



## HOW MEANINGFUL IS PUE?

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**DATA CENTRE OF THE FUTURE-HILTON  
PARK LANE**

17 June 2009

# Running Order

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- “ Introduction
- “ Issues surrounding PUE, its use and the future
- “ Research feedback
- “ Q&A\$

# Points to consider

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## Measurement

- “ Measurement is a good thing!
- “ Measurement needs process, procedure and frequency
- “ You can use what you want, but are you doing it efficiently

PUE is as good as any measure but with measurement

- “ A tool in one hand is a weapon in another

Metrics used to promote misleading results

Where is PUE being used

- “ RFPs / Planning Conditions / Briefs
- “ When / What / Why?
- “ Does anyone here deploy final IT load at Day 1 & never change it

Input or Output

# Power Usage Effectiveness - PUE

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The Green Grid's PUE (Power Usage Effectiveness) metric - become an industry standard in and around the data centre industry, and there is lively debate about who has achieved the lowest value.

Excellent guidance on how to measure, where to measure, frequency and reporting.

As the PUE value is being misused, the industry should look beyond any given value to understand what is being said.

# So what is PUE (and DCiE)?

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The definition:-

$$\text{PUE} = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

$$\text{DCiE} = \frac{1}{\text{PUE}} = \frac{\text{IT Equipment Power}}{\text{Total Facility Power}} \times 100\%$$

- “ Based on power measurements
- “ A ratio of power measurements
- “ PUE is a reciprocal of DCiE and vice versa

# What is an Efficient Data Centre?

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$$\text{PUE} = \text{Total Facility Power} / \text{IT Equipment Power}$$

$$\text{DCiE} = \text{IT Equipment Power} / \text{Total Facility Power}$$

PUE	DCiE	Level of Efficiency
3.0	33%	Very Inefficient
2.5	40%	Inefficient
2.0	50%	Average
1.5	67%	Efficient
1.2	83%	Very Efficient

Source: Green Grid

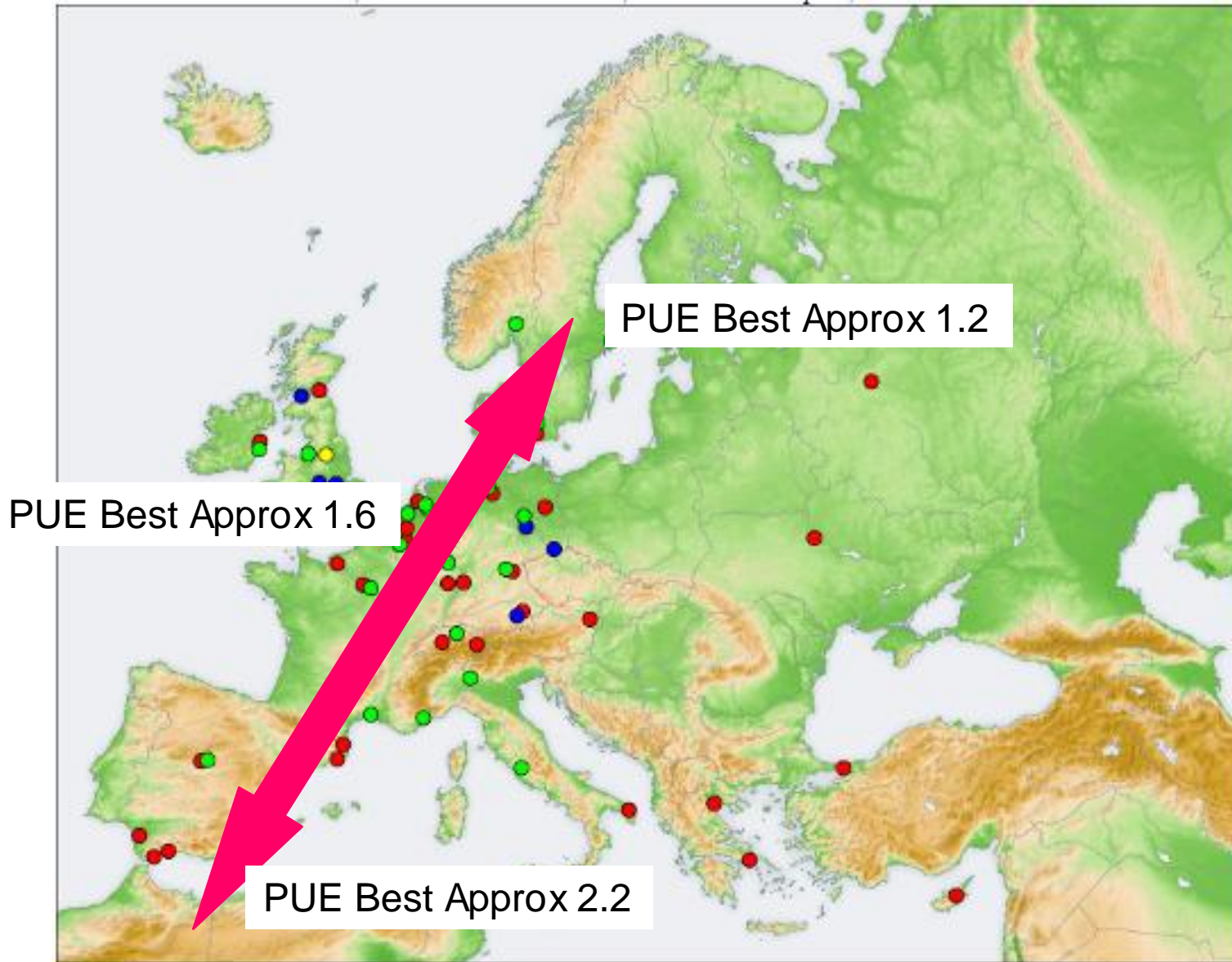
- “ The Green Grid indicates that a PUE of 2 is **Average**
- “ PUE of 1.5 to 1.6 is considered **Efficient**
- “ PUE of below 1.5 is difficult to achieve without careful design

# Factors that affect PUE

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“ Climate and location

# PUE Values . conventional cooling

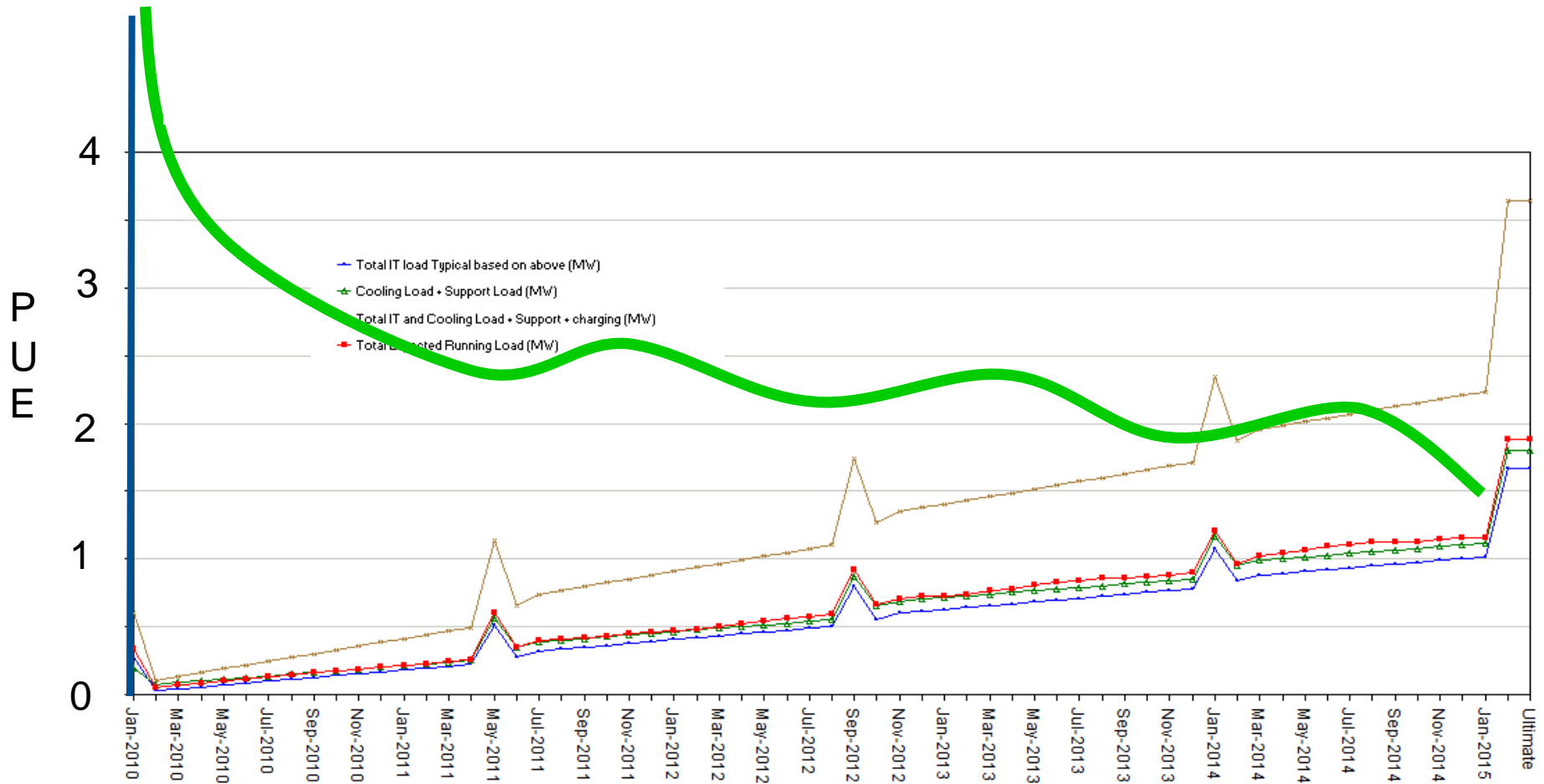


# Factors that affect PUE

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- “ Climate and location
- “ IT Loading of the data centre or hall(s)
  - . Plant utilisation
  - . Plant cycling
  - . Data centres are in constant flux
  - . Design PUE using nameplate ratings

# IT loading impact

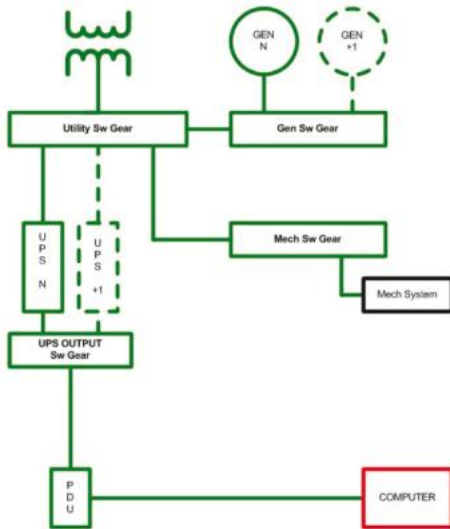


# Factors that affect PUE

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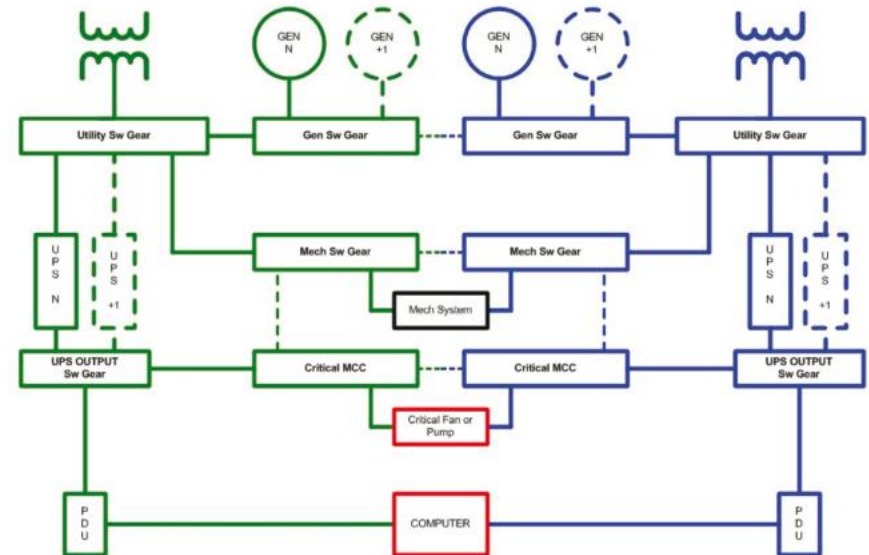
- “ Climate and location
- “ IT Loading of the data centre or hall(s)
  - . Plant utilisation
  - . Plant cycling
- “ Resilience and redundancy / Tier levels

# Resilience and redundancy



## TUI . Tier II . N+1 UPS

- “ Load via one UPS system
- “ Example 3 UPS modules supporting 1MW load at N+1, loading at max IT load approx 64%.
- “ Efficiency at 64% loading approx 94%



## TUI . Tier III+ or IV . 2(N+1) UPS

- “ Load via two UPS systems
- “ Example 2 x 3 UPS modules supporting 1MW load at 2(N+1), loading at max IT load approx 32%
- “ Efficiency at 32% loading approx 90%

# Factors that affect PUE

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- “ Climate and location
- “ IT Loading of the data centre or hall(s)
  - . Plant utilisation
  - . Plant cycling
- “ Resilience and redundancy / Tier levels
- “ **Plant performance**
  - . Quality of materials and components
  - . Factory Testing / Commissioning
  - . Multi Use Facilities

# Factors that affect PUE

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- “ Climate and location
- “ IT Loading of the data centre or hall(s)
  - . Plant utilisation
  - . Plant cycling
- “ Resilience and redundancy / Tier levels
- “ Plant performance
  - . Quality of materials and components
  - . Factory Testing / Commissioning
  - . Maintenance
- “ **When is PUE measured**

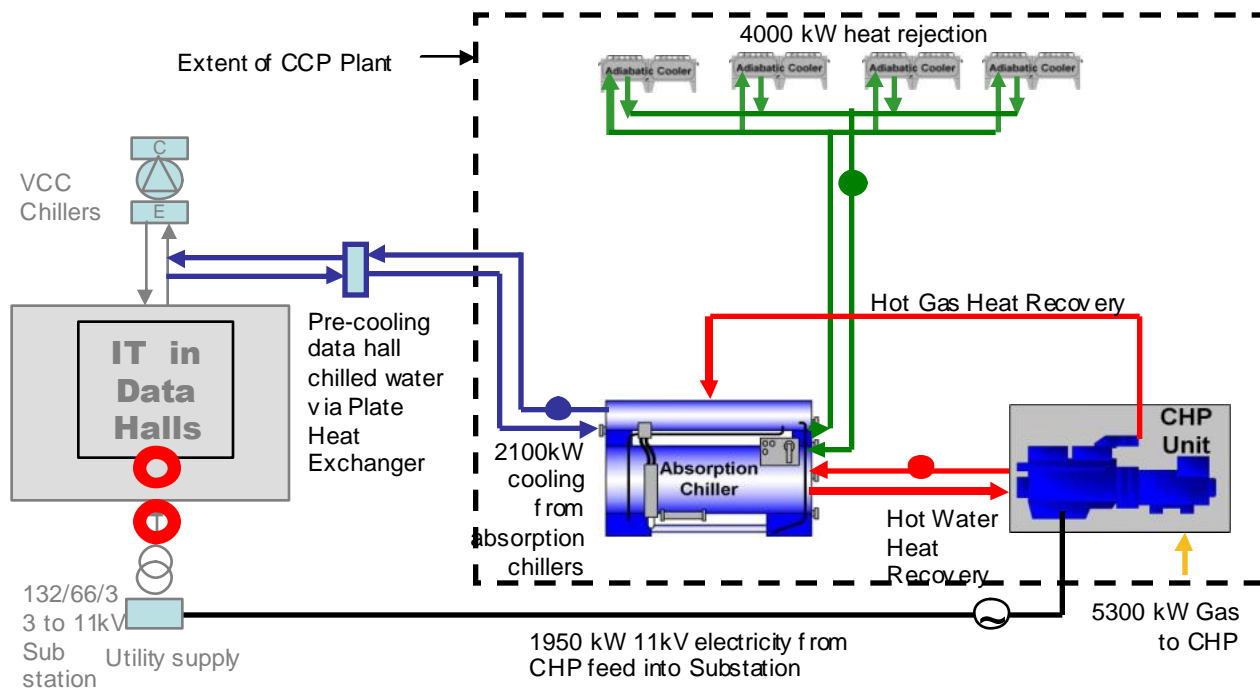
# Factors that DO NOT affect PUE

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- “ IT equipment performance
- “ Source of energy supply
- “ Utility costs
- “ Other costs elements such as inflation, interest rate etc
- “ Maintenance quality

# Energy sources

- “ Photovoltaic
  - “ Wind energy
  - “ Fuel cells
- Energy provided on site, no impact on PUE
- “ Tri-generation / CCHP



Where is PUE measured?  
Should gas kW be used?  
What is impact CCHP plant efficiency

# PUE and DCiE as a Design Benchmark

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- “ Commissioning is the time to stress test the site
  - . Traditional commissioning only tests the functionality of the site
  - . Set a benchmark
  - . Cost and time is worth it
- “ Provides long-term plan to improve efficiency
- “ Methodology
  - . Agree on load steps and data to be collected
  - . Step loads and measure

# Why Commissioning Data is Not Perfect

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- “ Not real world conditions
  - . Resistive Load Banks / Fan Heaters
  - . Higher density heat sources
  - . Little or no air management
  - . Discrete vs continuous measurement
  - . Sensitivity to weather conditions
  - . Etc

# Measurement - Motivations

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- “ Power re-billing
  - . Accurate, audit-able processes
  - . Budgeting and planning
    - “ Client end user
    - “ Customers
- “ Performance Monitoring (PUE & DCiE)
  - . Customer Impact
  - . Next phase of operational excellence
- “ Regulatory
  - . CRC
  - . Customer Governance
  - . Others

# Why DCiE and PUE are the Best Metrics

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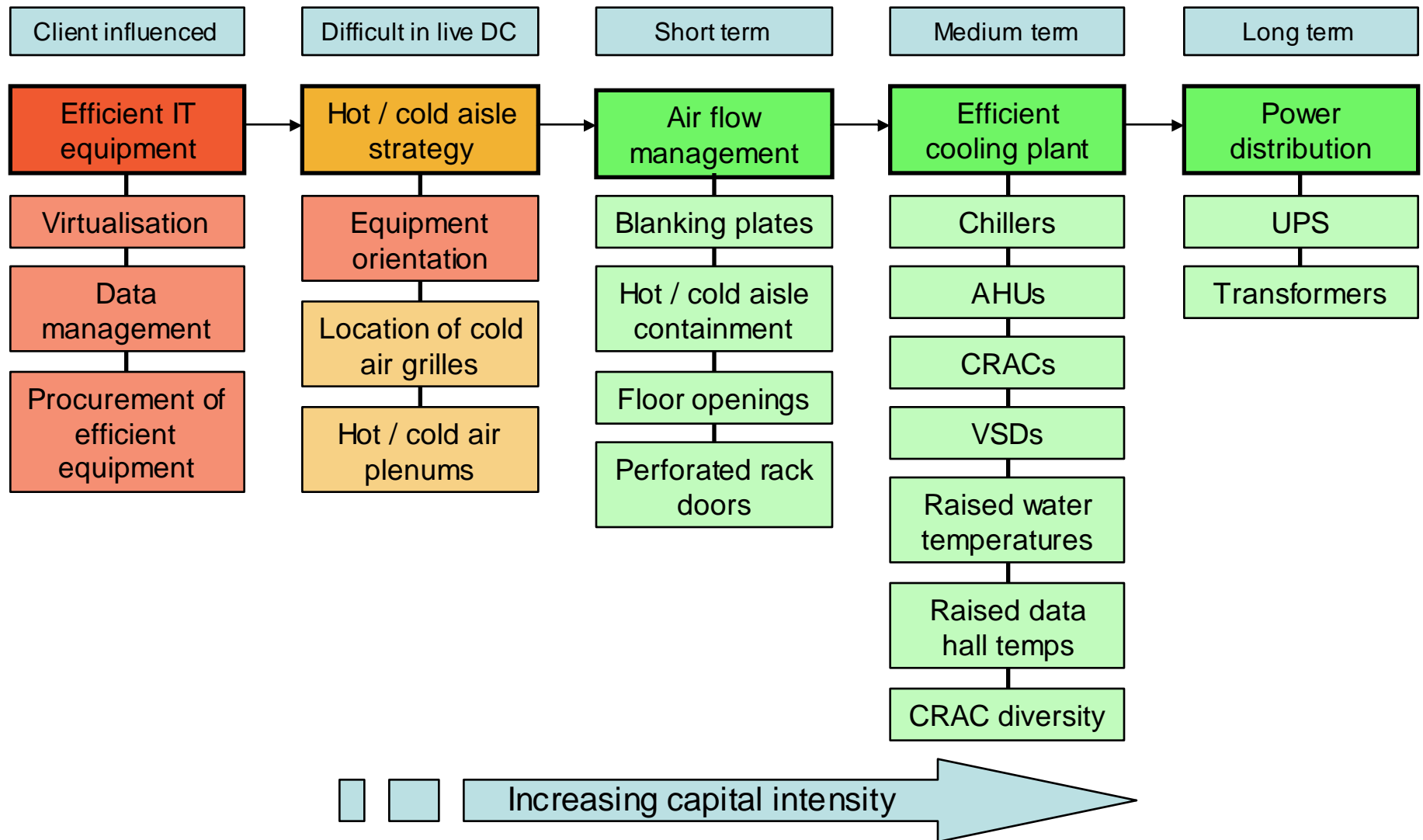
- “ Is IT productivity measurement YEARS away?
  - . More contentious than PUE/DCiE
  - . There will be a timeframe between decision on metric and agreement on methodologies, interfaces, etc.
- “ Measurements are only really being started in the last 2 years
  - . It is critical to get an understandable, easily implemented metric in the data centre today
  - . Arguments about % improvements in metrics difficult without a more rough baseline set of data
- “ Use of PUE figures will continue to be banded around
  - . % My PUE is better than yours!
  - . Need to reclaim PUE!

# So how can we improve our PUE

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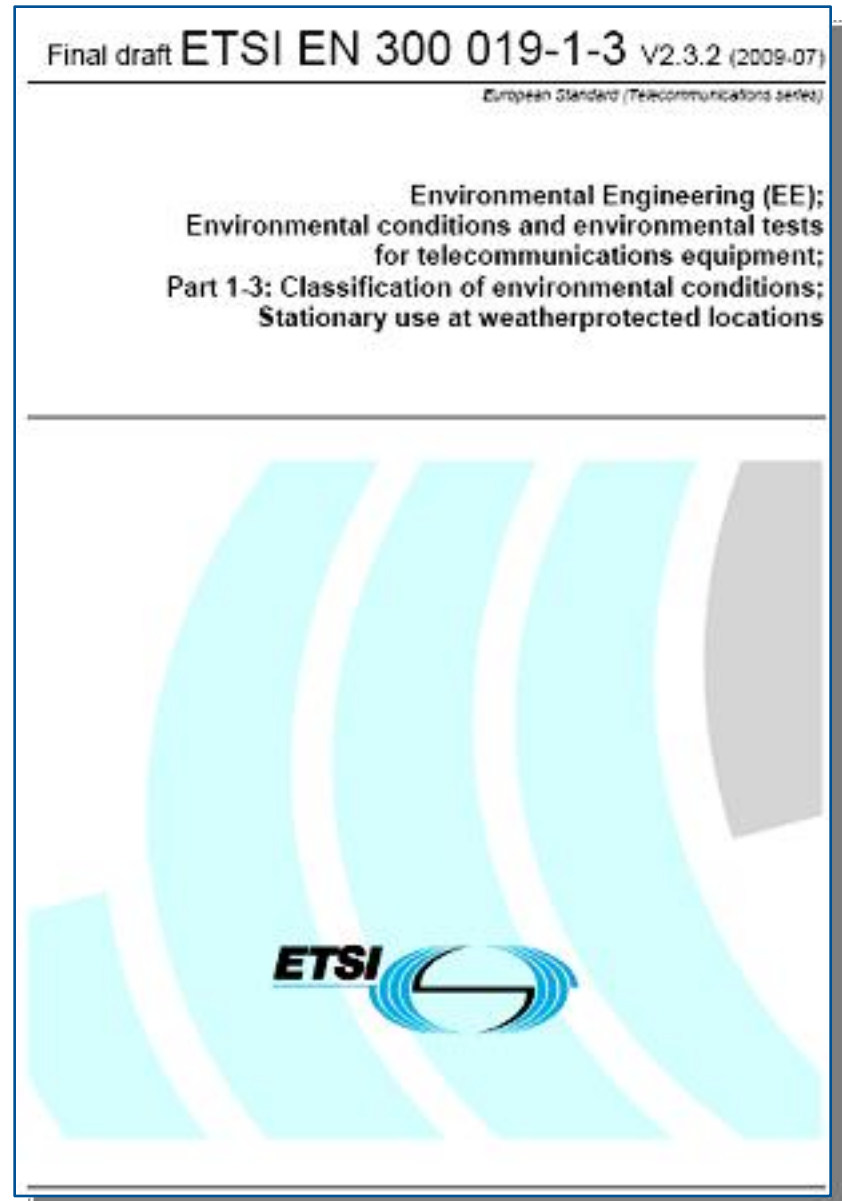
- “ Focus on new facilities, what about existing?
- “ A variety of measures
- “ Use a process to look at all aspects
- “ Keep it simple
- “ Take care with impact on resilience level

# Hierarchy of energy efficiency in data centres

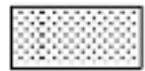
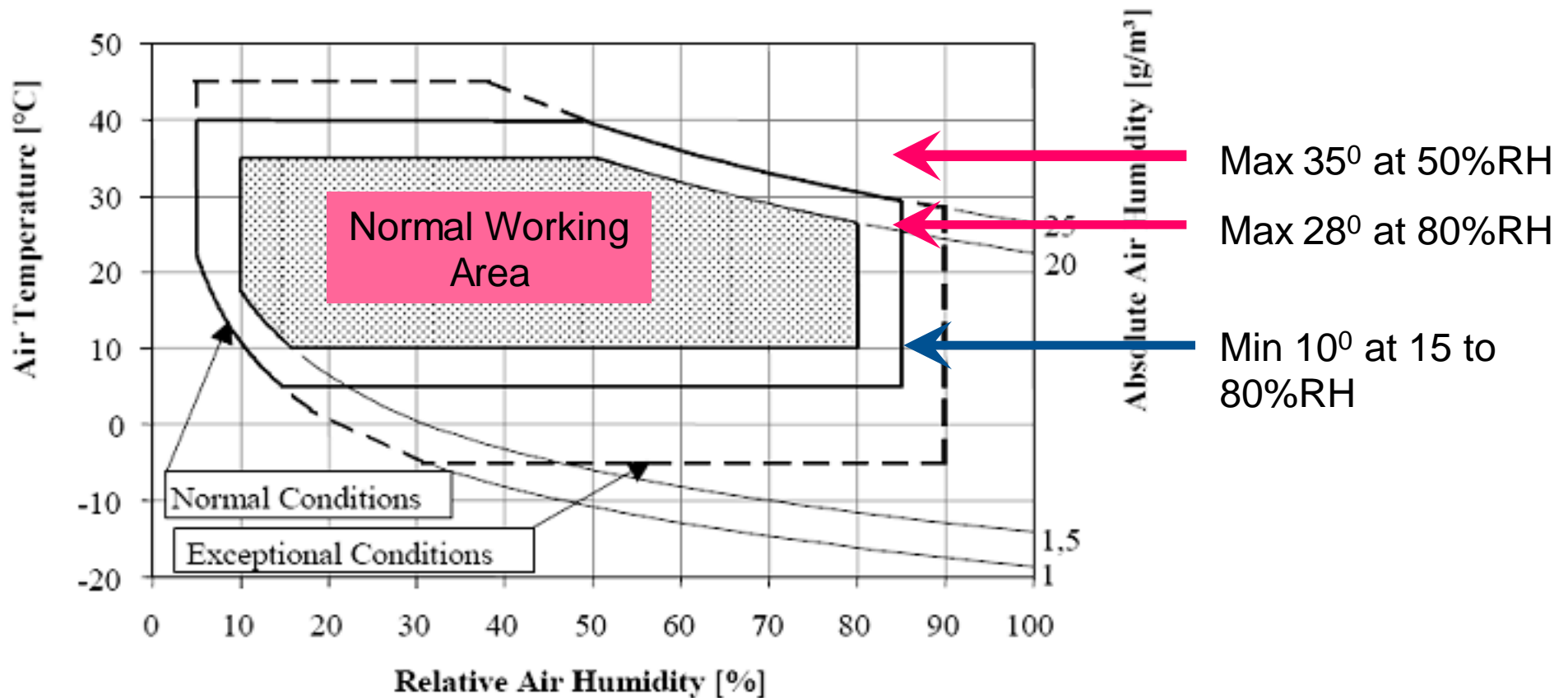


# ETSI Standards

- “ What is ETSI EN 300 019
- “ Published July 2009
- “ Enforceable in EU in 2012
- “ Six location classes
  - . 3.1 Temperature Controlled
  - . 3.2 Part Temperature Controlled
  - . 3.3 No Temperature Control
  - . 3.4 Heat-trap locations
  - . 3.5 Sheltered locations
  - . 3.6 Telecom control rooms
- “ Also environmental limits
  - . Biological (Fauna and flora)
  - . Chemical (gases and particles)
  - . Vibration



# ETSI standard . What is the Impact?



Values outside this field have a probability of occurrence of less than 10 % (see IEC 60721-3-0).



Exceptional climatic limits.



Normal climatic limits: Values outside these limits have a probability occurrence of less than 1 % .

# Overall Data Centre efficiency

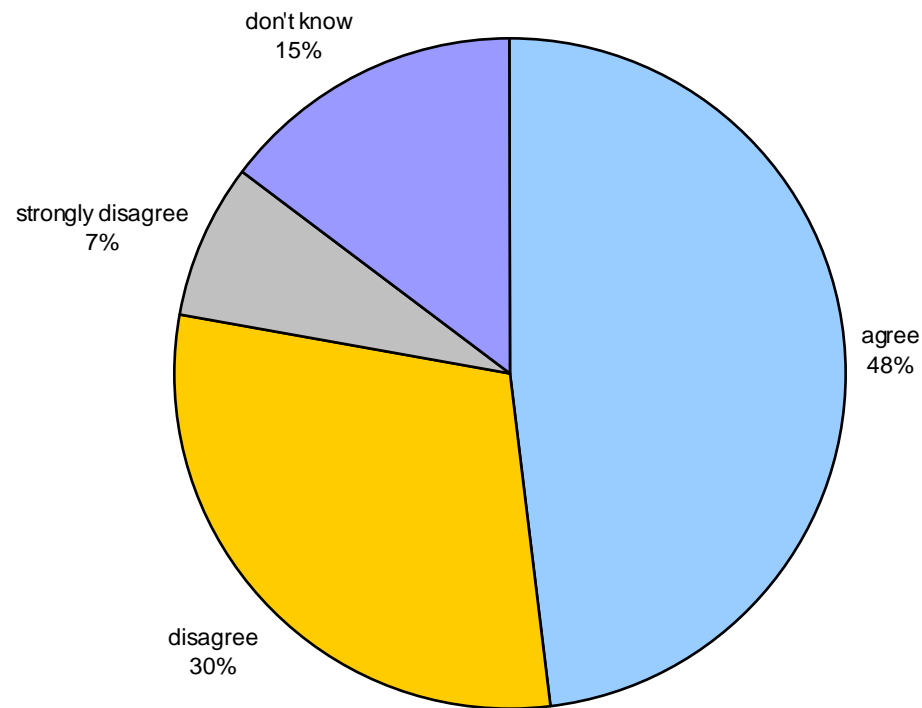
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- “ Water
- “ Fuel Oil
- “ Waste-Packaging
- “ Environmental Protection Agency . Defintion of PUE-Energy

# Research PUE

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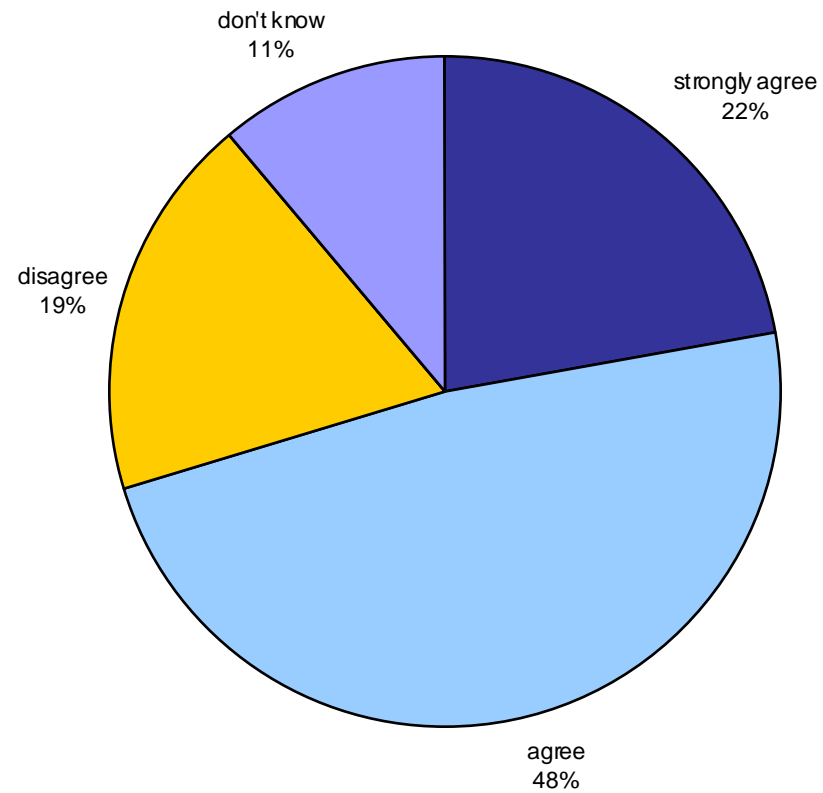
PUE is a good metric for measuring the efficiency of an individual data centre.



# Research PUE

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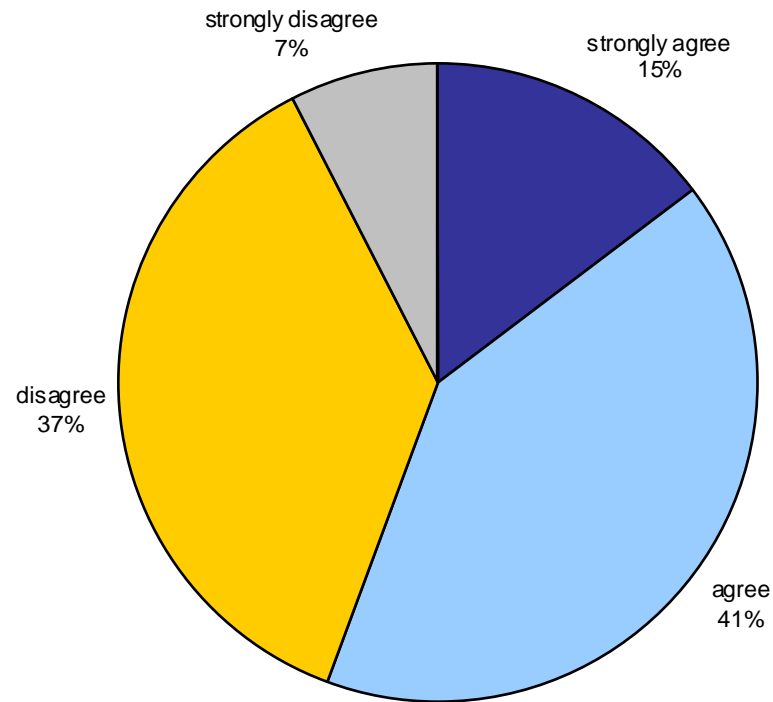
When comparing the efficiency of many data centres, PUE is too blunt a metric



# Research ETSI

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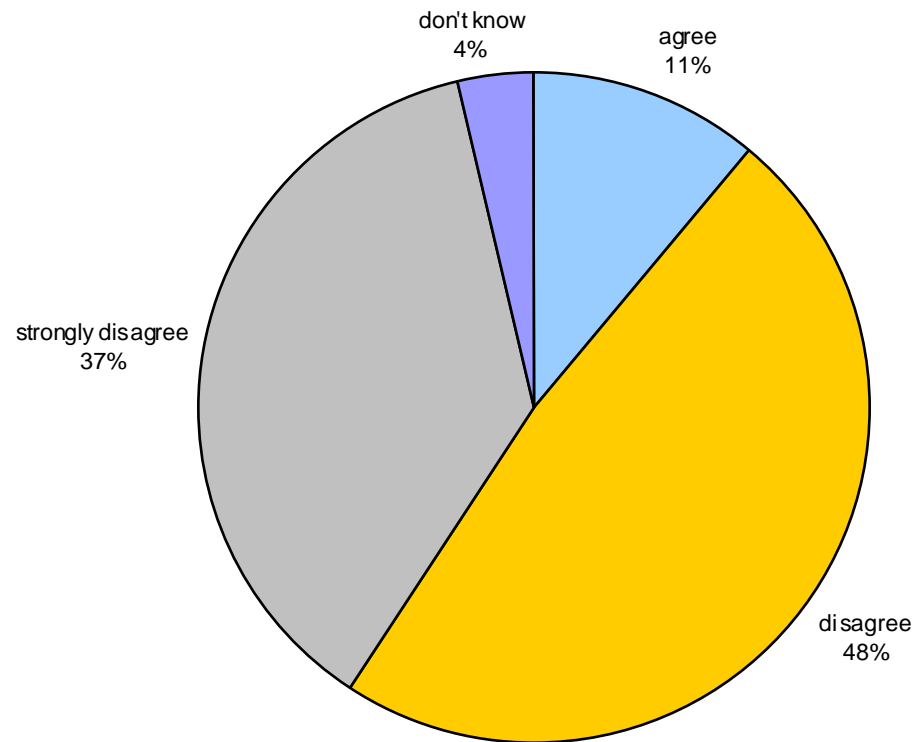
**In the next three years, data centres will run at much higher temperatures, at 30 degrees C, or more, air onto servers**



# Research Fresh Air Cooling

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Almost all new data centres in the UK will be full fresh air cooled by 2012



# Summary

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- “ PUE / DCiE is here to stay
- “ Many factors impact PUE
- “ Comparing data centre performance only on PUE is potentially dangerous without understanding underlying issues
- “ PUE is a measurement tool
- “ Measuring over time is key with robust transparent consistent information

# Questions?

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Thank you