IBM® Storage Scale System 6000

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 using the Product Attributes to Impact Algorithm (PAIA) model. Table 1 describes three typical IBM® Storage Scale System 6000 configurations considered for this PCF analysis.

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."

	Capacity	Hybrid	Maximum[6]
Model	5149-F48	5149-F48	5149-F48
Storage	4x 3.84 TB NVMe	24x 30.74 TB NVMe	48x 30.4 TB FCM
Processor	2x Canister with Dual AMD Genoa 48C processor	2x Canister with Dual AMD Genoa 48C processor	2x Canister with Dual AMD Genoa 48C processor
Memory	48x DDR5 DIMM	48x DDR5 DIMM	48x DDR5 DIMM
Adapters	4x CX-7 InifinBand / VPI adapter	4x CX-7 InifinBand / VPI adapter	4x CX-7 InifinBand / VPI adapter

Table 1: *Product configurations of the IBM Storage Scale System 6000 considered for this PCF analysis. The Capacity and Hybrid configurations attach to the 5149-091 Expansion Enclosure.*

IBM

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, June 26, 2024, copyright by the ICT Benchmarking collaboration including the Massachusetts Institute of Technology's Materials Systems Laboratory and partners.

For each configuration shown in Table 1, Table 2 provides the total estimated mean GHG emissions in carbon dioxide equivalent (kg CO_2e[1]) associated with manufacturing, assembly, electricity consumption[2], transportation and end-of-life handling, over 5 years, using hypothetical average GHG emissions factors. Figure 1 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 the three configurations is provided in Table 3. This PCF was generated using a distribution of emissions factors across the respective location, based on International Energy Agency (IEA) emissions factors[3].

Impact by phases of the product's lifecycle

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 2 shows that 90% - 96% 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, using the guidance provide in "Assessment of life cycle carbon footprints of products". IBM focuses on improving our product energy efficiency and on providing tools for our clients to estimate and measure the energy consumption of their product.

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.

		Total Estimated Mean GHG Emissions in kg CO_2e[1,3,4]	% of Estimated Mean GHG Emissions in the Use Phase[3]	Standard Deviation of the Estimated GHG Emissions in kg CO_2e[1]	95th Percentile of the Estimated GHG Emissions in kg CO_2e[1]
Capacity	Europe	55,400	90%	35,400	147,300
	United States	40,700	92%	11,500	71,200
	East Asia	115,900	95%	40,200	210,200
Hybrid	Europe	64,500	91%	41,200	172,000
	United States	47,500	93%	13,700	84,600
	East Asia	136,500	95%	48,600	251,800
Maximum	Europe	86,500	92%	56,200	228,400
	United States	63,500	93%	18,000	110,400
	East Asia	182,000	96%	65,700	337,400

Table 2: *Summary of the estimated GHG emissions for the typical product configurations listed in Table 1 for the IBM Storage Scale System 6000.*

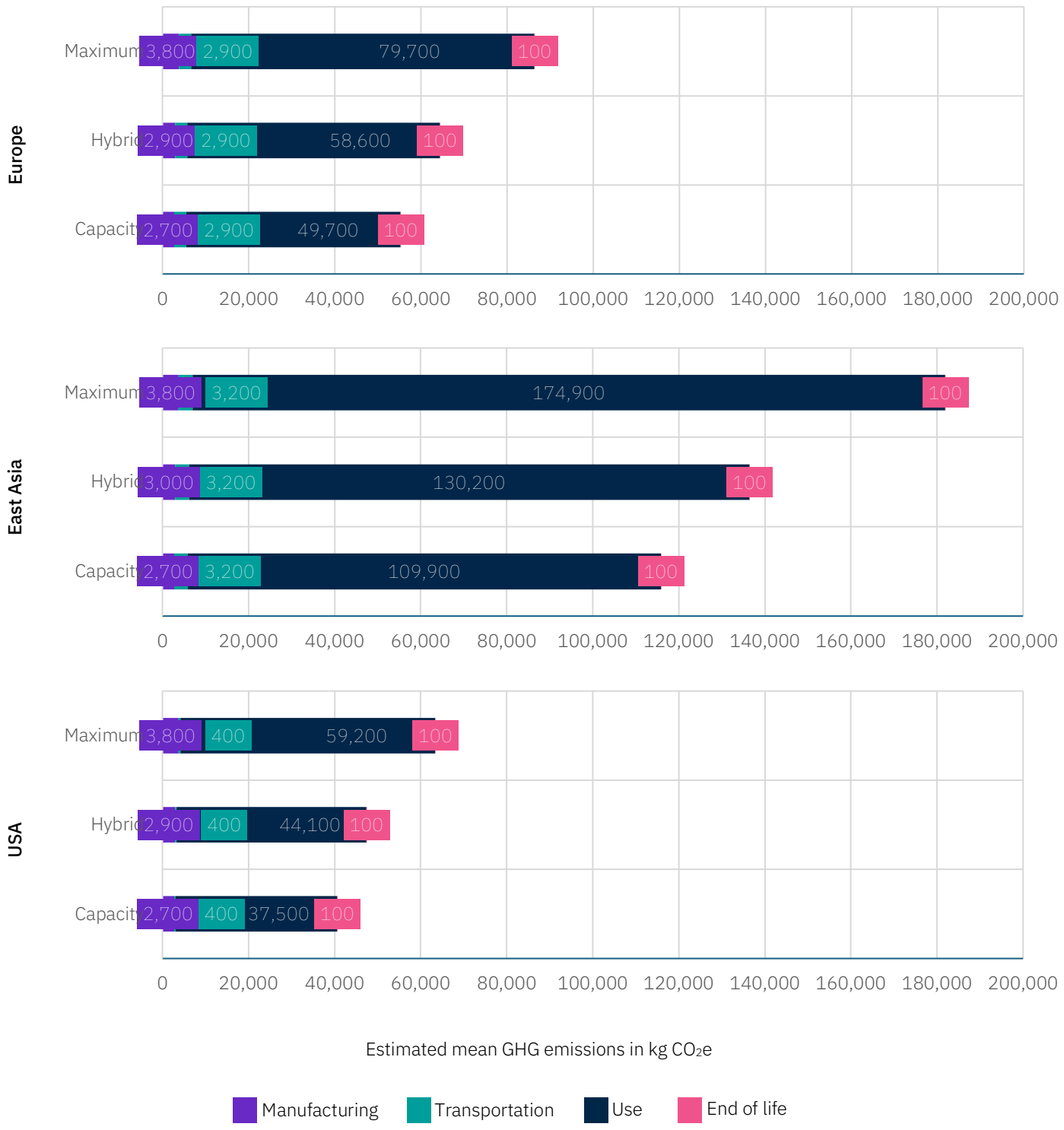

Figure 1: *Carbon footprint impact by phase for the IBM Storage Scale System 6000 product configurations listed in Table 1 using the PAIA model assuming a 5-year product lifetime.*

PAIA input data	Capacity	Hybrid	Maximum
Storage enclosure type	Rack	Rack	Rack
Storage array weight	69 kg	69 kg	69 kg
Number of arrays	1	1	1
Cardboard mass	9.8 kg	9.8 kg	9.8 kg
Plastic foam mass	2.7 kg	2.7 kg	2.7 kg
Chassis weight[4]	33.8 kg	33.8 kg	33.8 kg
Non-ferrous metal chassis weight	1%	1%	1%
Chassis IC package area	471 cm^2	471 cm^2	471 cm^2
Chassis PWB area	0.66 m^2	0.66 m^2	0.66 m^2
Number of PSUs	4	4	4
PSU dimensions	2.0 cm x 7.5 cm	2.0 cm x 7.5 cm	2.0 cm x 7.5 cm
PSU mass	1.0 kg	1.0 kg	1.0 kg
Length of cable	0.24 m	0.24 m	0.24 m
Number of fans	6	6	6
Number of SSD per array	4	24	48
Mass of each SSD	0.19 kg	0.19 kg	0.18 kg
SSD IC package area	Default	Default	125 cm^2
SSD IC fabrication location	Asia	Asia	Asia
SSD non-ferrous metal mass	Default	Default	0.07 kg
SSD PWB area	Default	Default	239 cm^2
SSD PWB substrate layers	Unknown	Unknown	12
Number of mainboards	2	2	2
Area of mainboard PWB	1,908 cm^2	1,908 cm^2	1,908 cm^2
Mainboard PWB layers	12	12	12
Mainboard IC quantity	191	191	191
Mainboard IC fabrication electricity intensity	0.004 kWh/IC	0.004 kWh/IC	0.004 kWh/IC
Mainboard IC die area	Default	Default	Default
Mainboard IC package area	212.9 cm^2	212.9 cm^2	212.9 cm^2
DRAM IC count	960	960	960
DRAM IC package area	1,161.6 cm^2	1,161.6 cm^2	1,161.6 cm^2
DRAM die area	Default	Default	Default
DRAM fabrication location	Asia	Asia	Asia
Number of sub-boards	14	14	14
Assembly location	Mexico	Mexico	Mexico
Product lifetime	5	5	5
Yearly energy consumption[5]	20,323 kWh	23,827 kWh	32,236 kWh
Transportation		Mode: Air	Mode: Truck
	Europe	9,700 km	150 km
	East Asia	10,900 km	150 km
	United States	0 km	3,200 km
Fraction recycled	0.97	0.97	0.97

Table 3: *Data used in the PAIA storage model for the IBM Storage Scale System 6000.*

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.

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. These values are 0.49 kg CO_2e/kWh for Europe, 1.09 kg CO_2e/kWh for East Asia, and 0.37 kg CO_2e/kWh for the United States. The region definition for Europe follows the World Bank definition.

4. The system rack is not included in the estimated carbon footprint.

5. Power consumption data is obtained using the published electrical power consumption for the 5149-F48. The power consumption assumes that the product operates 24 hours a day, 365 days a year for its product lifetime.

6. The configuration can be configured with either IBM® FlashCore Modules (FCM4) or NVMe drives. The data shown is for a configuration that utilizes the FCM4 drives. Using the NVMe drives results in a roughly 15% lower estimated mean use phase carbon emissions and a 10% lower estimated mean manufacturing GHG emissions.

Produced in the United States of America, July 9, 2024.