Reducing the carbon footprint of computing

IT organizations worldwide are finding solutions to reduce greenhouse gas emissions

As governments and industries seek to limit the amount of greenhouse gas emissions, environmental standards, organizations and legislations increase to actively address the impact of human activity on the environment. For businesses in many nations, compliance with environmental directives is required to avoid financial penalties. Contribution to global sustainability is also viewed by many businesses as a competitive advantage. Their clients prefer to do business with organizations that take action to minimize their greenhouse gas emissions.

Data center energy consumption

Most data center facilities consume up to 10 to 50 times the energy per floor space of a typical commercial office building[1], so for many businesses an energy efficient IT solution is an essential step towards achieving carbon footprint reduction.

An energy efficient data center design seeks to address all aspects of carbon footprint savings, from its IT hardware, heating, ventilation and air conditioning equipment to its physical layout and construction. Best practices for reducing electricity consumption include:

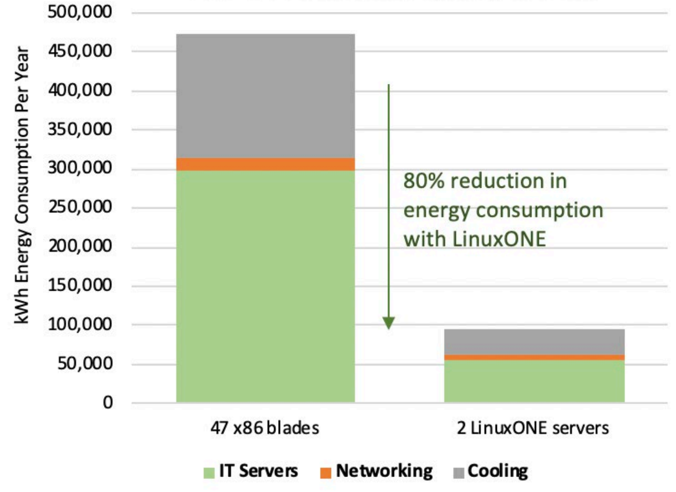
- Selecting server hardware that requires a smaller number of physical systems
- Using high energy-efficiency systems
- Keeping systems updated to the latest generation since lower energy consumption per unit of work is generally achieved with technology advancements
- Using system architectures that enable high compute and resource utilization on each system and high compute and storage density to avoid server sprawl
- Using software that enables high utilization of system resources and that enables use of virtualization to utilize targeted resources only when necessary
- Implementing computing models that facilitate resource sharing (cloud computing) and that reduce data and compute movement (edge computing)
- Adopting data center floor plans that decrease the amount of energy used for cooling (hot and cold flow separation and reuse of energy)

Energy consumption directives

In an effort to comply with the Netherlands' Supreme Court decision to reduce greenhouse gas emissions by 25% compared with 1990 levels by the end of 2020[2], one Dutch local government organization replaced part of its x86 server IT infrastructure with an IBM LinuxONE™ environment.

By moving its Linux applications from 47x86 blades to 11 IFLs on LinuxONE, energy consumption for the organization is projected to be reduced by 80%, resulting in 946 fewer metric tons of CO2 emissions over five years[3].

Annual Energy Consumption for Dutch Local Government Agency in kWh



[1] U.S. Department of Energy, https://www.energy.gov/eere/buildings/data-centers-and-servers

[2] Supreme Court of the Netherlands' decision, https://uitspraken.rechtspraak.nl/inziendocument?id=ECLI:NL:HR:2019:2006

[3] Energy savings are based on a carbon footprint assessment conducted by the IBM IT Economics team for a government agency in the Netherlands using four blade centers with a total of 47 blades at 8.5 KW (4.5 KW for blades and 4 KW for the chassis based on vendor published KW rates) for an estimated annual server energy consumption of 297,840 kWh versus two LinuxONE Rockhopper I servers with 6 IFLs each at 3.1 KW each, consuming an estimated total of 54,312 kWh annually. Network energy consumption of 2 KW for the blades (two for each blade center for a total of eight) and 1 KW for the LinuxONE servers (two switches for each server), based on vendor published KW rates for networking switches, results in an estimated 17,520 kWh for the blade centers and 8,760 kWh for the LinuxONE servers. Cooling energy consumption is estimated by using an efficiency factor based on the server's architecture and is proportional to the networking and servers' power consumption. In this assessment both blade centers and LinuxONE servers use a data center power utilization effectiveness rate of 1.5 as the factor to calculate cooling consumption, resulting in an estimated 157,680 kWh for the blade centers and 31,536 kWh for the LinuxONE servers. The assessment uses a kWh to CO2 factor of 505.2 grams of CO2 for 1 kWh based on Netherlands CO2 emissions intensity from electricity generation from the European Environment Agency, https://www.eea.europa.eu . Findings from IBM IT Economics assessments will vary according to each client environment.

Another European financial institution was considering a move of some of its IBM Z® applications onto x86 servers and decided to first assess its anticipated energy consumption.

Carbon footprint analysis indicated that the institution's energy consumption could triple (76%)[4] if moving to an x86 environment from its existing IBM z14® environment. Conversely analysis found that deployment on new IBM z15™ servers could reduce energy consumption by 14% compared to z14[4].

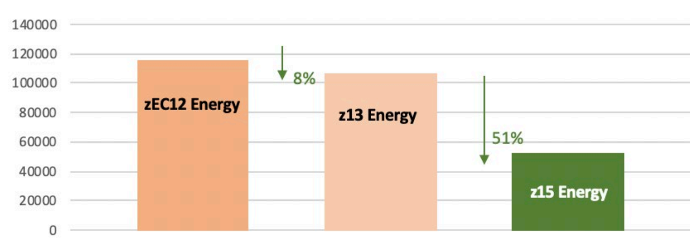
Total Annual Energy Consumption (kWh) Savings for European Financial Institution

z14 kWh savings versus x86	z15 kWh savings versus x86	z15 kWh savings versus z14
76%	79%	14%

For companies moving from earlier IBM Z technologies to z15, energy consumption savings can be significant as a result of hardware and software technology efficiencies with successive generations.

Using data from client environments in IBM IT Economics assessments, energy costs were calculated in a five-year cost model. In an IBM zEnterprise® EC12 (zEC12) to IBM z13® model, energy savings were 8%[5], and in a z13 to z15 model, energy costs decreased by 51%[6]. Additionally, the new z15 provides the Intelligent Power Distribution Unit (iPDU) as an option for lower power consumption in radiator-cooled systems[7].

zEC12, z13 and z15 Energy Consumption in Five Year Cost Model



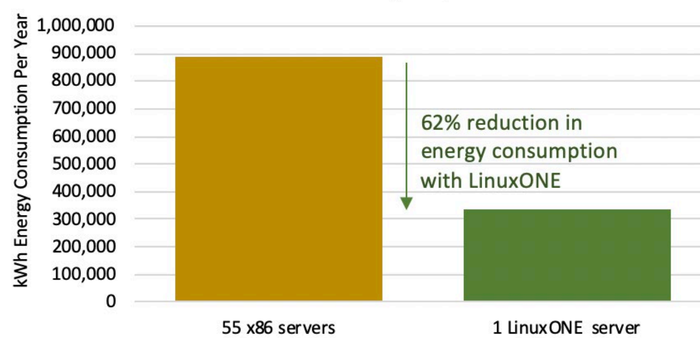
Other geographies are also focused on decreasing data center costs and carbon emissions. A large insurance company in Asia Pacific was experiencing significant IT growth. As its x86 data center grew, physical floor space charges and hardware costs increased, energy bills became higher, and its IT staff struggled with server administration complexities.

The company initiated an assessment of its current operations to find more effective scaling for new workloads. Analysis discovered that workloads running on 55 x86 servers could be consolidated onto one IBM LinuxONE system with a dramatic decrease in energy and floorspace usage. Floor space could be reduced by 86% and annual energy consumption could drop by 62%[8]. These savings enable the company to address their challenges of rapid growth with much denser workload consolidation, a smaller data center and simpler administration for its staff.

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%

Annual Energy Consumption for Asia Pacific Insurance Company in kWh



[4] Energy savings are based on a carbon footprint assessment conducted by the IBM IT Economics team for a European financial institution running workloads on six z14 servers versus running those same workloads on a sizing of 30 x86 blade centers. The z14 servers are estimated to consume 470,412 kWh annually based on published IBM rates totaling 54 KW. The sized blade centers are estimated to consume 1,487,448 kWh annually based on vendor published rates totaling 170 KW. Cooling energy consumption is estimated by using an efficiency factor based on the server's architecture and is proportional to the servers' power consumption. A factor of 2, based on the client's distributed server data center power utilization effectiveness (PUE), is used to estimate cooling energy consumption for the blade centers, and a cooling factor of 1.5 is used for IBM Z based on the PUE in IBM managed IBM Z data centers. Findings from IBM IT Economics assessments will vary according to each client environment.

[5] An IBM IT Economics model was used to examine z15 hardware and software upgrade costs. The cost model compared total operating costs over five years for hardware, software, people, networking, floorspace, and energy costs. The zEC12 to z15 replacement scenario assumes no workload growth over a five-year time period. The cost model analyzed a sampling of z/OS workloads. For the zEC12 to z15 scenario the model used CICS v5.1, Db2 v11, and COBOL v5.1 on z/OS v2 for the zEC12 environment, and CICS v5.4, Db2 v12 and COBOL v6.2 on z/OS v2.3 for the z15 environment. Using findings from the IBM IT Economics Research Lab, the zEC12 to z15 upgrade scenario showed an effective 33.5% reduction in MIPS usage. For the zEC12 to z15 scenario, a configuration of 6,000 General Processor MIPS and 3 zIIPs for a two frame zEC12 system was used versus a single frame z15 using 3,987 General Processor MIPS (representing a 33.5% reduction) and 3 zIIPs. Labor costs were held constant across the compared environments. Annual OpEx cost is based on an average of the model costs over five years and includes hardware maintenance, software, people, energy, networking, and floorspace. Datacenter costs include energy, networking, and floorspace. For additional information on the use case model, contact the IBM IT Economics Team at IT.Economics@us.ibm.com

[6] An IBM IT Economics model was used to examine z15 hardware and software upgrade costs. The cost model compared total operating costs over five years for hardware, software, people, networking, floorspace, and energy costs. The z13 to z15 upgrade scenario assumes 5% year to year workload growth over a five-year time period. The cost model analyzed a sampling of z/OS workloads. For the z13 to z15 scenario the model used CICS v5.3, Db2 v12, and COBOL v6 on z/OS v2.2 for the z13 environment, and CICS v5.4, Db2 v12 and COBOL v6.2 on z/OS v2.3 for the z15 environment. Using findings from the IBM IT Economics Research Lab, the z13 to z15 upgrade scenario showed an effective 5.8% reduction in MIPS usage. For the z13 to z15 scenario, an initial configuration of 10,000 General Processor MIPS and 3 zIIPs for a two frame z13 system was used versus a single frame z15 using an initial 9,420 General Processor MIPS (representing a 5.8% reduction) and 3 zIIPs. Labor costs were held constant across the compared environments. Annual OpEx cost is based on an average of the model costs over five years and includes hardware maintenance, software, people, energy, networking, and floorspace. Datacenter costs include energy, networking, and floorspace. For additional information on the use case model, contact the IBM IT Economics Team at IT.Economics@us.ibm.com

[7] On average, clients switching from an earlier IBM Z system to an IBM z15 system can save over $10,000 on their data center energy costs over a 5-year period. Power consumption may vary depending on factors including configuration, workload, etc. Energy cost savings are based on the national average cost of electricity. Individual results may vary.

[8] Energy savings are based on a workload consolidation assessment conducted by the IBM IT Economics team for an Asia Pacific insurance company running Linux workloads on 55 x86 servers with 3,264 x86 cores versus one LinuxONE Emperor II system with 170 IFLs. Analysis estimates total cost of ownership costs such as hardware, software, labor, floorspace and energy with 38.3 KW for the sized LinuxONE versus 101.6 KW for the x86 environment. The KW numbers are calculated using IBM and vendor published server KW rates, and multiplied by 2 for networking and cooling energy consumption based on the client's data center power utilization effectiveness (PUE) of 2, resulting in an estimated reduction from 335K kWh for LinuxONE versus 5.54M kWh for x86. Floor space in use for the 55 x86 servers in the assessment is 42.57 square meters versus an estimated 6.11 square meters for the LinuxONE server. Findings will vary according to individual client environments.

Consolidation of data and applications onto a centralized infrastructure such as IBM Z or LinuxONE can contribute to a more environmentally sustainable IT environment and to fewer greenhouse gas emissions. Running workloads on IBM Z and LinuxONE can also reduce server administration and other data center costs by offering a smaller physical server footprint.

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