InterNetX

E-Paper

GREEN PAPER.

How green can Data Centers be?



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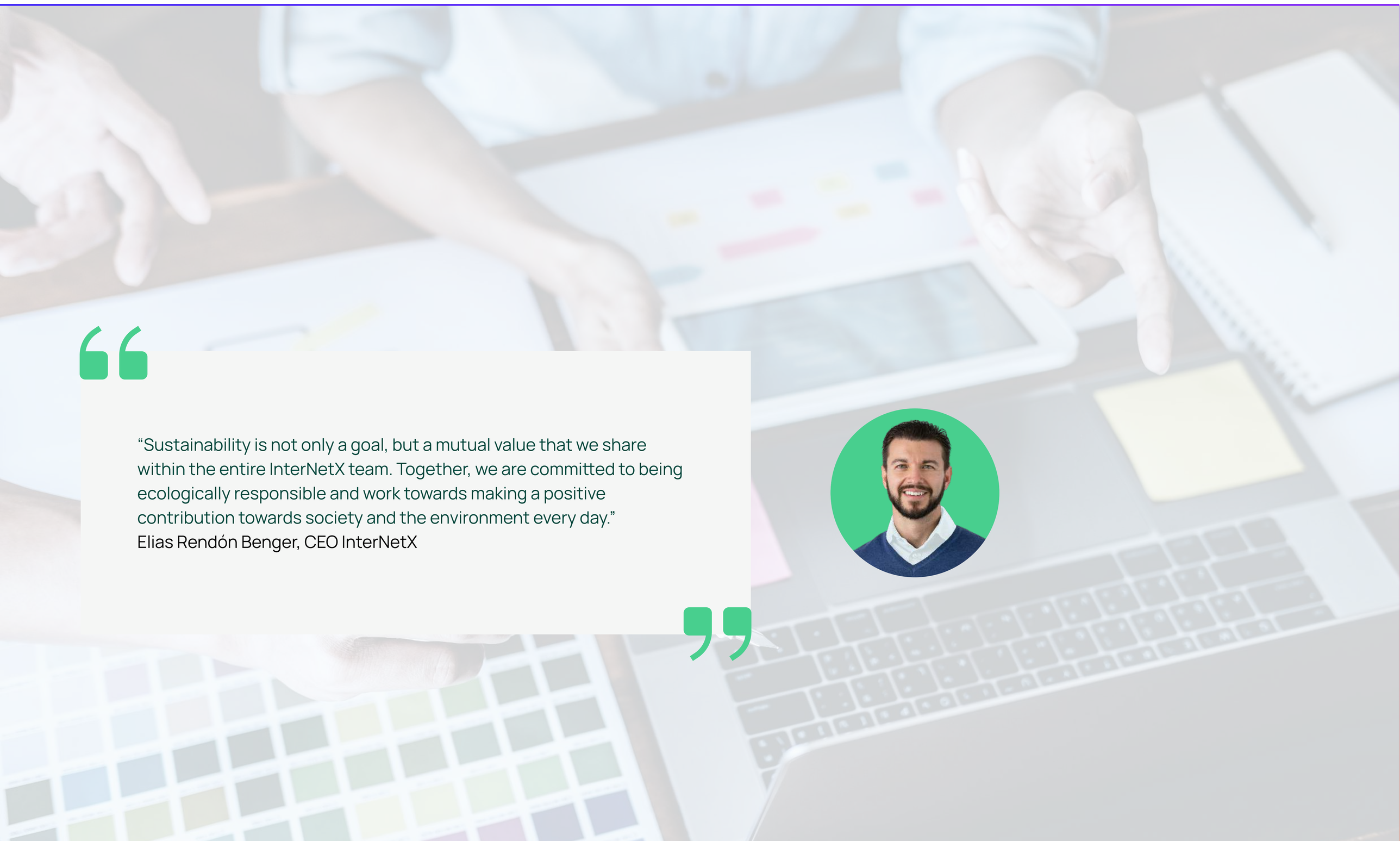


Executive Summary

In light of the ever-increasing demand for energy and the corresponding impact on the environment, it is essential that we develop and implement sustainable IT solutions.

This also applies to hosting and data centers are not exempted. This green paper examines the economic and ecological significance of data centers and searches for possibilities to operate them in a manner that is more sustainable. Can hardware actually be “green” and can it be run in an ecologically responsible way?

We look at measures witch can be implemented to reduce energy consumption, for example, how the use of appropriate software or the optimal utilization of capacity can enable energy-efficient forms of usage. We will consider the challenges associated with moving to sustainable and climate-neutral data center operations. This e-paper will conclude with a view to future developments and trends that aim to improve the environmental sustainability of data centers.



“Sustainability is not only a goal, but a mutual value that we share within the entire InterNetX team. Together, we are committed to being ecologically responsible and work towards making a positive contribution towards society and the environment every day.”
Elias Rendón Benger, CEO InterNetX



CHAPTER
01

ENERGY CONSUMPTION AND SUSTAINABILITY IN DATA CENTERS

It's not exactly news to IT experts. Data centers form the backbone of the IT industry. For decades, they have been evaluated according to their performance. However, many companies are taking a fresh approach these days. The idea of **green data centers** is pointing the way forward and many providers are already onboard. It is no longer considered utopian to combine performance, energy efficiency and ecological goals. Green data centers are the future. Although they will continue to form the basis for economic success, their enormous energy consumption is far too high. The demand for computing capacity, storage and data transfer is growing exponentially – and the development of mobile services, the "internet of things" in companies and the widespread use of AI is only just warming up.

According to the **email statistics report**[1] of the Radicati Group, **347 billion emails** are sent through networks daily, passing at least two servers and being handed from router to router and from switch to switch, before finally being delivered to the recipient. The number of visited websites exceeds the number of emails sent by far and requires the utilization of even more computing power and networks. These systems require large volumes of electricity for production, operation and cooling, resulting in an **enormous burden on the environment**, something which Consumers are often entirely unaware of. As efforts to reduce our environmental impact are gaining traction, there is also a growing awareness that the operation of data centers comes with a surprisingly large potential for saving valuable resources.

Apart from private aspects, the internet is probably the most important medium for the **economy, research and the financial world**. The majority of users are oblivious of the technical effort required to ensure that these services and websites function.

Whereas data centers were once just rooms in which a few servers performed their duties, these days they are vast faciilities that house thousands of devices and stretch over hectares. The question of environmental friendliness is not a new issue in this regard. For over 25 years, hardware has been labelled with logos and certificates that imply to users that the device is energy efficient. For example, the "Energy Star" is still displayed when powering up some monitors, conveying hte message that a device consumes less energy in standby mode than when operational and that it automatically switches to standby after a certain period of inactivity.

In order to fashion an effective statement about energy and environmental properties that can be used for marketing purposes, providers therefore resort to using their own labels, which generally do not display comparable values, but merely describe the general company philosophy. The value of such labels only becomes apparent upon closer inspection. Among a lot of vague promises, there are also instances that list clearly formulated principles that clearly focus on environmental protection and include auditable and sustainable measures.

Previously, the most important marketing instruments with regard to data centers were high figures. High speed. More storage. Larger hard drives. Faster data transfer. Lower costs. These were all more important than implementing a thrifty or sustainable manufacturing process. However, priorities have shifted and both **consumers and policymakers are increasingly demanding that providers place more value in lower consumption, longevity and environmentally conscious processes**. Well-designed ecological concepts are no longer considered a bonus, but fundamental product characteristics that are expected by customers and accordingly must be implemented and marketed.

[1] The Radicati Group, Email Statistics Report, 2021, page 3

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THE BIG QUESTION: CAN HARDWARE REALLY BE “GREEN”?

Most data centers use standardized hardware. Depending on the construction and preference of the manufacturer, there are differences in form and design. However, all use similar hardware at the core. Standard CPUs from Intel or AMD are found alongside standard memory bars on standard boards.

This is where companies can first take advantage of the potential for enhanced energy efficiency. The **selection of these hardware components** can make a difference of up to 50 watt at the same computing performance. Differences of this scale can quickly add up to more than 400 kilowatt hours per year – and that’s for each individual server. With these 400 kWh, one person can take warm showers for an entire year. InterNetX uses servers from Dell EMC, which have a significantly longer product life span than devices from comparable providers.

Hard drives and **SSDs** have less energetic leeway but have a significant impact on a device’s energy balance. Hard drives require more electricity and cooling than SSDs, but are less expensive, store considerably more data and reach a long period of use, depending on the utilization. Furthermore, modern components are much less temperature-sensitive and are also stable when operating in warmer environments. Apart from reducing their direct consumption, it also means less cooling is needed.

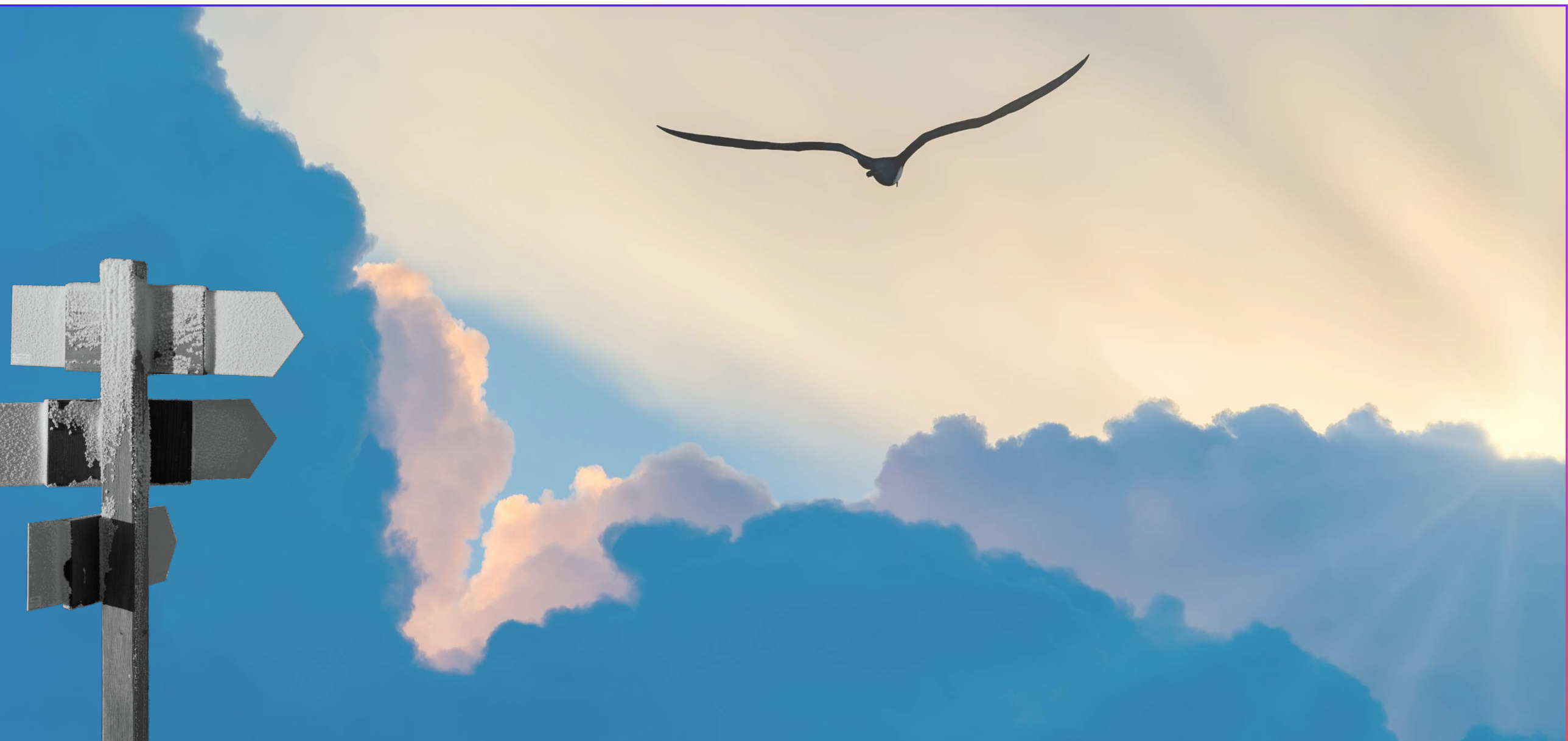
In order to run a data center efficiently, it is essential to rely on state-of-the-art hardware. Old, inefficient components should be identified as such and replaced with new, more efficient ones. This ongoing process ensures that energy is not wasted unnecessarily.

Info

InterNetX uses servers from Dell EMC, which have a much longer service life than hardware from comparable suppliers.

Hardware should by no means be disposed of prematurely. Life expectancy is often an underestimated component of the overall picture. In addition to inexpensive materials such as silicon, manufacturing memory, processors and other system components also requires rare earth metals, which are difficult to procure, as well as large amounts of water and energy.
If a system can no longer be used as an efficient server, it may make sense to reassign it to other tasks that generate less load.

Reusing or recycling hardware components after an energy audit makes perfect sense from an ecological and economic point of view. This allows loads to be distributed and resources (power, material, etc.) to be used sustainably and efficiently.



06

HEAT AND HUMIDITY AS CRITICAL FACTORS

A data center houses hundreds or thousands of devices whose waste heat must be dissipated reliably and as environmentally friendly as possible. The key is to strike a balance between heat transport and energy consumption.



The higher the ambient temperature in which a server is operated, the higher the probability of a defect. For a long service life and good profitability, the temperature must remain within a defined range, ideally at room temperature. The further the temperature of a room has to be lowered, the more energy is consumed.

Conventional **cooling units** use refrigerants and compressors to generate cool air that is pumped into the server rooms. Today this process is astonishingly efficient. This is made possible by innovative refrigerants that replace the CFCs used in the past. These refrigerants no longer have properties that are harmful to the ozone layer, but they still cause greenhouse gases that contribute to global warming

Structural measures can significantly increase the effectiveness of an air conditioning system. A smart layout of walls, ducts and server cabinets keeps the distances over which heat must be transported short. Water transports heat much better than air, which is why "open pipes" are not uncommon in server rooms. What works well in a home-built gaming PC also boosts cooling performance in a server rack, which is why server cabinets are often equipped with a network of water hoses and heat exchangers.

The **architecture of a data center** and the **building materials** used can be equally helpful in removing heat from rooms with as little effort as possible. A stream of air is generated following the chimney principle, and the warm air is replaced by fresh air with very little energy input.

However, not all environmentally friendly concepts of modern house construction can be applied to a data center.
Clay bricks contribute to a good indoor climate and help with cooling but get in the way of meeting other important requirements for a secure server environment.
Open windows certainly help with climate control but present a poor argument when it comes to dust, humidity, insects, criminals and other factors hostile to computers.

Lowering the **temperature** requires significantly more energy than keeping it at a constant low level. Devices also work better if the ambient conditions do not change.
Modern cooling concepts separate areas with cooled and non-cooled air so that only the interior of the server racks is actually air-conditioned and not the rooms in which they are located.

Measures against external sources of disruption

Structural measures:
intelligent positioning of walls, pipes and server cabinets

Architecture and building materials used:
dissipate heat using the chimney principle

Temperature:
ideally room temperature, if necessary cooled by conventional cooling units

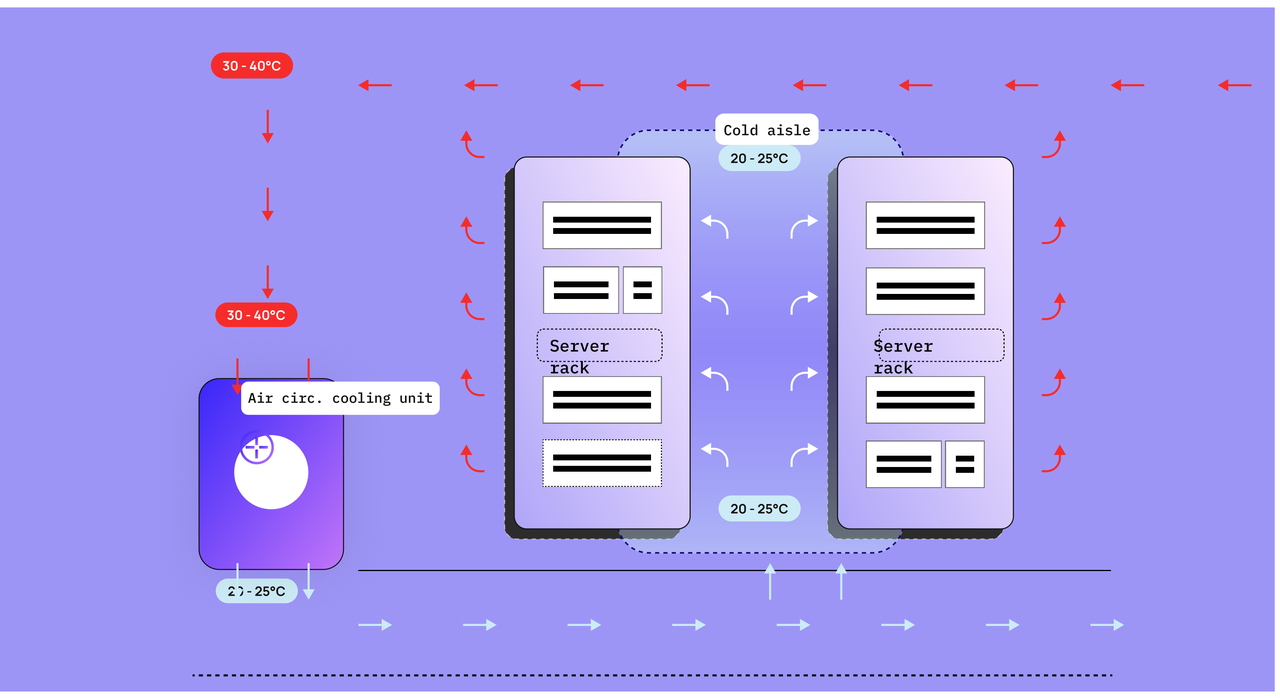
GREEN DATA CENTER @ INTERNETX

The InterNetX data center, for example, is not as cold as one might expect. The idea behind the **cold aisle containment** is that the cold air flows through the servers, cooling them constantly. The waste heat is expelled into the data center. This dramatically reduces the volume of air that needs to be cooled, and temperature fluctuations in the air have virtually no effect on the cooled systems. This also saves energy because the area that needs to be cooled is smaller.

Even more energy can be saved in the InterNetX data center by almost tripling the room height: The waste heat rises to the top and can be vented from there without affecting the equipment on the ground. In addition, maintenance work on the cooling system does not have to be carried out on the data center floor. **Cooling units** located in the so-called "**CoolW@ll®**" chill the air, which is then directed back down to the servers.



With **server housing**, often also known as **colocation**, the data center only provides the space and the technical connection. Customers operate their own hardware and only use the data center's premises for this purpose. This is particularly interesting for customers who use very specialized servers, such as Macs. Or for those who want to have full control over the hardware for security reasons. Cooling concepts for such diverse requirements present new challenges for data centers. Separate areas are therefore often provided for housing, offering more flexible climate control, but at the cost of higher energy consumption.



Cold aisle containment (cross section)

But heat is not the only energy issue: In addition to temperature, **humidity** has influences the operation and life span of the equipment. Wherever mechanical things move, such as the countless small fans, dust also plays a role. Great care is placed on removing humidity and dust from the air through air conditioning and filter systems. The best and simplest strategy to minimize this effort is to keep the air as dry and dust-free as possible. Airlocks and similar structural measures make a significant contribution to not wasting energy, removing heat, moisture or dust that is brought in by people entering the building.

Server Housing & colocation in the InterNetX data center

Our many years of experience and multitude of services offer numerous advantages:

1. Operating your own hardware
2. Redundant broadband network connection
3. Redundant power supply including UPS and diesel generator
4. Redundant air conditioning
5. Fire prevention
6. Video surveillance
7. International certifications
8. 24/7 access to your own systems via biometric access controls
9. 24/7 monitoring of infrastructure

Probably the most effective measure to save energy on cooling is to avoid generating heat in the first place. The fact that computer hardware heats up while working is a side effect of the transistors installed. The more they switch back and forth between their states, the more energy is consumed for the required process on the one hand, and emitted in the form of unwanted heat on the other.

Clock frequencies

A **high clock frequency** always entails a high level of energy loss due to unwanted heat generation. In order for the transistors in chips to work reliably at high clock frequencies, the applied voltage must also continue to rise, which in turn leads to increased heat dissipation

In special laboratory environments, clock frequencies of 10 GHz and more can be achieved with the help of complex cooling systems. While the computing power grows linearly, i.e. also doubles at double the clock frequency, the loss in the form of heat and electricity grows exponentially. The clock frequency is a good measure of how fast a processor can perform its calculations. However, it does not express how efficiently calculations are performed. Many tasks consist of countless smaller subtasks that can be completed independently of each other.

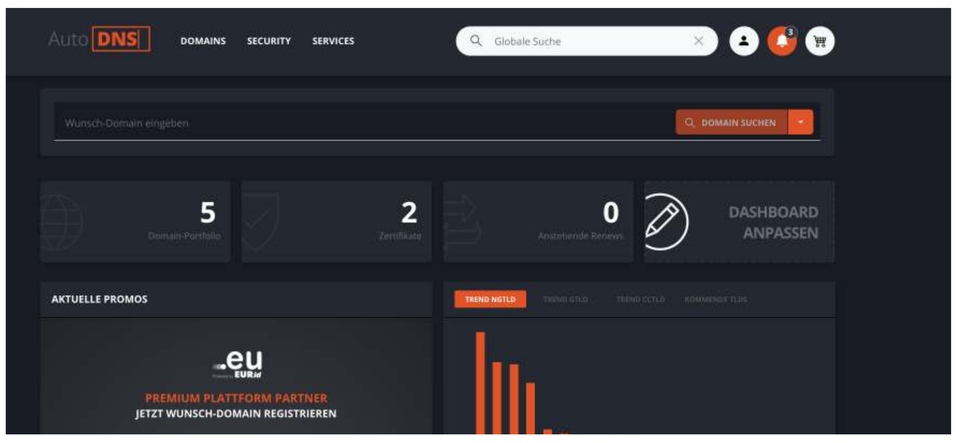
This is why in recent years, chips have been developed and used that have several slower processors on board instead of one extremely fast one. These CPU cores are complete processors that share the resources of a server. This "trick" ensures that both performance and losses increase linearly. In addition, parallel tasks are also truly processed in parallel, so the actual speed achieved can even be faster, depending on the programs running.

Consumers do not always know these technical details or can adequately assess the technical requirements. Advance consultation helps at this point to find the most suitable solution with the greatest possible environmental compatibility. In order for applications to benefit from the concept of multiple CPU cores, they must be specially designed for this purpose - demanding task for programmers.

EXCURSUS: SOFTWARE HAS AN IMPACT TOO

Updates to software and operating systems may include improvements to the way cores and other system resources are used. From an ecological point of view, it makes sense to always use up-to-date software. There are other reasons to take a closer look at the software used as well.

Computers have ways of slowing down or even shutting down some components when they are not or very rarely needed. While a server is waiting for the next task, large parts of the CPU, RAM and data carriers are switched off. These power-saving measures are designed to allow the components to either be quickly reactivated or to consume almost no energy at all. If a device is put to sleep too deeply, it no longer consumes power, but it takes a long time to get back into operating mode.



AutoDNS Dark Mode

It is up to the **operating system, firmware and hardware** to find the right balance. Old software that may not even be compatible with the power-saving features of the hardware is wasting valuable performance and energy. One way in which InterNetX addressed this issue is by adding a dark mode to its **AutoDNS domain management software**. Using the dark mode means that millions of small diodes in a screen do not have to shine as brightly. This reduces the power consumption of devices with OLED screens and ensures a longer battery life on numerous end devices.

EXPERT TIP

The hardware's field of application is crucial when it comes to deciding whether a few very fast **CPU** cores or several slower cores form the optimal basis.



CHAPTER
02

GREEN DATA CENTER. OPTIMAL UTILIZATION AND CONTAINERS AS PART OF A SOLUTION

Server workload and containers

The server workload is subject to large fluctuations over time. And different subsystems have different requirements: some need more memory, and others use more CPU resources. The concept of containers is used to optimize the utilization of existing hardware. Several independent environments run on one server. These environments can belong to different parties or fulfill different tasks. This better utilizes the existing hardware because the work of two or more servers is performed on one device and the containers can be quickly moved to more powerful hardware if required.

If a container requires more resources it can be run on a more powerful machine for as long as the increased requirements persist. Alternatively, several instances of the same container can be started, which can be switched off again as soon as the load drops. This has advantages for both the data center operator and the customer. Customers gain flexible access to almost unlimited performance, but only pay for the resources they actually use. At the same time, the data center can ensure a balanced use of resources.
From an ecological point of view, **cloud computing and the cloud** make perfect sense. Instead of building and maintaining your own infrastructure of servers, networks and services, you rent an existing one and digitally configure it to meet your needs.

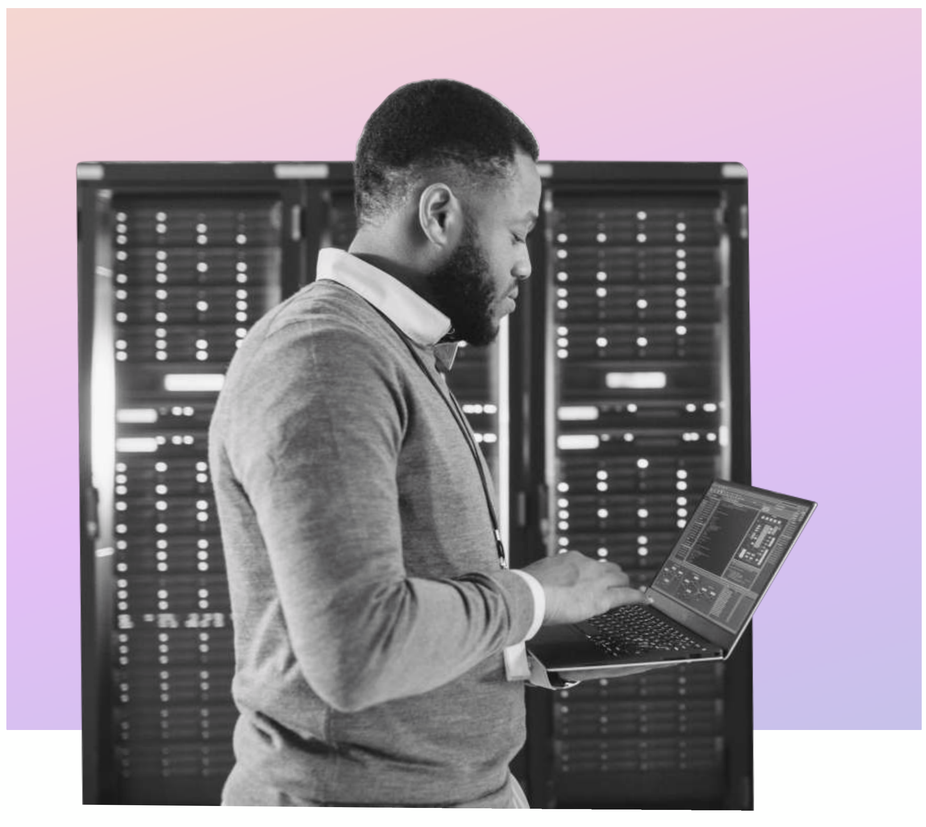
SUSTAINABLE SECURITY MEASURES



While 20 years ago a well-visited web server handled 20,000 page requests per day, today this is the load handled by a moderately busy system in one hour. In addition to the number of users, the type of data and the way it is transported has also changed dramatically. The requirements and amounts of data have grown enormously. Moreover, websites are no longer static HTML files consisting of pure text and a few images. Today, they are composed with the help of databases, content is loaded from different servers, images and videos are transformed in real time and encrypted with TLS/SSL. Emails no longer consist of pure text, but contain images and complex presentations. The very ease of access and considerable gain in convenience offered by the use of digital devices also brings with it a number of problems. Not least in terms of energy consumption.

In the past, malware was almost exclusively distributed via infected floppy disks, but today it spreads automatically via networks. The effort required to detect and ward off such threats has increased dramatically in recent years. In addition to **virus scanners** that transparently and automatically examine files, emails must be scanned and filtered for dubious advertising offers. **Denial of service attacks**, or **DDoS attacks** for short, which have become increasingly common, cause a huge load on the targeted servers. Apart from the economic damage to the operator, this results in an equally enormous waste of energy. The data center infrastructure therefore bears an ever greater responsibility in defending against such attacks.

On the one hand, effective protection naturally is essential for companies that want to know that their servers are safe. On the other hand, it reduces costs for energy, cooling, data transport and unnecessary support - all of which should be avoided in the interest of environmental protection. But **firewalls, intrusion detection systems and virus scanners** also use up resources. It is significantly more efficient to perform these tasks centrally for many servers at once, rather than thousands of times at many different locations. Protecting the transmitted data from being viewed by third parties is an important issue not only in the business environment.



SECURITY IN THE INTERNETX DATA CENTER

- 24/7 on-site staff
- Freestanding building, inconspicuous location
- Biometric access control system
- Room monitoring via motion detectors and cameras
- Closed circuit video surveillance system in the building
- Optimal protection against water, radiation and vandalism thanks to location on the 1st floor

FIRE PROTECTION IN THE INTERNETX DATA CENTER

- Early fire detection system (VESDA) via fire alarm panel (type: Zetfas)
- F90 fire walls and doors
- Optical smoke detectors / dual detectors / ionization detectors on the ceilings and in the raised floors
- Compressed gas extinguishing systems (type: INERGEN or nitrogen)



Almost every bit transmitted unencrypted can be stored and analyzed by third parties, which is why data encryption is becoming increasingly important. But effective **PKI encryption** is no simple matter and can not be achieved without consuming additional energy. Despite relatively simple mathematical operations, applying and generating keys and actually encrypting them is very time-consuming and increases the load on processors. The quality of the protection depends primarily on the length of the key. If it is too short, it can be "guessed" by trial and error; if it is too long, the complexity becomes so great that even calling up a web page becomes a test of patience.

This is where special circuits integrated into modern processors provide a remedy - at least in part. They contain important algorithms such as **RSA** (an acronym for its creators Ron Rivest, Adi Shamir and Leonard Adleman) or **AES** (Advanced Encryption Standard) and do not have to use the much more universal but inefficient arithmetic units.

Unfortunately, the protocols on which the internet is based were designed without any security mechanisms in mind. **IPv4** offers neither encryption nor authentication - any such application must be painstakingly mapped through multiple layers of transported data.

IPv6, the new version of the protocol, on the other hand, was designed with built-in security features. **VPN connections** and other modern protocols like **HTTP/2** use available resources much more economically.



CHAPTER

03

WHAT THE FUTURE HOLDS

The **demand for green data centers, servers and computing capacity** will continue to grow in the coming years, presenting many providers and companies with new challenges. Politicians and society see companies as having a responsibility to actively promote environmental protection. Switching to a green data center not only helps companies to meet market demands, but may also have a positive impact on their brand and image.

Optimally designing a sustainable data center, maintaining servers, and efficiently using existing hardware can help reduce consumption and the environmental footprint. Using power from renewable energy sources is another new opportunity to improve the co2 balance. As a company in a modern, future-oriented industry, it is also important to set a good example - despite the possibility of higher costs per kWh. **Smart power monitoring** across all components and throughout the data center building can help recoup these costs.

> “With a central power supply for individual servers, within racks for example, the hosting sector can be made even more sustainable in the future.“
>
> Carsten Schöne, Team Leader Data Center, Monitoring and Network



flow

In the future, data centers should be operated exclusively on green energy, and systems should be designed to be environmentally friendly. Let’s create that future together.

Applying **artificial intelligence (AI)** helps improve energy efficiency, reduce carbon emissions, enable predictive maintenance, increase safety, and automate routine activities. A modular and scalable design may allow resources to be used more efficiently and avoid unnecessary idle time. Another option is a sustainable architecture using renewable energy, green rooftops, and **energy-efficient materials**.
Advanced hardware and cooling technologies or waste heat reuse can help to reduce energy consumption. In addition, data centers could employ water reclamation and reuse technologies to minimize water consumption. **Recycling electronic components** and using sustainable materials can further reduce resource consumption.

GREEN POWER AS THE BASIS

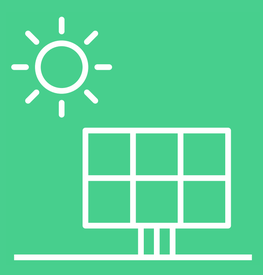
Despite all the optimizations, data centers - even green ones - naturally consume a lot of energy. The simplest and most effective way to use power efficiently is therefore for data center operators to tackle the problem themselves. Green data center operators sometimes leverage the option of powering their data centers with **self-produced solar electricity**. The choice of location according to hours of sunshine per year plays a role here.

Some energy concepts rely on coupling solar systems with power storage, and as a result, partially on a decentralized energy supply. However, the share of self-generated energy can only partially cover the demand.

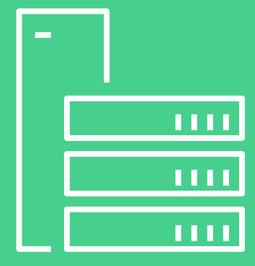
Data center operators must be able to guarantee their customers a steady power supply and must therefore also resort to conventional power from the grid and other power suppliers. But there are now many **low-cost green energy suppliers** that ensure a good operating balance even with high power consumption. **Wind and hydroelectric power** also play an important role in promoting renewable energy and reducing greenhouse gas emissions.



THE INTERNETX DATA CENTER



Power is generated on the roof of the data center during an average of 1,777 hours of sunshine a year.



Due to the triple room height, the waste heat rises upwards without affecting the equipment.



Cold aisle containment reduces the volume of air that needs to be cooled.



Additional energy requirements are met entirely through hydroelectric power..



The thermal effect on the roof of the data center is used for cooling.



Use of Dell EMC servers with a long service life.

Our data center in Munich has been certified in accordance with ISO/IEC 27001 and is powered 100% by environmentally friendly hydropower (TÜV-SÜD certificate). A photovoltaic system is operated on the roof of the data center to meet the energy requirements for climate control. Unfortunately, further expansion is not possible due to structural and regional reasons. The data center has an average PUE (Power Usage Effectiveness) value of 1.2, which is considered very efficient.

The climate circuit in the data center works with a closed water circuit, so no water is consumed for cooling the server rooms. We use part of the waste heat generated in the building ourselves. We are currently in talks with the city of Munich about supplying the heat externally, so that it can be used in nearby residential areas in the future. In the area of server virtualization, we are constantly working to achieve the highest possible efficiency and utilization on our servers using the latest technologies in both hardware and software.

ix.biz/datacenter

InterNetX

RACKS4ROOTS:
WHEN SUSTAINABILITY TAKES ROOT

"We committed to using green power ten years ago, and EMC and InterNetX were the first in Germany to run data centers this way."
Bernhard Huter, CEO EMC Home of Data



Together with EMC Home of Data, InterNetX set a target more than ten years ago:

InterNetX set a target more than ten years ago: to operate a data center using green energy. In other words, with power generated from renewable energy sources. A lot has happened in those ten years, and the data center in Munich was the first in Germany to operate carbon-neutrally - and continues to do so.

To further improve the ecological footprint, EMC Home of Data launched Racks4Roots. The idea is to plant a tree for every server rack in the data center each year. In 2022, more than 10,000 saplings were planted around Lake Spitzing, Germany. InterNetX has also been at the forefront of supporting the project, and will plant 5,000 trees this year - ten times as many as last year.

In the **Snapshot Podcast, Bernhard Huter** tells us more about the planting campaign, how he ensures maximum energy efficiency and waste avoidance in the data center, and where he sees the IT industry five years from now.



SNAP
SHOT

Sources

The Radicati Group, Email Statistics Report, 2021, page 3

Energy Star, www.energystar.gov, retrieved on 25.05.2023

EMC Home of Data, www.emc-homeofdata.de, retrieved on 25.05.2023

About.

With more than 4 million domains under management, InterNetX is one of the leading providers of white-label hosting and domain products. The domain experts provide ISPs, telecoms and agencies with domains, shared & dedicated hosting products, security solutions and network connectivity, as well as TLS/SSL and S/MIME products from all relevant CAs.

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