Savvio 10K.5 Enterprise HDD Product Life Cycle Analysis Summary

Product Description

The Savvio 10K.5 HDD is an ideal hard drive for mission critical applications. It delivers best-in-class mission critical random performance, highest capacities, and the low power that data centers need to meet demanding service level agreements and to keep up with data growth and reduce IT operating costs.

Life Cycle Analysis

Functional Unit, System Boundaries and Allocation Unit:

The functional unit for this study is a single Savvio 10K.5 hard disk drive in operation for 3 years. The base case of this study assumed product distribution and use in the United States, Europe, and Asia. The drive operates with a spindle speed of 10,000 RPM, 64MB of cache, and is configured with 512 Bytes per sector.

The system boundaries are inclusive of raw material extraction, material manufacturing, supplier transportation, 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 assembly have been excluded. All product components were considered in this study with the Bill of Materials provided by Seagate. Burdens at Seagate's assembly were allocated on a production unit volume basis..

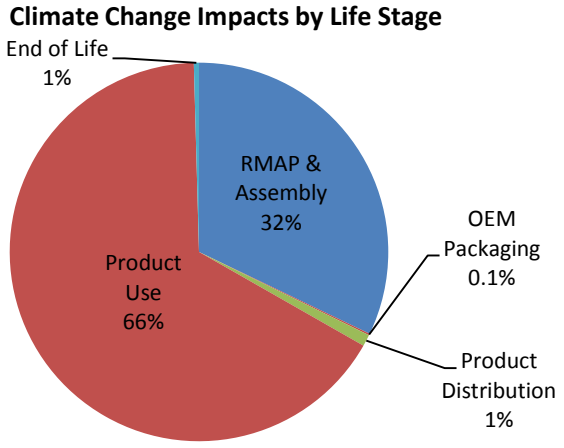
SimaPro v7.2 software and the Ecoinvent v2.2 database were used during preparation of the LCA. The ReCiPe mid-point hierarchical method was used to determine life cycle impacts for the product life cycle as shown below. This study, commissioned by Seagate Technology, was prepared by WSP Environmental, and 3rd party critically reviewed by EarthShift.

Calculated Results:

Mid-point Impact	Unit	Total
Climate change	kg CO2 eq	1.37E+02
Ozone depletion	kg CFC-11 eq	3.78E-06
Human toxicity	kg 1,4-DB eq	4.26E+01
Photochemical oxidant formation	kg NMVOC	4.30E-01
Particulate matter formation	kg PM10 eq	2.86E-01
Ionizing radiation	kg U235 eq	3.51E+01
Terrestrial acidification	kg SO2 eq	9.22E-01
Freshwater eutrophication	kg P eq	5.24E-02
Marine eutrophication	kg N eq	3.54E-02
Terrestrial ecotoxicity	kg 1,4-DB eq	5.77E-03
Freshwater ecotoxicity	kg 1,4-DB eq	9.19E-01
Marine ecotoxicity	kg 1,4-DB eq	8.50E-01
Water depletion	m3	5.31E+00
Metal depletion	kg Fe eq	5.33E+00
Fossil depletion	kg oil eq	3.25E+01

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 GHG emissions of 137 kg CO2e per product are split between the various life cycle stages as presented below.



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 assembly.Comprising 32%of the total product footprint, component manufacturing is largely determined by the materials used in each component and the energy intensity of component production.

As seen in the figure on the next page, the majority of raw material climate impacts are divided almost evenly between the Savvio 10K.5 hard drive's media and circuit board, with the remaining 15% divided between electronics, motor, and mechanical components.

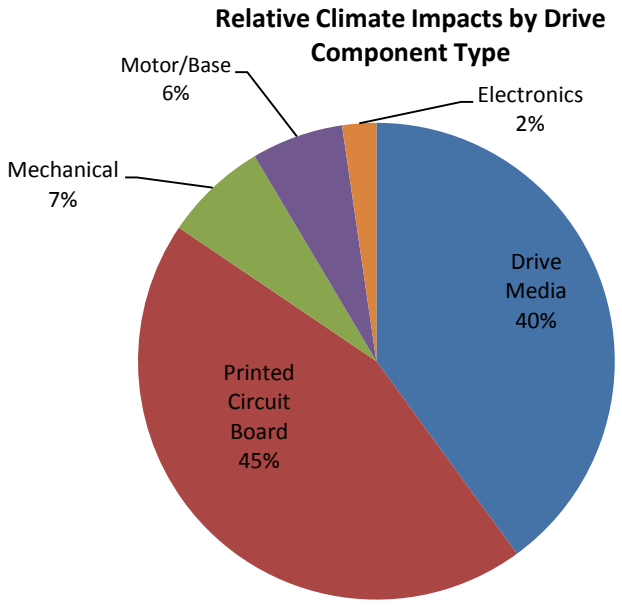
Production

The environmental impacts for each Savvio 10K.5 hard drive resulting from Seagate product assembly were estimated using Seagate's greenhouse gas (GHG) emission inventory activity data. These inventory data 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.

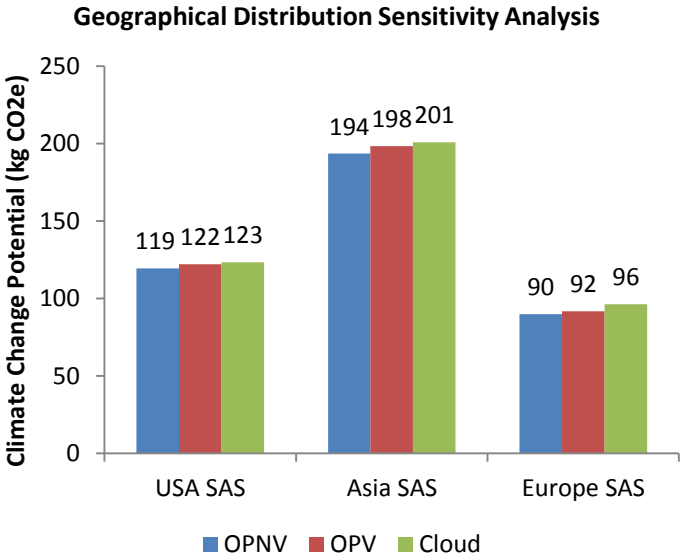
Distribution
The product life cycle assumes distribution to the United States, Europe, Asia, and shipments to customers from the Seagate assembly site. The total GHG emissions from product distribution amount to only 1% of the total life cycle impact.

Use Phase
The Savvio drives are intended for enterprise class data server use. Data centers 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 capacity factors often range as low as 25% to 45%. The estimated lifetime Savvio drive electrical consumption is 120 kWh, equivalent to the amount of energy needed to power a 100 Watt light bulb for 1.6 months.

Sensitivity analysis was conducted to evaluate how the product's climate impacts would change for distribution and use in different geographies. The representative product distribution models for US, Europe and Asia are available from Seagate. For each geographic region, the product use phase and end of life phase will be slightly different. The use phase sensitivity was modeled by changing the source of grid electricity from US average to Europe average and to China average for Asia. The sensitivity analysis also evaluates different server operating scenarios to determine the impact of utilization on the drive cycle. These scenarios represent low, mid, and high use intensity of a Serial Attached SCSi (SAS) drive as described below and illustrated in the chart below and to the right.



- On Premise Non Virtualized (OPNV) – Individual private servers running single applications hosted on-site, without virtualization, average CPU utilization of 10%
- On Premise Virtualized (OPV) – Individual private servers running single applications hosted on-site, with virtualization ratio of 5 to 1, average CPU utilization of 30%
- Public Cloud (Cloud) – A large-scale cloud service providing computing services to high numbers of customers; virtualization ratio of 8 to 1, average CPU utilization of 40%.



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 analysis based primarily on Ecoinvent unit processes. These processes represent the manual dismantling and depollution, and the mechanical treatment (shredding) of devices subject to the European Community Waste Electrical and Electronic Equipment Directive (WEEE) 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 Savvio 10K.5 drive, although it is recognized that this will produce an optimistic result for EOL impacts. Recycling of packaging waste was derived from Environmental Protection Agency (EPA) data on Municipal Solid Waste Generation, Recycling, and Disposal in the United States.

Savvio 10K.5 Enterprise HDD Bill of Substances

The table and chart below illustrate the 31 greatest mass substances in the Savvio disc drive comprising a cumulative concentration of nearly 99%. Each remaining chemical substance comprises less than 0.1% by weight of the product. Seagate Savvio 10K.5 Enterprise HDD disc drives contain no bromine or chlorine above 900 parts per million (ppm) or listed phthalates at the homogeneous material level. In addition, there are no JIG/IEC 62474 restricted chemicals over allowed limits, no ozone depleting chemicals, and no REACH substances of very high concern (SVHC) over 1000 ppm at the article level, as of the date of this writing owing to subsequent periodic additions to regulated and restricted chemicals lists that may not be accounted for here.

Substance	CAS Number	Cumulative Concentration of Substances (%)
FE	7439-89-6	46.565
AL	7429-90-5	72.1485
COPPER (METALLIC)	7440-50-8	78.4989
CRYSTALLINE SILICA	14808-60-7	82.7477
NEODYMIUM	7440-00-8	85.9864
SI	7440-21-3	88.3599
CHROMIUM	7440-47-3	90.3969
FIBROUS-GLASS-WOOL	65997-17-3	91.576
POLYETHERIMIDE	61128-46-9	92.3977
NICKEL	7440-02-0	93.0101
DYSPROSIUM	7429-91-6	93.5674
"DOPO"	35948-25-5	94.0856
PROPRIETARY		94.5802
FUSED SILICA	60676-86-0	95.0568
BASIC POLYMER: LCP	147310-94-9	95.4998
MANGANESE	7439-96-5	95.8351
SN	7440-31-5	96.1192
BARIUM TITANATE(IV)	12047-27-7	96.3834
POLYESTER MATERIAL	25038-59-9	96.638
AG	7440-22-4	96.8918
ACRYLIC POLYMER	37325-11-4	97.1172
POLYACRYLATE	600-07-7	97.3342
OLIGOMER	73324-00-2	97.5476
DIIRON-TRIOXIDE	1309-37-1	97.7594
POM	24969-26-4	97.9499
C	7440-44-0	98.1142
MAGNESIUM-OXIDE	1309-48-4	98.2606
AL2O3	1344-28-1	98.3917
HEXAFLUOROPROPENE POLYMER	9011-17-0	98.5167
ZINC	7440-66-6	98.6373
B	7440-42-8	98.7543