



## **10 Sustainability Advantages of IBM LinuxONE**

### **Executive Summary:**

The age of abundance is over having been replaced by the age of scarcity. Corporations, and especially IT and facilities executives, need to address the near- and long-term challenges posed by power and water costs and shortages, supply chain constraints, and sustainability obligations and objectives. All this must be tackled while concurrently meeting business needs for growth in compute and storage capacity.

Definitions regarding sustainability and efficiency frequently provoke debate within the data center and, even more so, when discussing strategies with other corporate executives. Wherever the bounds of said definitions rest as a matter of execution, virtually every enterprise data center executive would agree that their in-house methodologies and their associated metrics are not being operated at or near maximum efficiency. This is due, in part, to the divergent definitions and objectives for sustainability among enterprise fiefdoms, which must align if enterprises hope to optimize efforts around consistent objectives.

Sustainability, quite simply put, is the outcome of efficient use of resources. RFG has determined that there are 10 different areas of efficiency that should be measured, monitored, improved upon, and reported to track and determine resource utilization effectiveness. Most data centers today are only keeping track of two, at best three, of these areas. Moreover, most of the focus today is on the facilities components and not on the IT infrastructure, where most of the gains can be achieved. Understanding the opportunities can help IT data center executives attain efficiency in cost, productivity, and sustainability advancements, and satisfy current and upcoming regulatory requirements.

Simultaneously, they must also struggle with cyber privacy and security demands, increased competitive pressures, constrained revenue growth and budgets. Limited technical skills, support challenges, geopolitical issues, and the explosion in data storage and retention requirements while ensuring the right to be forgotten are also key obstacles to overcome.

The new generation of LinuxONE servers are architected to address these business issues and market dynamics by delivering technology that significantly differentiates it from other solutions on the market. LinuxONE delivers on 10 key sustainability advantages that exceeds those achievable with traditional x86 platforms while offering enterprise server reliability and scalability.

**Top 10 reasons:**

1. Energy savings.
2. Carbon emissions avoidance.
3. Space savings.
4. Rack density.
5. Water savings.
6. Reduction in cabling.
7. Circular economy/waste savings.
8. Risk reduction.
9. Scope 1 and 3 avoidances.
10. Total potential dollar savings.



**Top 10 reasons (detail):**

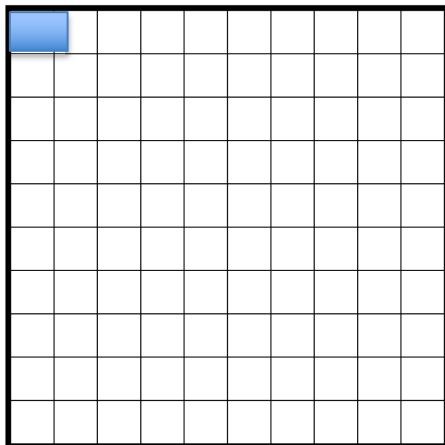
1. **Energy savings** – IBM LinuxONE can demonstrate energy savings in excess of 80% in a best-case scenario.

There is a long-standing belief that keeping servers in use for longer periods – five years or more – is both more cost effective and more sustainable. This was used as a justification for not buying new servers due to a supply chain shortage by many leading institutions. This justification is a red herring and false across a number of dimensions including energy efficiency, as systems even only three-years apart are dramatically more power efficient. An RFG analysis comparing Dell Intel Skylake R740 servers to an IBM LinuxONE Rockhopper 4 Max68 shows that the LinuxONE Max68 consumes only 16 percent of the power utilized by the Dell servers. In this analysis RFG chose to drive the LinuxONE Max68 at an average of 78% utilization. [A LinuxONE is architected to run at 100% utilization without crashing and can operate on average in the 80% utilization range.]

RFG analysis found that it is possible to consolidate 120 Dell Intel Skylake servers running at an average 17.4% utilization onto a single LinuxONE Max68 with a 78.3% utilization. When we factored in a PUE (power usage effectiveness) rating of 1.55 and included the additional switches required per rack, we found that the LinuxONE Max68 configuration consumed only 16% of the energy used by the Dell server configuration. That represents an energy savings of 84%.

The performance/watt of the LinuxONE Max68 configuration over the x86 solution came in at an impressive 6.1:1 ratio for the total configuration. For the Dell Skylake servers only, the performance/watt ratio was 5.6:1.

Moreover, the Dell servers utilizes 240 chips and 4,800 cores at a 17% utilization while the LinuxONE Max68 contains 16 chips and 68 cores operating at a 78% utilization. On a core-to-core comparison, the LinuxONE Max68 needed only 1.4% of the cores to perform the same workload. (See Appendix 1 for details.)



**A single Telum CPU core (blue rectangle), the microprocessor chip inside a LinuxONE, handles the performance of 70 Intel Skylake cores in this scenario.**



2. **Carbon emissions avoidance** – companies are buying carbon offsets to meet corporate and regulatory objectives. The switch to LinuxONE will significantly reduce the amount of offsets required (see chart below).

The average CO2 metric tons (MT) consumed by the LinuxONE configuration is 3.6 MT whereas the average CO2 metric tons devoured by the Dell configuration was 21.8. On an annualized basis, this converts to the LinuxONE Max68 consuming almost 80 million metric tons and the Dell configuration consuming approximately 490 million tons. Or, as the chart shows, the energy saved from using the LinuxONE Max68 instead of the 120 Dell servers could provide the energy required by more than 20,000 homes.

LinuxONE Max68 vs. Dell configuration emissions chart (using epa.gov greenhouse gas calculator)

	<b>Dell Skylake R740 Server</b>	<b>LinuxONE Max68</b>	<b>Delta</b>
<b>CO2 metric tons consumed/year</b>	191	31	160
<b>Equivalent miles driven per year by an average gas- powered passenger vehicle</b>	488,998,301	79,730,439	409,267,862
<b>Equivalent to CO2 sequestered by acres of forests in one year</b>	227,473	37,089	190,384
<b>Equivalent to CO2 emissions from home energy usage for one year</b>	24,041	3,920	20,121



3. **Space savings** – This component is both often misunderstood and has been severely understated. The space savings capabilities of LinuxONE can result in the 90% range compared with Dell rack mount systems. Additionally, enterprises are not recognizing the true cost of space savings in dollar terms – which has the potential to exceed even the energy savings.

In RFG's study, it is assumed each of the racks could support a maximum of 7.5 kW. Given that constraint, typical of enterprise data center configurations today, the Dell servers were spread over 10 racks while the LinuxONE Max68 configuration fit in a single standard 19" rack. This translates to a 90% savings in floor space. Whether one considers the cost of floor space based upon data center construction costs spread over 20 years or the cost of locating the servers in a colocation facility, this **savings could exceed \$200,000 per year.**

4. **Rack density** – This is a metric that many firms are now adopting.

The standard approach to measuring rack density is the amount of power the equipment within a server rack uses. Technicians measure rack density in kilowatts (kW) per cabinet and use this metric as a critical factor in data center design. According to the Uptime Institute 2023 survey, 64% of data center sites have server rack densities wherein the highest density is less than 15 kW while only 13% of sites have some rack densities that exceed 30 kW. The theory states that the more power one can pack into a small space, the lower the overall operational cost as space is not free – and can be very expensive when it means exploding beyond the existing walls.

The new generation of LinuxONE servers changes the power/space dynamic. The 120 Dell Intel Skylake servers were configured across 10 racks, with a maximum of 7.5 kW. If they could theoretically be placed on a single rack, they would require a rack density of 75 kW. But by using the LinuxONE Max68 solution, the rack power capacity remains at 7.5 kW – **10x less** than what the x86 solution needed.

5. **Water savings** – While the dollar savings here is not that large compared to the other areas, the primary concern is that water is a scarce commodity that needs to be contained to ensure data center operation and sustainability requirements. Thus, the topic needs to be addressed.

Data centers can consume three to five million gallons of water every day, which is enough to fill the water needs of a city with 30,000 to 50,000 people. Data center water usage has become a major concern in certain areas of the world where water has become a scarce commodity. Some data center and facilities executives are looking at replacing water cooling with other solutions, but the retrofit can be expensive. LinuxONE offers a simpler, more effective alternative.

On average, it is estimated that a data center uses 1.8 Liters of water per kilowatt of IT power consumed (Shehabi et al. 2016, 28). Thus, if one can reduce the power consumption by 84%, then the water consumption is also reduced by 84%.

**Switching to a LinuxONE solution would reduce the water consumption by a factor 6.25x.**

6. **Reduction in cabling** – This is an understated and often unrecognized area. The volume of cabling is one of the determining complexity factors, which impacts risk. This is not only true during initial setup and Day 2 operations. but is also an advantage when addressing capacity growth and resiliency.

Each of the Dell servers have cabling that connects the servers to the network, systems management, and storage. It is reasonable to assume that there is one systems management cable, at least two storage cables, and at least three network cables for each server. In fact, it is logical to assume that we have a mix of development, test, user acceptance, and production environments. One possible cabling environment is shown in the below chart. Herein, LinuxONE delivers a 98% reduction in cabling costs and operational support. LinuxONE provides a level of simplicity and risk reduction that cannot be obtained by operating clusters of x86 servers.

	<b>X86 servers</b>	<b>LinuxONE Max68</b>
<b>Systems management</b>	120	1
<b>Networking</b>	360	6
<b>Storage</b>	360	8

Running cables and port support costs are not inconsequential costs. Simplification from the reduction in cabling and ports reduces the potential for human errors and improves resiliency.

7. **Circular economy/waste savings** – This component examines hardware manufacturer sustainability effectiveness as vendors strive to increase the use of recycled and renewable materials and enhance product repairability, reusability, recyclability, and longevity.

To deliver a quality sustainable product, a hardware manufacturer must engineer offerings to consume the least amount of excess materials while ensuring that components used can be repaired, replaced, and recycled with a minimum of waste. With LinuxONE, reduced shipping materials represent a fraction of the waste materials that is used to package other systems. Moreover, from a recycle/reuse perspective, IBM's recycling capabilities (IBM Global Asset Recovery Services or GARS) are world class and unrivaled. IBM stated that in 2022, it took in end-of-life products and product waste across 60 countries with 97.3% (by weight) resold, reused, or sent for recycling, 2.4% sent to waste-to-energy for final disposition, and 0.4% sent to landfills or for incineration.

Many enterprises want to know the Lifecycle Assessment (LCA) of a potential hardware acquisition. The LCA tool provides a company with a formulaic way to assess environmental impacts throughout a product's lifecycle, i.e., from the material procurement, manufacturing, and product use phases to transportation (supply chain) and waste management (including disposal and recycling). Additionally, the EU has been developing regulations that will require vendors to declare their circular economy figures for their products.

RFG analysis examined the LCA impacts of LinuxONE and Dell rack servers. It found that the **LCA impact** of the Dell servers was **almost 5x** that of the LinuxONE servers. The greatest lifecycle phase impact in the analysis is the usage component. (This is discussed further in section 9.)





**8. Risk reduction** – A LinuxONE solution offers several different risk reduction capabilities unachievable with an x86 server farm.

The “seven nines” of availability of LinuxONE systems is only one factor. There are numerous operational risks that can be reduced because of the reduction of the complexity afforded with LinuxONE vs. multiple racks of x86 systems and databases. LinuxONE systems provide at least **99.99999 percent availability (3.1 seconds a year outage)** based upon 24x365 operations) enabled by several autonomic resiliency features to keep downtime to a minimum. Many users achieve 100 percent availability in 7x24x365 environments for months at a time, as the system is designed for continuous operations.

On the other hand, most x86 server platforms provide **between 99.9 percent availability (in excess of 500 minutes a year of downtime) and 99.99 percentage availability (53 minutes a year)**. Because of server outages, IT technicians tend to add more servers to the mix to limit the risk blast radius of an outage. This increases legal, regulatory, reputational, and revenue risk exposure.

Availability %	Downtime per year
99.8%	17.52 hours
99.9% ("three nines")	8.76 hours
99.95%	4.38 hours
99.99% ("four nines")	52.56 minutes
99.999% ("five nines")	5.26 minutes
99.9999% ("six nines")	31.5 seconds
99.99999% ("seven nines")	3.15 seconds

Cloud service providers claim to offer 99.9 percent availability or better but do not guarantee it. Additionally, the guarantees provided by cloud providers usually exclude planned downtime.

LinuxONE servers are hardened to keep running in virtually any environment and are resistant to fire, water, and earthquakes. This level of high availability is attainable because of duplication and redundancy of all key components coupled with software designed to keep the LinuxONE system running with virtually no downtime across one or more redundant systems which can be geographically dispersed.

A LinuxONE solution offers a far less complex operating environment as systems are designed as integrated, fault-tolerant platforms with simplified redundancy. The comparative complexity of the hardware and software environment required by an x86 server farm increases the risk factor and can lead to more human errors, which remains the largest cause of outages.

Finally, the probability of a cyber breach on a LinuxONE is far less than on an x86. LinuxONE comes with Data Privacy Passports, which provides end-to-end data-centric protection. Data is encrypted at its starting point and remains encrypted until it reaches the endpoint.





**9. Scope 1, 2, and 3 avoidance** – This section will address scope 1 and both the upstream and downstream Scope 3 savings.

From a sustainability impact viewpoint, all carbon emissions are categorized as scope 1, 2 or 3. The definitions are as follows:

- Scope 1: Direct emissions that result from activities within your organization's control.
- Scope 2: Indirect emissions from consumptions of electricity, heat, or steam that you purchase and use.
- Scope 3: Any other indirect emissions from sources outside of your direct control.

When looking at hardware sustainability from a vendor perspective, the largest component is the usage of the product by the customer. A customer's scope 1 is part of the vendor's scope 3. California's new Climate Corporate Data Accountability Act, which goes into effect starting in 2026, requires companies with annual revenues of US \$1 billion or more will have to report both their direct and indirect greenhouse gas emissions.

From a user perspective, carbon emissions must be quantified into four categories: manufacturing, usage, transportation, and end-of-life. The manufacturing component for servers will typically represent between 9% and 25%. The transportation and end-of-life components combined tend to be less than 10%. Thus, the bulk of the emissions are produced during the usage cycle.

Therefore, enterprises should evaluate the sustainability emissions factors for its hardware providers as a matter of course with each product acquisition. This analysis should be based upon specific product usage analysis and not a one based on overall corporate revenues (a common practice that is severely flawed but in widespread use). The results from these two analysis types can vary significantly and could lead the acquirer into coming to false conclusions.

As stated in section 7, the Dell rack servers discharge almost 5x the carbon emissions of the LinuxONE Max68 based on the RFG equivalence performance analysis. While this study looked at a specific set of Dell servers, a similar carbon emissions ratio is likely to be found when comparing a fully utilized LinuxONE Max68 server to other comparable x86 servers.



## 10. Best value/total potential dollar savings –

RFG has developed a Data Center Sustainability Analysis Model (RFG DC SAM) that includes conversion factors that quantifies the above items (items 1 - 5) and creates a potential dollar savings that can be achieved by migrating to LinuxONE. These savings can offset the LinuxONE TCA (total cost of acquisition) costs such that the breakeven could be less than 12 months. The other items are more specific to individual scenarios; thus, RFG will provide guidance as to how these savings can be realized. With reduced development and operations costs, organizations obtain improved margins as every dollar saved goes directly to the bottom line. Conversely, every added dollar required by operations will require an additional \$10 in revenue as an offset for breakeven. This **10:1 ratio** demonstrates the amplified value cost efficiency offers the enterprise.

Additionally, time-to-market of new or enhanced workloads creates added business value through new revenues and potential loyalty. On the cost side of the equation, companies can pay for the platform's usage with a consumption-based model, which ties costs to usage benefits. A holistic cost comparison must incorporate all life cycle costs rather than a subset or just hardware acquisition costs. The TCO for a LinuxONE server is less than the comparable x86 combination when one includes the costs for all the added hardware, software, databases, personnel, power, and disaster recovery systems.

The sustainability savings of a LinuxONE Max68 versus 120 x86 servers – when adding up all the sustainability components in our study – exceeded \$3 million per year. Operating the LinuxONE Max68 was **more than 35x less expensive**. Moreover, the acquisition costs for the LinuxONE Max68 should be less expensive than the comparable x86 servers, not to mention all the additional networking equipment required. A customer achieving similar savings would witness a return on investment (**ROI**) in **potentially less than 12 months**.

LinuxONE servers offer unmatched value on day one and throughout a three- or five-year life cycle and beyond. Additionally, LinuxONE servers offer the ability for sustainable, cost-effective in-place upgrades with the latest processing power, throughput, and security capabilities to continuously deliver an optimized cost/value proposition.

**Summary – Key Features:**

RFG believes that a LinuxONE server is the most sustainable server on the market today. Additionally, it is the least risk, highest performing, highly scalable, and most secure data server solution that can be acquired to meet most mid-sized to large enterprise business processing requirements. The platform can scale with the business demands while minimizing the impact to finances, operations, and risks. It can also be a platform of choice for private cloud, hybrid or multi-cloud ecosystems as well as for traditional legacy environments by reducing cost and complexity while enabling transformative business outcomes faster and easier than competitors' offerings.

Having a LinuxONE installation is like having one's own private cloud in that executives need not worry about the ability to scale up or down as they deal with economic uncertainties. Moreover, executives can feel secure knowing that their mission-critical databases and workloads are on reliable, secure LinuxONE systems and not in the public cloud or on x86 servers. The incorporated security features make it simpler for corporate management to meet their fiduciary requirements and reduce exposure to cyber incidents that result in negative goodwill, loss of revenues, financial remuneration, legislative penalties, etc.

Companies can enjoy the significant sustainability advantages of a LinuxONE while at the same time leveraging enterprise server benefits including availability, resiliency, reduced risks, productivity, cost advantages (ROI, TCA, TCO), refresh advantage, quality of service (QoS), and growth cost avoidance. Businesses remain in control of their environment affording agility and risk reduction with price and performance predictability always aligned with evolving business dynamics. No other platform offers this level of sustainability, security, and future-proofing while simultaneously cutting costs and minimizing operational risks.

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## Appendix 1

<u>x86 vs. LinuxOne analysis</u>			
	Dell R740	LinuxOne Max68	Ratio
number of servers	120	1	
number of chips/server	2	16	
% utilization	17.4%	78.3%	
# watts server	450	5295	
subtotal kWh average	29.7	5.3	5.61
PUE	1.55	1.55	
<u>racks+switches</u>			
number of racks	10	1	
number of switches (2/rack)	20	2	
total kw for switches	2.8	0	
total kw including PUE	50.3	8.2	16%
sq. ft. per rack	14	14	
# racks (12/rack)	10	1	
sq ft used	140	14	
sq ft % freed up		90%	
number of chips	240	16	7%
number of cores/chip	20	4.25	
total cores	4800	68	1.4%
total kw per year	440,946	71,896	16%
CO2 metric tons consumed/year	191	31	