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MODULE 8 : DATA CENTRE MANAGEMENT

Energy efficiency in the data centre

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According to IT research company, Gartner, 2 per cent of the world's carbon emissions are produced by data centres and are expected to exceed those of the airline industry by 2020.

It's no surprise therefore that there is an ever-increasing drive towards achieving energy-efficient data centres. However, data centres were originally designed with optimised security and redundancy in mind – not energy efficiency – so the over-specification of plant equipment is a common problem today.

A data centre is a dedicated space where companies can keep and operate most of the IT infrastructure that supports their business. This would largely be the servers and storage equipment that run application software as well as process and store data and content. For some companies this might be a simple cage or rack of equipment, for others it could be a room housing a few or many cabinets, depending on the scale of their operation.

The space will typically have a raised floor with cabling ducts running underneath; these feed power to the cabinets and carry the cables that connect the cabinets together.

Temperature and humidity

The environment is controlled in terms of temperature and humidity, to ensure the performance and the operational integrity of the systems within. Facilities will generally include



power supplies, backup power, chillers, cabling, fire and water detection systems, and security controls.

Data centres can be in-house, located in a company's own facility, or outsourced with equipment being colocated at a third-party site.

The life blood of this infrastructure is electrical power. Electricity is required to power not only the servers involved but also air conditioning systems, lighting and security systems. Without power, transactions simply cannot take place and opportunities may be lost forever. In many cases the cost of these lost transactions can be many millions of pounds per hour.

Generally, the power supply network in most of western Europe is reliable, but it is worth considering that the electricity supply network was not built, nor is maintained with a view to the levels of consequential loss that may be seen in a data centre. As a result some alternative means of power supply is a must.

> **"Energy benchmarking is key to improving energy performance, providing a top level indicator of potential savings"**

The type of standby power required by data centres has two distinct facets. Initially some form of power supply is required to ensure continuity of supply. An Uninterruptible Power Supply (UPS) performs this task.

UPS's come in two basic types: static (batteries) or rotary, but essentially both have the same limitation in that they are a store of energy, but cannot generate energy in their own right. However they do provide a sufficient window to get a much longer-term means of generation started. This would be on line, which is the second facet of standby power, and is usually found in the form of a number of diesel fuelled generator sets.

Benchmarking is key

Energy benchmarking is key to improving energy performance, providing a top level indicator of potential savings. It establishes a baseline for energy use in a typical facility, provides comparisons against similar facilities, identifies operational or maintenance problems, highlights areas for potential improvement and establishes best practice for incorporating into future designs.

The industry standard efficiency metric is otherwise known as the Power Usage Effectiveness (PUE) measure. This is the ratio of the total energy used by a data centre, including IT equipment

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and the energy consumed by the IT equipment only (PUE = Total facility power / IT equipment power). The total energy includes lighting, cooling and air movement equipment alongside inefficiencies in electricity distribution within the data centre. The IT equipment portion is that equipment which performs computational tasks.

A data centre which only supplies power to IT equipment would have a PUE = 1.0 because the numerator and denominator would both be assigned to IT equipment power. This is obviously not a realistic situation. Even in a lights-out data centre power will be consumed to provide cooling and air movement, and there will be electrical distribution inefficiencies.

Another metric used is Data Centre Infrastructure Efficiency (DCiE) which is the inverse of PUE. DCIE is the percentage value derived by dividing information technology equipment power by total facility power.

Another way of looking at a data centre is through Total Cost of Ownership (TCO). TCO models in data centres have tended to focus on driving down the cost of the IT equipment rather than seeking to optimise the energy expended in keeping it cool. This is perhaps understandable when energy costs are low but at a time when they are not only at an all-time high, but are also expected to double in the next ten years, a rethink in strategy which recognises the role of energy is certainly advisable.

Potential optimisation

Today's advanced Building Energy Management Systems (BMS) offer the potential for the optimisation of building services equipment and overall energy saving in a data centre. This is particularly true when combined with proven cooling algorithms, heat recovery strategies and precise control of the indoor IT environment according to actual demand.

Today's distributed BMS systems allow information from the entire data centre to be



collected – from power meters and HVAC (Heating, Ventilation, and Air Conditioning) equipment to actual temperature mapping of zones – designed to calculate real-time cooling demand. Advanced BMS provides user friendly engineering tools, which allow data centre operators to analyze their building performance in real-time in order to improve PUE and to create customized reports for continuous efficiency improvements.

There are a number of issues that all data centre owners should look to address.

The first step is to configure cabinets in hot and cold aisles. This is a fundamental design, without which it is extremely difficult to leverage any of the other technology innovations, or implement design best practice, that can make a significant difference to data centre performance.

Avoid the mixing of cold air supplied from the air conditioning systems with hot return air from the IT equipment. For example, ventilated floor tiles need to be correctly positioned within the cold aisles and preferably be fitted with VCDs (Volume Control Dampers).

Fit blanking panels to any cabinet free U (unit of measure that describes the height of equipment designed to mount in a 19-inch rack) and fit brush sealed grommets, or blanks, to any holes

> **"Today's building energy management systems offer the potential for the optimisation of building services equipment"**

within a raised access floor, if it is being used as a supply air plenum. This stops cold air bypassing the servers, mixing with the hot air to reduce the temperature into the cooling unit (of whatever type it is) and reducing efficiency.

Install hot or cold aisle containment systems. Controlling every aspect of the supply air path from an air handing unit, through the servers and back, prevents recirculation and mixing of hot and cold air. This improves the operational efficiency of air conditioning systems. Both hot and cold aisle containment systems can achieve this benefit.

Increase the room (or cold aisle) temperature to between 24˚C and 27˚C. Understanding of this is now becoming more widespread, however too many data centre managers still think that their room should be set at a temperature of below 19˚C. In some cases the reason for this is that the layout of the room means that hot spots are experienced. The solution is to fix the hot spot problem, not turn the air conditioning temperature down.

The American Society of Heating, Refrigeration & Air Conditioning Engineers (ASHRAE), is a technical committee that regularly issues and updates the limits for temperature, humidity and air-quality for ICT equipment. Their guideline temperature is 18˚C - 27˚C for server inlets and it is now generally accepted by manufacturers that servers can run far hotter without affecting performance or resilience. It is estimated that for every 1˚C increase in server inlet temperature, a saving of 4-5 per cent in energy costs can be achieved. So simply turning your air conditioner control from 18 to 24˚C could save up to 30 per cent in energy consumed.

Free cooling plants

Install indirect or direct free cooling. The practicality of these technologies is very site and budget specific; using specialised free cooling plants which are externally installed coupled to traditional chilled water or DX gas CRAC (Computer Room Air Conditioning) systems. This utilises the outside ambient air temperature to transfer cooling to a water and glycol mixture piped to the indoor units via a closed circuit. When in full 'Free Cooling' mode, power is only used to run pumps and fans. An improvement in the efficiency of data centre cooling of between 40-70 per cent is not uncommon. Direct free cooling uses fresh air to cool the servers. This is where air is passed over a wetted medium to reduce its temperature (when required) before being delivered to the servers. This form of cooling is highly energy efficient, with up to 90 per cent efficiency savings over normal CRAC systems. However, not all sites are suitable and issues around holes through the building fabric, humidity, filtration, redundancy and practicality need to be carefully considered.

Install high efficiency UPS systems and consider using UPS's in smart or line interactive modes. New models of UPS are generally 96 per cent efficient in online mode with output power factors

of 0.9, and in some cases 1. Many will have line interactive or 'Smart' modes where the inverter is turned off until the UPS senses any issue to the power supply. At this point the system will automatically switch the inverter back on to stabilise and protect the output power to the servers. To meet sustainability goals recyclable flywheel UPS technology, which uses stored kinetic energy instead of lead batteries for short term power, are worth considering, but higher implementation costs and site suitability may mean that this type of UPS is not always practical.

Install voltage regulators and/or power factor correction equipment. The mains power supplied to many sites in the UK is either over the voltage required for the equipment installed or the power factor is low. The use of voltage regulators will stabilise the voltage being supplied to the data centre at a defined level, typically 380v rather than between 400 & 430v. Power factor correction equipment will move the power factor as close to 1 as possible within reasonable cost. Both these technologies can deliver power cost savings of between 10-20 per cent.

Look at the lighting

Look at the lighting within the data centre. Although this will not provide the large energy efficiency gains that can be achieved in other areas, the lights in a data centre will only need to be on for limited periods. Wherever possible change lighting to high efficiency types with either compact fluorescent T5 or LED lamps and electronic control gear. Use proximity switching instead of standard switches so that once the area is vacated the lights will automatically turn off.

Replace legacy servers and storage with new high efficiency equipment; for example, leverage virtualisation, to maximise performance of the equipment already in situ. Virtualization software enables several operating systems and applications to run on one physical server or 'host'. Each self-contained 'virtual machine' is isolated from the others, and uses as much of the host's computing resources as it requires. The benefits of virtualization can include up to 80 percent greater utilisation of every server and a reduction in hardware requirements by a ratio of 10:1 or better.

Another option for providing data centre power is tri-generation. Tri-generation provides a means of using natural gas to power a suitably engineered gas generator solution, with the goal of producing three sources of energy; electricity, heating and cooling.

Of course, in a data centre environment, there is no requirement for the heating element and this is where such a system can really pay dividends; converting the engine water jacket circuit and exhaust heat from the gas generator in to cooling energy via an absorption chiller.

Continuity of operation is a major concern and, whilst energy-saving considerations score highly, operators will only consider these if the overall power solution available is robust and proven to support the mission critical nature of their operations.

In this respect, a tri-generation solution represents a relatively low-risk option. Combined heat and power technologies are already well proven in countless installations. For many operators, using the waste heat 'by-product' to power their cooling systems is a logical step forward.

Cisco forecasts that global cloud traffic, the fastest growing component of data centre traffic, is expected to grow 4.5-fold – a 35 percent combined annual growth rate (CAGR) – from 1.2 zettabytes of annual traffic in 2012 to 5.3 zettabytes by 2017. Overall global data centre traffic will grow threefold and reach a total of 7.7 zettabytes annually by 2017.

A zettabyte is one billion terabytes. For context, 7.7 zettabytes is equivalent to:

- 107 trillion hours of streaming music –about 1.5 years of continuous music streaming for the world's population in 2017;
- 19 trillion hours of business web conferencing – about 14 hours of daily web conferencing for the world's workforce in 2017;
- 8 trillion hours of online high-definition (HD) video streaming –about 2.5 hours of daily streamed HD video for the world's population in 2017.

> **"Organisations need to find simple and cost-effective ways to monitor and reduce energy consumption in their current data centres"**



Approximately 17 percent of data centre traffic will be fuelled by end users accessing clouds for web surfing, video streaming, collaboration and connected devices, all of which contribute to the 'Internet of Everything', which is the networked connection of people, data, process and things.

Other data centre traffic is not caused directly by end users, but by data centres and cloud-computing workloads used in activities that are virtually invisible to individuals. For the period 2012–2017, Cisco forecasts that 7 percent of data centre traffic will be generated between data centres, primarily driven by data replication and software/system updates. An additional 76 percent of data centre traffic will stay within the data centre and will be largely generated by storage, production and development data in a virtualised environment.

Data centres are therefore targeted when organisations are considering energy consumption. Collectively they are responsible for up to 3.3 per cent of Britain's total grid power, and reports suggest that at current growth rates data centres and telecommunication networks will consume about 1,963 billion kilowatts hours of electricity in 2020.

Data centres are also critical in ensuring businesses stay competitive. Therefore organisations need to find simple and cost-efficient ways to monitor and reduce energy consumption in their current data centres, and plan effectively to ensure that future data centres are as energy efficient as possible.

Further information

- The Green Grid: www.thegreengrid.org
- Cisco: www.cisco.com
- Gartner: www.gartner.com
- ASHRAE: www.ashrae.org
- European Data Centre Association: www.eudca.org
- Data Centre Management Magazine: www.datacentremanagement.com
- Data Centre World: www.datacentreworld.com

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ENERGY IN BUILDINGS & INDUSTRY

How to obtain CPD accreditation



Energy in Buildings and Industry and the Energy Institute are delighted to have teamed up to bring you this Continuing Professional Development initiative.

This is the eighth module in the eleventh series and focuses on energy saving in data centres. It is accompanied by a set of multiple-choice questions. To qualify for a CPD certificate readers must submit at least eight of the ten sets of questions from this series of modules to ***Energy in Buildings and Industry*** for the Energy Institute to mark. Anyone achieving at least eight out of ten correct answers on eight separate articles qualifies for an Energy Institute CPD certificate. This can be obtained, on successful completion of the course and notification by the Energy Institute, for a fee of £15 (for members) or £25 (for non-members).

The articles, written by a qualified member of the Energy Institute, will appeal to those new to energy management and those with more experience of the subject.

The two modules to come in this series will focus on utility purchasing and monitoring and targeting.

The first seven modules from this series (examining the Renewable Heat Incentive, the Green Deal, underfloor heating, voltage optimisation, heat pumps, thermal imaging and boilers and burners) as well as previous modules are available free of charge on CD. Send your request to **mark.thrower@btinternet.com.** Alternatively, they can be downloaded from the EiBI website: **www.energyzine.co.uk.**

MARK THROWER, MANAGING EDITOR

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Completed answers should be mailed to:

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SERIES 11 MODULE 8: QUESTIONS

DATA CENTRE MANAGEMENT

Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

1. What is a UPS?
- ☐ Uninterruptible Power Supply
- ☐ Universal Power System
- ☐ Unlimited Predictive Software
- ☐ Uninterrupted Power Source

2. What is the industry standard metric for efficiency?
☐ POS ☐ MCT ☐ PUE ☐ PSO

3. What is the recommended ASHRAE room temperature guide?
☐ 2-5˚C ☐ 18-27˚C ☐ 40-50˚C ☐ 60 – 70° C

4. What percentage efficiency benefits can free cooling bring?
☐ 10-20% ☐ 30 – 40% ☐ 40-70% ☐ 70-90%

5. What is the main benefit of virtualising IT?
- ☐ Less hardware
- ☐ More employees
- ☐ Remote access
- ☐ Cheaper

6. What is 107 trillion hours of streaming music equivalent to?
- ☐ 5.8 megabyte
- ☐ 6.7 gigabyte
- ☐ 7.5 terabyte
- ☐ 7.7 zettabyte

7. By 2020 data centres will produce more carbon emissions than which industry?
- ☐ Airline
- ☐ Shipping
- ☐ Rail
- ☐ Automotive

8. How much of the UK grid power is used by data centres?
☐ 1% ☐ 3.3 % ☐ 5.9% ☐ 7.8%

9. What is the main fuel source for tri-generation?
☐ Nuclear ☐ Coal ☐ Gas ☐ Oil

10. What percentage of data centre traffic will be fuelled by end users accessing clouds for web surfing, video streaming, collaboration and connected devices?
☐ 5% ☐ 17% ☐ 30% ☐ 45%

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