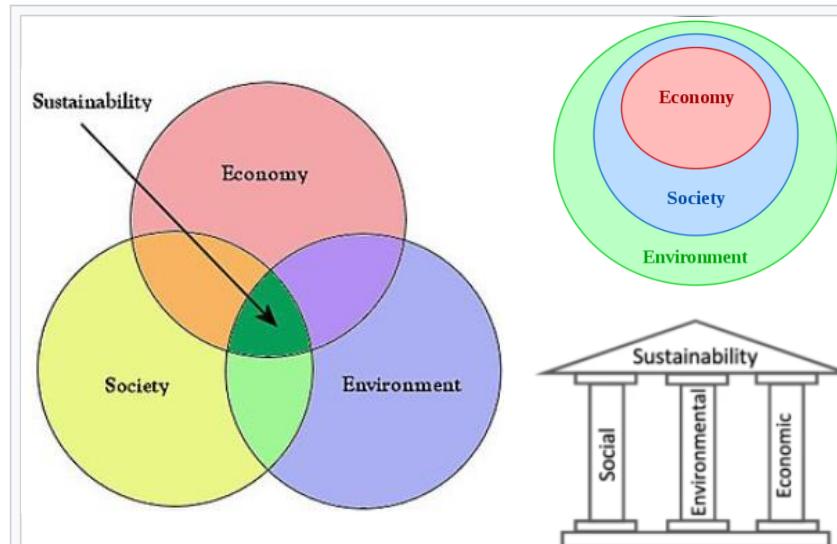


# Achieving your Sustainability goals by leveraging your zSystems and LinuxONE servers

Eduardo C. Oliveira, M.Math.  
Principal IBM zSystems Architect  
[eduardoc@us.ibm.com](mailto:eduardoc@us.ibm.com)



- **Sustainability** is a societal goal with three dimensions (also called pillars): the environmental, economic and social dimension. This concept can be used to guide decisions at the global, national and at the individual consumer level.



Commonly used schematics of the tripartite description of sustainability: Left, typical representation of sustainability as three intersecting circles. Right, alternative depictions: literal 'pillars' and a concentric circles approach.<sup>[1]</sup>



# SUSTAINABLE DEVELOPMENT GOALS

<b>1</b> NO POVERTY	<b>2</b> ZERO HUNGER
	
<b>3</b> GOOD HEALTH AND WELL-BEING	<b>4</b> QUALITY EDUCATION
	
<b>5</b> GENDER EQUALITY	<b>6</b> CLEAN WATER AND SANITATION
	

<b>7</b> AFFORDABLE AND CLEAN ENERGY	<b>8</b> DECENT WORK AND ECONOMIC GROWTH
	
<b>9</b> INDUSTRY, INNOVATION AND INFRASTRUCTURE	<b>10</b> REDUCED INEQUALITIES
	
<b>11</b> SUSTAINABLE CITIES AND COMMUNITIES	<b>12</b> RESPONSIBLE CONSUMPTION AND PRODUCTION
	

<b>13</b> CLIMATE ACTION	<b>14</b> LIFE BELOW WATER
	
<b>15</b> LIFE ON LAND	<b>16</b> PEACE, JUSTICE AND STRONG INSTITUTIONS
	
<b>17</b> PARTNERSHIPS FOR THE GOALS	



## CLIMATE ACTION: WHY IT MATTERS

### What's the goal here?

Taking urgent action to tackle climate change and its impacts.

### Why?

The climate crisis continues unabated as the global community shies away from the full commitment required for its reversal. 2010-2019 was warmest decade ever recorded, bringing with it massive wildfires, hurricanes, droughts, floods

and other climate disasters across continents.

### How are people being affected by climate change?

Climate change is affecting every country in the world. It is disrupting national economies and affecting lives and livelihoods, especially for the most vulnerable.

Weather patterns are changing, sea levels are rising, and weather events are becoming more extreme,

To limit global warming to 1.5C, as called for in the Paris Agreement, greenhouse gas emissions must begin falling by **7.6 % each year starting in 2020**

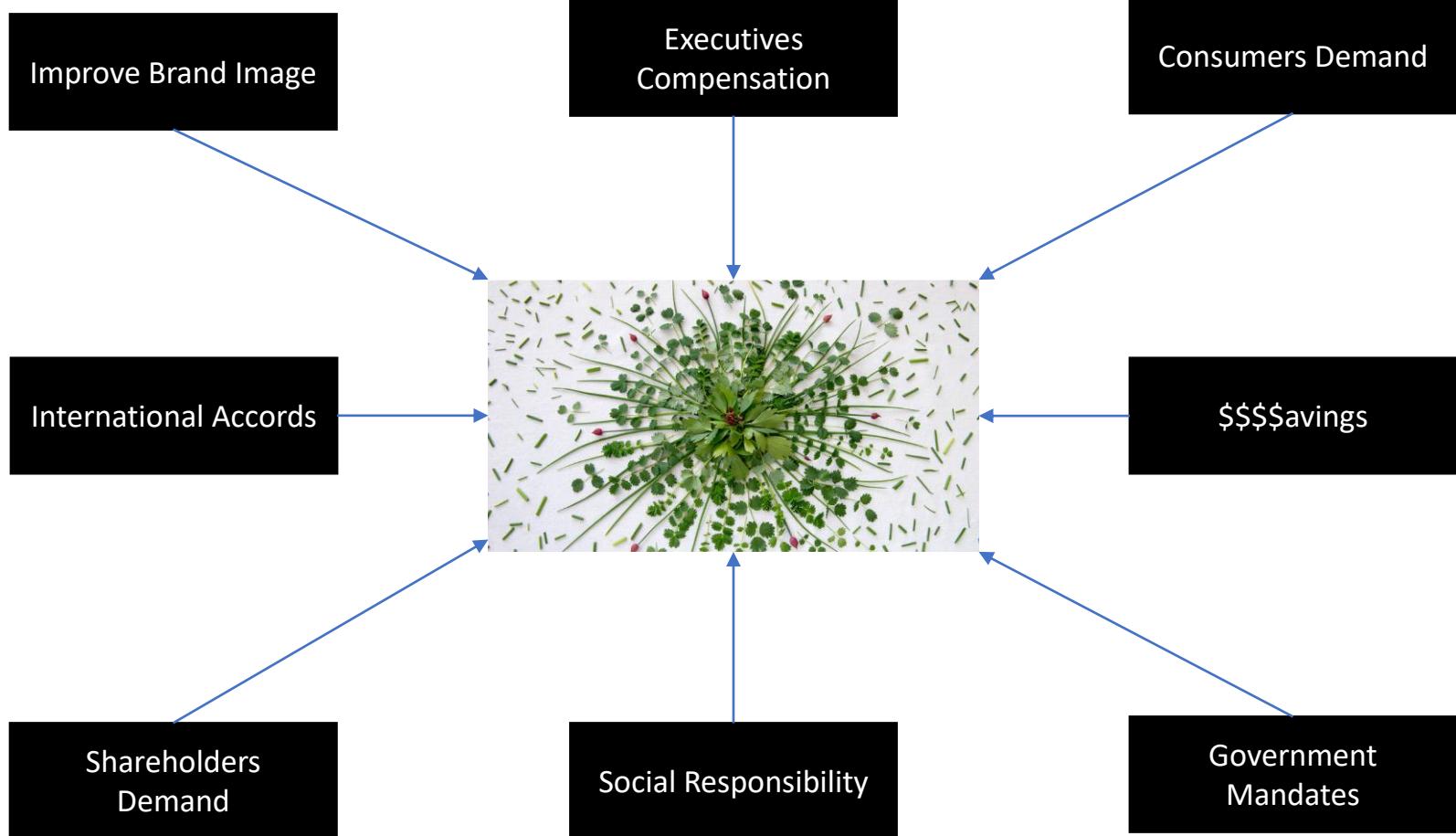
## GOAL 13: CLIMATE ACTION

Climate change is a global challenge that affects everyone, everywhere.



### ACT NOW TO STOP GLOBAL WARMING.

Global emissions of carbon dioxide (CO<sub>2</sub>) have increased by almost 50% since 1990.



# There are more than 2,500 climate laws and policies worldwide

<https://climate-laws.org/>

<http://www.aequilibria.com/en/netherlands-launches-progressive-carbon-tax/>

- US Environmental Protection Agency (EPA) Greenhouse Gas (GHG) Reporting Program
- UK Streamlined Energy and Carbon Reporting (SECR)
- World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol (GHGP)
- The International Standards Organization (ISO) 14064 standards for greenhouse gas accounting and verification
- Ireland: Climate Action Plan aims at achieving EU 2030 emissions targets as well as reaching net zero emissions by 2050
- Singapore: All facilities producing 25,000 tonnes or more of greenhouse gas emissions in a year will have to pay a carbon tax
- Colombia: The Colombia Low-Carbon Development Strategy (ECDBC)
- Morocco: Climate Change Policy of Morocco
- Vietnam: The National Climate Change Strategy

# World's Largest Data Centers

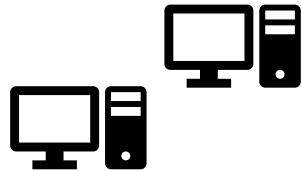
- #1: China Telecom- Inner Mongolia - 150 MW
- #2: China Mobile- Hohhot – 130 MW
- #3: China Mobile- Harbin – 120 MW
- #4: \*Range- International Information Hub (China) – 115 MW
- #5: China Unicom- Northwest – 110 MW
- #6: China Mobile- Southern Logistics Center – 102 MW
- #7: China Telecom- Guizhou Information Park – 100 MW
- #8: NSA- Bumblehive (USA) – 90 MW
- #9: Digital Realty- Lakeside (USA) – 85 MW
- #10: Tulip Telecom- Data City (India) – 80 MW

Metric	Value	Ranking
Size (sq. ft.)	10,763,910	#1
Investment (\$)	3 billion	#1
Power Consumed (MW)	150	#1
Green Power Output (MW)	0	N/A
Green Power Output (%)	0	N/A

\* IBM will provide design services, technology, training, solutions and business application

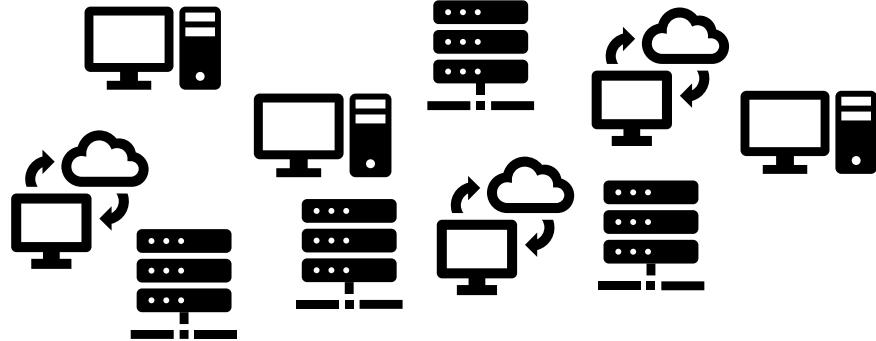
# Interesting Facts

2010 Computing Power



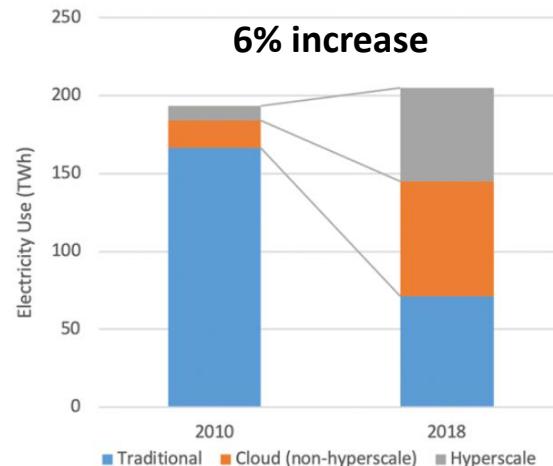
> 5x

2018 Computing Power



2010 World's data centers consumed 196 terawatt-hours of electricity

1% of WW electricity consumed/yr



2018 World's data centers consumed 205 terawatt-hours of electricity

1% to 2% of WW electricity consumed/yr  
(excluded virtual currency mining)

3% by 2030

# The 1% Principle...

$$1^{365} = 1$$

Just 1% more  $(1.01)^{365} = 37.8$

Just 1% less  $(0.99)^{365} = 0.03$



Little extra creates  
**37 times**  
stronger result

Little less creates  
**1500 times**  
weaker result

 Astro Astronomy Magazine   
May 18 at 11:00 PM · 

While 1 percent of anything doesn't sound like much, with light, that's still really fast – close to 7 million miles per hour!

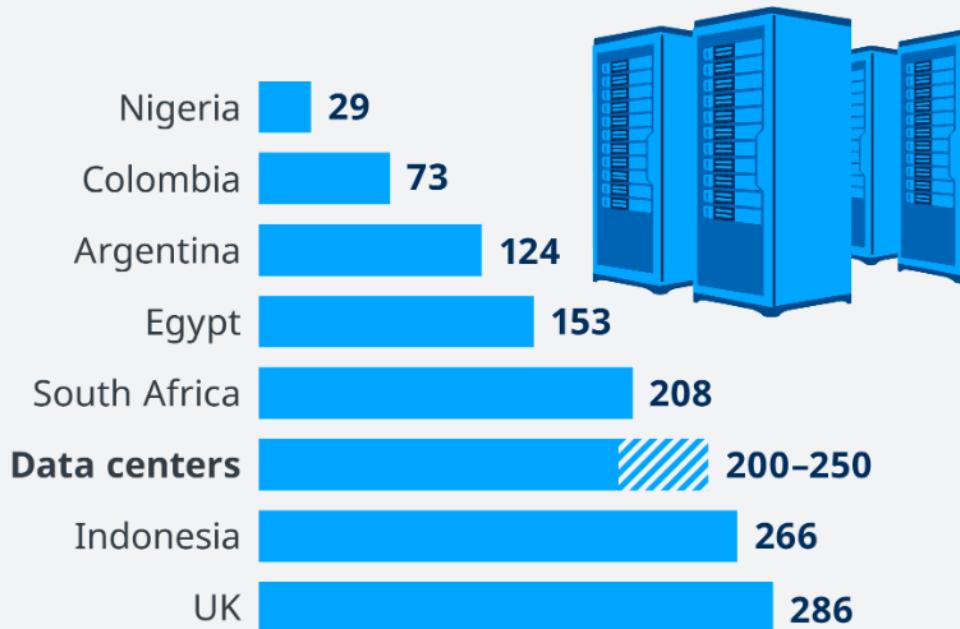


ASTRONOMY.COM

Astro for kids: Have we made an object that can travel at 1% the speed of light?

# Data centers use more electricity than entire countries

Domestic electricity consumption of selected countries vs. data centers in 2020 in TWh

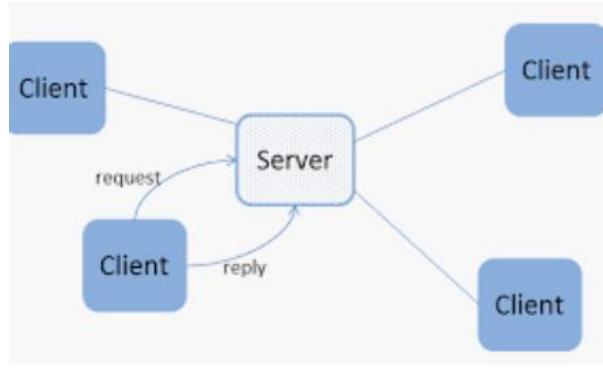


# The 40s to 80s Data Center



IBM 7094

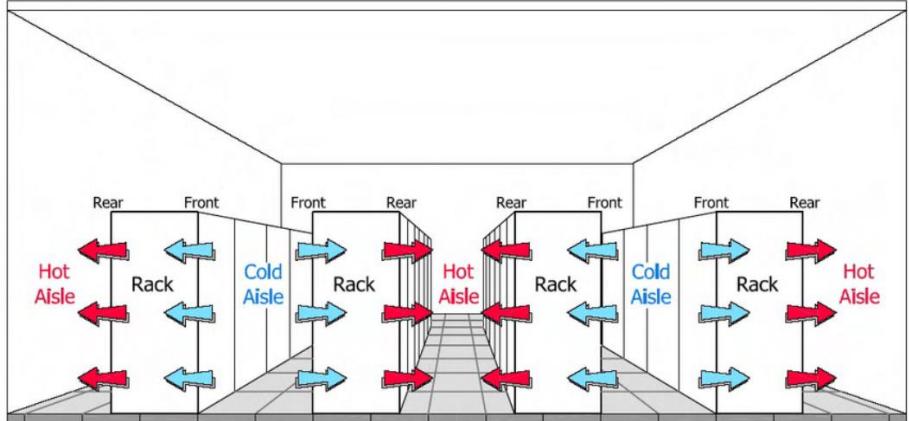
# The 90s to early 2000s Data Center



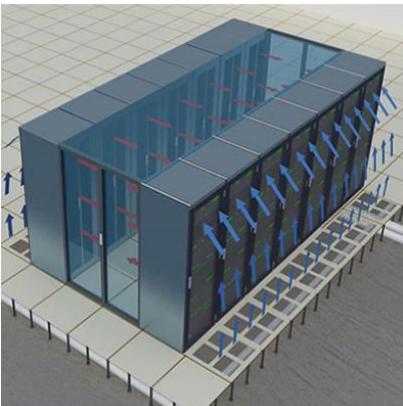
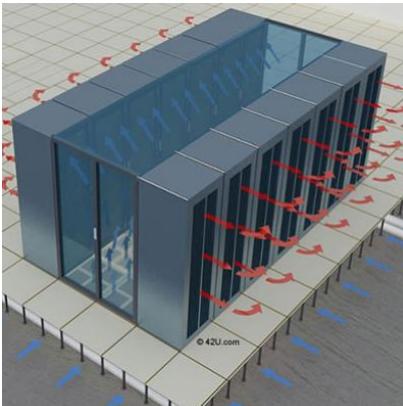
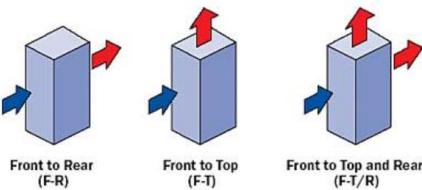
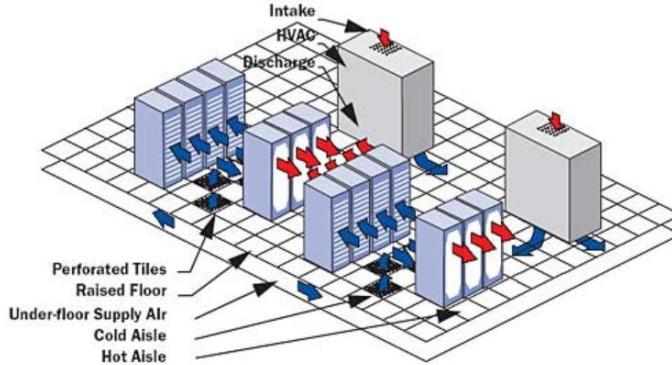
# Modern Data Centers



# Data Center Cooling



Typical Data Center HVAC Hot Aisle / Cold Aisle Layout



# POWER GENERATION – Top 5 WW

Rank	Station	Country	Location	Capacity (MW)	Annual generation (TWh)	Type	Notes
1.	Three Gorges Dam	China	30°49'15"N 111°00'08"E	22,500	111.8 (2020) <sup>[8]</sup>	Hydro	
2.	Baihetan Dam	China	27°13'07"N 102°54'22"E	16,000	60.24 (2021) <sup>[9]</sup>	Hydro	
3.	Itaipu Dam	Brazil Paraguay	25°24'31"S 54°35'21"W	14,000	103.09 (2016)	Hydro	
4.	Xiluodu	China	28°15'52"N 103°38'47"E	13,860	55.2 (2015)	Hydro	
5.	Belo Monte	Brazil	03°07'27"S 51°42'01"W	11,233	39.5 (expected)	Hydro	Installation of the 18th and final turbine was completed in November 2019.



14.	Grand Coulee	United States	47°57'23"N 118°58'56"W	6,809	20.24 (average)	Hydro	Largest in North America
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# Largest Power Plants in the World

Held record		Name of power station	Capacity (MW)	Location
From	To			
1911	1913	Vemork	108	Rjukan, Telemark, Norway
1913	1922	Lock and Dam No. 19	142	Hamilton, Illinois / Keokuk, Iowa, United States
1922	1939	Sir Adam Beck Station I	149.4-498 <sup>[46]</sup>	Niagara Falls, Ontario, Canada
1939	1949	Hoover Dam	705	Clark County, Nevada / Mohave County, Arizona, United States
1949	1959	Grand Coulee Dam	2,280	Washington, United States
1959	1963	Volga Hydroelectric Station	2,300–2,563	Volgograd, Russian SFSR, Soviet Union
1963	1971	Bratsk Hydroelectric Power Station	2,750–4,500	Bratsk, Russian SFSR, Soviet Union
1971	1983	Krasnoyarsk Dam	5,000–6,000	Krasnoyarsk, Russian SFSR, Soviet Union
1983	1986	Grand Coulee Dam	6,181–6,809	Washington, United States
1986	1989	Guri Dam	10,235	Necuima Canyon, Venezuela
1989	2007	Itaipu Dam	10,500–14,000	Iguazu Falls, Paraná River, Brazil / Paraguay
2007	present	Three Gorges Dam	14,100–22,500	Three Gorges, Yichang, Hubei Province, China

# US Leads on Geothermal Power Production

Rank	Station	Country	Location	Capacity (MW)	Ref
1.	The Geysers	 United States	 38°47'26"N 122°45'21"W	1,517	[102]
2.	Cerro Prieto	 Mexico	 32°23'57"N 115°14'19"W	820	[103][104][105]
3.	Larderello	 Italy	 43°13'56"N 10°53'07"E	769	[106]
4.	Olkaria	 Kenya	 0°53'14"S 36°18'25"E	727	[107]
5.	Imperial Valley	 United States	 33°09'48"N 115°37'00"W	403.4	[108]



Each kilowatt hour  
of **electricity** that  
you use produces  
half a kilogram of  
carbon dioxide CO<sub>2</sub>

Source: IBM IT Economics Team

# Each kWh of

# Conversely, each

U.S. electricity net generation and resulting CO<sub>2</sub> emissions by fuel in 2021

	Electricity generation	CO <sub>2</sub> emissions	million short tons	pounds per kWh
	million kWh	million metric tons		
Coal	897,885	919	1,013	2.26
Natural gas	1,579,361	696	767	0.97
Petroleum	19,176	21	23	2.44

Data source: U.S. Energy Information Administration, [State Electricity Profiles, U.S. Profile, Table 5 \(net generation\) and 7 \(emissions\)](#).

Note: Data are for utility-scale electric power plants, including [combined heat and power plants](#).

Source: IBM IT Economics Team



# 67%

of global businesses consider sustainability fundamental to remaining competitive.

– IBM Green Horizons initiative

<http://www.research.ibm.com/green-horizons/#fbid=g1UcJof4EKi>



Empowered consumers – along with employees, stakeholders and business partners – are also demanding more responsible business practices

– IBM Institute for Business Value (IBV) Executive Report,  
*Green and beyond – Getting smarter about the environment*



# IBM is doing its part by committing to net zero GHG emissions by 2030



**IBM will:**

- Reduce GHG emissions 65% by 2025
- Procure 75% of the electricity it consumes worldwide from **renewable sources** by 2025, and 90% by 2030
- **Remove emissions** in an amount which equals or exceeds the level of IBM's residual emissions



# zSystems and LinuxONE are reducing environmental impact

Typically, **half** the electricity and floor space

Generation Improvements

Recycled / recyclable / reused packaging

Lighter crates, responsibly sourced



**SEAL Sustainable Product Award**  
IBM received a SEAL Sustainable Product Award in the 2021 SEAL Business Sustainability Awards for the IBM z15. This award honors innovative and impactful products that are "purpose-built" for a sustainable future.



**2021 S&P Global Platts Global Energy Award**  
IBM received the Energy Consumer Sustainability Award at the 23rd S&P Global Platts Global Energy Awards for the company's decades-long leadership in addressing its impact on climate change and recent pledge to reach net zero greenhouse gas emissions by 2030.



**The Global CSR Awards 2021**  
IBM received a Best Environmental Excellence Award at the platinum level in The Global CSR Awards 2021 for its ambitious energy and climate commitments, and longstanding achievements related to energy conservation and climate protection.



# IBM is client zero in the battle for enterprise sustainability

IBM uses sustainable, responsible practices, and helps clients do the same

- Climate risk management
- Resilient infrastructure and intelligent operations
- Sustainable supply chains
- Electrification, energy and emissions management
- Sustainability strategy
- IBM Research



Sustainability as a transformation catalyst

Sustainability as a Business Strategy

Sustainability as a Business Imperative

The Rise of the Sustainable Enterprise

How to create more sustainable operations – one asset at a time

# Sustainability as a transformation catalyst

Trailblazers turn  
aspiration into action

IBM Institute for  
Business Value



While 86% of companies have  
a sustainability strategy,  
**only 35% have taken action**

This study was a collaboration between the IBV and Oxford Economics  
<https://www.oxforeconomics.com>

# Recommendations for making your infrastructure more green

- Take out cost and improve the efficiency of information technology
- Manage the environmental impact of buildings and physical assets
- Enable readiness with regulatory compliance

– IBM Institute for Business Value (IBV) Executive Report,  
*Green and beyond – Getting smarter about the environment*

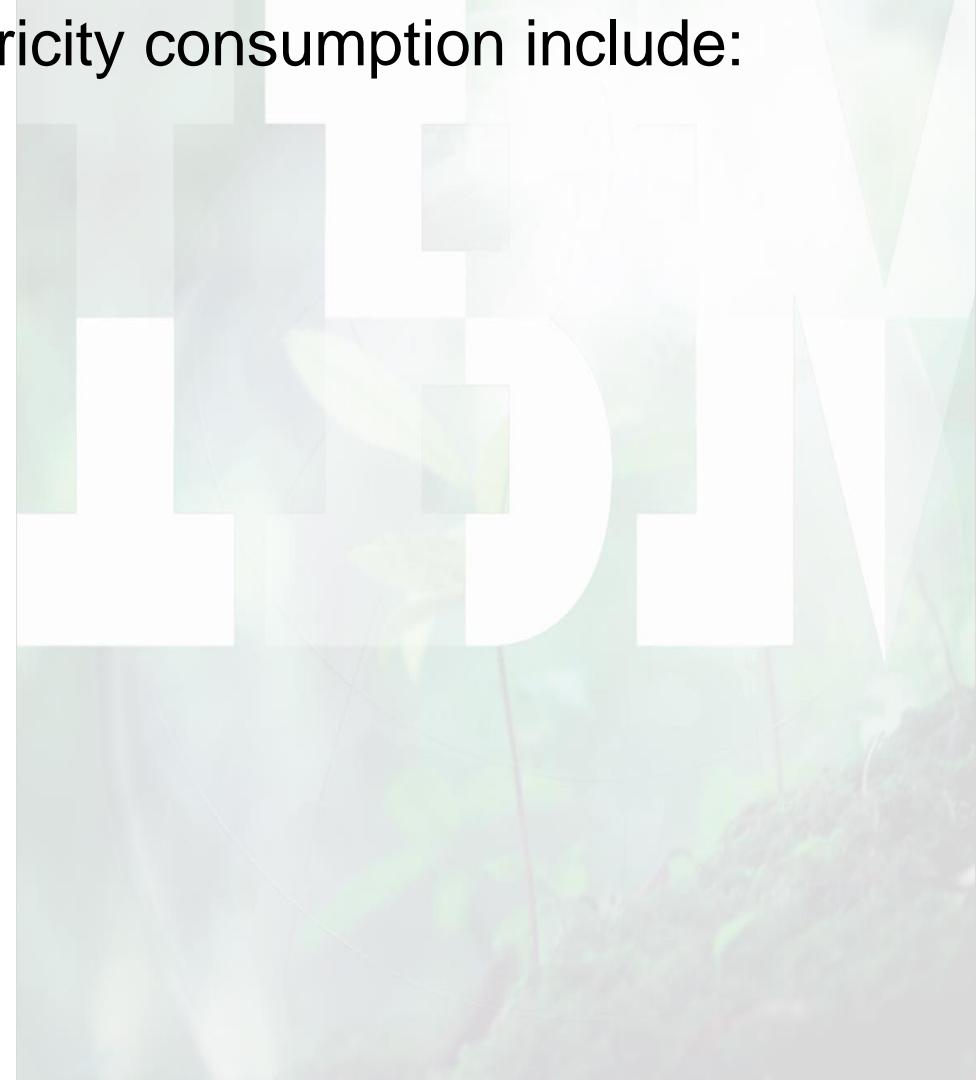


Follow the recommended practice for maximizing efficiency

Reduce server sprawl to avoid building new and larger data centers

Implement blockchain to provide audit worthiness and transparency

Best practices for reducing electricity consumption include:



A photograph of a small green plant with several leaves growing out of a clear glass bowl filled with various gold-colored coins.

**LinuxONE helps with all the best practices**

One LinuxONE system can do the work of several x86 systems, so you need fewer systems

For the same workload, a LinuxONE system consumes half as much energy as x86 systems

The LinuxONE architecture includes the fastest compute, designed to run at ~100% utilization

The 4th generation LinuxONE – LinuxONE Emperor 4 – is the most energy efficient the platform has been

IBM z/VM hypervisor is more efficient than the popular hypervisor for x86

# Growing IBM zSystems & LinuxONE Open Source Ecosystem

The image is a collage of numerous open source project logos, organized into five main categories:

- Linux Distributions & Virtualization:** Red Hat, ubuntu, SUSE, KVM, debian, openSUSE, fedora, ClefOS, alpine.
- Cloud & Container Services:** docker, LXD, openstack, kubernetes, minikube, HELM, Istio, OKD, OPENSHIFT, APACHE HTTP SERVER PROJECT, MARATHON, Sysdig, Terraform, kata containers, podman.
- Languages & Runtimes:** Java, JS, R, python, Open Liberty, Ruby, Scala, GO, node.js, pypy, ERLANG, PHP, RAILS, OCaml, OpenJDK, Groovy, Apache Tomcat, Clojure, HYPERLEDGER FABRIC, TensorFlow, WildFly, mosquitto, APACHE GEODE, HIBERNATE.
- DevOps/Automation:** CHEF, ANSIBLE, puppet, Jenkins, JMeter, Travis CI, ANTLR, Maven, sonarqube, Gradle, SALTSTACK.
- Big Data, Observability, Analytics:** splunk, Flink, Apache Solr, Apache Ignite, apache kafka, fluentd, Grafana, logstash, elasticsearch, kibana.

Below the main categories, there are two additional sections:

- Databases:** CouchDB, relax, mongoDB, MariaDB, RethinkDB, redis, PostgreSQL, MySQL, cassandra, SCYLLA, Couchbase.
- Middleware:** ACTIVEMQ, Camel, muleESB, RabbitMQ, mosquito, HIBERNATE.

At the bottom left, the URL [www.ibm.com/community/z/open-source-software/](http://www.ibm.com/community/z/open-source-software/) is displayed. At the bottom right, there are social media icons for LinkedIn, GitHub, and YouTube.

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# Open Mainframe Open Source Projects



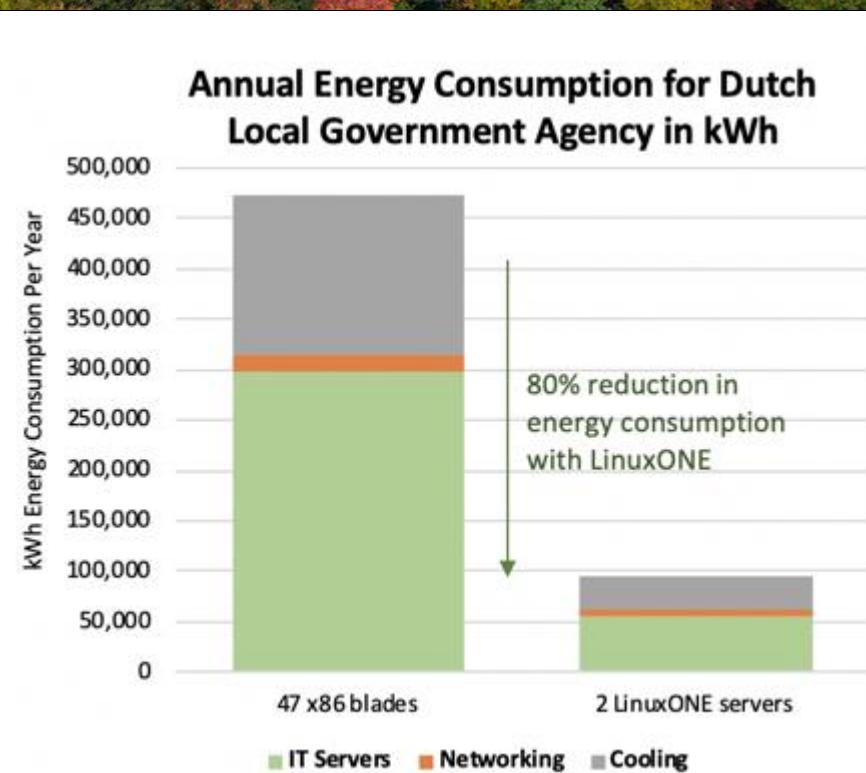
<https://www.openmainframeproject.org/projects>

# Improving sustainability by maximizing efficiency

- Dutch Government agency moves to LinuxONE to comply with new gas emissions law
- Migrated Linux workloads from 47 x86 blades to 11 cores on two LinuxONE servers
- Projected **80%** reduction in energy consumption
- **946 fewer metric tons of CO<sub>2</sub> emissions over five years**

1 metric ton is approximately 2,204.6 pounds

Average of **4 metric tons per year per blade** consolidated



# LinuxONE helping reduce carbon footprint and server sprawl

- Higher utilization and workload density
- Faster processors and larger caches
- Intelligent I/O subsystem
- More efficient software hypervisor

x86 and LinuxONE Energy and Floor Space Comparisons for Asia Pacific Insurance Company\*

Data Center Requirements	x86	LinuxONE	Savings
Energy	890,016 kWh	335,508 kWh	62%
Floor space	42.57 meters	6.11 meters	86%



\* Results from Carbon Footprint Assessment by IBM IT Economics Team

## IBM LinuxONE™ TCO and CO2e Calculator

- How much less power could you consume and how much money could you save?
- Answer the questions below to get a personalized total cost of ownership estimate for LinuxONE.

[Get started now](#)[Get started](#) > [Questions](#) > [Your results](#)

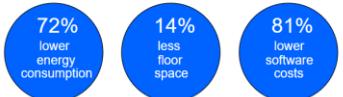
### Examine how to

- Determine CO2e emission differences between x86 and LinuxONE running similar workloads
- Consolidate per core licenses to drive TCO savings
- Reduce IT costs by running enterprise software on LinuxONE

### How it works

By answering just a few questions such as hardware, workload type and software, the IBM LinuxONE cost and emissions estimator provides a comparison of emissions and a high-level total cost of ownership.





Based on your inputs when comparing LinuxONE to x86:

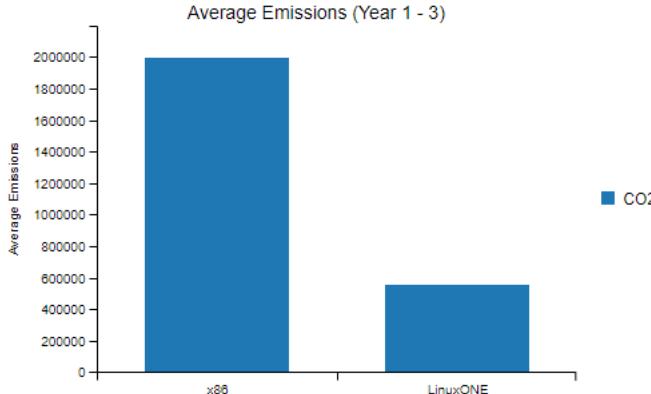
LinuxONE could lower the cost of your workloads over three years by \$42.06M with

- \* Immediate Savings
- \* TCO reduced by 55.1% in 3 years
- \* ROI = 122.6%

#### Your x86 server inputs

Servers	Type of servers	Workload	Processors per server	Cores per x86 server	# of physical production servers	# of physical non-production servers <sup>1</sup>	Total DR servers <sup>2</sup>	Total x86 servers	Total x86 cores
1 year old	Rack	Application	2	32	100	100	100	300	9600

1. For each set of production workloads is an additional 100% of corresponding physical servers for the Dev/Test and Quality Assurance non-production environment. A production workload environment of 100 cores, for example, is



#### CO<sub>2</sub> Emissions

Data Center Location  State

Cooling Factor

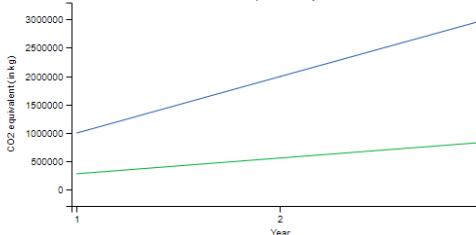
#### x86 CO<sub>2</sub> Emissions by year

	Year 1	Year 2	Year 3	3 Year Total
Yearly kWh	2,797,401	2,797,401	2,797,401	8,392,203
Emissions (CO <sub>2</sub> Eqv.)	996,798	996,798	996,798	2,990,394

#### LinuxONE CO<sub>2</sub> Emissions by year

	Year 1	Year 2	Year 3	3 Year Total
Yearly kWh	779,806	779,806	779,806	2,339,419
Emissions (CO <sub>2</sub> Eqv.)	277,868	277,868	277,868	833,605

#### Accumulated CO<sub>2</sub> Comparison by Year



# Blockchain on **LinuxONE** for audit worthiness and transparency

Unparalleled transparency metrics with  
IBM-backed blockchain technology

*“We were able to come up with a solution where you could take a given product and look at the specific environmental impact of that product, backed by and verified by blockchain technology.”*

– Mark Herrema, CEO of Newlight Technologies, Inc.



# References

Study on IBM LinuxONE power/carbon reduction

<https://www.ibm.com/downloads/cas/GYR3MWQN>

IT Economics Carbon Footprint Assessment:

<https://www.ibm.com/downloads/cas/LBK3PD16>

Demo of Envizi & Turbonomic showing environmental value of LinuxONE:

[https://mediacenter.ibm.com/media/1\\_319upu1y](https://mediacenter.ibm.com/media/1_319upu1y)

How Citi Drives Sustainability with LinuxONE:

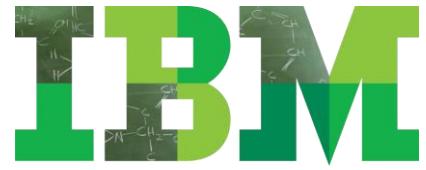
[https://mediacenter.ibm.com/media/How+Citi+drives+sustainability+with+IBM+LinuxONE/1\\_gfbe560d](https://mediacenter.ibm.com/media/How+Citi+drives+sustainability+with+IBM+LinuxONE/1_gfbe560d)

BBVA reduces CO<sub>2</sub> emissions and energy consumption of its Data Center processors by 50% with IBM technology: <https://www.bbva.com/en/sustainability/bbva-reduces-co-emissions-and-energy-consumption-of-its-data-center-processors-by-50-with-ibm-technology/>

LinuxONE Carbon Footprint Report: <https://www.ibm.com/downloads/cas/KLMA1MPR>

# References

Estimated Annual CO<sub>2</sub> Reduction is based on the Greenhouse Gas Equivalencies Calculator from the United States Environmental Protection Agency, <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.



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