PACCAR Capstone Fair
Wednesday May 31st, 2023

Ciara Gormley, Travis Mason, Rudolph Toepfer, Ashley Woodworth, Sally Yoon

PACCARpe Diem:

Vehicle System Life-Cycle Analysis

PACCAR CAPSTONE PROJECT

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INDUSTRIAL & SYSTEMS ENGINEERING

Problem Definition

Problem Statement, Project Goals, and Introduction to LCA

Problem Statement

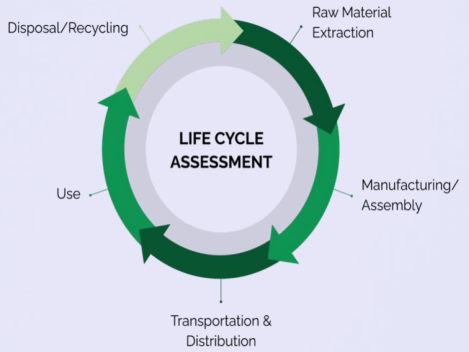
*PACCAR seeks a more comprehensive understanding of the environmental impacts via **a proof-of-concept Life Cycle Analysis (LCA) tool to gain insight of opportunities to improve sustainability of their products.***

Project Goals

- **Estimate environmental impacts** of a heavy-duty truck using a **streamlined LCA**
- Relay the **significance and use-case of LCA to PACCAR** to aid PACCAR sustainability initiatives

What is LCA?

- **Analyzes environmental impacts** associated with a specific life stage or part of a product
- Scientifically recognized and standardized
- The process of assessment from "**inception to expiration**": raw material extraction, processes of production, lifetime use, end of life, and disposal



Design Approach

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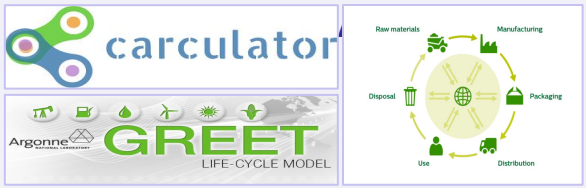
Project Steps:

Step 1: Research and Meet Stakeholders

Step 2: Identify Alternatives

- **Carculator-Truck**
- **GREET** (Greenhouse gases, Regulated Emissions, & Energy use in Transportation)



Step 3: Assumptions & Risks

Model Assumptions:

- Model based on **estimated data**
- Model will be **built upon**
- PACCAR is interested in LCA

Risks:

- **Inaccurate** data or analysis
- Model becomes obsolete

Step 4: Design and Build

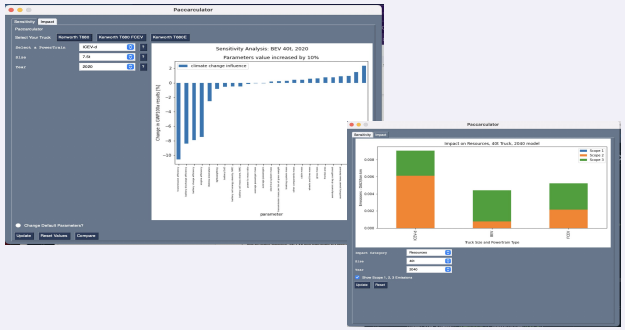
PACCARculator Interface:

- Single python file running the Carculator-Truck and PySimpleGUI packages to generate **modifiable data visualizations**

GREET-Based Materials Analysis:

- Excel-based software developed to **calculate fuel cycle & vehicle cycle emissions**

Step 5: Test and Iterate



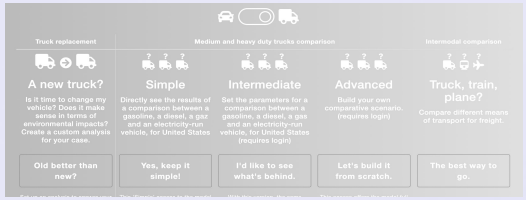
Project Results

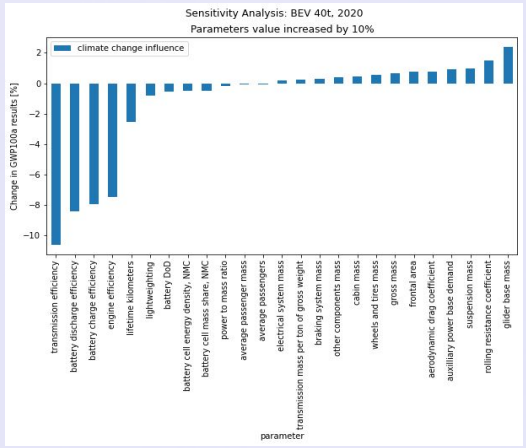
PACCARculator LCA Analysis and Demo

Demo Here: **https://drive.google.com/drive/folders/1G-nyEFT1a0g05zUTQL2-4-fSRbuCWR2u?usp=sharing**

The PACCARculator Interface:

- **Single python file** running the Carculator-Truck and PySimpleGUI packages to generate modifiable data
  - **Carculator-Truck –** open source LCA software
  - Creates a **user interface** allowing users to **modify and visualize Carculator-Truck inventories**
  - Compatible with any python IDE



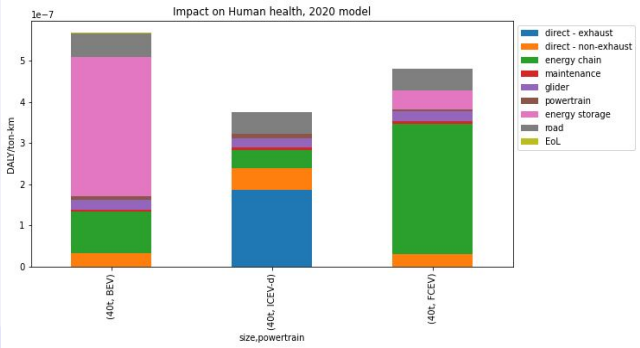


Sensitivity Analysis:

- PACCARculator generates a **climate change sensitivity analysis**
- Based on generalized truck data

Impact Analysis:

- Generated across categories of **environmental endpoints and midpoints.** Compares three powertrain types.
- Can also just show scope 1, 2, & 3 emissions

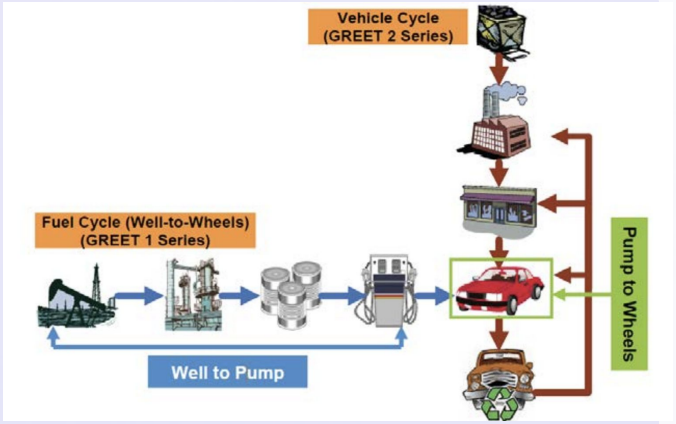


Project Results

GREET Materials Analysis

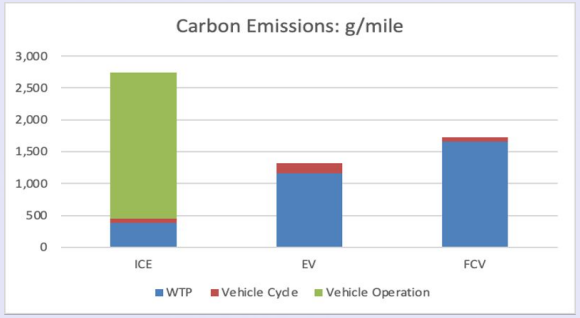
GREET-Based Materials Analysis:

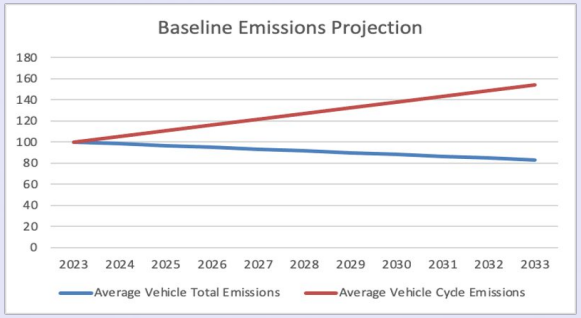
- Excel-based software developed to **calculate fuel cycle & vehicle cycle emissions**
- **Models manufacturing processes** with a limited amount of precision in streamlined LCAs
- **Materials analysis** can inform sourcing and composition



Visualizations and Analysis:

- Analysis based on Kenworth T680 with ICE, FCV & EV fuel cells
- Emissions defined by **vehicle cycle, vehicle operation, and well to pump** (WTP)
- Linear interpolation shows **PACCAR vehicle cycle emissions projected to increase as total lifetime emissions are reduced**





Conclusion

Project Impacts, Team Recommendations, Acknowledgements

Project Impacts

- **Starting point for PACCAR to implement LCA** as a common practice in United States based subsidiaries
- Recommendation Report: **benefits of LCA** & use-case for PACCAR

Project Demonstrations

- PACCAR has **multiple viable options for pursuing LCA implementation** and other environmental initiatives
- A streamlined LCA analysis interface is **very feasible to develop and can aid in sustainability-based decision making**

Recommendations:

1. **Build upon the PACCARculator and GREET**
2. Utilize LCA to **inform customers and stakeholders** about PACCAR's sustainability measures
3. **Pursue sustainability** in design, sourcing, manufacturing, & distribution

Acknowledgements: Thank you to Andrew Wells and Professor Patty Buchanan!

Thank You!

Any Questions?