

# City of Vancouver

## Life Cycle Analysis: Electric and ICE Vehicles

**Balpreet Kukreja**  
Fleet Engineer

11/27/2019



# Why Life Cycle Analysis (LCA)?

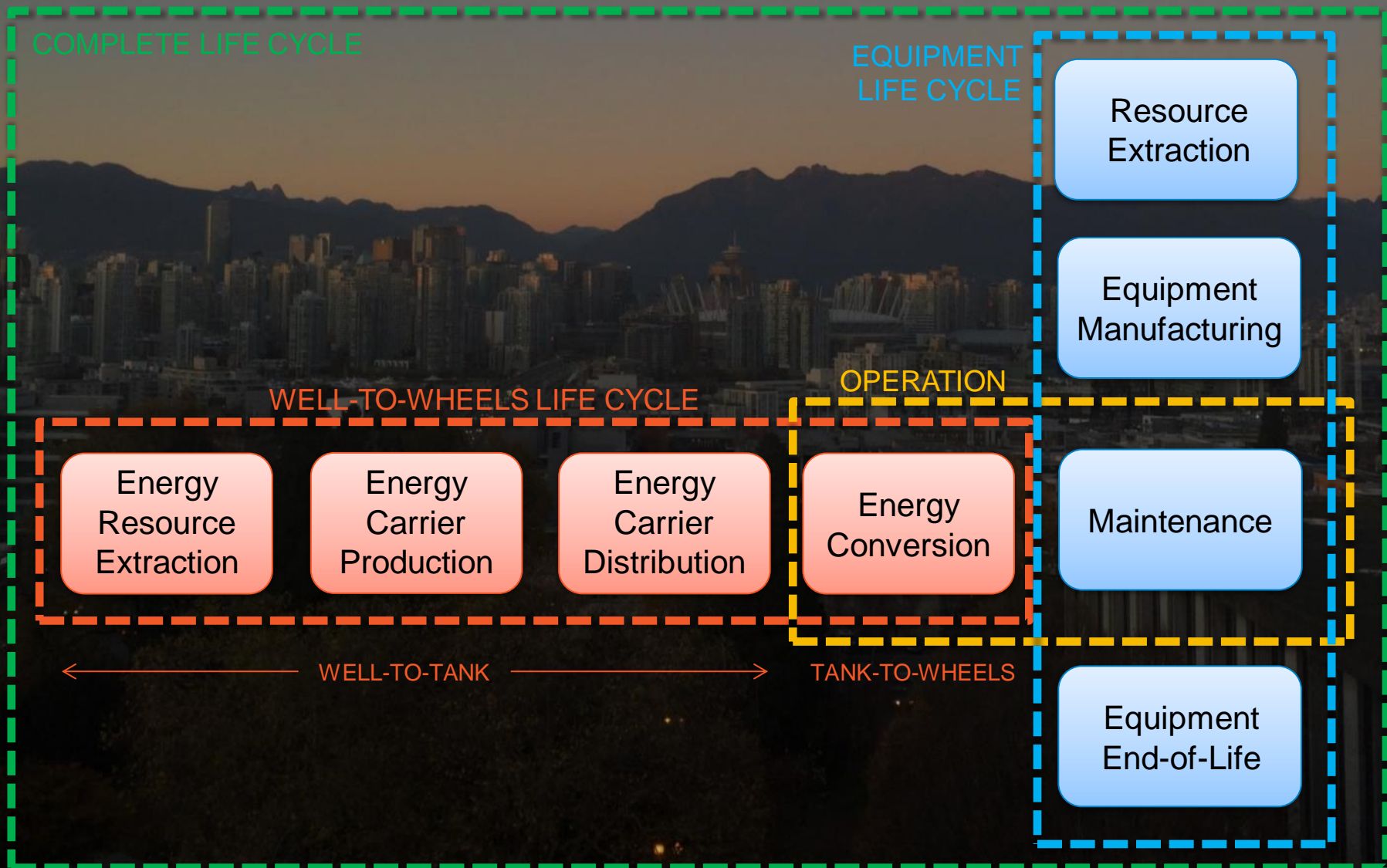
- Learn about the environmental impacts associated with all stages of a product's life
- Electric Vehicles
  - Resource Extraction
  - Manufacturing
  - Transportation
  - Operation
  - End-of-Life
- Inflows and outflows at every step

# Why Life Cycle Analysis (LCA)?





# Why Life Cycle Analysis (LCA)?

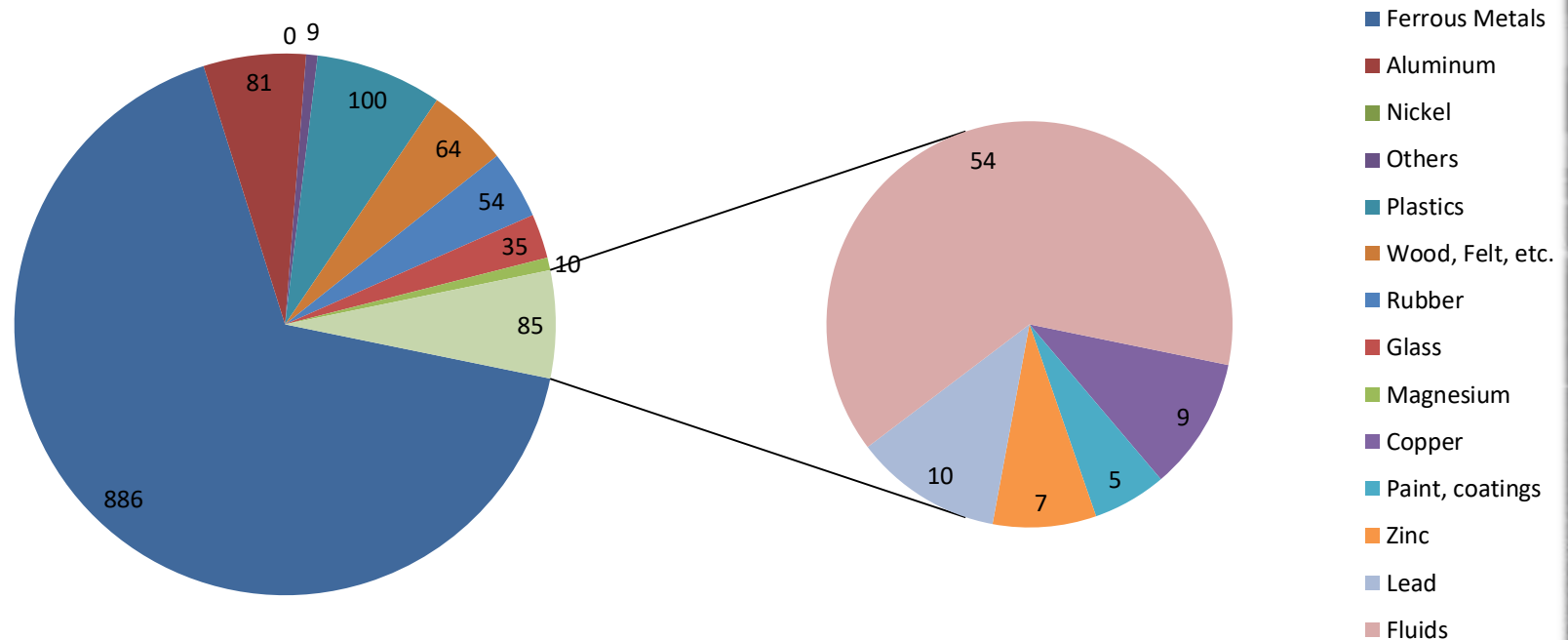


# Vehicles Analyzed

- (13) Ford Focus – 2006 or later
- (27) Mitsubishi i-MiEV – 2012 or later
- Vehicle life: 150,000km
  - Sensitivity analysis performed for 100,000km and 250,000km
- Functional unit: 1km travelled by vehicle
  - Energy consumption: MJ/km
  - Emissions: gCO<sub>2</sub>-eq/km

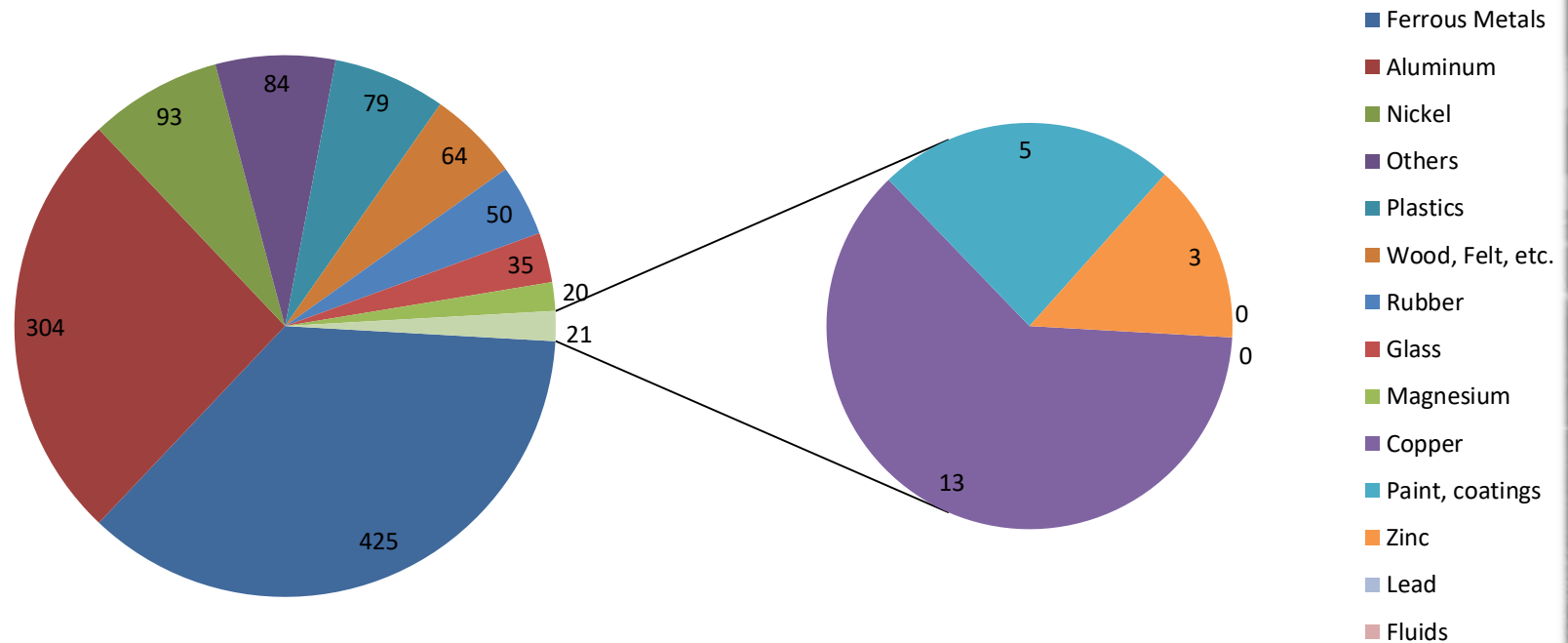
# Resource Extraction – Material Breakdown

ICEV mass distribution by material (kilograms)



# Resource Extraction – Material Breakdown

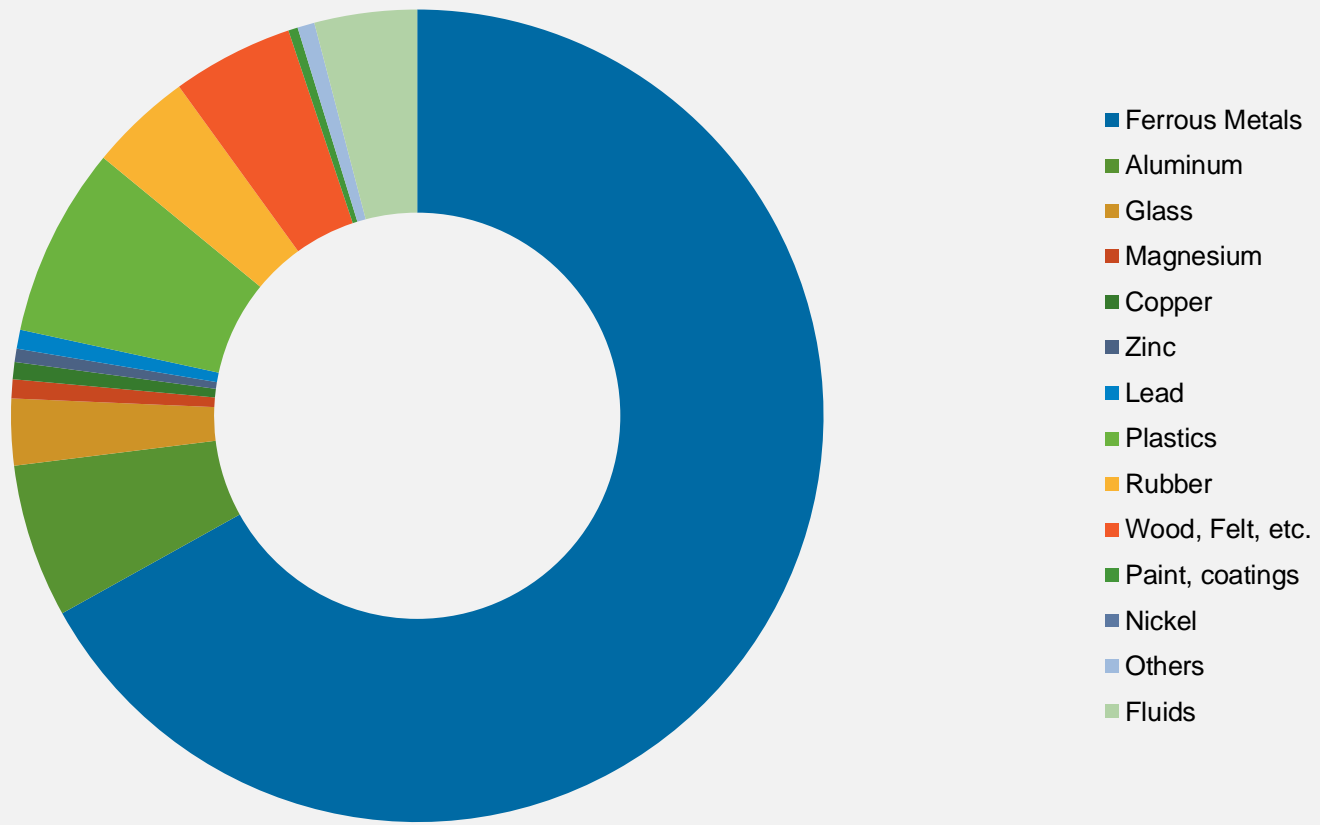
EV mass distribution by material (kilograms)





# Resource Extraction – Material Breakdown

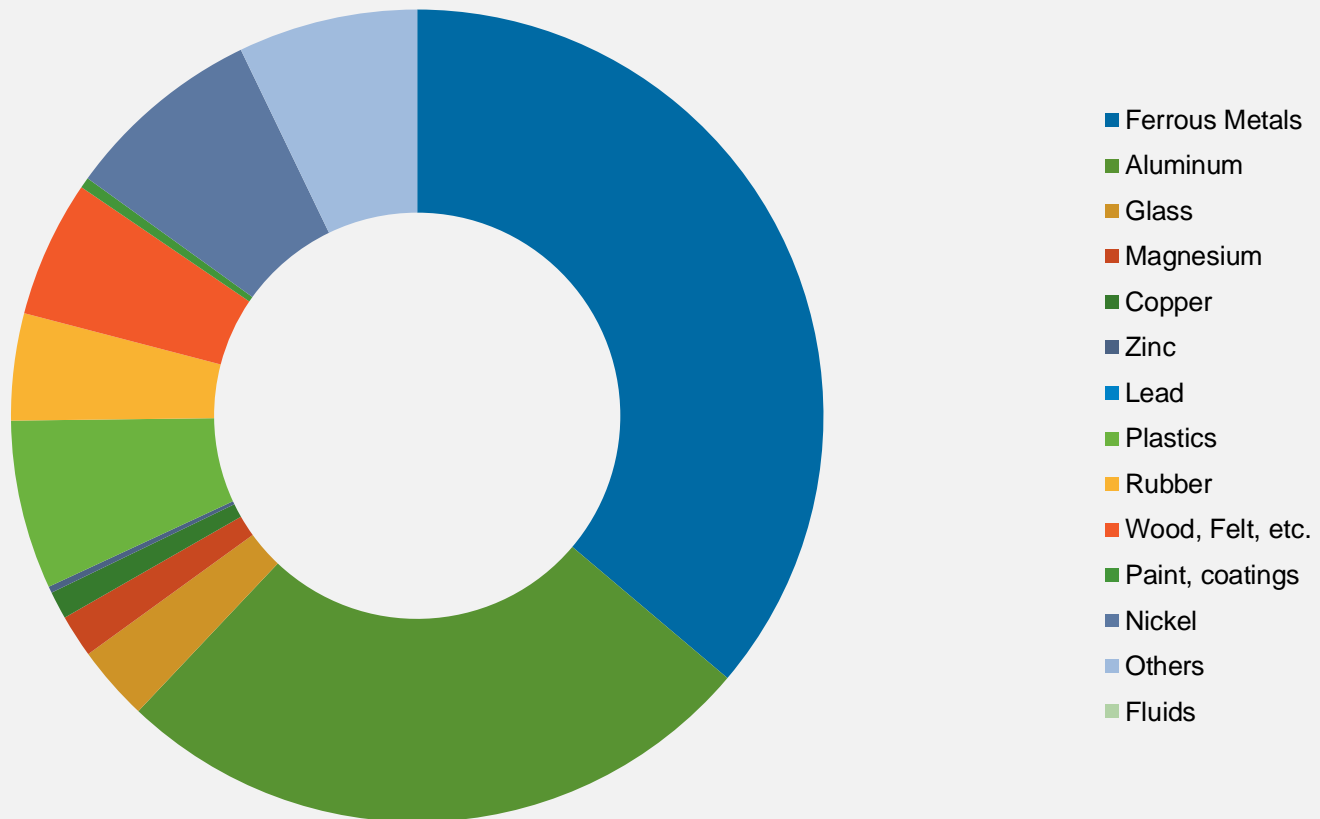
Mid-size ICEV (1997)



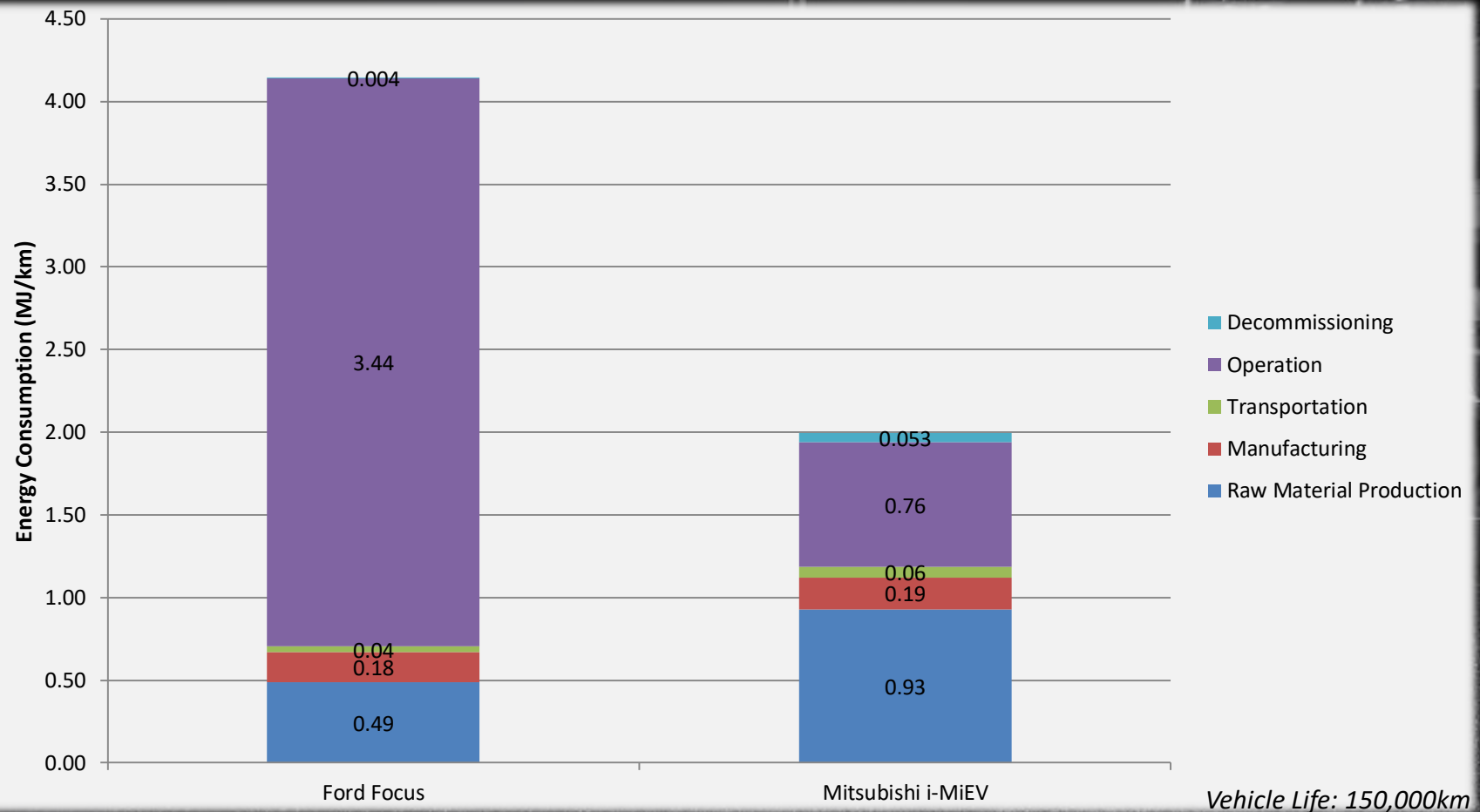


# Resource Extraction – Material Breakdown

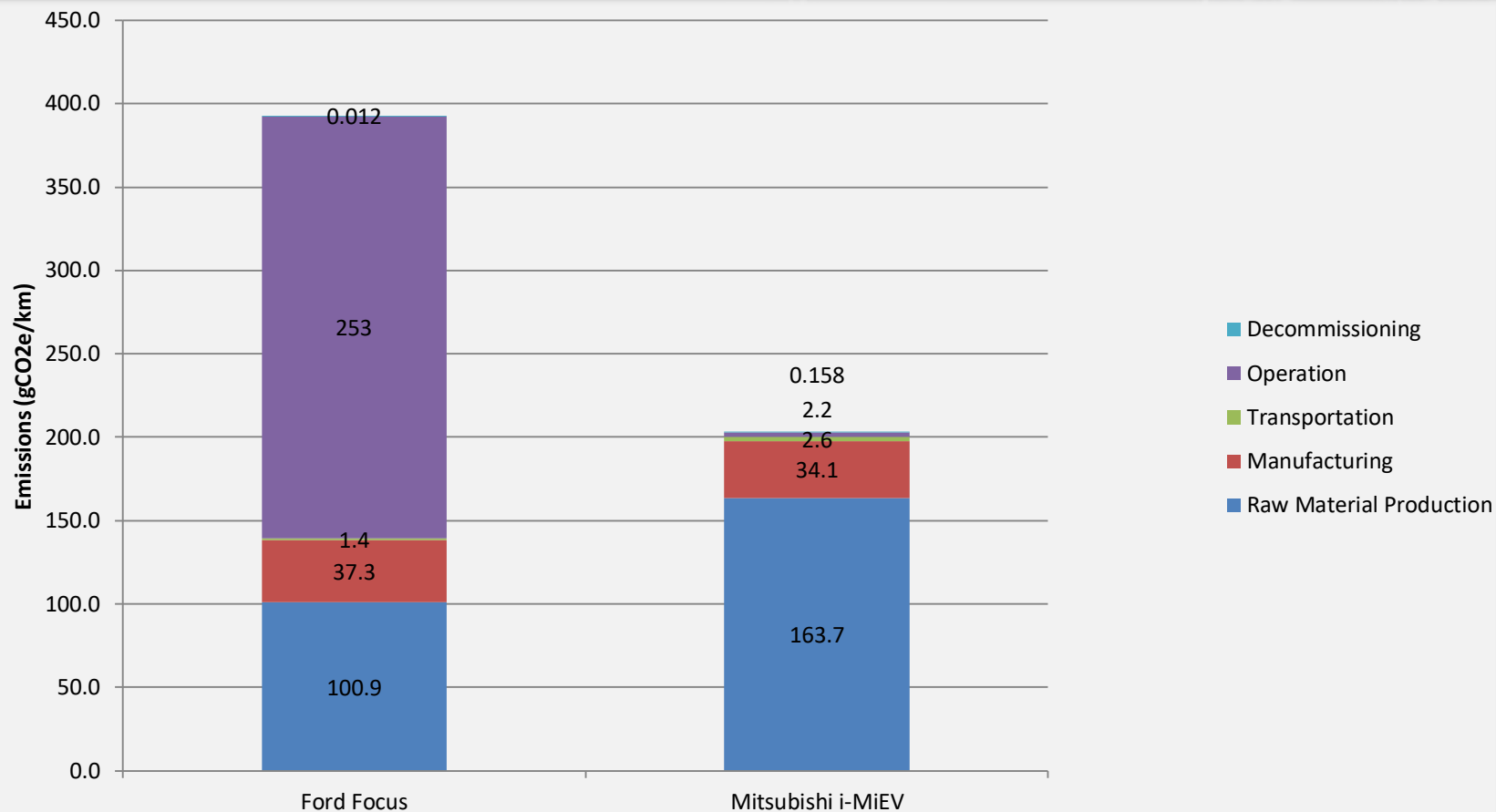
Mid-size EV (2020, predicted)



# Energy Intensity – MJ/km



# Emissions – gCO<sub>2</sub>e/km



Vehicle Life: 150,000km

# End-of-Life Possibilities

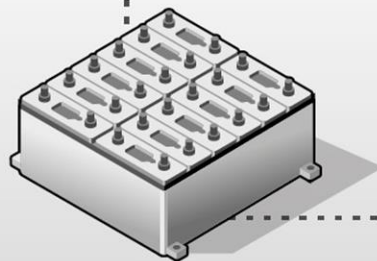
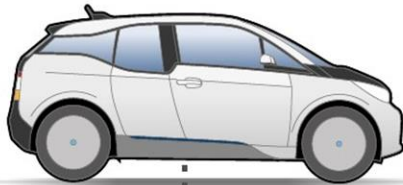




# End-of-Life Possibilities

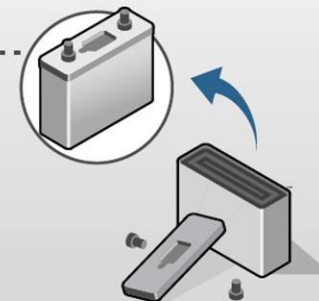
## 1 Recycle

At the end of its lifecycle in an electric car, the battery is still valuable.



## 3 Reuse

The battery modules are integrated in the stationary storage system.

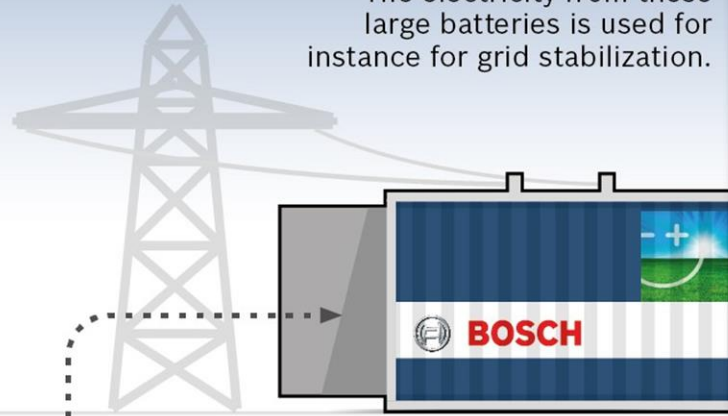


## 2 Refabricate

The used battery modules are tested and reassembled.

## 4 Resell

The electricity from these large batteries is used for instance for grid stabilization.



# QUESTIONS?

**Balpreet Kukreja**

Fleet Engineer

[balpreet.kukreja@vancouver.ca](mailto:balpreet.kukreja@vancouver.ca)

City of Vancouver



# Appendix – Data Sources

- Material Production
  - On The Road In 2020 – New Automobile Technologies – MIT Energy Lab
  - Malcolm Weiss et al. (October 2000)
- Manufacturing
  - Linear function of material mass by material type
- Transportation
  - Ford Focus
    - Transported by rail and truck from Wayne, MI
  - Mitsubishi i-MiEV
    - Transported by sea from Kurashiki, Japan
- Operation
  - Ford Focus
    - City of Vancouver operational data
  - Mitsubishi i-MiEV
    - ChargePoint dashboard
- Decommissioning
  - All parts shredded for both vehicles except lithium-ion battery in ICEV