineers in 1980. He is a licensed professional engineer in over 40 states and has international licenses as well.

Don co-founded and was the first chair of ASHRAE Technical Committee TC 9.9 and currently serves as its Publications Chair. He is a frequent keynote speaker on behalf of ASHRAE TC 9.9 for the data centre industry, having presented over 100 times and in more than 25 countries on various data centre-centric topics.

Paul Finch is a senior engineering and construction executive and has extensive global experience across the full spectrum of development management and complex engineering led capital projects and operations, with a particular focus on the design, construction and operation of data centres, technical real estate and high dependency mission critical assets and infrastructure projects, across the telecommunications, technology and banking & financial services sectors.

Paul is a Voting Committee Board Member of ASHRAE Technical Committee (TC) 9.9 - *Mission Critical Facilities, Data Centres, Technology Spaces and Electronic Equipment*.

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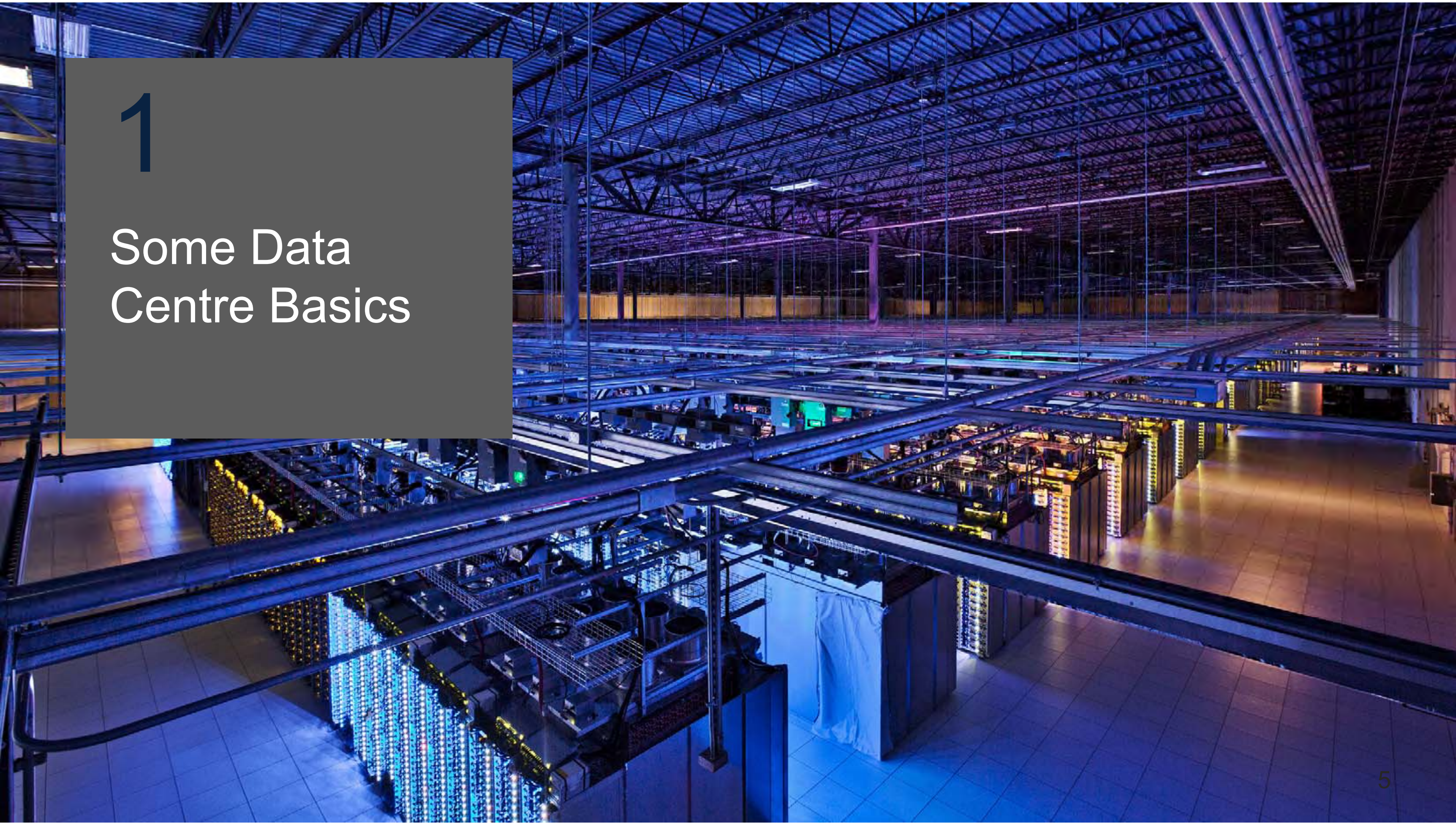
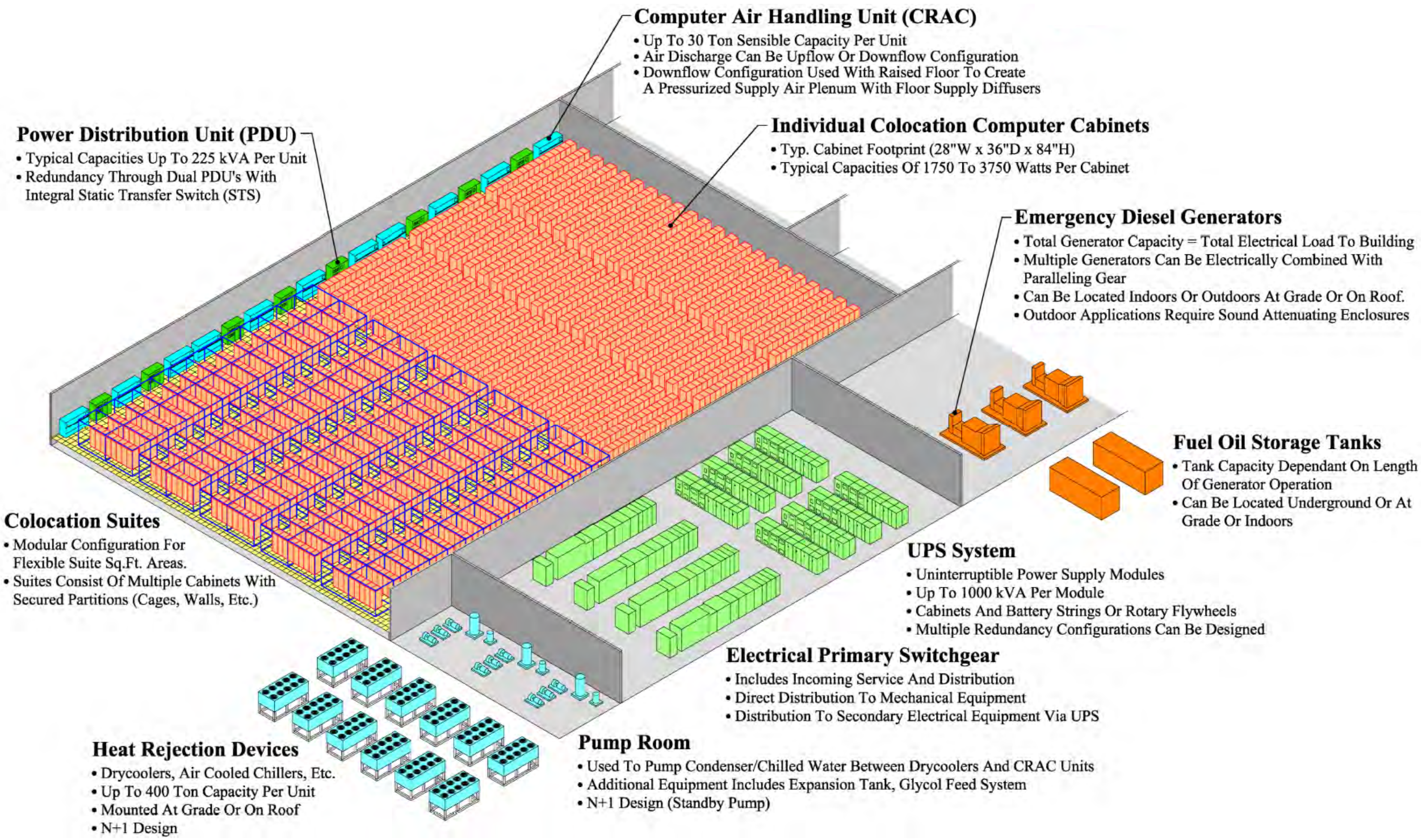
Some Data Centre Basics



Some Data Centre Basics
Data Centre Graphical Overview



Some Data Centre Basics

Data Centre Occupants and Fixtures, Furnishings & Equipment (FF&E)

Conventional Buildings

Human Occupants

Data Centres

Software Occupants

Some Data Centre Basics
Computer Cabinets & Racks

Some Data Centre Basics

Server Configurations

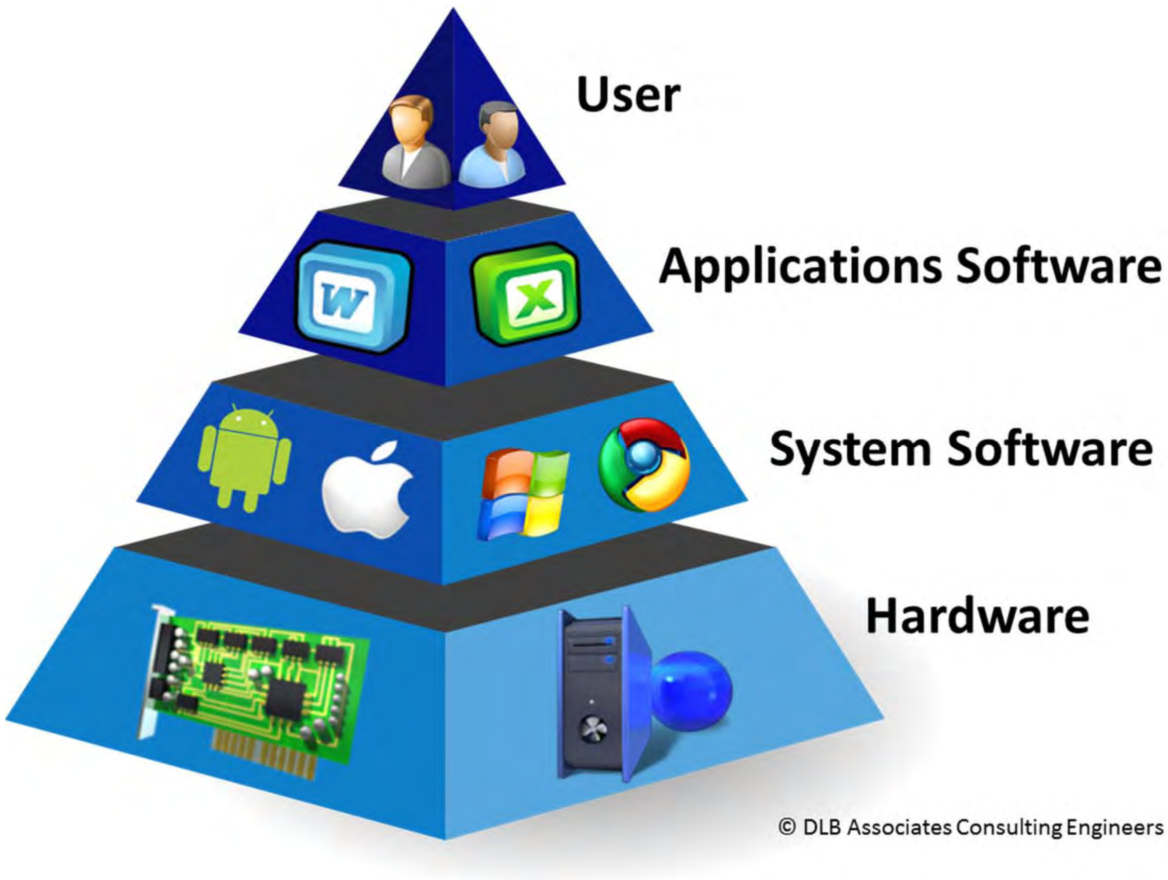
Tower Server
(tall & narrow)

1U Server
(short & wide)

Blade Server
(square)

Freestanding | **Rack Mounted**

Some Data Centre Basics
Hardware, System Software & Application Software



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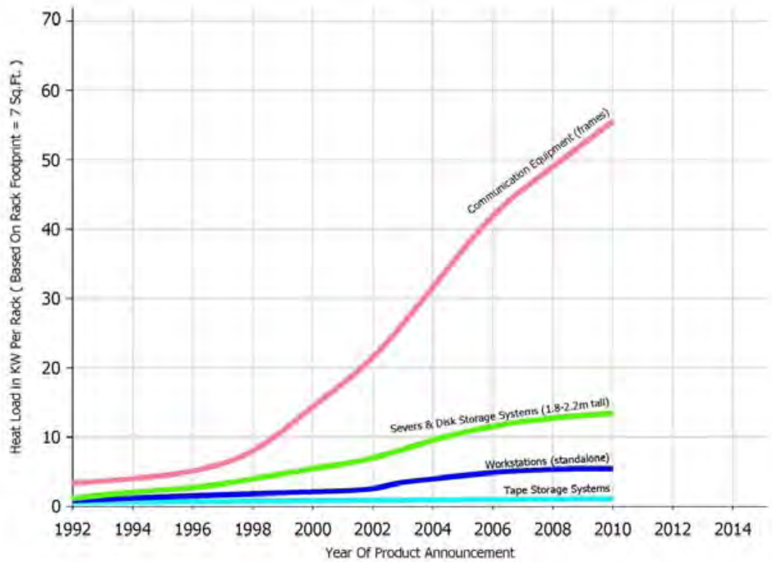
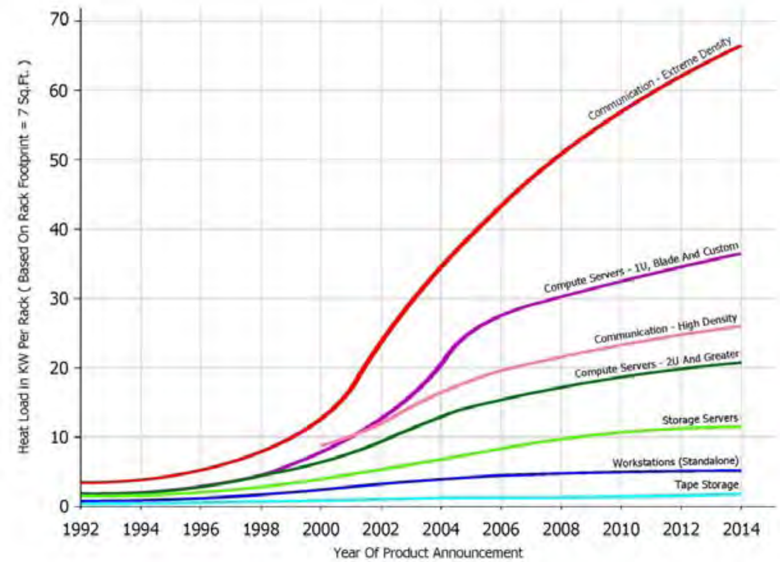
Key Trends in the Data Centre Industry

Key Trends in the Data Centre Industry

2000 & 2005 IT Equipment Power – Predictive Trends



Thermal Management Consortium in 2000:
Published Through The Uptime Institute

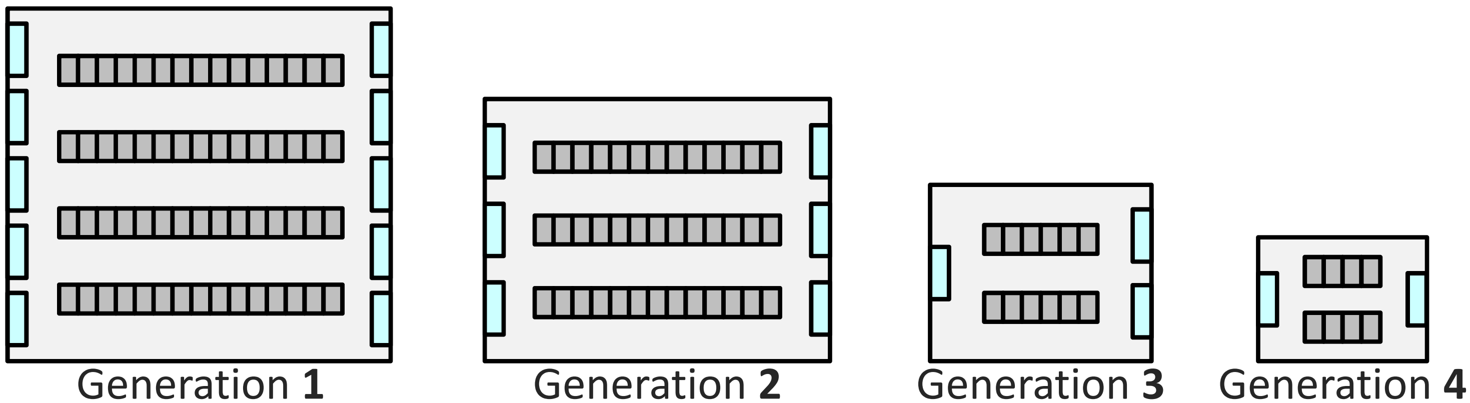


ASHRAE 2005 Publication:
Datacom Equipment Power Trends & Cooling Applications

History Validated these Trends

Key Trends in the Data Centre Industry

Data Center Generational Impact – 2007 to 2011



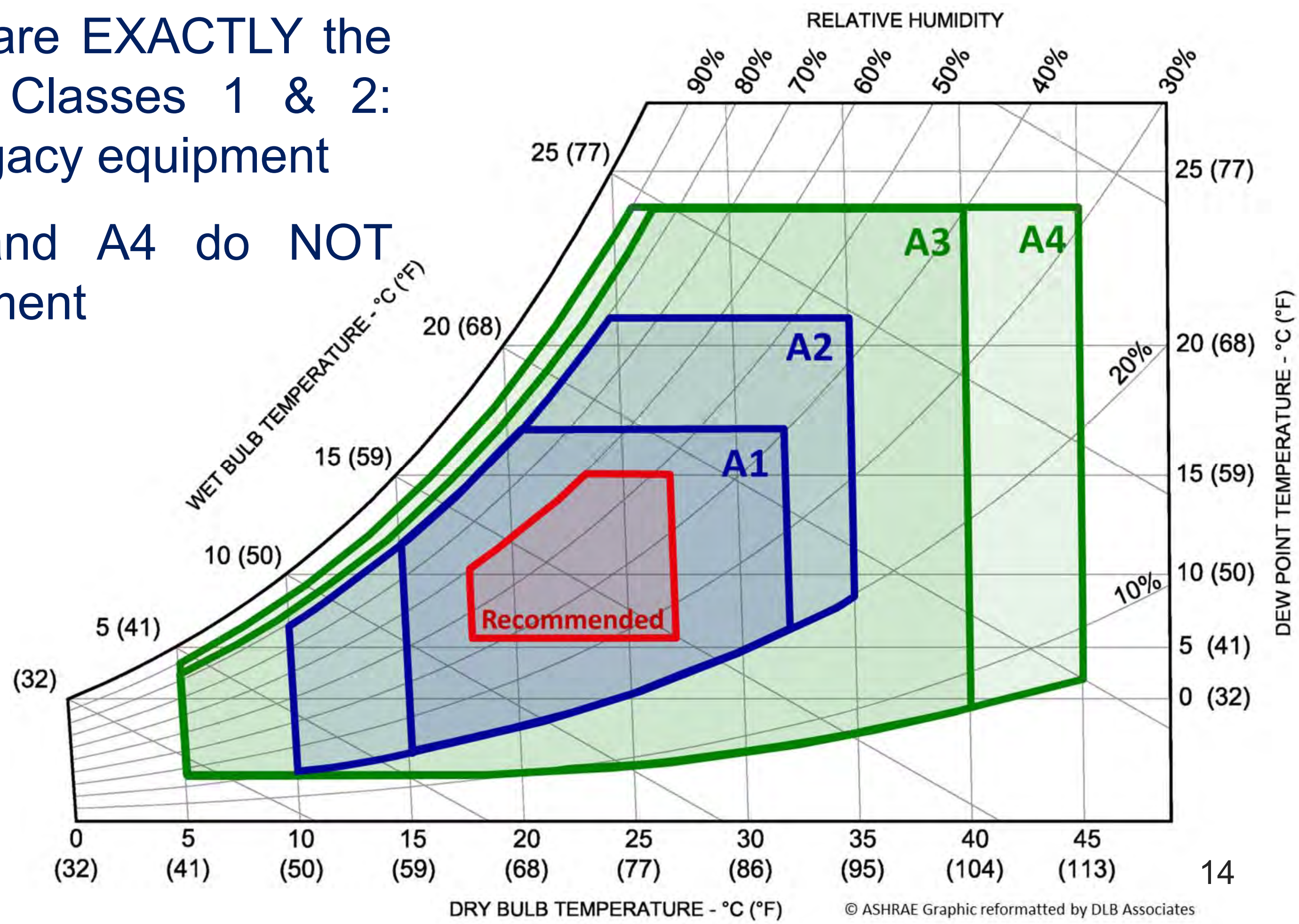
Generation 1 to 4 have the SAME IT Performance

Metric	**Comparative Change** (4U, 4 Processor)		
	Generation 1 (Year 1 – Baseline)	**Generation 4** (Year 4)	**Generation 1 to 4 Comparison**
IT Performance	100%	100%	**SAME**
IT Power per Rack	100%	119%	**+ 19%**
Rack Count	100% (60)	13% (8)	**- 87%**
Total IT Power	100%	18%	**- 82%**
Space Required	100%	15%	**- 85%**
Cooling Required	100%	20%	**- 80%**

Key Trends in the Data Centre Industry

ASHRAE Psychrometric Chart – 2011

- Classes A1 and A2 are EXACTLY the SAME as previous Classes 1 & 2: Apply to new AND legacy equipment
- New Classes A3 and A4 do NOT include legacy equipment



Key Trends in the Data Centre Industry
Volume Server Power Demand & Performance Growth

Volume Server Power Demand & Performance Growth (excludes extreme low energy servers)			
Volume Server	**CAGR**	**Growth in 3 Years**	**Growth in 5 Years**
Power Demand Growth	**2 to 6%**	**5 to 20%**	**10 to 30%**
Performance Growth	**25 to 30%**	**90 to 120%**	**200 – 250%**

Compounded Annual Growth Rate (CAGR)
Growth Projections are Rounded

Key Trends in the Data Centre Industry

Volume Server Power Trends to 2020 (fully configured, fully utilized max load)

Height	No. of Sockets	Heat Load / Chassis (Watts)			Heat Load / 42U Rack			Increase 2010 to 2020
		2010	2015	2020	2010	2015	2020	
1U	1s	255	290	330	10,710	12,180	13,860	29%
	2s	600	735	870	25,200	30,870	36,540	45%
	4s	1,000	1,100	1,200	42,000	46,200	50,400	20%
2U	2s	750	1,100	1,250	15,750	23,100	26,250	67%
	4s	1,400	1,800	2,000	29,400	37,800	42,000	43%
4U	2s	2,300	3,100	3,300	23,000	31,000	33,000	43%
7U (Blade)	2s	5,500	6,500	7,500	33,000	39,000	45,000	36%
9U (Blade)	2s	6,500	8,000	9,500	26,000	32,000	38,000	46%

Market Requirements force IT manufacturers to maximize performance/volume (creating high heat load/rack).
These rack heat loads will result in increased focus on improving data center ventilation solutions and localized liquid cooling solutions

High Risk to Generalize; One Shoe Definitely Does NOT Fit All

Key Trends in the Data Centre Industry

Volume Server Power Trends - Simple Adjustment Factor Example

Adjustment Factor	Volume Server Configuration	Heat Load / Chassis (Watts)			Heat Load / 42U Rack		
		2010	2015	2020	2010	2015	2020
1.00 (Original Value)	1U, 2s	600	735	870	25,200	30,870	36,540
0.50 (Your Data Center)	**1U, 2s**	**300**	**368**	**435**	**12,600**	**15,435**	**18,270**

How to adjust the published Trends for your environment:

1) Trend Chart Value for a 1U, 2s Volume Server in 2010: **600 Watts**
2) ACTUAL MEASURED Value for YOUR 1U, 2s Server: **300 Watts**
3) Calculated Adjustment Factor for YOUR 1U, 2s Server = **300 Watts / 600 Watts = 0.50**

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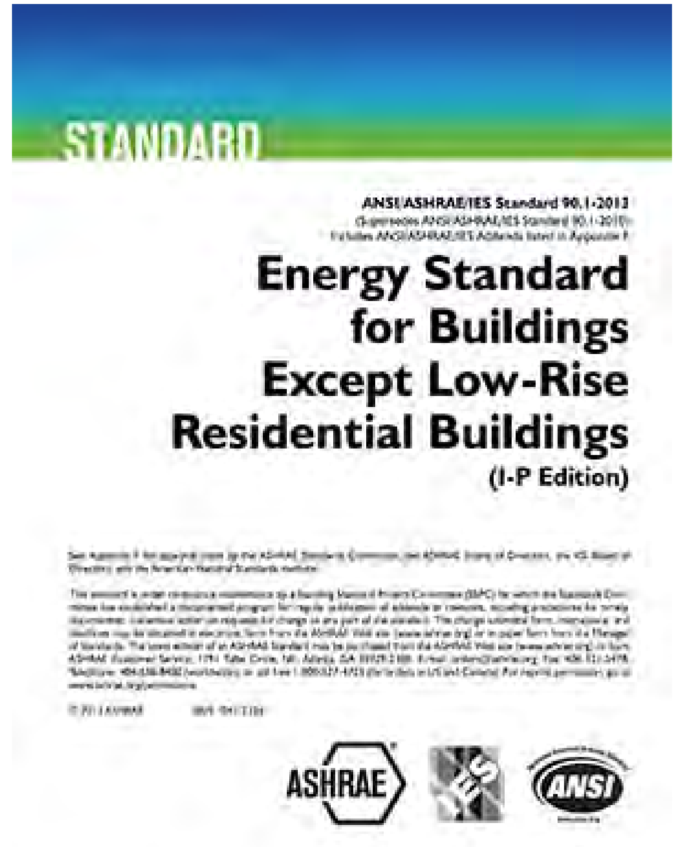
Energy Standards & Regulations

Energy Standards & Regulations
ASHRAE Standard 90.1 - 2013

- Purpose
- Scope
- Definitions, Abbreviations, and Acronyms
- Administration and Enforcement
- Building Envelope
- Heating, Ventilating, and Air Conditioning
- Service Water Heating
- Power
- Lighting
- Other Equipment
- Energy Cost Budget Method



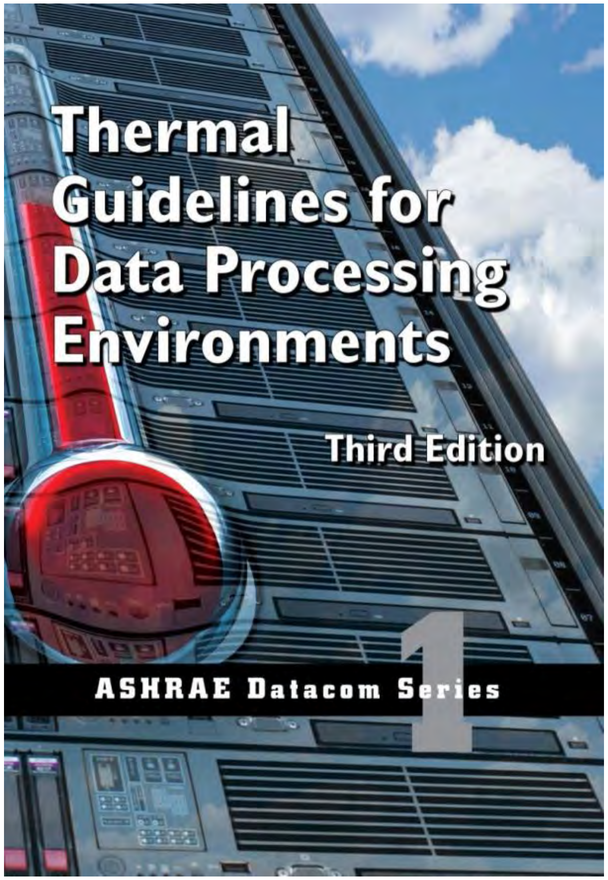
Energy Standards & Regulations
ASHRAE Standard 127 - 2012

- Purpose
- Scope
- Definitions
- Classification
- Rating Requirements
- Conformance
- References

Energy Standards & Regulations

ASHRAE Thermal Guidelines for Data Processing Environments – 3rd Edition

- Introduction
- Environmental Guidelines for Air-Cooled Equip.
- Environmental Guidelines for Liquid-Cooled Equip.
- Facility Temperature & Humidity Measurement
- Equipment Placement & Airflow Patterns
- Equip. Manufacturers Heat & Airflow Reporting
- Appendices A – J



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Measurement of Data Centre Energy

Measurement of Data Centre Energy
PUE Basics

- PUE: Power Usage Effectiveness
- pPUE: Partial Power Usage Effectiveness
- PUE defined by The Green Grid (TGG)
- PUE is an annualised metric considering kWh not kW
- PUE can NEVER be <1.0
- PUE does NOT receive credit for waste heat repurposes
- EUE (Energy Reuse Effectiveness) does consider waste heat

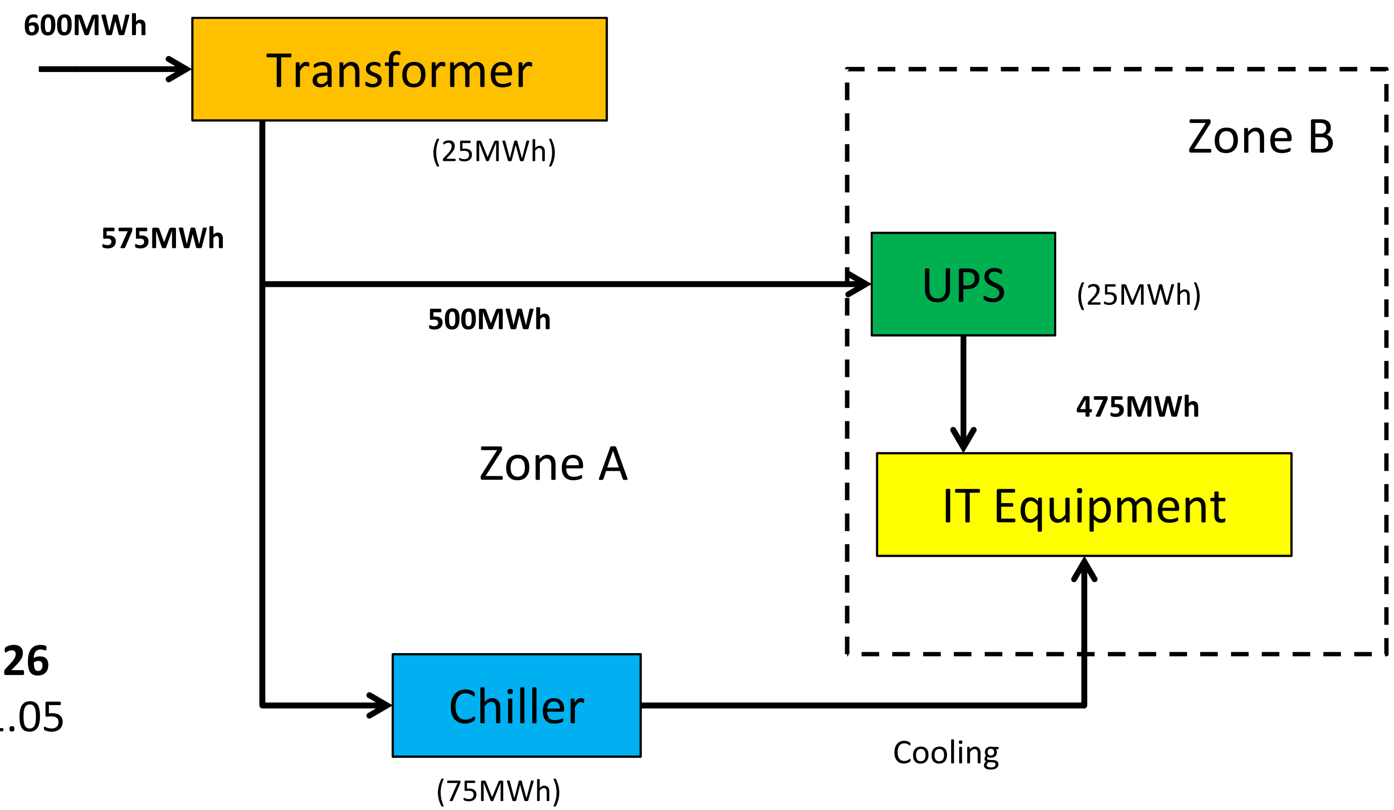
Measurement of Data Centre Energy
PUE & pPUE Definition

$$\mathbf{PUE} = \frac{\mathbf{Total\ Facility\ Energy}}{\mathbf{IT\ Equipment\ Energy}}$$

$$\mathbf{pPUE} = \frac{\mathbf{Total\ Energy\ Inside\ The\ Boundary}}{\mathbf{Total\ IT\ Equipment\ Energy\ Inside\ The\ Boundary}}$$

Measurement of Data Centre Energy

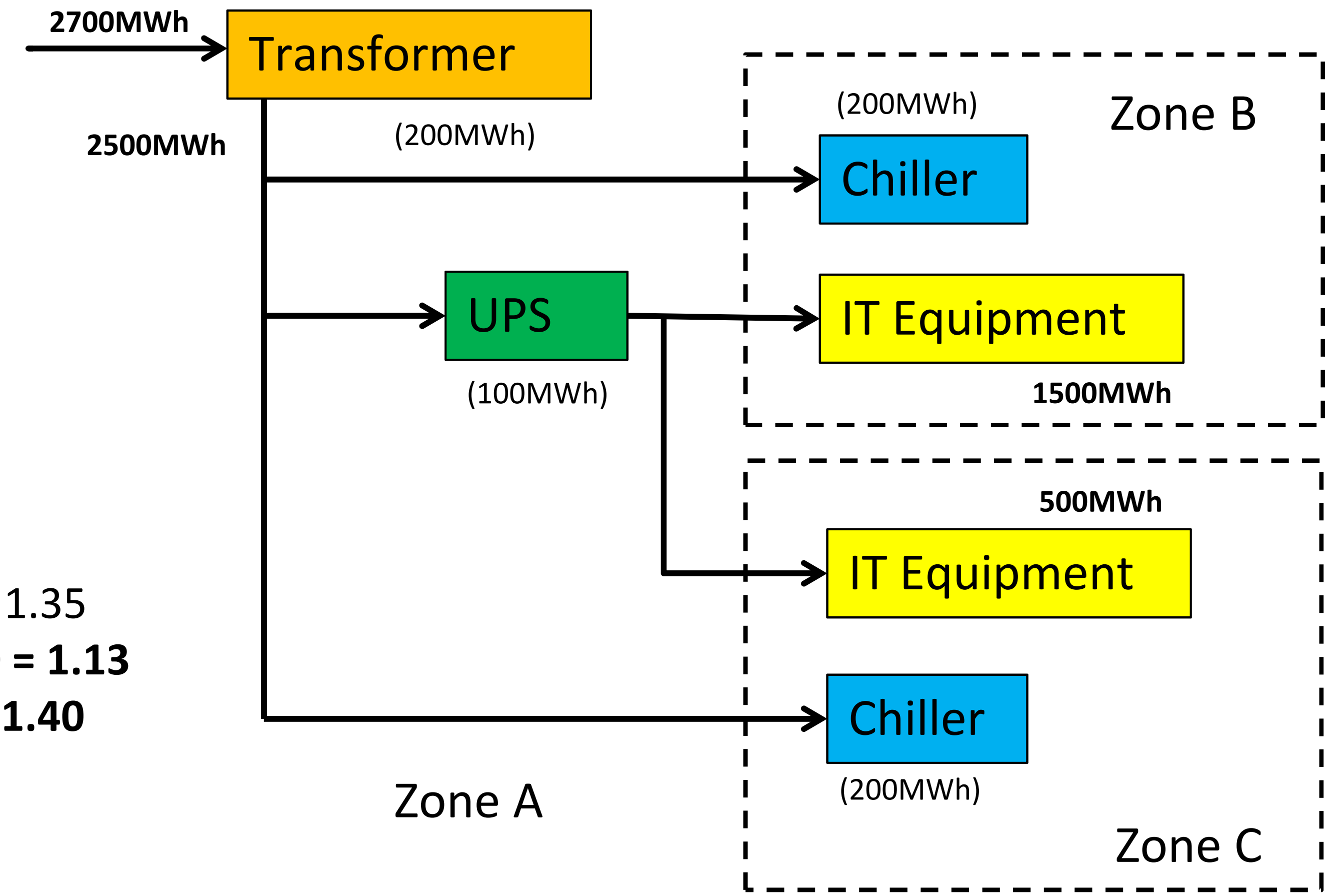
PUE Example



Example:

PUE (Zone A) = 600/475 = 1.26
pPUE (Zone B) = 500/475 = 1.05

Measurement of Data Centre Energy
pPUE Example



Example:

PUE (Zone A) = 2700/2000 = 1.35
$pPUE_1$ (Zone B) = 1700/1500 = 1.13
$pPUE_2$ (Zone C) = 700/500 = 1.40

Measurement of Data Centre Energy
PUE Measurement

Three defined levels of PUE measurement being:

- PUE_1 (Level 1: Basic)
  - UPS Output, Utility Input, Monthly/Weekly
- PUE_2 (Level 2: Intermediate)
  - PDU Outputs, Utility Input, Daily/hourly
- PUE_3 (Level 3: Advanced)
  - IT Equipment Input, Utility Input, ≤15 minutes

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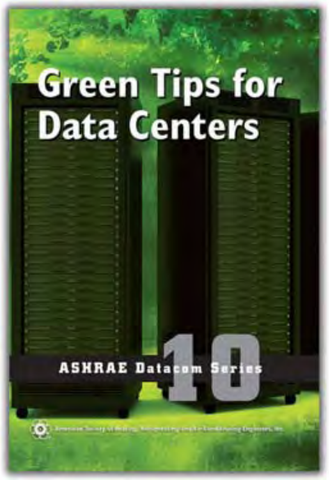
Best Practices for Efficient Operation

Best Practices for Efficient Operation
Design and Operational Opportunities

- **Energy Management**: measure performance, **plant & equipment right-sizing.**
- **Environmental Conditions:** optimise supply temperature and humidity control.
- **Air Flow Management:** improve return air management, separate hot and cold airstreams, Improve underfloor pressure management, Optimise IT cabinet airflow, Improve CRAH, CRAC, AHU efficiency.
- **Cooling Plant:** variable speed drives, cooling plant strategies, increase water efficiency, optimise pumping control, use of waste heat, optimise chilled water and condenser water supply temperatures, improve pumping efficiency, direct expansion vs. chilled water
- **Power:** improve UPS efficiency, improve transformer efficiency, minimise power distribution routes.
- **Lighting:** Improve lighting efficiency.
- **IT Equipment**: implement server virtualisation, optimise data storage, enable power management features, specify high efficiency power supplies, **IT infrastructure right-sizing.**



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Innovative Concepts & Solutions

Innovative Concepts & Solutions
Degree of Applicability Varies from Project to Project

- Thermal Guidelines for Data Processing Environments (2011) – adoption of the Allowable Range & X-Factors
- Compressor-less cooling solutions
- Application of in-direct outside air
- High Performance Computing (HPC) liquid cooling technologies – full oil emersion, processor heat-sink and closed-coupled heat exchangers
- Decentralised UPS
- Fine granularity phasing (e.g. one row at a time)
- Minimise the number of end-to-end voltage transitions

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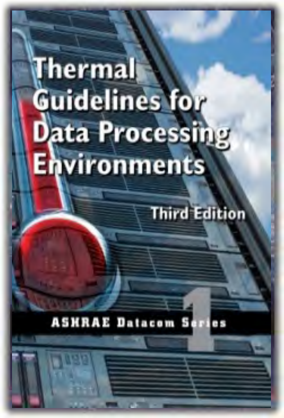
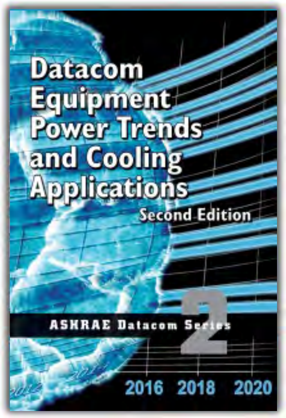
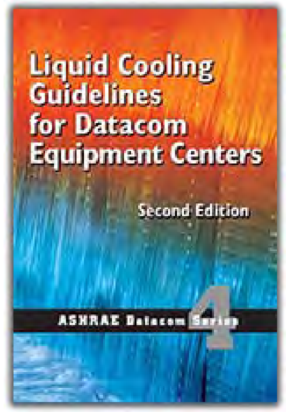
Further Reading

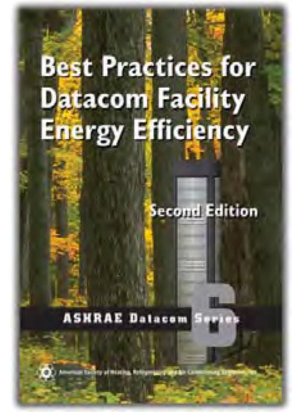
Further Reading & Reference Publications

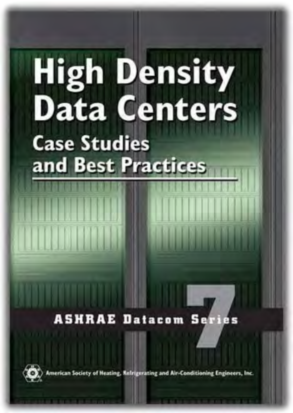
ASHRAE Datacom Series

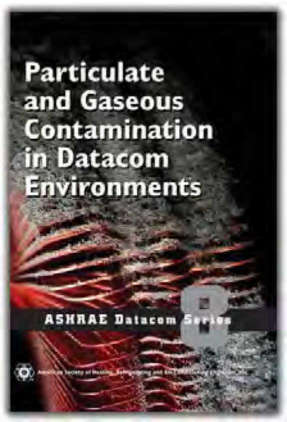


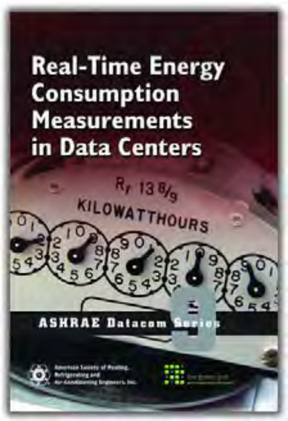


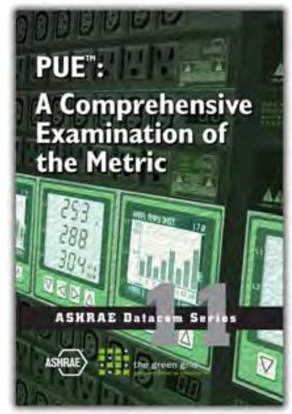












www.tc99.ashraetcs.org

www.ashrae.org

8 Question & Answers

THANK YOU

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