A report by

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Executive Summary: An assessment of the greenhouse gas emissions and waste impacts from improving the repairability of Microsoft devices

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Executive summary

Background

Microsoft has expressed a longstanding commitment to environmental sustainability. In response to increasing focus on repairability from customers, investors, policymakers, and other stakeholders, Microsoft commissioned this third-party study to investigate the connections between Microsoft's sustainability commitments and device repairability to further inform product design and plans for expanding device repair options. Microsoft considers its products to be of high quality and reliability. Accordingly, it expects demand for repair of Microsoft devices to be low and – in real terms – to constitue a small element of the company's overall environmental footprint. Nevertheless, Microsoft wishes to respond to its customers who are requesting repair services. Microsoft is also interested in understanding the sustainability benefits of enabling repair to align with Microsoft's corporate sustainability goals. Specific information related to Microsoft's work on hardware sustainability, including repairability, is available in Microsoft's 2021 Environmental Sustainability Report.

Oakdene Hollins is a technical, science-led, consultancy known as a leading analyst and developer of innovative approaches in the circular economy. For this report, Oakdene Hollins quantified the sustainability impacts of enabling greater repairability and of increasing consumer access to repair for Microsoft's devices. The sustainability impacts addressed in this report are measured as waste generated and greenhouse gas emissions associated with relevant manufacturing and repair processes. These impacts were quantified by using the amount of waste or emissions that are avoided by enabling device repair versus device replacement and the amount of waste or emissions reductions when comparing the impacts of localized ASP repair options against China-based factory repair options.

The report also assessed which additional Surface parts can be made available to the company's enterprise customers to facilitate repairs and which parts and repair documentation can be provided to independent repair shops and consumers beyond Microsoft's Authorized Service Provider network. The study also identified new mechanisms to enable and facilitate local repair options for consumers. Since this study used Microsoft internal product roadmaps for certain assessments, the full study is confidential and for Microsoft purposes only.

The study found that, compared to a device replacement scenario, all forms of repair offer significant greenhouse gas (GHG) emission and waste reduction benefits. It also found that enabling repair through device design, spare part offerings, and localization of repair have significant potential to reduce carbon and waste impacts. Finally, it highlighted the role that transportation logistics can play in contributing to overall GHG emissions associated with repair services. To further reduce waste and GHG emissions, Microsoft is advised to take steps to expand repair locations and capabilities across more devices and to promote mail-to repair services.

Assessment

Figure 1 summarizes the life cycle stages where Microsoft has substantial control over actions that can enable device repairability; Microsoft can take action to design products to enable repair and also to expand channels for repair. The design and repair/refurbishment stages, therefore, were in scope for study purposes.

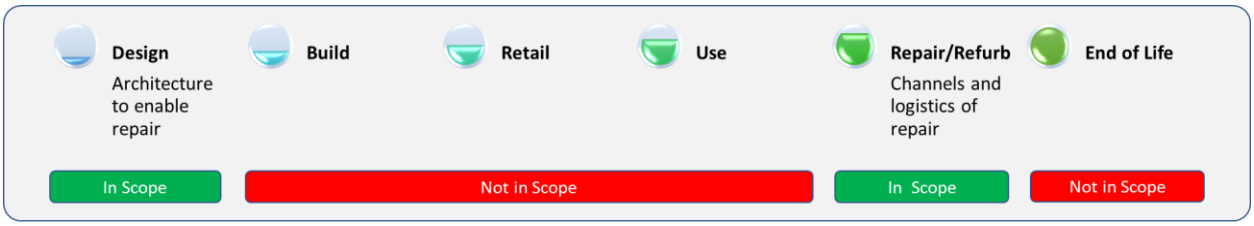

Figure 1: Product lifecycle stages evaluated for Microsoft enablement of repair

The evaluation of sustainability benefits associated with enabling greater device repair used a comparative analysis of different repair scenarios. Lifecycle assessment environmental data were used to make waste generation and greenhouse gas (GHG) emission comparisons across the assessed repair scenarios.

The scenarios assessed were as follows:

1. Broken device is replaced with a new device by the user and broken device is discarded (Base Case).
2. Broken device is refurbished at a factory in China using standard Microsoft procedure (Factory Repair)
3. Broken device is repaired by an Authorized Service Provider using Field Replaceable Units through an approved Microsoft procedure (ASP Repair).

The assessed devices and repair scenarios are shown in Table 1.

Device	Surface Pro 6	Surface Pro 8	Surface Book 3	Surface Laptop Studio
Year device Placed on Market	2018	2022	2020	2022
Repair option available when device placed on market	Factory Repair (refurbishment)	ASP Repair	Factory Repair (refurbishment)	ASP Repair
Region of repair	China	In region (United States)	China	In region (United States)

Table 1: Microsoft devices and repair options assessed

During Factory Repair, broken devices are sent back to the manufacturing factory where they are repaired and restored to like-new condition using a Microsoft-established procedure. Factory Repair was the only method of repair for Surface Pro 6 and Surface Book 3 when they were placed on the market in 2018 and 2020 respectively. Customers who requested repair for Surface Pro 6 and Surface Book 3 received a replacement device from Microsoft in exchange for their broken unit, which was then refurbished via the Factory Repair process and resold or used for product exchange.

ASP Repair occurs when a broken device is repaired by a Microsoft Authorized Service Provider (ASP), following a Microsoft approved procedure and using Microsoft-supplied spare parts, also known as Field Replaceable Units (FRUs). ASP Repair is a same-unit repair service and is currently only available for corporate customers of several newer Microsoft products but, according to Microsoft, is planned for expansion across more devices and more consumers. ASP Repair was a repair option for Surface Pro 8 and Surface Laptop Studio when they were launched in 2022.

Only repair services that were available at the time the selected products were placed on the market were assessed. This was done to ensure that the GHG emission and waste generation impacts that were calculated were accurate, based on Microsoft data, and would reflect both evolutions in device design and Microsoft repair services. According to Microsoft, any repair must meet Microsoft's quality & reliability standards, fulfilment of safety obligations, and compliance with environmental protection requirements and are the reasons why Factory Repair and ASP Repair are currently the primary routes for Microsoft device repair.

The study assessed and examined the waste and GHG emission impacts associated with the repair of five Surface devices and two Xbox consoles. Of the seven products, four Surface devices were selected for direct comparison of the sustainability impacts of the two repair options – Factory Repair and ASP Repair. A direct comparison of the Xbox consoles was not conducted because both Xbox consoles are currently repaired using in-region Factory Repair in North American, European, and Asian markets and a comparison of the Factory Repair option to the ASP Repair options was not feasible.

Of the Microsoft devices studied, two device pairs – Surface Pro 6/8 and Surface Book 3/Surface Laptop Studio – were chosen to illustrate how Microsoft designs are evolving to enable repair. Design improvements were evidenced by the increased number of FRUs available for the newer devices. The study showed that expanded repair services, enabled by product and process design changes and available FRUs, have the potential to significantly reduce waste and GHG emissions by enabling device repair in lieu of device replacement. Certain design changes have also reduced the need for collateral part[1] replacement during repair, further reducing waste and GHG emissions. We recommend that Microsoft continue this design strategy to further yield sustainability benefits across future Microsoft devices.

[1] "Collateral part" means a part needed for repair, which was not part of the root-cause failure but which had to be destructively removed and replaced during the repair process.

Using industry standard lifecycle assessment protocols, the sustainability evaluation was based on detailed device and FRU breakdowns to include mass and composition, part replacement rates in factory, a consideration of transport impacts associated with the appropriate location of repair, and GHG emissions and waste generation impacts associated with the assessed devices and relevant replacement parts.

For the selected devices, the overall sustainability benefits of repair were assessed by comparison to the Base Case scenario where a device failure results in a user purchasing a new replacement device and discarding the broken device with no refurbishment or repair. In comparison to this Base Case, both assessed repair options (Factory Repair and ASP Repair) resulted in reduced waste and GHG emissions. Figure 2, representing a major fraction of overall repair activity, provides a summary of the questions this report addresses, the findings, and data supporting the study's findings.

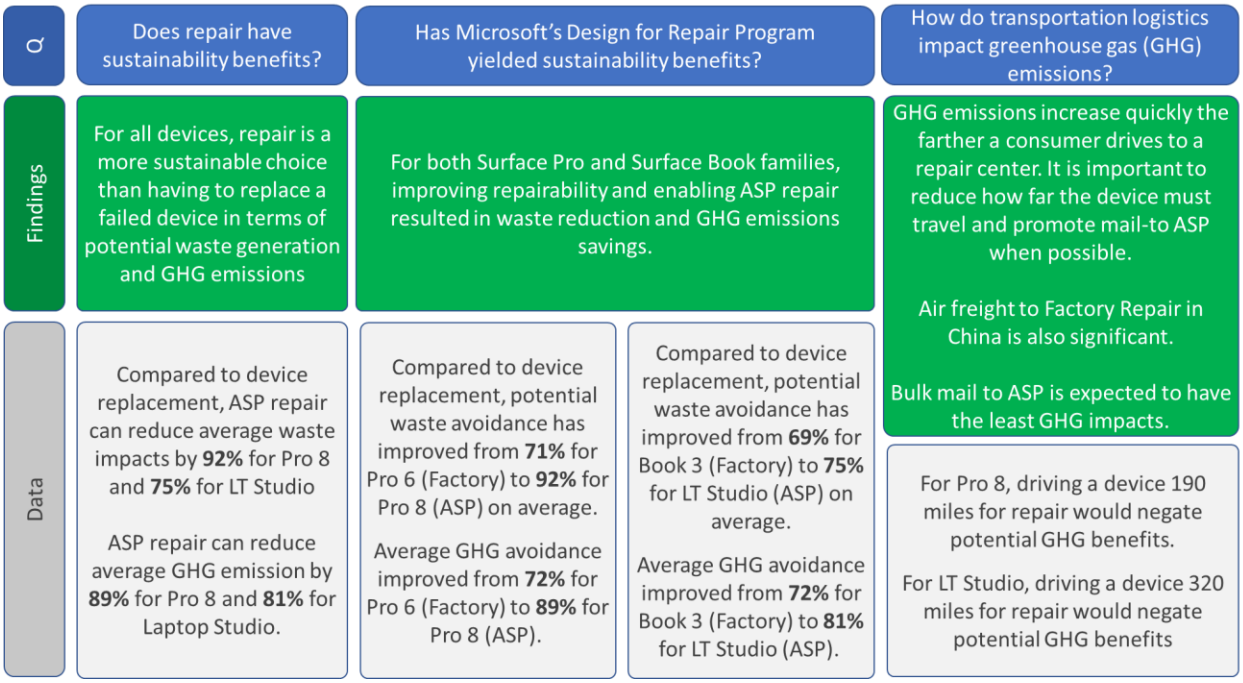

Figure 2: Summary of report findings – key questions answered regarding the sustainability benefits of repair

The reductions in waste and GHG emissions observed for the assessed devices are shown in the figures below. For each device pair, the top device failures, as indicated by Microsoft data, were analysed. Comparisons in waste generation and GHG emission impacts were only made for device repairs that had a corresponding FRU available for such repairs. As a result, three repairs were assessed for Surface Pro 6 and Surface Pro 8, while five repairs were assessed for Surface Book 3 and Surface Laptop Studio.

As shown in Figures 3 and 4, the study found that waste generation associated with ASP Repair of Surface Pro 8 and Surface Laptop Studio was much lower than the waste generation associated with Factory Repair of the previous generations of those two devices (Surface Pro 6 and Book 3). As shown in Figures 5 and 6, the study also found that the GHG emissions associated with ASP Repair of Surface Pro 8 and Surface Laptop Studio were also much lower than the GHG emissions associated with Factory Repair of the previous generation of those two devices (Surface Pro 6 and Book 3). These sustainability improvements can be attributed to progress in Microsoft's Design for Repair strategy which, among other things, has expanded FRUs and ASP Repair for newer devices.

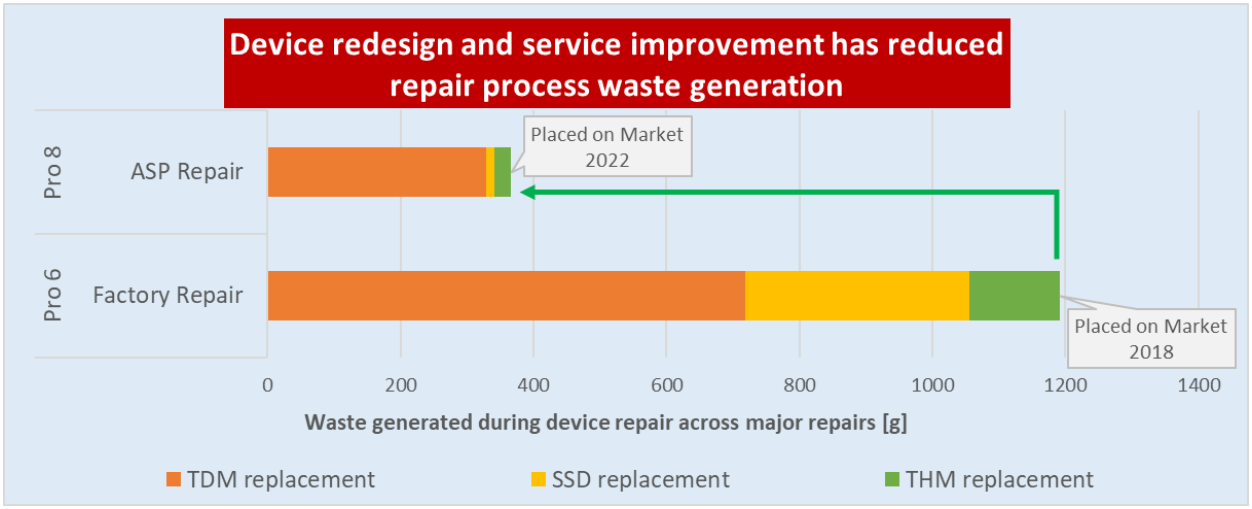

Figure 3: Waste impacts of Pro 8 ASP Repair compared to Pro 6 Factory Repair

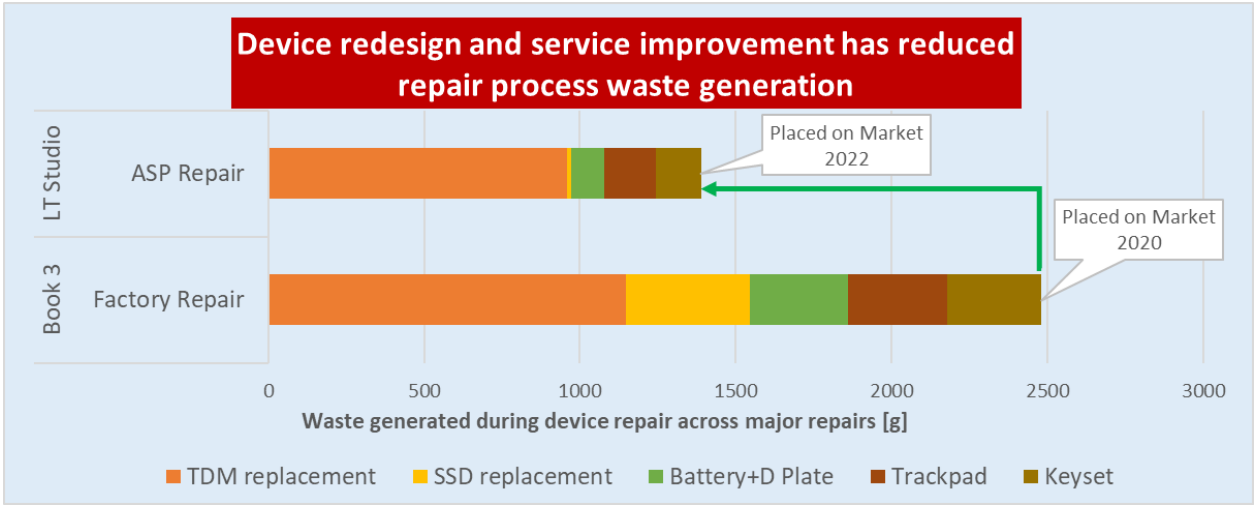

Figure 4:Waste impacts of Laptop Studio ASP Repair compared to Book 3 Factory Repair

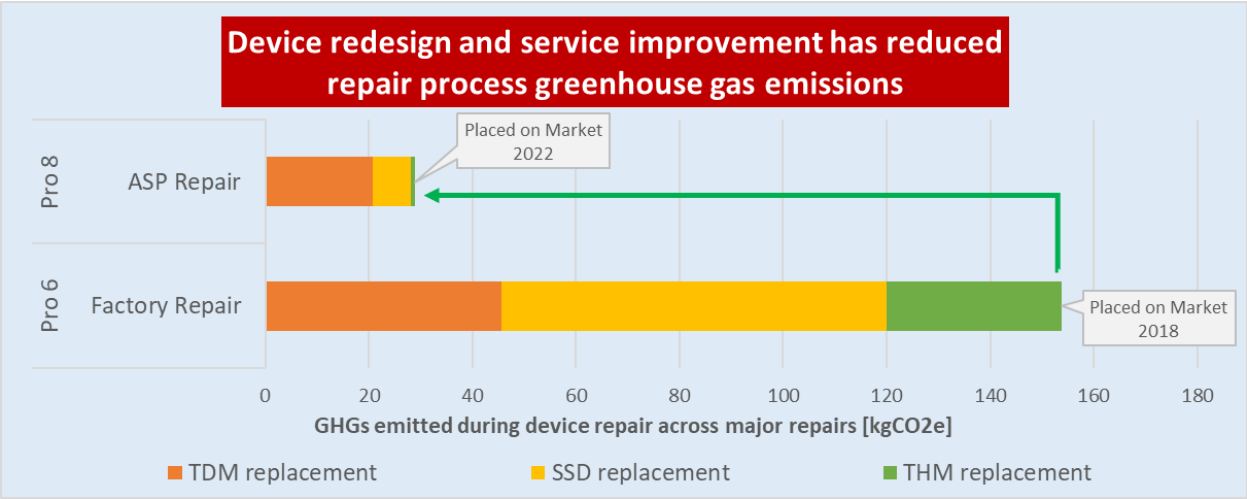

Figure 5: GHG emission impacts of Pro 8 ASP Repair compared to Pro 6 Factory Repair

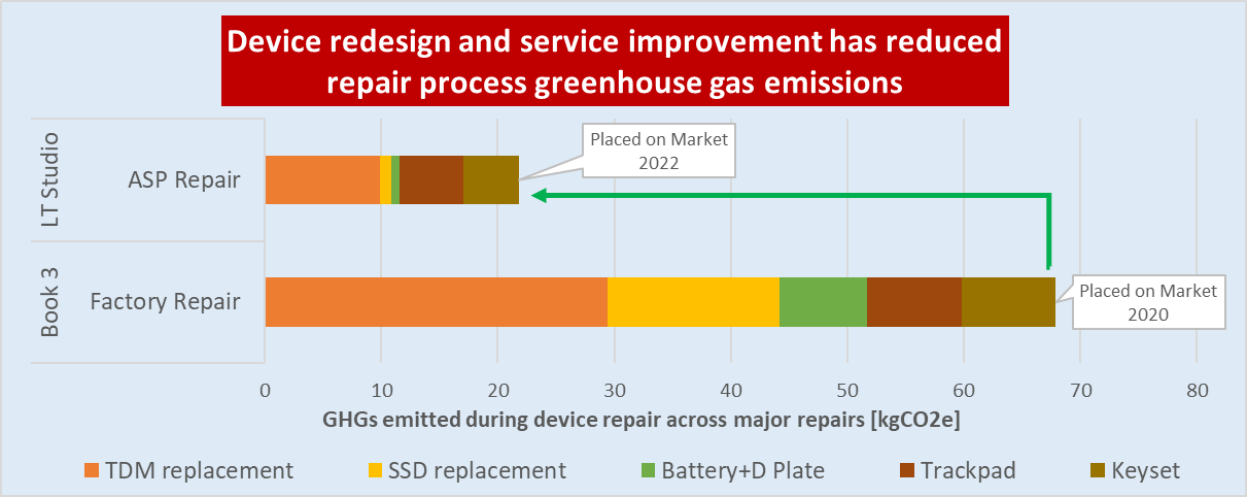

Figure 6: GHG emission impacts of Laptop Studio ASP Repair compared to Book 3 Factory Repair

The study showed that Factory Repair and ASP Repair both resulted in significant GHG emissions and waste avoidance when compared to the Base Case of device replacement. An example of this is shown in Figure 7, which shows the average GHG emissions avoided for both Surface Pro 6 Factory Repair and Surface Pro 8 ASP Repair when the full range of repairs were addressed. For the Surface Pro 6 Factory Repair process, the average GHG emissions avoided were over 70% in comparison to the Base Case of device replacement (shown as having 0% avoided emissions in Figure 7). For the Surface Pro 8 ASP Repair process, the average GHG emissions avoided were over 85% in comparison to the Base Case of device replacement. For all devices and repair scenarios assessed, the study found that waste and GHG emissions were avoided in significant percentages when compared to the Base Case of device replacement. Please note: Figure 7 does not include GHG emissions associated with transportation which will vary depending on transportation logistics (see below).

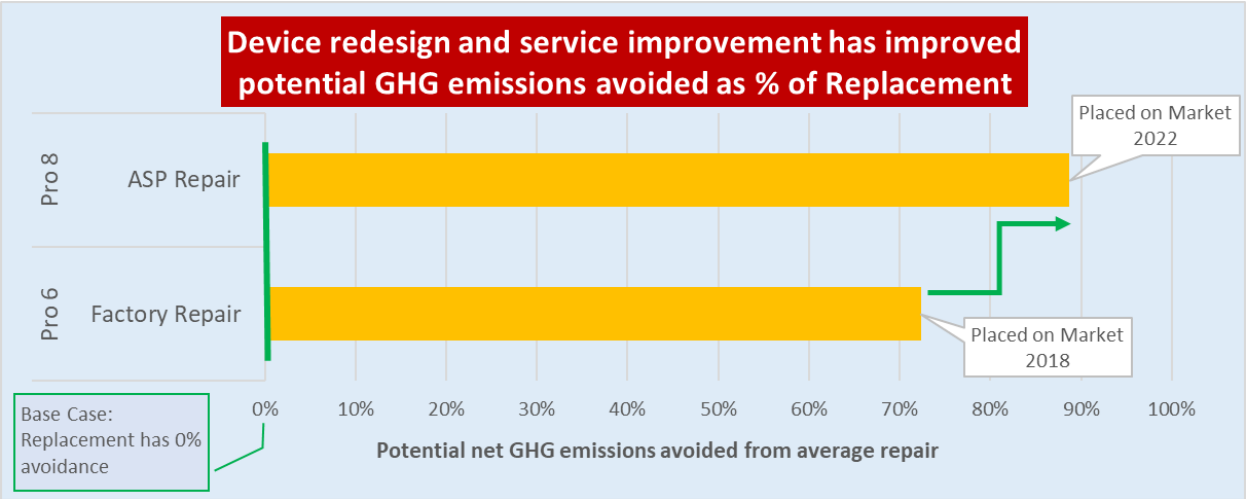

Figure 7: Average GHG emission impacts avoided through repair when compared to device replacement.

For all devices assessed, the study showed that repairing the product instead of device replacement can yield up to a 92% reduction in potential waste generation and GHG emissions. This result is based on the waste and GHG impacts associated with manufacturing new parts and devices.

The study found that transportation logistics by which broken devices are delivered to repair facilities and by which repaired devices are returned to end users are relevant for assessing the sustainability impacts of repair. Transportation logistics are often found to be a minor component of supply chain impacts. However, the study revealed that the transportation logistics chosen for device repair can have a substantial (>20%) impact on the net sustainability benefits of repair. If end users drive their broken devices to a repair facility, even over a short distance, GHG emissions may increase rapidly. The study showed that "mail-to'" services offered an order of magnitude lower GHG emissions impact even over much larger transport distances and, therefore, should be encouraged.

Part of Microsoft's strategy for improving speed and access to repair services is to increase the number of repair locations that are close to consumers. Currently, ASP Repair is only available to Microsoft's commercial customers, but this study supports the case for expanding ASP repair to all customers. For many customers, a repair facility may be within a reasonable driving distance. However, consumers in remote locations may find that a repair facility is not close by. It is these customers whom Microsoft should target for mail-to services provided this does not compromise speed of repair fulfilment.

Air freight is currently a key enabler of Factory Repair, which commonly takes place at factories located in China. Although air freight is a bulk service, high GHG emissions associated with air travel are reflected in GHG emission calculations[2]. While full refurbishment and some repairs may always need a Factory Repair option, careful consideration should be given to reducing Factory Repairs, when feasible, to reduce GHG emissions. This may be achieved by making more FRUs available to ASP providers and by creating Surface regional centres for Factory Repair similar to those currently in place for Xbox consoles. For example, a hub in Mexico, servicing the US market, could reduce GHG related impacts of Surface Factory Repair by approximately two thirds.

[2] See here: CO2 emissions for shipping of goods - Time for Change

This study was based on Microsoft-supplied data associated with Microsoft repair operations. Microsoft recognises that the data that it provided represents only a partial view of possible repair scenarios as the data only includes data from repair operations under its direct control. The study recommends that Microsoft compile additional data to model a more robust view of repair across all channels and ensure that it is targeting common failures to avoid unnecessary waste and GHG emissions associated with FRU manufacture.

Conclusions

Three main conclusions can be drawn from this study. First, compared to the Base Case of device replacement, Factory Repair and ASP Repair offer significant GHG emission and waste reduction benefits. Second, Microsoft's Design for Repair work to enable ASP Repair through device design, FRU offerings, and localization of repair has the potential to further reduce carbon and waste impacts. Finally, transportation logistics can have a significant impact on the overall GHG emissions of repair. Of the repair routes currently available, mail-to ASP has the lowest overall GHG impact. To further reduce waste and GHG emissions, it is recommended that Microsoft take steps to expand ASP repair locations and capabilities across more devices and promote bulk mail-to repair services when feasible.

Authors

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David has over 20 years' experience conducting projects related to circular economy, waste and resources, and in particular value retention. David's expertise pertains to technology and sustainability metrics, and he has led our value retention-based consultancy work globally.

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