Makara Enterprise HDD Product Life Cycle Assessment (LCA) Summary

Product Description

The Makara Enterprise Capacity 3.5 hard disc drive (HDD) is an ideal hard drive for storing critical data with exceptionally fast random performance. It supports the industry's best response times and uses comprehensive advanced caching technology to enable the fastest data transfers, providing world-class reliability and high-capacity storage that's perfect for meeting customer's server and data center needs.

Life Cycle Assessment

Functional Unit, System Boundaries and Allocation Unit:

The functional unit for this study is a single Makara hard disc drive in operation for 5 years. The base case of this study assumed product distribution and use primarily in the United States, Europe, and the Asia Pacific. The Makara drive family is available with capacities ranging from one to eight terabyte (TB), and a spindle speed of 7,200 RPM.

The system boundaries are inclusive of raw material extraction, material manufacturing, supplier transportation, final product assembly and distribution, packaging, consumer use, and assumed end-of- life (EOL). Burdens from the recycling of product components at EOL are included in the system boundary but avoided burdens from displaced virgin raw materials are subject to a cut-off and are not included. Systems infrastructure such as the manufacture of machinery or buildings used in product production and final product assembly have been excluded. All product components were considered in this study with the Bill of Materials provided by Seagate. Burdens at Seagate's final product assembly were allocated on a production unit volume basis.

GaBi ts v.6.110, SimaPro v8.0.3.1, and the ecoinvent v3.0 database were used during preparation of the LCA.

Overall Results

The ReCiPe mid-point hierarchical method was used to determine life cycle impacts for the Makara v5 SATA 4KN product life cycle as shown below.

Mid-point Impact	Unit	Total
Climate change	kg CO2 eq	3.58E+02
Ozone depletion	kg CFC-11 eq	8.63E+01
Human toxicity	kg 1,4-DB eq	6.35E-02
Photochemical oxidant formation	kg NMVOC	1.27E-01
Particulate matter formation	kg PM10 eq	1.28E+01
Ionizing radiation	kg U235 eq	8.09E+01
Terrestrial acidification	kg SO2 eq	1.19E-01
Freshwater eutrophication	kg P eq	6.38E-02
Marine eutrophication	kg N eq	1.59E+01
Terrestrial ecotoxicity	kg 1,4-DB eq	9.31E-06
Freshwater ecotoxicity	kg 1,4-DB eq	6.95E-01
Marine ecotoxicity	kg 1,4-DB eq	1.09E+00
Water depletion	m3	2.41E+00
Metal depletion	kg Fe eq	8.00E-03
Fossil depletion	kg oil eq	1.34E+03

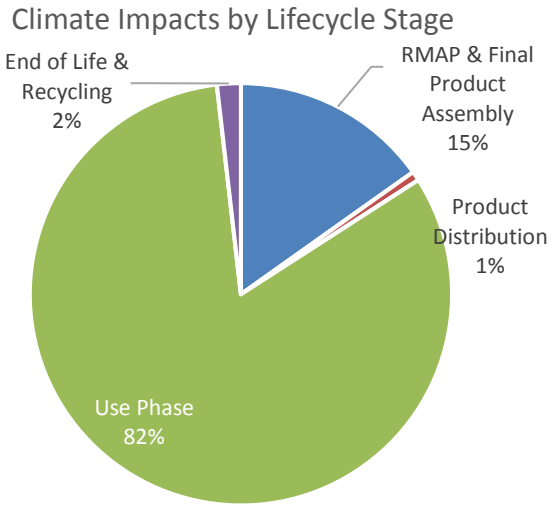
Climate Impacts

As Climate Impacts are often the foremost concern for our stakeholders, the remainder of this document will focus on analysis of carbon dioxide equivalent emissions (CO_2 eq) through the life cycle of the product. The total life cycle greenhouse gas (GHG) emissions of 358 kg CO_2e per drive are split between the various life cycle stages as presented below right.

Use Phase

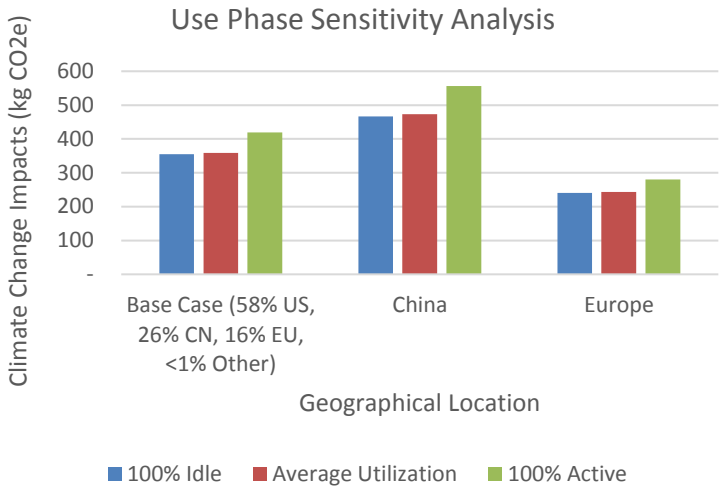
The Makara drives are intended for use in servers and data centers which operate continuously and provide online data storage and access capabilities throughout the day and year. However, data centers are equipped with redundant storage and computation capacity and consequently their annual utilization factors can often range as low as 10% to 40%. The estimated 5-year electricity consumption for the drive is 362 kWh, equivalent to the amount of energy needed to power a 100-Watt light bulb for two hours every day over the same time period.

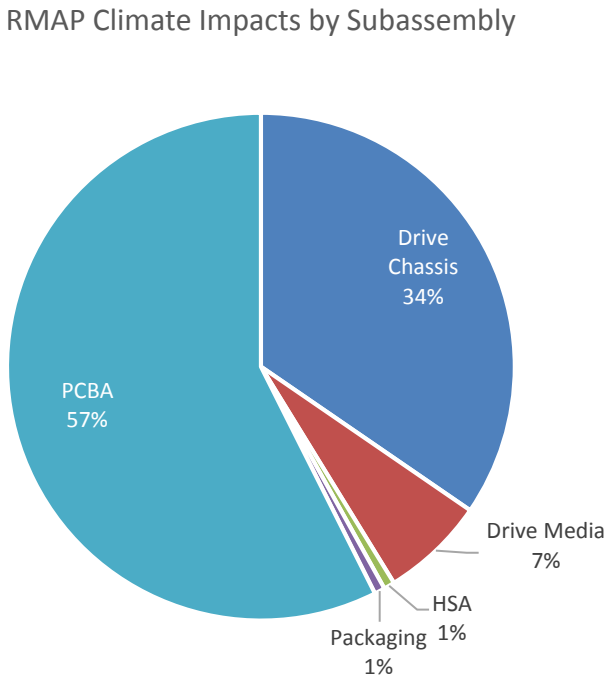
Sensitivity analyses were conducted to evaluate how the product's climate impacts would change for distribution and use in different geographies. The product is distributed and used in countries around the world, with dominant use in the United States, Europe, and Asia. For each geographic region, the use phase impacts will vary as a function of the local grid fuel composition and subsequent emission factors. The use phase sensitivity was modeled by changing the source of grid electricity from a base-case weighted average by country of use, (based on Seagate sales forecasts),to EU27 RER for Europe, and to China average for Asia, which respectively represent the lowest and highest grid emission factors of countries included in this assessment.



The sensitivity analysis also evaluates different server operating scenarios to determine the impact of utilization on the drive cycle. These scenarios represent the base-case average, minimum, and maximum utilization energy intensity of the base model drive.

- 100% Idle – Servers and hard disc drives are always powered on, but remain in idle mode.
- Average Utilization – Servers and hard disc drives are powered on and active, with use profile representative of typical server utilization.
- 100% Active – servers and hard disc drives are always powered on and active, and are never in idle mode.





Raw Material Acquisition and Pre-processing (RMAP)
This phase captures the impacts associated with raw material extraction to finished goods delivered to Seagate's point of final product assembly. Composing 15% of the total product footprint, component manufacturing impacts are largely determined by the materials used in each component and the energy intensity of component production.

As seen in the figure to the left, 57% of RMAP climate impacts are attributed to the Makara printed circuit board subassembly, largely driven by the embodied energy in the installed integrated circuits. The drive chassis subassembly (i.e. drive cover, labels, screws, etc.) account for an additional 34% of climate impacts, while the remaining 9% is split between the drive media, head stack subassembly (HSA) and packaging.

Final Product Assembly
The environmental impacts resulting from final product assembly by Seagate for each Makara hard drive were estimated using activity data from Seagate's GHG emission inventory. Activity data from the inventory were allocated to the product on a unit volume manufactured basis. Thus, all direct and indirect emissions from both production and facility operation (including heating and cooling, vehicle fleets, and fugitive emissions) have been captured in this estimate

Product Distribution
The product life cycle assumes distribution to customers in the United States, Europe, Asia Pacific, South Africa, and South America from the Seagate final product assembly sites in China and Thailand. The total GHG emissions from product distribution amount to only 1% of the total life cycle impact.

End of Life (EOL) & Recycling
Although the LCA data for electronic products' EOL/recycling phase has not been well established, and primary data are not available for this product, reasonable estimates of industry practices were made in this assessment based primarily on ecoinvent unit processes. These processes represent the manual dismantling and depollution, and the mechanical treatment (shredding) of WEEE devices in various fractions based on common transfer coefficients for this type of treatment in Switzerland. These processes have been considered as representative for the global situation, and applied to the Makara drive, although it is recognized that this will produce an optimistic result for EOL impacts. Recycling of packaging waste was derived from EPA data on Municipal Solid Waste Generation, Recycling, and Disposal in the United States.