IBM Storage DS8A50F

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 for representative products using the Product Attributes to Impact Algorithm (PAIA) model.



Limitations of PAIA

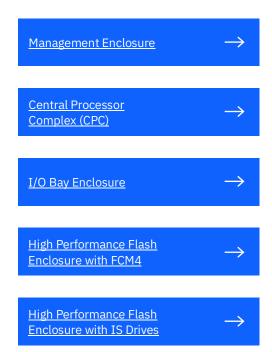
PAIA results represent a streamlined Life Cycle Assessment (LCA). While the product carbon footprint provides a high-level estimate of the emissions associated with the product, it should not be used for emissions inventory, formal carbon foot printing exercises or comparing products. LCA results are 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 life cycle carbon footprints of products.

The PAIA model was developed by the Massachusetts Institute of Technology's Materials Systems Laboratory and partners, Version 1.4.7, April 9, 2025, copyright by the ICT Benchmarking collaboration including the Massachusetts Institute of Technology's Materials Systems Laboratory and partners.

Components

This product consists of multiple components. A carbon footprint report is provided here for each component. To estimate the carbon footprint of your configuration, use the carbon footprint reports of the appropriate components ⁷.





Management Enclosure Product Carbon Footprint



<u>Table 1</u> describes a typical IBM DS8A50F Management Enclosure configuration. For this configuration, <u>Table 2</u> provides the total estimated mean GHG emissions in carbon dioxide equivalent (kg CO_2e^1) associated with manufacturing, assembly, electricity consumption², transportation and end-of-life handling over 5 years, using hypothetical average GHG emissions factors.

<u>Figure 1</u> shows the estimated contribution of each life cycle phase to the total estimated mean GHG emissions.

The data used in the PAIA server tool for each representative configuration is provided in <u>Table 3</u>. This PCF was generated using a distribution of emissions factors across the location, based on International Energy Agency (IEA) emissions factors³.

Management Enclosure

HMC appliance	2
Intra-rack ethernet switch	2
Rack control cards	2
Power supply units (PSU)	2
Frame with covers, cables, and rails	1
Annual energy use	1,572 kWh

Table 1: Typical product configurations of the IBM DS8A50F Management Enclosure. The estimated carbon footprint for the Management Enclosure is for a single enclosure. One enclosure is used per DS8A50F.

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 respective location. Table 2 shows that 12% - 41% of the carbon footprint occurs in the use phase. IBM recommends that you customize the use phase GHG emissions based on your specific data center conditions.

Uncertainty in the product carbon footprint

All estimates of carbon footprint are uncertain. To provide transparency around this uncertainty, Table 2 also reports the standard deviation and the 95th percentile of the carbon footprint estimate. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Configuration	Geography	Total estimated mean GHG emissions in kg CO ₂ e ^{1,3}	% of Estimated mean GHG emissions in the use phase	Standard deviation of the estimated GHG emissions in kg CO ₂ e ¹	95th percentile of the estimated GHG emissions in kg CO ₂ e ¹
Management	European Union	15,620	12%	3,500	29,700
Enclosure	Asia Oceania	20,320	22%	4,100	36,000
	United States	7,120	41%	1,600	14,500

Table 2: Summary of the estimated GHG emissions for the typical product configuration of the IBM DS8A50F Management Enclosure

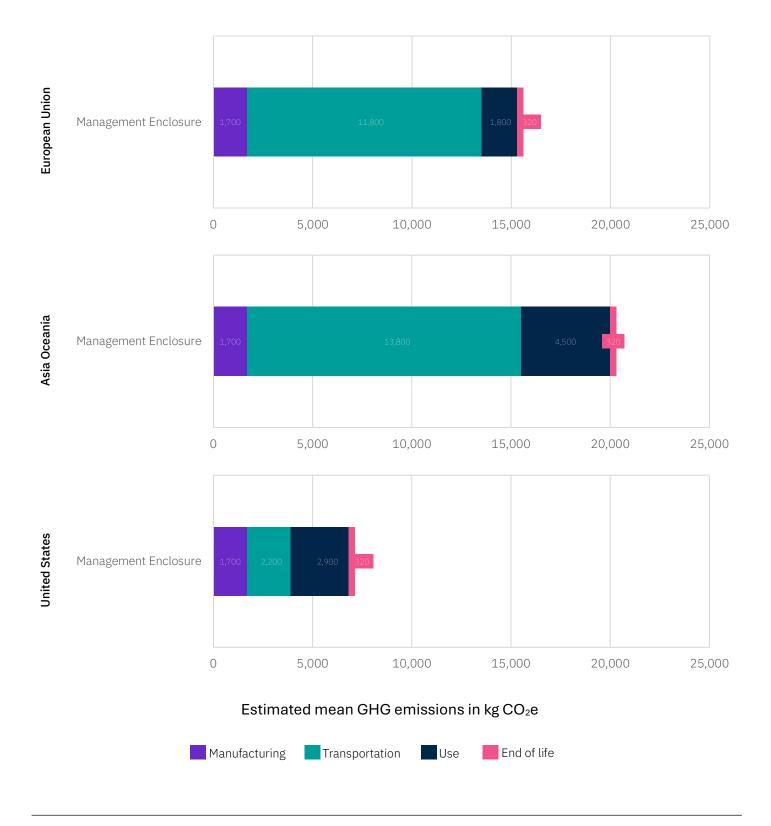


Figure 1: Carbon footprint impact by phase for the IBM DS8A50F Management Enclosure configuration listed in Table 1 using the PAIA model assuming a 5-year product lifetime

Management Enclosu	Management Enclosure		
Rack	Rack		
1	1		
4			
12			
35.4 kg			
371.0 kg			
45.4 kg			
1,630.6 cm ²			
2			
50.0 cm ²			
64 GB			
45.3	45.3		
10	10		
2			
1,417.6 cm ²			
22.0 cm ²			
12	12		
0.90 kg	0.90 kg		
19.1 cm x 8.0 cm	19.1 cm x 8.0 cm		
5 years			
1,572 kWh			
Mexico			
Mode: Air	Mode: Truck		
9,700 km	300 km		
11,738 km	300 km		
0 km	3,200 km		
0.90			
	Rack 1 4 12 35.4 kg 371.0 kg 45.4 kg 1,630.6 cm² 2 50.0 cm² 64 GB 45.3 10 2 1,417.6 cm² 22.0 cm² 12 0.90 kg 19.1 cm x 8.0 cm 5 years 1,572 kWh Mexico Mode: Air 9,700 km 11,738 km 0 km		

Table 3: Data used in the PAIA server model for the IBM DS8A50F Management Enclosure

Central Processor Complex (CPC) Product Carbon Footprint



<u>Table 4</u> describes a typical IBM DS8A50F Central Processor Complex (CPC) configuration. For that configuration, <u>Table 5</u> provides the total estimated mean GHG emissions in carbon dioxide equivalent (kg CO_2e^1) associated with manufacturing, assembly, electricity consumption², transportation and end-of-life handling over 5 years, using hypothetical average GHG emissions factors.

<u>Figure 2</u> shows the estimated contribution of each life cycle phase to the total estimated mean GHG emissions.

The data used in the PAIA server tool for the representative configuration is provided in <u>Table 6</u>. This PCF was generated using a distribution of emissions factors across the location, based on International Energy Agency (IEA) emissions factors³.

	CPC
Power9® 10-core processor	2
Memory	2,304 GB
PCIe interconnect card	7
Power supply unit	4
Annual energy use	9,382 kWh

 Table 4: Typical product configuration of the IBM DS8A50F Central Processor Complex (CPC)

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 respective location. Table 5 shows that 79% - 91% of the carbon footprint occurs in the use phase. IBM recommends that you customize the use phase GHG emissions based on your specific data center conditions.

Uncertainty in the product carbon footprint

All estimates of carbon footprint are uncertain. To provide transparency around this uncertainty, Table 5 also reports the standard deviation and the 95th percentile of the carbon footprint estimate. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Configuration	Geography	Total estimated mean GHG emissions in kg CO ₂ e ^{1,3}	% of Estimated mean GHG emissions in the use phase	Standard deviation of the estimated GHG emissions in kg CO ₂ e ¹	95th percentile of the estimated GHG emissions in kg CO ₂ e ¹
	European Union	13,230	79%	12,700	79,000
CPC	Asia Oceania	29,830	91%	16,800	86,500
	United States	19,030	90%	5,200	32,100

Table 5: Summary of the estimated GHG emissions for the typical product configuration of the IBM DS8A50F Central Processor Complex 6

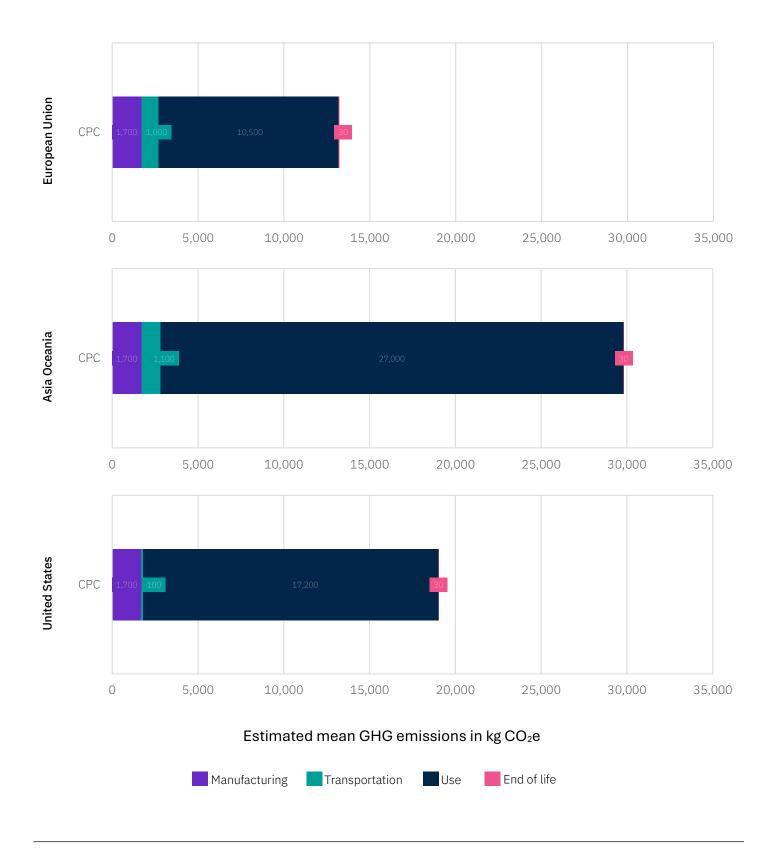


Figure 2: Carbon footprint impact by phase for the IBM DS8A50F Central Processor Complex product configuration listed in Table 4 using the PAIA model assuming a 5-year product lifetime ⁶

Server yearnity 1 Number of PSU 4 Number of fans 4 Server weight 36.2 kg Rack and mount weighté 0.0 kg Packaging weighté 2.196 cm² CPU quantity 2 CPU quantity 2.304 GB CPU package area (custom IC) 47.0 cm² CPU package area (custom IC) 64.0 cm² Chipset and other ICs package area 10 efault Chipset and other ICs quantity 6 efault SSD quantity 2 SSD quantity 2 SSD quantity 6 efault SSD quantity 9 efault PSU weight 9 efault PSU weight 9 efault P	PAIA input data	CPC				
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Number of fans 4 Server weight 36.2 kg Rack and mount weight⁴ 0.0 kg Packaging weight⁴ 0.0 kg CPU quantity 2 CPU package area (custom IC) 47.0 cm² DRAM total capacity 2 Chipset and other ICs package area Default SSD quantity 2 Sub card total PWB area Default Sub card main chip package area Default Sub card main chip package area Default Sub card chip count Default PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption ⁶ 9,382 kWh Assembly location Mode: Truck Mode: Truck Asia Oceania 1,738 km 300 km	Server quantity		1			
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Rack and mount weight⁴ 0.0 kg Packaging weight⁴ 0.0 kg Motherboard PWB area 2,196 cm² CPU quantity 2304 GB CPU package area (custom IC) 47.0 cm² Default Chipset and other ICs package area Default SSD quantity 2 Sub card total PWB area Default Sub card chip package area Default SU weight Default SU weight Default Product lifetime 5 years Yearly energy consumption³ 9,382 kWh Assembly location Mexico Mode: Air Mode: Truck Trunsportation 9,700 km 300 km Asia Oceania 11,738 km 300 km	Number of fans		4			
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Sub card main chip package area Default Sub card chip count Default PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption⁵ 9,382 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	SSD quantity		2			
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PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption⁵ 9,382 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Sub card chip count		Default			
Product lifetime 5 years Yearly energy consumption⁵ 9,382 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	PSU weight		0.90 kg			
Yearly energy consumption ⁵ Assembly location Mexico Mode: Air Mode: Truck European Union Asia Oceania United States 9,382 kWh Mexico Mode: Air Mode: Truck 300 km 300 km 3,200 km	PSU dimensions		19.0 cm x 8.0 cm			
Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Product lifetime		5 years			
European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Yearly energy consumption ⁵		9,382 kWh			
European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Assembly location		Mexico			
Transportation Asia Oceania 11,738 km 300 km United States 0 km 3,200 km			Mode: Air	Mode: Truck		
Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Transportation	European Union	9,700 km	300 km		
	παπορυπατίστ	Asia Oceania	11,738 km	300 km		
Fraction recycled 0.90		United States	0 km	3,200 km		
	Fraction recycled		0.90			

Table 6: Data used in the PAIA server model for the IBM DS8A50F Central Processor Complex

I/O Bay Enclosure Product Carbon Footprint



<u>Table 7</u> describes the IBM DS8A50F I/O Bay Enclosure configuration. For that configuration, <u>Table 8</u> provides the total estimated mean GHG emissions in carbon dioxide equivalent (kg $\rm CO_2e^1$) associated with manufacturing, assembly, electricity consumption², transportation and end-of-life handling over 5 years, using hypothetical average GHG emissions factors.

<u>Figure 3</u> shows the estimated contribution of each life cycle phase to the total estimated mean GHG emissions.

The data used in the PAIA server tool for each representative configuration is provided in <u>Table 9</u>. This PCF was generated using a distribution of emissions factors across the location, based on International Energy Agency (IEA) emissions factors³.

I/O Bay Enclosure

32 Gb FCP/FICON≈ host adapter	4
Device adapter	2
PCIe switch card	1
PSU	2
Annual energy use	6,377 kWh

 Table 7: Typical product configuration of the IBM DS8A50F I/O Bay Enclosure

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 respective location. Table 8 shows that 77% - 91% of the carbon footprint occurs in the use phase. IBM recommends that you customize the use phase GHG emissions based on your specific data center conditions.

Uncertainty in the product carbon footprint

All estimates of carbon footprint are uncertain. To provide transparency around this uncertainty, Table 8 also reports the standard deviation and the 95th percentile of the carbon footprint estimate. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Configuration	Geography	Total Estimated mean GHG emissions in kg CO2e ^{1,3}	% of Estimated mean GHG emissions in the use phase	Standard deviation of the estimated GHG emissions in kg CO2e ¹	95th percentile of the estimated GHG emissions in kg CO2e ¹
	European Union	9,730	77%	9,800	69,100
I/O Bay Enclosure	Asia Oceania	20,730	88%	11,600	59,000
	United States	13,030	91%	3,600	22,700

Table 8: Summary of the estimated GHG emissions for the typical product configuration shown in Table 7 of the IBM DS8A50F I/O Bay Enclosure

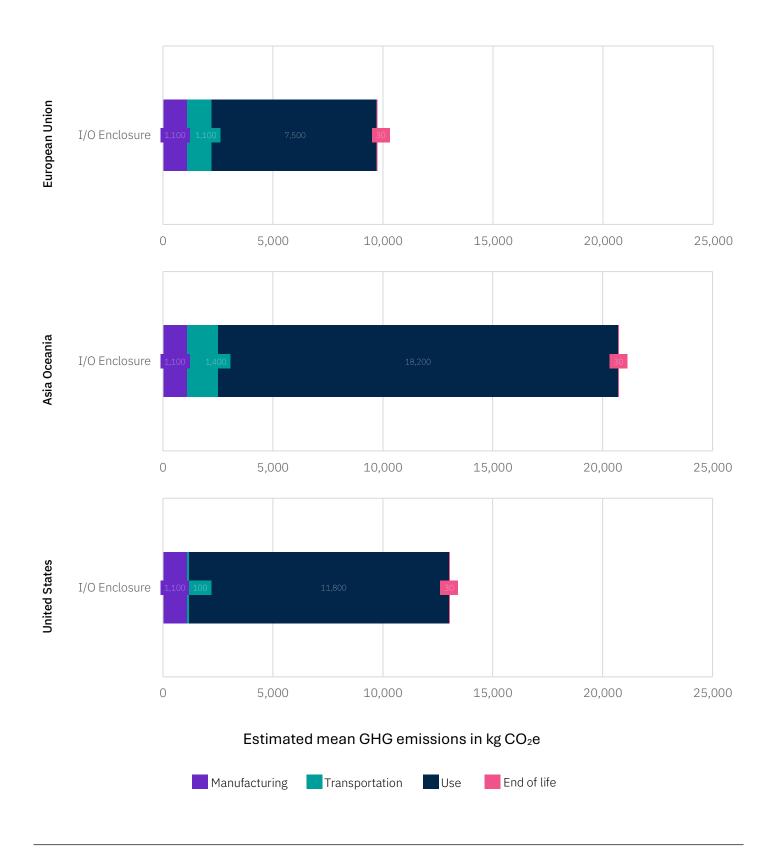


Figure 3: Carbon footprint impact by phase for the IBM DS8A50F I/O Bay Enclosure product configuration listed in Table 7 using the PAIA model assuming a 5-year product lifetime

Server type Rack Server quantity 1 Number of PSU 2 Number of fans 4 Server weight 46.3 kg Rack and mount weight* 0.0 kg Packaging weight* 0.0 kg Motherboard PWB area 1,298 cm² CPU quantity 2 CPU quantity 32 GB CPU package area (custom IC) 32 GB Chipset and other ICs package area 60.0 cm² Chipset and other ICs quantity 20 Sub card total PWB area 5,739 cm² Sub card total PWB area 5,739 cm² Sub card chip count 200 PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption² 6,377 kWh Assembly location Mexico Transportation Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km Evention remeded 0 km	PAIA input data	I/O Bay Enclosure			
Number of PSU 2 Number of fans 4 Server weight 46.3 kg Rack and mount weight² 0.0 kg Packaging weight⁴ 0.0 kg Motherboard PWB area 1,298 cm² CPU quantity 2 CPU package area (custom IC) 25.0 cm² DRAM total capacity 32 GB Chipset and other ICs package area 60.0 cm² Chipset and other ICs quantity 20 Sub card total PWB area 5,739 cm² Sub card chip count 200 PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption² 6,377 kWh Assembly location Mexico Interpretation Mode: Air Mode: Truck Transportation Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Server type	Rack			
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Chipset and other ICs quantity 20 Sub card total PWB area 5,739 cm² Sub card main chip package area 454 cm² Sub card chip count 200 PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption ⁵ 6,377 kWh Assembly location Mexico Interpretation Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	DRAM total capacity		32 GB		
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Sub card main chip package area 454 cm² Sub card chip count 200 PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption ⁵ 6,377 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Chipset and other ICs quantity		20		
Sub card chip count 200 PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption ⁵ 6,377 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Sub card total PWB area		5,739 cm ²		
PSU weight 0.90 kg PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption ⁵ 6,377 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Sub card main chip package area		454 cm ²		
PSU dimensions 19.0 cm x 8.0 cm Product lifetime 5 years Yearly energy consumption ⁵ 6,377 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Sub card chip count		200		
Product lifetime 5 years Yearly energy consumption⁵ 6,377 kWh Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	PSU weight		0.90 kg		
Yearly energy consumption ⁵ Assembly location Mexico Mode: Air Mode: Truck European Union Asia Oceania United States 6,377 kWh Mexico Mode: Air Mode: Truck 300 km 300 km 300 km	PSU dimensions		19.0 cm x 8.0 cm		
Assembly location Mexico Mode: Air Mode: Truck European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Product lifetime		5 years		
European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Yearly energy consumption ⁵		6,377 kWh		
European Union 9,700 km 300 km Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Assembly location		Mexico		
Transportation Asia Oceania 11,738 km 300 km United States 0 km 3,200 km			Mode: Air	Mode: Truck	
Asia Oceania 11,738 km 300 km United States 0 km 3,200 km	Transportation	European Union	9,700 km	300 km	
	παπομυπατίστ	Asia Oceania	11,738 km	300 km	
Fraction recycled 0.00		United States	0 km	3,200 km	
	Fraction recycled		0.90		

 Table 9: Data used in the PAIA server model for the IBM DS8A50F I/O Bay Enclosure

High Performance Flash Enclosure Gen3 with IBM FlashCore Module 4 Product Carbon Footprint



<u>Table 10</u> describes a typical IBM DS8A50F High Performance Flash Enclosure (HPFE) Gen3 with IBM FlashCore Module 4 (FCM4) configuration. For that configuration, <u>Table 11</u> provides the total estimated mean GHG emissions in carbon dioxide equivalent (kg CO_2e^1) associated with manufacturing, assembly, electricity consumption², transportation and end-of-life handling over 5 years, using hypothetical average GHG emissions factors.

<u>Figure 4</u> shows the estimated contribution of each life cycle phase to the total estimated mean GHG emissions.

The data used in the PAIA storage tool for each representative configuration is provided in <u>Table 12</u>. This PCF was generated using a distribution of emissions factors across the location, based on International Energy Agency (IEA) emissions factors³.

HPFE (FCM4)

ESM card	2
IBM FlashCore Module 4 (19.2 TB)	16
Power supply unit	2
Annual energy use	4,804 kWh

 Table 10: Typical product configuration of the IBM DS8A50F High Performance Flash Enclosure with FlashCore Module 4

The PCF for storage 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 respective location. Table 11 shows that 73% - 88% of the carbon footprint occurs in the use phase. IBM recommends that you customize the use phase GHG emissions based on your specific data center conditions.

Uncertainty in the product carbon footprint

All estimates of carbon footprint are uncertain. To provide transparency around this uncertainty, Table 11 also reports the standard deviation and the 95th percentile of the carbon footprint estimate. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided

Configuration	Geography	Total Estimated mean GHG emissions in kg CO2e ^{1,3}	% of Estimated mean GHG emissions in the use phase	Standard deviation of the estimated GHG emissions in kg CO2e ¹	95th percentile of the estimated GHG emissions in kg CO2e ¹
	European Union	7,530	73%	6,500	43,300
HPFE (FCM4)	Asia Oceania	15,930	86%	8,400	45,000
	United States	10,030	88%	2,700	18,100

Table 11: Summary of the estimated GHG emissions for the typical product configuration of the IBM DS8A50F High Performance Flash Enclosure Gen3 with IBM FlashCore Module 4 ⁶

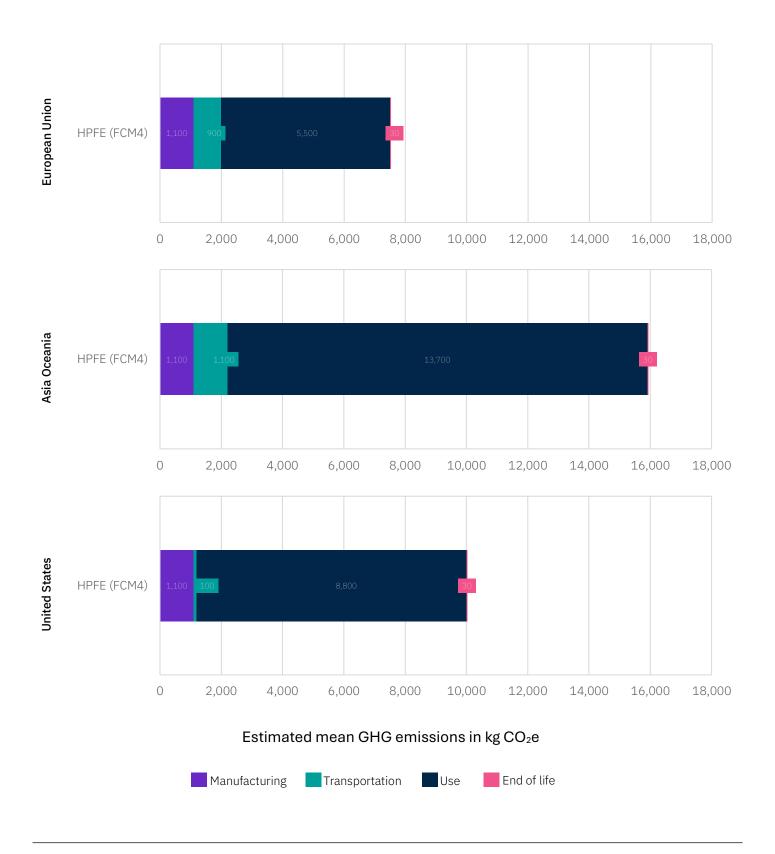


Figure 4: Carbon footprint impact by phase for the IBM DS8A50F High Performance Flash Enclosure Gen3 with IBM FlashCore Module 4 product configuration listed in Table 10 using the PAIA model assuming a 5-year product lifetime ⁶

PAIA input data		HPFE Gen3 with FCM4			
Storage enclosure type ⁴		Rack			
Storage array weight		25.0 kg			
Number of arrays		1			
Chassis weight		10.1 kg			
Non-ferrous metal chassis weight		Default			
Chassis IC package area		Default			
Chassis PWB area		Default			
Number of PSU		2			
PSU dimensions		32.0 cm x 5.4 cm			
PSU mass		1.25 kg			
Length of cable		2 m			
Number of fans		6			
Number of SSD per array		16			
Mass of SSD		0.176 kg			
SSD IC die area		Default			
SSD IC package area		125.8 cm ²			
SSD IC fabrication location		Asia IEA	Asia IEA		
SSD non-ferrous metal mass		0.074 kg			
SSD PWB area		239 cm ²			
SSD PWB substrate layers		12			
Number of mainboards		2			
Area of mainboard PWB		1,246.0 cm ²			
Mainboard PWB layers		12			
Mainboard IC quantity		14			
Mainboard IC fabrication electricity intensit	У	Default			
Mainboard IC die area		Default			
Total mainboard IC package area		31.0 cm ²			
DRAM IC count		0			
DRAM IC package area		0.0 cm^2			
DRAM die area		0.0 cm^2			
DRAM IC fabrication location		Asia IEA			
Number of sub-boards		0			
Assembly location		Mexico			
Product lifetime		5 years			
Yearly energy consumption ⁵		4,804 kWh			
Transportation		Mode: Air	Mode: Truck		
	European Union	9,700 km	300 km		
	Asia Oceania	11,738 km	300 km		
	United States	0 km	3,200 km		
Fraction recycled		0.90			

 Table 12: Data used in the PAIA storage model for the IBM DS8A50F High Performance Flash Enclosure with IBM FlashCore Module 4

High Performance Flash Enclosure Gen3 with Industry Standard Drives Product Carbon Footprint



<u>Table 13</u> describes a typical IBM DS8A50F High Performance Flash Enclosure (HPFE) Gen3 with Industry Standard (IS) Drives configuration. For that configuration, <u>Table 14</u> provides the total estimated mean GHG emissions in carbon dioxide equivalent (kg CO_2e^1) associated with manufacturing, assembly, electricity consumption², transportation and end-of-life handling over 5 years, using hypothetical average GHG emissions factors.

<u>Figure 5</u> shows the estimated contribution of each life cycle phase to the total estimated mean GHG emissions.

The data used in the PAIA storage tool for each representative configuration is provided in <u>Table 15</u>. This PCF was generated using a distribution of emissions factors across the location, based on International Energy Agency (IEA) emissions factors³.

	HPFE (IS)
ESM card	2
NVMe Flash drives	24
Power supply unit	2
Annual energy use	2,245 kWh

Table 13: Typical product configuration of the IBM DS8A50F High Performance Flash Enclosure Gen3 with Industry Standard Drives

The PCF for storage 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 respective location. Table 14 shows that 56% - 79% of the carbon footprint occurs in the use phase. IBM recommends that you customize the use phase GHG emissions based on your specific data center conditions.

Uncertainty in the product carbon footprint

All estimates of carbon footprint are uncertain. To provide transparency around this uncertainty, Table 14 also reports the standard deviation and the 95th percentile of the carbon footprint estimate. The 95th percentile means that 5% of the time the carbon footprint will exceed the value provided.

Configuration	Geography	Total Estimated mean GHG emissions in kg CO2e ^{1,3}	% of Estimated mean GHG emissions in the use phase	Standard deviation of the estimated GHG emissions in kg CO2e ¹	95th percentile of the estimated GHG emissions in kg CO2e ¹
HPFE (IS)	European Union	4,430	56%	3,100	21,500
	Asia Oceania	8,530	75%	3,900	23,200
	United States	5,330	79%	1,300	10,300

Table 14: Summary of the estimated GHG emissions for the typical product configuration of the IBM DS8A50F High Performance Flash Enclosure Gen3 with Industry Standard Drives ⁶

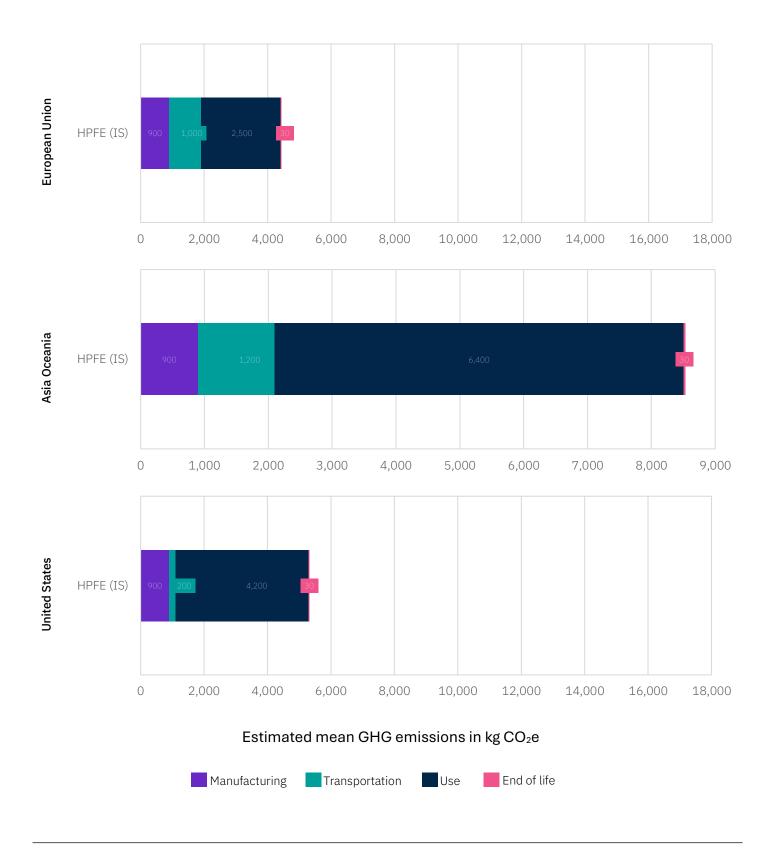


Figure 5: Carbon footprint impact by phase for the IBM DS8A50F High Performance Flash Enclosure Gen3 with Industry Standard Drives product configuration listed in Table 13 using the PAIA model assuming a 5-year product lifetime ⁶

PAIA input data		HPFE Gen3 with IS dri	ives		
Storage enclosure type ⁴		Rack			
Storage array weight		29.0 kg	29.0 kg		
Number of arrays		1			
Chassis weight		10.1 kg			
Non-ferrous metal chassis weight		Default			
Chassis IC package area		Default			
Chassis PWB area		Default			
Number of PSU		2			
PSU dimensions		32.0 cm x 5.4 cm			
PSU mass		1.25 kg	1.25 kg		
Length of cable		2 m			
Number of fans		6	6		
Number of SSD per array		24	24		
Mass of SSD		0.5 kg	0.5 kg		
SSD IC die area		Default	Default		
SSD IC package area		31.4 cm ²	31.4 cm ²		
SSD IC fabrication location		Asia IEA			
SSD non-ferrous metal mass		Default			
SSD PWB area		59.0 cm ²			
SSD PWB substrate layers		12			
Number of mainboards		2	2		
Area of mainboard PWB		1,246.0 cm ²			
Mainboard PWB layers		12	12		
Mainboard IC quantity		14	14		
Mainboard IC fabrication electricity intensity		Default	Default		
Mainboard IC die area		Default	Default		
Total mainboard IC package area		31.0 cm^2	31.0 cm ²		
DRAM IC count		0	0		
DRAM IC package area		0.0 cm^2	0.0 cm ²		
DRAM die area		0.0 cm^2	0.0 cm ²		
DRAM IC fabrication location		Asia IEA			
Number of sub-boards		0	0		
Assembly location		Mexico			
Product lifetime		5 years			
Yearly energy consumption ⁵		2,245 kWh			
Transportation		Mode: Air	Mode: Truck		
	European Union	9,700 km	300 km		
	Asia Oceania	11,738 km	300 km		
	United States	0 km	3,200 km		
Fraction recycled		0.90			

Table 15: Data used in the PAIA storage model for the IBM DS8A50F High Performance Flash Enclosure with Industry Standard Drives

Disclaimers

- 1. The results are reported using the units of kilograms of carbon dioxide equivalent (kg CO₂e). This represents the amount of global warming caused by a quantity of GHGs (CO₂, CH₄, N₂O, HFCs, PFCs and SF₆) at a specific point in time, expressed in terms of the amount of CO₂ which would have the same instantaneous warming effect. Recognizing the uncertainty in carbon footprint estimates, the results have been rounded.
- 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 mean electricity emissions factor used in the PAIA analysis for each location is calculated based on the energy consumption and use phase emissions. The mean use phase emissions values are 0.23 kg CO $_2$ e/kWh for Europe, 0.57 kg CO $_2$ e/kWh for Asia Oceania, and 0.37 kg CO $_2$ e/kWh for the United States.
- 4. The estimated carbon footprint was computed without including the system frame(s) and shipping crate. The estimated carbon footprint of the system frame and shipping crate are included in the carbon footprint of the IBM DS8A50F Management Enclosure.
- 5. Power consumption data is obtained from development lab measurements. Configurations and conditions represent typical power requirements for the specific configurations listed under Normal operating conditions. The power consumption assumes that the product operates 24 hours a day, 365 days a year for its product lifetime.
- 6. The estimated carbon footprint was computed for a single enclosure. The Processor Complex (CPC) and the High Performance Flash Enclosure Gen3 features are installed as pairs or two enclosures. The contribution of these elements can be estimated by multiplying the estimated carbon footprint of these elements by two.
- 7. The estimated carbon footprint for the DS8A50F system can be approximated as: $1 \times M$ anagement Enclosure product carbon footprint + $2 \times P$ rocessor Complex (CPC) product carbon footprint + $2 \times H$ igh Performance Flash Enclosure Gen3 with IBM FlashCore Module 4 feature product carbon footprint x number of ordered features + $2 \times H$ igh Performance Flash Enclosure Gen3 with Industry Standard Drives feature product carbon footprint x number of ordered features + $2 \times I$ /O Bay Enclosure feature product carbon footprint x number of ordered features.

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