Lyft, Inc.
Transit, Bikes & Scooters

Life Cycle Assessment Report in Conformance
with ISO 14044 and ISO 14040
Lyft Classic, Ebike 1.0, and Ebike 2.0 Bicycles

May 19, 2022

Forward-Looking Statements

Certain statements contained in this report are “forward-looking statements” within the meaning of the securities laws, including statements about Lyft’s strategies, commitment to sustainable hardware, plans to implement such commitments, Lyft’s efforts with respect to policy making and its ability to work with policy makers and other third parties. Such statements, which are not of historical fact, involve estimates, assumptions, judgments, and uncertainties. There are a number of factors that could cause actual results or outcomes to differ materially from those addressed in the forward-looking statements. Such factors are detailed in Lyft’s filings with the Securities and Exchange Commission. We do not undertake an obligation to update our forward-looking statements to reflect future events, except as required by applicable law.

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List of Abbreviations

ABS	acrylonitrile butadiene styrene
AR5	5th Assessment Report
BOM	bill of materials
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
EOL	end of life
g	gram
GHG	greenhouse gas
GLO	global
GWP	global warming potential
ICE	internal combustion engine
IOT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
kg	kilogram
LCI	life cycle inventory
LCIA	life cycle impact assessment
m	meter
mi	mile
MJ	megajoule
PA	polyamide
PC	polycarbonate
PC-ABS	polycarbonate-acrylonitrile butadiene styrene
PCBA	printed circuit board assembly
PE	polyethylene
PET	polyethylene terephthalate
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter under 2.5 microns
ROW	Rest of World
SOP	Standard Operating Procedure
TBS	Lyft Transit, Bikes, and Scooters
TRACI	Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts
VCU	vehicle control unit
VMT	vehicle miles traveled
W	Watts
WECC	Western Electricity Coordinating Council

Definitions

Climate Change/ Global Warming Potential (GWP)	Climate Change impacts describe the potential for global climate change as a result of specific products, services, or processes. It is quantified by Global Warming Potential (GWP), which is a measure of the energy a greenhouse gas will absorb relative to the energy carbon dioxide will absorb. [1]
Fossil Fuel Resource Depletion	Fossil fuel resource depletion describes the quantity of non-renewable energy resources depleted as a result of specific products, services, or processes.
Human Health Particulate Matter	Human health particulate matter ($PM_{2.5}$) impacts describe the resulting quantity of particulates below 2.5 microns in size emitted into the atmosphere as a result of specific products, services or processes. Exposure to particulate matter has been linked to various adverse human health conditions, including but not limited to decreased lung function, aggravated asthma, and premature death in people with heart or lung disease.[2]
Impact Categories	Impact categories describe the environmental consequences and physical environments affected by specific products, services, or processes. [3]
Integrated Production Phase	The period of the product life cycle that includes the activities from materials extraction through to the assembly of bikes.
Micromobility	Transportation over short distances provided by lightweight, usually single-person vehicles (such as bicycles and scooters)
Mode Shift	The switching of transportation modes to lower energy consumption methods, such as when people switch from driving in cars to taking alternative modes of transportation such as buses, trains, bicycles and scooters.

[1] (United States Environmental Protection Agency, 2022)
[2] (United States Environmental Protection Agency, 2022)
[3] (Mu, Xin, & Zhou, 2020) References

Multimodal	Characterized by multiple different travel modes. It can describe networks as well as individual trips.
Processes (LCA processes)	Sets of interacting activities that transform inputs into outputs.[4] ● Unit Processes: smallest unit analyzed for which input and output data are quantified ● System Processes (LCI): Aggregated life cycle result saved as a process
Rebalancing	Refers to the redistributing of rideables across a defined service area to locations, stations, or parking zones in order to meet user demand and travel patterns.
Use Phase	The period of the lifecycle where Lyft riders use Lyft bikes and Lyft teams perform the required operations to keep them maintained and operational.

[4] (JNS & Ciroth, 2019) References

Lyft Classic, Ebike 1.0, and Ebike 2.0, Cradle-to-Grave LCA Summary

Parameter	Description
Company Name and Contact Information	Lyft Inc. 185 Berry St #5000 San Francisco, CA 94107
Study Practitioner	Tolu Akinwumi, PE, Sr. Group Manager, Manufacturing Program Mgmt. & Sustainability Engineering Matt Yau, PE, Sustainability Engineer
Standards Used	ISO 14040 2006: Environmental management – Life cycle assessment – Principles and framework ISO 14044 2006: Environmental management – Life cycle assessment – Requirements and guidelines
Product Name	Lyft Classic bike, Ebike 1.0, and Ebike 2.0.
Product Description	The function of the Lyft Classic, Ebike 1.0, and Ebike 2.0 bicycles are to provide individual transport via electric and non-electric bike share.
Functional Unit (study basis)	The functional unit is one actual or modeled bike-mile traveled while transporting a passenger.
Temporal Boundary	Bike production and transport data were collected in 2021. Operational data were based on data from 2020 through 2021. The time period which results should be considered valid is ten years from the publication date of this study.
Country/ Region of Product Consumption	United States
Version and Issue Date	Version 1.0: May 19, 2022

Executive Summary

Lyft's approach to bikes and scooters is guided by four key tenets: transportation equity, safer streets, transit integration, and environmental sustainability.[5] To make meaningful reductions to our environmental footprint, we need to measure our impact and invest in sustainable hardware and operations that deliver the largest environmental benefits. We are taking a data-driven approach to our sustainability efforts by grounding our sustainability decisions in comprehensive life cycle assessments (LCAs) of our micromobility fleets and operations. LCAs provide a holistic approach for understanding the most significant impacts of our operations throughout the entire life cycle.

This study aims to determine the environmental impacts per actual or modeled bike-mile traveled, based on the entire life cycle of our classic and electric bikes operating in the United States. Lyft has two models of electric bikes: the Ebike 1.0, our original model already in operation, and the Ebike 2.0, which launched at the end of 2021. Ebike 2.0 is Lyft's first electric bike designed from the ground up. It has been engineered to greatly improve upon Ebike 1.0's operational performance and includes many features designed to enhance the ride experience while deterring use patterns that can negatively impact a unit's useful life. Some physical differences in the Ebike 2.0 relative to the Ebike 1.0 are an electronic display, beacon, and a bigger battery pack that is housed within the frame downtube instead of over top. With all these design improvements, Lyft expects the Ebike 2.0 to greatly outperform Ebike 1.0 in both estimated lifetime rides and trip length. However, to maintain consistency in our data methods, Ebike 2.0's estimated lifetime is modeled after Ebike 1.0 for this study and will be updated in future studies once sufficient actual mileage data has been collected. Finally, the study follows the International Standards Organization (ISO) 14040 and 14044 standards for LCAs and assesses life cycle impacts to climate change, human health particulate matter and fossil fuel resource depletion.

We will use the results of this assessment to prioritize technical solutions to environmental issues. We will also use the results to provide us with a unique, sustainability-conscious lens through which we will evaluate how to better design, build, and operate our micromobility systems. The results of this LCA will also inform updates to our sustainable design principles and accelerate our efforts in delivering more sustainable products. These principles guide our hardware community (e.g., engineers, industrial designers, product managers) to design and manufacture more sustainable micromobility hardware. They focus on material selection, designing for durability and range, and improving reuse and recyclability. We plan to build greater internal awareness and understanding of our design principles by integrating them into our product development process.

This study examines climate change, human health particulate matter, and fossil fuel resource depletion as the most relevant impact categories because they best align with Lyft's sustainability values and operations. These categories were selected because they best represent the impact of bikes and scooters in cities and the transport modes they potentially replace.

The climate change life cycle impacts are driven primarily by the Use and Integrated Production Phases (Figure ES-1). For Ebike 2.0, Ebike 1.0, and Classic bikes, automobiles used to conduct battery swapping and/or bike rebalancing operations are the primary contributors to the Use

[5] (Zimmer & Green, 2018) References

Phase of their life cycles. The Integrated Production Phase is the second largest impact phase of the bikes' lifecycles, and the bikes' aluminum content drives most of it. Aluminum content is also the largest contributor to all three impact categories because it carries the largest mass on the bikes and the energy intensity of mineral extraction and metal refinement processes used to produce aluminum alloys. The Transport and End of Life (EOL) phases are minor contributors to overall impact. The EOL Phase values are negative due to the reduction in environmental impacts seen when recycled content materials are used instead of virgin materials. Virgin materials require raw material extraction, raw material refining, material processing, and fabrication while recycled materials typically only need to be reprocessed. Figures ES-1 to ES-3 present the climate change life cycle impacts by phase for all bikes studied.

Figure ES-1: Ebike 2.0 GWP per Modeled Mile Traveled by Life Cycle Phase

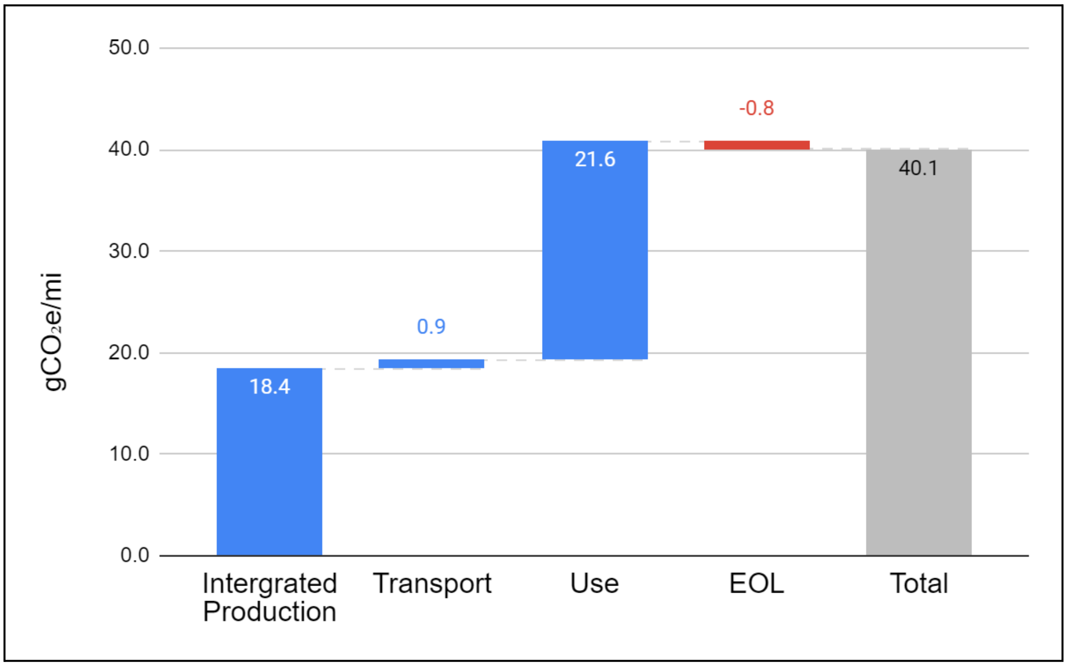


Figure ES-2: Ebike 1.0 GWP per Actual Mile Traveled by Life Cycle Phase

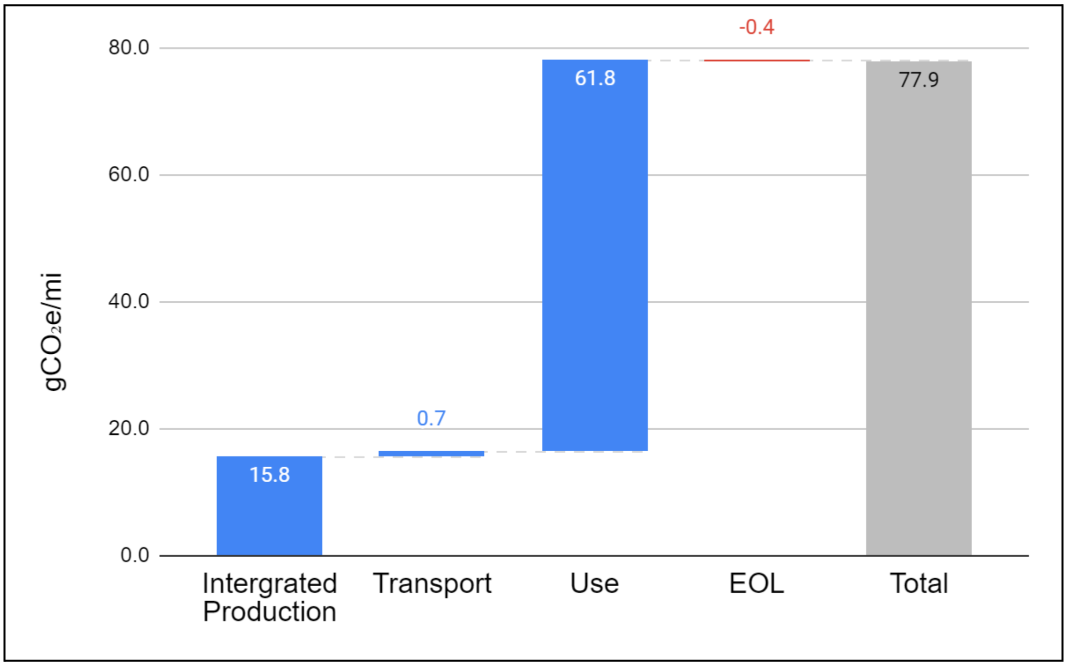
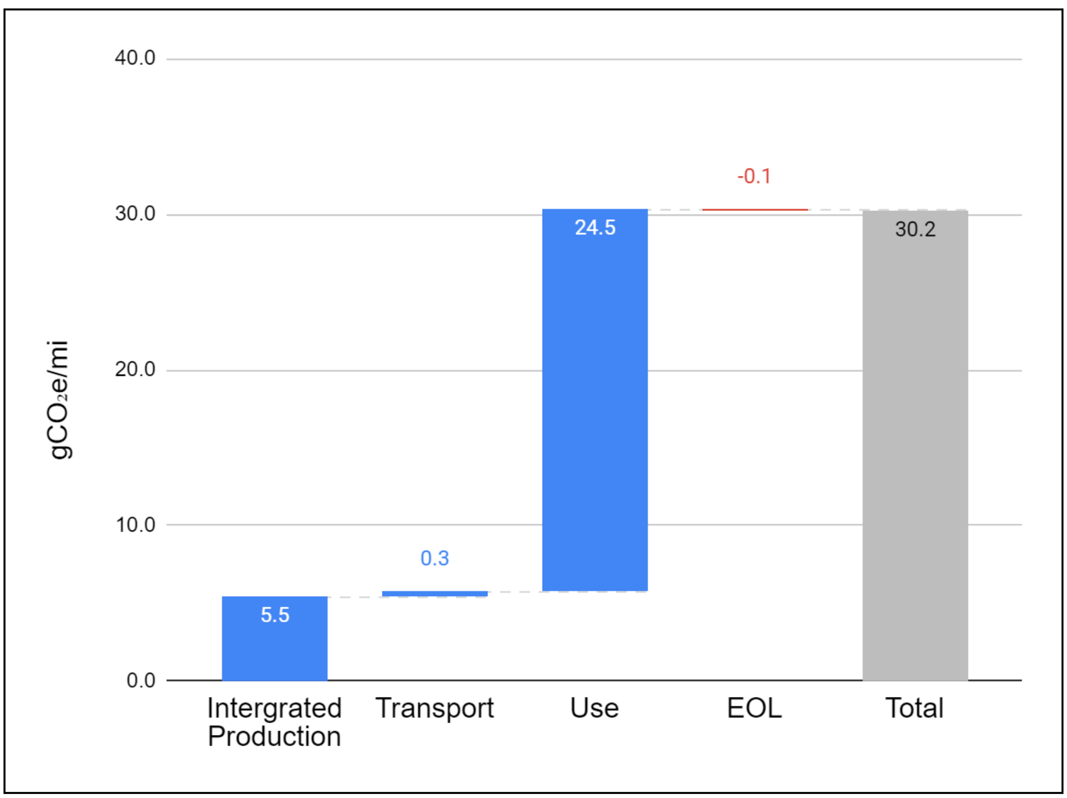


Figure ES-3: Classic GWP per Actual Mile Traveled by Life Cycle Phase



Multiple sensitivity analyses were performed to test the quality of the assumptions. For all rideables, scenarios were crafted that include two sensitivity cases along with the base case to test the lifetime hypotheses. For the Classic and Ebike 1.0 bikes, the base case was chosen based on actual miles traveled of a Lyft bike based on GPS-tracked ride data from our data dashboards operating in San Francisco. For the Ebike 2.0 bike, the base case is modeled after Ebike 1.0's actual miles traveled. The stress case for Classic bikes is based on Chicago operations, with longer transport and rebalancing distances, while the most optimistic case is based on New York City operations, where there are much shorter rebalancing distances. For Ebike 2.0 and Ebike 1.0, the stress case is based on the estimated lifetime of the Lyft 2.2 scooter and the most optimistic case is based on the classic bike operational lifetime estimate. The sensitivity cases were modeled on various rideable lifetime estimates, which contributed to differing operational emissions, including charging, battery swapping, and maintenance. Additional sensitivity analyses were conducted to identify other potential drivers of climate change, human health particulate matter, and fossil fuel resource depletion, including using air freight versus ocean freight.

The results of the LCA demonstrate that the majority of the impacts to climate change, human health particulate matter, and fossil fuel resource depletion arise from the Integrated Production and Use Phases, while the Transport (via ocean freight) and EOL Phases contribute to less than 5% of the overall life cycle impact. This study applies solely to the Lyft Classic, Ebike 1.0, Ebike 2.0, and Lyft operations.

1. INTRODUCTION AND GOALS OF THE STUDY

Lyft, Inc. launched its transit, bikes & scooters (TBS) business in July 2018, taking a key step toward achieving its mission of “improving people’s lives with the world’s best transportation.” Lyft currently operates the largest micromobility network in the United States with bikeshare and shared scooters across 14 markets, including systems such as Citi Bike in New York, Divvy in Chicago, and Bay Wheels in San Francisco. By providing a suite of multimodal transportation options, Lyft aims to improve the ease and convenience of mobility and encourage alternatives to car usage and car ownership. In fact, 50% of Lyft’s shared micromobility riders do not own or lease a personal vehicle. Additionally, 36% of Lyft’s shared micromobility riders who have access to a personal vehicle say that they use that vehicle less because of shared micromobility services.[6]

Lyft’s approach to bikes and scooters is guided by four key tenets: transportation equity, safer streets, transit integration, and environmental sustainability. To make meaningful reductions to our environmental footprint, we need to measure our impact and invest in more sustainable hardware and operations that deliver the largest environmental benefits. We are taking a data-driven approach to our sustainability efforts by grounding our sustainability decisions in comprehensive life cycle impact assessments (LCAs) of our micromobility fleets and operations. LCAs provide a holistic understanding of the most significant impacts of our operations throughout the entire life cycle. We will use the results of this assessment to prioritize technical solutions to environmental issues and to provide us with a unique, sustainability-conscious lens through which to evaluate how to better design, build, and operate our micromobility systems.

The types of trips that bikes and scooters are replacing -- the so-called question of “mode shift” -- away from more environmentally impactful forms of transportation such as personal ICE vehicles are outside the scope of this assessment.

1.1. Goals

This study aims to determine the environmental impacts per actual or modeled (for new vehicles) bike-mile traveled, based on the entire life cycle of the bike operating in Lyft markets. It follows the International Organization for Standardization (ISO) 14040 and 14044 standards for LCAs and assesses life cycle impacts to climate change, human health particulate matter, and fossil fuel resource depletion. Lyft expects new vehicles to greatly outperform existing vehicles in both estimated lifetime rides and trip length as a function of greater durability and user experience. For this study, we are assuming no changes to current bike durability and user experience; therefore, the benefits presented for the new Ebike 2.0 bike are primarily driven by the hardware features that improve operational performance (e.g., a larger battery that results in fewer battery swaps.)

1.2. Reasons for LCA

This report aims to assess the environmental sustainability of Lyft's Classic, Ebike 2.0, and Ebike 1.0 bike models via an LCA performed to ISO standards 14040 and 14044. The results of this LCA are intended to provide Lyft with a better understanding of its environmental impact. It will also inform current and future design decisions for Lyft hardware. The LCA will be publicly disclosed

[6] (Lyft, Inc., 2022) Lyft Multimodal Report References

and will be used to inform users and transportation agencies of the life cycle impacts of Lyft's rideables.

Additionally, more cities are requiring life cycle assessments of the environmental impacts of bike and scooter usage as part of their permitting process. For example, as of March 2019, the City of Portland's Shared Scooter Permit Application and City of Santa Monica's Shared ebike and Scooter Permit Application require applicants to provide an LCA within six months of receiving a permit.[7] Similarly, the San Francisco Municipal Transit Authority's powered scooter share permit application released in July 2019 dedicates an entire appendix to "Sustainability Guidelines and Requirements," raising the most stringent set of requirements to date for energy usage and efficiency, transit-friendly best practices, zero-waste and producer responsibility, as well as related data and reporting requirements.[8] Recent academic work and media articles have also drawn attention to the potential environmental ramifications of shared micromobility.[9, 10]

1.3. Intended Application

The intended application of this LCA is to equip Lyft's hardware community with actionable data to inform design decisions and ultimately create products with further improved environmental performance. This LCA will also provide useful environmental information to stakeholders and regulators on the environmental impact of Lyft's products.

The results of this LCA will also inform updates to sustainable design principles that will accelerate our efforts to deliver more sustainable products. These principles guide our hardware community (e.g., engineers, industrial designers, product managers) to design and manufacture more sustainable micromobility hardware. Our principles focus on material selection, designing for durability and range, and improving reuse and recyclability. We plan to build internal awareness and understanding of our design principles by integrating them into our product development process.

1.4. Target Audience

The primary audience of this LCA is Lyft's hardware community, including product managers, engineers, industrial designers, global supply managers, and others involved in Lyft's product development process. Since this LCA is intended to be publicly disclosed, the secondary audience of this LCA will be the general public, including our users and transportation agencies. The results of this LCA are not intended to be used comparatively.

[7] (City of Portland, Oregon, 2018)
[8] (SFMTA, 2019)
[9] (Hollingsworth, Copeland, & Johnson, 2019)
[10] (Pyzyk, 2019) References

2. SCOPE OF STUDY

2.1. Product System

The product system analyzed is a bikeshare transport non-electric bike and two unique battery electric bikes used on Lyft's platform. Some physical differences of the Ebike 2.0 electric bike relative to the Ebike 1.0 are an electronic display, beacon, and a bigger battery pack that is housed within the frame downtube instead of over top. Figure 2.1-1 to Figure 2.1-3 depict the Ebike 1.0, Ebike 2.0, and the Lyft Classic non-electric bike.

Figure 2.1-1: Photo of Ebike 1.0 Electric Bike

Figure 2.1-2: Photo of Ebike 2.0 Electric Bike

Figure 2.1-3: Photo of Classic Pedal Bike

2.2. Function of the Product System

The function of the product system is to provide individual transport via non-electric and electric bikes. These bikes are operated in markets across the United States including in Boston, Columbus, Denver, Portland, Minneapolis, New York, San Francisco, Santa Monica, and Washington, DC. Since the function of this product system is to provide individual transport, the functional unit is defined as the transported distance (actual or modeled bike-miles traveled).

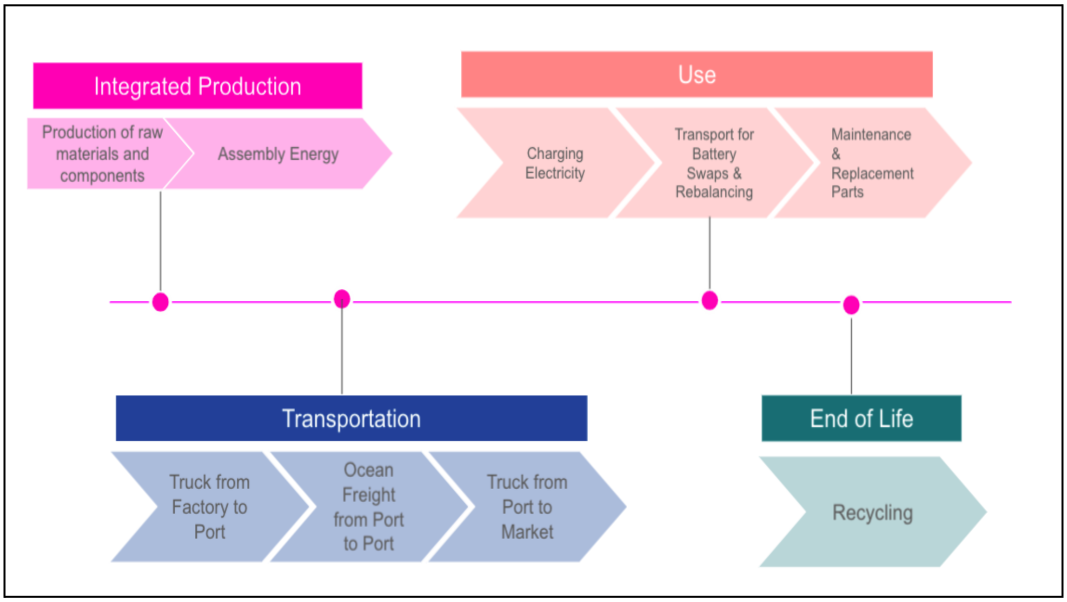
2.3. Functional Unit

The functional unit is one actual passenger mile traveled, or modeled passenger mile traveled (for the new Ebike 2.0 bike) – simply listed as actual or modeled miles through the study. A differentiation is made between actual and modeled miles because the Ebike 2.0 electric bike was launched at the end of 2021 and because of its limited time in the field, there is not a complete dataset for estimated lifetime. To accommodate, estimated lifetime miles for Ebike 2.0 are modeled as the 7.9-year estimated lifetime of the Ebike 1.0 electric bike. Thus, LCA results derived from modeled miles should be viewed as an approximation of real-world impacts, whereas actual lifetime mile LCA impacts are representative of real-world performance. Both actual and modeled miles are selected as the functional unit instead of the manufacturer's theoretical lifespan due to the nature of the shared bike environment. Shared bike systems withstand frequent use, are stored in an outdoor environment, are used in a shared capacity, and are subject to recurrent theft and vandalism. Due to these conditions, Lyft does not believe it would be appropriate to use the manufacturer's theoretical lifetime as the shared bikes would not last to their natural end of life (EOL) in a similar manner as a personal use bike.

2.4. System Boundary

The system boundary includes materials extraction, refining, manufacturing of the bike parts including final assembly. It also includes post bike assembly activities such as transportation of bikes from assembly to market, use during bike functional life including battery charging, vehicle miles traveled (VMT) for rebalancing and other operational purposes, maintenance, as well as end-of-life management of the bike, except transportation to recycling sites. This study does not include the infrastructure and processes required for the construction of roads and bike lanes. A process map of included processes is shown in Figure 2.4-1. The geographical boundary of the study is in the United States market where Lyft operates. The temporal boundary of this study is 10 years from the publication date because these configurations of bikes may be manufactured for another 3 years and have an estimated lifetime of eight years (12 years for Classic bike).

Figure 2.4-1: Process Map



2.5. Allocation Procedures

Allocation of inputs and outputs was avoided to the extent possible. For instances in which multiple bikes are processed together, the outputs are allocated on a per-bike basis. For example, for movement of bikes in the local markets, the environmental impacts of the vehicle operations are evenly allocated to each bike the operational vehicle can transport.

2.6. Cutoff Criteria

Lyft utilized the OpenLCA tool to perform the analyses in this report. Accordingly, standard cutoff criteria applicable to bike material streams in OpenLCA and ecoinvent version 3.5 were not adjusted and are relevant to the results of this study. The following processes were excluded from the boundaries of the study as they were assumed to be de minimis: manufacturing of packaging and containers used in transportation, warehousing of bike storage, charging infrastructure, EOL for the operational vehicles used for battery swapping and rebalancing, and the transportation of EOL components to the recycler. Any processes outside of the system boundary have also been cut off from this assessment, such as the life cycle impacts from constructing and maintaining the road infrastructure required to operate the bikes. The scrap materials outputs from the EOL Phase are accounted for as contributing to recycled content materials. As such, the emissions from these processes are accounted as negative. For the EOL Phase, the materials from the bike that are accounted for as scrap include steel, aluminum, electronics, powertrain, rubber, cables, etc., which all contribute to recycled content in future input materials. This study's allocation includes the credit for recycling in EOL, not in recycled content in the input materials to the bike.

2.7. Standards Used

ISO 14040/2006: Environmental management – Life cycle assessment – Principles and framework ISO 14044/2006: Environmental management – Life cycle assessment – Requirements and guidelines.

2.8. Study Practitioners

Tolu Akinwumi, PE, Sr. Group Manager, Manufacturing Program Management & Sustainability Engineering and Matt Yau, PE, Sustainability Engineer, internal to Lyft

2.9. Impact Assessment Methodology

Climate change (measured in grams of carbon dioxide equivalent [gCO_2e]), human health particulate matter (measured in grams of particulate matter under 2.5 microns ($gPM_{2.5}$), and fossil fuel resource depletion (measured in MJ) were selected as the most relevant impact categories to Lyft. This life cycle impact assessment utilized the following impact methodologies: EPA's Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts[11,12] (TRACI) and Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5) GWP 100 methods. The ecoinvent version 3.5 cutoff database[13] and OpenLCA 1.8 software[14] were used as the data providers. Table 2.9-1 presents a summary of the in-scope impact categories included in this assessment.

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[11] (Bare, Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), Version 2.1 - User's Manual, 2012)
[12] (Bare, TRACI 2.0: the tool for the reduction and assessment of chemical and other environmental impacts 2.0, 2011)
[13] (ecoinvent, n.d.)
[14] (Greendelta, 2021) References

Table 2.9-1: Impact Categories, Units and Characterization Method

Impact Category	Climate Change	Human Health Particulate Matter	Fossil Fuel Resource Depletion
LCI Results	Amount of a GHG per functional unit	Amount of PM per functional unit	Amount of resource consumption per functional unit
Characterization Model	Baseline model of 100 years from the IPCC	TRACI 2.1	TRACI 2.1
Category Indicator	Infrared radiative forcing (watts/meter squared W/m^2)	Particulate Matter	MJ of fossil fuel use
Characterization Factor	Global warming potential for each GHG (kg CO_2e/kg gas) excluding biogenic carbon	$gPM_{2.5}$/kg substance	MJ / kg substance
Category indicator result	gCO_2e per functional unit	$gPM_{2.5}$ per functional unit	MJ per functional unit

2.10. Selection of Impact Categories

Climate change, human health particulate matter, and fossil fuel resource depletion were selected as Lyft's most relevant impact categories as they best align with Lyft's sustainability values and operations. Lyft's mission of "Improving people's lives with the world's best transportation" includes commitments to reducing car ownership,[15] and using 100% renewable energy.[16] Lyft's latest commitment to reach 100% electric vehicles on the Lyft platform by 2030[17] impacts climate change, local air pollution (e.g., $PM_{2.5}$), and fossil fuel consumption. Lyft has also set out its vision of the resilient city of the future[18] by changing the face of the urban landscape to be built around people, not cars.

Additionally, transportation is the largest source[19] of greenhouse gas (GHG) emissions in the United States as well as a major contributor to local air pollution in urban areas. All other impact categories have been excluded as they fall outside the scope of this assessment. Table 2.9-1 presents a summary of the in-scope impact categories included in this assessment.

[15] Lyft, Inc. (2018, Dec. 13). Retrieved from Lyft Blog: https://www.lyft.com/blog/posts/ditchyourcardata
[16] Lyft, Inc. (2018, Sept. 11) Retrieved from Lyft Blog: https://www.lyft.com/blog/posts/lyft-commits-to-full-carbon-neutrality-and-100-renewable-energy
[17] (Lyft, Inc., 2020) Lyft, Inc. (2020, June 17). Retrieved from Lyft Blog: https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions
[18] Lyft, Inc. (n.d.). Retrieved from Lyft.com: https://www.lyft.com/bikes/resilient-streets
[19] (United States Environmental Protection Agency, 2019) References

2.11. Limitations and Assumptions

For the Use Phase, a critical determination for the study is selecting median instead of maximum, minimum or average rebalancing distances traveled by Lyft operations vehicles. Median was selected because it represents actual markets and specific geographies whereas averages produce data that may not be attributable to a specific operating market. Additionally, when compared to maximums and minimums, median data is more representative of Lyft's entire operations. The rebalancing distances measure the distances from a warehouse in a local market to the various bike stations and drive most operational environmental impacts. Median rebalancing distances happen to be in western region operating locales. As a result, Western Electricity Coordinating Council (WECC) grid factors were used. While the study presents a representative evaluation of median lifecycle impacts, it does not present the range of impacts across markets and may under-represent or over-represent impacts in locales outside of the median western regions. Since all the bikes in the study operate across the US, for future studies, it will be best to present median, as well as maximum and minimum rebalancing distances in addition to electricity grid factors specific to those regions. Specifically, for the Ebike 1.0, with median use case in Santa Monica, the WECC grid overestimates the emissions because the Santa Monica warehouse where charging occurs is powered by 100% renewable energy via the Clean Power Alliance utility. Lyft then purchases renewable energy certificates to reduce our environmental impact in markets that do not currently procure electricity from renewable energy utilities. Notably, charging emissions account for 27% of the 78gCO_2e/mi climate change impact seen on Ebike 1.0. So, for future studies, it will be important to present both renewable energy and standard grid charging environmental performance to present a more current view of Lyft operations.

Given the limitations of the ecoinvent version 3.5 dataset in providing region-specific information, Lyft data was generally preferred for providers. In many instances, the appropriate region (e.g., China or the U.S.) was not available as an option. In these cases, "rest of world" (RoW) and/or "global" (GLO) datasets were used. Additionally, the shared micromobility industry is still developing and new to the market. Issues that materially affected bike lifetime, such as theft and vandalism, are large issues. However, efforts to reduce theft and vandalism are continually being addressed by Lyft and have been improving over time. The current bike lifetimes are estimates and represent a snapshot in time given continual vehicle hardening improvements against theft and loss. For the Ebike 1.0 and Classic bikes, Use Phase assumptions were based on actual bike usage data from calendar year 2020. Since the Ebike 2.0 electric bike was launched in 2021, there is not a complete dataset for lifetime. Accordingly, estimated lifetime miles for Ebike 2.0 are modeled as the lifetime estimate of the Ebike 1.0 bike. The EOL recycling data is based on Lyft's policies and practices for recycling all operational hardware.

As of the writing of this LCA, the internal data regarding mileage traveled to recycler and efficiency of packing cannot accurately model the life cycle impact of EOL transportation to recycler. Improvements to internal processes are in progress to provide data for future assessments.

2.12. Data Quality

To the greatest extent possible, this LCA uses actual data. In a few cases, some components will use the closest approximation to the material listed on the BOM for impact analyses for e.g., OpenLCA standard aluminum alloy instead of the specific aluminum alloy for the bike under study. Operational data collected for the bikes are for the calendar year 2020. The BOM and logistics data collected are consistent with the design, manufacturing assembly, and supply chain for all bikes in calendar year 2021. Operational data, including VMT, are taken directly from real time Lyft data dashboards, while charging and rebalancing patterns such as swap times were obtained from interviews with operational personnel. EOL data are based on interviews with operational personnel and EOL standard operating procedures (SOPs) to recycle all rideable components. Any missing data for each unit process were substituted with assumptions based on best available or calculated data and noted in this report. All data collected were analyzed for completeness, precision, and representativeness. For the limited instances where actual data were not available, the data selected was also analyzed for representativeness. Throughout the data collection and modeling process, inputs and outputs were checked to ensure quality and accuracy. All elements of the data collection and modeling process were checked by an internal reviewer. Outputs were checked to ensure that results were consistent with both feasibility and actual operating conditions (e.g., mass BOM, bike lifetime, etc.). Further detail on data quality can be found in Table 6.6-1. Data limitations of the study include, but are not limited to, unaccounted distances from Lyft operational locations to recycling facilities, limitations of OpenLCA tools and ecoinvent database (including a limited selection of aluminum alloys),[20] median operational performance regions and corresponding electricity grids in those regions, and incomplete lifetime data for the Ebike 2.0 electric bike.

2.13. Description of Practitioner Value Choices

The practitioner value choices in the LCA present all results in a mid-point basis with no weighting or normalization. The three impact categories of global warming, human health particulate matter and fossil fuel resource depletion were selected as most material to Lyft's internal and external stakeholders. All other impact categories were excluded as they were not relevant to the goal and scope of this report. The functional unit was also a practitioner choice, as this LCA uses impact per bike's actual miles/modeled miles traveled instead of the theoretical manufacturer's expected lifetime. This was chosen because the manufacturer's expected lifetime can be overstated due to the physical stress that shared bikes face and is less accurate compared to Lyft's actual estimated lifetime data. For Lyft's new Ebike 2.0 electric bike, modeled miles were used instead of actual lifetime miles because sufficient actual miles have not been collected for the new vehicle. Modeled miles for the Ebike 2.0 electric bike assume the same number of estimated lifetime rides and average length of rides as the Ebike 1.0 electric bike.

2.14. Critical Review

WSP USA, Inc. provided an independent critical review (single reviewer) of this life cycle assessment to check conformance with the ISO 14040/2006 and 14044/2006 standards.

[20] (Gómez, Elduque, Sarasa, Pina, & Javierre, 2016) References

3. LIFE CYCLE INVENTORY ANALYSIS

3.1. Data Collection Procedures

The life cycle inventory assessment determines the various components of the bike, as well as their weights and material compositions. The results and related assumptions can be seen in the below sections. The LCA looked at four different life cycle phases, several of which include sub-components as outlined below in Table 3.1-1:

Table 3.1-1: Life Cycle Stages of the Lyft Classic and Ebike 2.0 Bikes

Integrated Production		Transport	Use			EOL
Materials Extraction and Production	Assembly	Transport	Rebalancing and Battery Swapping	Charging	Maintenance	End-of-Life

3.2. Integrated Production

The Integrated Production Phase includes the activities from materials extraction through assembly of the bikes. The raw data for the components of the Lyft bikes were obtained from the BOMs. Appendix Table 7-1 and Table 7-3 present the mass of each component for each bike summarized by material type. The primary components of the Classic bike are the aluminum frame, rubber tires, and various plastic components. The primary components of the Lyft Ebike 1.0 and Ebike 2.0 electric bikes include the aluminum frame, lithium-ion battery, motor, bike controller, rubber tires and various plastics components. Some key differences in Ebike 2.0 relative to the Ebike 1.0 are a bigger battery pack housed within the frame downtube and an electronic display and beacon.

Assembly inputs are modeled based on heat and electricity usage to produce a bicycle. These processes are isolated from an ecoinvent version 3.5 dataset that is based on the production of one 17-kilogram (kg) bicycle ("bicycle production - ROW"). However, actual masses from Lyft bills of materials are used for analyses. The heat and electricity from the ecoinvent version 3.5 dataset include the energy required to form the input metals into the component used in the final assembly.

3.3. Transportation

Transportation routing information was obtained from the Planning and Logistics Lead for TBS Global Supply Management. All bikes are manufactured in Taiwan and then shipped to the Port of Los Angeles. From there, they are transported to a depot in the local market, and then an operational warehouse. The distance from factory to port by road is estimated using Google Maps. Sea distances for transport by ocean are estimated using https://sea-distances.org/. Rough distance estimates from port to depot in the local market via truck are also determined via Google Maps. The distance from depot to warehouse is considered relatively negligible (i.e., less than 0.01% of total distance) and not included in the assessment. Note that distances are generally rough estimates and may not be precise. The freight transportation is modeled by using a freight transport methodology with weight and distance inputs.

3.4. Use

For the Ebike 2.0, the environmental impacts of the bike's Use Phase consist of the electricity used to charge the bike batteries, the vehicles used for battery swapping, rideable maintenance (including production of components), and the rideable's lifetime estimate. The Ebike 1.0 has similar operational parameters to the Ebike 2.0 but also includes vehicles used for rebalancing. Rebalancing refers to the redistribution of rideables across stations to meet user demand and travel patterns (e.g., removing rideables from full docks and adding them to empty docks). For the Classic non-electric bike, the environmental impacts of the bikes consist of the vehicles used for rebalancing, rideable maintenance (including production of components), and the rideable's lifetime estimate.

Bike lifetime estimates are calculated using the formula[21]:

$$Lifetime \ = \ Annual\ cumulative\ miles\ traveled \ / \ Annual\ number\ of\ vehicles\ reaching\ end\ of\ life$$

Bike lifetime distributions are independent of bike history and any time can be marked as time zero.[22] Therefore, the odds of a bike reaching its EOL is not a function of the bike's age. EOL for a vehicle is reached when a lead mechanic determines that a vehicle previously in normal operation is not repairable, excluding lost or stolen bikes. Thus, we can calculate the estimated lifetime of a bike in a fleet using the fleet's cumulative miles and total number of bikes that have reached EOL within a given timespan.

For example, suppose there was a fleet of 100 bikes that each traveled a combined 50,000 miles within a year for an average of 500 miles/bike. Also, suppose 10% of the fleet reached EOL at some point during that year. The estimated lifetime would be calculated as follows:

- *Total amount of fleet miles traveled: 50,000 miles*
- *Number of bikes reaching EOL: 10*
- *Estimated lifetime by formula = 50,000 miles / 10 bikes = 5,000 miles*

*If the fleet was continually replenished to maintain 100 bikes and had a 10% annual EOL rate, at the end of the 10 years, all the original 100 bikes would have reached EOL. The cumulative miles traveled would be 50,000 miles * 10 years = 500,000 miles and the average lifetime estimate for each bike would be 500,000 miles / 100 bikes, which is 5,000 miles.*

Since the Ebike 2.0 electric bike was launched in 2021, there is not a complete dataset for lifetime. Accordingly, estimated lifetime miles for Ebike 2.0 are modeled after the 7.9-year estimated lifetime of the Ebike 1.0.

Miles associated with energy used for rebalancing and battery swapping in the analysis are drawn from the total vehicle miles traveled (VMT) by service vehicles used specifically for those

[21] The calculations and estimates in this document are solely for the purpose of analyzing environmental impact and are not a guarantee of the useful life of a rideable and should not be relied upon for any other purpose.

[22] (Statistics How To, 2021) References

purposes. Bikes and batteries are transported using a large passenger vehicle (e.g. sprinter vans). Impacts from rebalancing and battery swapping vehicles are modeled on a per-vehicle basis in VMTs rather than a freight transport basis (by weight and distance) because the entirety of a service vehicle's storage capacity is used for rebalancing and charging operations. VMT is estimated based on the number of charging cycles for the vehicle (based on miles traveled and idle drain rates) and assumed miles traveled for bike collection and bike distribution, plus assumed additional VMT during bike lifetime for other purposes (e.g., compliance with local ordinances, etc.). The Ebike 1.0 and Ebike 2.0 electric bikes require battery swapping, while the non-electric Classic bikes do not. Classic bikes do require rebalancing to remove bikes from full docks and reposition bikes to empty docks to meet service level agreements as well as ensure availability for users looking to dock and retrieve bicycles. Rebalancing is typically only performed on Classic non-electric bikes however in markets such as Santa Monica where an electric bike is the only bike available in the Lyft fleet, electric bikes also undergo rebalancing.

Charging emissions are estimated based on the total energy required to charge the battery to full capacity. The batteries are swapped when they reach a minimum charge level. The number of charging cycles is modeled based on the bike travel distance, idle drain rate, and battery level. Battery swapping is performed in-field at the location of the bike, eliminating the need to transport the entire bike back to the Lyft warehouse to be charged. This significantly reduces the amount of operations vehicle transport that is required. ecoinvent version 3.5 includes unit processes for the Western Electricity Coordinating Council (WECC) and the medium voltage energy from this grid based on the location of the San Francisco market.

Maintenance rates of the Ebike 1.0 and Ebike 2.0 electric bicycles are extrapolated based on the ecoinvent version 3.5 dataset for maintenance processes for an electric bicycle. This includes a single battery replacement and replacement of major components including aluminum, steel, and injection molded plastic parts. Maintenance for the Classic non-electric bike is based on actual data from each component's mean trips between failure (MTBF), which is a measure of the frequency of failure (which can further be inverted to form a measure of component durability). Each component's MTBF was obtained, and the number of component replacements required was determined based on the number of estimated lifetime Classic bike trips.

3.5. End of Life

EOL for the bikes involves removing the swappable battery and sending the battery and bike components to recyclers. EOL handling is modeled based on the same weights of bike components used in the Production Phase. These weights are then matched up with relevant ecoinvent version 3.5 processes based on how each material is handled at EOL. All bike components are recycled at the EOL, as documented by Lyft SOPs and interviews with operations personnel.

3.6. Calculation Procedures

The data outlined in the lifecycle inventory section was compiled and calculated as inputs to OpenLCA in Google spreadsheets. The LCA calculations were performed in OpenLCA. The OpenLCA results were transposed onto Google sheets for analysis.

3.7. Data Validation

All primary data outlined in the life cycle inventory assessment section was internally validated by the data providers. Secondary data from OpenLCA and ecoinvent version 3.5 undergo regular validation by their respective creators. Throughout the data collection and modeling process, inputs and outputs were checked to ensure quality and accuracy. All elements of the data collection and modeling process were checked by an internal reviewer. Outputs were checked to ensure that results were consistent with both feasibility and actual operating conditions. Multiple rounds of review were conducted with relevant stakeholders (e.g., operations, data science, and supply chain teams) on key inputs, including bike mass and lifetime estimates.

3.8. Allocation Principles and Procedures

There are no co-products for input materials and processes that require allocation. All input materials and processes are part of the bike ecosystem and allocated amongst the bikes.

3.9. Sensitivity Analysis

Multiple sensitivity analyses were performed to test the quality of the assumptions. Scenarios were crafted to create two sensitivity cases to test the lifetime estimates hypotheses. The cases are shown in Table 3.9-1 below.

Table 3.9-1: Base Use Case vs Sensitivity Case

	Stress Case	Base Case	Most Optimistic Case
Ebike 2.0	3.8 years	7.9 years	12 years
Ebike 1.0	3.8 years	7.9 years	12 years
Classic	Chicago Operations	San Francisco Operations	New York Operations

The most optimistic sensitivity cases for electric bikes illustrate aspirational targets, while for the classic bike, most optimistic case sensitivities illustrate actual top quartile performance in our markets today. These sensitivities were selected to show the aspirational and realistic upper bounds for shared bicycle environmental performance, bringing into focus our current performance and presenting an outline for a vision of future performance. For the Classic and Ebike 1.0 bikes, the base cases are actual miles traveled based on actual GPS-tracked ride data from our data dashboards operating in San Francisco. For the Ebike 2.0 bike, launched at the end of 2021, the base case is modeled to be that of the Ebike 1.0, as it has not accumulated enough actual miles for this study. The stress case for Classic bikes is based on Chicago with longer transport and rebalancing distances, while the most optimistic case is based on New York City operations, where there are much shorter rebalancing distances. For Ebike 1.0 and Ebike 2.0, the stress case is based on the estimated lifetime of the Lyft 2.2 scooter and the most optimistic case is based on the Classic bike operational lifetime estimate. The sensitivity cases were modeled on various rideable lifetime estimates, which contributed to differing operational emissions, including charging, battery swapping and maintenance. Additional sensitivity analyses were conducted to identify other potential drivers of climate change, human health particulate matter, and fossil fuel resource depletion impacts, including using air freight versus ocean freight and recycling bikes at end of life versus disposal.

4. LIFE CYCLE IMPACT ASSESSMENT

The LCIA was conducted using the characterization factors included in OpenLCA V1.8. Three impact categories considered in this LCIA include climate change, human health particulate matter, and fossil fuel resource depletion. The IPCC AR5 GWP 100 method was used to quantify GHG emissions, measured in grams (g) carbon dioxide equivalents (CO_2e). The TRACI 2.1 method was used to quantify the particulate matter emissions and fossil fuel resource depletion, measured in $gPM_{2.5}$ and megajoules (MJ) respectively. All three category indicator results are midpoint assessment methods. The characterization models selected are generally accepted standards (IPCC for climate change and TRACI 2.1 for human health particulate matter and fossil fuel resource depletion).

4.1. Unit Processes

The primary source of secondary data and unit processes used by this assessment was the OpenLCA version V1.8 and ecoinvent version 3.5 cutoff database. Inputs derived from the life cycle inventory were paired to the most representative datasets in the ecoinvent version 3.5 and OpenLCA databases. While some processes may not be an exact match to the unit processes in the databases, they are a close approximation and sufficient for this assessment.

4.2. LCIA Results

The following sections present the detailed findings of the LCIA for each life cycle impact category. Units are presented as per the study's functional unit gCO_2e/mile (actual and modeled), as well as in gCO_2e/bike in Table 4.2-1 to Table 4.2-3 to illustrate the total impacts each individual bike operating at Lyft will have on average over its lifetime.

4.3. Climate Change

Climate Change impacts describe the potential for global climate change as a result of the processes involved throughout the lifecycle of the bikes in this study. They are quantified by Global Warming Potential (GWP), which is a measure of the energy a greenhouse gas will absorb relative to the energy carbon dioxide will absorb.

For the Ebike 2.0 electric bike, the climate change life cycle impact is driven primarily by the Use (54%) and Integrated Production Phases (46%). For the Ebike 1.0 electric bike, the climate change life cycle impact is driven primarily by the Use (79%) and Integrated Production Phases (20%). In the Use Phase for both electric bikes, the primary impact driver is ICE vehicles required to conduct battery swapping. Ebike 1.0's Use Phase emissions are significantly greater than Ebike 2.0's because in addition to ICE vehicles being used for battery swapping, they are also used to conduct rebalancing. The Transport and EOL Phases are minor contributors to overall impact (less than 5%). The EOL Phase values are negative due to a credit given to recycling processes for producing recycled content materials. For the Classic bike, the climate change life cycle impact is also driven primarily by the use (64%) and Integrated Production Phases (35%). In the Use Phase, the primary contributor (47% of Use Phase) is from the vehicles required to conduct rebalancing. The Transport and EOL Phases are minor contributors to overall impact (less than 5%). Figure 4.3-1 to Figure 4.3-3 present the Ebike 2.0, Ebike 1.0, and Classic lifecycle impacts for each phase. As illustrated in Figure 4.3-1 and Table 4.2-1, the GWP per actual mile traveled for the Ebike 2.0 bike is 40 gCO_2e/mi and 650,566 gCO_2e over the lifetime of the average Ebike 2.0.

The Integrated Production and Use Phases contribute the lion share of greenhouse gas emissions for Ebike 2.0.

Figure 4.3-1: Ebike 2.0 Bike GWP per Modeled Mile Traveled by Life Cycle Phase

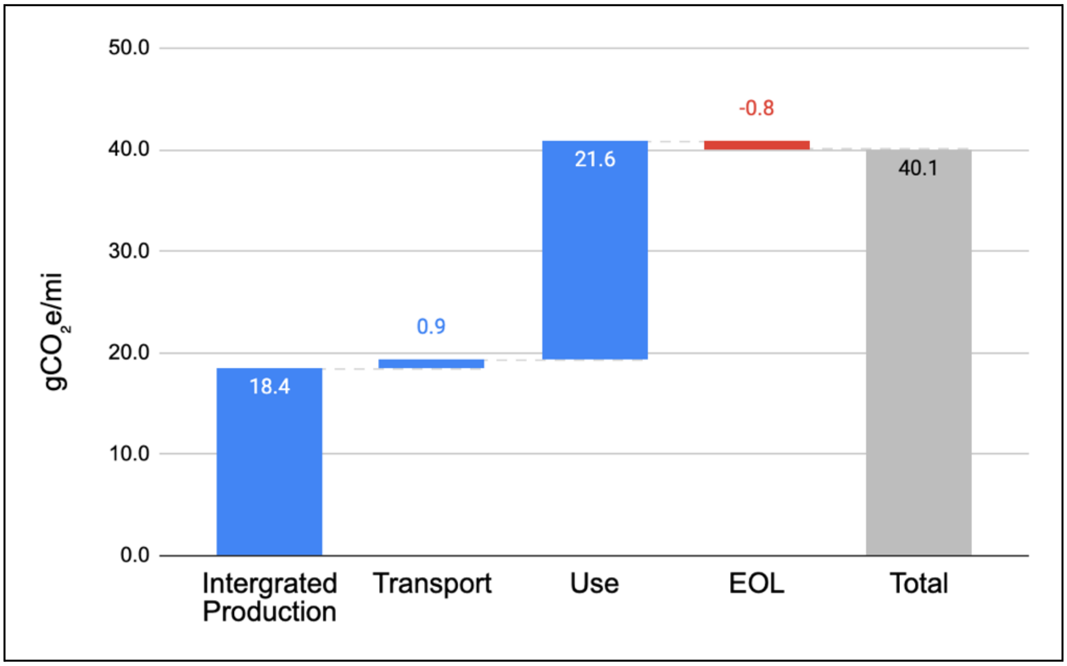

Table 4.3-1: Ebike 2.0 GWP for Entire bike Over Lifetime and per Modeled Mile Traveled

Impact Category	Climate Change	
Component	gCO_2e/Bike	gCO_2e/mi
Aluminum	87,162	6.9
Battery	52,802	4.2
VCU	47,153	3.7
Motor	13,503	1.1
Injection Molding	5,871	0.5
Other	27,146	2.1
Integrated Production - Subtotal	**233,637**	**18.4**
Transport - Subtotal	**11,657**	**0.9**
Charging Electricity	142,799	11.3
Maintenance	76,775	6.1

Impact Category	Climate Change	
Component	gCO_2e/Bike	gCO_2e/mi
Battery Swapping	53,657	4.2
Use - Subtotal	**273,231**	**21.6**
EOL - Subtotal	**-10,758**	**-0.8**
Total	**507,767**	**40.1**

As illustrated in Figure 4.3-2 and Table 4.2-2, the GWP per actual mile traveled for the Ebike 1.0 bike is 77.9 gCO_2e/mi and 1,424,686 gCO_2e over the lifetime of the average bike. The Use Phase contributes the most greenhouse gas for Ebike 1.0 and is driven by operations activities such as rebalancing and battery swapping. Most significant is rebalancing operations which typically only occur for electric bikes in markets where there are no Classic bikes. In Santa Monica, the median market chosen for this study, the Ebike 1.0 electric bike is the only bike in the market and as a result is rebalanced for optimal operations. Battery swapping on the other hand, is much greater for the Ebike 1.0 bike than for Ebike 2.0 because the Ebike 2.0 has a much bigger battery pack, which results in fewer swaps.

Figure 4.3-2: Ebike 1.0 Bike GWP per Actual Mile Traveled by Life Cycle Phase

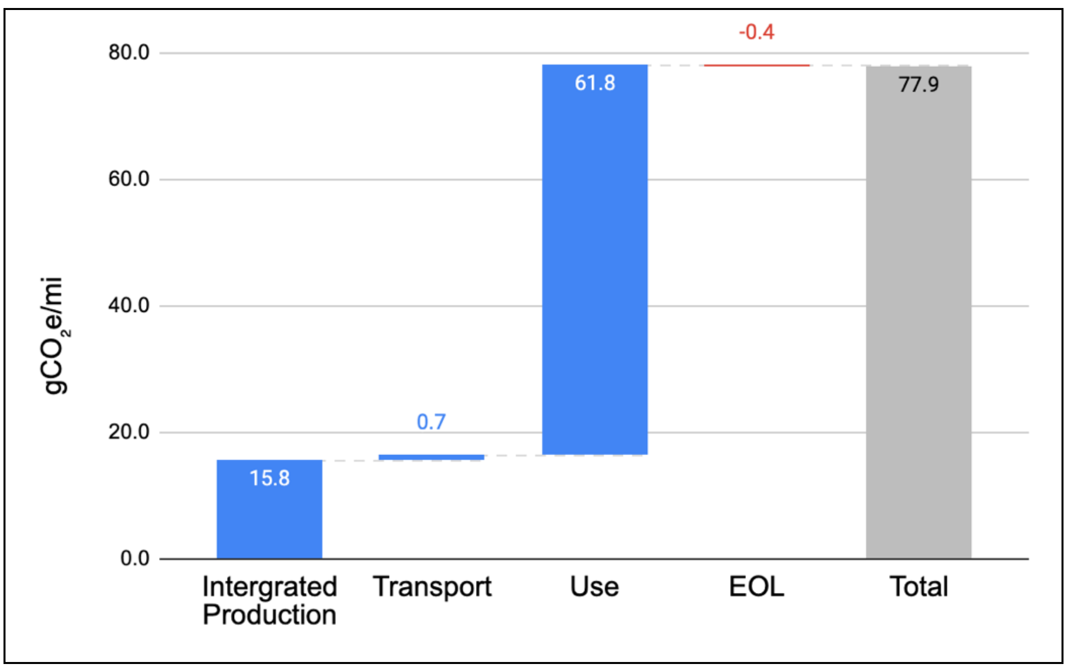

Table 4.3-2: Ebike 1.0 GWP for Entire bike Over Lifetime and per Actual Mile Traveled

Impact Category	Climate Change	
Component	gCO_2e/Bike	gCO_2e/mi
Aluminum	89,421	7.1
VCU	43,660	3.4
Battery	21,121	1.7
Motor	13,948	1.1
Polycarbonate	11,473	0.9
Other	20,274	1.6
Integrated Production - Subtotal	**199,897**	**15.8**
Transport - Subtotal	**9,452**	**0.7**
Rebalancing + Battery Swapping	437,993	34.6
Charging Electricity	268,186	21.2
Maintenance	76,775	6.1
Use - Subtotal	**782,954**	**61.9**
EOL - Subtotal	**-5,610**	**-0.4**
Total	**986,693**	**77.9**

As illustrated in Figure 4.3-3 and Table 4.2-3, the GWP per actual mile traveled for the Classic bike is 30.2 gCO_2e/mi and 687,739 gCO_2e over the lifetime of the average bike. Like the Ebike 1.0 bike, the Use Phase contributes most of the greenhouse gas for the Classic Bike due to rebalancing operations. The Integrated Production Phase for the Classic Bike is the lowest amongst all bikes because its only electromechanical components are lights.

Figure 4.3-3: Classic Bike GWP per Actual Mile Traveled by Life Cycle Phase

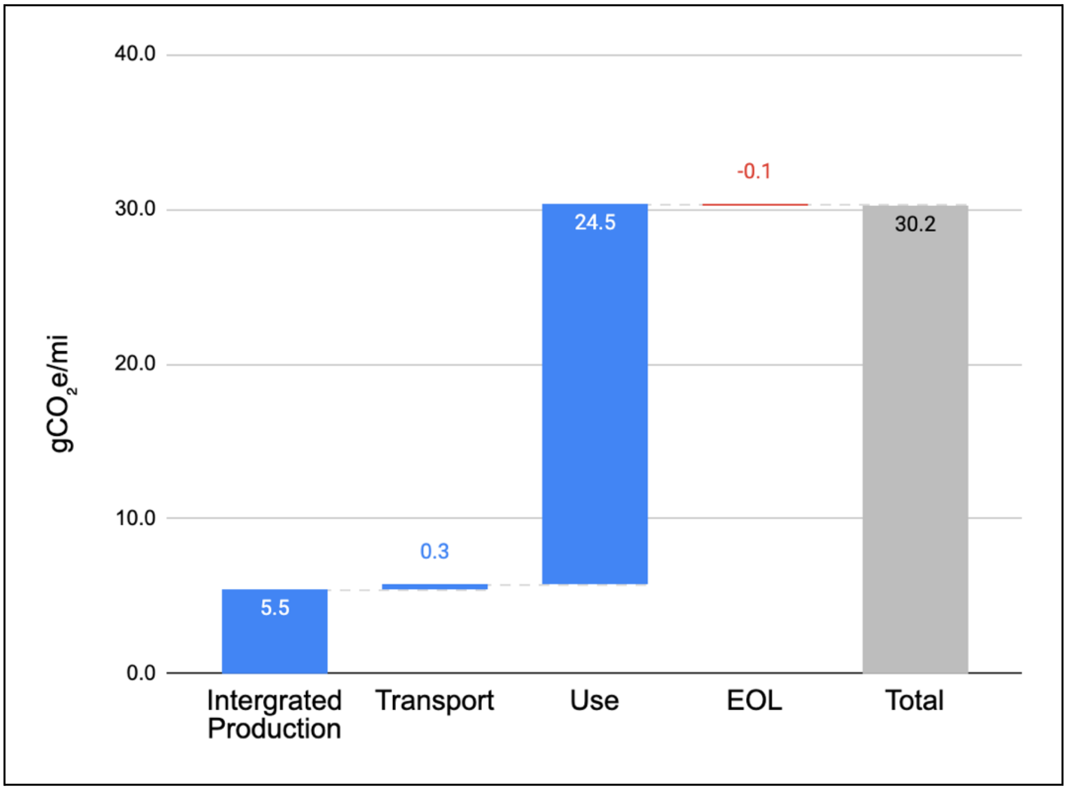

Table 4.3-3: Classic GWP for Entire bike Over Lifetime and per Actual Mile Traveled

Impact Category	Climate Change	
Component	gCO_2e/Bike	gCO_2e/mi
Aluminum	85,635	3.8
ABS	12,663	0.6
Rubber	5,248	0.2
Manufacturing Solid Waste	4,131	0.2
Electricity	3,694	0.2
Other	13,666	0.6
Integrated Production - Subtotal	**125,038**	**5.6**
Transport - Subtotal	**6,991**	**0.3**
Rebalancing	437,008	19.2
Maintenance	120,900	5.3
Use - Subtotal	**557,908**	**24.5**
EOL - Subtotal	**-2,198**	**-0.1**
Total	**687,739**	**30.2**

Diving deeper into the Integrated Production Phase for all bikes, Figure 4.3-4 to Figure 4.3-6 present a detailed breakdown into the life cycle. For the Ebike 2.0, aluminum accounts for the largest impact of the phase (37%) because aluminum makes up the largest mass of the bike and because, among modeled ecoinvent materials within the Ebike 2.0, aluminum has one of the largest emissions scaling factors – third only to PCBAs and the battery. Aluminum's large impact stems from the high energy intensity of an aluminum blast furnace and the assumption that this energy is drawn from a global energy grid.[23] The lithium-ion battery (23%) and printed circuit board assembly (PCBA) (20%) make up the next largest contributions. This is because, although they do contribute a small portion of the overall mass of the bike, their ecoinvent modeled emissions factors are substantial compared to the scaling factors of other materials found in the bike. The PCBA requires large amounts of energy, 1.5 kWh/cm2 from 1995 to 2005, to power the photolithography process used in the production of silicon parts populated onto layers of the board.[24] The high impact of the lithium-ion battery comes primarily from the hydrothermal and solid-state preparation steps of the lithium and cobalt compounds used in the production process.[25] For the Ebike 1.0, aluminum also accounts for the largest impact of the Integrated Production Phase (45%), while the lithium-ion battery (11%) and PCBA (22%) make up its next largest contributions. For the Classic bike, aluminum accounts for the largest impact of the Integrated Production Phase (69%) for two primary reasons. The first is that aluminum makes up the majority of the bike by mass (71.5%) as can be seen in Table 7-1. The second is that, since the

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[23] (ecoinvent, n.d.)
[24] (Boyd, 2009)
[25] (Argonne National Laboratory, 2015) References

Classic bike lacks a battery and uses only 2.6KG of rubber (Table 7-2), the primary ecoinvent emissions scaling factor of importance becomes that of aluminum. When taken together, these two facts explain aluminum's outsized contribution to the environmental impact of the Integrated Production Phase. The ABS plastic (10%) and rubber tires (4%) make up the next largest contributions.

Figure 4.3-4: Ebike 2.0 Bike GWP per Modeled Mile Traveled for Integrated Production Phase

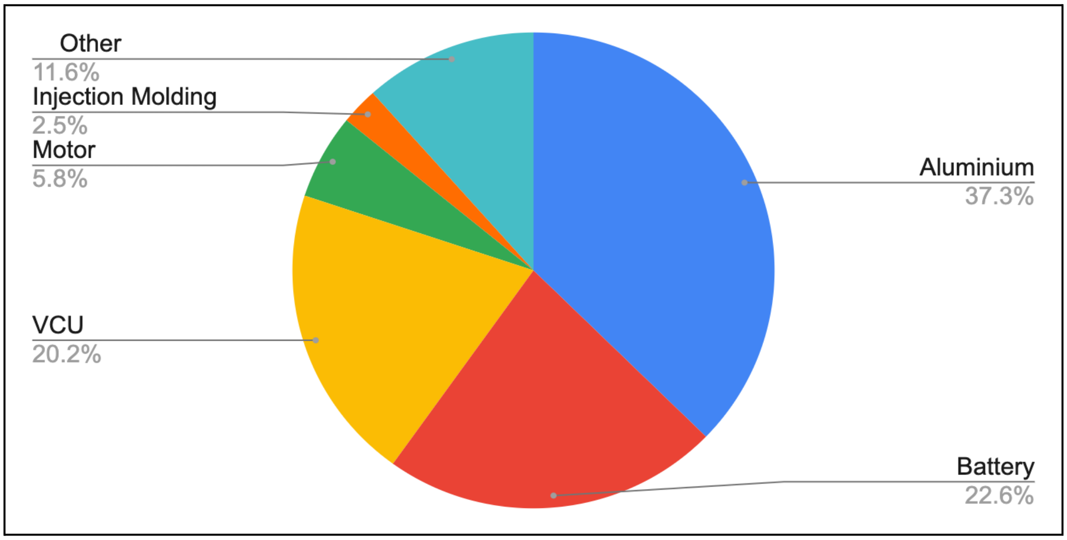


Figure 4.3-5: Ebike 1.0 Bike GWP per Actual Mile Traveled for Integrated Production Phase

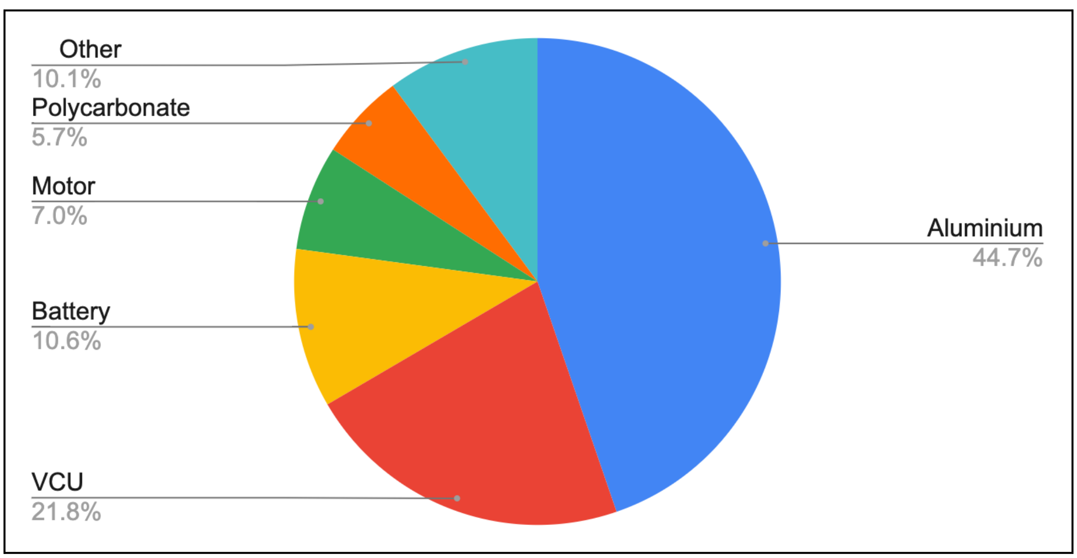
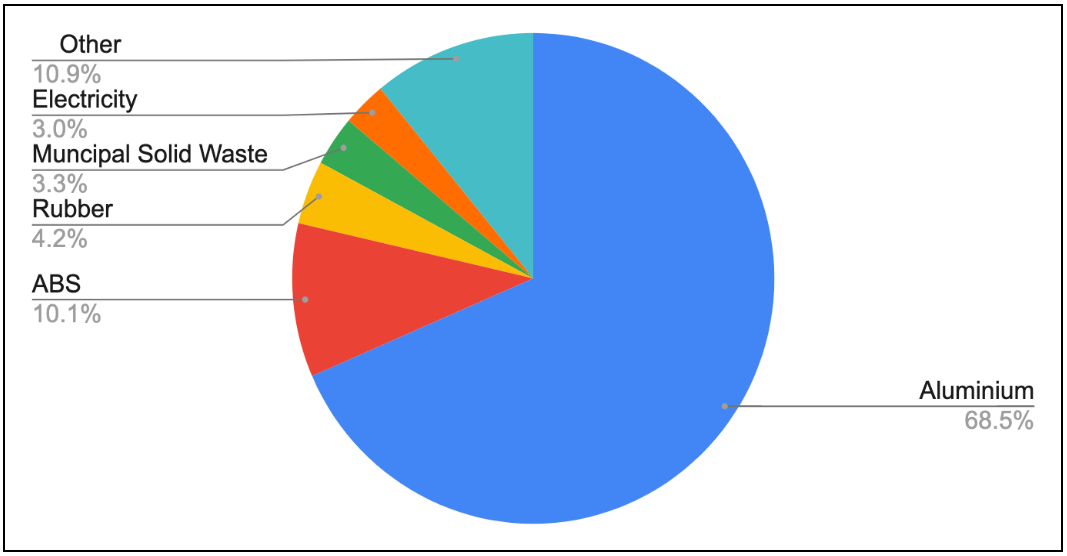


Figure 4.3-6: Classic Bike GWP per Actual Mile Traveled for Integrated Production Phase



4.4. Human Health Particulate Matter

Human health particulate matter describes the quantity of particulates below 2.5 microns in size emitted into the atmosphere as a result of the processes involved throughout the lifecycle of the bikes in this study. Particulate matter has been found to pose grave harm to human health including but not limited to decreased lung function, aggravated asthma, and premature death in people with heart or lung disease.

For the Ebike 2.0, the human health particulate matter life cycle impact is driven primarily by the Use (62%) and Integrated Production Phases (38%). In the Use Phase, the primary contributor is from the vehicles required to conduct battery swapping. Since Lyft has direct control over the service vehicles, understanding $PM_{2.5}$ in the Use Phase is important to understand the environmental impacts of $PM_{2.5}$ in Lyft's local markets. The Transport and EOL Phases are minor contributors to overall impact (less than 5%). The EOL Phase values are negative due to the recycling processes producing recycled content materials. Like Ebike 2.0, human health particulate matter life cycle impact for the Ebike 1.0 electric bike is driven primarily by the Use (80%) and Integrated Production Phases (19%). For the Classic bike, the human health particulate matter life cycle impact is driven primarily by the Use (72%) and Integrated Production Phases (26%). In the Use Phase, the primary contributor is the vehicles required to conduct rebalancing. The Transport and EOL Phases are minor contributors to overall impact (less than 5%). Figure 4.4-1 to Figure 4.4-3 present life cycle impacts by phase for human health particulate matter for Ebike 2.0, Ebike 1.0, and Classic bikes.

As illustrated in Figure 4.4-1 and Table 4.4-1, Human Health Particulate Matter per modeled mile traveled for the Ebike 2.0 bike is 0.07 $gPM_{2.5}$/mi and 935 $gPM_{2.5}$ over the average lifetime of the bike. The Integrated Production and Use Phases contribute the lion share of particulate matter for Ebike 2.0.

Figure 4.4-1: Ebike 2.0 Human Health Particulate Matter per Modeled Mile Traveled by Life Cycle Phase

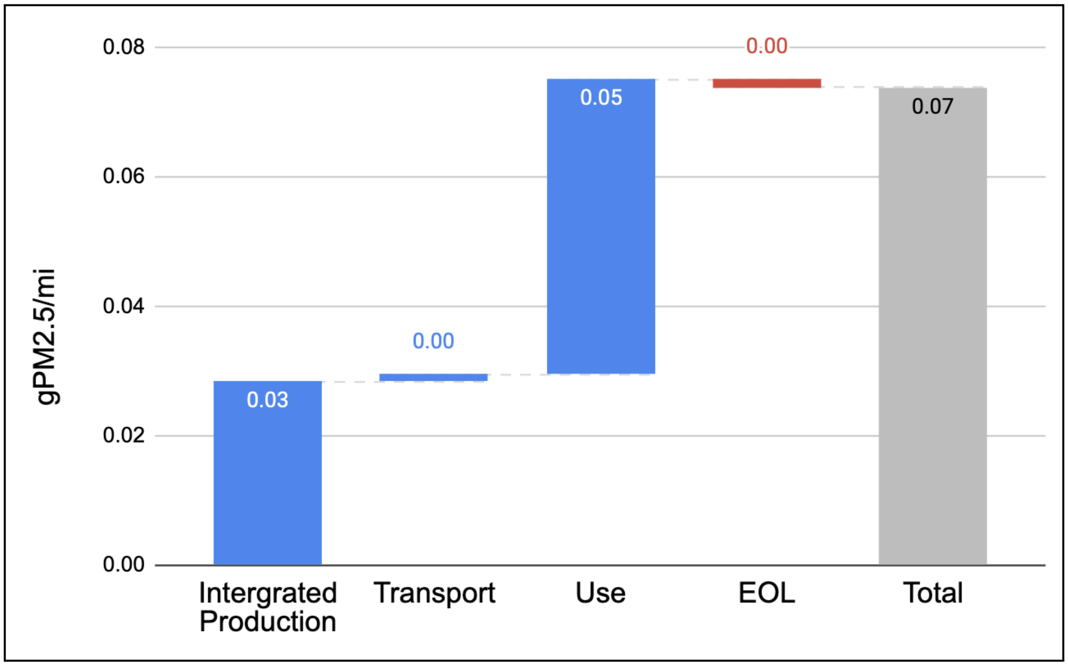


Table 4.4-1: Ebike 2.0 Human Health Particulate Matter for Entire Bike Over Lifetime and per Modeled Mile Traveled

Impact Category	Human Health Particulate Matter	
Component	$gPM_{2.5}$/Bike	$gPM_{2.5}$ /mi
Battery	113.90	0.01
Aluminum	91.99	0.01
VCU	68.76	0.01
Motor	31.02	0.00
Stainless Steel	13.61	0.00
Other	40.64	0.00
Integrated Production – Subtotal	**360**	**0.03**
Transport – Subtotal	**14.84**	**0.00**
Charging Electricity	404.15	0.03
Maintenance	144.90	0.01
Battery Swapping	29.24	0.00
Use – Subtotal	**578.29**	**0.05**
EOL – Subtotal	**-17.980**	**0.00**
Total	**935.07**	**0.07**

As illustrated in Figure 4.4-2 and Table 4.4-2, human health particulate matter per actual mile traveled for the Ebike 1.0 bike is 0.11 $gPM_{2.5}$/mi and 1,413 $gPM_{2.5}$ over the lifetime of the average bike. The Use Phase contributes the most particulate matter for Ebike 1.0 and is driven by operations activities such as rebalancing and battery swapping. Most significant are rebalancing operations, which typically only occur for electric bikes in markets where there are no Classic bikes. Battery swapping, on the other hand, is much greater for the Ebike 1.0 bike than for Ebike 2.0 because the Ebike 2.0 bike has a much bigger battery pack which results in fewer swaps. In Santa Monica, the median market chosen for this study, the Ebike 1.0 is the only bike in the market and as a result is rebalanced for optimal operations.

Figure 4.4-2: Ebike 1.0 Human Health Particulate Matter per Actual Mile Traveled by Life Cycle Phase

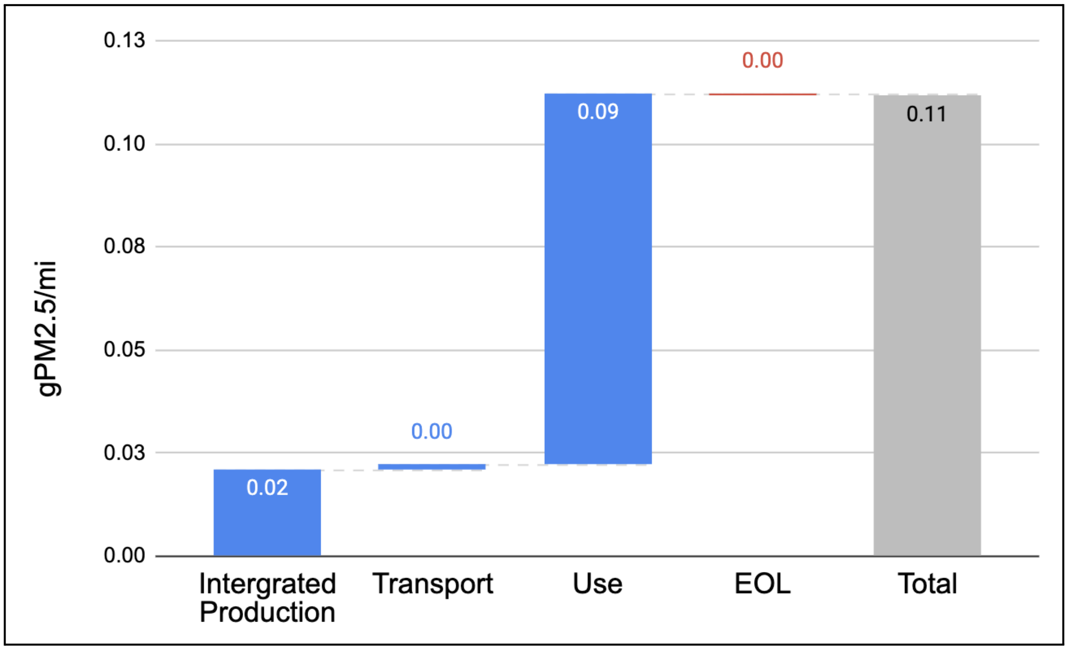


Table 4.4-2: Ebike 1.0 Human Health Particulate Matter for Entire Bike Over Lifetime and per Actual Mile Traveled

Impact Category	Human Health Particulate Matter	
Component	$gPM_{2.5}$/Bike	$gPM_{2.5}$/mi
Aluminum	94.38	0.007
VCU	63.67	0.005
Battery	45.56	0.004
Motor	32.04	0.003
Injection Molding	6.04	0.000
Other	26.55	0.002
Integrated Production - Subtotal	**268**	**0.021**
Transport - Subtotal	**12.04**	**0.001**
Charging Electricity	759.01	0.060
Rebalancing + Battery Swapping	238.66	0.019
Maintenance	144.90	0.011
Use - Subtotal	**1142.57**	**0.090**
EOL - Subtotal	**-9.510**	**-0.001**
Total	**1413.34**	**0.112**

As illustrated in Figure 4.4-3 and Table 4.4-3, human health particulate matter per actual mile traveled for the Classic bike is 0.02 $gPM_{2.5}$/mi and 506 $gPM_{2.5}$ over the lifetime of the average bike. Like the Ebike 1.0 bike, the Use Phase contributes most of the particulate matter for the Classic Bike due to rebalancing operations. The Integrated Production Phase for the Classic Bike is the lowest amongst all bikes because its only electromechanical components are lights.

Figure 4.4-3: Classic Human Health Particulate Matter per Actual Mile Traveled by Life Cycle Phase

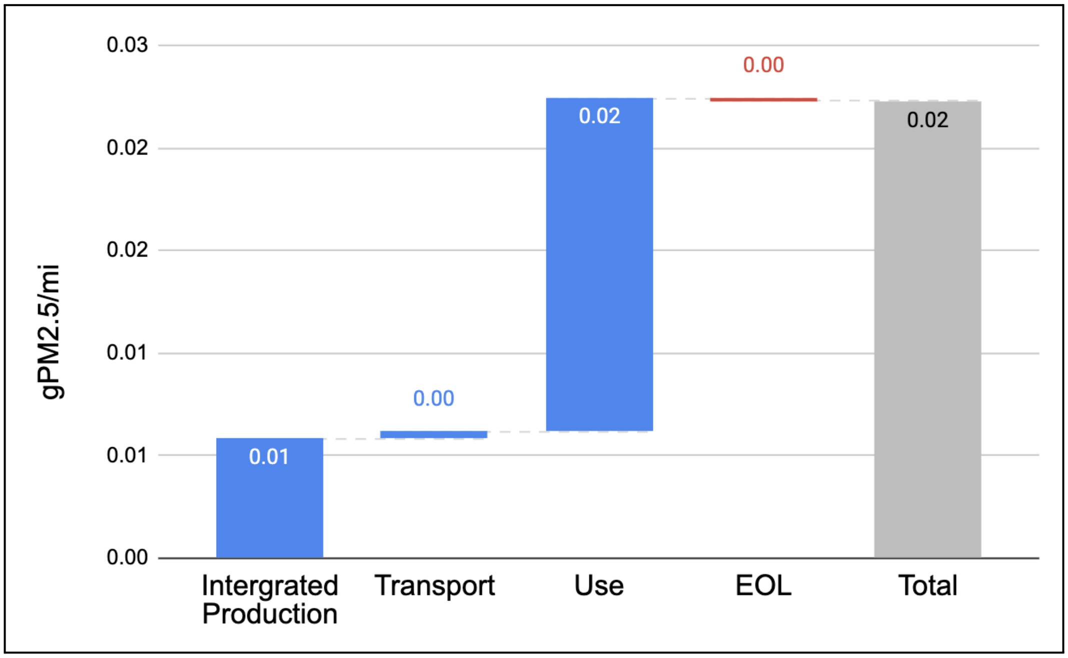


Table 4.4-3: Classic Human Health Particulate Matter for Entire Bike Over Lifetime and per Actual Mile Traveled

Impact Category	Human Health Particulate Matter	
Component	$gPM_{2.5}$/Bike	$gPM_{2.5}$/mi
Aluminum	90.38	0.00
Municipal Solid Waste	5.99	0.00
Rubber	5.24	0.00
Electricity	5.01	0.00
Stainless Steel	4.85	0.00
Other	21.62	0.00
Integrated Production - Subtotal	**133**	**0.01**
Transport - Subtotal	**8.90**	**0.00**
Rebalancing	238.12	0.01
Maintenance	130.18	0.01
Use - Subtotal	**368.30**	**0.02**
EOL - Subtotal	**-3.830**	**0.00**
Total	**506.46**	**0.02**

Figure 4.4-4 to Figure 4.4-6 dives deeper into the Integrated Production Phase for the human health particulate matter impact category, presenting a detailed breakdown of lifecycle impacts. For the Ebike 2.0 electric bike, the battery accounts for the largest impact (32%), while the aluminum (26%) and PCBA (19%) make up the next largest contributions. For the Ebike 1.0 electric bike, aluminum accounts for the largest impact (35%), while the battery (17%) and PCBA (24%) make up the next largest contributions. For the Classic bike, aluminum accounts for the largest impact (68%), while the manufacturing waste (4.5%) and rubber (4%) make up the next largest contributions.

Figure 4.4-4: Ebike 2.0 Human Health Particulate Matter per Modeled Mile Traveled for Integrated Production Phase

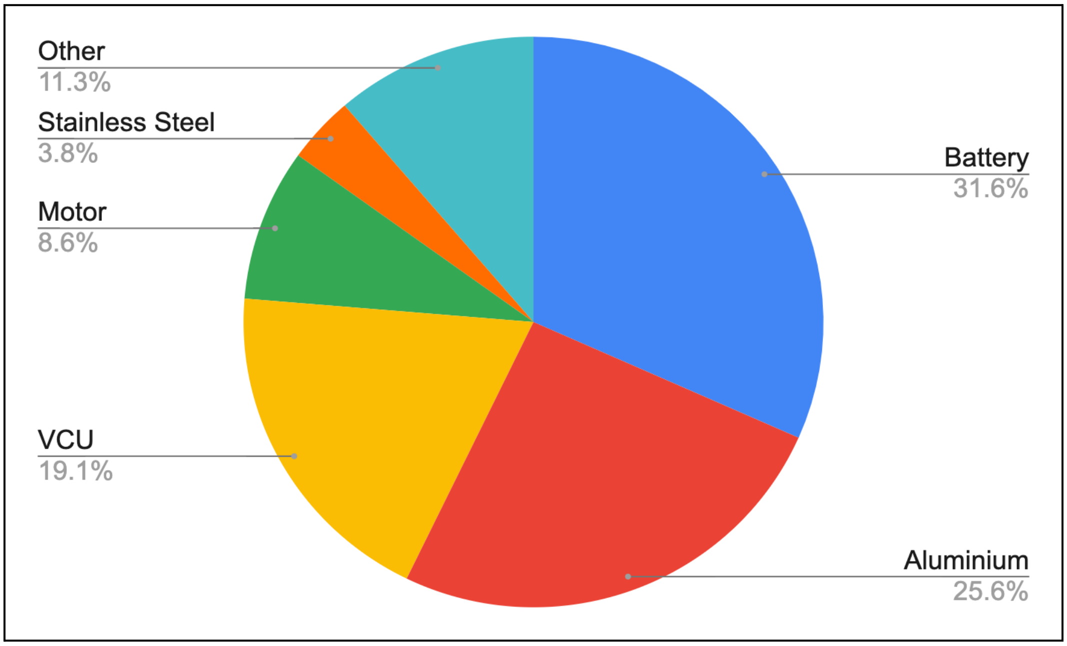


Figure 4.4-5: Ebike 1.0 Human Health Particulate Matter per Actual Mile Traveled for Integrated Production Phase

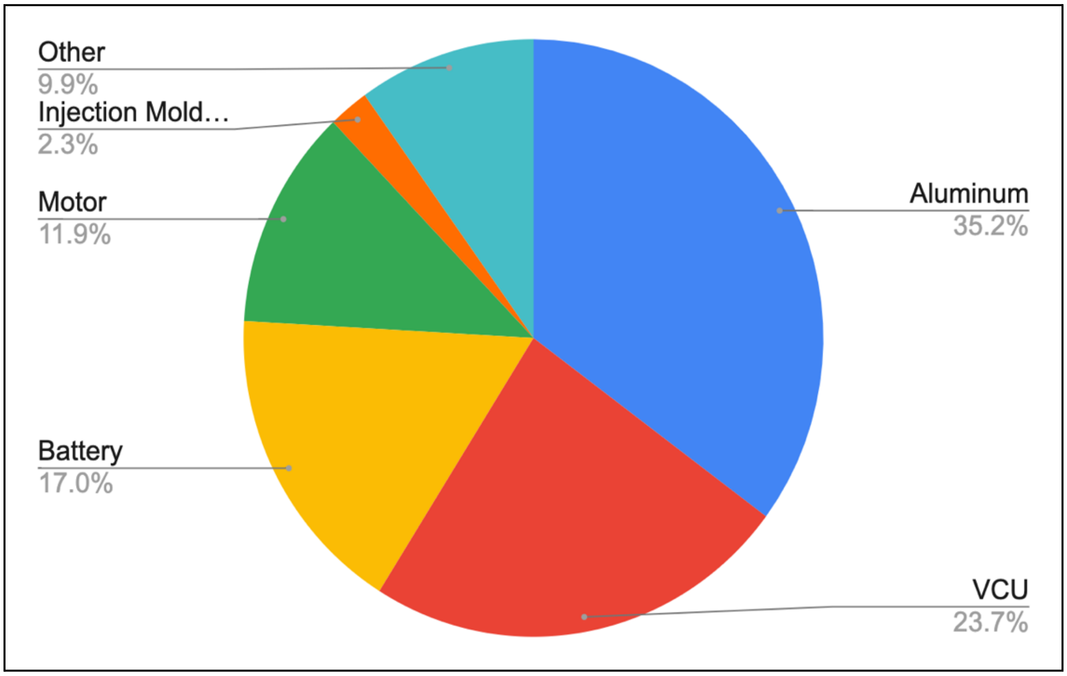
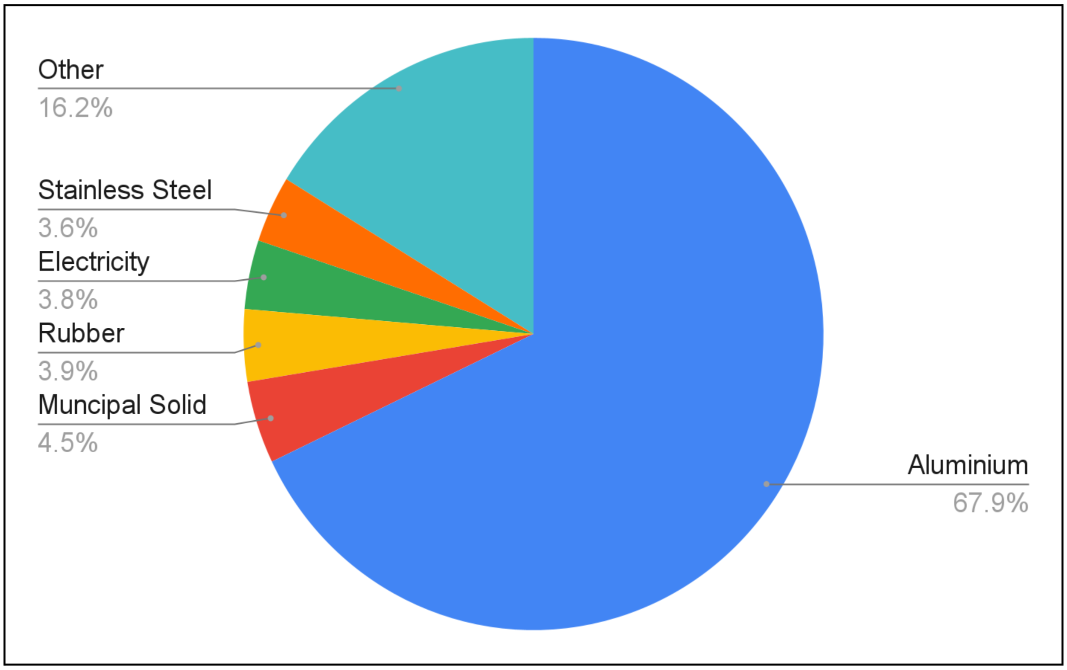


Figure 4.4-6: Classic Human Health Particulate Matter per Actual Mile Traveled for Integrated Production Phase



4.5. Fossil Fuel Resource Depletion

Fossil fuel resource depletion impacts describe the resulting quantity of non-renewable energy resources depleted throughout the lifecycle of the bikes in this study.

For the Ebike 2.0, the fossil fuel resource depletion life cycle impact is driven primarily by the Use (60%) and Integrated Production (37%) phases. In the Use Phase, the primary contributor is the vehicles required to conduct battery swapping. The Transport and EOL Phases are minor contributors to overall impact (<5%). Similarly, for the Ebike 1.0 electric bike, the fossil fuel resource depletion life cycle impact is driven primarily by the Use (87%) and Integrated Production (12%) phases. In the Use Phase, battery swapping, and vehicle rebalancing are the key contributors. The EOL Phase values are negative due to the recycling processes producing recycled content materials. For the Classic bike, the fossil fuel resource depletion life cycle impact is driven primarily by the Use (73%) and Integrated Production (24%) phases. In the Use Phase, the primary contributor (56% of Use Phase) is the vehicles required to conduct bike rebalancing. Specifically, for fossil fuel resource depletion, the Use Phase contributes to a larger portion of the total life cycle impacts due to the operations of these vehicles. A majority (40%) of the total impacts are from rebalancing operations. Figure 4.5-1 to Figure 4.5-3 represent life cycle impacts by phase for fossil fuel depletion for all bikes.

As illustrated in Figure 4.5-1 and Table 4.5-1, fossil fuel resource depletion per modeled mile traveled for the Ebike 2.0 bike is 0.04 MJ/mi and 534 MJ over the lifetime of the average bike. The Integrated Production and Use Phases contribute the lion share of fossil fuel resource depletion for the Ebike 2.0 bike.

Figure 4.5-1: Ebike 2.0 Fossil Fuel Resource Depletion per Modeled Mile Traveled by Life Cycle Phase

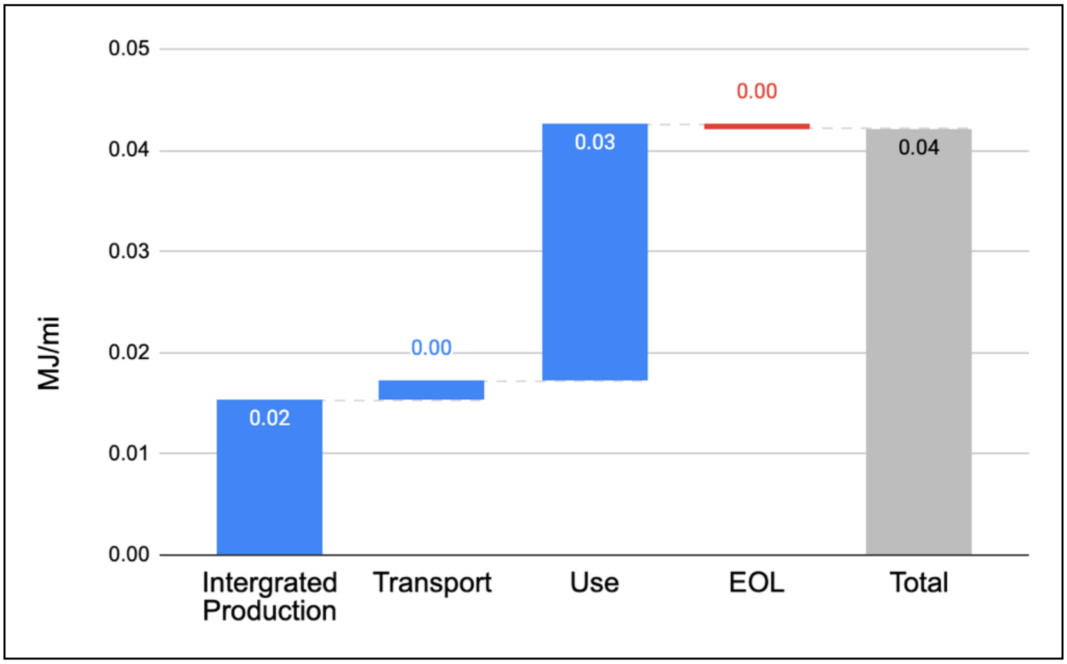


Table 4.5-1: Ebike 2.0 Fossil Fuel Resource Depletion for Entire Bike Over Lifetime and per Modeled Mile Traveled

Impact Category	Fossil Fuel Resource Depletion	
Component	MJ/Bike	MJ/mi
Battery	54.75	0.00
Aluminum	47.23	0.00
VCU	40.90	0.00
Rubber	20.69	0.00
Motor	9.08	0.00
Other	22.68	0.00
Integrated Production - Subtotal	**195.33**	**0.02**
Transport - Subtotal	**23.00**	**0.00**
Charging Electricity	130.33	0.01
Battery Swapping	101.92	0.01
Maintenance	90.28	0.01
Use - Subtotal	**322.53**	**0.03**
EOL - Subtotal	**-6.639**	**-0.001**
Total	**534.22**	**0.04**

As illustrated in Figure 4.5-2 and Table 4.5-2, fossil fuel resource depletion per actual mile traveled for the Ebike 1.0 bike is 0.11 MJ/mi and 1,344 MJ over the lifetime of the average bike. The Use Phase contributes the most fossil fuel resource depletion and is driven by operations activities such as rebalancing and battery swapping. Most significant are rebalancing operations which typically only occur for electric bikes in markets where there are no Classic bikes. Battery swapping on the other hand is much greater for the Ebike 1.0 bike than for Ebike 2.0 because the Ebike 2.0 bike has a much bigger battery pack which results in fewer swaps. In Santa Monica, the median market chosen for this study, the Ebike 1.0 is the only bike in the market and as a result is rebalanced for optimal operations.

Figure 4.5-2: Ebike 1.0 Fossil Fuel Resource Depletion per Actual Mile Traveled by Life Cycle Phase

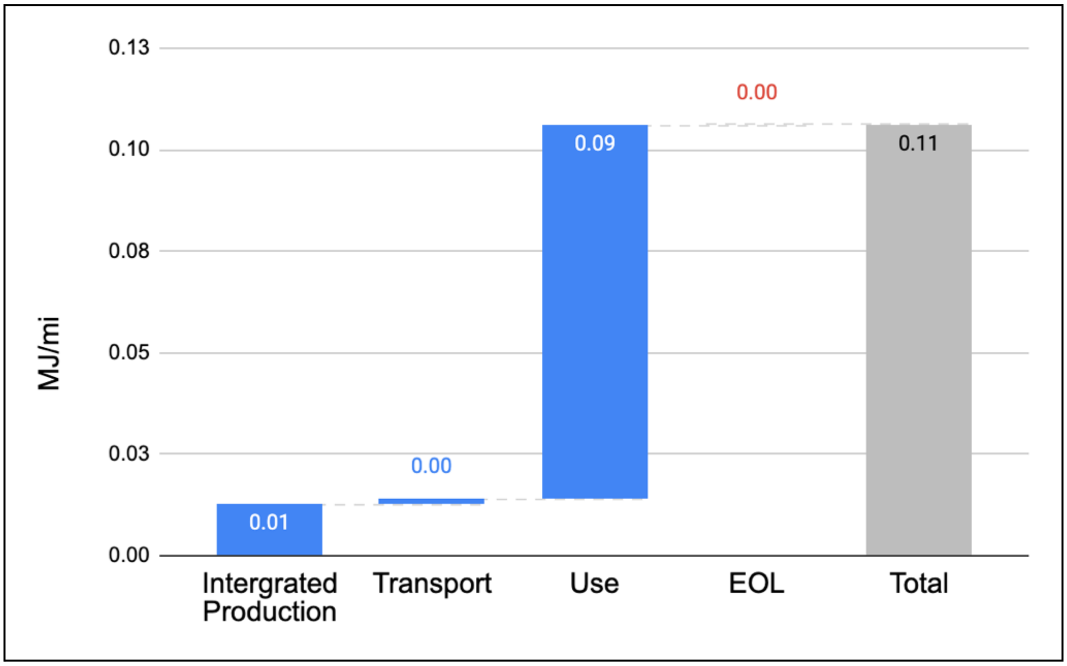


Table 4.5-2: Ebike 1.0 Fossil Fuel Resource Depletion for Entire Bike Over Lifetime and per Actual Mile Traveled

Impact Category	Fossil Fuel Resource Depletion	
Component	MJ/Bike	MJ/mi
Aluminum	48.45	0.00
VCU	37.87	0.00
Battery	21.90	0.00
Polycarbonate	18.85	0.00
Rubber	10.25	0.00
Other	23.93	0.00
Integrated Production - Subtotal	**161.26**	**0.01**
Transport - Subtotal	**18.65**	**0.00**
Rebalancing + Battery Swapping	831.98	0.07
Charging Electricity	244.76	0.02
Maintenance	90.28	0.01
Use - Subtotal	**1167.02**	**0.09**
EOL - Subtotal	**-2.712**	**0.000**
Total	***1344.22***	***0.11***

As illustrated in Figure 4.5-3 and Table 4.5-3, fossil fuel resource depletion per actual mile traveled for the Classic bike is 0.05 MJ/mi and 1127 MJ over the lifetime of the average bike. Like the Ebike 1.0 bike, the Use Phase contributes most of the fossil fuel resource depletion for the Classic Bike due to rebalancing operations. The Integrated Production Phase for the Classic Bike is the lowest amongst all bikes because its only electromechanical components are lights.

Figure 4.5-3: Classic Resource Depletion per Actual Mile Traveled by Life Cycle Phase

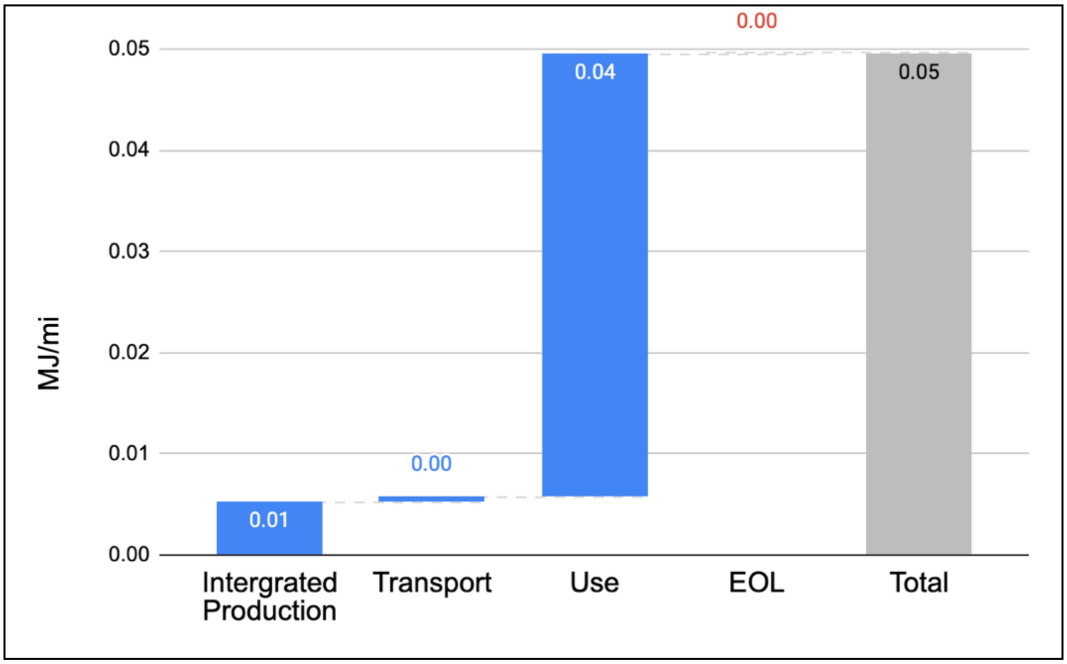


Table 4.5-3: Classic Fossil Fuel Resource Depletion for Entire Bike Over Lifetime and per Actual Mile Traveled

Impact Category	Fossil Fuel Resource Depletion	
Component	MJ/Bike	MJ/mi
Aluminum	46.40	0.00
ABS	35.61	0.00
Rubber	20.69	0.00
Injection Molding	4.74	0.00
Electricity	1.96	0.00
Other	9.75	0.00
Integrated Production - Subtotal	**119.15**	**0.01**
Transport - Subtotal	**13.79**	**0.00**
Rebalancing	830.11	0.04
Maintenance	164.50	0.01
Use - Subtotal	**994.61**	**0.04**
EOL - Subtotal	**-0.086**	**0.000**
Total	**1,127.47**	**0.05**

Figure 4.5-4 to Figure 4.5-6 dives deeper into the Integrated Production Phase for the fossil fuel resource depletion impact category, presenting a detailed breakdown of life cycle impacts. For the Ebike 2.0 electric bike, the battery accounts for the largest impact (28%) followed by aluminum (24%) and the PCBA (21%). For the Ebike 1.0 electric bike, aluminum accounts for the largest impact (30%) followed by the PCBA (24%) and the battery (14%). For the Classic bike, aluminum accounts for the largest impact (39%) followed by the plastic (30%) and rubber (17%).

Figure 4.5-4: Ebike 2.0 Resource Depletion per Modeled Mile Traveled for Integrated Production Phase

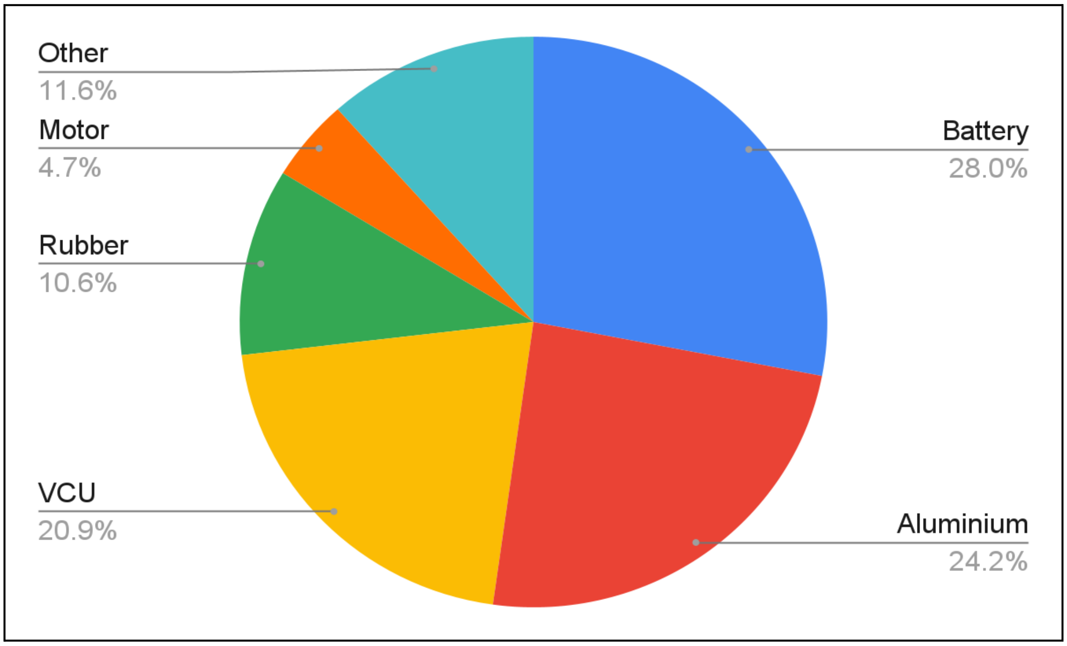


Figure 4.5-5: Ebike 1.0 Resource Depletion per Actual Mile Traveled for Integrated Production Phase

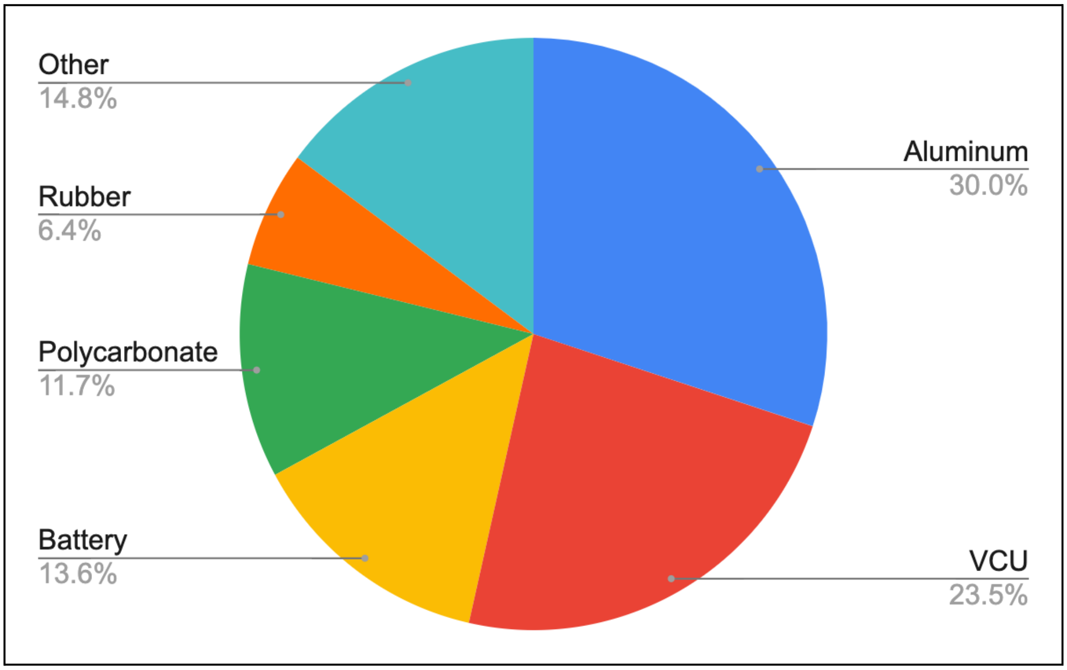
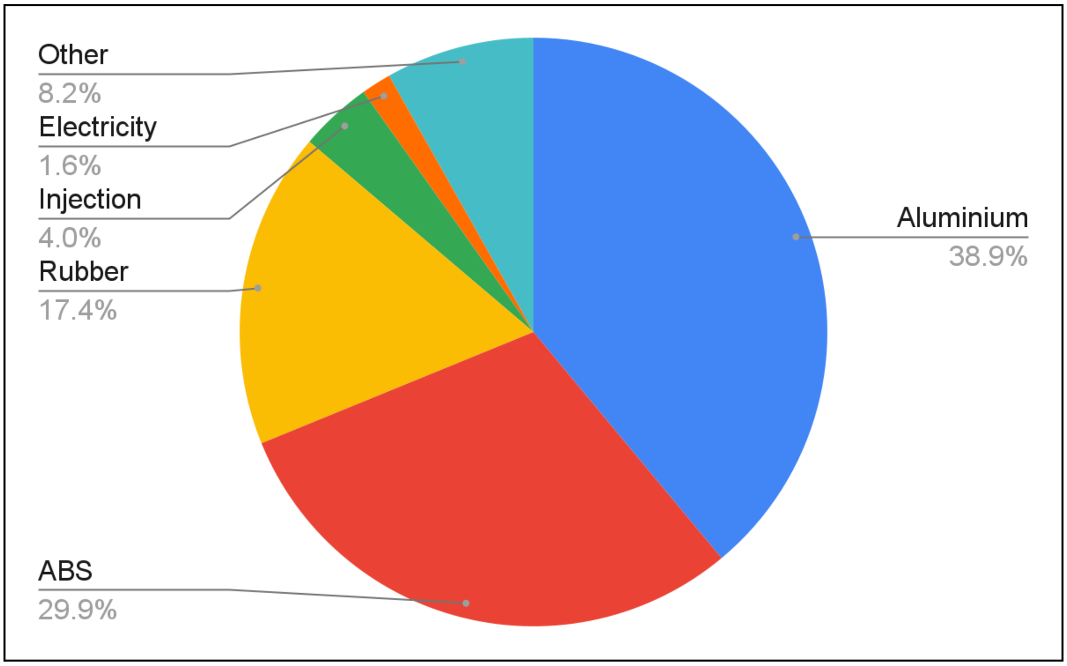


Figure 4.5-6: Classic Resource Depletion per Actual Mile Traveled for Integrated Production Phase



4.6. SENSITIVITY ANALYSIS RESULTS

Across all impact categories, Climate Change, Fossil Fuel Depletion and Human Health Particulate impacts, the following modeled sensitivities are uniform for Ebike 2.0 and Ebike 1.0 electric bikes. In the stress case for electric bikes, scooter lifetime estimates are assumed while in the most optimistic case, the Classic bike lifetime estimate is assumed. For Classic bikes, the sensitivity cases are driven by operations in different cities which have varying densities of operations and user behavior impacts.

As illustrated in Table 4.6-1, the Classic bike generally has the lowest impact across the board except for Fossil Fuel Resource Depletion on Ebike 2.0, which is assumed not to require rebalancing in this study. For Climate Change impacts, 80% of Classic bike emissions come from its Use Phase, driven by the ICE vans used in rebalancing operations. The Classic bike Use Phase has an outsized impact because the Integrated Production Phase is lowest amongst all Lyft bikes. The Ebike 2.0 and Ebike 1.0 electric bikes have more than three times the Integrated Production Phase emissions because of compute and electrical hardware components, namely, their electric motor, battery, connectivity system, and CPU. These components contain precious metals and chemicals and require more energy intensive processes to manufacture. As mentioned earlier, Lyft does not plan to rebalance Ebike 2.0s and, as a result, the Use Phase emissions of Ebike 2.0s are three times smaller than those of Ebike 1.0s. Where Ebike 2.0s are rebalanced as part of regular operations, Use Phase emissions will more closely resemble those of the Ebike 1.0.

Table 4.6-1: LCIA results comparison across all impact categories

	Classic	Ebike 2.0	Ebike 1.0
Climate Change	g CO_2/mi		
Integrated Production	5.50	18.45	15.78
Transport	0.31	0.92	0.75
Use	24.53	21.57	61.81
EOL	-0.10	-0.85	-0.44
Total	**30.24**	**40.09**	**77.90**
	Classic	**Ebike 2.0**	**Ebike 1.0**
Human Health Particulate Matter	$gPM_{2.5}$/mi		
Integrated Production	0.01	0.03	0.02
Transport	0.00	0.00	0.00
Use	0.02	0.05	0.09
EOL	0.00	0.00	0.00
Total	**0.02**	**0.07**	**0.11**
	Classic	**Ebike 2.0**	**Ebike 1.0**
Fossil Fuels	MJ/mi		
Integrated Production	0.01	0.02	0.01
Transport	0.00	0.00	0.00
Use	0.04	0.03	0.09
EOL	0.00	0.00	0.00
Total	**0.05**	**0.04**	**0.11**

4.7. Climate Change

In the stress case for electric bikes, scooter lifetime estimates are assumed; in the most optimistic case, the Classic bike lifetime estimate is assumed. For Classic bikes, lifetime estimates are fixed, and the sensitivity cases are driven by operations in different cities which have varying densities of operations and user behavior impacts.

The impacts of varying bike lifetime estimates are best illustrated by changes to the Integrated Production Phase seen in the Ebike 1.0 and Ebike 2.0 electric bikes (Figure 4.7-1 and Figure 4.72). In the Integrated Production Phase, environmental impacts (numerator) remain fixed as the methods of material extraction and manufacture of the bikes are fixed for the sensitivity study. So as estimated lifetime miles (denominator) change, environmental impacts change significantly. As illustrated in Figure 5.1-3, the environmental impacts do not change in the Integrated Production Phase for Classic bike, because estimated lifetime miles are fixed.

Changes to environmental impacts in transport are unique for the Classic bike and uniform for Ebike 2.0 and Ebike 1.0 electric bikes. As illustrated in Figure 4.7-3, there are only minor changes to Transport Phase emissions for Classic bikes because only the delivery destination is changing. For the stress case, Classic bikes are delivered from Taiwan to Chicago. In the most optimistic case, they are delivered from Taiwan to New York City, and in the base case they are delivered from Taiwan to San Francisco. For the Ebike 1.0 and Ebike 2.0, on the other hand, the bikes' transportation distances are fixed, and bike lifetime estimates drive the changes to environmental impacts in the sensitivity cases.

Finally, in the Use Phase, once again environmental impacts are unique for Classic bike (Figure 4.7-3) and uniform for Ebike 1.0 and Ebike 2.0 (Figure 4.7-1 and Figure 4.7-2). For the Classic bike, rebalancing and battery swapping distances and frequency in Chicago (stress case), New York City (most optimistic case), and San Francisco (base case) drive the differences in environmental impacts in the sensitivity analyses. For the Ebike 1.0 and Ebike 2.0 electric bikes, on the other hand, lifetime estimates affect the sensitivity cases in both the numerator (Use Phase environmental impacts) and denominator (estimated lifetime miles). Therefore, estimated lifetime miles also affect the environmental impacts because rebalancing and swapping actions are a function of the operational life of the bike.

Figure 4.7-1: Ebike 2.0 GWP Comparison Between Sensitivity Cases

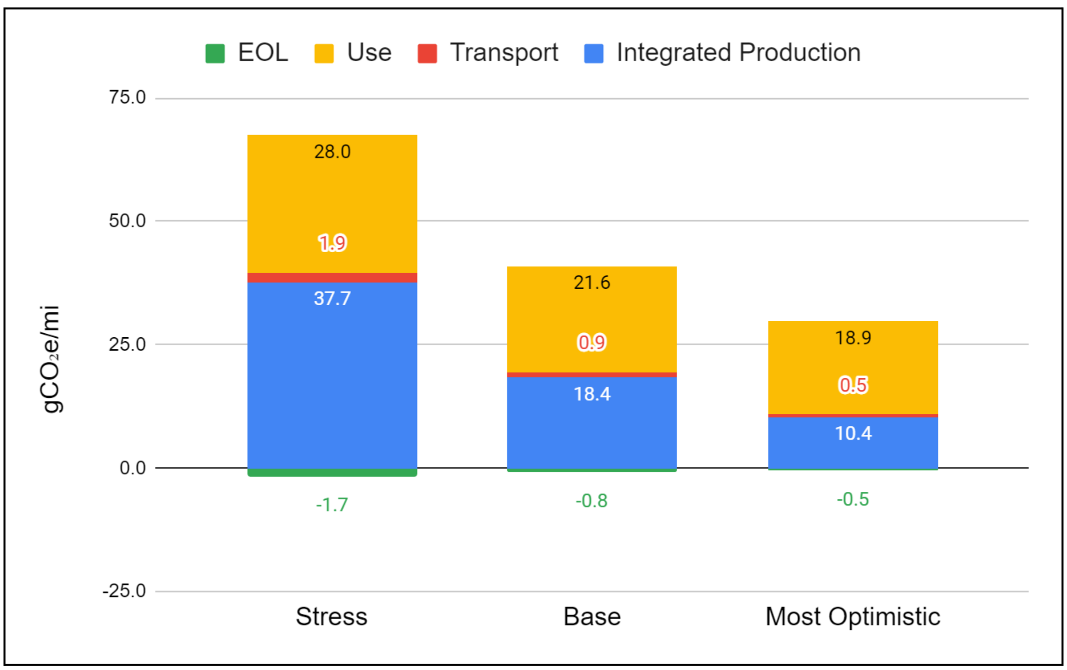


Figure 4.7-2: Ebike 1.0 GWP Comparison Between Sensitivity Cases

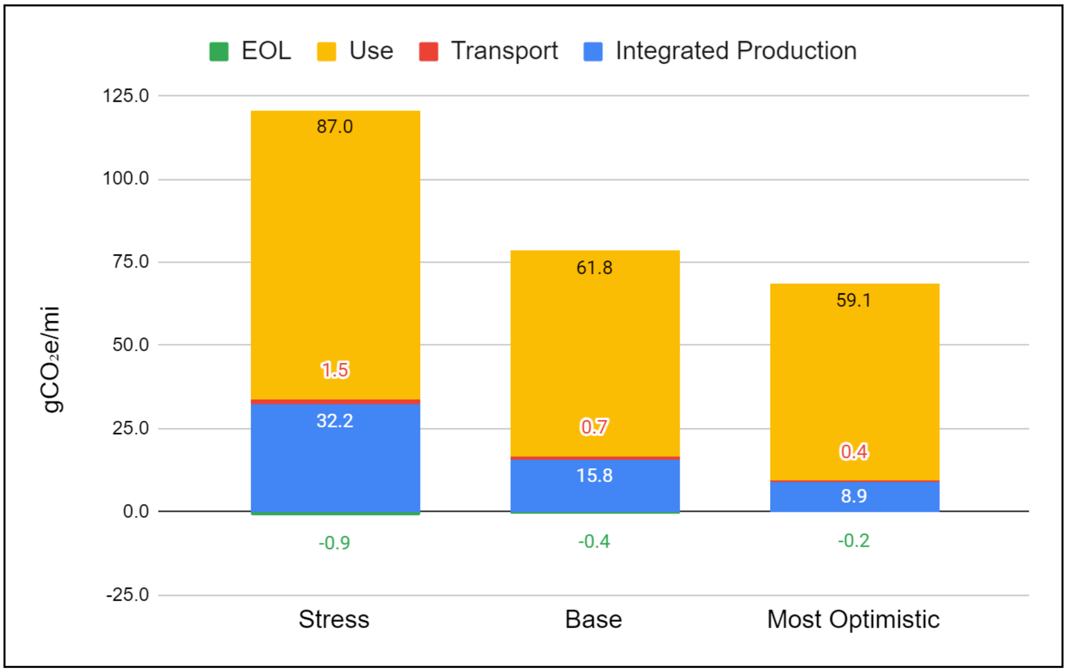
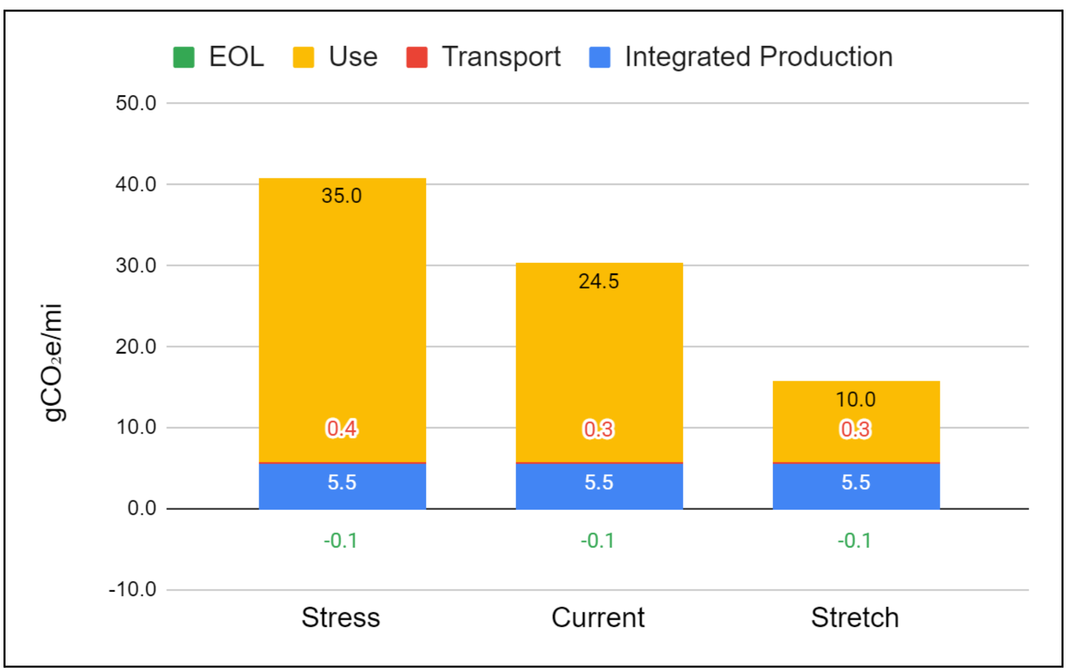


Figure 4.7-3: Classic GWP Comparison Between Sensitivity Cases



4.8. Human Health Particulate Matter

See section 4.7 for details on how sensitivity approaches affect environmental impacts presented in Figure 4.8-1, Figure 4.8-2, and Figure 4.8-3.

Figure 4.8-1: Ebike 2.0 Human Health Particulate Matter Comparison Between Sensitivity Cases

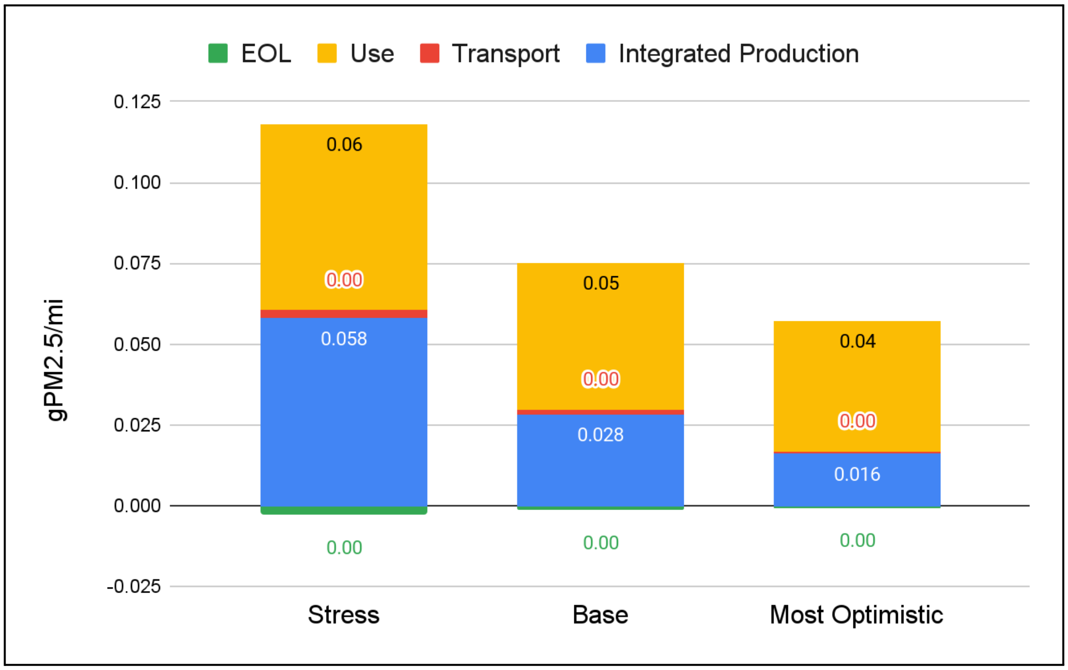


Figure 4.8-2: Ebike 1.0 Human Health Particulate Matter Comparison Between Sensitivity Cases

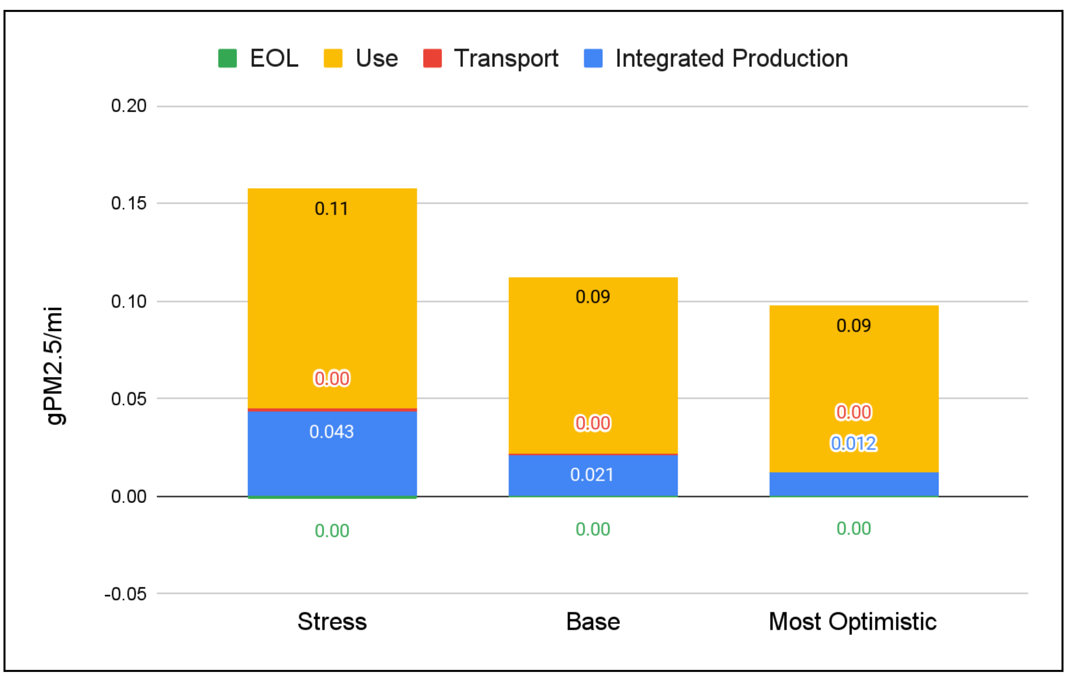
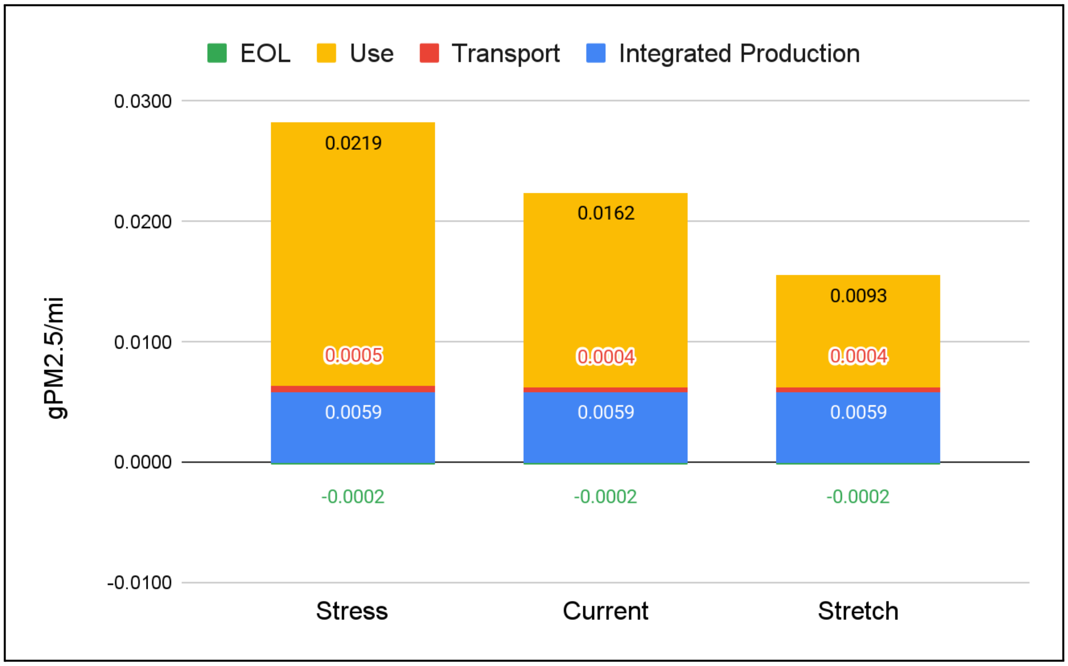


Figure 4.8-3: Classic Human Health Particulate Matter Comparison Between Sensitivity Cases



4.9. Fossil Fuel Resource Depletion

See section 4.7 for details on how sensitivity approaches affect environmental impacts presented in Figure 4.9-1 and Figure 4.9-2 and Figure 4.9-3.

Figure 4.91: Ebike 2.0 Fossil Fuel Resource Depletion Comparison Between Sensitivity Cases

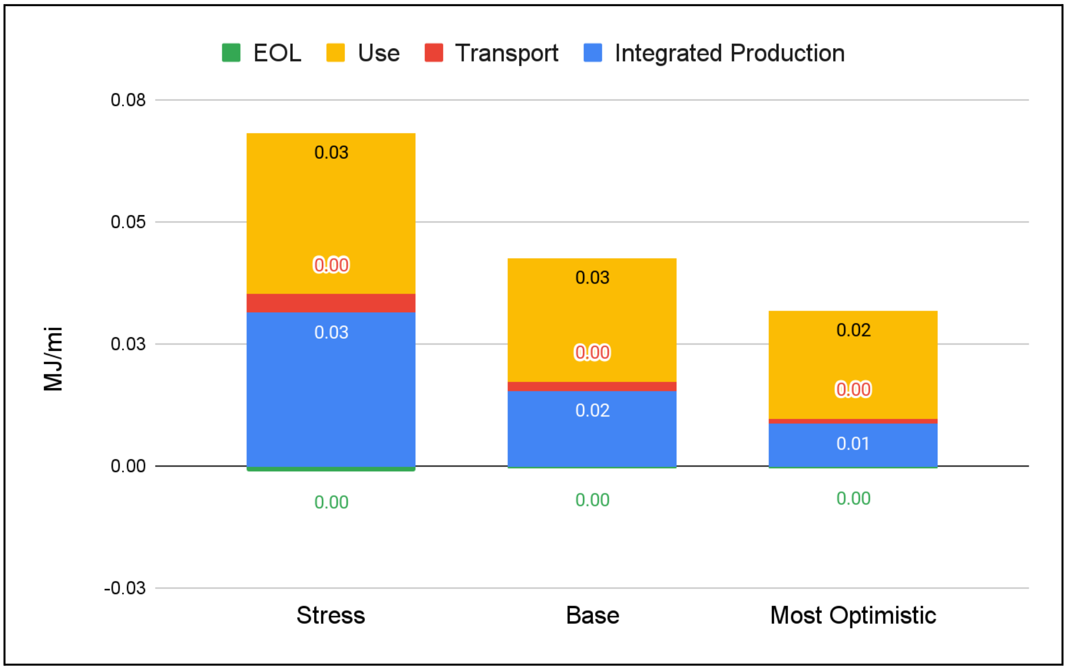


Figure 4.92: Ebike 1.0 Fossil Fuel Resource Depletion Comparison Between Sensitivity Cases

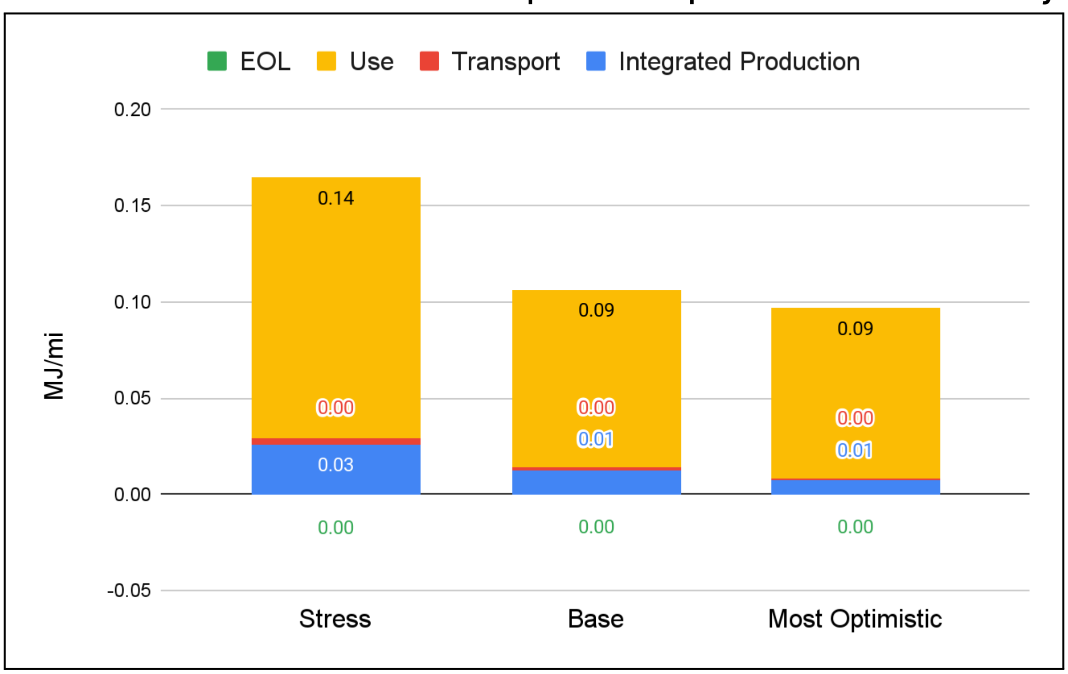
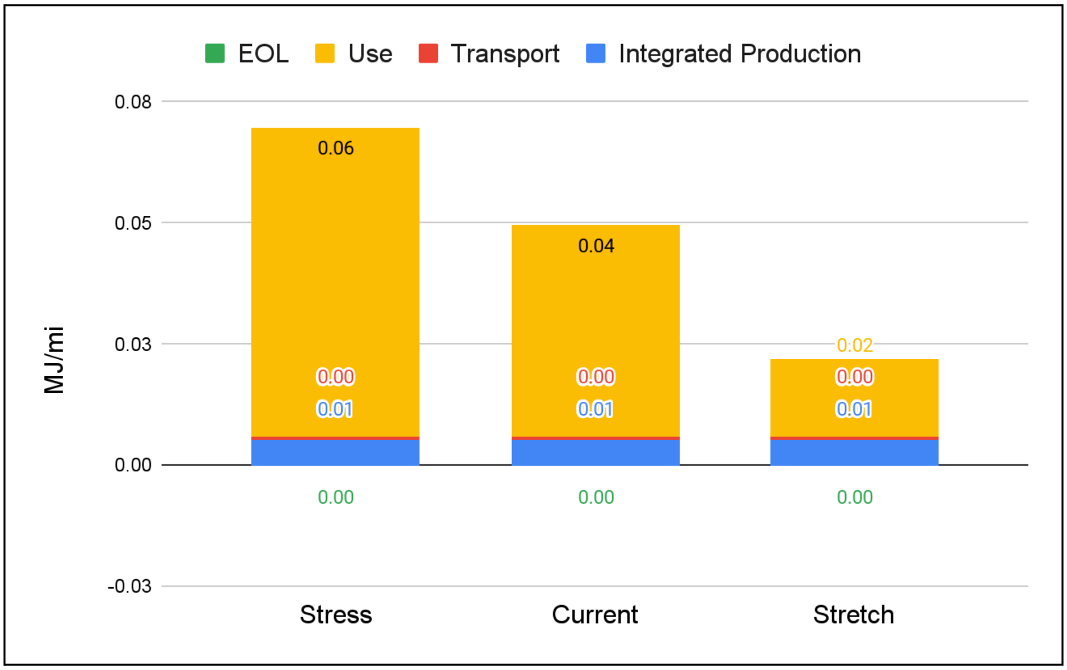


Figure 4.9-3: Classic Fossil Fuel Resource Depletion Comparison Between Sensitivity Cases



4.10. Air Freighting vs Ocean Freight

Shipping bikes by air freight rather than ocean freight drastically increases GHG emissions (119% higher overall life cycle impact) due to the increased fossil fuel usage. As illustrated in Table 4.10-1, air shipping transforms Transport Phase emissions by up to an order of magnitude. While changes to impacts are greatest in the Climate Change category, the Human Health Particulate Matter and Fossil Fuel Resource Depletion categories also see significant increase as well.

Table 4.10-1: Lyft Bikes Air Freight vs. Sea Freight Across all Impacts

	Classic		**Ebike 2.0**		**Ebike 1.0**	
	Base + Air	**Base**	**Base + Air**	**Base**	**Base + Air**	**Base**
Climate Change	**gCO_2e/mi**		**gCO_2e/mi**		**gCO_2e/mi**	
Transport	22.1	0.3	87.5	0.9	53.7	0.7
Total	52.0	30.2	126.7	40.1	130.8	77.9
Human Health Particulate Matter	**$gPM_{2.5}$/mi**		**$gPM_{2.5}$/mi**		**$gPM_{2.5}$/mi**	
Transport	0.02	0.00	0.04	0.01	0.01	0.01
Total	0.04	0.02	0.12	0.08	0.12	0.12
Fossil Fuel Resource Depletion	**MJ/Mi**		**MJ/Mi**		**MJ/Mi**	
Transport	0.01	0.00	0.16	0.00	0.12	0.00
Total	0.06	0.05	0.20	0.04	0.22	0.11

Climate Change: From a climate change perspective, the impacts from air freight eclipse the impacts from all other phases combined. Figure 4.10-1 to Figure 4.10-3 present the life cycle impacts for air freighting versus ocean freight for climate change.

Figure 4.10-1: Ebike 2.0 GWP Comparison Between Air and Ocean Freight

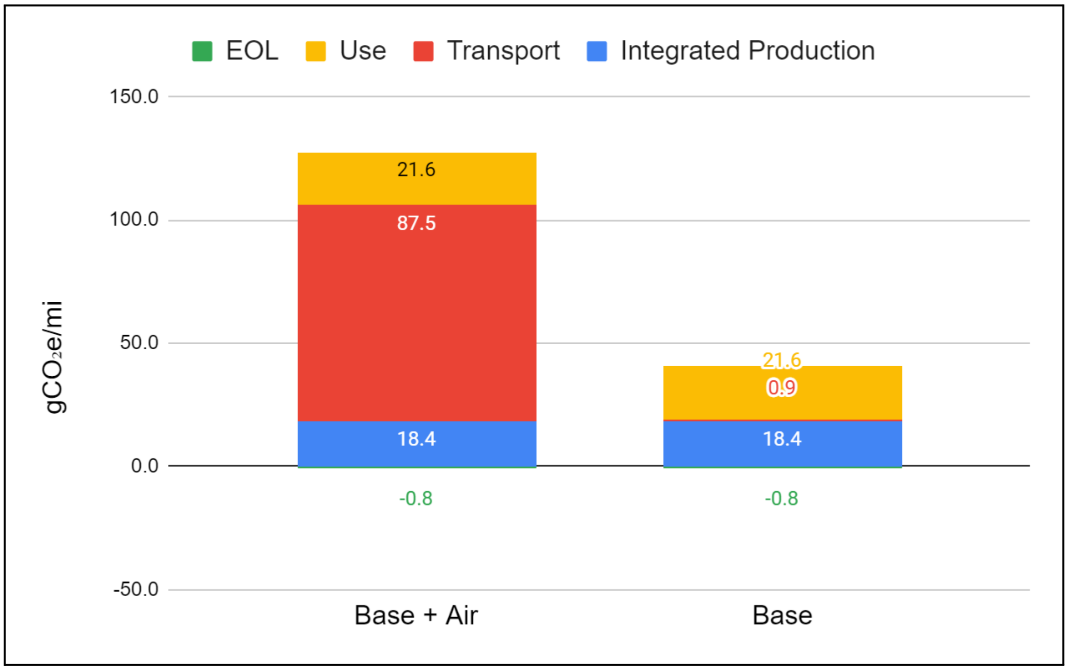


Figure 4.10-2: Ebike 1.0 GWP Comparison Between Air and Ocean Freight

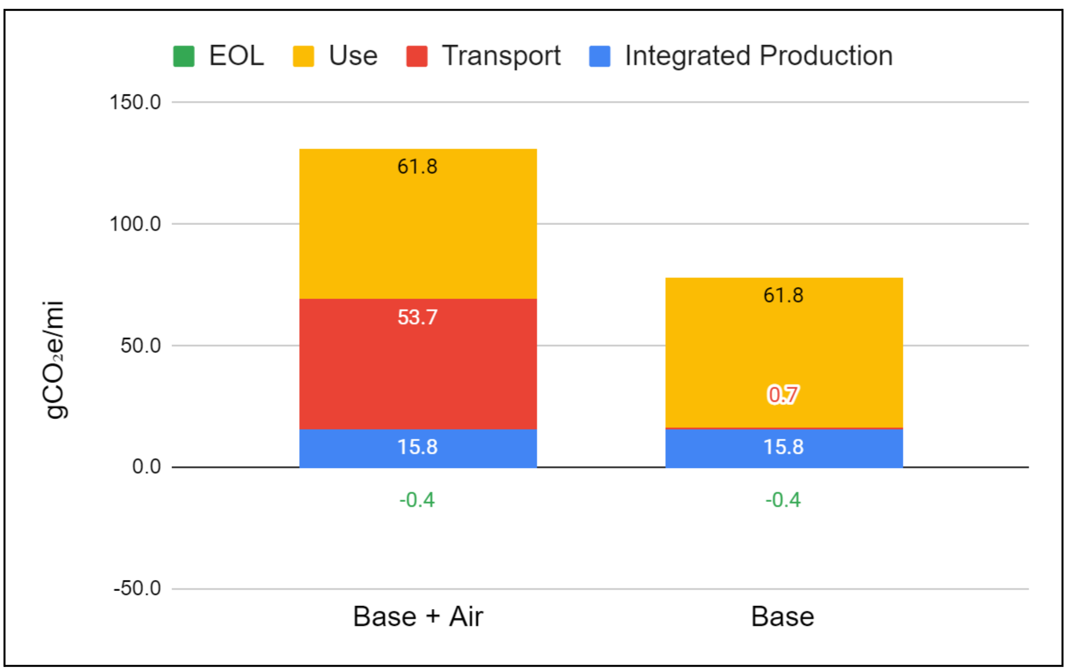
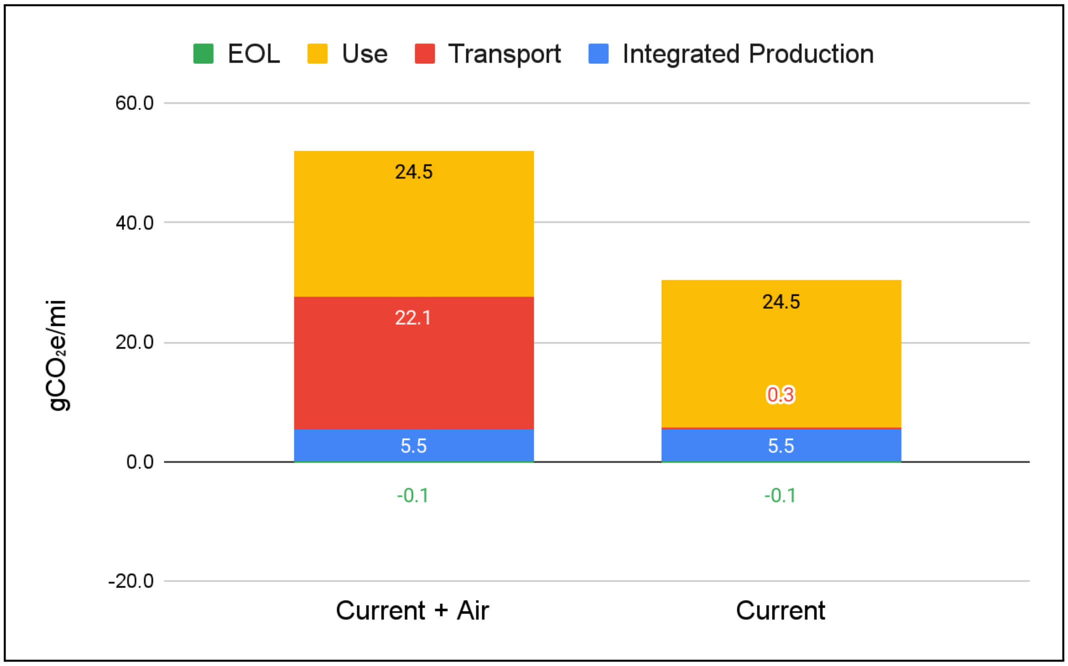


Figure 4.10-3: Classic GWP Comparison Between Air and Ocean Freight



Human health particulate matter impacts are not as sensitive to the change in logistics mode as compared to climate change or fossil fuel resource depletion. The total increase in overall impact is 41%. Figure 4.10-4 to Figure 4.10-6 present the life cycle impacts for air freighting versus ocean freight (current case) for human health particulate matter.

Figure 4.10-4: Ebike 2.0 Human Health Particulate Matter Comparison Between Air and Ocean Freight

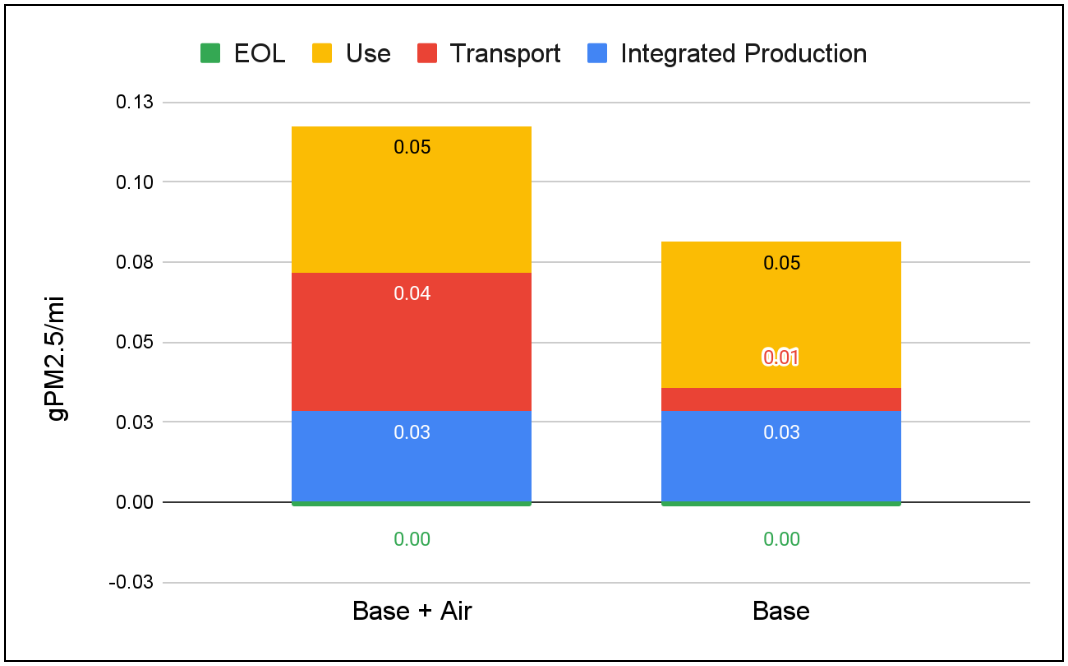


Figure 4.10-5: Ebike 1.0 Human Health Particulate Matter Comparison Between Air and Ocean Freight

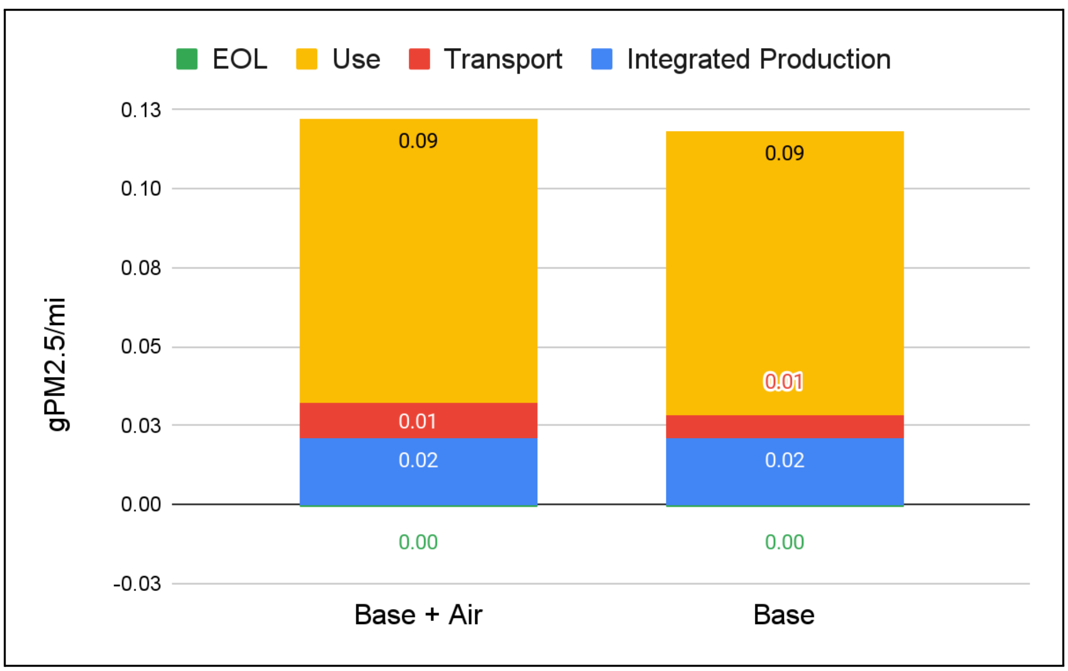
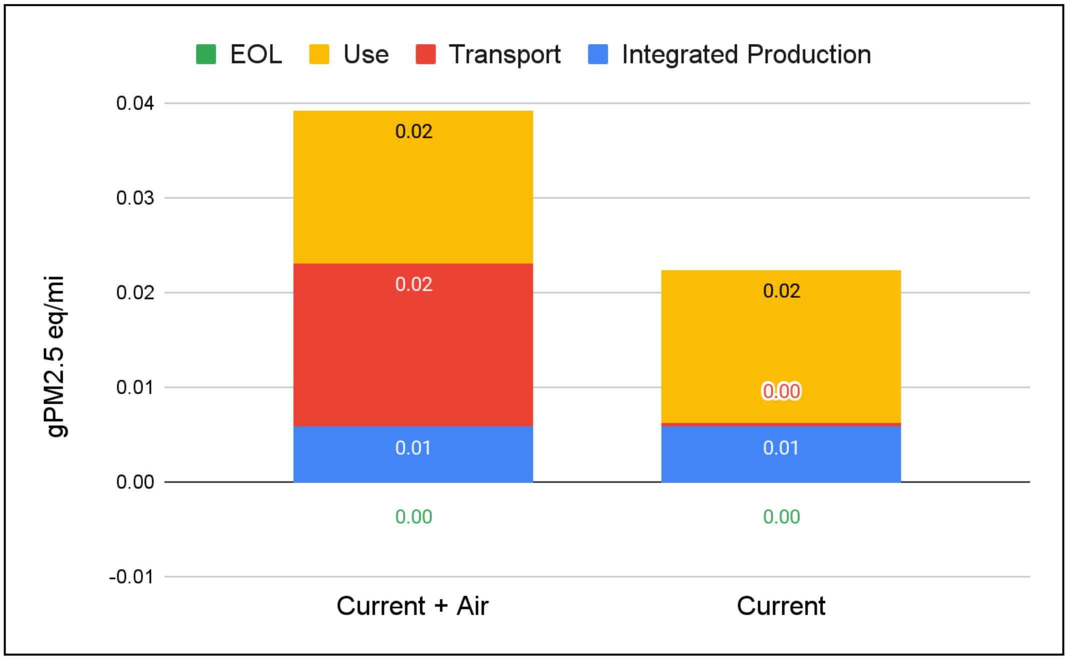


Figure 4.10-6: Classic Human Health Particulate Matter Comparison Between Air and Ocean Freight



Fossil fuel resource depletion impacts are very sensitive to overseas shipment choices. Shipping via air instead of sea increases the overall impact by 171%. Figure 4.10-7 to Figure 4.10-9 present the life cycle impacts for air freighting versus ocean freight (base case) for all three bikes.

Figure 4.10-7: Ebike 2.0 Fossil Fuel Resource Depletion Comparison Between Air and Ocean Freight

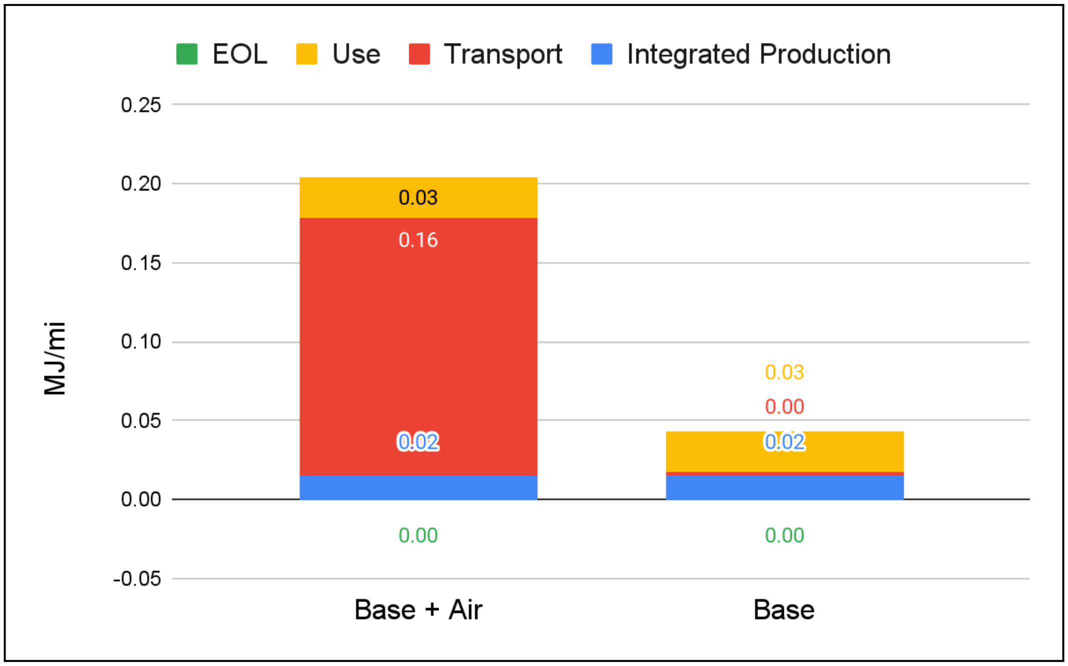


Figure 4.10-8: Ebike 1.0 Fossil Fuel Resource Depletion Comparison Between Air and Ocean Freight

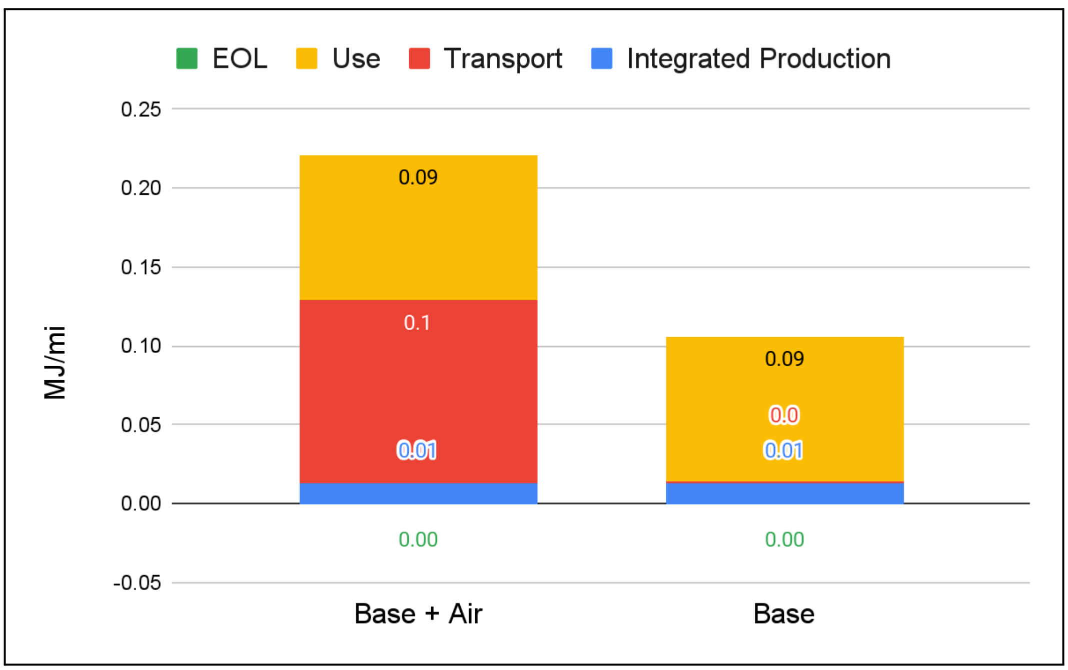
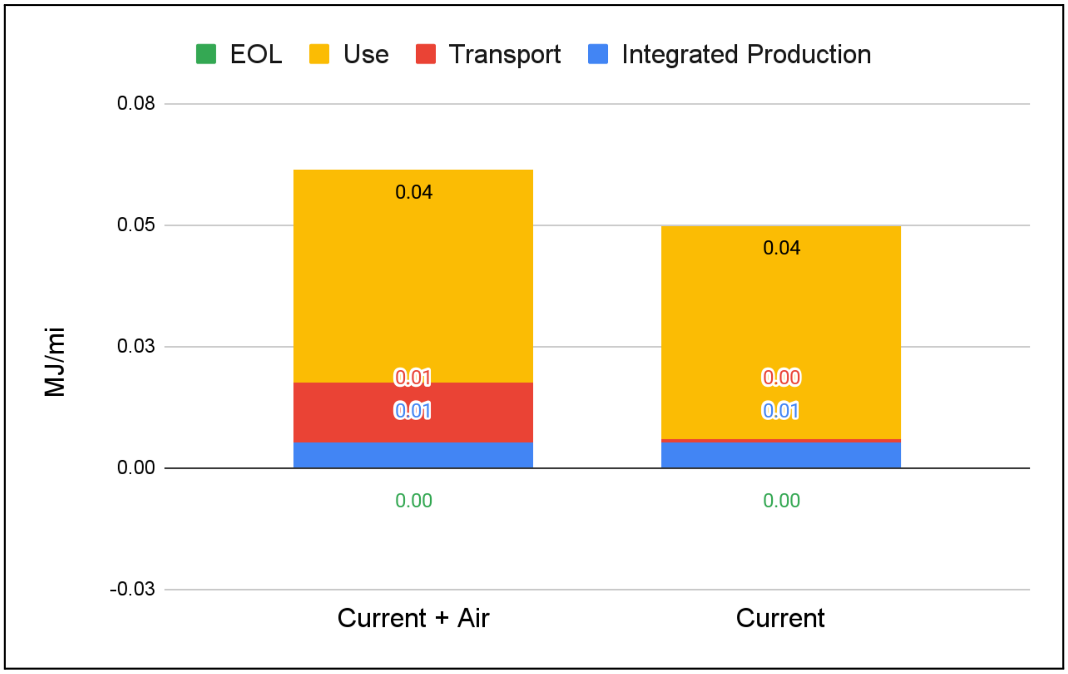


Figure 4.10-9: Classic Fossil Fuel Resource Depletion Comparison Between Air and Ocean Freight



4.11. Limitations and Assumptions

This life cycle model applies solely to the Classic, Ebike 1.0, Ebike 2.0 bikes and Lyft operations. Limitations presented in section 2.12 also apply to the sensitivity analyses.

In the sensitivity analyses, only overseas transport was considered and presented. However, given the environmental impacts of the Use Phase, it will be insightful in future studies to perform sensitivities on the operational transport impacts, such as using EVs for rebalancing and battery swapping activities. This may help Lyft find more nuanced solutions to reducing Use Phase environmental impacts.

Finally, the sensitivity analyses did not present the impact of varying grid energy mixes across regions, as well as 100% renewable energy procurement. Given some Lyft operations already charge rideables with 100% renewable energy, presenting this information may provide a more current picture of Lyft's environmental impact as well as potentially encourage further investment in cleaner energy.

5. LIFE CYCLE INTERPRETATION

5.1. Identification of Relevant Findings

The results of the LCIA demonstrate that most of the climate change, human health particulate matter, and fossil fuel resource depletion impacts arise from the Integrated Production and Use Phases of the pedal and electric bikes, while the Transport (via ocean freight) and EOL treatment contribute to less than 5% of the overall life cycle climate change impacts.

In the Use Phase, the primary contributor across all impact categories is from the vehicles required to conduct battery swapping and rebalancing. Specifically, for fossil fuel resource depletion, the Use Phase contributes to a larger portion of the total life cycle impacts due to the operations of these vehicles.

In the next largest impact phase, Integrated Production, aluminum accounts for most of the impacts in all three impact categories due to the fact that aluminum makes up the largest mass of the bike as well as the energy intensity of mineral extraction and metal refinement processes used to produce aluminum alloys. The manufacturing of the aluminum alloy for the frame of the bike results in almost half of the Integrated Production Phase impacts for all three impact categories. The battery, motor and PCBA are the next major contributors to the three impact categories with the remaining components, accounting for less than 5% of both climate change and human health particulate matter impacts. For climate change, the lithium-ion battery and PCBA make up the next largest contributions, while for human health particulate matter, and fossil fuel resource depletion it is the lithium-ion battery and motor. All three components require the extraction and energy intensive refining of precious metals to produce, driving their respective life cycle impacts. The PCBA requires small amounts of gold, tin and other precious metals that contribute to life cycle climate change impacts that are outsized for the weight of the overall mass.

The sensitivity analysis also showed that recycling was not sensitive in any scenario to the in-scope life cycle impacts (less than 1.5% increase in total impacts for climate change, human health particulate matter and fossil fuel resource depletion). However, with more data, future studies can measure the impacts of transporting components to recyclers when they reach end of life, and this could change recycling lifecycle impacts. Air freight on the other hand, greatly impacted fossil fuel resource depletion and climate change.

All the contributing factors that impact a bike's lifespan have been considered in this LCA due to the use of the real-world factors of estimated vehicle life and mileage traveled. This LCA also includes measures that have already been implemented to improve efficiency or reduce environmental impacts, including those described in the following sections.

5.2. Lyft Operations Teams

From the beginning of Lyft's operations in bikes and scooters, all the operations staff used to repair, recharge, and rebalance the Lyft fleet have been employees of either Lyft or one of Lyft's operations partners rather than gig workers. Centralized operations can maximize vehicle density and leverage software for optimizing routes, and telemetry for changing field conditions. On the other hand, decentralized models using gig workers to retrieve, rebalance and recharge rideables, may be less efficient and more impactful to the environment because of poor economies of scale (e.g., they can carry fewer bikes in their vehicles) and the inability to realize the efficiencies of a centrally planned system. Using a single operations team for rebalancing and recharging allows Lyft to leverage operational technologies to minimize the VMT of the service vehicles and reduce the associated environmental impact, which is reflected in this model. Finally, centralized operations enable uniform approaches to charging vehicles which is a major contributor to environmental impacts. As Lyft continues to improve the sustainability of its fleet, it can build upon 100% renewable energy power such as is done in Santa Monica via the Clean Energy Alliance utility.

5.3. Battery Swapping

The Ebike 1.0 and Ebike 2.0 electric bikes allow for battery swapping in the field. Thus, operations vehicles do not need to collect the rideable and transport it to a Lyft warehouse for charging. This reduces the amount of vehicle space and weight being transported across the cities. The in-field battery swapping significantly reduces the GHG emissions, particulate matter emissions and fossil fuel resource depletion.

5.4. Extended Lifetime

Lyft continually makes improvements for durability and theft deterrence. Each of the bikes assessed in this report include various improvements designed for durability and longevity. In particular, the Ebike 2.0 delivers what Lyft expects will be the most efficient and durable electric bike in its fleet.

5.5. Conclusions and Recommendations

The Classic bike generally has the lowest impact across all impact categories except for the Fossil Fuel Resource Depletion impact category due to its rebalancing needs (see Table 5.5-1). For Climate Change impacts, 80% of Classic bike emissions come from its Use Phase, driven by the ICE vans used in rebalancing operations. The Classic bike Use Phase has a relatively outsized percentage impact because its Integrated Production Phase is lowest amongst all Lyft bikes. The Ebike 2.0 and Ebike 1.0 electric bikes have more than three times the Integrated Production Phase emissions because of compute and electrical hardware components. These components contain precious metals and components that require more energy intensive processes to manufacture. Lyft does not typically rebalance electric bikes, and Ebike 2.0 has been analyzed as such. As a result, the Use Phase emissions of Ebike 2.0s are three times smaller than those of Ebike 1.0s. Where Ebike 2.0s are rebalanced as part of regular operations, Use Phase emissions will more closely resemble that of the Ebike 1.0 electric bike. In the sensitivity analysis, all three impacts were found to be driven primarily by the Use Phase. Thus, the analyses are sensitive to rebalancing and battery swapping. This conclusion presents itself as an opportunity for further refinement to produce more accurate, location-specific results on a per market basis.

Table 5.5-1: Climate Change Impacts for All Bikes

Bikes	gCO_2e/mi
Classic	30.2
Ebike 1.0	77.9
Ebike 2.0	40.1

The result of this LCA will help inform and internally prioritize efforts on how to continue to reduce the environmental impacts of Lyft's Classic, Ebike 1.0 and Ebike 2.0 bikes. Specifically, for bike hardware, these results will be invaluable to inform future design considerations. This LCA is only the starting point for our bike and scooter program's sustainability journey. Lyft has developed sustainable design principles based on reducing life-cycle impacts drawn directly from this LCA. Specifically, we will be embarking on sourcing recycled materials with lower environment impacts as well as developing more durable designs to further resist theft and damage. Lyft will continue to adopt circular economy principles to identify opportunities to incorporate both open and closed-loop recycling. Additionally, future studies may dive deeper into the environmental impacts of road transport for recycling bikes that have reached their end of life. As part of continual efforts to improve service vehicle operations, improvements are being made to our operational technology dispatch system as well as the use of electric tricycles for battery swapping and maintenance operations.

Additionally, improvements to this and future LCAs could include:

- Gathering primary data for more manufacturing impacts, such as electricity and heat needed to assemble and test rideables.
- Expanding the study to include other markets in which Lyft operates. Since the median distance for rebalancing and battery swapping was chosen, separate studies could be conducted at other locations to better estimate the lower impacts of lower or higher distances traveled.
- Modeling planned sustainability initiatives, including the use of recycled materials and electric vehicles for rebalancing battery swapping.
- Gathering distances from Lyft operating markets to recycling facilities and quantifying EOL transportation environmental impacts.
- Using actual Ebike 2.0 electric bike data after launch into multiple markets.

Since the estimated bike lifetime is a large factor in overall environmental impacts, we are continuously collecting data and will update the sensitivity analyses accordingly.

5.6. Data Quality Evaluation

Table 5.6-1 presents a summary of the data quality evaluation for the LCA.

Table 5.6-1: Data Quality Evaluation Summary

Data Quality Requirements	Evaluation	Qualitative Assessment
Temporal coverage	BOM and logistics data collected are from the latest design, manufacturing assembly and supply chain for all bikes. The operational data collected was for the calendar year 2020 operating across all Lyft markets. The time related coverage is satisfied in both recency and completeness of a calendar year. The time period which results should be considered valid is ten years from the publication date of this study. However, the process data (e.g., vehicle emissions, electricity grid mix) is expected to improve in the next decade, making the result of this assessment a conservative approach.	Excellent
Geographical coverage	Operational data were collected from all Lyft markets. The operational unit processes were selected to the appropriate areas in the United States. Due to the international nature of the supply chain, the secondary data for the Integrated Production Phases were selected based on the location of production and material sourcing. Given the limitations of the ecoinvent version 3.5 dataset in providing region-specific information, GLO and ROW were used for production to represent Chinese and Taiwanese production. The study could be improved in the future by using factors specific to Asian regions for production data instead GLO and RoW.	Sufficient
Technology coverage	Bike operations technologies are specific to Lyft micromobility operations. Electric bike and standard bike ecoinvent version 3.5 manufacturing process and industry models were used for Ebike 1.0/Ebike 2.0 and Classic Lyft bikes respectively. ecoinvent datasets were used for comparison only; Lyft bike specific components and their masses were used to perform the analyses. The technology coverage is satisfied based on the use of the most recent ecoinvent version 3.5 databases.	Excellent
Precision	Primary data were collected for each major phase of the LCA, including the full BOM, including utilities data for charging rideables in operations. Thus, these inputs are	Excellent

Data Quality Requirements	Evaluation	Qualitative Assessment
	considered to have high precision, as no estimated or measured data are used. Other supply chain and operational parameters required estimates, such as transport distances by truck and ocean and the specific breakdown of VMT by operational vehicles.	
Completeness	The mass of the entire bike was accounted for in the BOM. The major operational processes (e.g., charging, rebalancing, maintenance, EOL) are also included. All processes involved in the bike's manufacturing, transport, use and EOL are included in this assessment, except where specified in the cut-off criteria, including: ● manufacturing of packaging and containers used in transportation; ● warehousing of bike storage; ● EOL for the operational vehicles used for battery swapping and rebalancing; ● transportation of EOL components to the recycler; and ● constructing and maintaining the road infrastructure required to operate the bikes. None of these processes excluded from this study are expected to have a significant impact on results, except for transportation of EOL components to recyclers. This is a data gap, and future studies should include this information to better evaluate EOL impacts. The level of completeness of this study is considered sufficient for the purposes of this study.	Sufficient
Representativeness	The secondary data and unit processes selected represent the appropriate geographical and technological coverage. For a limited number of processes, exact matches were not available, and the closest proxy was selected. This represented a single unit process, which was the use of an unspecified controller cable for the bike IOT cabling. Thus, the representative criteria are satisfied.	Good
Consistency	All secondary data are maintained by ecoinvent version 3.5 and has been modeled according to ecoinvent version 3.5 and OpenLCA guidelines. All components of this assessment were applied uniformly with this methodology.	Excellent

Data Quality Requirements	Evaluation	Qualitative Assessment
Reproducibility	The bike BOM and Lyft operational data are confidential business information, so these exact results could not be reproduced using the public data from this report. However, an LCA practitioner with these details would be able to reproduce these results if given access to the data contained in the Appendix to this report.	Excellent
Sources	Lyft's suppliers provided the BOM and other manufacturing details. Lyft's operational teams provided details on logistics, charging and maintenance. Lyft's data science teams provided data on usages and estimated bike lifetimes. Secondary data on energy inputs were gathered from the ecoinvent version 3.5 database. Throughout the data collection and modeling process, inputs and outputs were checked to ensure quality and accuracy. All elements of the data collection and modeling process were checked by an internal reviewer. Outputs were sense checked to ensure that results were consistent with both feasibility and actual operating conditions (e.g., mass BOM, estimated bike lifetime, etc.). For cases in which an exact match could not be found between the Lyft BOM and an ecoinvent material, the most similar material available was used as a proxy. A proxy was used for 45 of the 896 parts in the BOM, accounting for 6.14% of the BOM by count and 4.4% by mass.	Good
Uncertainty	To the extent possible, this LCA uses actual data, specifically for the operational data and data used to estimate device lifetime. For the components, some will use the closest approximation to the material listed on the BOMs. Any missing data for each unit process was substituted with assumptions with best available or calculated data and noted in this report. A small degree of uncertainty arising from these assumptions is unavoidable. For example, imprecision in distances for transportation of the bike to the market could arise from a variation in actual miles traveled by the trucks versus the road distances calculated using mapping software. There were no assumptions made for any of the key drivers of life cycle impact. The assumptions and proxy industry data were used in low impact areas, such as assembly energy.	Sufficient

6. REFERENCES

Argonne National Laboratory (2015, September). *Material and Energy Flows in the Production of Cathode and Anode Materials for Lithium Ion Batteries,* 2015, pp. 13-17

Bare, J. (2011). TRACI 2.0: the tool for the reduction and assessment of chemical and other environmental impacts 2.0. *Clean Technologies and Environmental Policy 13*, 687-696.

Bare, J. (2012, August 29). *Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), Version 2.1 - User's Manual.* Retrieved December 27, 2021, from EPA.gov: https://nepis.epa.gov/Adobe/PDF/P100HN53.pdf

Boyd, S. (2009). Life-cycle Assessment of Semiconductors. Retrieved April 16, 2022, from escholarship.org: https://escholarship.org/content/qt8bv2s63d/qt8bv2s63d_noSplash_b2f48cfb6a20be519dcdb2570300412a.pdf, pp. 38

City of Portland, Oregon. (2018, July 11). *E-Scooter Pilot Program.* Retrieved December 27, 2021, from Portland.gov: https://www.portland.gov/transportation/escooterpdx/documents/2019-e-scooter-pilot-program-permit-application

ecoinvent. (n.d.). *Database*. Retrieved from ecoinvent.org: https://ecoinvent.org/the-ecoinvent-database/

Greendelta. (2021). *Download OpenLCA*. Retrieved from OpenLCA: https://www.openlca.org/

Gómez, P., Elduque, D., Sarasa, J., Pina, C., & Javierre, C. (2016). Influence of Composition on the Environmental Impact of a Cast Aluminum Alloy. *Materials (Basel), 9*(6), 412.

Hollingsworth, J., Copeland, B., & Johnson, J. X. (2019). Are e-scooters polluters? The environmental impacts of shared dockless electric scooters. *Environmental Research Letters*.

JNS, & Ciroth, A. (2019, April 1). *ask.openlca*. Retrieved from OpenLCA: https://ask.openlca.org/53/difference-between-system-process-and-unit-process

Lyft, Inc. (2018, September 11). *Lyft Commits to Full Carbon Neutrality and 100% Renewable Energy.* Retrieved from Lyft Blog: https://www.lyft.com/blog/posts/lyft-commits-to-full-carbon-neutrality-and-100-renewable-energy

Lyft, Inc. (2018, December 13). *Why 130,000 Lyft Passengers Were Ready to Ditch Their Personal Cars in Less than 24 Hours.* Retrieved from Lyft Blog: https://www.lyft.com/blog/posts/ditchyourcardata

Lyft, Inc. (2020, June 17). *Leading the Transition to Zero Emissions: Our Commitment to 100% Electric Vehicles by 2030.* Retrieved from Lyft Blog: https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions

Lyft, Inc. (2022, April). *Lyft Impact.* Retrieved April 29, 2022, from Lyft Multimodal Report: https://www.lyft.com/impact/multimodal-report

Lyft, Inc. (n.d.). *Our vision for the future of cities.* Retrieved from Lyft.com: https://www.lyft.com/bikes/resilient-streets

Mu, D., Xin, C., & Zhou, W. (2020). Chapter 18 - Life Cycle Assessment and Techno-Economic Analysis of Algal Biofuel Production,. (A. Yousuf, Ed.) *https://www.sciencedirect.com/science/article/pii/B9780128175361000187*, 281-292.

Pyzyk, K. (2019, July 17). *Reduce, reuse, rescoot? A look at e-scooters' long-term sustainability.* Retrieved December 27, 2021, from Smart Cities Dive: https://www.smartcitiesdive.com/news/reduce-reuse-rescoot-a-look-at-e-scooters-long-term-sustainability/558691/

SFMTA. (2019, July). *Powered Scooter Shared Permit Program.* Retrieved December 27, 2021, from SMFTA.com: https://www.sfmta.com/sites/default/files/reports-and-documents/2019/07/appendix_6_-_sustainability_guidelines_and_requirements.pdf

Statistics How To. (2021). *Memoryless Property*. Retrieved from https://www.statisticshowto.com/memoryless-property/

United States Environmental Protection Agency. (2019). *EPA GHG Emissions.* Retrieved from EPA.gov: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-main-text.pdf?VersionId=yu89kg1O2qP754CdR8Qmyn4RRWc5iodZ

United States Environmental Protection Agency. (2022). *Health and Environmental Effects of Particulate Matter (PM).* Retrieved from Particulate Matter (PM) Pollution : https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm

United States Environmental Protection Agency. (2022). *Understanding Global Warming Potentials*. Retrieved from Greenhouse Gas Emissions: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

Zimmer, J., & Green, L. (2018, July 16). *Lyft's Approach To Bikes & Scooters: Accelerating Public + Private Mobility.* Retrieved December 27, 2021, from Medium: https://medium.com/@johnzimmer/lyfts-approach-to-bikes-scooters-90ce505ff49

7. APPENDIX

Table 7-1: Classic Bike BOM

Components	Item category	Mass (kg)	Modeled Component in OpenLCA
BRAKE LEVER COVER - RIGHT	Plastic part	0.0308	ABS
BRAKE LEVER COVER - LEFT	Plastic part	0.0308	ABS
SUB ASSY, REAR MUDGUARD, SWIFT	Sub-assembly	0.987	ABS
Bike - Handlebar Welded Assembly, ED Black	Metal part	0.794	aluminum
Bike - Basket Assembly w/ Hardware, No Solar	Sub-assembly	0.907185	ABS
Bike - Shifter Cable Housing w/ Pre-crimpled Ferrules, 1550mm	Sub-assembly	0.048	Stainless steel
Swift, Front Brake Cable, 1067 mm long	Metal part	0.079	Stainless steel
Wire Harness Front Cable, Y portion	Cable Harness or Assembly		Cable
Front brake cable with housing	Cable Harness or Assembly	0.06	Stainless steel
Black Seat Post	Metal part	0.03	aluminum
Kickstand (kit)	Sub-assembly	0.566	aluminum
CHAINCOVER - BLUE	Plastic part	0.337	ABS
Chain guard Bracket	Metal part	0.177	Iron
BOTTOM BRACKET	Metal part	0.074	aluminum
Grip Bell, Black on BRASS	Sub-assembly	0.322	ABS
Bike - Block Pedal Set,	Sub-assembly	0.058	aluminum
CHAIN SPRING CONNECTING LINK	Metal part	0.203	carbon steel
CHAIN SPRING CONNECTING LINK	Commodity part	0.311	steel

Components	Item category	Mass (kg)	Modeled Component in OpenLCA
Bike - Left Brake Lever Assembly	Sub-assembly	0.003	aluminum
Bike - Right Brake Lever Assembly	Sub-assembly	0.116	aluminum
Rear Brake Cable, 1750mm, soldered end	Sub-assembly	0.115	Stainless steel
Rear Brake Cable Housing - 1515mm, pre-crimped ferrules	Sub-assembly	0.026	Stainless steel
Bike - Stem Clamp Cover w/ Side Panels	Plastic part	0.063	ABS
Stem upper crown with fasteners	Sub-assembly	0.136	aluminum
Dynamo connector	Cable Harness or Assembly	0.433	aluminum
Fork, Classic Bike	Metal part	3.5	aluminum
Bike - Mudguard Front Spacer w/ 3PC Bushing MO	Plastic part	0	ABS
Front Mudguard	Plastic part	0.02	ABS
Bike - Saddle w/ Reflector	Sub-assembly	0.197	PVC
Triangle Neutral Spring	Metal part	0.0145	aluminum
Frame, Classic Bike	Metal part	3.17515	aluminum
BOTTOM PLATE, CLASSIC BIKE	Metal part		aluminum
Non-Drive-Side Crank Arm	Metal part	0.261	aluminum
Drive Side Crank arm	Metal part	0.449	aluminum
Headset- Z 1.5R (KIT)	Sub-assembly	0.125	Steel Cr (SUJ-2)
Front Wheel - SA XL-FDD Hub, Tire, Tube, Reflectors	Sub-assembly	2.3635	aluminum
Front Wheel - Hub, Tire, Tube, Reflectors	Rubber portion of wheel	1.3265	Rubber
REAR WHEEL WITH HUB	Sub-assembly	4.3335	aluminum

Components	Item category	Mass (kg)	Modeled Component in OpenLCA
REAR WHEEL WITH HUB	Rubber portion of wheel	1.3265	Rubber
HEAVY-DUTY SEAT TUBE CLAMP ASSEMBLY	Sub-assembly	0.0943	aluminum
ALUMINUM DOCKING TRIANGLE	Metal part	0.35	aluminum

Table 7-2: Ebike 2.0 BOM

Components	Mass (kg)	Modeled Component in OpenLCA
Front wheel assembly		
Wheel	1.88	aluminum
Tubes	0.30	rubber
Tires	1.03	rubber
Rear wheel assembly (motor)		
Motor/Wheel	3.12	motor
Wheel	1.8830	aluminum
1 tube	0.3005	rubber
1 tire	1.0260	rubber
Frame	6.20	aluminum
Fork	2.15	aluminum
Handlebar + Stem	1.38	aluminum
Battery	7.00	Battery
Battery downtube components	0.71	aluminum
Basket	1.54	PC
Body plastics	1.09	PC
Left Chain guard	0.46	PC
Right Chain Guard	0.46	PC
VCU	1.08	PCBA
Cockpit Plastics	0.28	PC
Beacon	0.12	PC

Components	Mass (kg)	Modeled Component in OpenLCA
Motor controller and tail module	0.44	motor
Cable lock assembly	0.87	Stainless Steel
Wire harness assemblies	0.39	Cable
Bottom bracket	0.4570	Steel
Chain	0.3595	carbon steel
Spider/chainring	0.4000	Steel
Crankarms	0.5120	Aluminum
Pedals	0.33	Aluminum
Wings	0.45	PC
Kickstand	0.3420	aluminum
Chain tensioner	0.0900	Steel
Brake levers	0.2750	Steel
Saddle	0.5340	aluminum
Seat post	0.7535	aluminum
Seat clamp	0.3720	aluminum
Brake cables	0.05	stainless steel
Fasteners	1.38	steel

Table 7-3: Ebike 1.0 BOM

Component	Weight (kg)	Modeled Component in OpenLCA
CABLE,MAIN_HARNESS,EBIKE 1.0	0.047	Cable
CHAIN COVER - BLACK	0.176	ABS
CHAIN GUARD BRACKET	0.075	Aluminum
SWIFT - BOTTOM BRACKET SET	0.377	Steel
SWIFT - BOTTOM BRACK	0.377	motor
Motor	3.300	Motor
SWIFT BIKE - FRAME WELDED ASSY, PAINTED	1.674	Aluminum

SWIFT BATTERY CABLE COVER	0.091	ABS
Epoxy adhesive Plastic bonder	0.074	Epoxy
SWIFT, FRONT BRAKE CABLE HOUSING	0.045	ABS
SWIFT, TORQUE SENSOR EXTENSION CABLE	0.272	Cable
BIKE - SHIFTER CABLE HOUSING W/ PRE-CRIMPLED FERRULES	0.049	ABS
REAR BRAKE CABLE	0.263	Cable
SWIFT, BATTERY MOUNT SHIM BLOCK	0.136	ABS
EVT, BATTERY MOUNT, EBIKE 1.0	0.572	Aluminum
STEM UPPER CROWN WITH FASTENERS	0.107	Aluminum
HEADSET Z 1.5R (KIT)	0.499	Aluminum
TOP CAP, M6 BOLT AND STAR NUT (KIT)	0.025	Steel
HEAVY-DUTY SEAT TUBE CLAMP ASSEMBLY	0.094	Aluminum
MOV4 SWIFT BIKE - FORK WELDED ASSY, W/ PAINT	1.064	Aluminum
BIKE - MUDGUARD FRONT SPACER W/ 3PC BUSHING MO	0.544	ABS
FRONT MUDGUARD	0.207	ABS
SWIFT, CHAIN RING WITH BRACKET	0.201	Aluminum
Swift, Crank arms	1.180	Aluminum
Fixed Kickstand	0.363	Steel
HARDWARE ONLY	0.095	Steel
TAIL LIGHT ASSY, SMART FENDER, EBIKE 1.0, V3	0.404	ABS
LINK CHAIN WITH MASTER LINK	0.326	carbon steel
HUB INTERFACE (KIT)	0.000	N/A
HUB: SILVER, ROLLER BRAKE	2.541	Aluminum
REAR ROLLER BRAKE KIT	1.270	Aluminum
REAR ROLLER BRAKE	0.953	Aluminum
ROLLER BRAKE GREASE	0.126	N/A
REFLECTOR WHEEL WHITE	0.290	PC
HUB INTERFACE	2.904	Aluminum
SMARTGUARD	0.499	N/A

RIM TAPE	0.390	N/A
TUBES SUNLT THORN RES	0.597	Rubber
RIM - SHINING 26", 36H, SILVER W/ EYELET	0.544	Aluminum
ROLLER BRAKE GREASE, 100G	0.126	N/A
REFLECTOR WHEEL WHITE	0.290	PC
RIM TAPE	0.390	N/A
SMARTGUARD	0.499	N/A
TUBES	0.597	Rubber
PILLAR SPOKE , SILVER	0.082	Aluminum
RIM - SILVER W/ EYELET	0.544	Aluminum
REAR BRAKE CABLE HOUSING - PRE-CRIMPED FERRULES	0.100	Cable
Bike - Block Pedal Set	0.449	Aluminum
PEDAL RIGHT	0.204	Aluminum
PEDAL LEFT	0.204	Aluminum
BIKE FRAME BOTTOM PLATE	0.095	Steel
RAW PLATE	0.145	Steel
BIKE - HANDLEBAR WELDED ASSEMBLY	0.785	Aluminum
GRIP BELL, BLACK ON BRASS	0.056	Rubber
BIKE - LEFT BRAKE LEVER ASSEMBLY	0.119	Aluminum
BIKE - RIGHT BRAKE LEVER ASSEMBLY	0.119	Aluminum
DISC BRAKE	0.000	
GRIP REV5	0.064	Rubber
STEM UPPER CROWN WITH FASTENERS (ONLY TOPCAP AND 4 SCREWS)	0.107	Steel
SEAT / SEATPOST SUBASSEMBLY	0.082	Aluminum
BLACK SEAT POST	0.581	Aluminum
BIKE - SADDLE W/ REFLECTOR	0.667	PC
CORRUGATED WIRE LOOM	0.054	Steel
BIKE - BASKET RACK	0.644	Aluminum
FRONT LIGHT ASSY, EBIKE 1.0	0.045	PC
BIKE - BASKET SOLAR PLASTIC	0.558	ABS
CAT EYE ROUND WHITE REFLECTOR/ REFLECTOR FRONT WHITE	0.100	PC
BLACK FIBERTEX BUNGEE CORD	0.047	Fabric

Table 7-4: Base Use Case vs Sensitivity Cases (miles; listed in yrs. in paper)

	Stress Case	Base Case	Most Optimistic Case
Ebike 2.0	6,200 miles	12,666 miles	22,500 Miles
Ebike 1.0	6,200 miles	12,666 miles	22,500 Miles
Classic	Chicago Operations	San Francisco Operations	New York Operations

8. APPENDIX: Critical Review Statement

Review of the LCA Report (Dated May 19th, 2022) "Lyft, Inc. Transit, Bikes & Scooters Life Cycle Assessment Report in Conformance with ISO 14044 and ISO 14040 Lyft Classic, Ebike 1.0, and Ebike 2.0 Bicycles,"

Conducted by Lyft, Inc.

Review Statement Prepared by the lead Critical Reviewer:

Julie Sinistore, PhD

Senior Project Director

Sustainability, Energy and Climate Change

WSP USA, Inc.

May 19th, 2022

The critical reviewer has completed the review of the report named above. The review has found that:

- The approaches used to carry out the LCA are consistent with the ISO 14040 (2006a) and ISO 14044 (2006b) principles;
- the methods used to carry out the LCA appear to be scientifically and technically valid;
- the interpretations of the results are defensible; and
- the report is transparent concerning the study steps.

The review was not conducted according to ISO 14044:2006a section 6.3 because the study does not make comparative assertions intended to be disclosed to the public. The review was conducted in four stages. WSP first reviewed and approved the goal and scope document. Upon completion of the study, WSP submitted written comments and recommendations to Lyft, which were addressed in a revised document and written responses to questions and comments through three rounds of review by WSP. Once the study was finalized, WSP performed a final review. This critical review should in no way be construed as an endorsement of the products or the results of this study.

WSP concluded that the study includes all of the mandatory elements required by the noted ISO Standards.

This review statement only applies to the report named above, dated May 19th, 2022, and not to any other versions, derivative reports, excerpts, press releases, or similar publications.

Julie Sinistore

Julie Sinistore, PhD
Senior Project Director
WSP USA, Inc.