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Bird Rides, Inc.

Date

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LIFE CYCLE ASSESSMENT OF TRANSPORTATION USING BIRD'S ELECTRIC SCOOTERS – EXECUTIVE SUMMARY

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LCA Commissioner	**Bird Rides, Inc.**
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EXECUTIVE SUMMARY

Bird Rides, Inc (Bird) is a micromobility company whose mission is to bring low-cost, environmentally friendly transportation solutions to cities. Using the Bird app, anyone can access Bird's fleet of shared micromobility vehicles (i.e., electric scooters and bicycles). Bird's scooters and bicycles have been growing in popularity as a method of transportation within towns and cities and to connect to mass transit. Bird's scooters and bicycles move passengers from point A to point B over relatively short distances. Micromobility transportation vehicles have the potential environmental benefits of improving the air quality in the cities in which they operate and reducing carbon dioxide emissions that contribute to global climate change from improving the ridership of mass transit and reducing the use of internal combustion vehicles.

Bird intends to provide its electric scooters to cities in Europe, which requires a Life Cycle Assessment (LCA) to understand the life cycle impacts of Bird's micromobility service using electric scooters for transportation in the context of the European market. Ramboll has documented Bird's LCA methodology and outcomes in this LCA report.

LCA Goal and Scope

The goal and scope of this LCA study include:

(a) Evaluate the cradle-to-grave carbon footprint of transportation using Bird's fleet of electric scooters in Europe.
(b) Assess the contribution of various life cycle stages to the overall carbon footprint of transportation using Bird's fleet of electric scooters.
(c) Identify areas in which the carbon footprint of transportation using Bird's fleet of electric scooters can be improved.

This LCA study was prepared in accordance with the International Standards Organization (ISO) standards *ISO 14040 – Life cycle Assessment – Principles and framework* (International Standards Organization (ISO), 2006), *ISO 14044 – Life cycle assessment – Requirements and guidelines* (International Standards Organization (ISO), 2006) (ISO series 14040 and 14044), and *ISO 14067 – Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification* (International Standards Organization (ISO), 2018) (ISO 14067), and *ISO/TS 14071 – Life Cycle Assessment – Critical Review processes and reviewer competencies: Additional requirements and guidelines to ISO 14044:2006* (International standards organization (ISO), 2006) (ISO/TS 14071).

The scope of this LCA study included the following:

- **Functional Unit**: transportation using Bird's fleet of electric scooters, represented by the reference flow of one passenger-kilometer traveled.
- **System Boundary**: Cradle-to-grave; the life cycle stages included in the system boundary are manufacturing and assembly of the electric scooters, additional manufacturing of electric scooter components for replacement, transportation of the electric scooters to the customer markets, charging and fleet management vehicles for scooter use, and the disposal of the electric scooters at end-of-life.

- **Impact category assessed:**[i] Intergovernmental Panel on Climate Change (IPCC) Global warming potential (GWP) 100a, which is reported in units of metric tons of carbon dioxide (CO_2) equivalents (CO_2e) and is referred to as life cycle greenhouse gas (GHG) emissions throughout this LCA report. LCA results are relative expressions and do not predict actual impacts or actual damages, the exceeding of thresholds, safety margins, or risks.
- **Data Quality:** Where available, primary data from Bird for European use cases was used for the LCA. Estimated data for electricity and fuel efficiency are based on known scooter use locations and the fuel types of fleet management vehicle from the European Environmental Agency (EEA). All other secondary life cycle data was extracted from the Argonne National Labs GREET 1 and 2 models. Scooter manufacturing, assembly, and disposal data was not available for specific Bird models, so proxy data was used. In addition, the lifespan of the scooter models and the fuel type and travel distance of fleet management vehicles are based on Bird's operation in the United States' market and not in Europe.
- **Key Assumptions:** The GHG emissions of Bird's transportation using its fleet of electric scooters were evaluated for two service cases using one of two scooter models, Bird Three (Case 1) and Bird S (Okai ES400) (Case 2). These two models are the most used by Bird customers, and a single model will be deployed according to the evaluation criteria described by the potential customer.

  The life cycle stages of Bird's LCA include manufacturing and assembly of the electric scooters in Hong Kong, additional manufacturing of scooter components for replacement, transportation of the electric scooters to the end market in Europe, charging and fleet management vehicles for scooter use, and the disposal of the electric scooters at end-of-life.

  The baseline of electricity grid mix is the average grid mix of eight European countries in which Bird plans to deploy Bird's scooters. The baseline lifetime spans are 1,095 days (3 years) for Case 1 and 730 days (2 years) for Case 2, which determines the lifetime travel kilometers (km) of 4,295 km (Case 1) and 3,055 km (Case 2). The baseline of fleet management vehicles is conservatively 100% gasoline fuel, even though fleet managers already operate some electric vehicles and Bird is transitioning further toward electrification.

LCA Results

The results of life cycle GHG emissions are as follows:

- **Case 1: Bird's micromobility service using Bird Three scooters for transportation** – the life cycle GHG emissions are estimated to be 57 grams (g) CO_2e per passenger-km (91 g CO_2e per passenger-mile). The largest contribution is from the manufacturing stage at 81%. The contribution of scooter use including charging and fleet management

[i] There are limitations with using one impact category, per ISO 14067 "decisions about product impacts that are only based on a single environmental issue can be in conflict with goals and objectives related to other environmental issues".

vehicles is 6%. The other phases including assembly, replacement, transportation, and disposal range between 2% and 4%.

- **Case 2: Bird's micromobility service using Bird S (Okai ES400) for transportation**- the life cycle GHG emissions are estimated to be 120 grams (g) CO_2e per passenger-km (192 g CO_2e per passenger-mile). The largest contribution is from the manufacturing stage at 77%. The replacement of scooter components contributes 12% of the life cycle GHG emissions. The contribution of scooter use is 4%. The other phases including assembly, transportation, and disposal range between 1% and 3%.

The manufacturing and replacement of Bird vehicles (i.e., additional manufacturing of scooter components for replacement) result in a significant impact on the life cycle GHG emissions of Bird electric scooters. This result is mainly caused by the use of aluminum materials that have a very low recycled content.

LCA Sensitivity Analysis

To test the robustness of the LCA assumptions and results, the sensitivity of GHG emissions impact was simulated per the following three parameters associated with operational variables in cities:

- **Scooter lifespan** – Refurbishment is Bird's main approach to extend the life cycle of scooters currently on the road, through programs that Bird is committed to in the UK and Italy. Refurbishment is estimated to extend the life of the scooters to five years. The LCA looked at three lifespans as follows-
  - Minimum: 2 yrs for Case 1 and 1 yr for Case 2,
  - Baseline: 3 yrs for Case 1 and 2 yrs for Case 2, and
  - Maximum: 5 yrs for Case 1 and Case 2,
- **Fleet management vehicles by fuel type** – The collection of scooters is associated with the direct impact of fuel combustion emissions on cities where Bird operates its micromobility service. Bird is investigating the benefits of electrifying its fleet management vehicles. The sensitivity analysis tested three scenarios of fleet management vehicles by their fuel types consumed as follows:
  - Minimum: 100% electric vehicles,
  - Baseline: 100% gasoline fueled vehicles, and
  - Maximum: 100% diesel fueled vehicles
- **Electricity grid mix** – The impacts of the use of Bird's scooters depends on the location of the Grid mix where they are charged and Bird is investigating how it can help support electrification in cities. The impact of grid mix was simulated with a country's having minimum or maximum GHG emissions per kWh among eight European countries, in which Bird plans to deploy Bird's scooters. The LCA looked at three grid mix scenarios as follows:
  - Minimum: Sweden,
  - Baseline: the average grid mix of eight European countries in which Bird plans to deploy Bird's scooters, and
  - Maximum: Germany

The sensitivity analysis results of the life cycle GHG emissions impact for two Bird's service cases are provided in **Table 1** and illustrated in **Figure 1** and **Figure 2**.

Table 1 Sensitivity Analysis of Life Cycle GHG Emissions Impact (g CO_2e per passenger-km)[ii] of Two Bird's Service Cases

Bird Service Cases	Baseline	Scenarios	Lifespan	Grid mix	Fleet management
Case 1 - Bird Three	57	Min	83	55	54
		Max	37	58	58
Case 2 – Bird S (Okai ES400)	120	Min	234	118	116
		Max	57	121	122

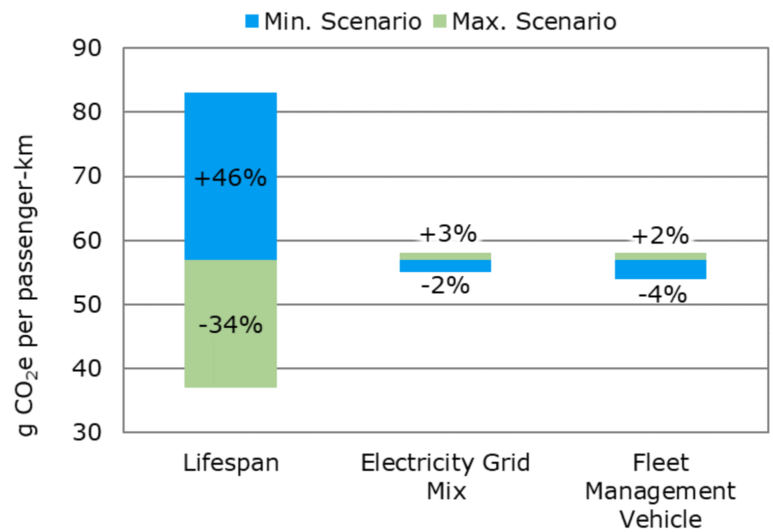

Figure 1 Sensitivity Analysis of the Life Cycle GHG Emissions Impact of Bird's Service Case 1

[ii] Emissions associated with scooter collection, material use, and mechanical processes for refurbishment were not included into the sensitivity analysis, which is a limitation of the study and should be improved as Bird increases its refurbishment program and collect more data.

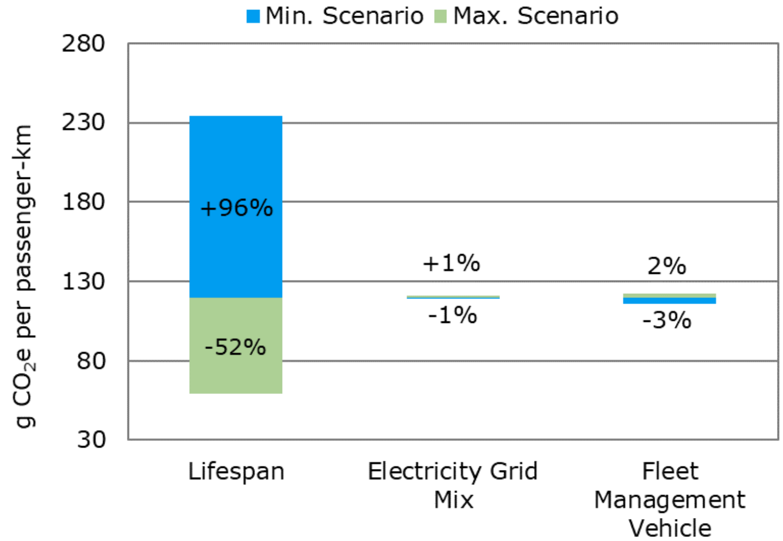

Figure 2 Sensitivity Analysis of the Life Cycle GHG Emissions Impact of Bird's Service Case 2

Scooter lifespan - Compared to the baseline impact of Case 1 (57 g CO_2e per passenger-km), lifespan extension of up to five years from refurbishment can reduce emissions up to 37 g CO_2e per passenger-km (by 34%). Compared to the baseline impact of Case 2 (120 g CO_2e per passenger-km), lifespan extension of up to five years from refurbishment can reduce emissions up to 57 g CO_2e per passenger-km or by up to 52%. However, the impacts of Case 1 and Case 2 increases to 83 (by 46%) and 234 (by 96%) g CO_2e per passenger-km for the minimum lifespans respectively.

Fleet management vehicles by fuel type - Using electric vehicles only for the fleet management reduces by 3 gCO_2e per passenger-km for Case 1 and 4 g CO_2e per passenger-km for Case 2 from the baseline impacts simulated from gasoline-fueled vehicles only. Using diesel fueled vehicles only increases by 1 g CO_2e per passenger-km for Case 1 and 2 g CO_2e per for Case 2.

Electricity grid mix - The Sweden grid mix reduces the baseline impacts of the two cases by 2 g CO_2e per passenger-km. The Germany grid mix increases by 1 g CO_2e per passenger-km for both cases.

In summary, the life cycle GHG emissions of scooters are highly sensitive to the lifespan as compared to the grid mix and the charging vehicle type.

LCA Findings and Recommendations

From the LCA findings, the following recommendations are made regarding improving the life cycle GHG emissions of Bird's micromobility service using Bird's electric scooters for transportation:

- Reducing the GHG impact of the manufacturing phase. The GHG emissions of manufacturing phase are from the energy use of material production. The major component contributing to the GHG emissions of scooter manufacturing is its frame made of cast aluminum, which is produced from 100% virgin material. In addition, China's grid mix, which relies on mainly coal-fired power, is used for the manufacturing phase. Accordingly, efforts to increase the recycle content of cast aluminum and use renewable electricity in manufacturing would reduce the life cycle GHG emissions of Bird scooters.

- Extend the electric scooter lifespan (lifetime kilometers traveled). Efforts to extend the lifespan and/or lifetime kilometers traveled of electric scooters can reduce the GHG impacts associated with the manufacturing phase, which as discussed above, contributing significantly to the life cycle GHG emissions of scooters. As discussed in sensitivity analysis, the lifespan of the electric scooters had a significant effect on the life cycle GHG emissions of Bird's micromobility service using Bird's electric scooters for transportation. Additionally, Bird may want to consider researching and developing sturdier design and materials that are directly associated with manufacturing phase as this could lessen the GHG emissions associated with manufacturing and therefore improving the life cycle GHG emissions of Bird's micromobility service using Bird's electric scooters for transportation.
- Future work. Investigating case studies about diverse maintenance strategies and estimating their efficiency on increasing the lifespan travel kilometers of electric scooters can be the future work of micromobility service providers using electric scooters.