CODE OF CONDUCT DATA CENTRES

European Commission

The European Programme for Energy Efficiency in Data Centres: The Code of Conduct

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Why Data Centres?

- In the commercial sector electricity consumption in the European Union (EU 28) has increased in the period 2003 to 2012 from 698 TWh to 845 TWh, i.e. a growth of 21% while total electricity consumption in the EU 28 in the same period has grown by 4%, and in the residential sector by 5%.
- The JRC in 2007 has evaluated the data centres total energy consumption as 56 TWh or 2% of total electricity consumption per year in Western Europe and at the time it was projected to increase to 104 TWh per year by 2020.
- This is line with the US consumption of data centres representing 1.7% to 2% of US total electricity consumption (Koomey 2011).
- Another report estimates West Europe data centre energy consumption in 2013 at 86 TWh/year or 3% of total electricity consumption. Western Europe represent about one third of total global DC consumption estimated at 31 GW.

EU Codes of Conduct

- Led by European Commission Joint Research Centre
- Flexible mechanism to initiate and develop policy
- Forum for industry, experts and Member States
- Open and continuous dialogue on market and product performance
- Identify and focus on key issues and agree solutions
- Set ambitious voluntary standards and commitments

Why a New Initiative?

- There is no EU regulatory or voluntary initiatives addressing the energy efficiency of data centres. This creates risk of confusion, mixed messages and uncoordinated activities.

- Need for independent assessment and coordination – tailored to European conditions such as the climate and energy markets regulation.

- The new Code of Conduct provides a <u>platform to bring together European stakeholders to discuss</u> and <u>agree voluntary actions</u> which will improve energy efficiency.

What is the Code of Conduct?

- Code of Conduct is a **voluntary commitment** of individual companies, which own or operate data centers (including colo), with the aim of reducing energy consumption (against a BaU scenario) through the adoption of best practices in a defined timescale.

- Energy efficiency targets are complemented by **general commitments** to monitor power and energy consumption, adopt management practices, switching off components not needed, and reducing energy consumption where possible.

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Aims

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To **raise awareness** among managers, owners, investors, with targeted information and material on the opportunity to improve efficiency.

To provide an **open process and forum** for discussion representing European stakeholder requirements.

To create and provide an **enabling tool for industry** to implement cost-effective energy saving opportunities.

To develop a set of **easily understood metrics** to measure the current efficiencies and improvement.

To produce a **common set of principles** in harmonisation with other international initiatives.

To **support procurement**, by providing criteria for equipment (based on the Energy Star Programme specifications, when available, and other Codes of Conducts), and best practice recommendation for complex systems.

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Scope

- The Code of Conduct covers:
  - "Data centres" of all sizes – server rooms to dedicated buildings
  - Both existing and new
  - IT power and Facility power
  - Equipment procurement and system design

- The Code of Conduct is for:
  - **Participants**: Data centre owners and operators
  - **Endorsers**: Vendors, consultants, industry associations

Four Basic Scenarios

- Day to day operations (energy management)
- Normal replacement cycle/adding new servers
- Retrofit/ dedicated energy efficiency programme
- Designing new data centres

Rules of Participation (1)

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- For existing data centres partnership application start with an initial energy measurement, and energy audit to identify the major energy saving opportunities.

- An **Action Plan** must be prepared and submitted, once the Action Plan is accepted the **Participant status** in granted.

- Participant must implemented the Action Plan according to the agreed time table. Energy consumption must be monitored regularly, as described in the monitoring section. *It is expected to see over time progresses in the energy efficiency indicator related to the data centre*.

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Rules of Participation(2)

- The revised retrofit and new build best practices will apply from 2011 onwards for new participants.

- A new construction data centre must be efficient according to the best practices from the start (design phase) and not wait to be retrofitted in the 36 months period. Energy monitoring shall start ASAP

Rules of Participation(3)

- The Commission will approve the plan submitted within 30 days, or explain its reasons for not approving and grant Participant status to the organisation.
- The Participant carries out its Action Plan, and reports at the completion of the actions to the Commission.
- The Commission will review the Participant 's report, and check whether it corresponds to the Action Plan.
- Mandatory regular (annual) reporting of monthly energy

Participant Type

Type	Description
Operator	Operates the entire data centre from the physical building through to the consumption of the IT services delivered.
CoLo provider	Operates the data centre for the primary purpose of selling space, power and cooling capacity to customers who will install and manage IT hardware.
CoLo customer	Owns and manages IT equipment located in a data centre in which they purchase managed space, power and cooling capacity.
Managed service provider (MSP)	Owns and manages the data centre space, power, cooling, IT equipment and some level of software for the purpose of delivering IT services to customers. This would include traditional IT outsourcing.
Managed service provider in CoLo	A managed service provider which purchases space, power or cooling in this data centre.

Rules of Participation(4)

- All Participants have the obligation to continuously monitor energy consumption and adopt energy management in order to look for continuous improvement in energy efficiency.

- One of the key objectives of the Code of Conduct is that each Participant benchmark their efficiency overtime, using the Code of Conduct metric (or more sophisticated metrics if available) so to have evidence of continuous improvements in efficiency.

Best Practices

Category	Description
Entire Data Centre	Expected to be applied to all existing IT, Mechanical and Electrical equipment within the data centre
New Software	Expected during any new software install or upgrade
New IT Equipment	Expected for new or replacement IT equipment
Build or retrofit 2010 onwards	Expected for any data centre built or undergoing a significant refit of the M&E equipment from 2010 onwards

Best Practice Intent:

- Neither a prescriptive nor exhaustive list of specific technologies
- Focussed on goals and processes
- Structured to allow the addition of new technologies

Best Practices

- Establish common vocabulary and terminology
- Provide operators with an understanding of the available technology options
- Their relative merits
- The processes they should establish
- The communication that is necessary
- The relationship between technology areas
- Most people are non-expert in some area(s) of the data centre
- Best Practices are guidance to operators on how they might improve energy efficiency
- Practices are scored 1-5 (min-max) based upon their likely energy use benefit
- Practices are ordered by score
- Practice scores are not intended to be summed for an ‘overall score’

Results

- **325** DCs have requested Participant Status
- **275** DCs have been approved as Participant
- **114** organisations have at least one DC approved as Participant
- In Europe we have DC Participants in 21 countries: Portugal, Spain, France, Italy, Switzerland, Austria, Romania, Greece, Hungary, Poland, Malta, Finland, Sweden, Denmark, Netherlands, Germany, Belgium, Luxemburg, UK, Bulgaria, Finland, Turkey and Ireland.
- One Participant outside Europe: Ebay with 4 DCs in the US

Feedback from data submitted by Participants

Progress so far

What has worked?

New build facilities

- Modular build
- Part load efficiency
- Air flow containment

Existing facilities

- Air flow management
- IT equipment power management
- Regular review of cooling, set points etc
- Metering

Progress so far

What has not worked?

Environmental range

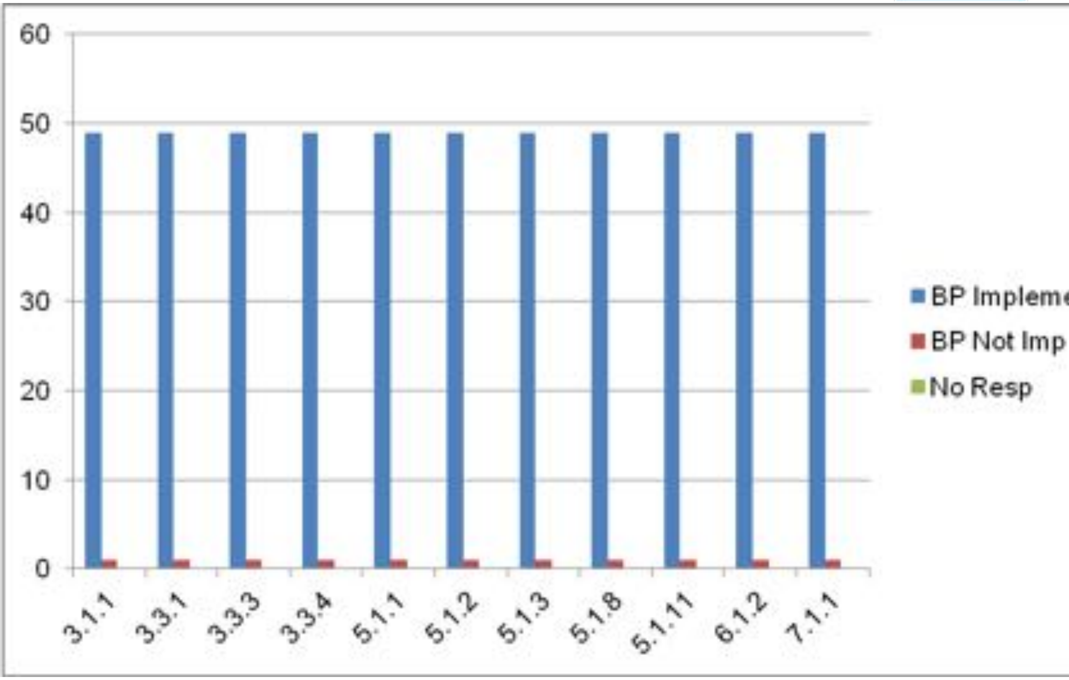
- Low temperature set points
- Low target IT intake temperature
- Narrow humidity control ranges

Efficient software

- Still no metrics
- Hard to formally procure for something you can't easily measure

Evaluation of best Practices

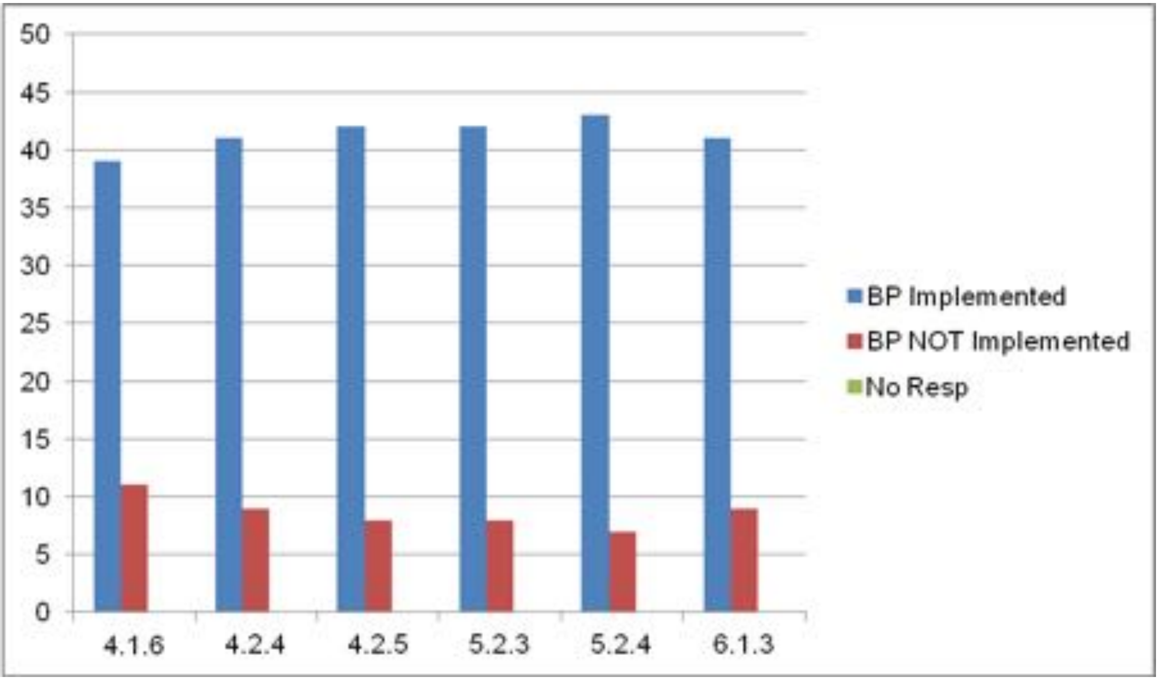
Top Implemented Best Practices



Best Practice	Brief Description	No of Implementations
3.1.1	Group Involvement	49
3.3.1	Build resilience to business requirements	49
3.3.3	Lean Provisioning	49
3.3.4	Part Loading	49
5.1.1	Design Contained Hot/Cold	49
5.1.2	Blanking Plates	49
5.1.8	Design Hot/Cold	49
5.1.11	Perforated Doors	49
6.1.2	High Efficiency UPS	49
7.1.1	Turn off lights	49
7.1.2	Low Energy Lighting	49
9.1.2	IT Energy Consumption Meters	49
9.2.1	Periodic Manual Readings	49

It is clear that the majority of the top implemented practices are those that do not require capital expenditure or major changes to business practices, indeed all of the practices could be considered to be the “low hanging” fruit.

Lowest Implemented Best Practices



Best Practice	Brief Description	No of Implementations
4.1.6	Power Management	39
4.2.4	Select Efficient S/W	41
4.2.5	Develop efficient S/W	42
5.2.3	Review Cooling	42
5.2.4	Review Cooling Strategy	43
6.1.3	UPS Operating Modes	41

Lowest Implemented Best Practices (2)

2.3.1.1 Enable Power Management Features

This best practice was the worst performing throughout the whole of the applicants reviewed, there are a number of reasons why applicants have not implemented this best practice, these include:

Applicant is a CoLo Provider and therefore does not have direct control over hardware settings.

Introduces IT instability

Other projects are in progress that demand higher resources, it is too early for us to look at this practice

CoLo providers should be endorsing the EUCoC formally or informally to clients, and we make a comment on this in the summary.

It may be the case that the business cannot allow the downtime required to implement the best practice at a hardware level, that technical staff are not aware of the nuances of power management and how it will effect normal operation or that they are unaware that there are power management features and services available.

Lowest Implemented Best Practices (3)

2.3.1.2 Select efficient software

The selection of efficient software is problematic as no software markets itself as being “energy efficient”, however it seems that many organisations have developed procurement clauses that would require an “energy efficient software” decision point, in some cases I believe that the use of virtualisation software or work stream dynamically control resource software is being used.

Some applicants, as CoLo providers would not have control over the selection of software.

2.3.1.3 Develop efficient software

Again, in the absence of global “green coding” guidelines or standards it is difficult for applicants to understand and implement this practice, however green coding is gaining ground and workshops are available in certain countries, it may be the case that a general “coding” best practice includes energy efficiency techniques.

Lowest Implemented Best Practices (4)

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2.3.1.4 Review Cooling

Many of the applicants not implementing this best practice are CoLo providers stating that they are reliant on customers informing them of equipment changes, we make a comment on this in the summary.

2.3.1.5 Review Cooling Strategy

Again, most of the applicants cite that there is a balance between energy efficiency and operational requirements; we make a comment on this in the summary.

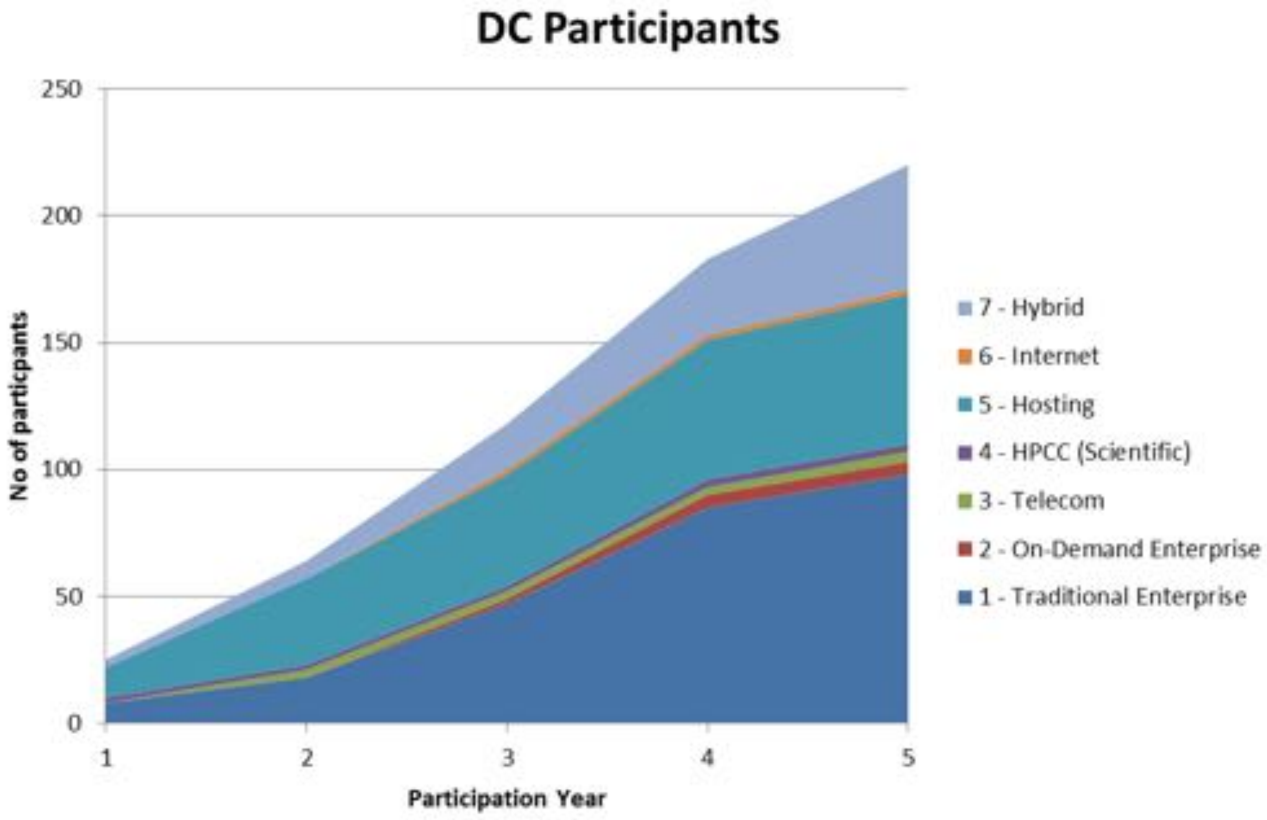
2.3.1.6 UPS operating modes

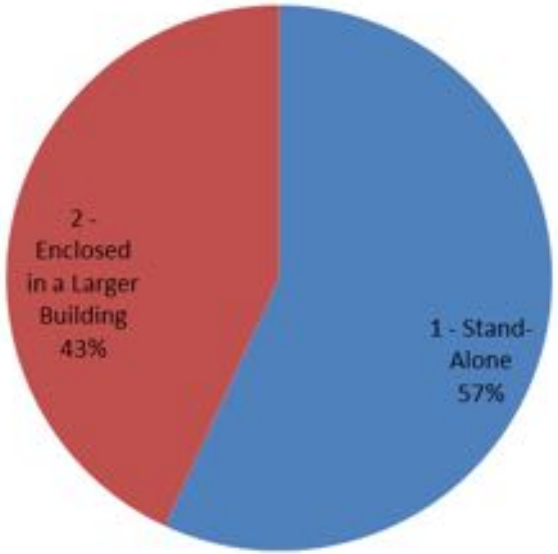
There are two main reasons why this best practice has not been implemented in this organisations that are non-compliant, these are:

That the UPS installed in the facility does not have an “eco mode”.

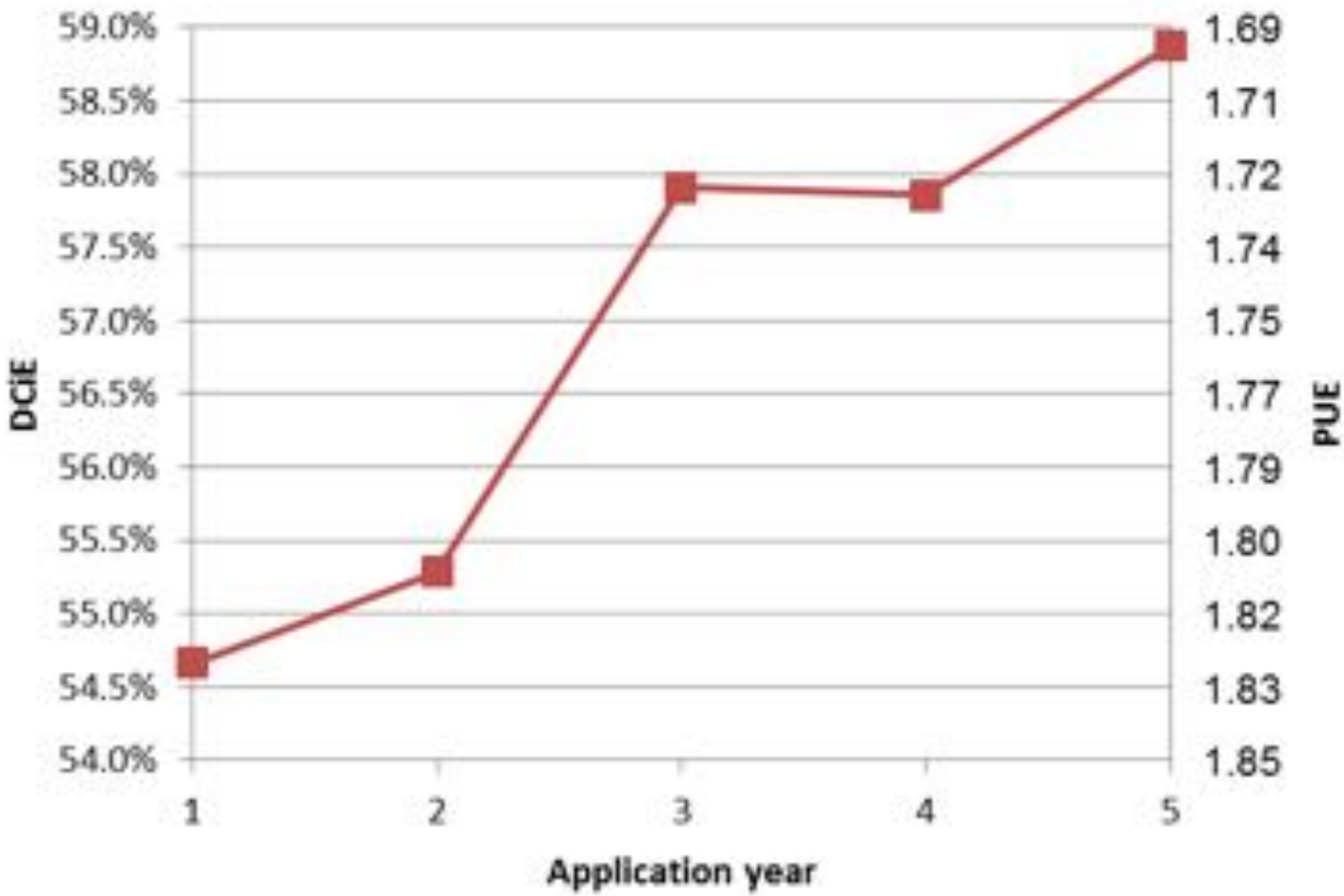
The “eco mode” itself does not provide sufficient rapid fail over for use within the facility.

Total dataset	**221**	
Total annual electricity consumption	**3 223 500**	**MWh**
	3200	**GWh**
Average DC floor area	**2500**	**m²**
Average Rated IT load	**1 900**	**kW**
Average annual electricity consumption	**14 400**	**MWh**
	14.6	**GWh**
Average DCiE	**57**	**%**
Average PUE	**1.77**	
Average high temp setpoint	**24.3**	**degC**
Average low temp setpoint	**20.2**	**degC**
Average high humidity setpoint	**62.4**	**% RH**
Average low humidity setpoint	**33.4**	**% RH**

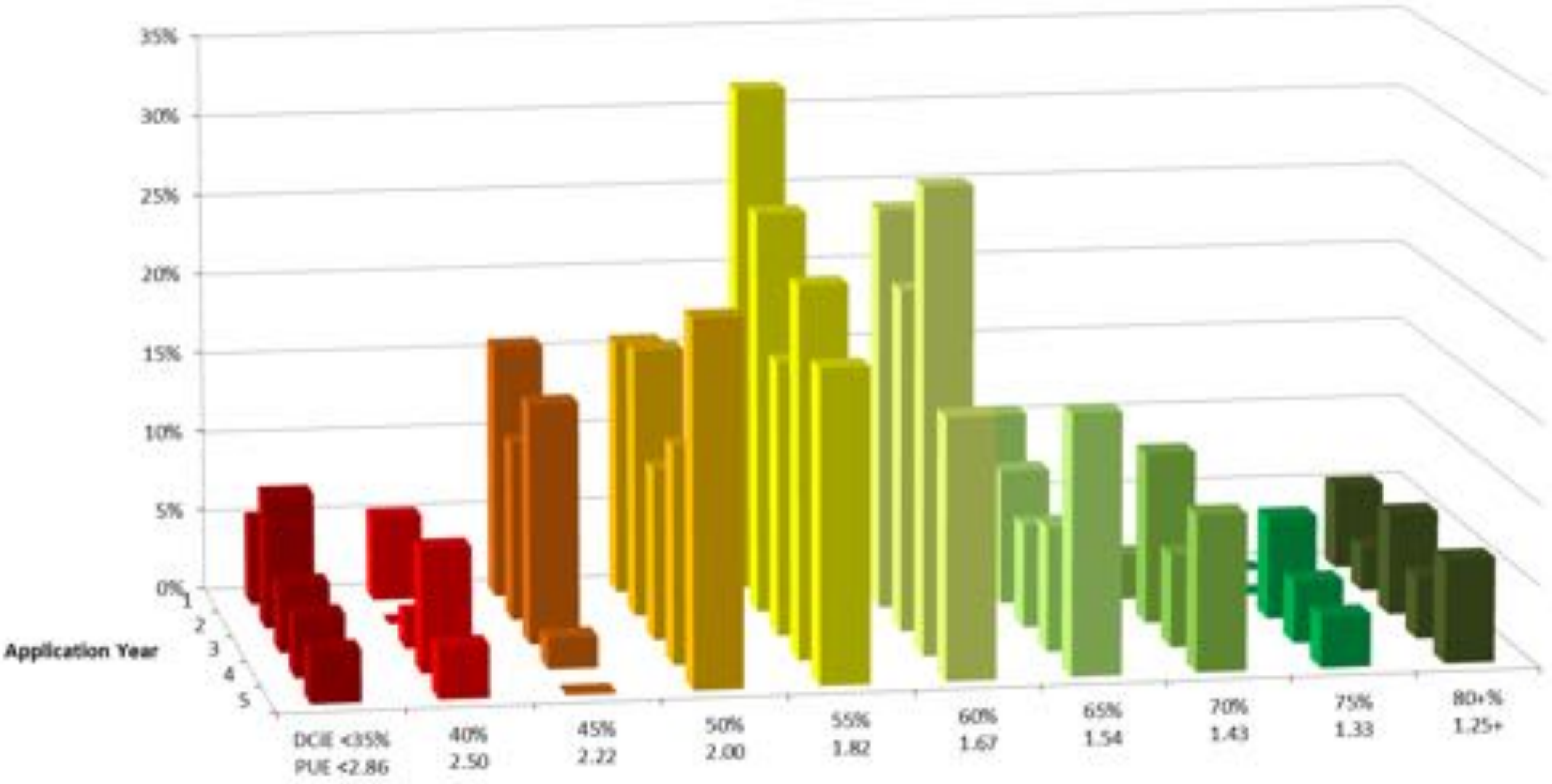

DC Participants
250
200
150
100
50
0
No of particpants
1
2
3
4
5
Participation Year
7 - Hybrid
6 - Internet
5 - Hosting
4 - HPCC (Scientific)
3 - Telecom
2 - On-Demand Enterprise
1 - Traditional Enterprise


2 - Enclosed in a Larger Building 43%
1 - Stand-Alone 57%

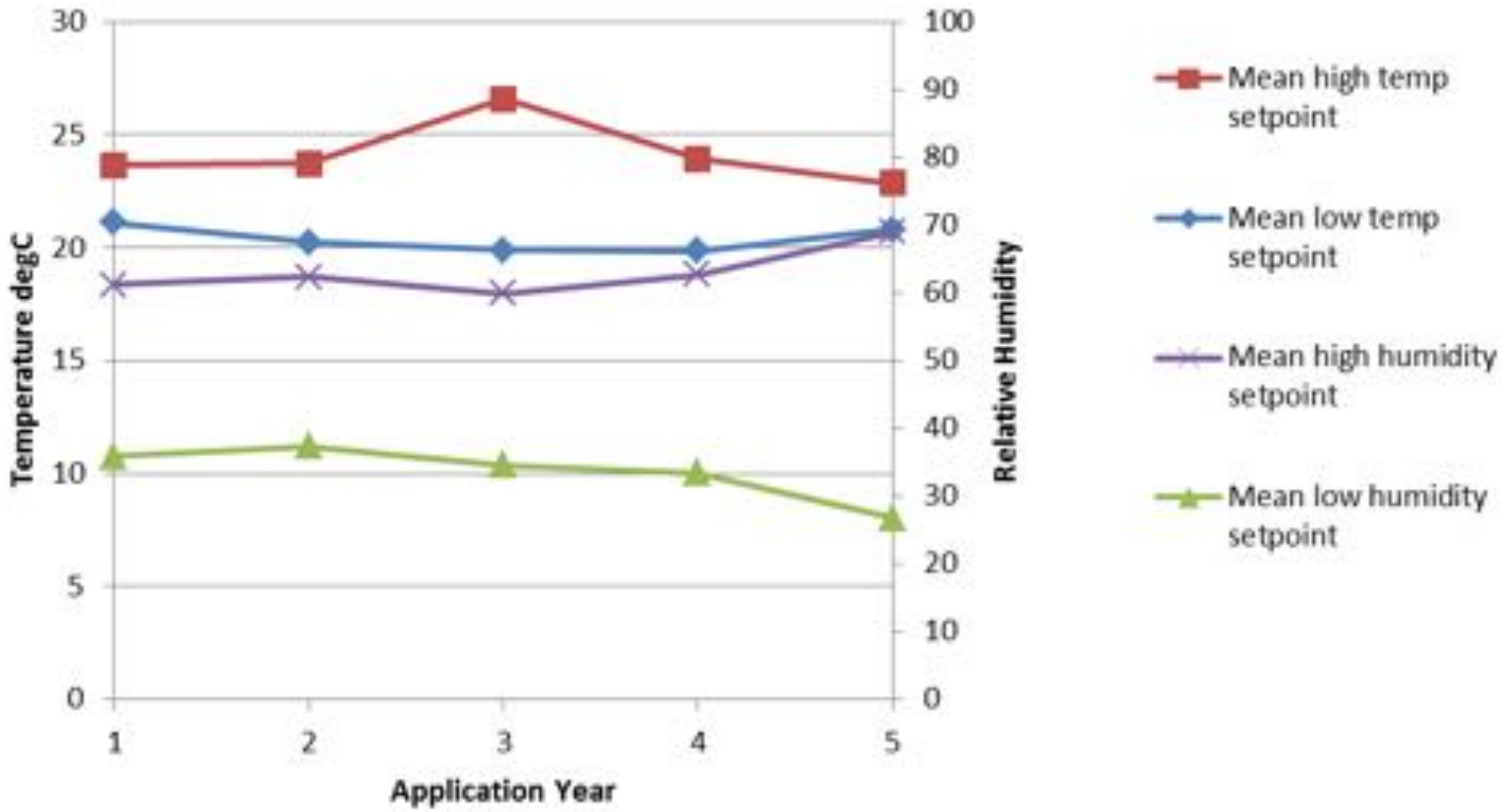
Average Applicant DCiE change over time



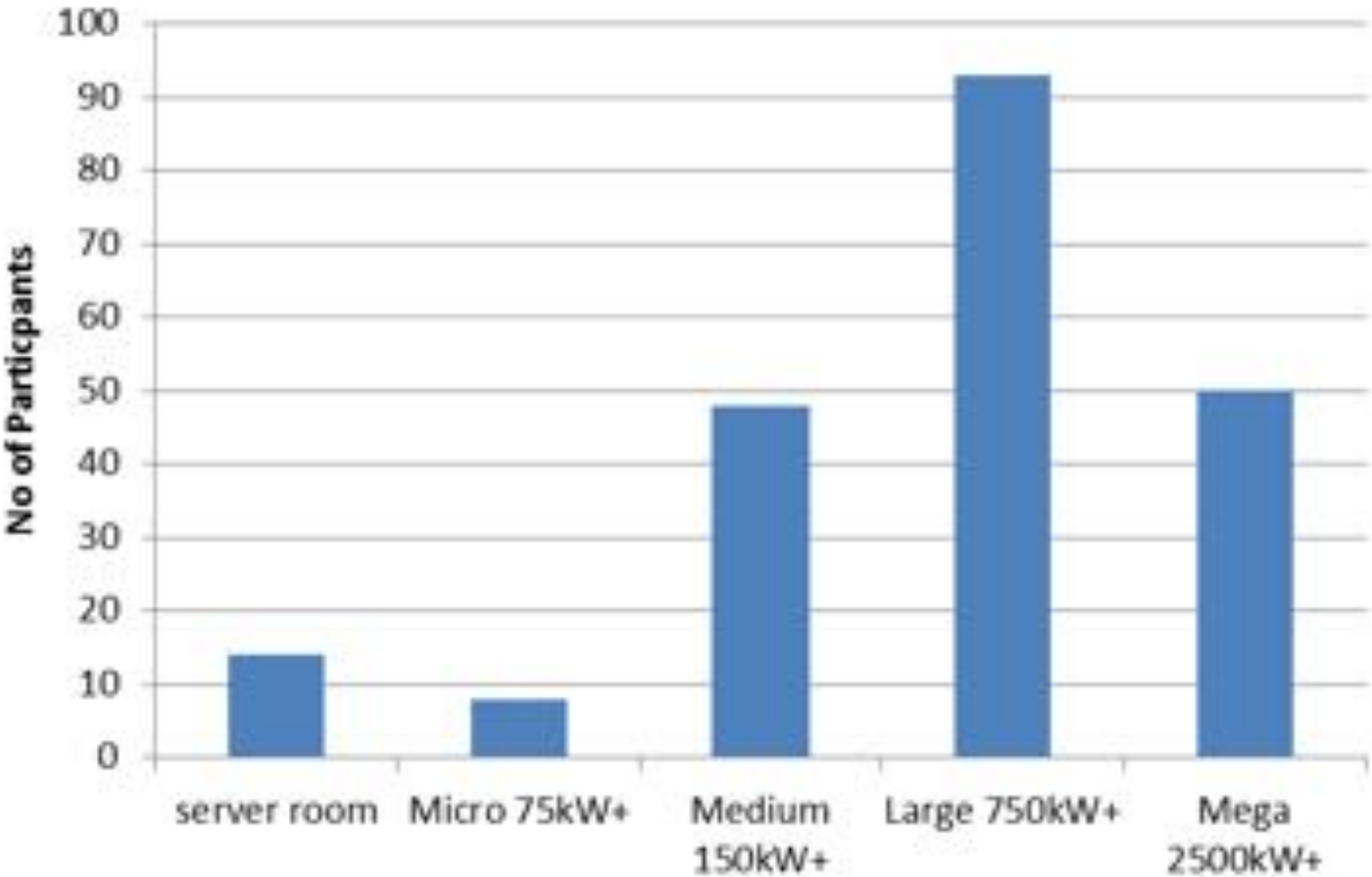
Efficiency distribution by application year



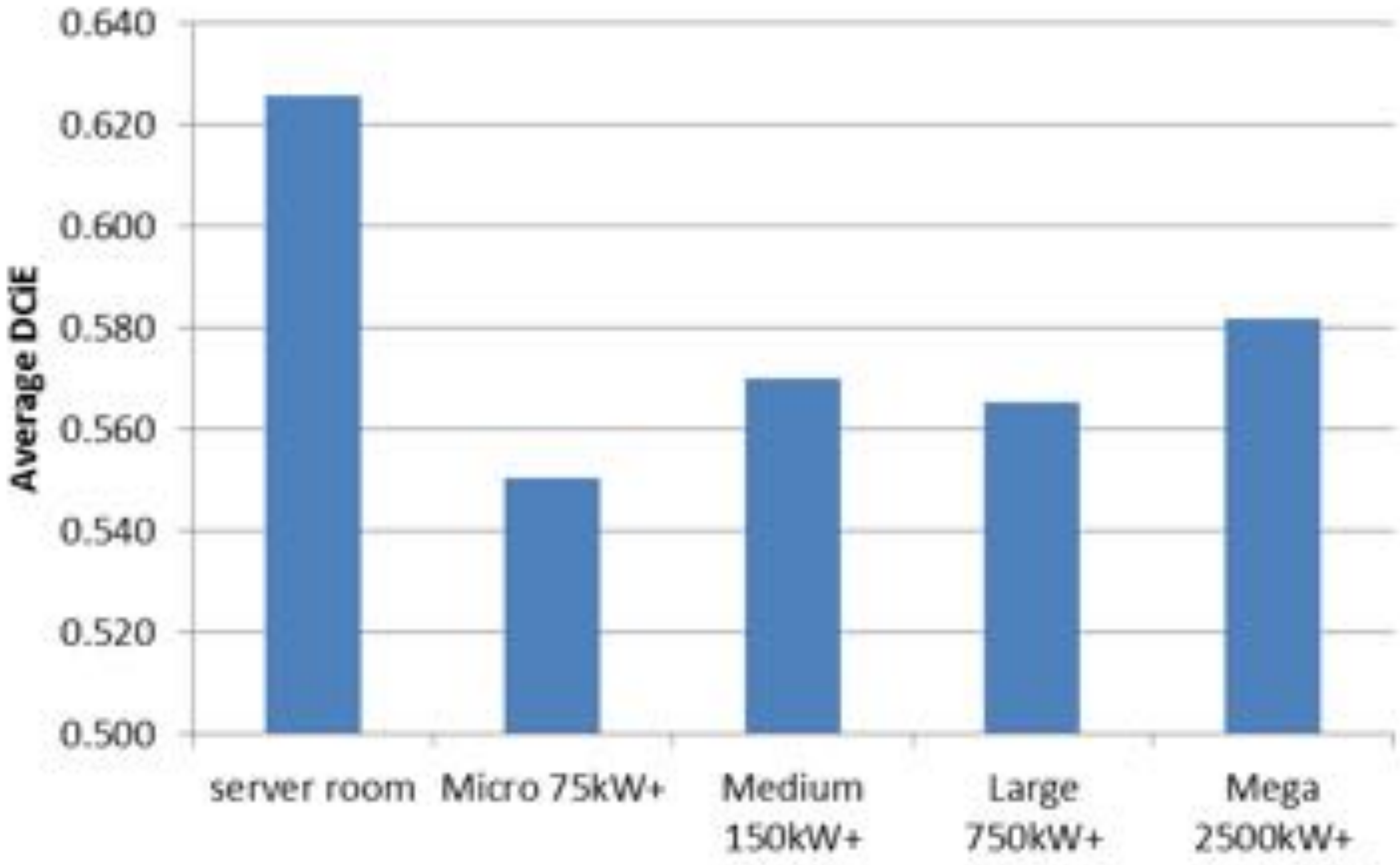
Mean temperature and humidity setpoints by year of application

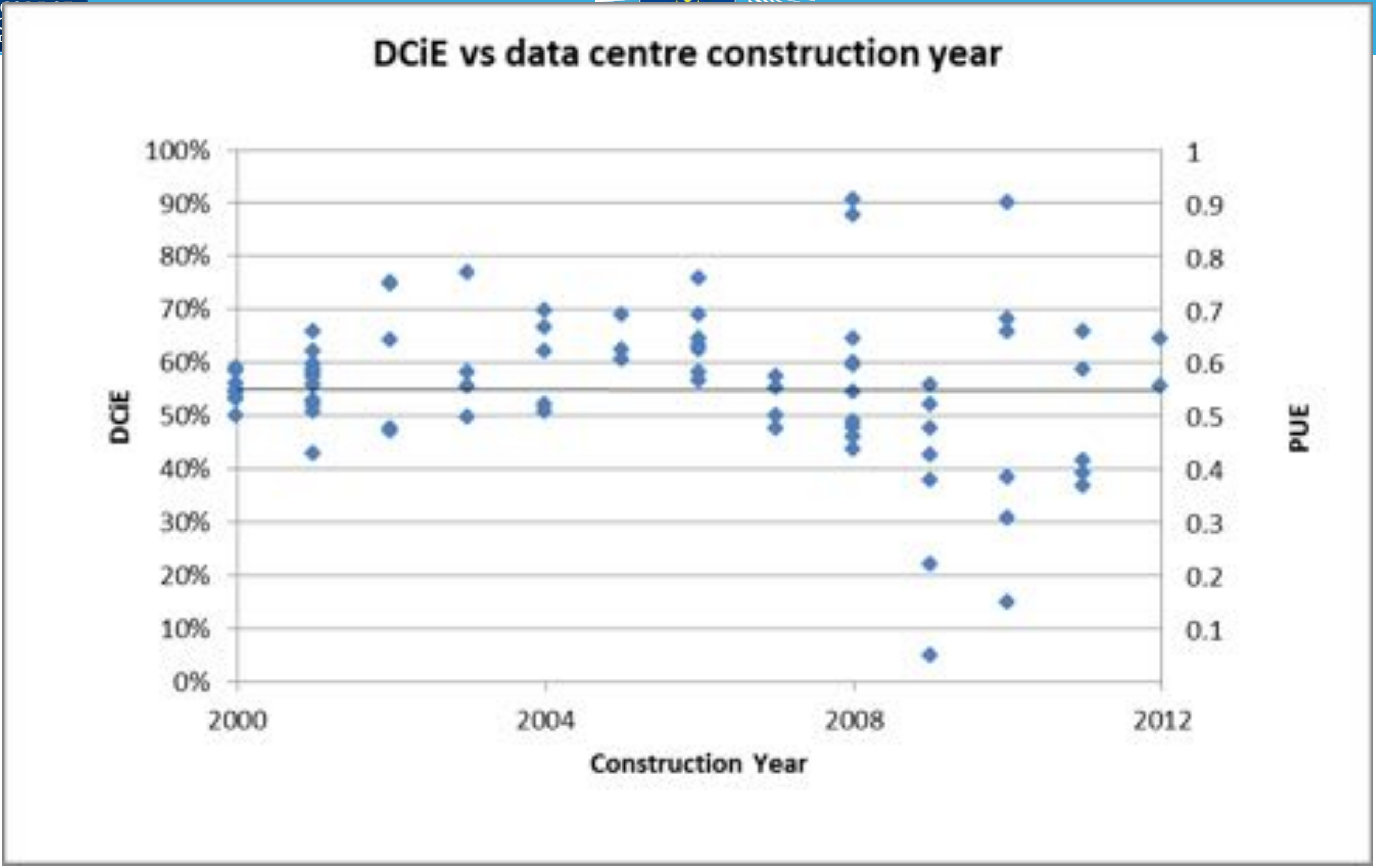


Participants by DC size



DCiE by DC size





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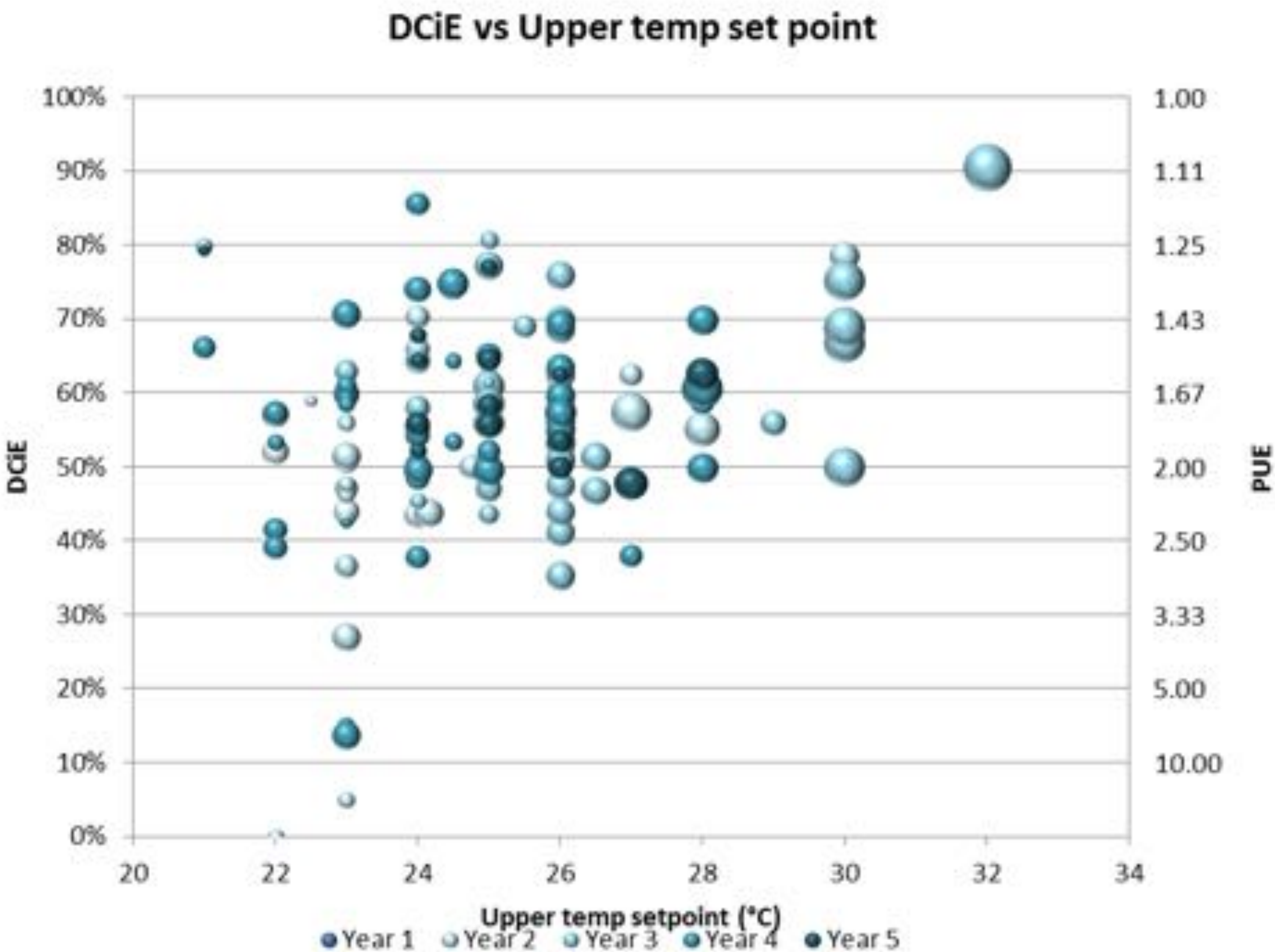
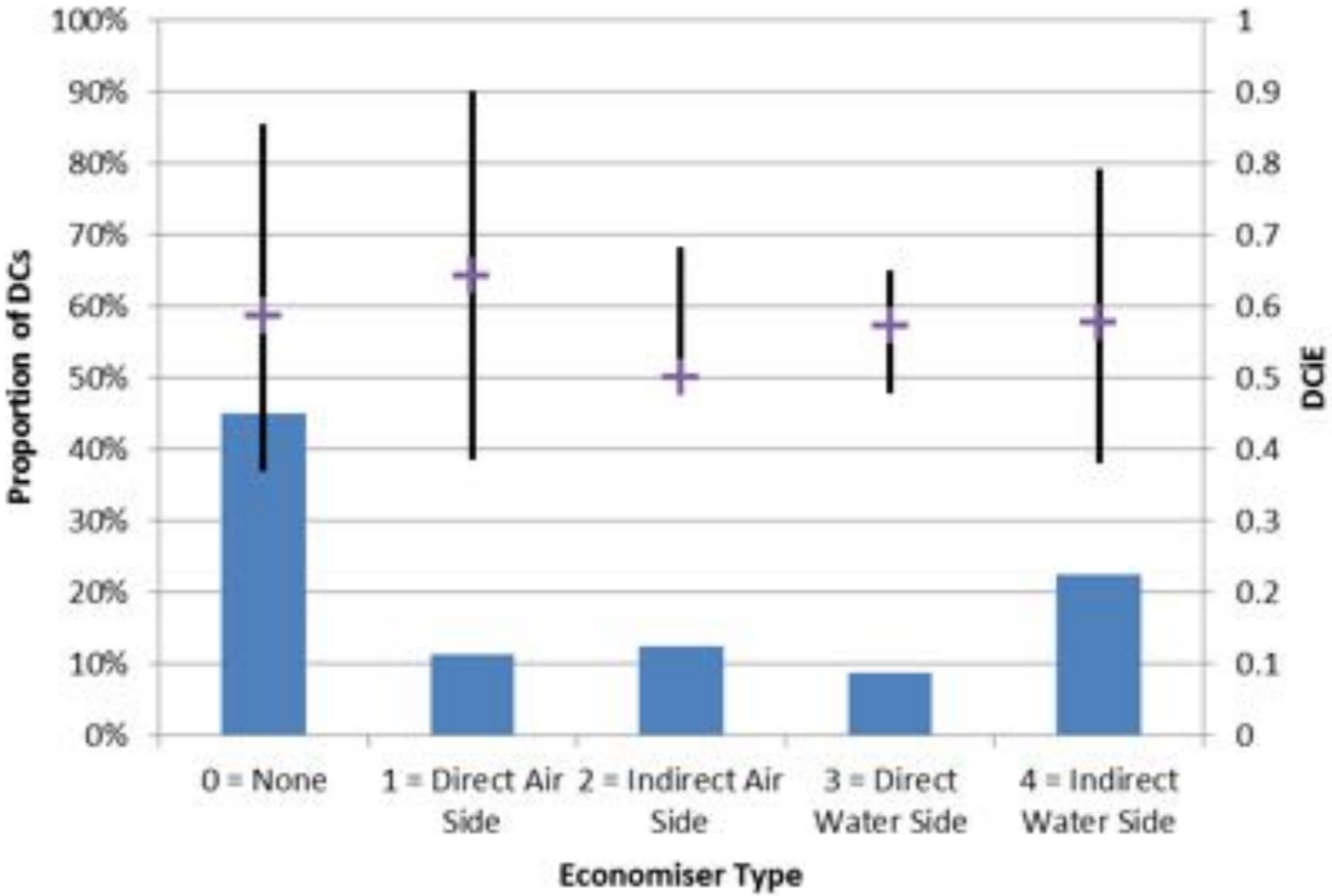

DCiE vs Upper temp set point
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
DCiE
1.00
1.11
1.25
1.43
1.67
2.00
2.50
3.33
5.00
10.00
PUE
20
22
24
26
28
30
32
34
Upper temp setpoint (°C)
Year 1
Year 2
Year 3
Year 4
Year 5

Economiser use and DCiE



ARM Ltd - data centre in Cambridge, United Kingdom

It's a High-Density data centre (up to 24kW per cabinet)
Tier-3, lights out facility
365 Free-Cooling
Efficient Flywheel UPS (98% at 100% load and still 96% at 40% load)
Annualised PUE of 1.05
100% Renewable Energy
Rain Water recapture
Energy Efficient Transformer
No Waste in the Construction

Capgemini UK – data centre Merlin in Swindon, United Kingdom

Use of fresh air, free cooling, modular sized rooms and the monitoring and management of energy consumption at the rack and Power .

Each module is equipped with a highly efficient dedicated Air Optimiser climate control cooling unit which cools air in three stages, with primary "fresh air" cooling, second-stage evaporative cooling and backup third-stage cooling through Direct Expansion R410a (DX). Distribution Unit (PDU) level, it achieves a Power Usage Effectiveness (PUE) of 1.2

Low energy losses transformer and flywheel UPS are very low at only 60 kW per 1,000m2.

The Trend Building Management System (BMS) is a sophisticated and energy-efficient System, which fully manages hot and cold air flows enable constant peak operational efficiency

Equinix – data centre Amsterdam 3 in Amsterdam, The Netherlands

Opened in October 2012, the new-build facility provides 17,800 m² of gross space in Amsterdam Science Park, one of Europe's most network-dense locations.

the data centre deploys Aquifer Thermal Energy Storage (ATES) in the ground instead of mechanical cooling and combines this with hybrid-cooling towers. This allows full use of free-cooling and generates hot water for the neighbouring University throughout the year. This is used in combination with Hybrid cooling towers

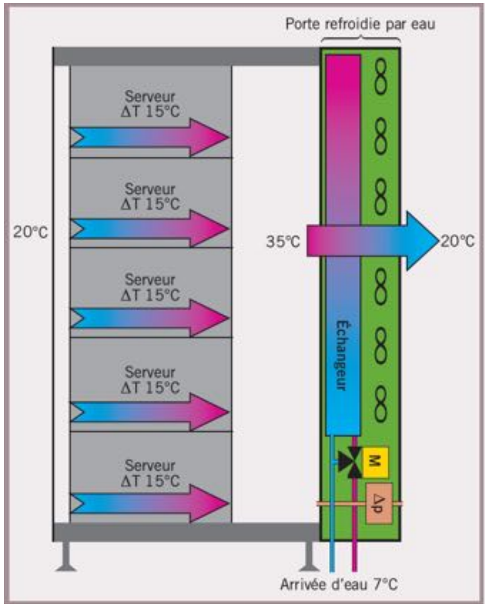
These and other sustainable technologies generate significant energy savings contributing to a target PUE of 1.2 or less, therefore allowing customers to reduce their CO_2 footprint significantly at the same time as enjoying world-class application performance

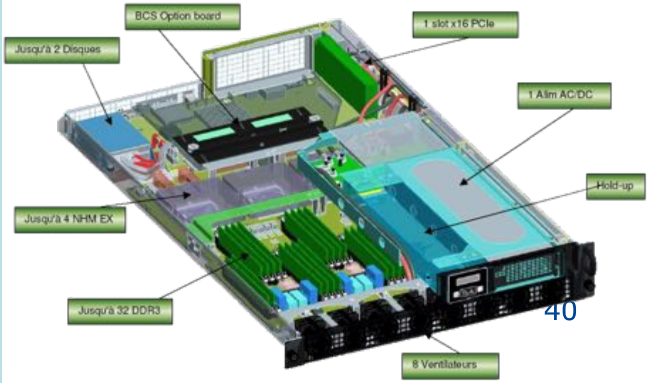
CEA-DAM – data centre TERA in Bruyères-le-Châtel, France

For Tera-100, the first petascale system hosted at CEA, CEA decided in 2009 to work with the vendor of the supercomputer in a joint R&D effort targeting three optimization axes towards higher energy efficiency:

Reduction of electricity consumption of IT equipment; Usage of more efficient cooling system allowing high density racks; and usage of passive devices to reduce the usage of UPS units.

A water cooled door was developed. This cold door is composed of an air/water heat exchanger, big fans and a regulation system. It allows a very effective cooling of IT components and it is compatible with the high energy density needed for HPC. Most of the IT configuration, including the compute nodes (85% in terms of electric consumption) is directly powered by the electricity provider and protected against short term power failures by UltraCapacitor Module (UCM) in each enclosure.





eBay Inc – data centre Phoenix 1 in Phoenix, Arizona, US

The PHX01 data center is a 4 story, purpose built Tier IV data center with approximately 6,039 square meters of raised floor technical space. The following Best Practices have been implemented

Airflow Management and Design (5.1)& Cooling Management (5.2) including Deployment of rack lineups in a hot aisle/cold aisle arrangement; Site wide use of blanking panels .Temperature and Humidity Settings (5.3) This site has implemented setpoint adjustments and control changes to address temperature and humidity High Efficiency Cooling Plant (5.4) CRAC (5.6) , including: Installation of VFDs on all white space CRAH units and establishing a floor wide temperature sensor network to aid in the control algorithm, installation of ultrasonic humidification systems to replace all steam generation systems.

Unilever, data centre Chester Gates in Chester, United Kingdom

The Chester Gates data centre has been designed and built on a modular basis, leveraging the latest available technologies and where practical retro-fitting to older sections of the data centre. In March 2013 average PUE was 1.41 down from 1.68 March 2012. The data centre uses external ambient air as a free cooling medium together with a cooling system known as ‘closed cell–close control’ or ‘4C’. Other solutions implemented are:- replacement of legacy non-free cooling chillers, pumps and CRAC units with high capacity components offering improved coefficients of performance; introduction of smart LED lighting and implementation of ultrasonic humidification.
Savings in the consumption of energy by IT equipment have been achieved through the adoption of newer server and storage technologies which enable improved IT service consolidation and virtualisation across platforms.

Google, data centre in St. Ghislain, Belgium

Google's first chiller-less data center
- 100% "free cooled" using conventional cooling towers
- Evaporative cooling uses 100% recycled water, pulled from an industrial canal and treated at a purpose-built plant at the data center
- Elevated cold aisle temperatures
- 99% + efficient on-server batteries replace traditional UPS
- 90+ efficient power supplies for servers
- Trailing Twelve Month Energy Weighted PUE of 1.10 for 2010
- All emissions are offset as a part of Google's corporate carbon neutral commitment

The Datacenter Group, data centre in Amsterdam, Netherlands

- Installation of an **own developed cooling systems** which uses **indirect adiabatic outside air cooling**. This means cooling through evaporation and no use of conventional refrigerants. Proof of concept trials with cooling system started in 2008. Cooling system completely replaced in 2010.
- From the start The Datacenter Group has chosen for the best UPS that was available, this means an **UPS with an efficiency of 97%.**
- **Complete monitoring** of energy consumption, almost every outlet in the building is monitored.
- **C02 neutral**, we purchase 'green power'
- Installation of the latest **ISO 14001 certificate** to ensure all internal procedures are sustainable.
- Active participant of the MJA-3, which is a Dutch initiative in order to decrease **yearly** the energy consumption with **2%.** With an average of 30% in 2030.
- Achieved **EUE** (average PUE over the year 2011) of **1.16**

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Migration Solutions Ltd, data centre Sentry42 in Norwich, United Kingdom

- Free cooling chillers
- The water temperature is raised so that cooling is only ever required when the ambient outside temperature is above 20° C
- Metering at every point in the electrical systems (main incomer, primary switchgear, PDU and cabinet power strips)
- All cabinets are in a Cold Aisle arrangement
- Blanking panels in all cabinets
- 100% LED lighting throughout the data centre
- Equipment to capture and re-use the heat

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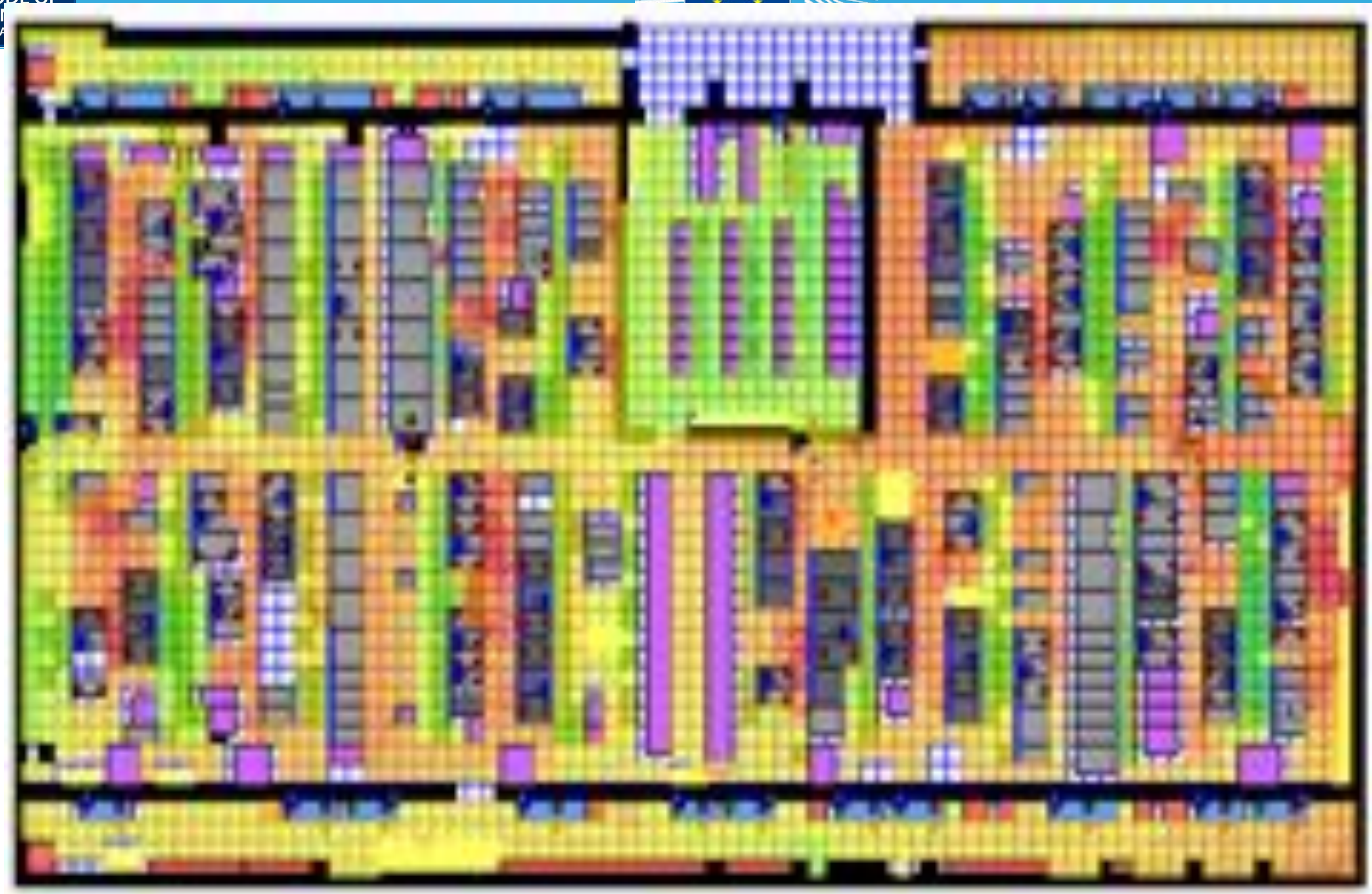
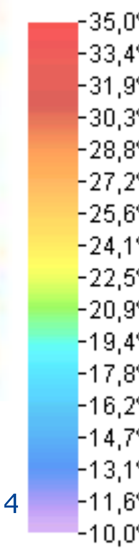
A typical roadmap for an IBM DataCenter

Thermal map as measured by MMT² (room t° increased as per Ashrea³)





² **MMT = Measurement and Management Technologies** a data center optimization solution developed by IBM Research Division.

³ **25 ° C** set as target server inlet temperature

Conclusions (1)

How should we be improving DCs under 150kW?

- Engagement, marketing
- Technology inc migration
- Operations

Time for CoC to be more ambitious with Best Practices for DCs over 150kW?

Conclusions (2)

- There is increasing interest for the Code of Conduct among data centres operators
- This is the only independent pan European scheme in the EU to certify that a data centre has adopted energy efficiency best practices
- We collect DC data to track efficiency improvement over time
- We have now established an Annual Award for the best implementations

Thank You for Your Attention

For more information contact

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http://re.jrc.ec.europa.eu/energyefficiency/html/standby_initiative_data_centers.htm