Power Management in data centres
made easy

Avocent

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Content

Introduction

Congratulations on picking up “Power Management in data centres made easy”. Here we will explain to you how you can operate your data centre more efficiently and save money with intelligent power management. A study conducted by the EPA (Environmental Protection Agency) shows that the power costs of a data centre consume up to 30 percent of a company’s IT budget. Surely you want to avoid this? Rather, you will want to improve the economic viability of your data centre and avoid server crashes.

This booklet explains how you can analyse the power consumption of data centres, ensure an optimum spread of energy load and retain reliability in the long term with the right form of management.

About this booklet

This booklet is a simple guide to efficient power management in data centres. It is split into four chapters:

Chapter 1 explains the principles of sustainable power management. Here you can learn whether your data centre is efficient or not and what measures you can take to cut costs.
Chapter 2 focuses on power. What makes power management good and what are the benefits of good management? What should intelligent power distribution units be able to do and why can you save money by using a three-phase power supply? This chapter will answer all these questions.
Chapter 3 shows how you can easily manage local and remote data centres. You will also learn how you can manage the power of a data centre 300 kilometres away from the comfort of your own desk.
Chapter 4 summarises the ten main reasons to achieve efficient power management in your data centre.

 This bulb symbol draws your attention to benefits

Chapter 1 – The principles of effective power management

In this chapter you will learn

- *that solving energy problems first means you need to understand the facts*
- *how you can tell if a data centre is efficient or not*

Why is power management so important?

Most data centres consume too much energy. This increasingly causes problems when data centres are extended, as sufficient extra energy isn't available. High operating costs coupled with energy prices which are set to increase in the long term can also see IT costs shoot up. This is one area offering huge potential savings. Scope for optimisation comes from reducing IT use and the volume of IT equipment as it is one of the largest power users.

Simply unplugging equipment however is not the solution because the requirements regarding availability and power processing have risen enormously over the past few years. Other promising strategies are on hand, including for example identifying those areas where power and cost savings can be made. Alternatively you could optimise existing infrastructures, through virtualisation or the use of workflow analyses so that certain processes are run at cheaper off-peak times. But which strategy is most appropriate for your data centre? You can only answer this question when you have the information you need to serve as a basis for your decisions.

Turn darkness into light!

The lack of accurate information about energy consumption in data centres is astoundingly high: a fact proven in a survey carried out by Research Concepts[1] amongst staff responsible for IT found that around one third had no idea of the power costs of their data centre. If you are going to optimise power consumption, it's essential that you are first aware of your precise energy requirements, right down to the smallest item of

[1] Survey conducted on behalf of Avocent, a division of Emerson Network Power.

equipment. This can be done using power manager software tools[2]. This works with power distribution units and can be used to establish power consumption, capacity utilisation and the energy costs of individual equipment, power distribution units, racks and rows of racks and for the entire data centre. Once you've discovered what you didn't know, you can look forward to countless benefits.

The first step to reducing costs is to establish the power consumption of every single device and the data centre as a whole. Once you know how much electricity you are using, the data can be compared with the maximum amount of energy available. This will help you in sustainable capacity planning. It will show you whether planned extensions are actually needed or feasible. If additional equipment is connected to the wrong place in the network, this may cause power circuits to overload, resulting in downtimes and loss of data. Protect yourself from wasted investments and server crashes by knowing your data centre!

By using the right tools you can also learn when a rack, server or any other rack-level equipment is operating at close to its capacity limit. To know this, you need simply define a maximum power limit value for the equipment. Once power consumption approaches this value, the software transmits an automatic alarm. This enables you to take measures early on to prevent crashes and ensure the availability of IT resources. Such measures might include moving certain server activities to cheaper off-peak times or virtual servers. In principle, those applications which place only low utilisation demands on the servers and thereby use power unnecessarily are suitable for virtualisation. It is interesting to note at this point that an idle server can still consume up to 50 percent of the power it needs when fully operating.

Given the ever-growing cost of energy, there is no harm in knowing how much power the different parts of a company are using to raise cost-awareness amongst users. The appropriate costs can then be billed to the right departments. Companies which do not yet use what are known as chargebacks will presumably start doing so in the future

[2] Avocent Power Manager® is a software tool which collects real time metre data for use in reporting an automating power threshold breach warnings.

as they allow you to see where energy savings are needed. We recommend targeted measures and charging costs following the consumer pays principle. When you know how much power each server consumes, it's simple.

It would be of little use to simply subject a data centre to an actual analysis, remedy problems and then forget about it all because the data centre and load levels change over time. That's why power management tools not only offer a real-time reporting function which indicates acute problems such as power peaks but also a historical reporting function, which can be used to analyse power consumption trends. The data

collected can be used to identify equipment currently using disproportionate amounts of power and also to generate statistics over longer periods. This can form the basis for continually improving energy efficiency. The real-time and historical reporting functions will assist you in remedying problems in the long term and making the right strategic decisions for data centre resources.

Understanding your energy consumption – the benefits at a glance

- Avoid wasted investments and server crashes – with accurate capacity planning
- Take countermeasures before problems arise – with an automatic alarm
- Make the actual consumers pay – by assigning power costs
- Hunt out and remove high power users – with the real-time reporting function
- Improve energy efficiency on an ongoing basis – with the historical reporting function

Uncovering efficiency

Now you know what is going on in your data centre. You are aware of the power consumption of individual IT equipment and the data centre as a whole. But how you can tell if a data centre is efficient or not? The equation below will give you what is known as a PUE (Power Usage Effectiveness) value, which you can use to estimate how sustainable your data centre actually is.

$$\frac{\text{Total Facility Power}}{\text{IT Equipment Power}} = \text{PUE (Power Usage Effectiveness)}$$

This approximate value comes from supplier consortium The Green Grid. It shows the total power consumption of the data centre (Total Facility Power) in proportion to the power consumption of IT equipment (IT Equipment Power).

The power consumption of IT equipment includes server, CPU and network equipment loads. The total power consumption of the data centre also includes the load from the building, and the power consumed in cooling or for example UPS systems. The PUE

value is currently the main parameter used internationally to establish and compare the energy efficiency of data centres.

A PUE value of 2 is usual for standard data centres. It means that two kilowatts of power has to be supplied to the data centre for every kilowatt of power that the servers need. The second kilowatt is used by the data centre infrastructure, predominantly by the energy supply and air conditioning.

A PUE value of 3 would mean that only a third of the energy in the data centre is actually being used directly by IT systems. If the value is greater than 2, there is an urgent need for measures to save energy. The theoretical optimum is 1.4.

Please note however that optimisation measures such as virtualisation, which are restricted to IT systems, do not impact positively on the PUE value but may in fact increase it even if you are of course saving energy and money! The only way to reduce the PUE value is to reduce the amount of power used in your data centre.

To make savings in all areas your goal should therefore be to achieve the lowest possible PUE value. This will help the environment and your budget.

Chapter 2 – Intelligent power management – increased efficiency, fewer downtimes

In this chapter you will learn

- *the elements of efficient power management*
- *why you should dedicate more attention to power management*

What are the characteristics of good power management?

Poor power management can prove to be very expensive. If a rack is using more power than intended, it jeopardises the availability of all connected equipment and therefore all the applications this equipment supports. Remember that system failure and the associated downtime is often more costly that your normal electricity bill. What better reason do you need to start paying attention to power consumption? It takes just a few steps to improve your power management. These steps include correct use of uninterrupted power supplies, intelligent power distribution units, selecting the right power supply and cabling that people can't trip over.

Uninterrupted power supply – play it safe

The power supply is the Achilles' heel of all IT equipment. Servers and other equipment which need to be available whenever running should be fitted with an uninterrupted power supply (UPS) to stave off a power cut or brief periods of insufficient or excess power levels.

UPS systems are now commonplace in data centres but can be incorrectly used. People are often not aware that different UPSs offer different levels of protection and that various IT devices do not have the same protective needs. There are three established types of UPSs: the standby or offline UPS, the line interactive UPS and the double conversion or online UPS. If you want to minimise the costs of downtimes and damage to equipment, it's important that you use the different types correctly.

Standby UPSs offer restricted scope for use and only protect against mains power failure and brief voltage fluctuations. They are primarily suited to non-critical desktop

applications. Line interactive UPSs are better suited to all other desktop, small network and point-of-sale applications. They protect against mains power failure and peaks in voltage and can constantly compensate for voltage fluctuations.

Double conversion UPSs should however be used with critical equipment and applications such as servers. These UPS systems first convert the AC voltage supplied into DC voltage in order to use this to produce perfectly conditioned AC voltage, which has multiple benefits.

One such benefit is a more constant voltage supply. Converting voltage within the UPS isolates the integrated equipment from the source of power, which prevents voltage problems from passing through the UPS to the equipment and restricting function or causing damage. Many of the problems caused by voltage issues can thereby be resolved without use of battery power. This in turn makes longer runtimes possible during downtimes and extends the battery's life.

Getting the most out of your power distribution units

The power distribution strategy is very important in terms of the efficiency of data centres and the availability of IT equipment. Traditional methods of power distribution with just one phase can be easily exhausted in the distribution of power to racks as power density continues to rise. The following sections will explain the functions which intelligent power distribution units (PDUs) should offer.

Basically they should provide you with all the tools you need to monitor, measure, reduce and manage rising power costs and minimise downtimes. Power distribution units[3] can be used as standalone units or integrated into the power management software. Integration also allows process-related trends over time to be tracked to measure and monitor the power consumption, power capacity and power costs of IT equipment.

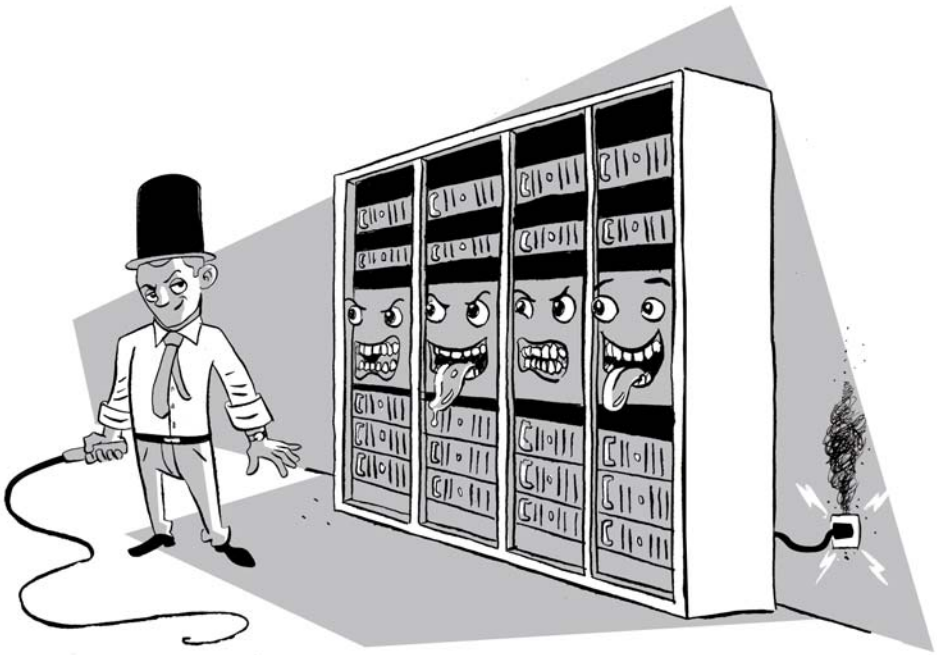
[3] Avocent PM2000 and PM3000 units support outlet-level metering and switching capability to provide data center professionals the tools they need to monitor, measure, reduce and manage their growing power consumption costs of IT equipment.

Physical features – vertical versus horizontal

Power distribution units fitted in racks are available in either a vertical or horizontal form. The horizontal power distribution units normally have a maximum of ten sockets. If you need more sockets, the vertical version is right for you. If using vertical configurations however, you should ensure that there is enough space on the rack rails for the power distribution units so as not to hamper the installation or movement of other IT equipment.

Measuring function – identifying high power users

In order to individually determine the actual power consumption of IT equipment, at phase level and at PDU level, these power distribution units must have a measurement function. The right size for upstream electrical infrastructure can be determined using the data relating to power consumption. This is extremely useful when installing new



racks for example. The electrical infrastructure is optimised and the efficiency of the entire power supply chain enhanced, which in turn cuts power costs.

Of course power distribution units with a measurement function also identify IT equipment consuming above-average levels of power, enabling you to reduce energy consumption.

Switching function – reducing downtimes

In order to ensure maximum possible availability of all equipment critical to the company's function, the power distribution units used should have both a measuring function and a switching function. Switching functions allow you to switch equipment on and off or restart it remotely. They are incredibly important for reducing the downtimes of servers or networks which are no longer responding.

Using remote control, you can intervene straight away, saving you from having to travel to the data centre in person. In other words, remote control eliminates staff travel and the travel costs saved can be invested in something more useful. Another benefit of power distribution units with switching capability is that they allow sockets to be switched on in a staggered manner such that the power limit values for the power supply are not exceeded when the equipment in the rack is switched on. This is a huge benefit to applications running on several servers, which are interdependent and therefore have to be started or powered down in a particular order.

Defining limit values – when PDUs trigger alarms

A human being cannot keep track of everything that is happening all the time. So in data centres, this becomes the job of power distribution units with their exact real-time monitoring of all connected equipment.

All you need to do is define a threshold value for power and ambient parameters. Then the power distribution unit will do the rest by issuing a message, should imminent overload problems arise. This allows problems to be detected in good time, and downtimes resulting from overloaded power supplies to be minimised.

Intelligent power distribution units – the benefits at a glance

- Identify high power users in the data centre – using the measurement function.
- Reduce downtimes and save money – with the switching function.
- Solve problems before they cause damage – with the alarm function.

Allowing power to flow correctly – three-phase power at rack level

A redundant power supply is now a standard feature of most IT equipment. In order to make best use of the equipment's integrated redundancy, every single rack should be connected to at least two, totally separate, power supplies. Ideally these two power supplies should also be fed from different sources and they should be able to handle the entire anticipated load capacity. As soon as you can estimate the loads you expect per rack, you can take the next step towards efficient power management, and select the right power supply for each rack by choosing from a single- or three-phase power supply.

Racks with a low load can be easily powered with a single-phase current. But it is a good idea to separate the phases at the output of the installed floor-mounted distributors and to supply the individual phases to different racks to ensure an even load.

However, if the load densities per rack exceed 5 kilowatts, you should use a three-phase power supply. This offers several benefits, including lower cabling costs because loads exceeding 5 kilowatts are supported by one single three-phase power supply rather than several single-phase supplies. The fewer the power supplies that have to be routed to the individual racks, the lower the cabling costs.

Another benefit is that the electrical infrastructure is more reliable. Using three-phase current and power distributor units installed on the rack with a measurement function will allow for an even distribution of load on all three phases. These balanced loads will minimise harmonics and overheating on the neutral conductor, and therefore reduce problems in the mains power supply and within the IT equipment. A further benefit of three-phase current is that it improves the reliability of the IT infrastructure, since fewer

power supplies will improve the circulation of air, which in turn prevents equipment from overheating. The greater capacity of the three-phase power supply also means that downtimes are less likely thanks to additional power reserves, and it offers more scope for future extensions, allowing additional equipment to be installed without the power supply of the current equipment being impaired in any way.

Three-phase power – the benefits at a glance

- Keep your cabling costs down.
- Improve the reliability of the electronic infrastructure.
- Improve the reliability of the IT equipment.
- Extend your data centre without impairing the current power supply.

Intelligent cable routing – getting power flows right

Cables which are not routed intelligently not only give an impression of disorder but can actually impact negatively on the energy balance. So tidy cable routing is a must. We would recommend installing distributor elements for network cables, known as patch fields, in the cabinet systems. These split the individual connections and lend the cabling a structure. Power and data cables should also be kept separate so that when used with copper wiring they don't interfere with one another as the networks speed up over time.

Routing cables under the ceiling of the data centre is a great solution. Provided that the structural circumstances permit it, this is a better solution than false floors because these are used for air conditioning and a multitude of cables will impair the flow of cooling air required. This will automatically result in additional energy costs for recirculating air to provide the necessary amount of cold air. You may also prefer to use wider cabinets for cable routing within the rack for the very same reason. If space is tight, the many cables behind the servers may act like a cable wall for the warm air that needs to be dissipated. The IT equipment's fans then have to work against a resistance and consume considerably more energy. This in turn impacts negatively on the cooling and power consumption of the IT equipment.

Chapter 3 – Increasing efficiency with the right kind of management

In this chapter you will learn

- *how to make light work of complex management*
- *how to solve problems remotely*

An overview of the entire data centre

The last two chapters taught you about the benefits of efficient and intelligent power management. The sections below will show you how to manage all the IT resources of a data centre and manage power from one and the same console and how to remedy problems from a remote location.

Simple management

Integrated infrastructure control requires management software[4]. This can present the numerous heterogeneous systems and equipment together in an attractive format for remote access via KVM-over-IP, console servers or service processors. In other words, a wide range of IT equipment in the data centre such as network devices, physical servers (with or without integrated service processors), blade servers or virtual servers can be reliably and centrally managed from one console. Each user can use views that they define themselves on the browser-based user interface.

Such tools also provide automatic alarms and scope for producing reports or graphics. Audits into access, events or communication can also be produced. The tools also simplify and speed up the preparation of new management appliances by providing software configuration templates, preconfigured with known parameters. These functions make data centre management straightforward and easy to understand.

Management at any time and from any location

Appropriate management software should also allow you to access all network equipment at any time from anywhere in the world. Diagnosis and modifications should be possible, regardless of the status of the operating system or network in which the equipment is integrated.

If the software provides out-of-band functions, problems can be diagnosed and solved even if servers are no longer able to communicate across the network or gateways, routers and other equipment needed for IP connectivity are no longer available. Remote management is one of the elementary functions of management software and is a huge aid to troubleshooting because staff no longer have to be present in person. This is turn impacts positively on both the operational continuity of your IT equipment and staff productivity.

[4] Avocents DSView® 3 management software consolidates data center management functionality into a single interface and delivers the data center control necessary for the 24/7 data center.

Remote power management

Management software which allows virtually all equipment in local and remote data centres to be accessed and controlled, therefore lies at the very heart of efficient management. For example, these functions can be extended by the Power Manager so that energy consumption, energy costs and the energy trends of IT equipment can be monitored and measured using intelligent power distribution units at a multitude of levels.

From a management standpoint, remote administration is an essential part of power management. This is true for example for “lights-out” data centres, which are not manned, as it reduces the risks of faults and improves safety. Many companies now use such data centres for a whole host of reasons, be it for disaster recovery situations or quite simply to save money, for example in a smaller data centre in a branch. If the IT offers no scope for remote system management, including the ability to reset crashed equipment and power it back up again, then lights-out data centres are simply not feasible.

But if you have a management system which supports an out-of-band function and power distribution units which allow for restarts or activation/deactivation from a remote connection, the power can be conveniently managed from your desk. Detailed information about power levels and the equipment’s surroundings arrives on your desk too. This means that you can access all the data you need on power consumption, capacity utilisation and energy costs from the comfort of your own office. All IT equipment in local and remote data centres can then be controlled from one central console. And you can avert the risk of server crashes from a distance!

Chapter 4 – Ten good reasons to ensure efficient power management

In this chapter you will learn

- *why using intelligent power management is worth it*

Reducing downtimes

Server downtimes in data centres need to be kept as short as possible to avoid idle times and possible data losses as these may have serious financial consequences. Intelligent power distribution units will help you to avoid this situation in many ways. Firstly, measuring the power and energy consumption of the data centre will give you valuable information about where new racks or servers can be added. If you have this data, you won't connect equipment in the wrong place and bring about downtimes caused by power overloads.

Power distribution units which allow you to set threshold values offer additional protection by using an alarm function to draw your attention to imminent problems. You can then respond in good time and guarantee uninterrupted availability. Another useful tool in reducing downtimes is the switching function provided by power distribution units. Through remote control, this allows you to restart equipment or to switch it on or off remotely. Problems in lights-out or very remote data centres can then be quickly remedied before a failure causes more serious damage.

Avoiding wasted investments

You need to use your budget as efficiently as possible and avoid wasting any of it. There are tools on the market which will help you avoid wasted investments in the data centre. Intelligent power management software will show you how much power is being used. You can then compare this data with the maximum amount of energy available, be it for the whole data centre, one particular rack, a server or a group of servers. This information makes effective capacity planning possible as you can see whether planned extensions are really necessary or feasible. Other tools[5] are available for more

[5] Avocent's Data Centre Planner® 3.0 gives you the power to actually see your IT. Capacity planning and visual modeling that delivers insight, so you can simply plan and manage your data centre.

extensive resource planning. This offers a simulation feature which allows you to check the impact of planned modifications, guaranteeing reliable planning for the whole data centre.

Keeping energy bills low

As energy prices continue to rise, the need to save on energy costs will gain in importance. This is easier than many people might imagine. The Power Manager can continuously monitor peak-time and off-peak power consumption. Data centre operators receive a comprehensive picture of the energy use of every piece of IT equipment and the associated costs.

The software can be used to produce reports and this data compared to establish how much power is being used at peak times compared with off-peak. For example, the report will show you which racks are causing power peaks and when they do this. The reasons for these peaks can then be established and such activities moved to a time when the price per kilowatt-hour is lower. A virtual server would be an alternative to this.

Minimising budget overspends

Power distribution units which allow you to define threshold values and a maximum power consumption limit will stem budget overspends. When the defined value is reached or exceeded, a message is automatically issued and you can then respond accordingly. Again you can move the activities in question to off-peak times, use virtual servers or take other optimisation measures to save money.

Charging costs following the consumer pays principle

There is little sense in paying for something that you don't use. There is just as little sense in the marketing department paying the energy costs of the accounts department. We would therefore highly recommend that the power consumption of a company's individual departments be evaluated, especially now that energy prices are on the rise.

For example, if all the servers for the accounts department are grouped in one rack, the number of kilowatt-hours consumed can be used to work out the percentage of the monthly bill for which accounts is responsible. The Power Manager and its ability to accurately work out how much power each server uses allows the power costs incurred to be easily charged using the consumer pays principle. In addition to correctly assigning costs, you can also heighten staff awareness of energy costs and make them more willing to use energy-efficient technology and working practices.

Continuously improving efficiency

If you can access all power consumption data in a data centre in real time, you can easily minimise interruptions during operation, extend the operating hours and also ensure optimum power management. The Power Manager provides you with live information on IT power consumption at any time. A historical reporting function is useful for a long-term and balanced overview of consumption. This will collate energy consumption data over long periods and reproduce this as statistics.

Once the trends have been analysed and past and current power consumption compared, any problems found can be remedied. This information can also be used to make optimum decisions relating to data centre resources and you can continue to improve your PUE value.

Solving problems before they arise

If you use intelligent power distribution units to set threshold values for power and environmental parameters, not only can you prevent budget overspends, you can also save money by solving problems before they cause any damage. The power distribution units issue a message and alarm to warn of imminent overload problems. This will indicate problems at an early stage and you can respond appropriately to avoid costly downtimes and idle times.

Making savings with the right kind of power supply

When selecting a power supply for a data centre, you can choose from single- and three-phase current. Given the high loads encountered nowadays, most people opt for three-phase current, which should be used for power densities of more than 5 kW. This brings potential savings with it, including lower cabling costs through the use of one single three-phase power supply rather than several single-phase ones. Increased reliability of the electrical and IT infrastructure is another benefit of three-phase current and you also stand to gain from less damage caused by overheating.

The greater capacity of the three-phase current also allows for more growth in the future. More equipment can be connected without the power supply of existing equipment having to be interrupted.

Remote troubleshooting

Crashed equipment or unresponsive servers may result in costly problems, but they can be remedied remotely before damage sets in with the help of remote control and power distribution units with a switching function. This allows you to respond quickly and flexibly while simultaneously saving you money. There is also no need for staff to travel to the centres, reducing the company's travel budget accordingly.

Power distribution units with a switching function can also help you save money in the face of rising power costs, since unused servers can be remotely switched off to prevent energy being consumed for no reason.

The right cable routing to reduce energy consumption

The benefits you can enjoy from power management solutions can be further enhanced by noting the following cable routing tips. If cables are intelligently routed in data centres, energy efficiency can be further increased. Use patch fields to make your cabling more structured. Ensure that power and data cables are kept separate so they don't interfere with one another and possibly cause failures.

If permitted by the structural circumstances, cables should be routed on the data centre's ceiling. By keeping cables out of false floors, you can avoid impairing the supply of cool air through the floor and also prevent additional energy costs. If the cables then converge in cabinets of a sufficient size without any "cable walls" where dissipating heat can build up, you can be sure of intelligent cable routing.

Conclusion

As data centre managers are not usually responsible for paying the costs incurred, there is often little motivation for change and very few of them use sustainable power management. But pressure from management and also legislation is increasing. In the UK, the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme came into effect in April 2010. This forces data centre operators to address the issue of energy efficiency and calls them to account financially if their CO2 emissions are too high.

Acting towards immediate reduction in energy consumption today rather than putting actions off until tomorrow is not only being forced by legislation, it is also driven by the promise of major financial benefits and a pioneering corporate image. This booklet shows that it's hardly rocket science. There are many solutions to help reduce the energy consumption of power-hungry data centres at little cost and effort.

About Emerson Network Power

Emerson Network Power, a business of Emerson (NYSE:EMR), is the global leader in enabling Business-Critical Continuity™ from grid to chip for telecommunication networks, data centers, health care and industrial facilities. Emerson Network Power provides innovative solutions and expertise in areas including AC and DC power and precision cooling systems, embedded computing and power, integrated racks and enclosures, power switching and controls, infrastructure management, and connectivity.

All solutions are supported globally by local Emerson Network Power service technicians. Aperture and Avocent solutions from Emerson Network Power simplify data center infrastructure management by maximizing computing capacity and lowering costs while enabling the data center to operate at peak performance. For more information, visit www.Aperture.com, www.Avocent.com or www.EmersonNetworkPower.com.

About Emerson

Emerson (NYSE:EMR), based in St. Louis, Missouri (USA), is a global leader in bringing technology and engineering together to provide innovative solutions for customers in industrial, commercial, and consumer markets through its network power, process management, industrial automation, climate technologies, and appliance and tools businesses. Sales in fiscal 2009 were $20.9 billion. For more information, visit www.Emerson.com.

Solutions and tools you need to monitor energy consumption, costs and trends across all levels within the data centre and remote locations……..
made easy

'A must read for anyone involved in data centre management'