DATA CENTERS & THE ENVIRONMENT

2021 REPORT ON THE STATE OF THE GREEN DATA CENTER

ENERGY-EFFICIENT DATA CENTER TECHNOLOGIES DEPLOYED WORLDWIDE COULD BE EQUIVALENT TO ONE TREE'S CARBON-SEQUESTERING CAPACITY FOR EVERY PERSON ON EARTH

SUPERMICRO

Dear IT-Innovator,

Since our inception and throughout our rapid growth, Supermicro has grown to become an industry leader in responsible IT by helping our customers optimize their data center power utilization to preserve our vulnerable environment while saving on operating expenses. Supermicro's 2020 survey findings validate this essential social responsibility: Supermicro's resource-saving solutions enable enterprise, HPC, cloud and service providers, and "IT Innovators," like yourself, to deploy their workloads more rapidly and efficiently while reducing their Total Cost to the Environment (TCE). Worldwide deployment of these technologies would be equivalent to planting one tree for every person on earth. We encourage you to review our report to learn more and take action to reduce your expenses.

Charles Liang
President and CEO of Supermicro

DATA CENTERS & THE ENVIRONMENT REPORT

The modern data center operates with little human activity, yet in aggregate worldwide, consumes nearly 3% of the world's power production. As digital transformation increases, data center energy consumption could soon reach 8%, by one estimate.[1] Corporate data centers are expected to provide uninterrupted availability of a wide range of applications to a diverse set of endpoints, from on-premise employees on secure connections to potentially billions of globally distributed edge devices. These data centers, which are the critical infrastructure for telecommunication/5G, social media, banking, news and entertainment, and many more services, are the backbone of today's economy.

As the demand for data center services increases due to public needs (e.g., 5G, AI, and Video Streaming), additional computing power must be acquired. Thus, energy consumption grows as well. System performance, amount of storage, and connectivity needs of today's servers have increased dramatically in recent years. The power requirements accompanying this rise in data centers' growth and server requirements impact the environment and contribute to climate change. Managing the impact of data centers on climate change is a central tenant of Supermicro's product strategy. We continue to lead the industry in green computing by optimizing power solutions and advances in cooling and Resource Saving Architecture (RSA), all of which substantially impact E-waste and carbon footprint.

This report, the third in a series on data centers and green computing, looks at how IT managers, operators, and those who purchase data center equipment consider actions that lessen their impact on the environment. The survey on which it is based asked respondents to list their considerations for greener choices that allow their data centers to perform as expected while lowering their carbon footprint. According to the survey results, this report examines how CxO's and IT managers are working towards implementing greener data centers.

How Is Your Data Center Performing?

Data centers range in size from a few servers in a well-ventilated closet to immense facilities with complex cooling systems commonly referred to as hyperscale data centers. Some of these consist of millions of square feet dedicated to housing millions of servers that run every second of the year.

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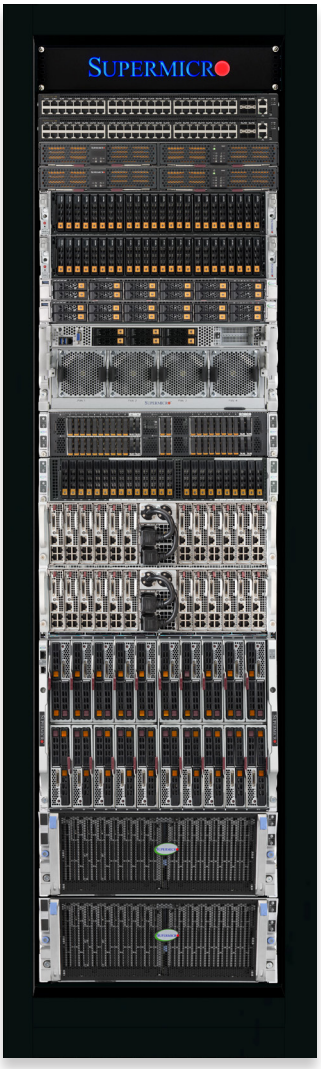
Cooling and power costs have become so significant that finding cost effective, reliable, and greener electricity has become a critical business concern. Decisions on where to build data centers are frequently dependent on local electricity costs and cooling opportunities—and even factor in the supply of cold water nearby.

A record 53.6 million metric tonnes (Mt) of electronic waste was generated worldwide in 2019, up 21% in just five years, according to the UN's Global E-waste Monitor 2020.[2]

Data center managers are asking the following questions when evaluating the greenness of their data centers:

- Are my servers and storage systems optimized for energy efficiency while performing essential business workloads and maintaining Service Level Agreements?
- Do I understand where electricity is being used in my data center?
- What can we do in the near term to reduce data center power usage?
- What types of systems should I plan to purchase that will optimize costs and reduce environmental impact while providing the critical business infrastructure to enable company growth and leadership?
- What is the optimum refresh cycle to acquire new servers and storage?
- How much will these new servers minimize the impact on the environment?
- What is the right model (on-prem, cloud, or hybrid-cloud) that reduces the environmental impact?
- Do we have a plan to minimize the environmental impact of decommissioning older or underperforming IT assets?



42U rack

Making choices as to what activities to pursue starts with understanding the data centers' effect on the environment.

Total Cost to the Environment (TCE)

The Total Cost to the Environment (TCE) calculation is a way to measure the many ways a data center affects the environment and factors in greenhouse gas (GHG) emissions, sustainably sourced and environmentally-friendly/recyclable materials, and electronic waste disposal. Such metrics will become familiar as evaluating the entire lifecycle of electronic items becomes more visible. The TCE is a developing measure that will evolve over time.

Data center managers are learning more about how the architectural choices can impact their TCE. These managers are discovering a wide range of variables and attributes to consider when attempting to minimize their data center's TCE. These variables and attributes include the following:

- Power usage effectiveness, or PUE, is a ratio that describes how efficiently a computer data center uses energy, specifically, how much energy is used by the computing equipment (in contrast to cooling and other overhead).
- Server form factor (multi-node or blade) with higher power density and shared power and cooling for reduced power usage.
- Refresh cycles—newer systems use less power per unit of work than older systems providing better performance per watt.
- Using system components that are designed to be more efficient when operating, such as sharing power supplies and cooling fans, to achieve lower operating costs.
- E-waste planning—how to optimize the decommissioning of older and out-of-date systems.
- Inlet temperatures—as long as hot and cold aisles are contained, allowing the inlet temperature to rise can result in lower cooling costs.
- Choosing renewable energy sources to power the data center.

Thus, the TCE can be considered a function of some or all of these factors. Over 26% of the survey respondents thought that the TCE was a measure of their data center's success.

As an example, assume

$$TCE = f(\text{Server power, power density, inlet temperatures, E-waste activity, PUE})$$

A data center would be considered "greener" when the following occur:

- Shared power and cooling from multi-node or blade systems results in an increase of rack power density above 25kW.
- Inlet temperatures are closer to the maximum operating temperature of the servers and are above 26°C.
- Server refresh cycles are in line with technology advances, about every three years.
- E-waste is reduced through refresh cycles with full recycling and 100% compliance.

Designed properly, green data centers can save money while also reducing environmental impact. From the actions described above, and regardless of the installation's

Ultra–1U: 84 CPUs, 252 TB*, 504 NVMe drives per rack

BigTwin®–2U: 168 CPUs, 504 TB*, 504 NVMe drives per rack

SuperBlade®–8U: 200 CPUs, 600 TB*, 400 NVMe drives per rack

*DRAM only

North America	Europe	Asia-Pacific (not including China)	China
Upgrade critical components 45%	Upgrade critical components 44%	Upgrade critical components 50%	Upgrade critical components 55%
Purchase and install more servers 41%	Increase investment with cloud hosting providers 41%	Upgrade software components 47%	Implement a more inclusive E-waste program 45%

Table 1: Top two responses per region on 2021 plans for data center investments and expansion

size, the result is lower operating expenditures (OPEX), lower capital expenditures (CAPEX), and a cleaner environment. The figure below is a description of the example actions and the expected results.

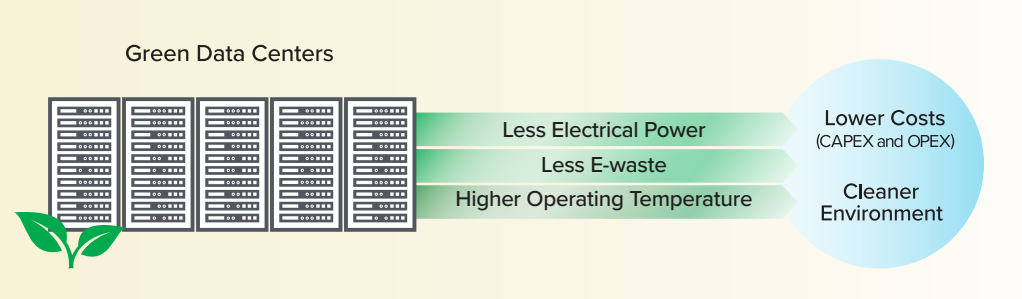


Figure 1: Green Data Center Benefits

Becoming aware of how green their data center is, enables IT managers to create strategies to reduce their carbon footprint.

Green Data Center Awareness

IT managers around the world are creating strategies to deal with the TCE of their data centers. The first step is to become more aware of how the data centers operate.

Many respondents seemed to imply, “The more you know, the better.” Since the PUE is so critical to the TCE, it is notable that 94% of the respondents are aware of the average PUE in their data centers, compared to only 31% in 2019. The ultimate goal is to have a PUE of 1.0, which equates to using all of the energy in a data center to power computer, storage, and networking infrastructure systems. A data center that is considered green would have a PUE of less than 1.25. The PUE mentioned most in the survey response was between 1.50 and 2.50, as this range was cited by 58% of respondents. Large enterprises most often (71%) had a PUE of greater than 1.50. Concern about the PUE went up between the 2019 and 2020 survey from 15% to 25%.

One of the most critical steps that can be taken to move toward a more green data center is to optimize the power used per unit of work. Across all regions, to “improve server utilization through management software, virtualization, and containers” was noted as being crucial. China was twice as likely (14%) as the other regions to explore decommissioning older/zombie servers and twice as likely to utilize higher-powered servers (24%). The Americas (24%) and EU (22%) were twice as likely to explore advancing cooling technologies.

Whether the respondent’s job function was that of C-Level, IT Management, Data Center Facilities Manager, or Engineering, all highlighted the need to improve server utilization through management software, virtualization, and containers as the most important steps (see Appendix). The findings indicate that regardless of job function,

everyone agrees that this is a top priority. The largest businesses (enterprise/very large) were half as likely to decommission servers to optimize power density (4% and 5%, respectively). Reducing overall expenditures, not just through less electricity usage, is essential to organizations' bottom lines. Plus, supporting ways to reduce environmental effects may positively affect customers' choice of service providers.

Increasing the density of compute power within a rack increases the overall power effectiveness and leads to a greener data center.

Green Data Center Power Effectiveness

Power and cooling are vital components to understanding the TCE of a data center. A green data center will use less electricity to power servers and less cooling to keep them within a desired operating temperature range. Higher server density within a rack drives power efficiencies and also reduces the need for data center real estate, an additional cost.

In contrast to the 2019 survey, the 2020 survey showed a large shift in the reported power per rack. In 2019, the largest category was less than 10kW per rack, where 57% of the responses landed. In the 2020 survey, this was only 16%, quite a significant change. This is evidence that higher density computing is an important consideration when looking at saving money on power costs.

There are several strategies that can directly lead to a reduction in the power used in a data center.

Transitioning to Green

Several actions can be implemented quickly to move to a greener data center and reduce OPEX and CAPEX costs: optimize PUE, faster refresh cycles, server selection, consolidate through virtualization, and increasing inlet temperatures.

Optimizing PUE

By reducing the amount of energy used for cooling, the PUE of a data center will increase, as a higher percentage of the energy used in the data center will go to powering infrastructure equipment. Higher inlet temperatures will reduce the AC needs, resulting in a better PUE.

MULTINODE AND BLADE SERVERS

Supermicro BigTwin® (2U 4 node server)

High-density, multinode servers deliver massive computing power in minimal space for workloads such as High Performance Computing (HPC), Artificial Intelligence (AI), cloud, grid, and analytics, while reducing costs, energy, and space requirements.

Multinode servers provide significant power and space savings compared to standard industry rackmount servers. These servers integrate two or more independent nodes into a single enclosure, thus increasing density.

The main advantage for green data centers is saving power due to shared components including power supplies, fans, enclosures, and cabling.

- **Blade Servers:** optimized to use less space and energy, minimizing power consumption
- **Multinode Servers:** designed with two or more independent server nodes in a single enclosure; ideal for enclosures with limited space.
- **Hyperconverged Infrastructure (HCI) Servers:** combines storage, compute, and networking into a single system. This decreases data center complexity and increases stability.

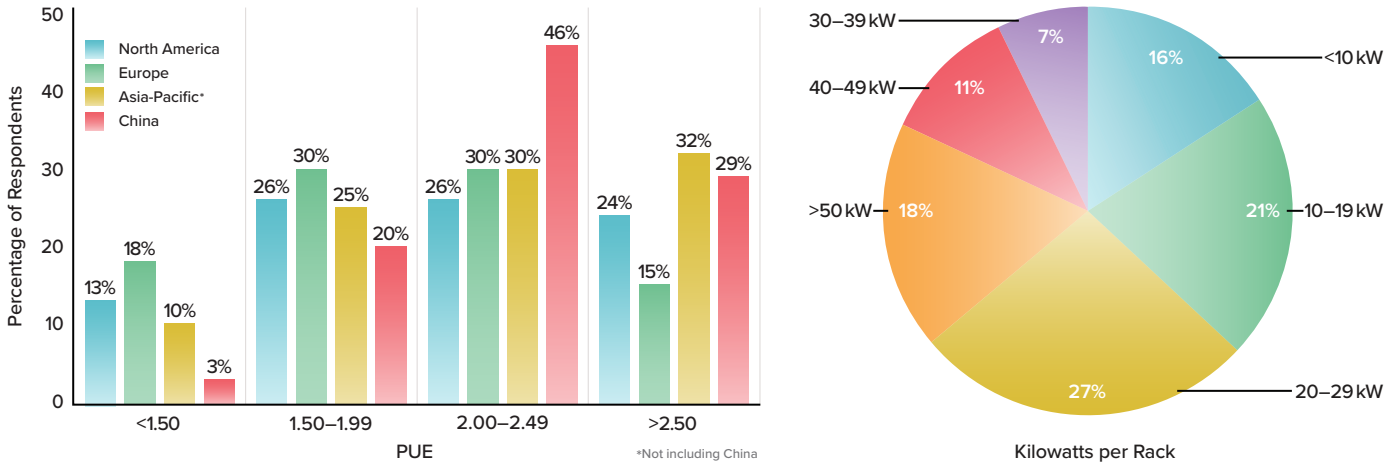


Figure 2: Kilowatts per rack differs by geography and overall responses

Servers, and specifically CPUs/GPUs, produce heat that must be removed from the system. Powerful fans draw in ambient air, forcing hot air from the systems. Running systems at a higher temperature reduces HVAC costs since the energy needed for lower temperature air cooling is reduced. In the 2020 survey, the most common inlet temperature was in the 21°C to 24°C range (39%). At the cooler end (<21°C), the number of responses increased from 17% in 2019 to 26% in 2020. Very few organizations were willing to run the server inlet temperatures above 32°C. We are encouraged to see that more data center managers are considering or moving towards higher inlet temperatures, although a number seem to desire cooler inlet temperatures, perhaps concerned with how the infrastructure will perform at higher temperatures. Estimates are that for every 1°C increase in inlet temperature, AC requirements decrease by about 4%. Using servers that operate at higher temperatures can save operating costs by putting less demand on the HVAC system.

On a regional basis, to optimize the inlet temperature, free air cooling was the preference for all regions, except Europe, in which management software and virtualization (22%), eliminating older and zombie servers (19%), and exploring airflow strategies (19%) were the priorities. The Americas were the least likely region to utilize liquid cooling.

Though all regions preferred the 18°C–24°C range, the Americas and Europe were more likely to run in the sub 18°C range. China and APAC were more comfortable running in the 25°C–32°C range. The largest businesses (large/very large/enterprise) were the most comfortable letting equipment operate at higher temperatures of over 25°C.

The inlet temperature maintained in a data center has a significant effect on the facility's power usage. A quick calculation shows that for a single data center rack operating at 32°C, the savings would be about $12,628 per rack, per year, compared to operating at 24°C. This is an impressive amount of power savings for just one rack in one year and the savings for a larger data center consisting of 100 racks, would be linear.

Faster Refresh Cycles

As computing power increases per constant dollar spent (an extrapolation of Moore's Law), a server's power usage has generally remained constant over time. New semiconductor processing techniques have allowed power usage to stay consistent while the performance continues to increase through semiconductors and architectural changes.

Replacing older systems with newer ones, that can support more intensive workloads, supports green computing. The 2020 survey showed that 68% of respondents were refreshing their servers every year or two to three years. This compares to just 37% for the 2019 survey. For those that keep servers for six or more years, only 8% in the 2020 survey said they do so, compared to 23% in the 2019 survey. For organizations that refresh very frequently, about every year, 7% did so in the 2019 survey but this number increased significantly to 26% in the 2020 survey. Large enterprises were also

CALCULATING PUE

A large data center may contain over 100 racks of equipment (20% of respondents). If the power used per rack averages 35kW, then the total energy used over a year is 100 x 35kW x 8760 hours = approximately 30.7 million kw/year. With a 10% reduction achieved by using newer components and servers, it's possible to save up to 3.1 million kW. Not only does this equate to real OPEX savings in reduced power bills, but a substantial reduction in GHG emissions as well.

Based on one estimate,[3] the GHG avoidance by a large data center reducing power by 10% offsets the need to plant 12,000 trees to sequester carbon. For a more detailed look at cost-saving energy variables, see Table 2.

We can estimate the energy costs of a rack running under a full load as follows:

Rack Power Capacity (kW) x Electricity Price ($/kW-hour) x Hours per Year x PUE

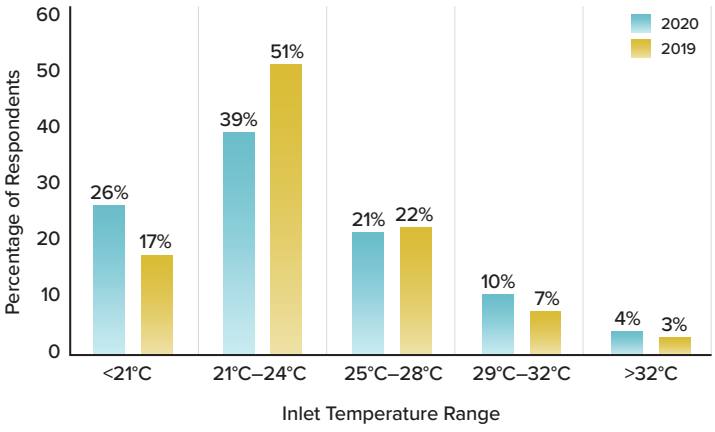
Note: Lower PUEs (a measure of data center efficiency) results in lower operating costs

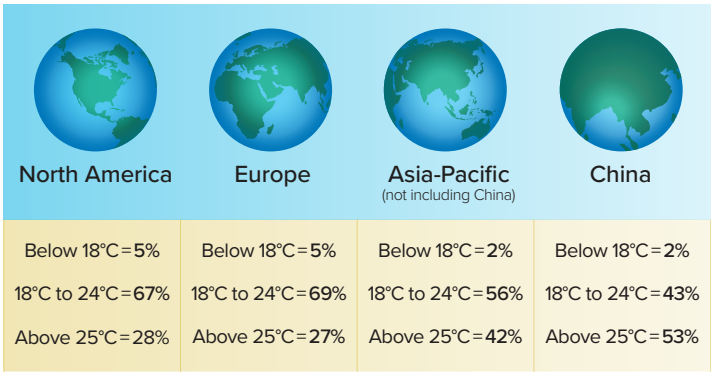
A quick determination of how much power is used per rack, and the cost savings if more efficient servers are used, can be calculated as shown in Table 2. As indicated, using 10% more efficient servers yields savings of $3,000 annually per rack for a moderate rack system and up to $6,000 per rack for denser racks. In addition to cost savings, increasing kW usage per rack dramatically reduces GHG emissions.

kW per rack	PUE	Hours/ Year	Cost Per kW	Total Cost	Savings @10%	Equivalent Trees Planted (Est.)
25	1.25	8760	$0.11	$30,100	$3,100	= 100 Trees
30	1.10	8760	$0.11	$31,800	$3,180	
45	1.40	8760	$0.11	$60,700	$6,000	

Table 2: Cost per rack (electricity)

Source: Cost Per kW[3]





Below 18°C=5%	Below 18°C=5%	Below 18°C=2%	Below 18°C=2%
18°C to 24°C=67%	18°C to 24°C=69%	18°C to 24°C=56%	18°C to 24°C=43%
Above 25°C=28%	Above 25°C=27%	Above 25°C=42%	Above 25°C=53%

Figure 3: Server inlet temperatures differ by geography, affecting cooling expenses

the most likely to refresh every year, most likely due to the availability of increased IT capital. A far greater number of large enterprises (twice as many) refreshed their servers more frequently than smaller organizations and rarely waited more than six years to refresh.

Shared Power and Cooling

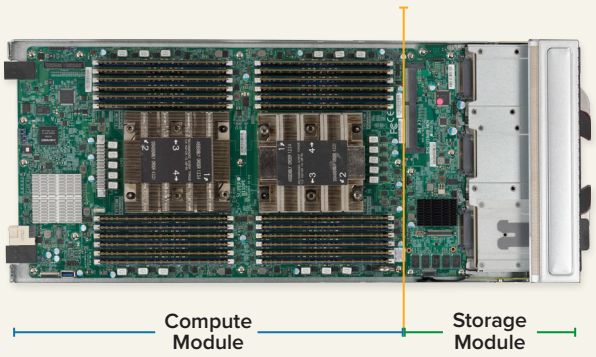
New technologies and chassis/enclosure innovation allow for reduced power consumption by combining components that can be shared within a single-server chassis, whenever possible. This includes x86 server designs with shared power supplies to distribute power to multiple blades and nodes, and with fans that can cool multiple servers concurrently. Typical rackmount servers with their own redundant power supplies and fans are limited by the standard chassis size (1U).

Power supplies that drive multiple servers in the same chassis will operate at higher utilization, increasing efficiency. Larger fans can be used to cool multiple servers, requiring less power to draw in ambient air to provide adequate cool air for all critical components for maximum reliability and uptime. Blade-based systems have been shown to use over 10% less power than the same computing power installed as 1U rackmount servers. Also, the reduction in the number of cables in a system, which are minimal with a blade form factor, results in less

DISAGGREGATED SERVERS

The 6U SuperBlade utilizes a disaggregated architecture that enables the independent upgrades of system components. Each blade is composed of a storage module and a separable compute module with CPUs from Intel®, for example, and memory that can be refreshed at faster rates than the rest of the system.

Supermicro 6U Disaggregated SuperBlade®



obstruction of airflow, thus increasing the efficiency of removing heat from the system. Likewise, multi-node servers show about a 10% reduction in overall power usage.

By designing servers from the start to be more energy-efficient, rather than modifying them later, the energy consumed for given workloads is reduced, reducing costs and the need for carbon offset actions. However, refreshing the servers too quickly results in more E-waste per year, and more CAPEX spent on obtaining new servers. Newer systems are more efficient, but replacing them more often will require greater spending. Thus, as part of a greener data center and a lower TCE, some tradeoffs need to be considered. Figure 5 below is a conceptual chart of how a TCE refresh could be minimized.

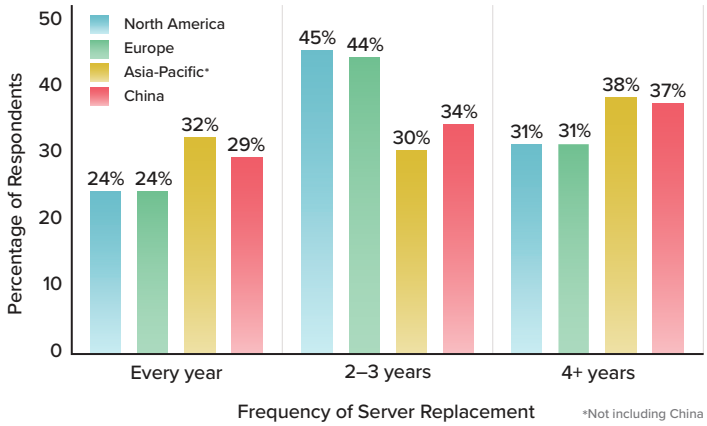


Figure 4: Frequency of server replacement, by geography

Disaggregated Servers Are the Future

Disaggregated servers give data centers the ability to spend less time and money on refreshing servers so that they can refresh faster and take advantage of the latest technologies. For example, if a newer, higher-performing CPU is available, a data center operator can upgrade the CPU without upgrading the memory subsystem. In the survey, 34% of the respondents mentioned that they refresh their hardware every four years or longer. Using disaggregated servers, data centers can refresh faster, improve performance, lower energy use, reduce CAPEX, and minimize E-waste. In the past, to take optimal advantage of server technology improvements, data centers had to replace the entire server, even though components (chassis, cables, power supplies, network switches, fans, management, and I/O) still had many years of useful life remaining. This server replacement approach results in significant waste. The all-or-nothing server design limitation inspired the innovative functionality of the disaggregated server.

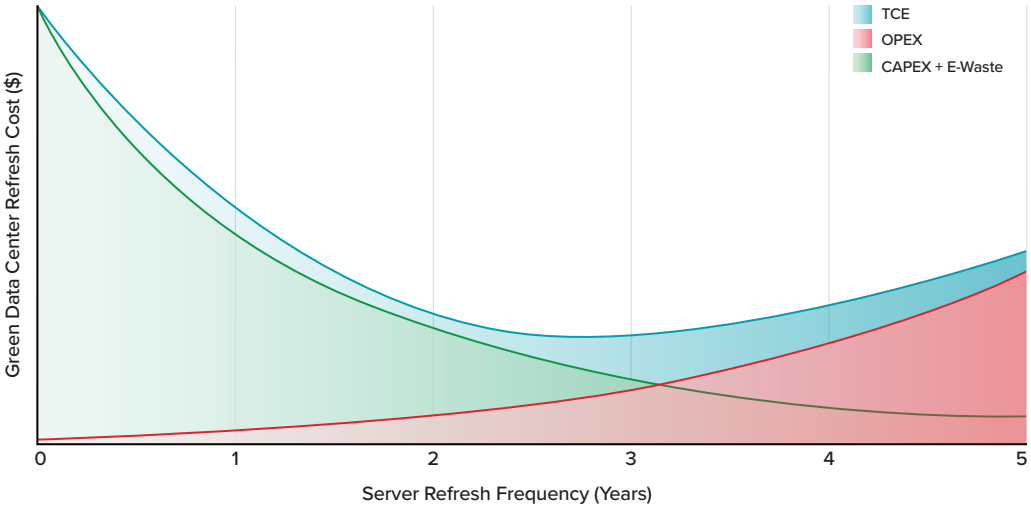


Figure 5: Factors that affect server refresh frequency

North America	Europe	Asia-Pacific (not including China)	China
Selecting energy-efficient servers 45%	Upgrade server components 48%	Upgrade server components 49%	Upgrade server components 53%
Upgrading server components 43%	Select energy-efficient servers 39%	Employ greater server virtualization 48%	Employ greater server virtualization 50%
Consolidate/eliminate lightly-used or comatose servers 37%	Consolidate/eliminate lightly used or comatose servers 37%	Consolidate/eliminate lightly used or comatose servers 45%	Consolidate/eliminate lightly used or comatose servers 45%
Make critical HVAC adjustments 33%	Employ greater server virtualization 37%	Adopt airflow management strategies 38%	Adopt airflow management strategies 45%

Figure 6: Respondents plans for optimizing PUE

E-waste is a serious problem and can be a major factor to consider when working towards a greener data center. Various approaches to mitigating E-waste are shown in Figure 7, which indicates an increase in efforts to plan for E-waste in the 2020 survey.

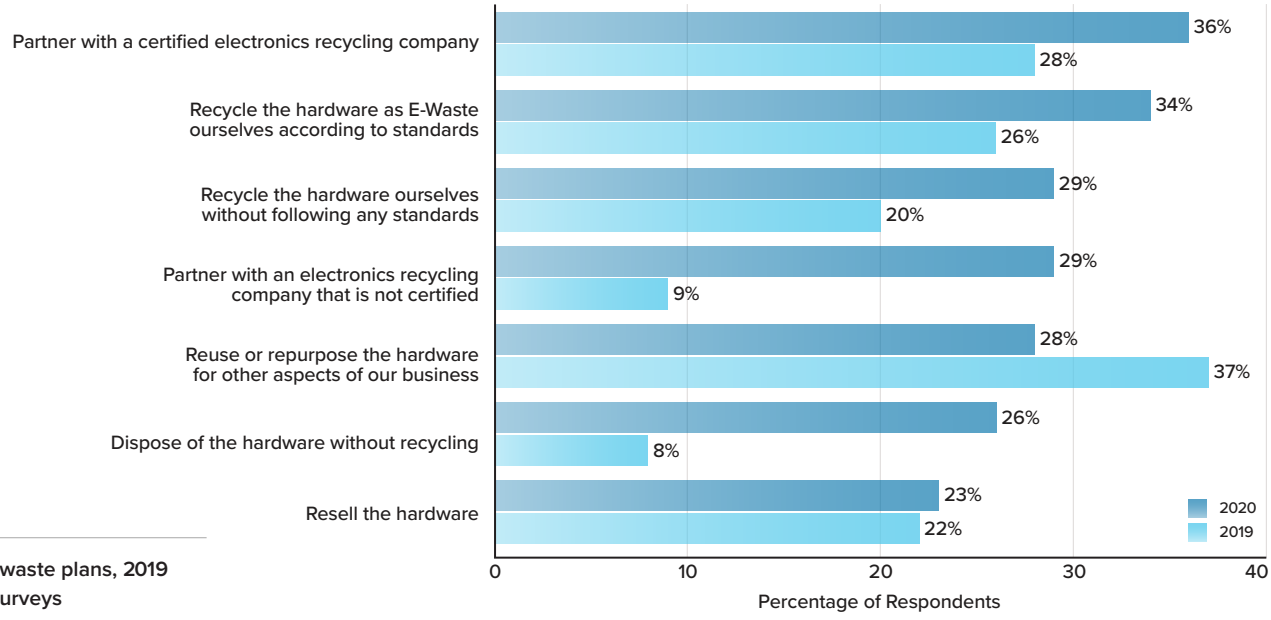


Figure 7: E-waste plans, 2019 and 2020 surveys

Decommissioning Plans and E-waste Planning

Deciding what to do with systems at, or close to the end of their useful lives, has become an essential factor when considering the TCE. Simply discarding electronic components causes significant environmental harm.

Most organizations understand the need to measure their power usage and cooling costs as part of an OPEX budget and other calculations. However, one of the essential elements of a TCE calculation is what happens to equipment that is no longer needed or has outlived its usefulness. The decommissioning of servers and plan for E-waste is a critical component of a TCE plan.

In the 2020 survey, 54% of the respondents do have a decommissioning and reuse policy, and they closely follow it. Almost 80% of large enterprises are compliant with their policies. About 20% of all respondents do have a policy but do not follow it closely. Another 11% state that although they do not have a policy today, they are developing one in regards to decommissioning outdated hardware.

The larger the organization, the more likely the survey participants were to respond "Yes, and we follow it closely," with large enterprises leading by a significant margin (77%). 16% of these largest enterprises noted not having an official decommissioning/recycling policy. The smallest businesses were the most likely to have no plan and no intent to make one (18% and 18%), respectively.

Geographically, there were differences as to the top two methods for handling outdated hardware when decommissioning. The disposal of unused servers and storage systems dramatically affects the "greenness" of a data center.

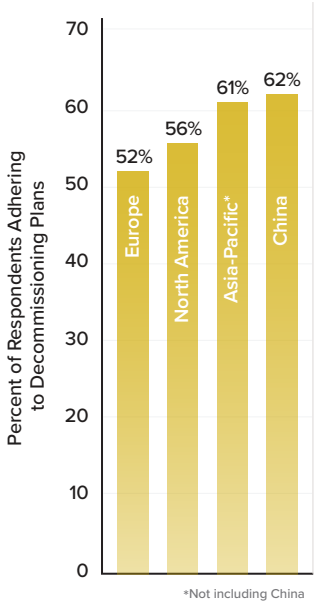


Figure 8: Decommissioning Plans by Region

North America	Europe	Asia-Pacific (not including China)	China
Recycle the hardware as E-waste ourselves according to standards 38%	Recycle the hardware ourselves, without following any particular standards 32%	Recycle the hardware as E-waste ourselves according to standards 42%	Reuse/repurpose the hardware for other aspects of our business 49%
Partner with a certified electronics recycling company 36%	Partner with a certified electronics recycling company 30%	Partner with a certified electronics recycling company 39%	Recycle the hardware as E-waste ourselves according to standards 46%

Figure 9: Top Two Methods for Decommissioning Outdated Hardware by Region

Across all geographies, decommissioning plans were available, and a majority of the responses show that these policies were being followed closely, over 50% of the time, according to the respondents. The highest geography that did not have an official plan was the China region, with 18% responding that there was no plan, compared to only 6% in North American and 8% in Europe.

Summary

Organizations of all sizes that operate data centers are becoming keenly aware of their impact on the environment. Faster refresh cycles to take advantage of power-usage improvements, lowering PUEs in high-density racks, operating at higher inlet temperatures, and proper decommissioning process all contribute to a data center's greenness. From the recent survey, many managers are taking action to reduce power needs and effects on the environment.

Supermicro offers strategic leadership in the domain of Green Computing and has pioneered this as a corporate initiative with significant investment, including top-performing power supply systems, advanced cooling systems, ultra-high elemental reuse via its Resource Saving Architecture and more, all made in the USA (Taiwan and Netherlands available for regional support). The Supermicro product family reduces costs through energy reduction, without compromising performance by leveraging these innovative technologies to create world-class data center solutions while protecting the planet at the same time.

"Reimagine, repurpose, reuse, reinvent, is my framework of choice for driving innovation in the green computing space. Technology increasingly drives the engines of today's businesses, so IT leaders must prioritize energy savings, protecting the environment, and reducing the Total Cost to the Environment (TCE)."

–Shesha Krishnapura, Intel® Fellow & IT Chief Technology Officer

Managing the impact of data centers on climate change is a central tenet of Supermicro's product strategy, where we continue to lead the industry in green computing. Supermicro is uniquely positioned to help data center managers evaluate the greenness of their data centers and provide thought leadership on enhancements to save energy and the environment. Supermicro has subject matter experts who can help guide and advise these decisions.

As a result of our strategy, Supermicro offers a wide range of energy-efficient servers and storage systems for the most demanding workloads that are easily deployed and are simple to upgrade to the latest technologies. The Supermicro product family saves energy by using innovative technologies that have been shown to lessen power usage while maintaining the highest performance available today. Supermicro designs and manufactures servers and storage systems in Silicon Valley, which can reduce shipping costs and greenhouse gas emissions by sourcing close to the factory and close to the customers.

Appendix

The third annual Supermicro Data Centers & the Environment survey provides an overview of the significant trends shaping data center TCE considerations. Responses were obtained from over 400 data center managers and IT practitioners globally. The survey consisted of about 30 questions, and the results are based on the responses. Not all respondents answered all questions, and due to rounding, the totals may not add up to 100%. Highlights from the survey include the following:

- 70% of organizations classify themselves as large, very large, or enterprise businesses, higher than respondents from the 2019 survey (27%)
- Datacenters are more globally spread out in 2020 than in 2019, where almost 80% of the respondents were located in the Americas
- The distribution of Job Functions showed that more C-level roles responded in 2020 compared to 2019 (43% vs. 27%) and was quite a bit higher than in 2018 (12%)

Job Function		Business Size		Verticals		Data Center Location	
C-Level	43%	Small Office	3%	Software and/or Cloud Services	21%	North America	38%
IT Management	40%	Small Business	6%	Telecommunications	20%	Europe	38%
Data Center Facilities Management	12%	Medium Business	21%	Manufacturing	13%	Asia/Pacific	37%
Engineering	4%	Large Business	30%	Financial/Insurance	10%	Latin America	6%
Other	1%	Very Large Business	30%	Retail/Wholesale Distribution	8%	Africa/Middle East	5%
		Enterprise	10%	Consulting/Professional Services	7%		
				Colocation/Multi-tenant Data Centers	4%		
				Other	19%		

Figure 8: Respondent Demographics

References

(1) https://www.digitalrealty.com/blog/green-data-centers-are-imperative-for-enterprise-success
(2) http://ewastemonitor.info
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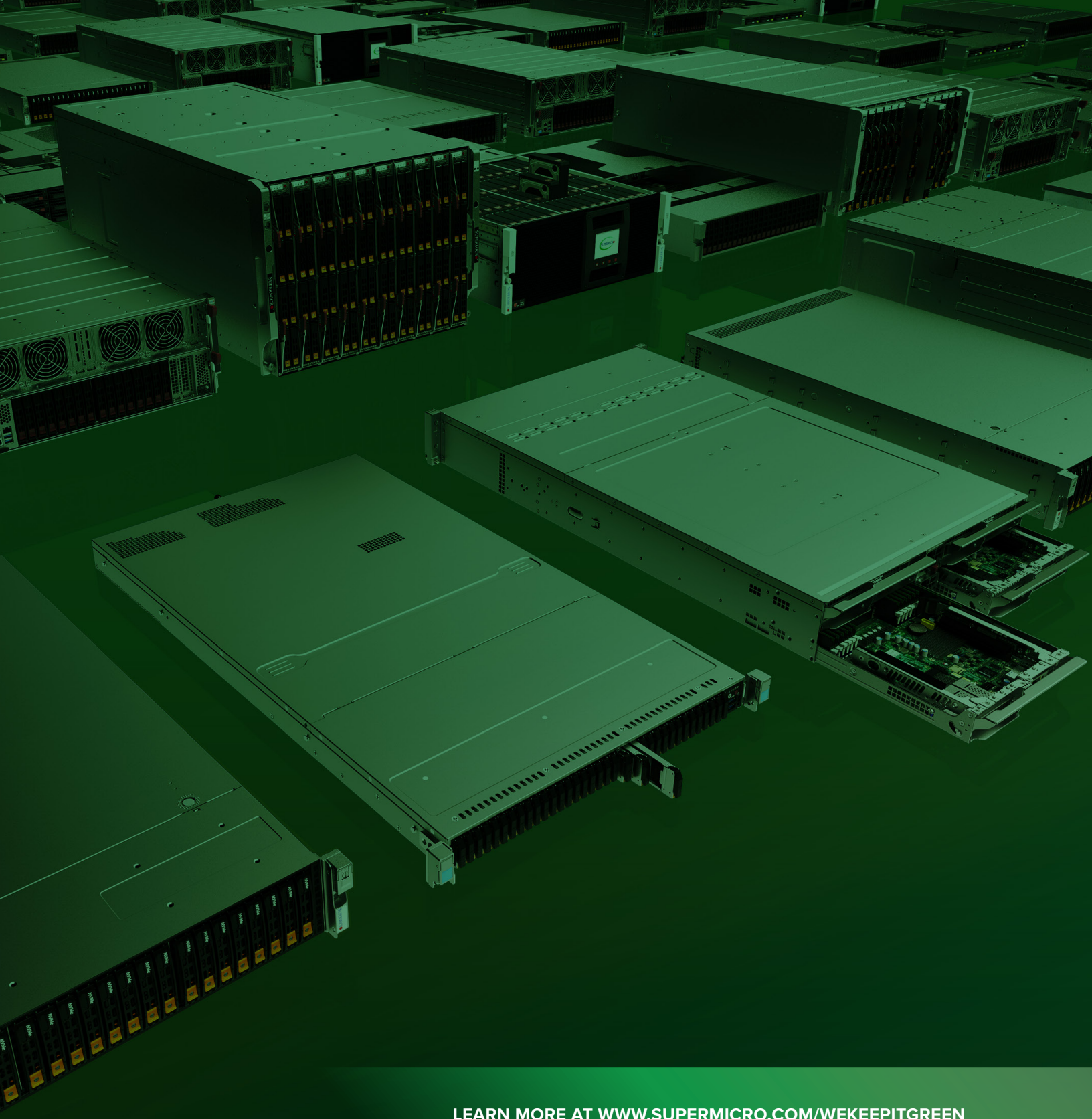
About Super Micro Computer, Inc.

Supermicro (SMCI), the leading innovator in high-performance, high-efficiency server technology is a premier provider of advanced server Building Block Solutions® for Enterprise Data Center, Cloud Computing, Artificial Intelligence, and Edge Computing Systems worldwide. Supermicro is committed to protecting the environment through its "We Keep IT Green®" initiative and provides customers with the most energy-efficient, environmentally-friendly solutions available on the market.



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