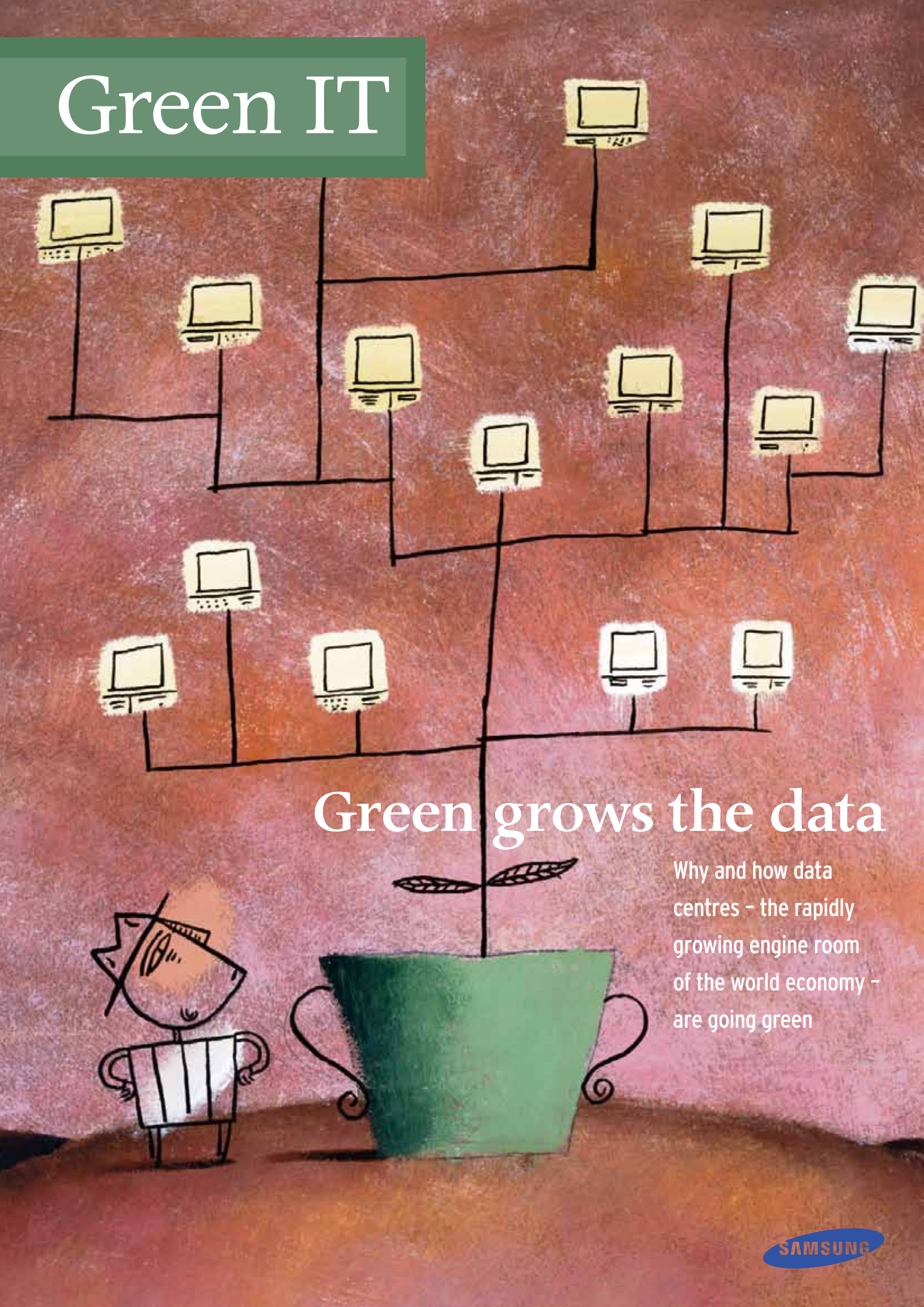
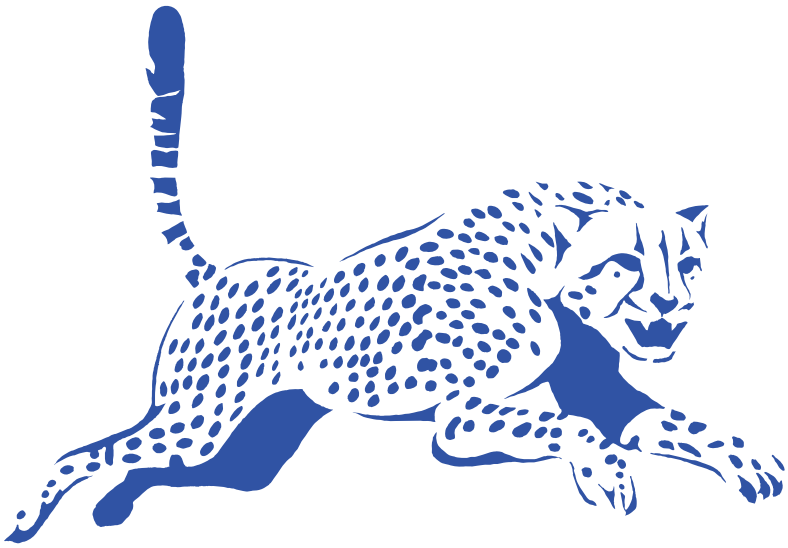
# Green IT



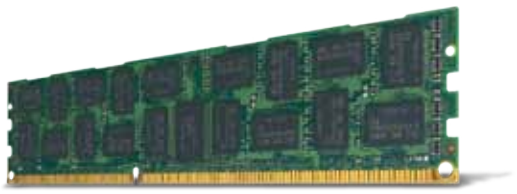
## Green grows the data

Why and how data centres – the rapidly growing engine room of the world economy – are going green

SAMSUNG



# Less energy. More speed.



## The new 30 nano class Green DDR3

Samsung's 30 nano class 4G bit DDR3 server memory chip is the most advanced, best-performing chip we've ever created. It saves 86% more energy, processes two times faster and is far more reliable than its predecessor.* In fact, its energy usage is so small, operating and maintenance costs of your server farm are significantly reduced. Welcome the eco-innovation that doesn't compromise performance – just one more reason the leader in green memory technology is Samsung.

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* Samsung internal test result, compared to Samsung 60 nano class DDR2 memory chip. Actual performance difference may vary depending on the test environment.

# ICT holds key to energy challenge

Our technology-rich lives depend on energy-hungry data centres to sustain them. But as the industry has realised, it's time to curb that appetite

Most people could be excused for knowing little about where their information and data comes from when they surf the internet, download music and videos or engage in those addictive, multiplayer online games.

A generation is growing up with an insatiable thirst for escapades captured on YouTube, streamed sports highlights and personal photo libraries, accessed first on 'traditional' desktop PCs but more and more on smart mobile devices, such as the iPhone.

But behind the touchscreens is one of the fastest growing industries on the planet: the data centre, where millions of servers and countless disks process and store the services that we take for granted and for which most of us pay for only indirectly, if at all. Without thousands of data centres dotted round the globe, the modern consumer economy would almost certainly collapse.

No less important is the corporate data centre. Nearly all large organisations, from government departments to process manufacturers to high-frequency financial traders, have a 'mission critical' need for always-available, large-scale data processing and huge amounts of online storage.

In truth, there has long been a need for such facilities but the sheer volume and scale of information and communications technology (ICT) today has raised important questions about the energy and other resources they consume.

A key point is easy to address: overall, ICT and data centres are proving to be vital, energy-saving technologies for other industries such as transport, construction and power generation and distribution itself, as the influential Smart 2020 report showed.

But as that same report demonstrated, by 2020 the number of servers in data centres will shoot up tenfold to some 120m, and this area of ICT will be the fastest growing user of energy in the sector.

Organisations are now realising that strategies are needed to cut their energy use in data centres, not least to save money in rising power costs but also as part of corporate responsibility for carbon emissions. And, as in so many other cases, the ICT industry itself now has a rich and growing range of answers to the challenge of how to minimise the impact.

> 'A generation is growing up with an insatiable thirst for ever-increasing volumes of YouTube escapades, streamed sports highlights and personal photo libraries'

Server technology, the engine of the data centre, has improved greatly in energy efficiency with major contributions now being made by 'green' memory and solid-state disk storage. The 'virtualisation' trend – whereby server resources are maximised to perform more work – is a crucial development. Equally, the changes we are seeing towards cloud computing and the migration of processing back to the data centre from new smart personal devices will be profound.

Providers of data centres are playing their part by employing this technology side-by-side with highly imaginative ways to build and cool their facilities, often with renewable energy. It is making increasing sense for companies of all sizes to investigate specialist data centre operators.

This is a vibrant and critical part of the world economy and we can expect the questions about who is saving the most energy – but still increasing the effectiveness of their ICT resources – to be a regular agenda item at board level in the years ahead.

**Smart 2020 report: www.smart2020.org**












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Cover illustration: James Yang

# Why it's cool to be green in IT

## Sophie Curtis explains why Greenpeace's criticism of Facebook's data centre is good for the ICT industry

At a time of international climate change talks and confusion over carbon taxes, one story has caused real angst and outrage in the information and communication technologies (ICT) industry: Greenpeace's campaign against Facebook's data centre.

Greenpeace launched its Cool IT Challenge in 2009. Its aim was to persuade data centre operators to reduce their energy usage and to promote technological solutions to climate change. The environmental campaign group singled out Facebook for criticism because it decided to locate a data centre in Oregon, using electricity from PacificCorp – a company that produces 67 per cent of its energy from coal.

"Facebook appears to be on a path that will make breaking our addiction to dirty coal-fired electricity even more difficult," wrote Kumi Naidoo, Greenpeace's international executive director, in an open letter to Mark Zuckerberg, the founder and chief executive of Facebook. "No global business leader, particularly not one who reaches so many people daily, could deny that in this time it is both a threat to a company's reputation and financial health risk to ignore the company's environmental impacts."

The story irritated the green IT movement because, in terms of power efficiency, Facebook's data centre is among the best in the world. The temperate climate of Oregon allows the centre to operate without the use of mechanical chillers – normally one of the biggest consumers of energy in a data centre. Facebook could have chosen to locate its data centre where there was better access to green electricity, says the company, but it would have had to use so much more energy to cool the centre that the carbon footprint would have been higher.

Facebook's conundrum confronts data centre managers all over the world. While everyone accepts that a good energy-saving strategy has environmental benefits, it is not enough to consider energy consumption in isolation.

"Any business creating a data centre today will make it energy efficient," says Simon Mingay, a research vice-president at IT analyst Gartner. "It's got nothing to do with greenness or climate change, it's just good business sense to do that because data centres are increasingly energy intensive, and energy prices are going to go up.

"Greenpeace is pointing out that, just because you're energy efficient, it doesn't mean you are doing good things for the climate," he adds.

### Guzzling energy

In 2008, the European Commission (EC) published a Code of Conduct on Data Centre Energy Efficiency, because the electricity used in data centres – by enterprise servers and other ICT, cooling and power equipment – constitutes a substantial proportion of the European Union's energy consumption.

Data centres in Western Europe used 56 terawatt hours (TWh) of electricity in 2007, according to the EC, and this number is expected to rise to 104 TWh by 2020 – roughly equivalent to the total electricity consumption of Portugal.

The increase is largely due to an influx of fresh equipment in data centres to cope with the massive growth in traffic and new mobile service requirements. "The workload inexorably climbs so the demand will inexorably climb," Mingay says. "The industry is doing a lot to improve energy efficiency purely because the clients are demanding it."

The best established metric for measuring power consumption in data centres is the power usage effectiveness (PUE) rating, invented by a global consortium of IT companies and professionals known as the Green Grid. The PUE metric divides the amount of power used by a data centre by the amount that reaches the IT equipment.

"If you have an imaginary data centre with a PUE of exactly 1, then all the energy is used just on IT," explains David Snelling, the vice-chairman of the Green Grid's EMEA technical work group. "If you have a data centre with a PUE of 2, then for every kilowatt hour that you spend on IT equipment, you've spent another kilowatt hour doing other stuff – mostly getting rid of the heat from the building."

A few years ago, it was fairly common for data centres to have a PUE of between 2 and 3. Data centre managers would run

## The case for cutting consumption

- **Lower direct costs (energy)**
  **Power giant E.ON claims that wholesale energy prices have soared by 35 per cent since spring 2010**
- **Lower indirect costs**
  **These include climate change levies and potential future carbon taxes, as a result of the government's Carbon Reduction Commitment**
- **Corporate social responsibility**
  **There is a culture of sustainability developing within society, and pressure is on businesses to do their part in moving to a greener economy**
- **Increased capacity**
  **Consolidation and virtualisation within a data centre allow managers to decommission idle servers, opening up opportunities for market expansion**
- **Forthcoming regulations**
  **It is only a matter of time before governments bring in legislation to improve energy efficiency. Reduce consumption now and stay ahead of the game**

Bloomberg via Getty Images


**Opposition: Facebook chief executive Mark Zuckerberg is facing pressure from environmental groups to 'unfriend' coal**

air-conditioners at full tilt, giving little thought to the energy they were wasting. Nowadays, data centres often have a PUE of between 1.2 and 1.5. The Facebook data centre is exceptional; it has a PUE of 1.15. (For more on energy metrics, see page 10).

This improvement has been achieved in part by reducing the amount of energy used by IT equipment. Consolidation and 'virtualisation' of servers contributes to savings, and new server energy management software can detect when servers are idle and reduce energy consumption automatically. Innovative cooling solutions have also played an important role. By some estimates, the energy used to cool IT systems accounts for nearly half the cost of running a data centre. Techniques such as hot-aisle/cold-aisle containment and raising the temperature in the data centre help companies to cut costs. New cooling methods such as evaporative and free air-cooling require capital investment, but they can also reduce energy consumption in the long term. (See article pages 12-17).

The growth of 'cloud computing' is also having a noticeable effect on data centre energy consumption. Pike Research predicts that its adoption will lead to a 38 per cent reduction in worldwide data centre energy expenditure by 2020. Pike also estimates that data centres will consume 139.8 TWh of electricity in 2020, a fall of 31 per cent from 201.8 TWh in 2010.

'Greenpeace is pointing out that, just because you're energy efficient, it doesn't mean you are doing good things for the climate'

"There is a basic concept that economy of scale gives you a benefit," says Snelling. "So if there is a way to outsource your IT requirement from a small inefficient server room to a large data centre, then do it. The more cloud-like (in terms of virtualisation and so forth) the data centre is, the better chance it has of being even more efficient."

## Counting the costs

Most of these changes in the data centre have been driven as much by potential cost savings as any sense of corporate social responsibility. A Gartner report published in September 2010 revealed that energy-related costs account for about 12 per cent of overall data centre expenditure.

Gartner warns that energy is the fastest-rising cost in the data centre, and power, cooling and energy supply issues – as well as cost problems – are likely to get worse during the next few years, as organisations emerge from the recession and expand their technology infrastructure.

There is also likely to be an increasing number of indirect costs, associated with climate change levies and carbon taxes. The coalition government is preparing to introduce its carbon cap and trade scheme in 2012 (see also page 8), which will force large organisations to monitor their emissions and purchase allowances for each tonne of $CO_2$ produced by the energy they use.

"If you look at what has happened with COP15 in Copenhagen, and even Cancun, countries are putting targets on the table around carbon emission reduction," says

**Wind power: just one of the options for data centre operators wanting to reduce their carbon footprint**

Harkereet Singh, the chairman of the Green Grid's EMEA technical work group. "On the ground, eventually it will equate to some kind of emissions trading scheme or reduction initiative, which is likely to cost. By doing things now, you're really mitigated against all those issues."

As the Facebook controversy has demonstrated, it is no longer sufficient to look at the issues of energy efficiency and carbon emissions in silos. The sustainability movement demands that the ICT industry takes a broader view of green IT and its impact on the environment.

Some organisations (including Facebook) are turning to renewable energy to power their data centres,

'It is both a threat to a company's reputation and financial health risk to ignore the company's environmental impacts'

to reduce their consumption of grid electricity and improve their green credentials. In June 2010, Next Generation Data Europe, a data centre operator based in Wales, claimed to be the first in Europe to run a facility entirely on renewable energy.

Some other data centre operators are also looking at ways to reuse the excess heat generated by their servers. Telehouse West in London's Docklands, for example, has a network of pipes that will transport water, warmed by the excess heat from the racks of servers, to more than 1,000 homes in the area, free of charge.

## Leading by example

As data centre operators work to improve the sustainability of their own practices, the wider ICT industry is also coming under increasing pressure to play a more central role in cutting other sectors' energy consumption. ICT can help businesses to move towards paperless offices, to reduce travel through the use of virtual conferencing, and to make smarter buildings and improve logistics to reduce energy waste.

Stuart Neumann, an analyst at Verdantix, has predicted that between 2012 and 2015 many organisations will set up sustainable technology business units and projects to look beyond current green IT initiatives. "The revenue opportunities created by sustainable business projects are vastly bigger than the current highly competitive 'new wine in old bottles' green IT market," says Neumann. "Shifting perception of the opportunity internally requires a broader, more stimulating vision of sustainable business."

Hamadoun Touré, the secretary-general of the International Telecommunication Union (ITU), has already trumpeted the role of ICT in efforts to mitigate against climate change. "ICTs are uniquely powerful tools for reducing emissions in every other sector," said Touré in December 2010. "Because of this major role, they offer one of the most significant opportunities to reduce greenhouse gas emissions, especially in those industries that are among the highest producers of $CO_2$, such as energy generation, waste disposal, construction and transport."

While the onus of responsibility may seem heavy, these challenges present fantastic business opportunities for the ICT sector. As well as reducing their own energy usage, ICTs can provide the resources to change the way industries consume energy across the globe.

Greenpeace's attack on Facebook makes sense within this context – though it has very little to do with Facebook's data centre being inefficient. Greenpeace has decided to make an example of Facebook because it recognises that ICT is an enabling solution for a low-carbon economy and now wants the industry on board, helping to drive policy.

**Sophie Curtis is deputy editor of eWEEK Europe**

## From waste to watts

**In the US, data centres are thought to use up 1.5 per cent of energy on the electrical grid, which is roughly equivalent to the amount of energy used to treat sewage. Like sewage, most of us like to have our data processed for us, and both industries involve various levels of waste, some of which can be useful. For example, sewage waste can be reused as fertiliser; waste energy from a data centre can be used to heat surrounding buildings.**

**Some scientists have suggested that the two could be even more closely related. Research by HP Labs suggests that the heat generated by data centres could be used to increase the efficiency of the anaerobic digestion of animal waste, which would produce methane that could then be used to generate power for the data centre.**

**"This symbiotic relationship allows the waste problems faced by dairy farms and the energy demands of the modern data centre to be addressed in a sustainable manner," says HP Labs.**

## Cuts in the clouds

**'Cloud computing' has the potential to reduce energy consumption and carbon emissions by 30 per cent or more, according to a report by Microsoft. Small businesses, of about 100 users, moving business applications away from on-site servers into the cloud can see net energy and carbon savings of more than 90 per cent. For mid-sized organisations, of about 1,000 users, the savings are between 60 and 90 per cent.**

**Large data centres, such as those run by Microsoft and other technology giants, benefit from economies of scale and operational efficiencies, while large public cloud environments can serve millions of users across many companies on one massive shared infrastructure, according to the report.**

**However, organisations shouldn't forget that, even if their data is in the cloud, it still has an energy and carbon footprint. IT managers need to check that their cloud provider is operating an efficient data centre, otherwise they will be saddled with extra costs.**
**(See also page 22).**

# A new green tax?

## The regulations governing green IT in the UK have become a bit of a moving target. Tom Jowitt tries to end the confusion

Although businesses are facing rising power costs and growing environmental legislation, both from the government and the European Union, the new lie of the regulatory land is far from clear.

One of the biggest causes of confusion concerns the UK's Carbon Reduction Commitment (CRC), now known as the CRC Energy Efficiency Scheme. This mandatory climate change and energy-saving scheme is perhaps the most important regulation that companies have to contend with when dealing with energy consumption in data centres and other power-hungry facilities.

The CRC was designed to bring about the equivalent of 4.4m tonnes of $CO_2$ savings a year by 2020, cutting business energy bills by £1 billion a year. The scheme applies to any large organisation that uses more than 6,000 megawatt-hours of electricity a year, and requires them to monitor energy use and purchase allowances for each tonne of $CO_2$ produced by the energy it consumes. The current pricing is about £12 per tonne. The more $CO_2$ an organisation produces, the more allowances it has to purchase, and so the greater the incentive to cut emissions.

The original CRC agreement stated that the funds raised from buying $CO_2$ allowances would be pumped back into the system, rewarding those companies that cut their bills the most. This was known as 'revenue recycling'. But in its Comprehensive Spending Review last October, the coalition government shifted the goalposts. It decided to pocket the money put into the scheme, raising £1 billion a year by 2014-15. The money will be used to pay off the public deficit, rather than being recycled to participants.

### Change of direction

This u-turn is being presented by the government as a simplification of the CRC scheme, in effect turning the CRC from a complex process with incentives into nothing more than a green tax.

"The CRC is now effectively a tax and the current position is that we are not sure what is going to happen with it," says Brian Murray, a consultant at ICT services provider 2e2. "The main point is that companies will not be rewarded for their carbon emission reductions, except for the obvious cost savings from a reduced electricity bill. That said, it is something that we, the industry, need to do something about."

Companies were supposed to register for the scheme by last September, but many did not sign up in time. This lack of preparation was blamed on poor understanding of the CRC scheme and an overly complex registration process. Some commentators feel the original CRC did need revising. But the changes to CRC have left many questions unanswered.

To keep companies guessing, the government has opened a new round of consultations that closes on 11 March. This could see the scheme merged with other green taxes such as the Climate Change Levy – an additional charge being added directly to bills.

However it comes about, it is very clear that there will be legislation that will put electricity prices up. Apart from the climate change argument, the government needs to reduce electricity demand before the country encounters a power generation capacity crunch in 2015, when nuclear plants reach the end of their life and dirty coal power stations must close.

The 451 Group, an IT analyst firm, warns that the CRC and other legislation will have an impact on data centre operators and those businesses with large server farms, but the delayed introductory phase means that organisations have more time to register and get up to speed on the laws.

> 'Companies do not adopt green IT to save trees. They adopt it because it makes sense and saves money'

"The changes proposed to the CRC mean that participants, such as large data centres, will pay at least 10 per cent more for their energy within a few years – this is in addition to an estimated 10–20 per cent increase introduced by the Energy Review," says the 451 Group. "This will rightly worry data centre operators, and some furious lobbying can be expected."

These additional CRC costs (coupled with uncertainty about how they will increase over time), could see businesses decide to outsource their data centres, either moving into 'colocation' space, signing over their facilities to be managed by service providers, or moving offshore.

"The first issue is that companies that have significant data centres are always looking for new locations," says Murray, of 2e2, "and the main factor for them is power. If CRC acts as a restriction and is going to cost them more, that is going to drive businesses to place their facilities offshore.

"The second factor is the lack of certainty in the UK," says Murray. "If businesses are not sure of what their potential costs are going to be, they will not be able plot their TCO (total cost of ownership) here, compared to say having a facility in Amsterdam."

Murray also points out that the UK, especially in South-East England, has a shortage of power generation capacity, a problem it shares with parts of Europe. "The main factor to remember is that companies do not adopt green IT to save trees," says Murray. "They adopt it because it makes sense and saves money."

### KEY GREEN REGULATIONS

| | |
|---|---|
| **CRC Energy Efficiency Scheme (formerly just the Carbon Reduction Commitment or CRC)** | Businesses that use more than 6,000 MWh of electricity per year (measured by half hourly meters) are required to buy carbon permits to cover their energy use. The scheme also includes reputational and behavioural incentives. The government is currently working to simplify the terms and encourage industry engagement. |
| **BREEAM (BRE Environmental Assessment Method)** | The most widely used environmental assessment method for buildings. A best practice standard for sustainable design, which has become the de facto measure to describe a building's environmental performance. |
| **Waste Electrical and Electronic Equipment (WEEE)** | Introduced into UK law in January 2007 to reduce the amount of electrical and electronic equipment being produced and to encourage everyone to reuse, recycle and recover it. |

Alastair Grant/AFP/Getty Images

**Comprehensive spending review: George Osborne and Danny Alexander, leave the Treasury offices on October 20, 2010. The coalition government announced the harshest spending cuts for decades, including changes to the Carbon Reduction Commitment through which they hope to raise £1 billion a year**

## Smart buildings and disposing of waste

Another green regulation concerns buildings. In the UK, the BREEAM (BRE Environmental Assessment Method) measures buildings that are sustainably designed and assesses how this affects the building's performance.

"The R&D for sustainable buildings in the UK is now catching up to that enjoyed elsewhere, such as in Scandinavia for the past two decades," says Murray. "The UK has been very slow getting into the act."

But one of the most common problems that companies regularly encounter is how to dispose of old IT equipment under the European WEEE (Waste Electrical and Electronic Equipment) Directive, introduced into UK law in 2007. 'E-waste' is the fastest-growing waste stream in the EU, and it is predicted to grow to 12m tonnes a year by 2020. What is more, 67 per cent of e-waste collected in the EU is unaccounted for. It is either put in landfill, sent to substandard treatment facilities, or illegally exported.

This means that only a third of old IT equipment in the EU is being treated according to its directive, which is under review.

WEEE might push companies to keep old equipment running for longer, if it weren't for the fact that newer kit is more efficient and will save on energy costs: "IT equipment just gets much less efficient over time," says Murray. "All vendors will list the energy-efficiency rating of their product when new, but what we need to consider is how much less efficient it will be later on.

"When we see companies, they are usually battling power constraint issues. Often it is the age of their equipment that is driving their power burn and not delivering much computing power in return. It takes more money to power and cool a server than to buy it, but that thinking is not part of the corporate culture."

> 'CRC is now effectively a tax and we are not sure what is going to happen with it'

### QUESTIONS FOR THE IT DEPARTMENT

| ISSUE | QUESTION |
|---|---|
| **IT equipment disposal** | Does the disposal of old kit meet WEEE criteria? |
| **Energy cost savings** | Are we running old power-hungry equipment when we could use newer, more efficient kit? |
| **The great switch-off** | Are desktops powered down at night? Is the workload of every single server accounted for? (ie, can we switch it off?) |
| **Energy cost control** | Who pays the electricity bills? Is it the IT department or the facilities department? |
| **Energy measurement** | Can we measure our power consumption? If we cannot, how can we control it? |
| **Energy alternatives** | Can we make use of renewable energy? |

# Go figure

## Too many companies have no idea how much they spend on energy. So how can they cut costs? Tom Jowitt examines the metrics and models for auditing

"You cannot hope to control it if you cannot measure it." This may sound like a trite saying, beloved of auditors and managers, but it raises a valid point. Too many organisations have no idea about their energy expenditure because the electricity bills are paid by the facilities department out of its budget. But if the IT department has no idea of what is being spent on electricity, how can it hope to improve energy efficiency?

There is a clear need for ways to measure energy consumption and efficiencies, particularly in organisations with their own data centres or large server farms, where power consumption can be very high.

Last year, for example, the analyst company Gartner warned that energy-related costs now make up 12 per cent of data centre expenditure. The researchers said that this will rise in the next few years as organisations expand their IT infrastructure as they emerge from the downturn. Data centres are also set to face a rapid rise in problems associated with power, cooling and space, thanks to the new generation of high-density equipment.

Adopting metrics to measure energy use is critical – and it is a rapidly evolving field.

### Power usage

One of the most common metrics used now is power usage effectiveness (PUE) drawn up by the Green Grid – a global consortium of IT companies and professionals working on data centre issues. Gartner predicts that continuous PUE readings will become the norm for most large data centres by 2015. Meanwhile, The 451 Group believes that this year more data centres will announce average PUE ratios below the 1.5 mark. The closer to 1 the result, the more efficient the data centre is, as more of the power entering the facility is reaching the servers.

'The European code of conduct is extremely comprehensive – but it may not be suitable for some companies'

Andrew Donoghue, of The 451 Group, points out that despite the PUE metric being barely three years old, it is viewed by some as obsolete, even though it has rapidly become the de facto measurement of energy in data centres. But one drawback of PUE is that it ignores the IT productivity or 'useful work' done by components such as servers.

The Green Grid has proposed the introduction of just such a data centre energy productivity metric. This identifies the useful work carried out in the data centre and divides it by the resource consumed to produce that work. The 451 says that the resource in question is open to interpretation, but the Green Grid is pushing ahead with energy as a prime contender.

"PUE is useful as an internal tool only, full stop," says Brian Murray, consultant at IT services provider 2e2. "You can see how your data centre's PUE rating changes over time. But as soon as you cross the line and start using it externally, it is meaningless. How can you use it to compare one data centre that doesn't have much equipment installed inside it, to another that is heavily utilised, where the PUE goes through the roof?"

### THE KEY METRICS

| METRIC | WHAT IT DOES |
|---|---|
| Green Grid - power usage effectiveness (PUE) | PUE has become the standard way to measure how efficiently a data centre uses energy. This simple ratio divides the energy the centre uses by the amount that reaches the IT equipment. |
| Green Grid - carbon usage effectiveness (CUE) | This new measure multiplies PUE by the amount of $CO_2$ emitted per unit of energy used. CUE can go to zero if the data centre is entirely powered by sustainable energy. |
| Emerson Network Power - compute units per second (CUPS) | Emerson admits that CUPS is effectively a theoretical proxy until a more effective productivity metric is established. But the company claims it allows some useful calculations of data centre efficiency where compute efficiency = CUPS/watts consumed. |
| McKinsey - corporate average data centre efficiency (CADE) | The CADE value takes into account not only power usage but also a company's central processing unit (CPU) utilisation rates and the effectiveness with which the data centre's IT equipment transforms energy into 'useful' work. |
| Japan's Green IT Promotion Council - data centre performance per energy (DPPE) | Japan's answer to PUE. DPPE = (IT equipment utilisation x total IT equipment ability) / (total DC power consumption - green energy used) = IT equipment real use / total power consumption. |
| Green Grid - water use efficiency (WUE) | A programme to increase awareness about the efficient use of water in cooling systems. |
| Others | Companies have developed their own metrics and auditing tools. |

John Zoiner

**Power usage: many IT departments have no idea about their energy expenditure**

## Carbon emissions

In December the Green Grid came up with another metric to measure carbon emissions produced by data centres. Carbon usage effectiveness (CUE) enables companies to calculate the greenhouse gas emissions produced by the energy they use.

The Green Grid points out, however, that while PUE has a direct effect on energy costs and therefore saves money, cutting CUE will not directly save a great deal of money. This may change, however, as carbon tax laws such as the UK's Energy Efficiency Scheme start to take effect.

## Water efficiency

The Green Grid's measure of water efficiency (WUE) is also expected to be published soon. This metric could prove more complex, as water is not actually consumed in industrial processes. But it is often made dirty when used in a data centre's cooling systems, as well as in generating the power used by the data centre.

## Codes of practice

While some analysts believe that the future lies with CUE and PUE, others such as the British Computer Society's Data Centre Specialist Group (DCSG) believe it lies in taking a more holistic approach to IT efficiency.

In December the British Computer Society (BCS) launched its data centre efficiency scheme, dubbed the certified energy efficiency data centre award (CEEDA), for those looking to follow energy efficiency best practice. The BCS award has been designed to give data centre operators independent accreditation and verifiable evidence that their data centre is following energy efficiency best practice.

The award is based on the EU Code of Conduct for Data Centres, which was developed in close collaboration with the IT industry, data centre owners and operators. The code was created in response to increasing energy consumption in data centres and the need to reduce the impact on the environment, the economy and energy supply security.

> 'PUE is a uesful internal tool. But as soon as you start using it externally, it is meaningless'

But the voluntary nature of the code has raised questions about its uptake. Sentrum, a data centre specialist, recently warned, for example, that the code was not getting any significant support in the UK and, that by 2010, only 15 per cent of large UK organisations had adopted it.

"The European code of conduct and the BCS award are useful and are not outdated because they haven't been around long enough," said Murray, of 2e2. "The European code of conduct is extremely comprehensive. This has the unfortunate effect sometimes of it not being suitable for some companies. It really is horses for courses. If you are seeking a comprehensive code, then opt for the European one which is a useful guidebook, but if you are seeking something more realistic, then the BCS one is a better bet."

### CODE OF CONDUCT

| CODE | PRO | CON |
|---|---|---|
| EU Code of Conduct for Data Centres | Comprehensive code | Limited uptake and perhaps too comprehensive and voluntary for most organisations |
| BCS CEEDA | Independently verifiable | Less comprehensive option and barely known due to recent launch |

# Losing power

## Data centres use – and lose – a lot of energy. Peter Judge explores where savings can be made

As society has become more information-driven, data centres have grown – and so has their energy consumption. A data centre can use more than 1 megawatt (MW) of power and, in many organisations, IT is the biggest electricity demand. In some cases the cost of the electricity used in the data centre exceeds the cost of the hardware running there.

Before the push towards green IT, half the power going into a 1 MW data centre was being used to power the cooling system – and the power use (as measured by the PUE metric) was 2.0 (For details of PUE see page 10).

The goal was to achieve a PUE nearer 1.0. "In a 1 MW data centre, you can shed half a megawatt of power to run the exact same equipment," says Dean Nelson, senior director of eBay's data centre architecture, and one of the founders of the Green Grid. Depending on how much you pay for your electricity, that can bring savings of £300,000 a year.

Some companies haven't started on green IT yet, but the past ten years have seen massive strides towards efficiency involving servers, storage, and networking – the three main components of any data centre. But the biggest area of improvement is in how servers are cooled.

### Virtual servers

Apart from the cooling systems, the biggest power hog in a server room is... the servers. And the easiest, most obvious, way to save power is to run fewer servers. But that is not as simple as it sounds. Demand for processing power is continually growing, and that means that more servers are packed closer together in data centres. New designs such as 'blade servers' increase the server capacity of a data centre and the need for cooling.

The IT industry's answer to this problem is 'virtualisation', which involves running multiple servers on one computer. In a virtualised data centre, instead of separate machines for every task – for email, order processing and personnel, for instance – each department has a 'virtual machine' that runs on pooled resources.

As a result, fewer computers are running

and resources are used more efficiently. When one machine has capacity, virtual servers can be moved on to it, and empty hardware can be shut down. If a machine is decommissioned, annual savings of about £250 a year can be made in power costs.

There are also ever-more complex ways to save power within the servers. In the newest processors from Intel and its rival AMD, sections of the chip can shut down if there is no load, again reducing the power use.

Modern servers also have power management features built in so that they can be put into a lower power state automatically. Often servers are delivered with these features switched off; while it makes sense to switch them on, it is important to make sure that any features are compatible with applications running on the server.

As virtualisation has taken hold, servers have altered at every level. The processors are now designed to run multiple virtual machines. They also have multiple 'cores' so that one processor can do the work of two older processors, using similar levels of power.

## Memory gain

Servers now tend to be built with more memory, so that the energy use of the servers' RAM has become significant, and the type of memory becomes important. Research carried out by TÜV Rheinland reached a surprising conclusion – that the system memory of servers can be one of the most significant factors in the energy use of the whole data centre. In a test using servers that had 48GB of memory, TÜV found that using modern memory – made using a 30nm process (Samsung's Green technology) as opposed to more mainstream 50nm memory – resulted in a saving of 70W per server, or about 20 per cent of the power required by the servers.

As the green memory used less energy, it also produced less heat, so the air output from the servers was 1.5˚C cooler, and the centre's cooling system had to work less hard. As a result, the overall energy demand of the data centre went down greatly.

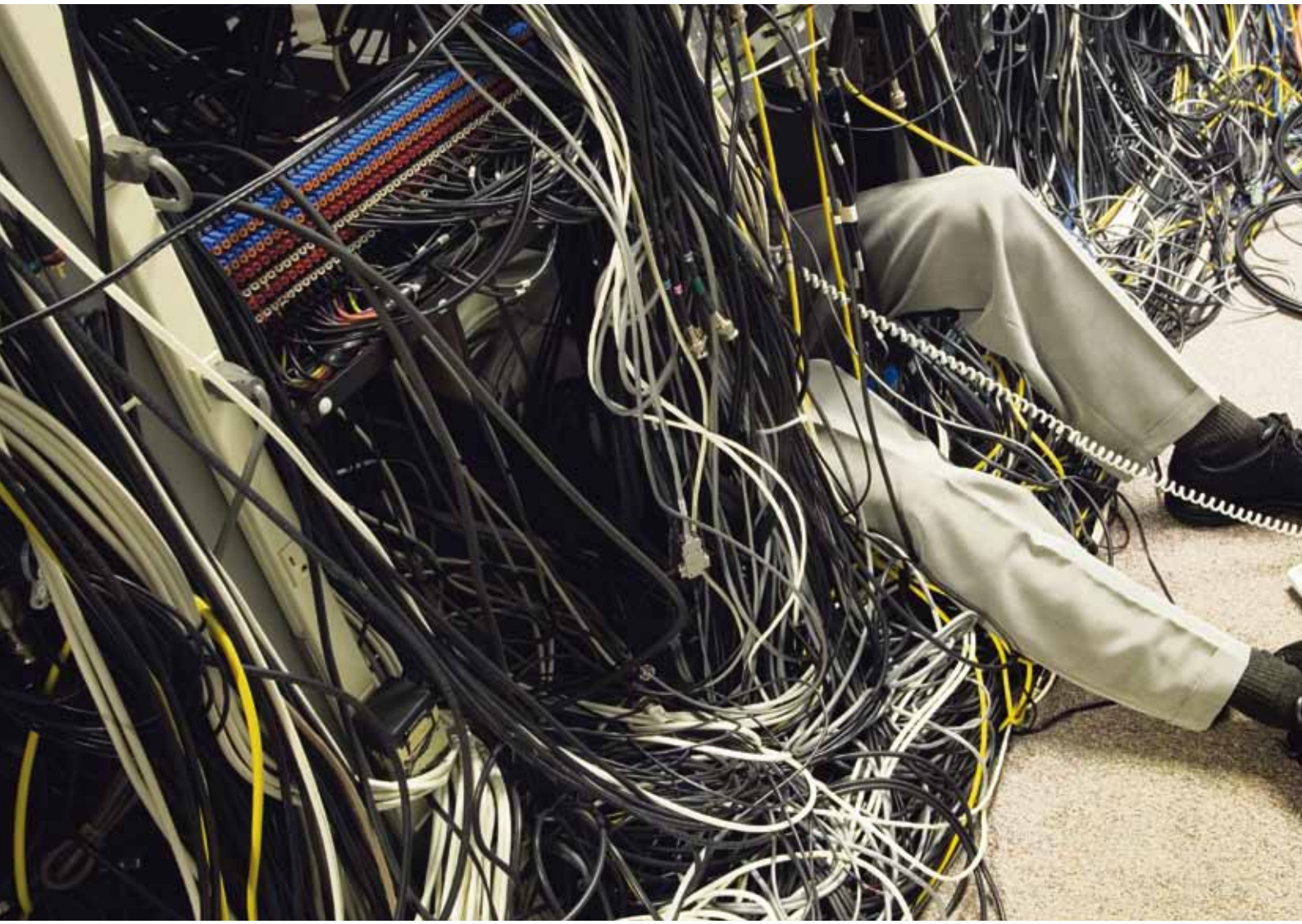
"A data centre investing in 1,000

'Believe it or not, the most significant technology for cooling data centres is a flat piece of metal with screw holes'

## Liquid solutions

**Many commentators believe that the future of data centre cooling is to use liquid. The most powerful mainframes and supercomputers have traditionally used water-cooling, because it is more efficient. Liquids are better at cooling than gases – they can hold more than a thousand times the extra heat in a given volume.**

**But, as we've seen, to deliver more power, vendors have packed servers more tightly in the blade and rack systems. The result is more heat. It looks as if water-cooling will return. Some server racks already use water flowing inside the doors to keep the cabinets cool. But some companies are going beyond that to run liquid right through the machines, up against the computer chips themselves. Water and electricity don't mix, so these systems use an inert oil that does not conduct electricity, and does not pose a fire risk.**



**Greater efficiency: the easiest, most obvious, way to save power is to run fewer servers**

state-of-the-art server systems, while adopting 30nm class instead of 50nm class memory, will save up to 23 per cent in total energy consumption, or 170 kW," say the researchers. "This could save up to €1m (£850,000) from the total cost of ownership, assuming an operating lifetime of four years."

## Storing up problems

Storage is the hardest part of the data centre to keep a grip on. Every system needs storage, but, with back-ups, old data and copies, the amount of storage can get out of control. While IT managers could rein in most IT purchases during the recession, storage kept growing. According to estimates by EMC, it was up by 62 per cent during 2010. And more storage means more power. (For more on this major part of the data centre, see page 20).

## The importance of networking

Networks are the least energy-hungry of the main components of the traditional data centre, using only about 10 per cent of the energy (once the cooling system has had its share).

'Free air-cooling doesn't work when the outside air is hot, which is why there has been a growth in data centres in places where the weather is cold'

However, that might change, as other components become more efficient. Virtualisation can make servers more efficient, but because virtual servers can move around the data centre from one machine to another, the traffic on the network increases. Similarly, more efficient storage systems can mean more data moving around – because they don't leave data parked somewhere, but go and get it when it is needed.

The increase of network traffic in data centres has produced an urgent need to make networks use less energy. A 'green Ethernet' standard has been created for this network protocol, which shuts down network cables when there is no real traffic on them.

The amount of energy saved can be significant and network vendors, including HP, Brocade and Force10, are selling 'refreshes' – offering to rewire customer networks to save money on power. NTT, for example, saved $380,000 (£238,000) on power in five years by opting for Brocade's technology, according to the vendor.

## Up the aisle

Believe it or not, the current most significant technology for cooling data centres is a flat piece of metal with screw holes. The 'blanking plate' can drastically reduce the energy needed by creating more efficient airflow around the servers. It's so simple and basic that data centre owners are offering free plates to customers.

"Data centre cooling isn't rocket science," says Mike West, managing director of Keysource, a data centre company that has built low-energy data centres, including the Petroleum Geo-Services building in Weybridge.

David Samuel Robbins

In his view, cooling data centres is no different from cooling other buildings, except for the "high density hardware". The basic tools for cooling servers are pretty much the same as those for cooling buildings – air-conditioning units. The first way to improve on their performance is to focus the cold precisely where the heat is. If you can direct the cool air to the hot parts of the server, you don't have to waste energy cooling the whole server room. This has led to a strategy of 'hot aisles' and 'cool aisles'. Cold air goes in, usually from the front of the servers, passes through them, cooling them down, and warm air is sucked out of the back and pumped away.

'Cold-aisle containment' is where the blanking plates come in. Screwed in at strategic points in the server racks, the blanking plates stop hot air escaping and recirculating to the intakes.

Cooling servers without blanking plates is like running the office air-conditioning with the windows open. It takes more energy to offset the warm air that leaks backwards, so data centre managers have to turn up the chillers.

Once the basics are sorted out, the next thing to think about is the cooling technology. Air-conditioning units built like refrigerators are inefficient, but the scope for turning them down will depend a lot on where your data centre is. If the outside air is cool enough, you can use it to cool down the servers, without having to use a refrigerator. This is known as 'free air cooling'. It's even possible to use evaporation – the 'wet T-shirt effect' – to reach an even lower temperature than the outside air.

There's more to it of course. Very few data centres pull air straight in from outside. The dust in it would eventually clog the fans in the computers. "If you kill two-tenths of 1 per cent of your servers with outside air, you will offset all the savings you make by improving efficiency," says John Bean, director of racks and cooling at APC by Schneider Electric. "Is shaving a few PUE points worth that risk?"

Free air and evaporation emerged as methods that data centre builders had to pull together for themselves, but now they have been combined in units called 'economisers' – which plug into data centres and provide the best cooling possible.

## Data's gone to Iceland

Free air-cooling doesn't work when the outside air is hot, which is why there has been a growth in data centre space in places where the weather is cold. In Northern Europe, a well-designed data centre should not have to turn its chillers on for most of the year.

A plentiful supply of renewable sources of power is also good. The combination has led to a mini-boom in data centres in Iceland, a cold country that gets much of its electricity from geothermal energy – and which recently changed its tax laws to encourage data centres to be built there.

Iceland's electricity is 30 per cent cheaper than that of the UK, says Jón Viggó Gunnarsson, managing director of Thor, a data centre company, which has chillers but never uses them. "We have a water system to add evaporative cooling when we need it. But in Iceland, that is never."

The rest of the world might be able to switch its chillers off more often if servers are run at a higher temperature, so that less cooling is necessary. Raising the temperatures in the 'cold aisle' means that there are more days when it is cold enough outside to use the ambient air temperature.

With all these factors taken into effect, free-air cooling is becoming more widespread than anyone expected. Even the warmest countries have some cool periods: "In Casablanca, for instance, you can use outside air cooling 60 per cent of the time, thanks to the cold nights," says Marc Faig, innovations officer at cooling specialist AST Modular.

**Peter Judge is the UK editor of eWEEK Europe**

## Questions to ask IT directors

- **How old are our servers? If they are more than two years old, consider investigating replacements**
- **Go for consolidated servers, with multiple-core chips, and blade architectures that share overheads such as fans**
- **Are our servers virtualised? Virtualisation boosts efficiency**
- **Do we have large and new blocks of server memory? Newer memory manufacturing processes make chips that run cooler**

- **Have you enabled energy-saving functions such as power management?**
- **Is there waste in our storage? Simply eliminating multiple copies of data can reduce energy use – as well as avoiding the need to buy new storage hardware**
- **How essential is it that we run our data centre in-house? Transferring data centre management to a third party can be very useful in freeing the company from payment of carbon tax, while benefiting from economies of scale and expertise in the data centre company**
- **Can we improve cooling? Start with simple measures such as blanking plates and work up to major overhauls involving free-air and evaporative cooling**
- **Is our energy green? Running on-site generation can improve efficiency and count in your favour in the carbon scheme**

# Smarter ICT

It should be remembered that overall, ICT and data centres are proving to be vital energy saving technologies for other industries such as transport, construction, power generation and distribution, as these highlights from the influential Smart 2020 report shows

**$4.4**

**Million is the amount the Empire State Building in New York has saved annually since implementing a smart building project. The building uses up to 38 per cent less energy.**

**13.7%**

**Less traffic on the road in Seoul, South Korea from a pilot Smart Transformation Pricing (STP) solution. A key aim is to show the true cost of road transportation and to apply a charge based on miles travelled which would replace the fixed and annual taxation charges.**

**40%**

**Was saved on a household's electricity in Cambridgeshire, UK after it was fitted with an AlertMe Energy kit. It uses a smart meter reader, several smart plugs and an online connection to allow consumers to monitor and control their energy usage.**

**$5**

**Million per year is the estimated operational savings at the 1.75 million square feet GreenSpaces information technology park near Delhi, India. Smart components used include sensors, charging points for electric vehicles, on-site power generation and metering.**

## IT in a can

While the green IT revolution has been working on greater efficiency, another movement has been making data centres portable, and the two turn out to be closely related. All too often, when a company needs processing power, it has to have it quickly. About five years ago, Sun Microsystems came up with the idea of building data centres inside shipping containers – the standard-sized metal boxes that travel the world on the back of lorries and ships.

If you build the racks and servers into the container, you can ship a pre-built data centre anywhere you want it. Then you just need to plug it into the power and the network – and maybe plumb in water for the cooling.

SGI, one of the pioneers of containerised data, has launched the Ice Cube, which uses free air cooling and can reach a PUE of 1.06, which would be a credit to any purpose-built data centre. Another of the canned data leaders, AST, built a whole "economiser" unit for free-air cooling, and placed it on top of its containers, creating double-decker boxes that are twice as green as before.

# Q&A with Dr Joseph Reger, chief technology officer (CTO), Fujitsu Technology Solutions

### When did the industry – and Fujitsu – become interested in green IT?

We've had a dedicated team on green IT for two years, including 100 people in Japan. I have long been convinced that sustainability and energy efficiency would be important to our industry, but it is fair to say that while we have been able to produce ever-higher performance for our products, no one really cared until relatively recently what the energy costs were. Even now, despite our efforts at Fujitsu to engineer much higher levels of efficiency, it is not something that people, especially consumers, are prepared to pay a premium for. The payback for us at present is more in industry recognition and leading roles in a wide range of IT consortia.

### What is the contribution of IT to energy use?

On its own, IT is only a small part of world energy consumption, but over the last few years it has become apparent that it is a key enabler for other industries to improve their carbon output. What we can do for others now far outbalances our own harmful emissions – IT is a great force for good in the energy stakes.

### Data centre energy use is going up, though…

Yes, and the concept of the 'next-generation', energy efficient data centre is starting to take hold now among corporate customers. Chief executives and chief financial officers are seeing the connection between fiscal costs in the running of what is a key operational unit and contributions to wider energy savings in society, as carbon moves up the corporate responsibility agenda. The interest does vary across Europe, but in countries such as the UK and Germany, and in Scandinavia, it's a big topic now, although it is also influenced by regulation, of course. What is amazing, perhaps, is that many chief information officers, or IT directors, do not see the energy bill in their budget. This is an OPEX (operating expense) that should absolutely be part of their IT remit and it's getting attention at board level now.

### Where can savings in the data centre be made?

For the IT equipment, especially servers, we have greatly improved the technology from a raw energy efficiency viewpoint – it is reaching 95 per cent efficiency now, up from 50-60 per cent a few years ago, and we are struggling to make further gains. What is more interesting now is to look at what work the servers are doing, such as with the recent SPECpower benchmark, which aims to measure the basic computational work the servers are running for a given power output. Further along this road we should be able to extend this idea to show the energy use of high-level software, such as the SAP suite. Meanwhile, the virtualisation movement that is sweeping through the industry is dramatically increasing energy use by five fold or so.

### What else is on the horizon?

The architecture of servers and the many 'clients' out there, such as notebook and desktop computers, is essentially the same technology platform. What we will be able to do is collect the client processing as 'virtual' instances on servers – with the latest multicore processors we could be running 2,000 'client instances' on a single server rack, which would consolidate our processing in an amazingly efficient way – and this is one reason why data centres are now becoming ever more popular in the plans of organisations.

### Should organisations outsource their data centres?

Yes, because the energy efficiency of a specialist installation is almost always better than anything you can build yourself. In any case, with the growing importance of 'cloud computing', old fashioned concepts of outsourcing are becoming outdated – now it's about sharing and consolidating IT for much lower complexity, and the biggest gains for organisations are in fact in systems management and maintenance, as well as energy efficiency. There is a view that IT is a strategic function that must all be done in-house. Certainly, there are concerns about security and compliance, but in my view IT operations is not a core competence, and should be seen like many other mature functions that are routinely handled by specialist companies. The strategic part of IT is of course the implementation of business processes, but not the actual running of them. So when we look at energy efficiency, the do-it-yourself approach is not the most efficient way for us to move forward collectively.

**Joseph Reger has held the CTO's post at Fujitsu for ten years and is an IT trends expert. He is based in Munich.**

# Boost your memory power

By introducing the new generation of DRAM technologies, businesses can reduce the energy consumed by their data centres and still meet the demands of virtualisation

Virtualisation is a proven technique enabling cost-effective server or cloud-based computing to achieve the flexibility and scalability needed to cope with changing traffic volumes.

It is implemented using significantly higher quantities of DRAM (dynamic random access memory) per server than is found in traditional data centre computers. As a result, the power used up in system DRAM represents a greater proportion of a data centre's overall power consumption.

This should encourage system integrators to move to newer DRAM technologies using advanced process nodes, as these have inherently lower power consumption than earlier generations of the technology.

To verify whether today's latest 30nm-class DRAM modules can deliver appreciable savings in overall energy consumption compared to the previous generation of 50nm-class DRAMs, and to measure the advantages in terms of the running costs of a typical data centre, a back-to-back comparison was performed using two servers running 30nm-class and 50nm-class DRAMs.

To ensure the comparison was reliable, two identical state of the art Fujitsu Primergy TX300 S6 server systems were used, featuring an identical configuration and both with major components such as power supply, CPU, fan and hard disk drive (HDD) storage.

The servers were each fitted with 12 Samsung-registered DRAM modules providing total DRAM density of 96GB. The conventional modules were built with 1GB chips fabricated in 56nm/1.5V technology, while the advanced DRAM modules were built using 2GB M393B1K70DH0-CH9 Samsung ICs, made with 35nm/1.35V technology.

The tests were conducted in a climate chamber to simulate a realistic data centre environment. Measurements were taken using sensors installed throughout the test set-up. Major parameters measured included the IT power supplied and the server exhaust air temperature.

> A data centre investing in 1,000 server systems could cut its total energy consumption by as much as 23%

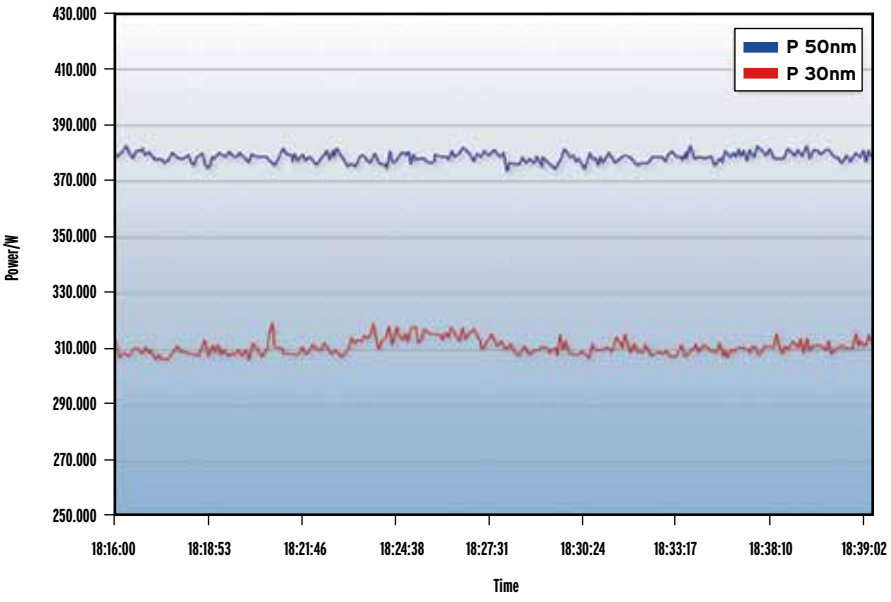
The tests were conducted with 20 virtual machine (VM) clients in a logged-in state. Following these steady-state measurements, SPECpower tests were performed under a variety of server loading conditions to test the effects on efficiency (performance per watt) of moving from 56nm DRAM to 35nm.

Measurable differences in power consumption and heat generation between the two systems were recorded. The test set-up showed a 70W difference in power consumption between the two systems, while the system working with 30nm class DRAM modules also displayed 1.5˚C lower exhaust air temperature.

The reduced overall power consumption recorded with the 30nm DRAM modules showed that significant savings can be made in the total operating costs of the system. In addition, the lower exhaust air temperature indicated that the cooling burden can also be reduced. In data centres with computer room air-conditioning (CRAC), this can be sufficient to allow the system specifier to choose between a smaller and lower-cost CRAC system, reduced runtimes or the use of less intensive operating modes.

According to this comparison, the potential total savings for a data centre with hundreds or thousands of servers are significant. A data centre investing in 1,000 server systems could reduce its total energy consumption by as much as 23 per cent, equivalent to around 170kW, by replacing 56nm DRAM with 35nm technology. This represents some €1m (£850,000) of savings at current energy prices.

**www.samsung.com**




**Power cut: the newer 30nm DRAM is consistently more efficient than the older 50nm**

# Take the green test

## A new certification process for data centres can help companies to identify savings in both energy and money and reduce their carbon footprint

In companies that with large administrative services, the data centre frequently accounts for 40-60 per cent of the total electricity costs. It's an aspect of the operation that businesses are beginning to focus on to help them to cut costs and power consumption, minimise $CO_2$ emissions and, in general, to help them to meet their sustainability and environmental objectives.

TÜV Rheinland, a leading provider of testing services in the field of quality, safety and efficiency, has developed a concept that secures permanent reduction of energy use in data centres and leads to the green IT certificate 'Energy-efficient data centre'. Sustainability of energy savings is at the core of the concept.

It focuses on sustainable 'rethinking'. Continual improvement of energy use is achieved by continuous monitoring of data on energy consumption. It includes quality assurance and conforms to the European standard ISO 50001.

Typically, the infrastructure consumes around 60-70 per cent of the energy used by a data centre while the IT hardware environment consumes about 30-40 per cent. Improvements in energy consumption can already be achieved by consolidation, virtualisation and the use of modern computers.

Yet using such computer systems increases not only computer capacity, but possibly also the energy demand of the air-conditioning systems. It often becomes necessary, therefore, to install new cooling systems – for example for water cooling on printed circuit boards.

As a result, the overall energy performance of the data centre is not necessarily improved.

The best approach is to draw up an 'energy balance' measure for the data centre and to assess and optimise energy efficiency and $CO_2$ emissions as a whole, rather than piecemeal.

After an initial efficiency check to assess the centre and potential for savings, further assessments can be carried out to give a more detailed picture. A comprehensive report then pinpoints the various potential areas for improvement, specifying how much energy can be saved and how much bills could be cut, as well as the likely reduction in $CO_2$ emissions.

Typically, the infrastructure consumes around 60-70 per cent of the energy emitted by a data centre while the IT hardware environment consumes about 30-40 per cent

With this as guidance, the data centre operator can decide on the specific steps to take in order to bring about the changes as quickly as possible.

After making the necessary changes to the data centre, a certification audit can be carried out: a standardised list of criteria covering more than 100 energy efficiency elements is used for the assessment. When a minimum number of the boxes have been ticked, the 'Energy-efficient data centre' certificate is issued by TÜV Rheinland.

Inconsistencies that have developed over time are frequently found during the first energy check. Further questions then often reveal surprisingly obvious deficiencies which can usually be corrected with little cost or effort. The scope for saving on $CO_2$ emissions is particularly interesting. In one case of a 500sq metre data centre, it was found that some 200 tonnes of $CO_2$ per year could be saved (a potentially important factor for carbon emissions trading).

Energy efficiency and the concept of 'green IT' is a relatively new topic where data centres are concerned but it does makes sense to take a closer look at their operation and identify potential savings. To date, we have measured the energy performance of more than 50 data centres and in most of them the scope for savings was more than 25 per cent. For companies, such findings are often the start of a 'green company' initiative.

Take the path to the 'Energy-efficient data centre'. Seize the opportunities presented by energy and $CO_2$ savings and permanently reduce your energy use. It will, among other things, enable you to keep costs under control.

**SAP case study:**
**http://tinyurl.com/5u75rlp**

# Storing up problems

## Bryan Betts looks at how we can make more efficient use of the growing data mountain

When you see a typical data centre, you'll notice lots of servers flashing lights at you. But there is also rack upon rack of disk drives whirring away, storing the mass of data to which the world has become addicted. Energy efficiency projects are often focused on servers, but your storage is also consuming power and generating excess heat.

Fortunately, green storage can be cheaper, faster and more compact, so that it needs less space, power and cooling in the data centre. Much of this is achieved by reducing the disk space needed to hold your data, says Rob Commins, manager of sales enablement at HP's StorageWorks division. "There's a saying: 'The greenest disk drive is no disk drive at all'," he explains. "If we can reduce that capacity footprint, that's the biggest way to drive value."

Many technologies enable you to store more data using less space and energy (see box). Unfortunately, they all need investment in new hardware and software. But first, carry out an audit to see where the power in your data centre is going.

"It is quite common to find a lot of hardware powered on but not in use, for example a storage array whose data has not been touched in five years," says Leah Schoeb, who chairs the Green Storage Initiative at SNIA, the Storage Networking Industry Association. "In most cases I've seen, companies have saved on facilities costs after an audit, and then there's more savings from the surrounding infrastructure, especially air-con."

Schoeb adds that a data audit – to see what you have stored, whether you need it, and whether it is on the right type of storage – can also be useful. But she says there are not many software tools to help with this.

### Pooling resources

Having done the assessments and audits, it may be time to change the storage infrastructure. One step could be storage virtualisation, which collects different storage capacity, typically via networking, and merges it in a single shared pool. The result is less wasted space – if a server or application needs ten gigabytes (GB) more, instead of finding a 250GB disk, you give it 10GB from the pool.

Data management can help too. Simply educating users to email links to a specific file instead of the entire file can save a lot of space, as can picking the right RAID (redundant array of independent disks) level for data. The RAID-1 scheme is fast and provides immediate running on a back-up, but it doubles the number of disks needed. Shifting to the RAID-5 or RAID-6 schemes is more efficient, as data is reconstructed on live drives if one drive fails, even though performance is not quite as good.

If your storage is networked via a SAN (storage area network) that has grown organically, a lot of power might be going to meshed SAN switches. Replacing these with a SAN director, which provides the same number of SAN ports in a single box, should be significantly more efficient.

> 'See what you have stored, whether you need it and whether it is on the right type of storage'

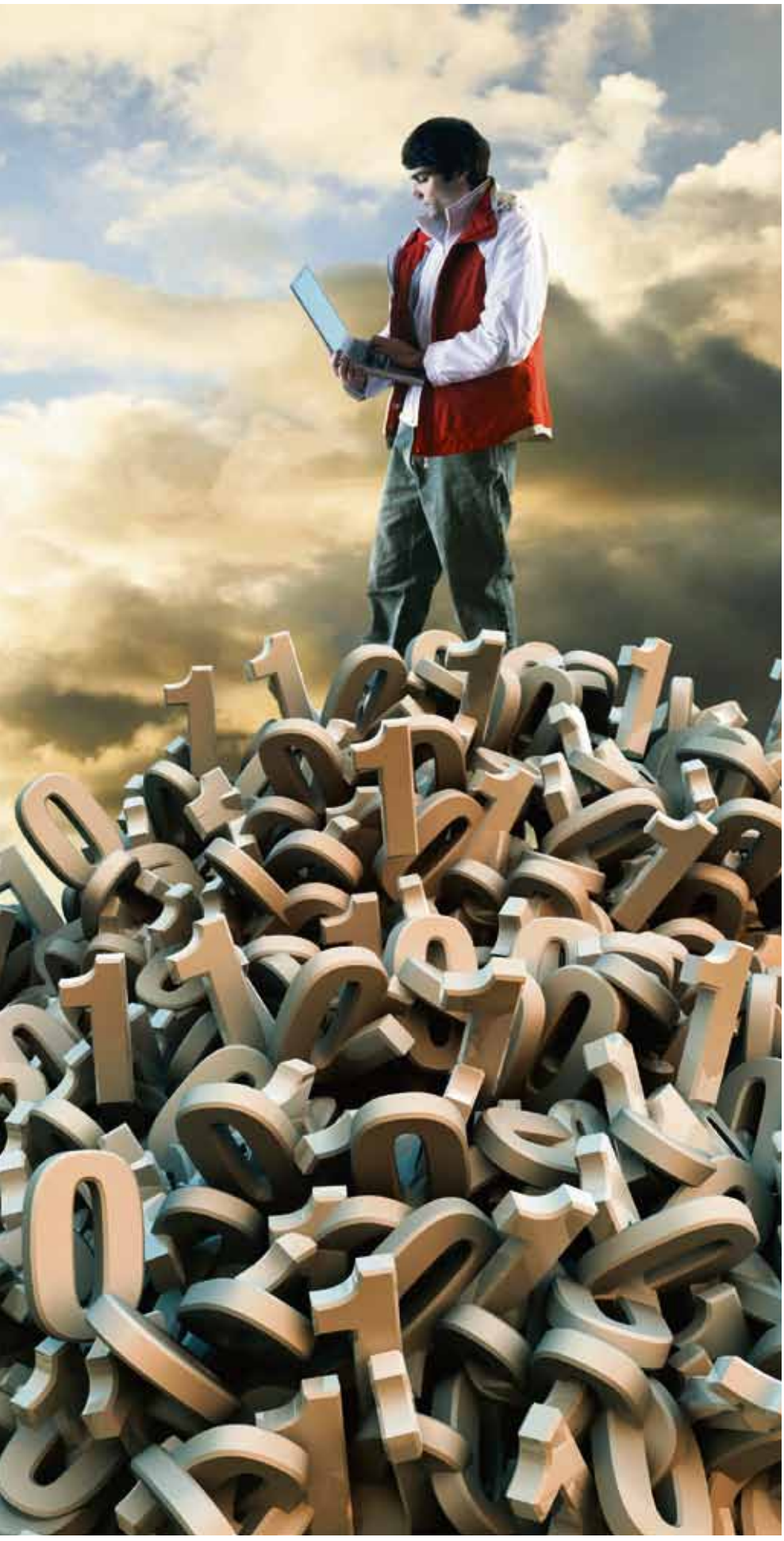
Then there is storage that takes less energy. A disk drive's power consumption is in theory proportional to its spin speed squared, although new fast drives may be more efficient. New storage is even more efficient, in particular solid-state disks (SSDs), which store data on stationary chips, not spinning disks.

"Not only is SSD many times faster than a hard drive, it consumes around one-fifth as much power because it is purely electrical, with no disks to spin or other mechanical parts to move," explains Jim Elliot, vice-president for memory marketing and product planning at Samsung Semiconductor. "Less power consumed also means less heat generated, so less energy-hungry cooling is needed, of course."

From a performance perspective, he says, one SSD can replace up to 20 15,000 RPM hard drives, which multiplies the energy savings. SSDs are not cheap, but that is still quite a saving.

**Bryan Betts is a freelance IT journalist**

Colin Anderson



# Energy-saving

**You can save energy by moving data on to less power-hungry storage.**

- **De-duplication looks for duplicated files or bits of files (pages within presentations, say), and replaces them with pointers to a shared copy. It can dramatically reduce the disk space needed, but the number-crunching involved may slow down data access.**
- **Data compression uses advanced mathematics to analyse files and store them more efficiently. Again, the reduction in disk space is paid for by an increased workload on the storage server, which can slow it down.**
- **Storage consolidation or convergence involves replacing several smaller storage systems with a few large ones, accessed via the LAN or a storage area network (SAN). It means energy-hungry components such as power supplies and storage controllers can be larger and more efficient, and can also save energy by allowing resources to be shared.**
- **Storage tiering reflects the different value placed on data by putting it on different storage. Typically, data currently in use goes on expensive fast disk, with data that has not been used in a while moved on to cheaper bulk disks. In some systems, the hottest data goes on super-quick SSD flash memory.**
- **Thin provisioning can dramatically reduce wasted free space. It means that physical disk blocks are allocated to a logical volume only as they are occupied. So a server might think it has a 2TB volume, but if it only puts 100GB of data on it, the volume occupies only 100GB on disk.**
- **MAID, or 'massive array of idle disk', is for data that is not needed often, but when you need it, you need it online – customer records, say. It uses cheap, high-capacity hard disks that are put into a low power 'sleep' mode – in effect, switched off – when not being accessed.**
- **Tape may be old-fashioned, but is still the cheapest and most energy-efficient way to store data for the long term, as a cassette on a shelf merely requires a bit of temperature and humidity control.**

# Going for green – the European data centres leading the way


## Strato's advance in Berlin

Strato, based in Berlin, is the second largest web-hosting operation in Europe. It has two data centres in Germany but its East Berlin base offers the greatest environmental challenge. The building has been in use since 1997, but was not built with sustainability in mind.

The company, a division of Deutsche Telekom, decided to move towards energy efficiency and by 2007 it was certified as carbon-neutral. It achieved this by switching to renewable energy provided by hydroelectric generators on the Rhine. In 2008, its 35,000 servers were still consuming too much energy, equivalent to 5,000 average households, but within 18 months this was cut by 30 per cent through the introduction of simple energy-saving policies.

### Board management

The company and the processor-manufacturer Advanced Micro Devices (AMD) redesigned the component boards within the servers. These boards do not run at full power all day long but, during idle times, they still consume energy – but now at only half the usual power. Virtualising servers to spread the load more evenly also keeps idle servers to a minimum.

Despite reducing server sprawl by virtualisation, there are 43,000 servers and the heat produced is a major problem. The centre uses cool air containment corridors that effectively add a false roof between two banks of servers; the air is drawn through the servers into the corridor and expelled. This is particularly effective in an old building with high ceilings.

Now the company is moving to lower power processors in the servers to cut a major heat source. The latest AMD processors should improve efficiency by 25 per cent.

Julian Ardisson, director of product marketing at Strato, said the server updates will cut the centre's PUE from 1.8 to 1.5. He expects this to fall to 1.3 within two or three years.

## NGD gives 100 per cent

A data centre operator in Wales claims to be the first in Europe to run a facility on 100 per cent renewable energy. Next Generation Data (NGD) Europe, in Newport, says it won't be charging customers such as BT and Logica any more for renewable energy in its 750,000sq ft data centre.

### Back-up ready

And if anything goes wrong with the supply, it has an array of onsite backup generators. "In an industry which consumes over 2 per cent of the UK's total power supply, it is a significant step to ensuring our operations are as competitive, efficient and environmentally friendly as possible," said Nick Razey, the chief executive of NGD.

The company is sourcing the power from renewable power company Smartest Energy. The provider claims to be the leading purchaser and supplier of electricity from independent generators in the UK and supplies electricity to companies such as Marks & Spencer, Toyota, Hitachi and Eurostar.

## Ark goes underground

Ark Continuity, a data centre specialist, is building a campus above an old bath stone mine that will provide low carbon efficiencies for the organisations using the facility. The first phase of the data centre in Spring Park, Corsham, Wiltshire, opened in late 2009, with a modular structure that gives users their own space. The centre currently has a PUE of 1.5.

### Set in stone

Further phases will use the Victorian stone mine below the site with underground cooling to go even further, according to Pip Squire, the project and engineering director of Ark Continuity. "The next stage of development is proving to be one of the most energy-efficient data facilities in the world – achieving a PUE of less than 1.2 without introducing fresh-air into the data rooms," he says. "At the heart of the design is the use of a secure underground space with a stable, consistent temperature of 9°C."

Stone was mined at the site until the 1920s, and the mine was redesigned as an underground aircraft engine factory in the Second World War. After the war, part of the quarry became a government nuclear bunker, and part was used for Navy stores, until it was decommissioned and sold in 2000.

# Telehouse warms the East End

Last year, Telehouse opened its flagship green data centre, Telehouse West, in London's Docklands. Built over nine storeys and offering a total of 19,000m² of floor space, the £80m centre has room for several hundred telecoms operators, internet service providers and others.

As well as providing secure, resilient data centre services, Telehouse says the facility can help UK businesses achieve their green IT commitments. It has its own substation powered by a combination of fuels, including at least 10 per cent renewables, and it features solar panels on the roof to provide 6,000 kilowatt hours of power a year.

The decision to use renewable energy sources was partly driven by pressure from the Greater London Authority, London Thames Gateway Development Corporation and the London Borough of Tower Hamlets to implement a sustainable energy strategy. Tower Hamlets, for example, requires that all major developments over 1000m² incorporate renewable power generation.

## Housing benefit

However, Bob Harris, Telehouse's technical services director, said what really "swung the pendulum" for the planners was the company's strategy to use nine megawatts of low-grade waste heat to power local buildings. The company says this will save the community about 1,100 tonnes of $CO_2$ a year.

Telehouse has built a network of pipes that transport water, warmed by the excess heat from the servers, to more than 1,000 homes in the area, free of charge. The data centre also benefits, as the water returning from the homes provides free cooling, thus reducing Telehouse's expenses.


# Capgemini's green 'gold standard'

**In 2010, the Environment Agency became one of the first customers of a data centre said to be "the greenest data centre in the world". Capgemini's Merlin data centre, in Swindon, has set a global standard for energy efficiency, with a power usage effectiveness (PUE) rating of 1.08. It is also one of just a handful of centres in the UK to be certified at Tier 3 by the Uptime Institute, for being "highly resilient, extremely green and ultimately secure".**

**At the recent Datacentre Leaders' Awards in December, Capgemini won the 'green' category for the Merlin facility, up against other contenders in the UK and Europe.**

**In a paper on Merlin, the company reports: "The data centre industry average PUE is approximately 2.5. There is an industry-wide effort to reduce this, with a 'best practice' target of around 1.3.PUE. Only a handful of providers are capable of achieving a PUE of less than 1.2. According to their own figures, Google's E data centre (1.12 PUE) and HP's Wynyard facility [in the UK] (1.16 PUE) have achieved this."**

## What's on offer

**The centre has 3,000m² of technical floor space in 12 modules. It uses fresh air and evaporative cooling, which is said to cut cooling energy by more than 92 per cent when compared with a conventional data centre using chilled water, and 75 per cent compared with a high-efficiency modern centre with free-air cooling.**

**A sophisticated climate control system continuously monitors the air temperature and quality and makes fine adjustments to stop cold air loss and prevent recirculation of hot air.**

**Capgemini adds: "Driving out dirty battery-based power systems as part of Merlin's approach to electrical efficiency is something which the industry should have addressed long ago."**

**In 2009, the Environment Agency selected Capgemini to provide the partial outsourcing of IT services under a seven year contract that aimed 'to be the greenest in government'.**

# The green case for outsourcing

## With data centre operators vying for the best energy ratings, it makes sense to look at outsourcing IT operations, writes Graham Jarvis

Although making your data centre more energy-efficient will save money and reduce carbon emissions, it is a costly business. It could be more cost-effective to outsource to a data centre provider.

Tony Rooke, the head of environment and sustainability at Logica, says small companies can cut their energy bills by up to 15 per cent; medium-size companies can save up to £100,000; and corporates can save several million pounds by outsourcing.

Outsourcing can offer instant access to the latest 'green technology', but most organisations will be staying with older systems for a while. As Kerry Hallard, the communications director of the National Outsourcing Association (NOA), puts it: "Most companies are in mid-flow with their contracts, and it's easier to implement green IT when it comes to negotiating a new data centre agreement."

Research by the NOA and Manchester Business School reveals what Hallard describes as "a strong appetite for both corporate social responsibility and environmental issues". The study shows that 94 per cent of data centre operators highlight their environmental policy in their credentials; and 82 per cent of clients verify suppliers' environmental policies during the procurement process.

Paul Anderson, the programme director for infrastructure outsourcing at IT services company Capgemini, says that its contract with the Environment Agency stipulates green metrics covering power reduction in data centres and information about the agency's carbon footprint.

### Check green claims

Many data centres and IT vendors claim to be carbon-neutral, but they sometimes stretch the truth. You should ask prospective suppliers where their servers are, how much energy the data centre consumes based on its power usage effectiveness rating (PUE – see page 10), and compare it with other centres offering similar deals.

Take care with PUE quotations, though, as some data centres measure the energy consumption and carbon emissions of the entire operation or company, while others just analyse aspects of it.

Pip Squire, the projects and engineer director at data centre company Ark Continuity, says that the company's PUE calculation includes "all of our security systems, power supplies and everything else – the whole facility achieves an average PUE of 1.4 but, with the addition of 'adiabatic' cooling (no heat gained or lost), it will achieve 1.2. I don't believe you can get below this level."

Steve Dininno

Capgemini's new Swindon data centre could, however, set a new world-class standard (see page 23).

### Where does energy come from?

Some customers are concerned about where energy is sourced and are thinking about investing in renewables, although that may not reveal the full picture, as the Facebook example shows (see page 4).

## Everyone can go green

**Using green and sustainable IT isn't just for large corporates. Small and medium-size enterprises (SMEs) can also cut costs and play their part in the green IT movement. Here are some tips:**

- **Conduct a thorough energy consumption audit. Analyse where you can make financial and energy savings.**
- **Develop an environmental policy. As well as green IT, you may need to change your staff's attitudes towards the energy they consume.**
- **Consolidate your IT into a small rack. Make sure that your servers are deployed in a modular facility with the scope to overspill to another room. Data suites can then operate at 80-90 per cent of their capacity and increase efficiency.**
- **Avoid investing in unnecessary IT resources. Only buy what you really need.**
- **Consider outsourcing or using 'cloud-based' computing services. You can gain access to enterprise level IT applications and services on a small budget, and to IT experts you probably wouldn't be able to afford otherwise. An entire business can be run using applications online such as Netsuite or Salesforce.com, and Google applications come free via the internet.**
- **Look at mobile technology. Some small organisations run their entire IT on notebook computers and smartphones, accessing only 'cloud computing' applications such as Salesforce.com.**

## Questions to ask a data centre operator

- Are you a member of a green energy body, such as the Green Grid?
- Do you operate an ISO 14001 compliant environmental management system?
- What is the power usage effectiveness (PUE) of your data centre?
- How much renewable energy do you use?
- When the CRC Energy Efficiency Scheme is applied, will you surcharge customers or bear the cost?
- What cooling techniques do you use?
- Does your service also meet security and reliability standards?
- How do you dispose of old server hardware? Do you comply with the WEEE Directive?

'Many data centres and IT vendors often claim to be carbon-neutral or green, but sometimes they are stretching the truth'

Mark Chapman, the commercial director at Carbon Statement, which provides carbon management services, recommends asking about plans for expansion. He says that 'security' doesn't just mean keeping data safe from hackers. It's also about how efficiently the data centre prevents energy leaks and waste by, for example, insulating its buildings.

"Customers should also consider the amount of energy used in cooling," says Jón Viggó Gunnarsson, the managing director of the Thor Data Centre in Iceland.

Thor uses fresh air to cool its equipment and Iceland's renewable hydro and geothermal resources as primary power sources. Gunnarsson claims that customers can save up to 45 per cent by outsourcing their IT to Iceland, although he believes that only 5 per cent of organisations are 'going green'.

### From carrot to stick

Before October 2010 the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme encouraged companies to invest in green IT (see page 8). Some commentators feel the governmenthas made a mistake by introducing a carbon tax. They think this penalises more than 5,000 businesses that have energy bills of more than £500,000, rather than rewarding them for trying to reduce their carbon footprint.

Data centre operators could be particularly hard hit by the change in tack. While the scheme could influence some decisions to build new facilities in the UK, the drive for operators to offer market-leading green facilities is only likely to increase. And with the difficulties involved in calculating carbon emissions, outsourcing of data centre activity could look increasingly attractive.

**Graham Jarvis is an IT and business journalist**

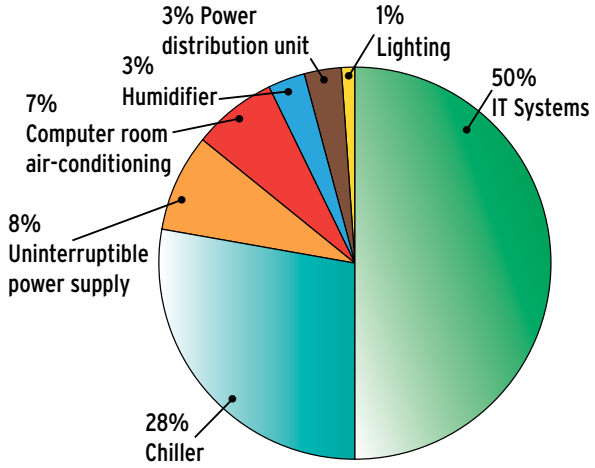
# A checklist for change

The facts and figures you need before setting up and running a greener data centre, or shifting your business to established energy-efficient operators

## Report shows cost savings

A White Paper by Neil Rasmussen, of APC by Schneider Electric, a power specialist, details the payback that can be gained by applying the right principles in data centres. Points made in Implementing energy efficient data centres include:

- Tools for modelling electricity costs are not commonly used in designing data centres
- The data centre group is often not responsible for bills
- Electricity costs are not routinely matched to operating practices




**Typical data centre power use**

A key principle is that reducing energy consumption can not only save energy costs but also the power infrastructure costs. High efficiency servers and power systems save both types of cost.

Retiring old and little used equipment in favour of high-efficiency systems and using intelligent power management systems is important, but virtualisation can have a 'dramatic' effect, by eliminating servers. And 'right-sizing' the power infrastructure to the IT load can make substantial savings.

Rasmussen makes the startling overall claim that "simple no-cost decisions made in the design of a data centre can result in savings of 20-50 per cent of the electricity bill and, with systematic effort, up to 90 per cent of the bill can be avoided".

**The paper includes tables showing typicalpayback scenarios. See whitepapers.apc.com**

## The benefits of cloud computing

Businesses that choose to run business applications 'in the cloud', instead of in their own infrastructure, can help to reduce energy consumption and carbon emissions by a net 30 per cent or more, according to a study commissioned by Microsoft and conducted by Accenture and WSP Environment and Energy.

The study focused on three widely deployed and commonly used Microsoft applications for email, content sharing and customer relationship management. Customers could choose to install each application on their own IT infrastructure or use the corresponding Microsoft cloud application. The study results suggest that choosing the cloud option can significantly reduce carbon emissions.

**Savings come from:**

- 'Dynamic provisioning' – large operations enable better matching of server capacity to demand on an ongoing basis
- Multi-tenancy – large public cloud environments are able to serve millions of users at thousands of companies simultaneously on one massive shared infrastructure
- Server use – cloud providers can drive efficiencies by increasing the portion of a server's capacity that an application actively uses, so performing higher workloads with a smaller infrastructure footprint

**A white paper on the research is available at tinyurl.com/64vmj5h**


## Kilowatts for cash

**There's nothing like cash to encourage energy efficiency – and as computer firm Fujitsu reports, rewarding employees for identifying IT equipment that is obsolete and can be decommissioned can pay dividends. A 'kilowatts for cash' programme works by offering a percentage of the savings made from removing systems that are not doing useful work.**

**Fujitsu estimates that 5 per cent of a data centre's servers may be unused. Turning off even a few of these can have significant benefits. Not only are there savings in energy and heat output, but there can also be returns on licensing, maintenance and space.**

**One major multinational has estimated that a kilowatts for cash programme could yield as much as €1m (£860,000) in the first year of implementation.**

# Useful links to a greener data centre

## A list of companies, agencies and trusts for energy help and advice

Imagezoo

### What the government can do for you

- Department of Energy and Climate Change: **www.decc.gov.uk**
- CRC Energy Efficiency Scheme: **tinyurl.com/co7jqq** **tinyurl.com/nstvnb**
- CRC Registry: **tinyurl.com/26zakfr**
- Scottish Environment Protection Agency: **tinyurl.com/4hqxpuz**

### Costing out the green response

- How much power do different server types consume? Try Fujitsu's green IT calculator to find out. **tinyurl.com/4va35ob**
- And what about using green memory? Plug your figures into Samsung's calculators at **tinyurl.com/6djm8u6**
- Greenpeace Cool IT challenge: **tinyurl.com/6keteto**

### Data centre challenge

- Fujitsu reckons that 28 per cent of IT departments know how much energy they use and it is inviting organisations to take its 'data centre challenge'. It will guarantee to prove that it can reduce the operating costs, space and energy use of your data centre by at least 40 per cent. "If we can't deliver, we'll donate £10,000 to the Climate Group," says Fujitsu.

### Essential reading

- *Low-Carbon and Environmental Leadership in the ICT Industry* by Gartner and the World Wildlife Fund, 2010 ranks technology providers according to measures to cut carbon emissions.
- Gartner *Data Centers Need a Solution-Based Approach to Gain Efficiencies:* **tinyurl.com/4nxya5d**
- Capgemini report on Merlin, *The World's Most Sustainable Data Center:* **tinyurl.com/68kwlqn**
- White paper on Usage and Public Reporting Guidelines for the Green Grid's Infrastructure Metrics (PUE and DCiE): **tinyurl.com/63fb9xs**
- Verdantix *Green Quadrant: Sustainable Technology Services 2011:* **tinyurl.com/6fl6os4**
- Pike Research report on *Cloud Computing Energy Efficiency:* **tinyurl.com/47q8mun**
- Ark Continuity *The Holy Grail of 'Green' Data Centres... is not PUE:* **tinyurl.com/6zb9ewe**
- *Best Practices for Energy Efficient Storage:* **tinyurl.com/5ue4wor**
- *Smart 2020* – a major report released in 2008 on the opportunities for information and communications technology to cut global carbon emissions: **www.smart2020.org**
- Samsung and partners – *Leveraging Memory Technology to Cut Data Center Power Consumption:* **tinyurl.com/66vp6cz**
- APC by Schneider Electric – *Implementing Energy Efficient Data Centers:* **tinyurl.com/6zh9pnm**

### The expert view – analysts and agencies

- Global e-Sustainability Initiative (GeSI): **www.gesi.org**
- Green Data Center News: **www.greendatacenternews.org**
- The Green Grid: **www.thegreengrid.org**
- SNIA Emerald (Green Storage Initiative): **www.sniaemerald.com**
- Global Action Plan: **www.globalactionplan.org.uk**
- eWEEK Europe: **www.eweekeurope.co.uk**
- The 451 Group: **www.the451group.com**
- Quocirca: **www.quocirca.com**
- Smart Planet: **www.smartplanet.com**
- Gartner: **www.gartner.com**
- Uptime Institute: **www.uptimeinstitute.org**

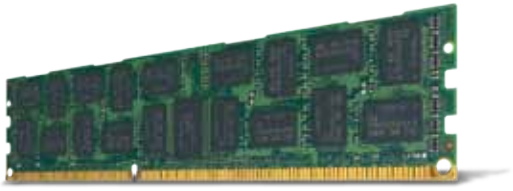
### Standards of practice

- *EU Code of Conduct on Data Centres Energy Efficiency:* **tinyurl.com/66gu9jz**
- *Certified Energy Efficient Datacentre Award (CEEDA):* **www.ceeda-award.org**
- **Carbon Trust Standard**
  All businesses and organisations are eligible to apply for the Carbon Trust Standard, a programme that applies for a two-year period. To maintain certification you must reapply and demonstrate year-on-year reductions in carbon emissions. **www.carbontruststandard.com**
- **BREEAM (Building Research Establishment Environmental Assessment Method) – environmental assessment method for buildings**
  HSBC achieved the UK's first 'excellent' rating for design and procurement of a North London data centre in 2008. **www.bre.co.uk**
- **LEED (Leadership in Energy and Environmental Design): www.usgbc.org**

### What's happening where?

- Data Centres Europe 2011 (Nice, France) 5–6 May 2011: **tinyurl.com/6yjyqq9**
- Government ICT Goes Green 14 September 2011 (London)**: www.govnet.co.uk**
- Green IT Expo, 1 November 2011 (London): **www.greenitexpo.com**

# Less energy. More memory.



## The new 30 nano class Green DDR3

Now, the leader in green memory introduces the best-performing chip upgrade ever – Samsung's 30 nano class 4G bit DDR3 server memory chip. It has four times more memory, processes twice as fast and saves 86% more energy than its predecessor.* In fact, the energy usage is so small, maintenance costs of your server farm are significantly reduced. Welcome the new eco-innovation that performs without compromise – the 30 nano class Green DDR3.

www.samsung.com/greenmemory

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* Samsung internal test result, compared to Samsung 60 nano class DDR2 memory chip. Actual performance difference may vary depending on the test environment.