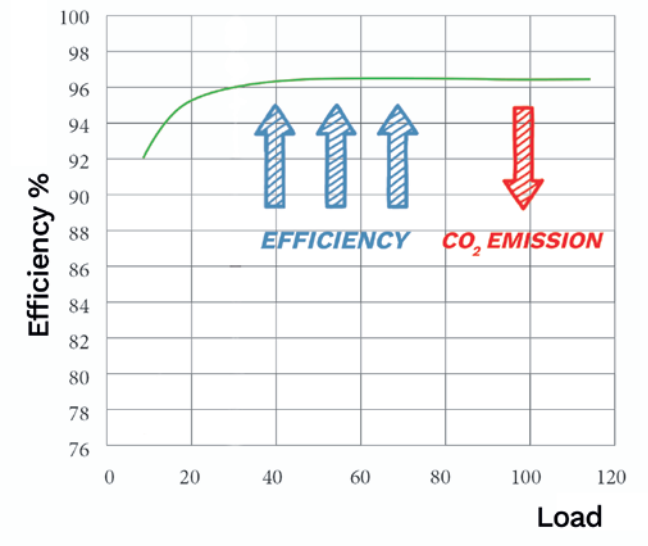
CARBON CUTTING IN THE DATA CENTER

INTRODUCTION

According to data from the independent research agency Software.org, there will be at least 50 billion devices connected by the end of this year (2020). Factors such as increased interconnectivity, growth of the Internet of Things (Iot) and development of Industry 4.0 mean that the demand for data and energy required for data generation, and the consequent need for space and energy for their storage, continue to grow at an incessant pace.

According to research by the Global e-Sustainability Initiative (Gesi- international strategic partnership of ICT companies and industry associations engaged in the creation and promotion of technologies and practices that promote economic sustainability) Data Centers consume about 3% of the world's energy produced daily, generating at least 2% of the planet's greenhouse gas emissions. The environmental impact generated in this circumstance is equivalent to that caused by the aviation industry.



Specialists in the field say that the amount of energy that is used by Data Centers doubles every 4 years, although in recent years progress has been made in the design of hardware to be more efficient.

There are two ways a data center consumes energy. There is the energy used to run IT equipment such as servers or UPS units (Uninterruptible Power Supply). In addition, the air conditioning required to keep all machinery fresh enough to operate safely without the risk of overheating should also be taken into account.

According to TechUK, the entity representing the British technology industry, electricity is one of the largest operating costs that a Data Center has to incur, and can account for 25 to 60% of total overhead costs.

At this moment, the Hyperscale Data Centers, capable of hosting increasing computing capacities, typically consume about 30 Gwh of energy per year, which leads to a bill of around 3 million euros per year. The potential efficiency shortages will result in a huge amount of energy waste, with all the associated economic and environmental costs. So, whatever the size or configuration, In-House, Colocation or Cloud, there is no data center operator that can avoid becoming more energy efficient, thus reducing energy consumption and carbon dioxide (CO_2) emissions.

In fact, many new Directives and Regulations of European governments push in this direction. All large companies and organisations must publicly declare in their annual reports progress in reducing greenhouse gas emissions, risking high fines if they haven't implemented the necessary improvements.

HOW TO MEASURE DATA CENTER EFFICIENCY

PUE (Power Usage Effectiveness) is a measurement metric devised by the Green Grid consortium, which indicates how efficient a Data Center is in using the electricity that feeds it. The PUE is in fact a parameter that makes the idea of how much electric power is dedicated to the supply of only IT equipment compared to complementary services such as cooling and air conditioning system or UPS losses.

The PUE is therefore the ratio between the total power absorbed by the Data Center (PT) and that used only by IT equipment (PIT).

The closer its value is to the unit (optimal measurement) the more efficient the Data Center is, since it indicates that all the energy absorbed by the plant is used for IT equipment.

However, in recent years PUE is becoming a less relevant metric, because experts in the field have highlighted some inaccuracies and gaps in the calculation of variables to be considered in the efficiency of a Data Center.

Indeed, PUE does not take into account climatic differences and other criteria such as the amount of water used for cooling or whether the plant produces and/or uses renewable energy sources.

Although it was - and still is - a useful reference for encouraging continuous performance improvement, PUE has limitations in considering all the variables of the Data Center infrastructure.

For this reason, various types of measurements have been considered in order to try to overcome these limits and replace the PUE:

- **Green Power Usage Effectiveness (GPUE)** is an energy efficiency measure that considers the amount of sustainable energy used by a Data Center, its carbon footprint per kilowatt hour usable (kWh) and the efficiency with which the Data Center uses energy, in particular, how much power is actually absorbed by computer equipment (in contrast to cooling and other overhead costs). It is an addition to the definition of energy efficiency (PUE) and was initially proposed by Greenqloud.
- **Data Center Infrastructure Efficiency (DCIE)** - is a performance improvement metric used to calculate the energy efficiency of a Data Center; and is the derived percentage value, dividing the power of the computer equipment by the total power of the structure (which shows that it is the inverse of the PUE).
- **Grid Usage Effectiveness (GUE)** - shows the Data Center's network dependency in relation to the IT load.
- **Carbon Usage Effectiveness (CUE)** - CUE is a metric defined by the Green Grid that measures the sustainability of the Data Center in terms of carbon emissions specific to the Data Center. The CUE is a combination of PUE and the Carbon Dioxide Emission Factor (Carbon Dioxide Emission Factor) and is calculated by dividing the total CO2 emissions caused by the total energy of the Data Center for the energy consumption of computer equipment. An alternative way to calculate the CUE is to multiply the annual PUE value of the Data Center by the carbon emission factor for the region as determined by the EPA. CUE units are kilograms of carbon dioxide per kilowatt-hour.

So far, however, none of these new metrics have been able to consolidate as an effective and reliable alternative. Thus, although the PUE value is not perfect at all, it is likely that it will remain the main parameter used to measure the energy efficiency of data centers for the time being.

IMPROVING EFFICIENCY - MODULAR UPS

Over the years, huge progress has been made in cooling technologies, considering that the air conditioning system can represent almost half of the total energy consumption of a Data Center.

The use of intelligent cooling techniques, such as the configuration of separate hot and cold corridors or the use of closing plates and heat exchangers on the rear doors of the racks (Rear Door Heat exchanger- Rdhx), have helped to reduce energy losses for cooling the system.

However, improvements in energy efficiency alone are not enough. As an indispensable part of a data center's infrastructure, the Uninterruptible Power Supply (UPS) offers enormous potential for significant additional savings.

In recent years, the UPS units that were typically installed in the Data Center included large independent systems that only achieved optimized efficiency when feeding loads that reached 80-90% of the maximum power available.

To be able to provide the required redundancy, these units, which had a fixed capacity during the initial installation then tended to be oversized: consequently, in the case of operation at lower loads, the efficiency of the UPS reduces, thus wasting a considerable amount of energy.

In more recent times, the switch to modular UPSs has offered greater efficiency, but also additional benefits such as scalability and greater interconnectivity with the latest generation systems. Furthermore, in the event of replacement of end-of-life UPS installed in the last ten years, the Data Center can take advantage of the technological advances made.

A modular installation consists of several rack-mount units and, each UPS unit connected in parallel, is able to provide the necessary power and redundancy.
This modular approach allows an initial design and installation proportional to the specific load requirements of a Data Center, resulting in less possibility of oversizing or unnecessary capacity - this results in less waste leading to greater efficiency and reduced energy consumption.

Modularity also provides flexibility for facility managers, as it allows modules to be added when required vertically by placing additional modules in the rack equipment or horizontally by installing additional racks alongside existing ones.
This allows you to achieve an integrated scalability or a "pay as you grow" approach (purchase of additional equipment and devices only in case of expansion). Modern modular UPSs are in fact smaller, lighter and generate less heat, and for this reason they need less energy and cooling.

The units are also transformerless, which improves efficiency by an additional 5% compared to conventional monolithic UPS, and can deliver up to 96% efficiency even from 25% of the applied load.

When it comes to preventive maintenance of the UPS, the modular units have the added advantage of being 'hot swappable' (hot replacement): if any module is at risk of failure, or even if it fails, it can be easily replaced without the power protection system of the Data Center being switched off for maintenance.

ECO MODE, UPS MONITORING AND BATTERY STORAGE

The efficiency of modular UPS units can be increased up to 99% when operating in "ECO mode". However, the additional environmental benefits that may arise from the use of the ECO mode shall be carefully assessed taking into account the potential risk of exposure of the

critical load of the Data Center to any fluctuations in the power supply; in fact this type of mode is not always usable, but must be evaluated on a case-by-case basis.

Another area where modular UPS can improve efficiency is its compatibility with energy management software (EMS - Energy Management Systems) and DCIM (Data Center Infrastructure Management) commonly used for automation of many Data Center processes and systems.

In essence, the unit becomes an "intelligent" UPS that continuously collects, processes and exchanges information on system performance such as: operating temperatures, mains supply voltage, UPS output values and residual battery life time. All this information can be used in real-time to optimize the overall performance of the system and identify possible areas to optimize in the future, thus ensuring that the process of reducing CO_2 emissions is continuously improved.

For hyperscale Data Centers with UPS distributed in different locations, cities, or even countries, as well as unmanned facilities without onsite personnel to intervene in the event of a breakdown, this connectivity and ability to monitor remotely is an invaluable tool. It helps to optimize load management and reduce inefficiencies.

The UPS, or more precisely its batteries, has a potential use as a reserve of renewable energy. Many power generation and distribution models are moving increasingly towards Demand-Side Response (DSR), where many large industrial consumers can actively adjust their energy consumption in real-time in response to actual network demand. This mechanism makes it possible to adjust peak supply and/or demand in favour of greater network flexibility and stability, obtaining an economic advantage in return.

For many UPS there is also the opportunity to use lithium-ion (Li-Ion) batteries, which offer a higher power density occupying only half the space compared to a more traditional model of lead-sealed battery (SLA).

In fact, lithium-ion (Li-Ion) batteries can be used to store a surplus of energy generated during periods of low demand, when the cost of the network is lower. The energy that is stored can then be used during peak periods when the costs are higher or in case of an interruption.

Accumulated energy surpluses can be resold to the National Grid on demand, generating significant additional revenue for data center operators. Just think, for example, of the United Kingdom where there is already more than 4 GW of energy stored inside the UPS batteries; this figure could increase exponentially if the Data Center sector increases its implementation of DSR models.

PRACTICAL EXAMPLE OF EFFICIENCY AND SAVINGS

The incredible impact that the improvement of UPS efficiency can have on the reduction of $C0_2$ emissions of a Data Center is demonstrated by a recent project that involved Riello UPS.

Riello UPS was chosen to replace the entire power supply system to protect two Data Centers of one of the largest suppliers of consumer goods in the world.

Installed for the first time in 2007, the existing power protection system consisted of individual 400 kVA and 800 kVA static units that operated at 12-25% of the maximum load. The overall efficiency of the UPS system was on average 92%. But in the Data Center's main distribution room, efficiency was just 89%, resulting in a huge waste of energy.

The large equipment on site required significant cooling, which was expressed in the consumption of about 414 kW of energy per year for an annual cost of about € 320 000. These costs were then added to the expenses to be incurred for the maintenance and operation of the UPS.
The UPS units in the Data Center were large, inefficient and transformer-based, and were replaced with the Riello UPS Multi Power: a more compact solution, modular, transformer-free and with all the features to meet the efficiency requirements of the system.

The efficiency of the UPS subsequently increased from 92% to 96% enabling the customer to make significant savings in overall power consumption.

The annual carbon emissions at the two sites were reduced by 71.89% from 2147 kg to 603.5 kg. Air conditioning costs decreased by 71.81% (saving 297.3 kW of energy per year, corresponding to € 226 000) and it was also possible to achieve cooling energy savings of up to 1.25 million kWh, sufficient to power about 316 average-sized houses for one year.

These cost savings and environmental improvements were achieved in less than half of the previous space, allowing for a 59% reduction in UPS footprint per m^2. In this way, the recovered space can be used for future expansion.

CONCLUSION

Data centres in Europe already consume almost 250 TWh of energy per year and this figure will only increase. We are entering an era in which administrators and managers are increasingly required to be able to do “more with less” and meet the growing demands.

Taking proactive measures to reduce energy consumption and reduce carbon dioxide emissions in data centres makes sense not only from an environmental point of view, but has become a mandatory procedure. For Data Centers of all shapes and sizes, the benefits of adopting the most modern, scalable, more efficient and less expensive UPS upgrade are obvious.

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