Workspace
Technology Limited

Technology Paper 003

Server Room & Data Centre Energy Efficiency

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Introduction

Energy efficiency is imperative to environmental and IT economic productivity and can no longer be ignored. Slowing the growth rate of electric power use for servers and data centres is necessary to reduce the rate of growth of greenhouse gas emissions.

It is estimated that 1.2% of the nation's electricity in the year 2005 (more than double that of 2000) was consumed by servers alone. Actual data centre power consumption used by disk and tape storage, network and communications and other IT hardware is significantly higher. This level of consumption makes IT hardware and data centres a leading contributor to carbon emissions.

The increase in computational performance is outstripping the much slower rate of energy efficiency. In mathematical terms, server compute performance has been increasing by a factor of three every two years, however, energy efficiency is only doubling in the same period. This means computational performance increased by a factor of 27 between 2000 and 2006. Energy efficiency has gone up as well, but only by a factor of eight during the same period.

Identified key characteristics of a green data centre

The criticality of IT is no longer in question for many organisations. In the overall scheme of things, data centre energy consumption has been overlooked by most organisations, with IT performance taking precedence over all other considerations. Enterprises which become early green adopters can have both high IT performance and energy efficiency while also creating a competitive advantage by saving operating costs.

The four separate performance factors that define a green data centre are:

IT hardware productivity – IT managers should ask themselves how can they maximise and fully utilise the fraction of their IT equipment that is employed productively.

Maximum computational performance per unit of internal power – IT personnel who select platforms should ask themselves how they can select hardware that delivers the most effective computing performance per watt of internal power used.

Efficient delivery of power at the plug to internal I.T hardware components – IT procurement personnel should ask themselves how they can select IT equipment that delivers input power to its internal components most efficiently.

Efficient site infrastructure – facilities / IT managers should ask themselves how they can maximise the amount of useful power delivered to the IT equipment, for each unit of power consumed at the electricity metre.

Whilst the first three of the items are focused at IT technology, the fourth item is focused on the Network Critical Physical Infrastructure (NCPI).

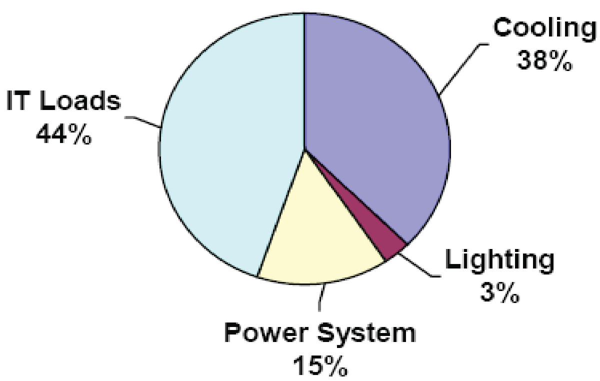
This technology paper focuses on the efficient deployment of NCPI and we have outlined these as "Ten ways to improve data centre infrastructure efficiency".

Why are data centres so energy-inefficient?

In a perfect world, data centres would operate at 100% efficiency. However, this is neither practical nor possible. A 100% efficiency would mean that the IT equipment used all the electricity that you put into the data centre. Typically, only 30% of the electricity is used by the IT equipment. The remaining 70% is consumed by chillers, UPS systems, computer room air conditioners, power distribution units and other infrastructure components. So, when you pay your electric bill, 30% of it is for your IT and 70% for your infrastructure. In other words, data centres typically draw more than twice as much power as their IT loads require, of which a significant proportion can be avoided.

By matching the infrastructure closer to the load, the amount of wasted energy can be reduced significantly as well as making savings in initial capital investment.

Breakdown of electricity consumption of a typical data centre

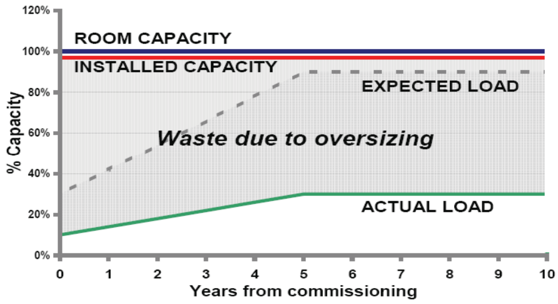


10 Ways to Improve Data Centre Infrastructure Efficiency

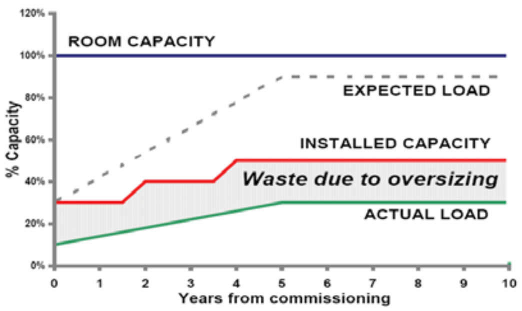
"Right-size" Infrastructure — One

Most IT rooms have been designed to meet the maximum future estimated power and cooling needs. Conventional thinking holds that you are "better safe than sorry" when building the data centre. This approach often comes with a high energy price tag and usually leads to underutilised equipment and poor energy efficiency. As a consequence there is a negative effect on both the corporate bottom line and the environment.

Typical Traditional Build showing waste due to day one over sizing of capacity



Practical and Achievable Levels with right size technology deployment



Utilising a modular, scalable power and cooling architecture that allows you to deploy as needed, avoids "just in case" over sizing. This is the single best strategy for improving data centre efficiency. Savings are even greater for redundant systems.

In practice "right size" designs are delivered through a combination of new technology with modular architectures, designs incorporating planned "parallel" system expansion, and phased room deployments.

Preventing Cold Air "Leakage" — Two

When raised access floors are deployed in combination with down flow AC systems the leakage of cold air in the wrong places will reduce the effective cooling capacity of the system. Increasing cooling capacity to compensate is expensive and wasteful of energy.

A better solution is to reclaim lost cooling capacity by sealing unmanaged openings that are wasting cold air. This will ensure air is circulated to where it is needed via correctly positioned grille floor tiles.

Typically these opening are found where cable access is required, below cabinets.

Example Brush Floor Grommet System

The installation of specially designed raised floor brush grommets will help seal the floor and prevent leakage of air where cables are routed into equipment cabinets.

The incorporation of floor sealing systems will help:

- **Increase existing cooling unit capacity**
- **Reduce the need to purchase additional cooling units**
- **Improve equipment reliability and extend equipment life**
- **Increase static pressure under the raised floor and improve cool air delivery through perforated tiles and floor grates**
- **Facilitate cold aisle/hot aisle best practices.**

Three
Efficient Air Conditioner Architecture

Traditional server room and data centre cooling was delivered through a "room" only architecture.

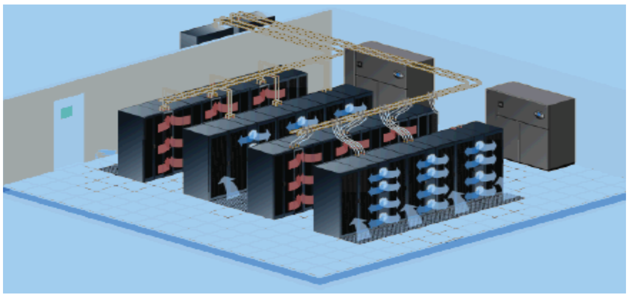
As detailed within our Technology Paper 001 (entitled Server Room Cooling Issues & Solutions Explained), room level "base" cooling, when combined with raised access floors and "hot and cold" aisle arrangements, is effective up to an average of 5Kw per cabinet.

When designing new facilities or assessing cooling expansion within existing rooms, in many instances simply deploying additional room based downflow/upflow air handling units will be ineffective and will merely add to the energy inefficiency of the room.

Contemporary designs will allow for the deployment of a combination of room and row-based units, which promote higher efficiency in high-density environments.

Where high density server clusters are deployed, technology based on 'In Row' or 'overhead configurations' deliver shorter air paths and require less fan power. CRAC supply and return air temperatures are higher, preventing dehumidification and greatly reducing humidification costs.

Combined down flow and In Row cooling configuration



Four
Implement AC Equipment Energy Saving Features

Many air conditioners have economiser options that can offer substantial energy savings, depending on your geographic location.

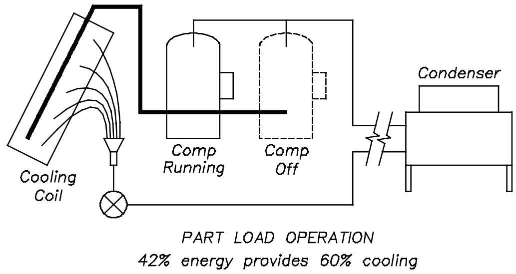
Examples of technology options on AC systems include:-

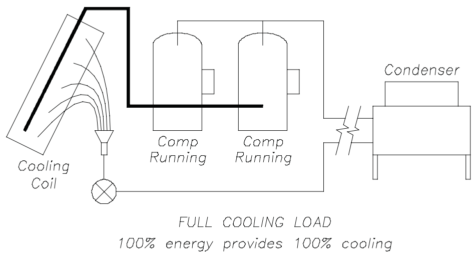
Dual Compressor/Variable Refrigerant Flow

By far the biggest user of energy within an AC system is the compressor circuits. By installing two compressors and utilising a variable refrigerant flow, energy saving can be made when loads are running under capacity.

When on part load running on 1 compressor, typically approx. 60% of cooling duty is achieved with only 45% of the input power to the compressor.

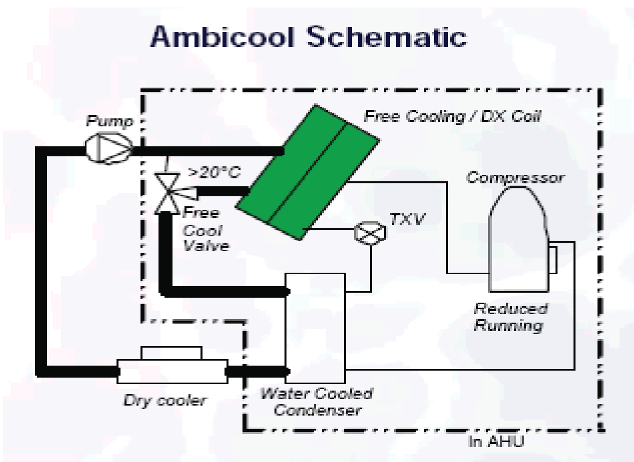
When running 1 compressor the SHR will be 1.00, therefore all of the cooling is sensible i.e. no latent cooling. This is extremely beneficial in the winter months when the RH is low saving on humidifier energy & replacement humidifier bottles, as a conventional system would need to humidify to replace the latent taken out.





Free Cooling

A free cooling system reduces annual energy consumption and consequently costs, by exploiting low average ambient temperatures to provide partial or full free cooling via a Glycol water system. When the glycol is cooler than the room air, it passed through a free cooling coil before reaching the condenser, picking up heat directly from the room rather than the refrigeration system. This reduces the running time on the compressor, thereby saving energy. As an example, some degree of free cooling is available for 70% of the year in northern Europe.



Heat Exchange Systems

A heat exchanger is a component that allows the transfer of heat from one fluid (liquid or gas) to another fluid. There is no direct contact between the two fluids. Heat is transferred from the hot fluid to the metal isolating the two fluids and then to the cooler fluid.

The deployment of heat exchange systems can allow heat removed from the data centre to be used to heat other parts of the building during winter months. The deployment of this technology needs to be integrated with the main building comfort cooling systems for maximum benefit.

Typically a 20Kw Net sensible cooling unit will require 9Kw of energy to power. When combined with dual compressors and free air cooling, this can be reduced to as low as 4Kw depending on load and external temperatures. Further energy savings can be made when heat exchange units are installed.

Five

Efficient Floor Layout

Floor layout has a huge impact on the efficiency of your data centre air conditioning system. Many existing facilities are unplanned, where both cooling and equipment cabinets are randomly deployed without any thought for efficient air flow. Cabinet aisles facing the same direction and cold air directed to cool hot exhaust air at the rear of cabinets are not uncommon configurations.

At the most basic level the employment of a hot-aisle/cold-aisle configuration will help solve air flow efficiency. Relocation of existing AC units is not always practical. It is recommended that managers of IT or facilities seek professional assistance from a data centre specialists to help design new rooms or plan improvements within existing facilities.

Six

Efficient UPS Equipment

Running costs are directly proportional to UPS efficiency and anything less than 100% means energy is being wasted. For large power ratings, the savings from a 1% improvement in operating efficiency can of course be quite substantial over the working life of a UPS.

The installation of modern transformerless UPS technology significantly improves efficiency and also saves on floor space at typical operating loads.

Typical efficiency ranges from 94% to 98%. The closer the load is matched to the UPS the more efficient the system. When analysing systems the light load efficiency figures should be taken into account.

Seven

Balanced "Vented Floor Tiles"

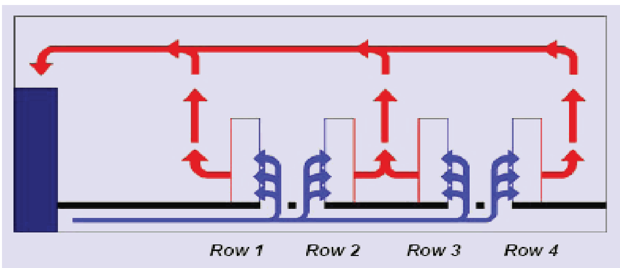
Data centres using a raised floor often do not have the right number of vented tiles, nor are they located correctly. Very often these tiles are placed inappropriately. Examples include placing tiles under equipment cabinets, at the rear of equipment cabinets and the premise of cooling "hot spots".

Example Floor Grille Tile

Poor positioning of grille tiles will generate mixing of hot and cold air. Typically floor grille tiles should be positioned within the "cold aisle" to ensure the flow of cold air to the correct locations.

The airflow throughout the floor grille tiles should match the airflow of the AC air handling units. Typically a standard adjustable floor grille tile will allow approx. 300 litres per second of air flow which equates to approx. 3Kw of cooling. An imbalanced system will generate back pressure on the AHU systems and will fail to deploy sufficient cold air.

Down Floor Air Flow via Floor Grille Tiles



A well designed system will ensure the maximum efficiency of the airflow and help reduce energy consumption by the air conditioning units.

Eight

Coordinate Air Conditioners

Many data centres have multiple air conditioners that actually undermine one another's performance. One may heat while another one cools, one may humidify while another one dehumidifies. The result is gross waste.

Multi-unit installation must be positioned to ensure effective return airflow within minimum mixing of hot and cold air paths. In addition, the use of networked BMS control technology such as Trend Controllers within the AC units ensures the systems can be configured to manage system operation.

A professional assessment will be required to diagnose and correct any such problems.

Energy-Efficient Lighting

Nine

Lighting systems offer extraordinary opportunities for cost-effective energy savings. In addition, many strategies for reducing lighting energy use, often improve the visual environment.

Essential steps to creating an efficient and effective lighting system are summarised below:-

- Deliver the appropriate amount of light for the tasks that will be performed in the space, and distribute that light in a way that prevents glare
- Take advantage of natural daylight whenever possible, while avoiding direct sunlight
- Install appropriate controls for electric lights. These controls work either by turning lights off when they are not needed or by dimming light output so that no more light is produced than necessary
- Use high-efficiency fluorescent systems as the primary light source for most commercial spaces
- Use compact fluorescent and incandescent sources where appropriate to "round out" the lighting system and provide visual variety

Install Blanking Panels

Ten

IT equipment installed within cabinets cools itself by drawing air from the data centre. Most equipment will draw the cold air in from the front and expel the heated exhaust air from the rear of the equipment. If the hot exhaust air is allowed to recirculate to the inlet air, this will cause mixing of hot and cold creating an overheating condition.

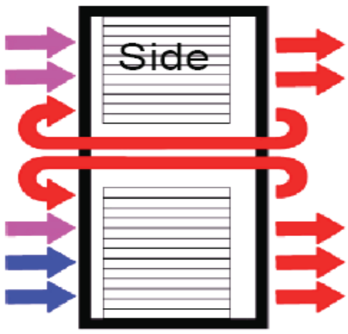
Many data centre managers decrease the bulk air temperature supplied to the room to attempt to balance the effect. This is an energy inefficient method generating additional condensate (water) by the main air conditioning system, resulting in a need for supplemental humidification. This can lead to increased electricity costs.

The simple and effective method to prevent air recirculation within cabinets is to install blanking panels as shown on the diagram below. This strategy reduces hot spots and saves energy by increasing the CRAC return air temperature. The use of snap-in tool less blanking panels make installation easy and inexpensive.

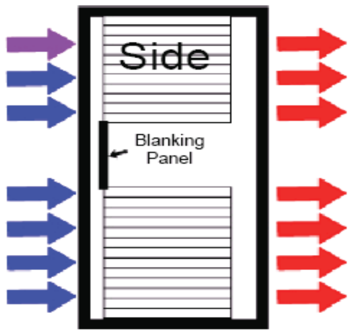
These should be installed as part of an overall strategy to prevent mixing of hot and cold airflows within the data centre.

Diagrams of rack airflow showing effect of blanking panels

Without blanking panels



With blanking panels



Conclusions

Conclusion

We believe that an environmental approach will result in massive, industry-wide savings. Based on findings of the Uptime Institute, there are predictions of up to 60% energy savings in a new green data centre with no loss of available performance. To underline the magnitude of the benefits for even small to medium sized data centres, this can result in businesses saving many tens of thousands of pounds. Within the UK many energy efficient products are registered under the Enhanced Capitol Allowance Scheme (www.eca.gov.uk) which enables 100% of the costs to be claimed against taxable profits during the period in which the investment was made.

Scalable and right-sized solutions that can grow with IT load, offer the best opportunity to improve electrical efficiency, reduce energy costs and contribute ecologically. The energy efficient design principle should be combined with savings made through energy efficient server platforms and virtualisation.

About Workspace Technology

Workspace Technology provides a range of services for Network Critical Physical Infrastructure (NCPI) facilities which include communications, server and data centre facilities.

The design and implementation of ecodesign* energy efficient solutions forms part of Workspace Technology's overall strategy for providing clients with a complete turnkey approach to the design and build of server room and data centre solutions.

Workspace Technology's expertise and services incorporates consultancy, upgrades, expansion, re-locations, turnkey design & build, planned maintenance and support and remote monitoring services.

A copy of Workspace Technology's "Environment" Server Room Solutions and Services can be downloaded from www.workspace-technology.com.

Workspace Technology are approved Integration Partners for a number of leading manufacturers for UPS and critical cooling systems and are APC InfrastruXure Partners.

*ecodesign represents Workspace Technology's commitment to help clients reduce their carbon footprint through the deployment of energy efficient technology and designs

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