IBM® LinuxONE 4 Express

Product carbon footprint

IBM® is committed to environmental leadership in all its business activities, from operations to the design of its products and use of its technology. To help our clients better understand the environmental impacts associated with IBM products, we report the product carbon footprint (PCF) for representative products.

Table 1: *Typical product configuration of the IBM® LinuxONE 4 Express*

CPC drawer	
Model	Max16
Quantity	1
IFL	4
Memory	384 GB
PCIe Fanout	2
6U Shipping POD and Pallet	1
PCIe+ I/O drawer	
Quantity	1
FICON Express32S SX	4
OSA-Express7S 10 GbE SR1.2	4
10 GbE RoCE Express 3.0 SR	2
PCIe Interconnect Gen4	2
9U Shipping Pod	1
Support Element	
1U Server Support Element	2
6U Shipping Pod	1
Ethernet Switch	
24-port Ethernet Switch	2

IBM® LinuxONE 4 Express

CPC drawer product carbon footprint
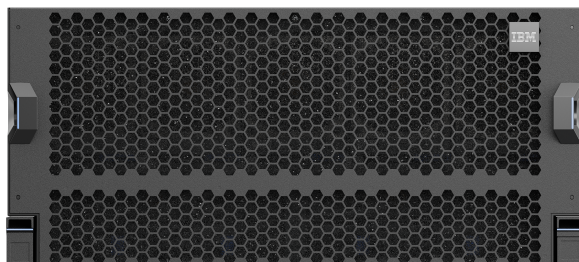
Table 2: *Typical configuration of the IBM® LinuxONE 4 Express CPC drawer.*

Model	Max16
Activated IFL	4
Customer Memory	384 GB
PCIe Fanout	2
6U Shipping POD and Pallet	1

This PCF estimate was produced using the Product Attributes to Impact Algorithm (PAIA) model, developed by the Massachusetts Institute of Technology's Materials Systems Laboratory and partners, Version 1.4.0, January 12, 2024, copyright by the ICT Benchmarking collaboration including the Massachusetts Institute of Technology's Materials Systems Laboratory and partners.

PAIA input assumptions

The PCF assumes a typical configuration of the product as described in Table 2. The numbers for your specific configuration might be different. The data used in the PAIA server tool is provided in Table 3.

Table 3: *Data used in the PAIA server model for the IBM® LinuxONE 4 Express CPC drawer.*

General	
Server type	Rack
Server quantity	1
Number of PSU	4
Number of fans	5
Server weight	83.0 kg
Rack weight	N/A
Packaging weight[3]	47.6 kg
Motherboard	
PWB area	2,374.6 cm^2
CPU quantity	2
CPU package area	56.4 cm^2
DRAM total capacity	1024 GB
Chipset & other ICs package area	Default
Chipset & other ICs quantity	Default
Daughterboards	
Sub card total PWB area	2422.6 cm^2
Sub card main chip package area	177.4 cm^2
Sub card chip count	69
PSU	
PSU weight	1.13 kg
PSU dimensions	19.2 x 10.0 cm
Use[4]	
Product lifetime	5 years
Yearly energy consumption	11,817 kWh
Location	
Assembly location	United States
Use location	Europe
Transportation	
To country of use by air	6,120 km
Within country of use by truck	300 km
End of life	
Fraction recycled	0.97
Fraction shredded recycling	0.00

The estimate

32,900

kg CO_2e[1]

This number is the estimated mean GHG emissions in carbon dioxide equivalent associated with the manufacturing, assembly, electricity consumption[2], transportation and end-of-life handling of the IBM® LinuxONE 4 Express CPC drawer over 5 years using hypothetical average GHG emissions factors for the European Union.

All estimates of carbon footprint are uncertain. For this product, the estimate has a mean of 32,900 kg CO_2e and a standard deviation of 20,800 kg CO_2e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. IBM also reports the 95th percentile of the carbon footprint estimate, which is 89,800 kg CO_2e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Impact by phases of the product's lifecycle
The PCF for server equipment is largely driven by the use phase which is highly variable based on the electricity generation source used to power the product, the expected use life of the product, and the power profile. This PCF was generated using a distribution of emissions factors across the European Union, based on International Energy Agency (IEA) emissions factors. The mean electricity emission factor used in this analysis for the European Union is 0.50 kg CO_2e/kWh.

The analysis for this product shows that 89% of its carbon footprint occurs in the use phase. IBM focuses on improving our product energy efficiency and on providing mechanisms for our clients to measure the actual energy consumption of the product. It is recommended to customize your use phase emissions using your specific electricity grid emissions factor and power information available from the Hardware Management Console (HMC) Environmental Dashboard.

Figure 1 shows the estimated mean contribution for the individual phases of the product's lifecycle over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. Figure 2 shows the uncertainty in the product's carbon footprint. The blue bar representing the mean and one standard deviation and the error bars representing the 5th and 95th percentile of the carbon footprint estimate.
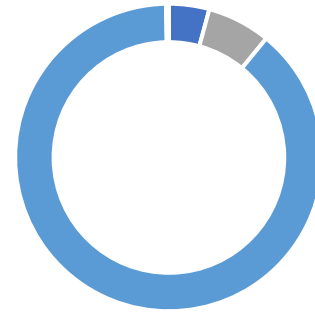
- Manufacturing (4.3%; 1,400 kg CO2e)
- Transportation (6.7%; 2,200 kg CO2e)
- Use (89.0%; 29,300 kg CO2e)
- End of Life (0.3%; 100 kg CO2e)

Figure 1: *Estimated mean GHG emissions in kg CO_2e by lifecycle phase for the IBM® LinuxONE 4 Express CPC drawer typical product configuration listed in Table 2 using the PAIA model.*
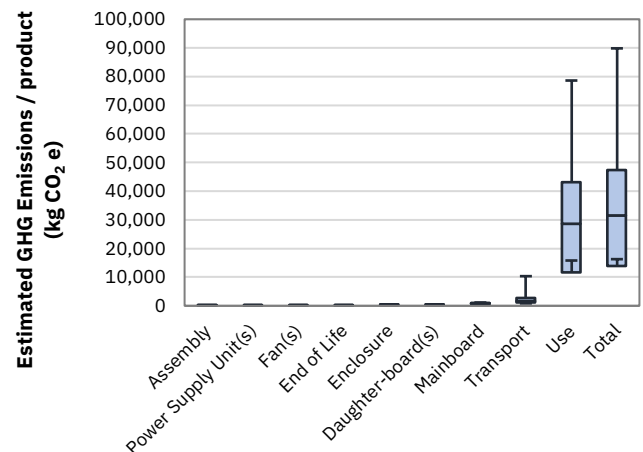

Figure 2: *Uncertainty in the PCF estimate for the IBM® LinuxONE 4 Express CPC drawer typical product configuration listed in Table 2; the estimate has a total mean of 32,900 ± 20,800 kg CO_2e over a use period of 5 years.*

IBM® LinuxONE 4 Express

PCIe+ I/O drawer product carbon footprint

Table 4: *Typical configuration of the IBM® LinuxONE 4 Express PCIe+ I/O drawer.*

FICON Express32S SX	4
OSA-Express7S 10 GbE SR1.2	4
10 GbE RoCE Express 3.0 SR	2
PCIe Interconnect Gen4	2
9U Shipping Pod	1

This PCF estimate was produced using the Product Attributes to Impact Algorithm (PAIA) model, developed by the Massachusetts Institute of Technology's Materials Systems Laboratory and partners, Version 1.4.0, January 19, 2024, copyright by the ICT Benchmarking collaboration including the Massachusetts Institute of Technology's Materials Systems Laboratory and partners.

PAIA input assumptions

The PCF assumes a typical configuration of the product as described in Table 4. The numbers for your specific configuration might be different. The data used in the PAIA server tool is provided in Table 5.

Table 5: *Data used in the PAIA server model for the IBM® LinuxONE 4 Express PCIe+ I/O drawer.*

General	
Server type	Rack
Server quantity	1
Number of PSU	2
Number of fans	6
Server weight	90.7 kg
Rack weight	N/A
Packaging weight[3]	32.2 kg
Motherboard	
PWB area	2164.0 cm^2
CPU quantity	0
CPU package area	N/A
DRAM total capacity	N/A
Chipset & other ICs package area	Default
Chipset & other ICs quantity	Default
Daughterboards	
Sub card total PWB area	13,642 cm^2
Sub card main chip package area	353 cm^2
Sub card chip count	32
PSU	
PSU weight	1.04 kg
PSU dimensions	20.0 x 10.0 cm
Use[4]	
Product lifetime	5 years
Yearly energy consumption	4,310 kWh
Location	
Assembly location	United States
Use location	Europe
Transportation	
To country of use by air	6,120 km
Within country of use by truck	300 km
End of life	
Fraction recycled	0.97
Fraction shredded recycling	0.00

The estimate

14,300
kg CO_2e[1]

This number is the estimated mean GHG emissions in carbon dioxide equivalent associated with the manufacturing, assembly, electricity consumption[2], transportation and end-of-life handling of the IBM® LinuxONE 4 Express PCIe+ I/O drawer over 5 years using hypothetical average GHG emissions factors for the European Union.

All estimates of carbon footprint are uncertain. For this product, the estimate has a mean of 14,300 kg CO_2e and a standard deviation of 7,600 kg CO_2e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. IBM also reports the 95th percentile of the carbon footprint estimate, which is 39,500 kg CO_2e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Impact by phases of the product's lifecycle
The PCF for server equipment is largely driven by the use phase which is highly variable based on the electricity generation source used to power the product, the expected use life of the product, and the power profile. This PCF was generated using a distribution of emissions factors across the European Union, based on International Energy Agency (IEA) emissions factors. The mean electricity emission factor used in this analysis for the European Union is 0.50 kg CO_2e/kWh.

The analysis for this product shows that 74% of its carbon footprint occurs in the use phase. IBM focuses on improving our product energy efficiency and on providing mechanisms for our clients to measure the actual energy consumption of the product. It is recommended to customize your use phase emissions using your specific electricity grid emissions factor and power information available from the Hardware Management Console (HMC) Environmental Dashboard.

Figure 3 shows the estimated mean contribution for the individual phases of the product's lifecycle over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. Figure 4 shows the uncertainty in the product's carbon footprint. The blue bar representing the mean and one standard deviation and the error bars representing the 5th and 95th percentile of the carbon footprint estimate.
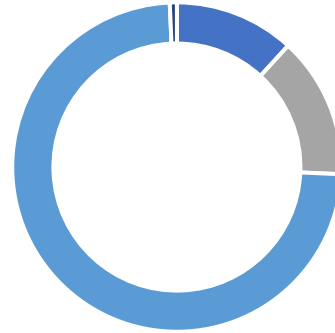
- Manufacturing (11.9%; 1,700 kg CO2e)
- Transportation (14.0%; 2,000 kg CO2e)
- Use (74.1%; 10,600 kg CO2e)
- End of Life (0.7%; 100 kg CO2e)

Figure 3: *Estimated mean GHG emissions in kg CO_2e by lifecycle phase for the IBM® LinuxONE 4 Express PCIe+ I/O drawer typical product configuration listed in Table 4 using the PAIA model.*
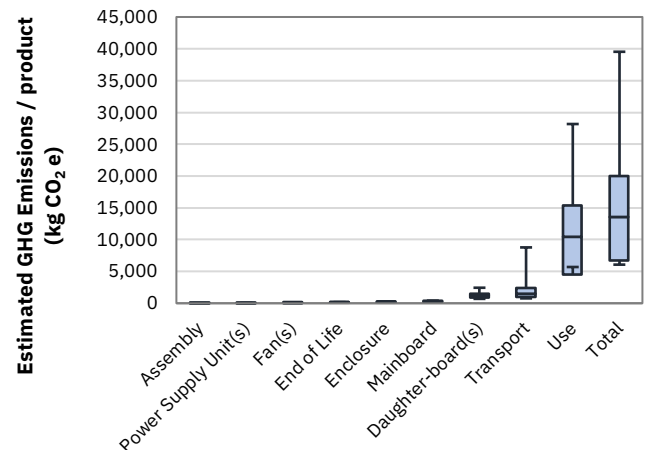

Figure 4: *Uncertainty in the PCF estimate for the IBM® LinuxONE 4 Express PCIe+ I/O drawer typical product configuration listed in Table 4; the estimate has a total mean of 14,300 ± 7,600 kg CO_2e over a use period of 5 years.*

IBM® LinuxONE 4 Express

Support Element product carbon footprint

Table 6: *Typical configuration of the IBM® LinuxONE 4 Express Support Element.*

1U Server Support Element	2
6U Shipping Pod	1

This PCF estimate was produced using the Product Attributes to Impact Algorithm (PAIA) model, developed by the Massachusetts Institute of Technology's Materials Systems Laboratory and partners, Version 1.4.0, January 18, 2024, copyright by the ICT Benchmarking collaboration including the Massachusetts Institute of Technology's Materials Systems Laboratory and partners.

PAIA input assumptions

The PCF assumes a typical configuration of the product as described in Table 6. The typical configuration consists of a pair of 1U Server Support Elements. The numbers for your specific configuration might be different. The data used in the PAIA server tool is provided in Table 7.

Table 7: *Data used in the PAIA server model for each IBM® LinuxONE 4 Express Support Element.*

General	
Server type	Rack
Server quantity	1
Number of PSU	2
Number of fans	5
Server weight	16.0 kg
Rack weight	N/A
Packaging weight[3]	27.2 kg
Motherboard	
PWB area	791.1 cm^2
CPU quantity	1
CPU package area	14.1 cm^2
DRAM total capacity	32 GB
Chipset & other ICs package area	15.8 cm^2
Chipset & other ICs quantity	5
Daughterboards	
Sub card total PWB area	863.9 cm^2
Sub card main chip package area	N/A
Sub card chip count	1
ODD	
Quantity	1
PSU	
PSU weight	0.89 kg
PSU dimensions	19.4 x 8.0 cm
Use[4]	
Product lifetime	5 years
Yearly energy consumption	657 kWh
Location	
Assembly location	United States
Use location	Europe
Transportation	
To country of use by air	6,120 km
Within country of use by truck	300 km
End of life	
Fraction recycled	0.97
Fraction shredded recycling	0.00

The estimate

5,800

kg CO_2e[1]

This number is the estimated mean GHG emissions in carbon dioxide equivalent associated with the manufacturing, assembly, electricity consumption[2], transportation and end-of-life handling of the IBM® LinuxONE 4 Express Support Element pair over 5 years using hypothetical average GHG emissions factors for the European Union.

All estimates of carbon footprint are uncertain. For this product, the estimate has a mean of 5,800 kg CO_2e and a standard deviation of 2,600 kg CO_2e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. IBM also reports the 95th percentile of the carbon footprint estimate, which is 16,400 kg CO_2e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Impact by phases of the product's lifecycle
The PCF for server equipment is largely driven by the use phase which is highly variable based on the electricity generation source used to power the product, the expected use life of the product, and the power profile. This PCF was generated using a distribution of emissions factors across the European Union, based on International Energy Agency (IEA) emissions factors. The mean electricity emission factor used in this analysis for the European Union is 0.50 kg CO_2e/kWh.

The analysis for this product shows that 55% of its carbon footprint occurs in the use phase. IBM focuses on improving our product energy efficiency and on providing mechanisms for our clients to measure the actual energy consumption of the product. It is recommended to customize your use phase emissions using your specific electricity grid emissions factor and power information available from the Hardware Management Console (HMC) Environmental Dashboard.

Figure 5 shows the estimated mean contribution for the individual phases of the product's lifecycle over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. Figure 6 shows the uncertainty in the product's carbon footprint. The blue bar representing the mean and one standard deviation and the error bars representing the 5th and 95th percentile of the carbon footprint estimate.
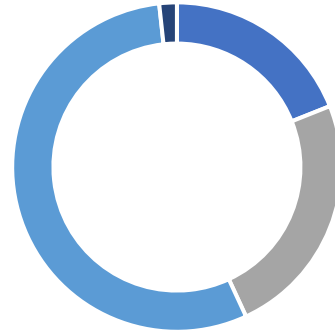
- Manufacturing (19.0%; 1,100 kg CO2e)
- Transportation (24.1%; 1,400 kg CO2e)
- Use (55.2%; 3,200 kg CO2e)
- End of Life (1.7%; 100 kg CO2e)

Figure 5: *Estimated mean GHG emissions in kg CO_2e by lifecycle phase for the IBM® LinuxONE 4 Express Support Element pair typical product configuration listed in Table 6 using the PAIA model.*
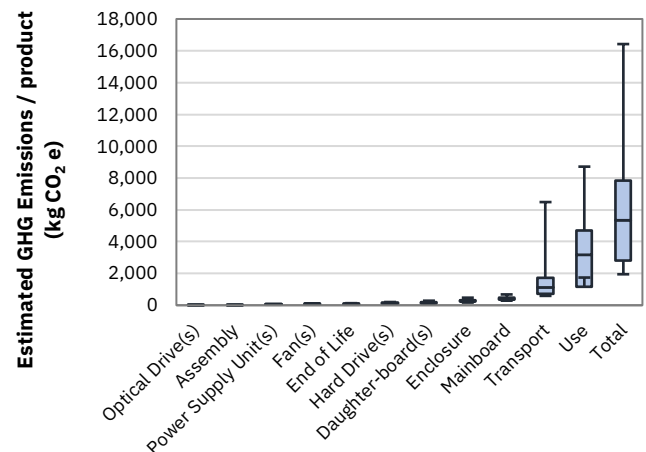

Figure 6: *Uncertainty in the PCF estimate for the IBM® LinuxONE 4 Express Support Element pair typical product configuration listed in Table 6; the estimate has a total mean of 5,800 ± 2,600 kg CO_2e over a use period of 5 years.*

IBM® LinuxONE 4 Express

24-port Ethernet Switch product carbon footprint

Table 8: *Typical configuration of the IBM® LinuxONE 4 Express 24-port Ethernet Switch.*

24-port Ethernet Switch	2

This PCF estimate was produced using the Product Attributes to Impact Algorithm (PAIA) model, developed by the Massachusetts Institute of Technology's Materials Systems Laboratory and partners, Version 1.4.0, January 29, 2024, copyright by the ICT Benchmarking collaboration including the Massachusetts Institute of Technology's Materials Systems Laboratory and partners.

PAIA input assumptions

The PCF assumes a typical configuration of the product as described in Table 8. The typical configuration consists of a pair of 24-port Ethernet Switches. The numbers for your specific configuration might be different. The data used in the PAIA network tool is provided in Table 9.

Table 9: *Data used in the PAIA network tool model for each IBM® LinuxONE 4 Express 24-port Ethernet Switch.*

General	
Form factor	Rack
Product-only weight	3.3 kg
Packaging weight[5]	N/A
Chassis weight	2.6 kg
Motherboard	
PWB area	0.06 m^2
CPU quantity	1
CPU package area	7.3 cm^2
DRAM total capacity	1 GB
Chipset & other ICs package area	3.0 cm^2
Chipset & other ICs quantity	4
Daughterboards	
Sub card total PWB area	N/A
Sub card main chip package area	N/A
Sub card chip count	1
Fan Tray	
Fan count	1
Ports	
Ports count	24
PSU	
PSU count	1
PSU weight	0.19 kg
PSU dimensions	12.7 x 7.6 cm
Use[4]	
Product lifetime	5 years
Yearly energy consumption	482 kWh
Location	
Assembly location	United States
Use location	Europe
Transportation	
To country of use by air	6,120 km
Within country of use by truck	300 km

The estimate

2,800

kg CO$_2$e[1]

This number is the estimated mean GHG emissions in carbon dioxide equivalent associated with the manufacturing, assembly, electricity consumption[2], transportation and end-of-life handling of the IBM® LinuxONE 4 Express 24-port Ethernet Switch pair over 5 years using hypothetical average GHG emissions factors for the European Union.

All estimates of carbon footprint are uncertain. For this product, the estimate has a mean of 2,800 kg CO$_2$e and a standard deviation of 1,700 kg CO$_2$e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. IBM also reports the 95th percentile of the carbon footprint estimate, which is 3,800 kg CO$_2$e over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Impact by phases of the product's lifecycle
The PCF for network equipment is largely driven by the use phase which is highly variable based on the electricity generation source used to power the product, the expected use life of the product, and the power profile. This PCF was generated using a distribution of emissions factors across the European Union, based on International Energy Agency (IEA) emissions factors. The mean electricity emission factor used in this analysis for the European Union is 0.50 kg CO$_2$e/kWh.

The analysis for this product shows that 86% of its carbon footprint occurs in the use phase. IBM focuses on improving our product energy efficiency and on providing mechanisms for our clients to measure the actual energy consumption of the product. It is recommended to customize your use phase emissions using your specific electricity grid emissions factor and power information available from the Hardware Management Console (HMC) Environmental Dashboard.

Figure 7 shows the estimated mean contribution for the individual phases of the product's lifecycle over a use period of 5 years using hypothetical average GHG emissions factors for the European Union. Figure 8 shows the uncertainty in the product's carbon footprint. The blue bar representing the mean and one standard deviation and the error bars representing the 5th and 95th percentile of the carbon footprint estimate.
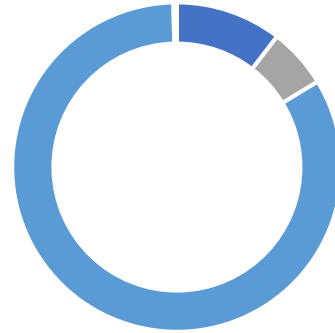
- Manufacturing (10.7%; 300 kg CO2e)
- Transportation (6.1%; 170 kg CO2e)
- Use (85.7%; 2,400 kg CO2e)
- End of Life (0.4%; 10 kg CO2e)

Figure 7: *Estimated mean GHG emissions in kg CO$_2$e by lifecycle phase for the IBM® LinuxONE 4 Express 24-port Ethernet Switch pair typical product configuration listed in Table 8 using the PAIA model.*
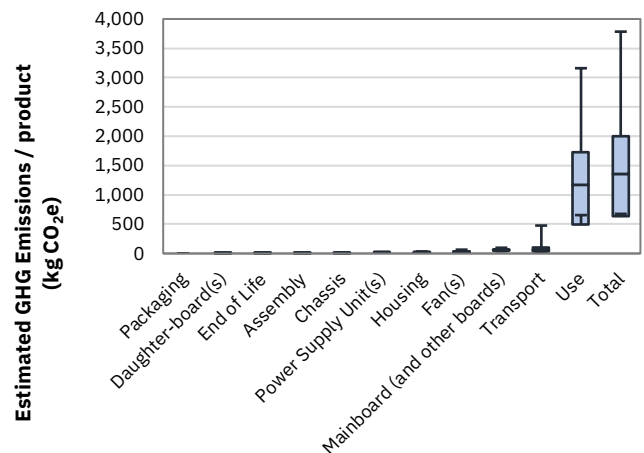

Figure 8: *Uncertainty in the PCF estimate for the IBM® LinuxONE 4 Express 24-port Ethernet Switch pair typical product configuration listed in Table 8; the estimate has a total mean of 2,800 ± 1,700 kg CO$_2$e over a use period of 5 years.*

Limitations of PAIA

PAIA results represent a streamlined Life Cycle Assessment (LCA). While the product carbon footprint provides a high- level estimate of the emissions associated with the product, it should not be used for emissions inventory, formal carbon foot printing exercises or comparing products. LCA results are strongly influenced by the assumptions made by the analyst; if those assumptions are inconsistent, comparisons are not likely meaningful. Furthermore, PAIA may not be compliant with the primary data requirements of some LCA standards. The results from the PAIA tools are liable to change over time as the methodology is improved and data is updated. More information on these limitations, as well as general guidance for interpreting this report, is available in the publication
"[Assessment of lifecycle carbon footprints of products](#)"

Disclaimers

[1] The results are reported using the units of kilograms of carbon dioxide equivalent (kg CO_2e). This represents the amount of global warming caused by a quantity of GHGs (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) at a specific point in time, expressed in terms of the amount of CO_2 which would have the same instantaneous warming effect. Recognizing the uncertainty in carbon footprint estimates, the results have been rounded to the nearest thousand.

[2] The electricity consumption is incurred by clients using an IBM product. The estimate used is not specific to any client deployment of the IBM product or client workload.

[3] The estimated carbon footprint was computed including the shipping crate.

[4] Power consumption data is obtained using the IBM Power Estimation Tool for the 3932, a web-based tool for estimating power requirements for the IBM® LinuxONE 4 Express. This tool estimates the typical power requirements for the specific configuration listed in Table 1 under Normal operating conditions. The energy consumption assumes that the product operates 24 hours a day, 365 days a year for its product lifetime.

[5] The IBM® LinuxONE 4 Express 24-port Ethernet switch pair is shipped with the Support Element pair in the same packaging.