International Council on Systems Engineering
A better world through a systems approach

Holistic Approach to Sustainability

A Comparative Life Cycle Assessment of Battery-Electric versus Biodiesel Transit Buses in Hawaii

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Today We Will...

Describe what Life Cycle Assessment is

Test-drive it in a real-world challenge

Highlight synergies with SE

Hawaii

Defining the challenge

50%

2005 GHG emissions levels by 2030

100%

Renewable Energy by 2045

Net Negative

GHG Emissions by 2045

Hawaii

Defining the challenge

~100 Electric Buses in Oahu by 2028 [1]

Diesel Replacement Program [2]

Maui Biodiesel Pilot Program

[1] Hawaii DoT, 2025, [2] Hawaii State Energy Office, 2025

Question to Answer

What is the best technology route for transit buses to support the 2030 50% GHG reduction goal?

Reference Architectures

Class 8a Bus
40 ft long
40 passengers

Diesel ICE

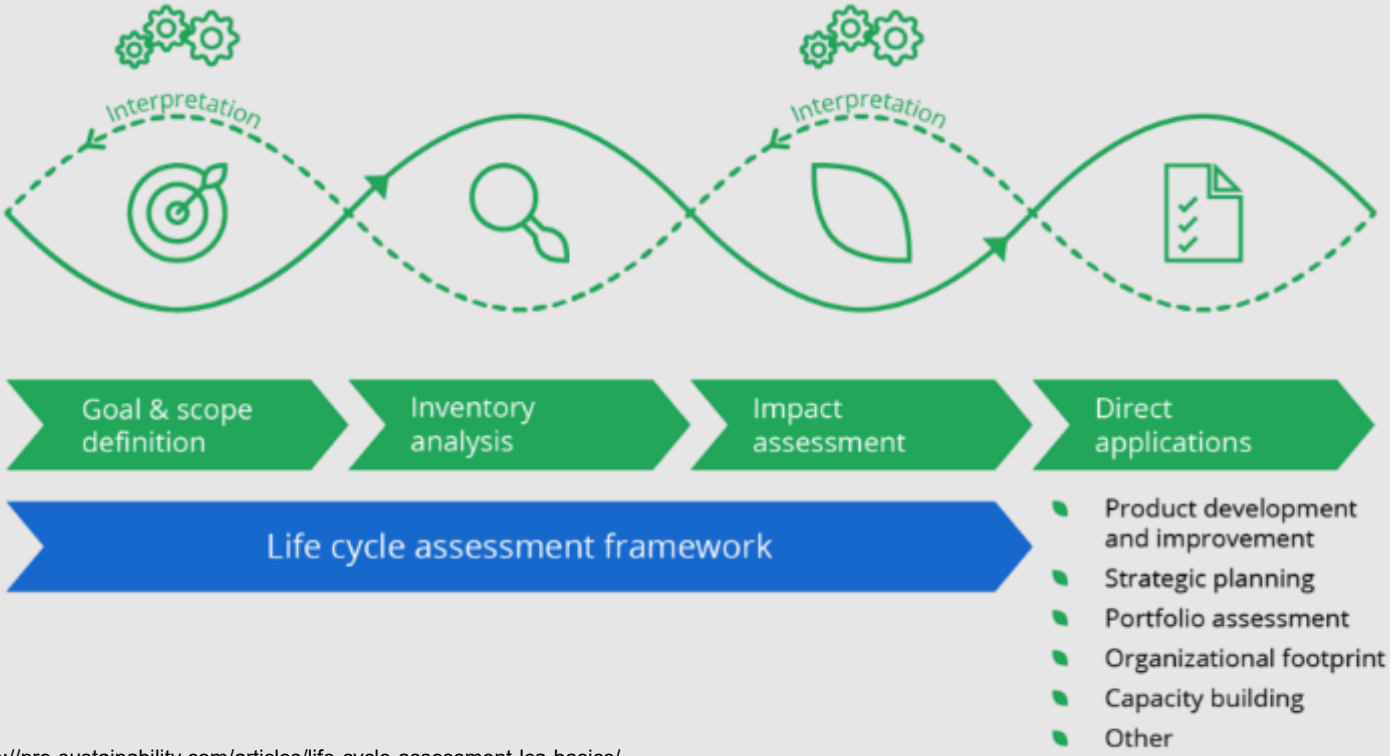
https://tcatbus.com/tcat-board-diesel-buses

Battery electric

https://www.gillig.com/2020/06/30/gillig-applauds-fta-low-no-emission-grant-awards/

Life Cycle Assessment

Life Cycle Assessment – ISO 14040

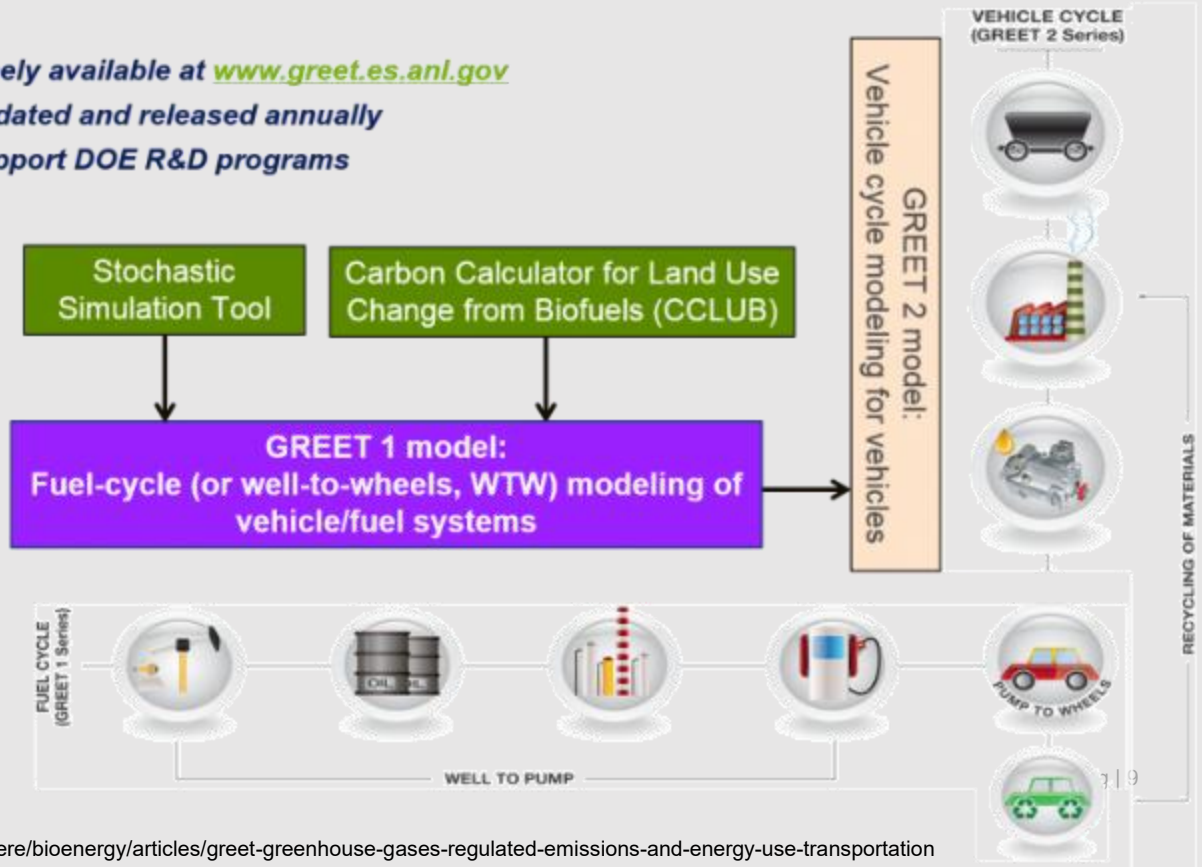


https://pre-sustainability.com/articles/life-cycle-assessment-lca-basics/

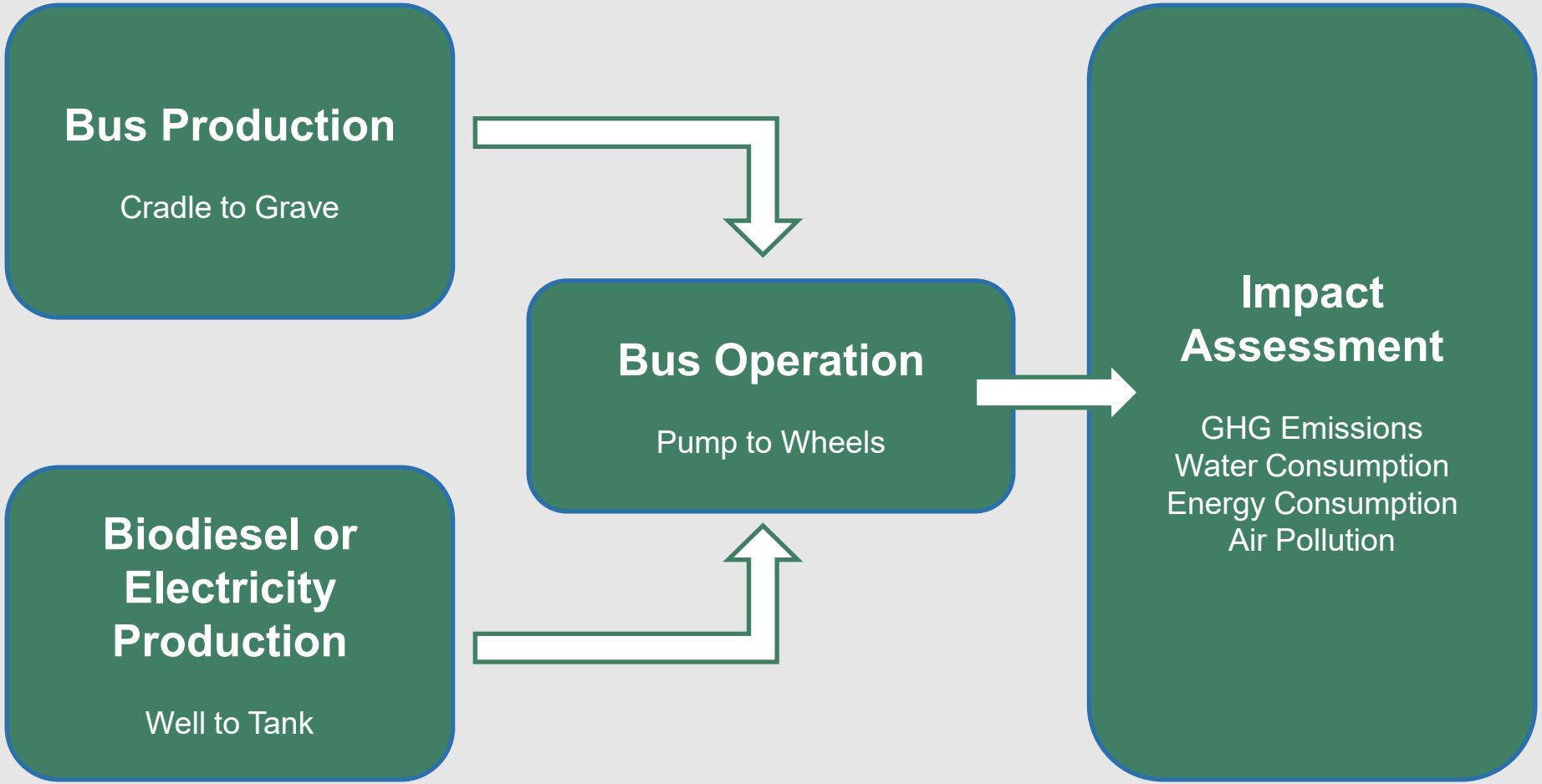
LCA Modelling

The GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model

- ✓ *Freely available at www.greet.es.anl.gov*
- ✓ *Updated and released annually*
- ✓ *Support DOE R&D programs*



https://www.energy.gov/eere/bioenergy/articles/greet-greenhouse-gases-regulated-emissions-and-energy-use-transportation



Adapted from Szczurowski et al., 2022

Key Assumptions

Vehicle-Mile

Functional Unit

67% Oil

2022 Hawaii Grid Mix

B100

100% Biodiesel Fuel

Local Biodiesel

Pacific Biodiesel Process

Li-Ion Battery Replacement

One replacement in 500,000 miles

Results

Biodiesel Buses Have Less Impact Overall

48%
Less Energy Consumption

89%
Less Water Consumption

41%
Less GHG Emissions

Largest Impacts from Electric Buses

Li-Ion Batteries Life Cycle

Hawaii Electricity Grid Mix

Could Biodiesel be a transition fuel for Hawaii?

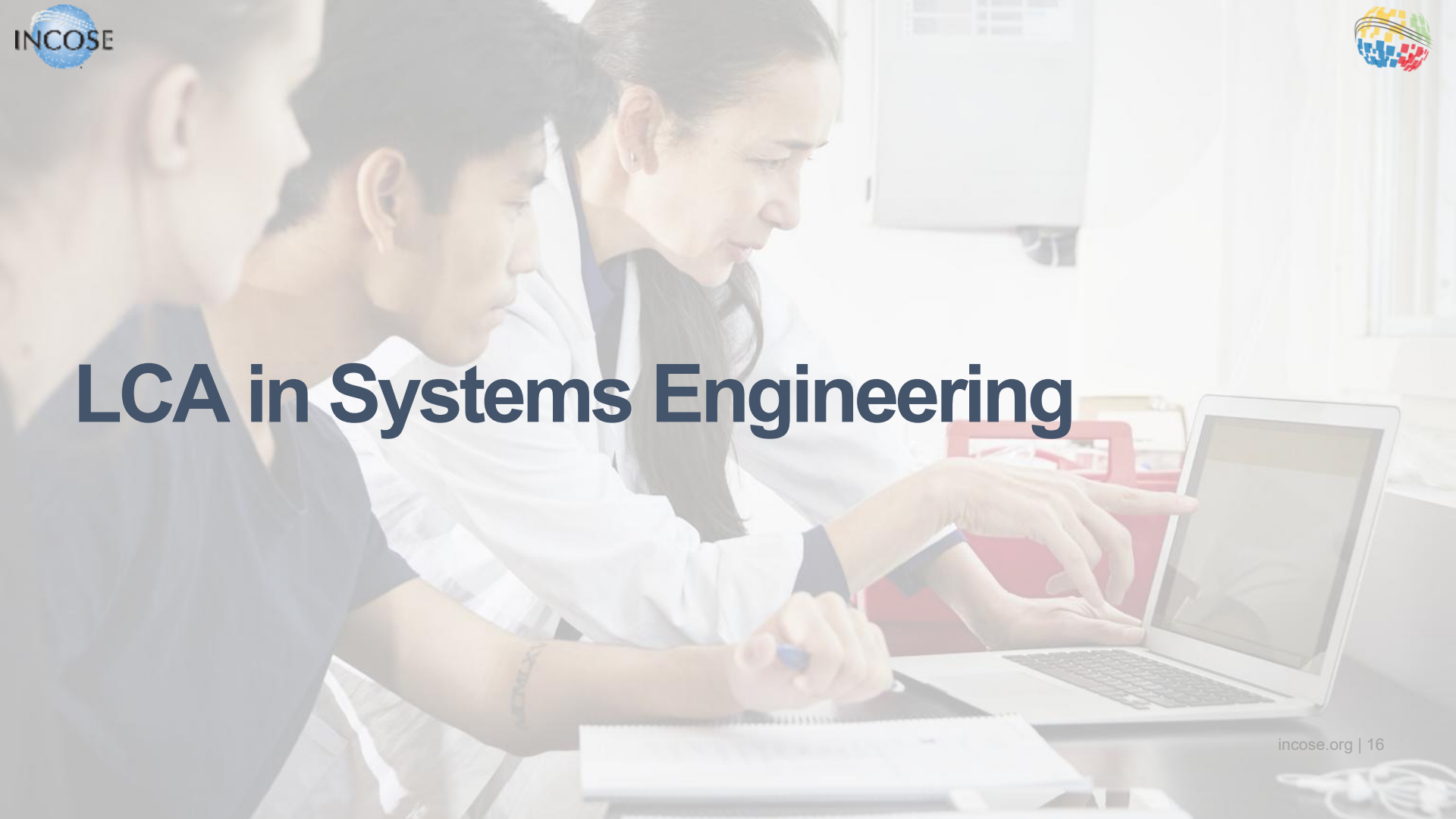
Key Limitation is Model Data Accuracy

Generic Database

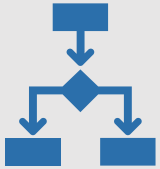
No Charging Infrastructure

Class 8 Truck Components

LCA in Systems Engineering



LCA as Decision Making Tool



Concept Screening

Trade-Off Criteria

Regulatory Compliance

Thank you!

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