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DATACENTERS ENERGY MANAGEMENT CHALLENGE

Strategies to Optimize Energy Consumption

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INTRODUCTION

The exponential growth of digital information has led to an explosion in the demand for information storage and processing infrastructures in data centers. These information processing centers are responsible for approximately 3% of global electricity consumption, representing a significant challenge to both environmental sustainability and the global economy. In this context, optimizing energy consumption in data centers has become a top priority for organizations and governments seeking to contribute to the reduction of greenhouse gas emissions and improve operational efficiency.

Modern data centers are equipped with advanced technologies and highly sophisticated systems, but they also face challenging challenges related to the ever-increasing demand for resources and the pressure to maintain optimal performance levels. The continuous search for new solutions and strategies to optimize energy consumption in data centers is essential to achieve sustainable environmental and economic goals.

The importance of this issue lies in the ability of datacenters to adapt to future changes in the demand for information and communication services, as well as in the possibility of contributing to the construction of fairer and more sustainable societies.

In this article, Atlantic Power Energy explores different aspects of strategies to optimize energy consumption in datacenters, offering perspectives on how to take advantage of the infrastructure that composes them, making the most of them with the lowest energy consumption, thus contributing to a more sustainable future.

DATACENTER ENERGY CONSUMPTION

Datacenters are specialized facilities dedicated to the storage and processing of large amounts of digital data. Their rapid growth and technical evolution have made these information processing centers one of the main consumers of electrical energy worldwide.

Some of the factors influencing high energy consumption in data centers include:

- **Hardware density:** The computing equipment used in data centers is constantly evolving, resulting in increasingly powerful and compact devices, capable of executing several tasks simultaneously by virtualizing machines on a single physical computer. This trend has led to a densification of physical infrastructure, requiring higher amounts of energy and cooling per m^2 to keep them operational.

- **Refrigeration:** Refrigeration and air conditioning installations are critical elements in datacenters, as they allow the ideal temperatures to be maintained to guarantee the stability and durability of computer equipment. However, these facilities also consume a lot of energy.

- **Redundancy:** For security and reliability reasons, many data centers incorporate dual-power and redundant systems, which increases energy consumption and decreases operating efficiency.

These factors, along with others such as the growth of artificial intelligence, augmented reality, the metaverse and other technologies that demand large amounts of information processing, make datacenters a sector with a great contribution to global energy consumption. In addition, the continued growth of the data center industry poses challenges for economic and environmental sustainability, making it

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imperative to develop innovative strategies to optimize energy consumption in these facilities.

Within data centers, each subsystem uniquely contributes to total energy consumption, and its detailed analysis can reveal opportunities to improve operational efficiency and reduce associated costs. The typical distribution of energy consumption across the main subsystems of a data center is explored below:

1. IT Infrastructure

The IT infrastructure subsystem includes servers, storage, networking, and other computing equipment. This subsystem is usually one of the largest consumers of energy in a data center, as these devices require constant power to operate and process data.

2. Refrigeration Systems

Cooling is essential to maintain the right temperatures in the data center and ensure the optimal operation of computer equipment. Refrigeration systems, such as air conditioning units and liquid cooling systems, can account for a significant portion of total energy consumption.

3. Power Systems

Power systems, which include UPS (Uninterruptible Power Supply Systems) and backup generators, are critical to ensuring continuity of power supply in the event of outages or fluctuations in the power grid. These systems also consume a considerable amount of energy.

4. Lighting and Other Auxiliary Equipment

Although they represent a smaller fraction of total consumption, lighting, environmental monitoring, security, and other ancillary equipment systems also contribute to the overall energy consumption in a data center.

5. Electrical Distribution

The datacenter's internal electrical distribution, which includes electrical panels, transformers, and wiring, also consumes energy in the form of resistance and transformation losses.

By understanding the distribution of energy consumption by subsystems in a data center, managers can identify specific areas where measures can be implemented to improve energy efficiency. Strategies such as server virtualization, cooling optimization, efficient use of UPS, and adoption of more efficient technologies can help reduce overall energy consumption and make the data center more sustainable and profitable in the long run.

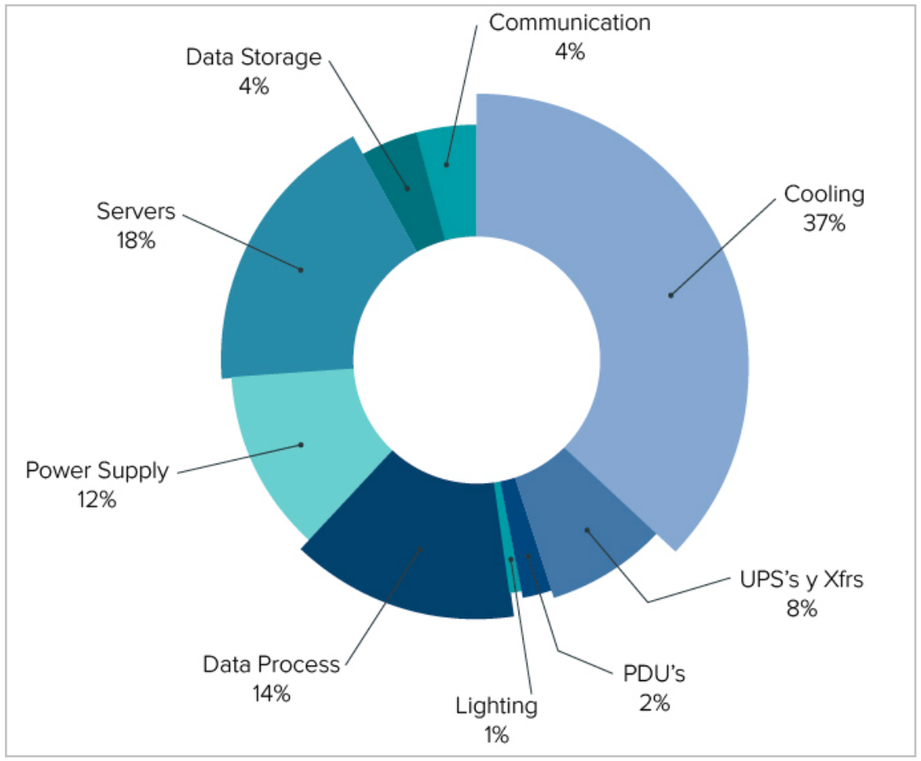

Figure 1.
Distribution of Typical Energy Consumption in a Datacenter

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The IT load (servers, power supplies, processing, communication and storage) occupies only 52% of the total energy consumption, which leaves the remaining 48% to the teams in charge of supporting the IT equipment. Within the subsystems that make up a Datacenter, most of the energy consumed is related to cooling processes. encompassing about 37%. This panorama shows a great opportunity in possible improvements within the equipment that supports the operation, where technological innovation processes seek to implement equipment with greater efficiency, as well as strategies related to reducing consumption while increasing the work done by IT teams.

ENERGY EFFICIENCY METRICS IN DATACENTERS

1. **PUE (Power Usage Effectiveness):** This is the most commonly used measure and is calculated by dividing the total energy consumed by the data center by the energy consumed solely by IT equipment. An ideal PUE is 1.0, which would indicate that all power is being used exclusively to power IT equipment.

$$PUE = \frac{DataCenter\ Total\ Power}{IT\ Load\ Power}$$

2. **DCiE (Data Center Infrastructure Efficiency):** This is the inverse of PUE (1/PUE) and provides a measure of the efficiency of the data center, expressing what percentage of the total energy is used to power IT equipment. For example, a DCiE of 50% indicates that half of the energy is used for IT equipment, while the other half is used for infrastructure.

$$DCiE = \frac{IT\ Load\ Power}{DataCenter\ Total\ Power} * 100\%$$

3. **UEER (Upper Energy Efficiency Ratio):** This metric is used to evaluate the energy efficiency of a data center under partial load. It is similar to PUE but takes into account efficiency at different load levels, which can be useful for evaluating datacenter performance in low utilization situations.

4. **CUE (Carbon Usage Effectiveness):** This metric focuses on the amount of carbon emissions generated by the operation of the datacenter. It is calculated by dividing the total carbon emissions by the amount of energy consumed by the datacenter. A lower CUE indicates a lower carbon footprint associated with the operation of the data center.

5. **WUE (Water Usage Effectiveness):** Evaluates the efficiency of water use in a datacenter, providing information on water consumption in relation to the energy used.

¿HOW TO MEASURE PUE IN YOUR DATACENTER?

Measuring your data center's PUE provides you with valuable insights into how energy is being used in your facility and helps you identify areas for improvement to reduce energy consumption and associated costs. Below is a detailed guide on how to measure PUE in your datacenter:

Step 1: Define the Measurement Parameters

Before you start measuring PUE, it's important to clearly define the parameters to be taken into account. This includes the total energy consumed by the datacenter (including computer equipment, lighting, cooling, etc.) and the energy consumed exclusively by IT equipment.

It is necessary to identify the equipment that is part of the IT load and those that are part of the support infrastructure (UPS, cooling, lighting, security, etc.), defining the measurement points.

Step 2: Install Measuring Equipment

To accurately measure the energy consumption in your datacenter, it is necessary to install suitable measuring equipment such as electrical energy meters on the main and secondary boards. It is useful to have equipment that integrates metering systems, UPS with smart displays, monitor PDU racks, power meters and PDUs.

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Step 3: Collect Data

Durante un período de tiempo representativo (por ejemplo, un mes), registre con precisión los datos de consumo de energía total y de los equipos informáticos. Asegúrese de incluir todas las fuentes de consumo eléctrico relevantes.

Over a representative period of time (e.g., one month), accurately record total energy consumption and IT equipment data. Be sure to include all relevant sources of electricity consumption.

As an example of calculation, we will review the case of a datacenter that has 10 racks and two power arms (2N). In the **Board 1** The consumption in each of the IT racks is detailed, and a total consumption of 39.1kW.

IT Rack	Consumption W
A1	4200,0 W
A2	3250,0 W
A3	3600,0 W
A4	3124,0 W
A5	4800,0 W
B1	4560,0 W
B2	3440,0 W
B3	3750,0 W
B4	3824,0 W
B5	4570,0 W
IT Load	**39,1 kW**

Board 1.
Power Registration per IT Rack

Another value needed to calculate the PUE is the total power consumption of the datacenter, which includes not only the IT load but all the auxiliary subsystems: cooling, lighting, security, NOC, etc. For the calculation of the example, we will assume that there are two power paths, where eachone has a main board with its respective power meter, from which the consumptions recorded in the Board 2.

Description	kW
Ppal path A Board	35,0 kW
Ppal path B Board	37,0 kW
DC Power	**72,0 kW**

Board 2.
Total Datacenter Power

Step 4: Calculate PUE

Once the necessary data has been collected, calculate the PUE by dividing the total energy consumed by the data center by the energy consumed exclusively by the computer equipment. An ideal PUE would be 1, which would indicate maximum efficiency.

For the example analyzed, the PUE calculation is shown in the Board 3 and in the Figure 2.

PUE Calculation	
Description	**kW**
Ppal Path A Board	35,0 kW
Ppal Path B Board	37,0 kW
DC Power	72,0 kW
Potency IT (A + B)	39,1 kW
PUE	**1,8**

Board 3.
PUE Calculation

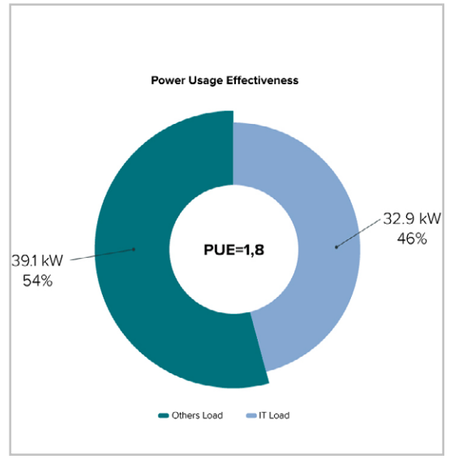

Figure 2.
PUE Chart for Case Example

Step 5: Analyze Results and Take Action

Once you've calculated your PUE, analyze the results obtained. Identify areas where energy efficiency can be improved, such as optimizing cooling, upgrading outdated equipment to more efficient ones, or implementing virtualization technologies.

Measuring your datacenter's PUE not only allows you to assess its current energy efficiency, but also gives you the opportunity to implement significant changes to reduce your environmental impact and operating costs.

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For the example being analyzed, a PUE of 1.8 indicates that for every unit of energy used by IT equipment, an additional 0.8 units are required for operations such as cooling, lighting, and other ancillary systems. It suggests that a significant proportion of total energy goes to tasks not directly related to IT equipment, indicating scope to improve the energy efficiency of the data center. Reducing PUE through measures such as optimizing cooling systems, upgrading equipment, implementing virtualization techniques, and using more efficient technologies can help decrease overall energy consumption and make the data center more sustainable and profitable in the long run. In this specific case, it is necessary to analyze each of the subsystems more deeply to find the possible point of greatest energy savings.

STRATEGIES TO OPTIMIZE ENERGY CONSUMPTION IN DATACENTERS

Optimizing energy consumption in a data center not only reduces operating costs, but also contributes to environmental sustainability. Below are specific strategies for optimizing energy consumption in each key subsystem of a data center:

1. IT Infrastructure

- Server Virtualization: Consolidating multiple physical servers into one virtual server reduces the amount of hardware needed, decreasing power consumption and improving efficiency.

2. Refrigeration Systems

- Hot/Cold Aisle Confinement: Separating hot and cold aisles helps direct airflow more efficiently, reducing the load on refrigeration systems.
- Equipment Upgrade: Replacing outdated equipment with more energy-efficient models can significantly reduce energy consumption.
- Use of Efficient Technologies: Using cooling systems with dynamically modulated compressors, electronically controlled (EC) fans and monitoring options allows for reduced energy consumption within the datacenter.

** Atlantic Power has equipment specially designed to decrease the power required, while maintaining the reliability of your data center.*

Atlantic Power with its MDCs (Micro Data Center), offers the following customized features:

- Modularity with the capacity to grow according to demand.
- Easy to assemble and grow in the future because it can be assembled like a lego, which facilitates installation in rooms that are difficult to access or the possibility of moving to another site if necessary.
- Option of redundancy in power and air conditioning.
- Can be operated with rack-mount air technology or with in-row airs.
- Possibility of operation with UPS power equipment and rectifiers with a wide power range.
- Single-phase, three-phase, and modular UPS options are available for standard 19” cabinet mounting.
- Operation with different types of single-phase and three-phase voltage, in both types 380V/220 and 208V/120V 50/60Hz
- The MDCs have internal air distribution through cold aisles and return through hot aisles.
- They are the ideal choice to provide critical load equipment with a protected environment with regulated energy and precision climate control.
- 3rd level access control at all doors.
- DCIM monitoring of all system operating parameters.

Figure 3.
Atlantic Power Hall Confinement & Micro Data Center

Figure 4.
Atlantic Power Precision Cooling Systems

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Another type of measurement that helps to know the behavior of the room is to use CFD (Computational Fluid Dynamics) software, as it allows, through the integration of variables easily measurable in the field, to simulate the operation of HVAC systems and find points for improvement.

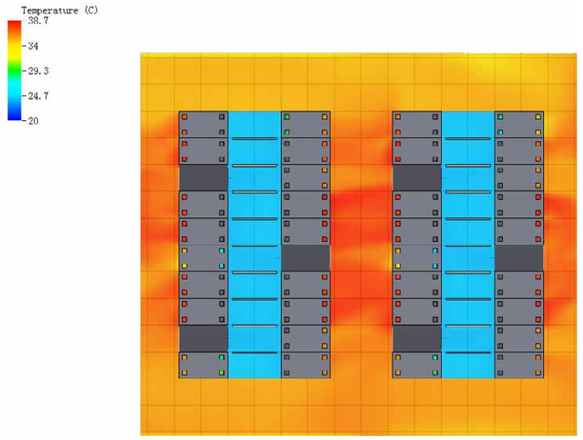

Figure 5.
Example of Simulation with CFD Software

3. Power Supply Systems (UPS)

- Design Optimization: Design redundant UPS systems with adequate capacity to avoid oversizing and unnecessary losses.

- Active Load Management: Implementing smart systems that adjust the load according to actual demand can improve energy efficiency.

- Use Modular UPSs: That allow custom growth and high efficiency at partial loads.

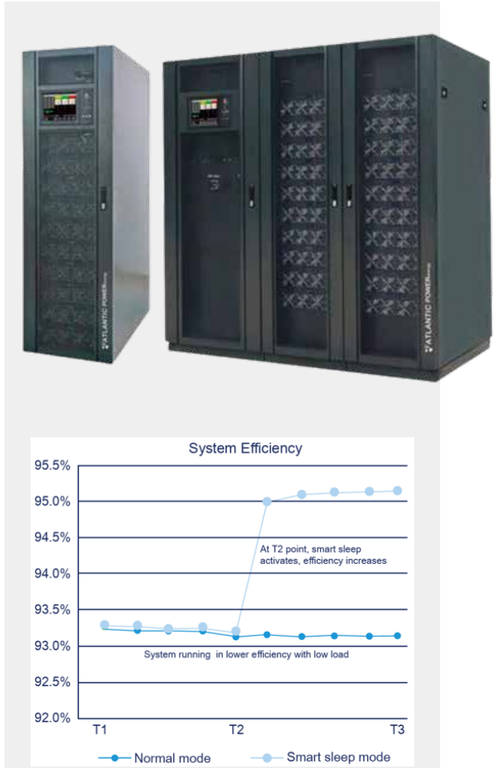

Figure 6.
Typical Efficiency of ATP Modular UPS with Smart Sleep

* *Atlantic Power Modular UPS with over 95% efficiency and Smart Sleep function, to improve efficiency at partial loads.*

4. Batteries

- Adoption of Lithium-Ion Batteries: Lithium-ion batteries are more efficient and have a longer lifespan than traditional batteries (VRLA), which reduces energy consumption. In addition, its total cost of ownership (TCO) is lower compared to other technologies.

Figure 7.
Atlantic Power UPS Battery Bank

5. Energy Monitoring and Management

- Implementation of Continuous Monitoring Systems: Using advanced tools to monitor energy consumption in real time allows you to identify opportunities for improvement and take corrective action quickly.

- Constant Analysis and Optimization: Conducting regular audits and detailed analyses of energy consumption helps identify patterns, trends, and areas where further improvements can be implemented.

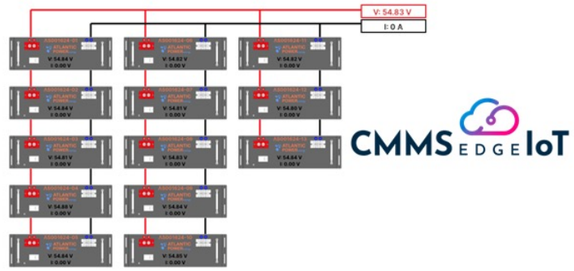

Figure 8.
Asset Monitoring with CMMS Edge

CMMSedge IoT (Internet of Things) is a proprietary maintenance software platform, based on conditions with which you can monitor in real time the variables with which critical assets operate. You will be able to obtain readings, alarms, historical behavior graphs, customizable reports and event reports, you will be able to configure alarms associated with work orders with the aim that the technical service team anticipates a failure and thus avoid future problems and unscheduled stoppages.

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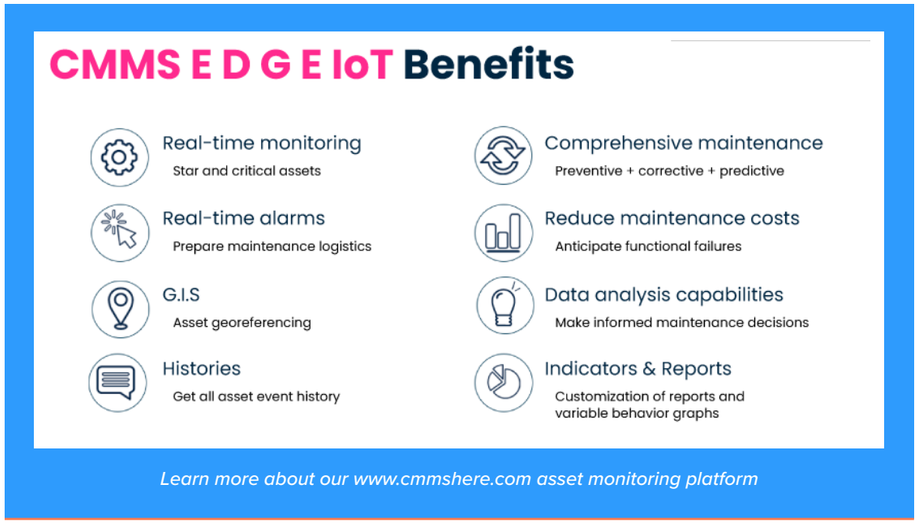

CONCLUSIONS

To improve energy efficiency in data centers, it is critical to implement innovative strategies in each key subsystem. By understanding the distribution of power consumption by subsystems, such as cooling, servers, power supply, among others, administrators can identify specific areas where measures can be implemented to reduce energy consumption. Strategies such as server virtualization, cooling optimization, efficient use of UPS, and adoption of more efficient technologies are critical to achieving a more sustainable and profitable data center in the long term.

The selection and correct installation of the infrastructure that supports the operation of the datacenters is crucial in efficiency metrics. Efficient part-load UPSs with technologies that intelligently manage the load have to be considered within the design and implementation processes of data centers. Lithium-ion batteries allow for a higher energy density, saving space, in addition to integrating battery management systems (BMS) that will allow efficient management of different operating variables.

On the other hand, it is necessary to have refrigeration equipment manufactured with electronically controlled fans and compressors that can vary their capacity according to the demand for thermal load to be dissipated. At this point, it is also important to have aisle confinement systems, so that the efficiency of air operation is increased by increasing the temperature delta between the supply and return temperature.

Integrating all this infrastructure into an asset monitoring and management system will allow you to know the consumption of each subsystem in real time, and identify patterns, trends and points for improvement, in addition to all the benefits offered by the integrated monitoring system.

In short, by implementing innovative strategies, improving energy efficiency metrics, and using high-quality products, data centers can significantly improve their energy efficiency, reduce their environmental impact, and optimize their operations in the long run. The combination of advanced technologies, sustainable practices, and proactive management is critical to achieving an efficient and sustainable data center in the future..

About Atlantic Power Energy

With more than 15 years of experience in the sector, Atlantic Power stands out as a leading manufacturer of UPS, precision air conditioners, VRLA and Lithium-ion batteries, generators, switches and reclosers for MV, data center infrastructure and asset monitoring. With an extensive track record of delivering reliable and efficient energy solutions throughout North, Central and South America, as well as the Caribbean, our company prides itself on offering not only high-quality and efficient pro-

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ducts, but also exceptional technical service that ensures customer satisfaction at all stages of the process, from initial consultation to installation and ongoing maintenance.

Our equipment is renowned for its high reliability and low failure rate, making it the preferred choice for a wide range of critical applications in various industries. At Atlantic Power, we are committed to providing state-of-the-art energy solutions that exceed our customers' expectations and ensure the continuity of their operations at all times.

We continue to innovate to provide our customers with state-of-the-art products with the best standards of safety, quality and efficiency.

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