Freight Day V

Life Cycle Emissions and Life Time Costs of a Medium-duty Diesel and a Battery Electric Truck. A Case Study for Toronto

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Overview

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- Objective
- Method
- Results
- Conclusions

Introduction

Medium-duty Truck (MDT)

Gross Vehicle Weight Rating : 6,351 – 11,793 kg

- Powered by **diesel fuel**
- 28 L/100km → 23 L/100km
- 19% increase in energy use in Canada
- 49% increase in sales in Canada

Introduction

Battery-Electric Vehicle

Advantages

- Zero emissions
- low maintenance costs
- low fuel cost
- Quiet

Disadvantages

- Higher manufacturing emissions
- High purchase cost
- Limited range

Objective

- Determine **fuel consumption** for medium-duty diesel truck and Battery-electric truck
- **Life cycle GHG** emissions
- **Total cost of ownership** (purchase cost, operating cost, and maintenance cost over the vehicle lifetime)

Method – Energy consumption modeling

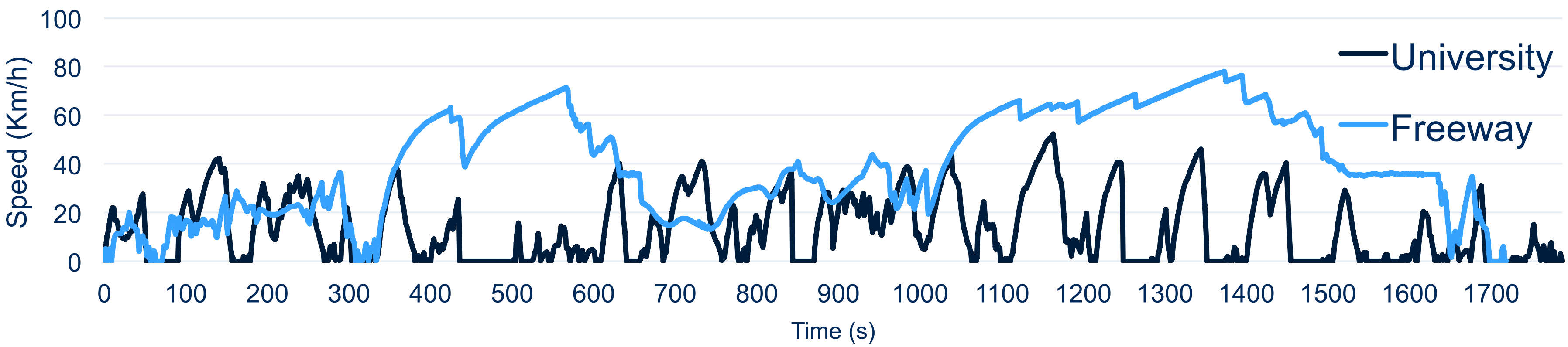
Simulation Tool: *Autonomie*

1. Truck fuel type and cargo weight

Diesel Truck:	Battery-electric Truck
Curb weight: 3774 kg	Curb weight: 4432 kg
Maximum Payload: 7875 kg	Maximum Payload: 7558 kg

Energy Consumption Modeling – cont’

2. Drive cycle: Toronto MDT University (city condition) and Freeway (freeway condition)



3. Operating temperatures (-20°C ,-10°C, -5°C, 0°C, 10°C , 20°C, 30°C,40°C)

Method – Life Cycle Assessment (LCA)

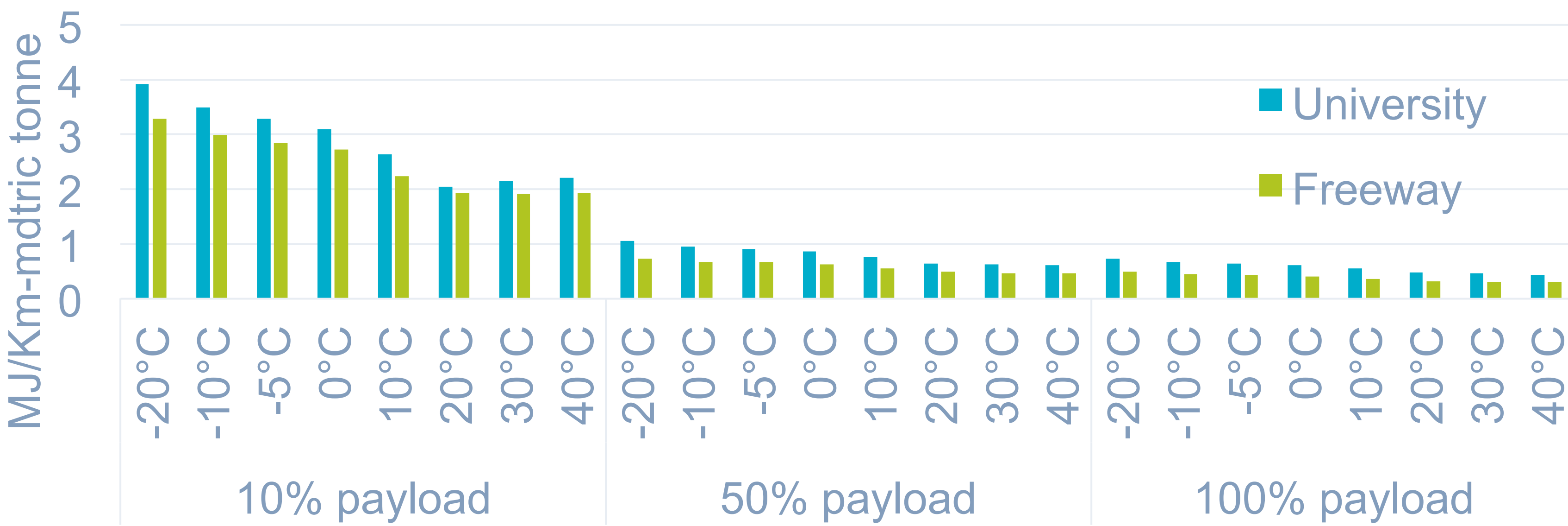
- Well-To-Wheel Greenhouse Gas emissions ($g\ CO_2e/km$ metric-tonne) from:

1. Fuel cycle:
   - Fuel (diesel/electricity) production
2. Vehicle operation cycle:
   - Emissions from using the vehicle
3. Vehicle cycle
   - Emission from vehicle manufacturing

Results – Energy Consumption Simulations : Diesel Truck

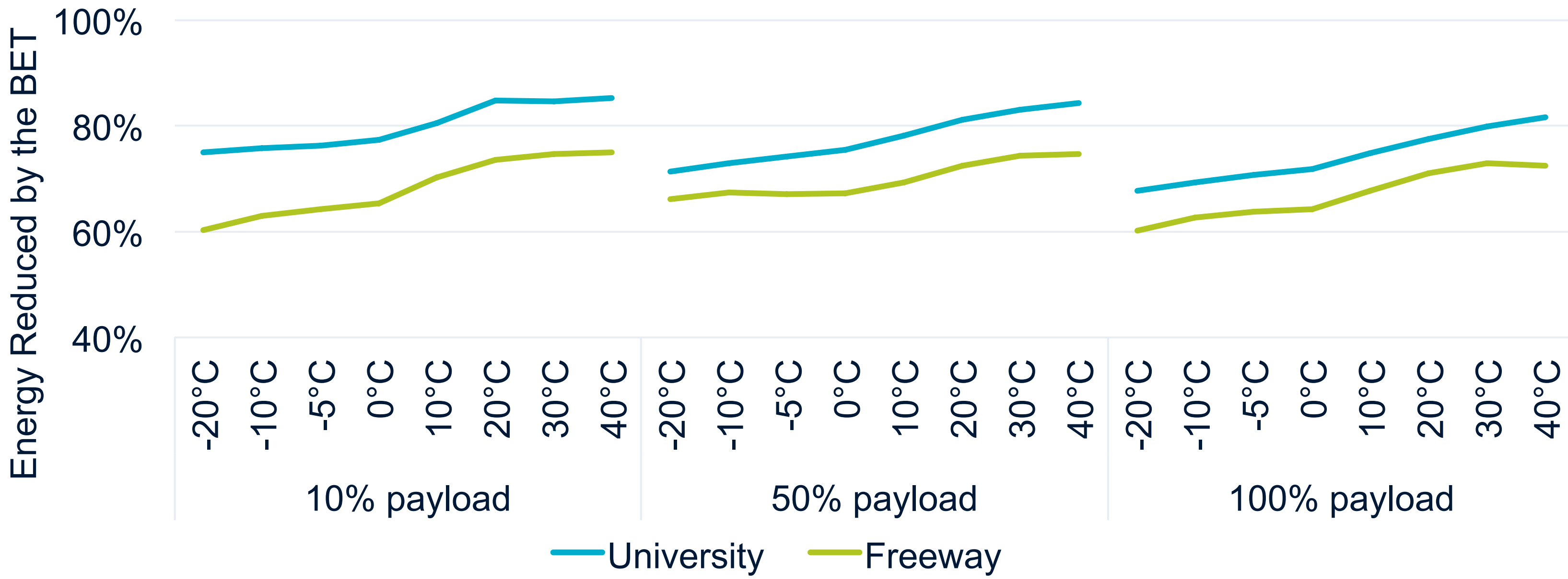
Maximum energy increase: Diesel Truck	Cold weather	Warm weather
University	21%	17%
Freeway	12%	8%

Results – Energy Consumption Simulations : Battery-electric Truck



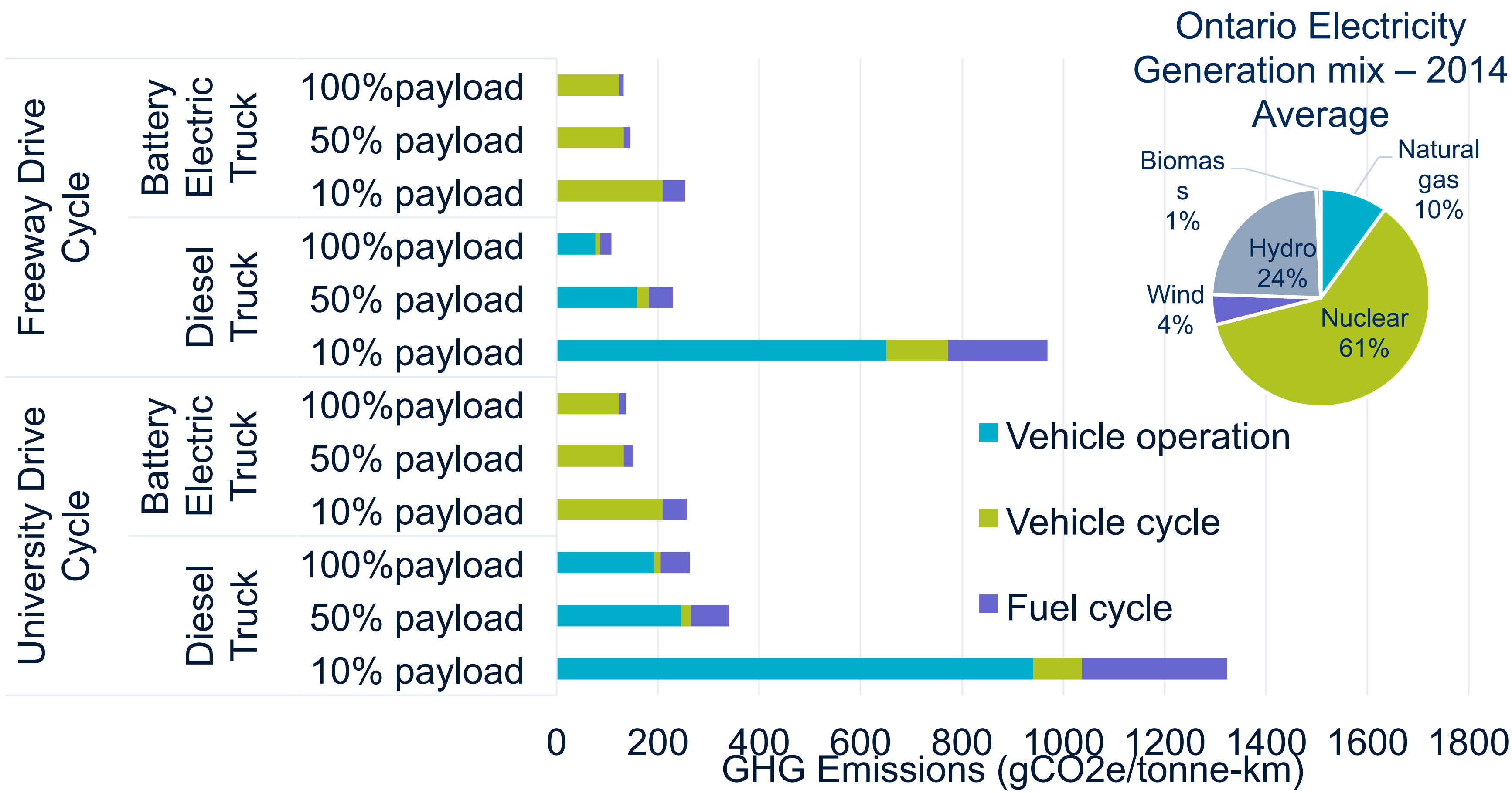
Maximum energy increase: Battery-electric Truck	Cold weather	Warm weather
University	91%	8%
Freeway	63%	0%

Results – Energy Consumption: comparison



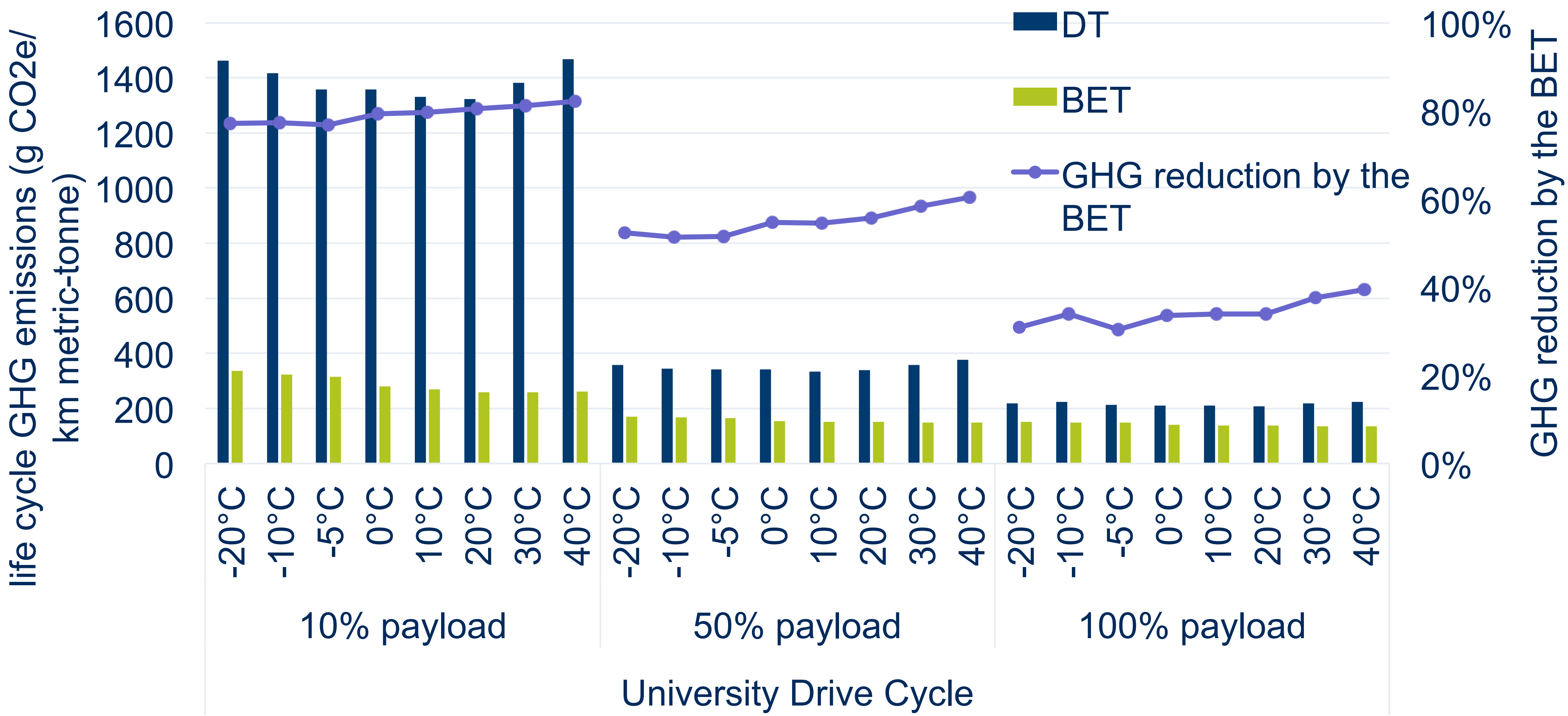
- More energy is reduced by the BET in the University drive cycle, especially in warm weather

Results - Life cycle GHG emissions



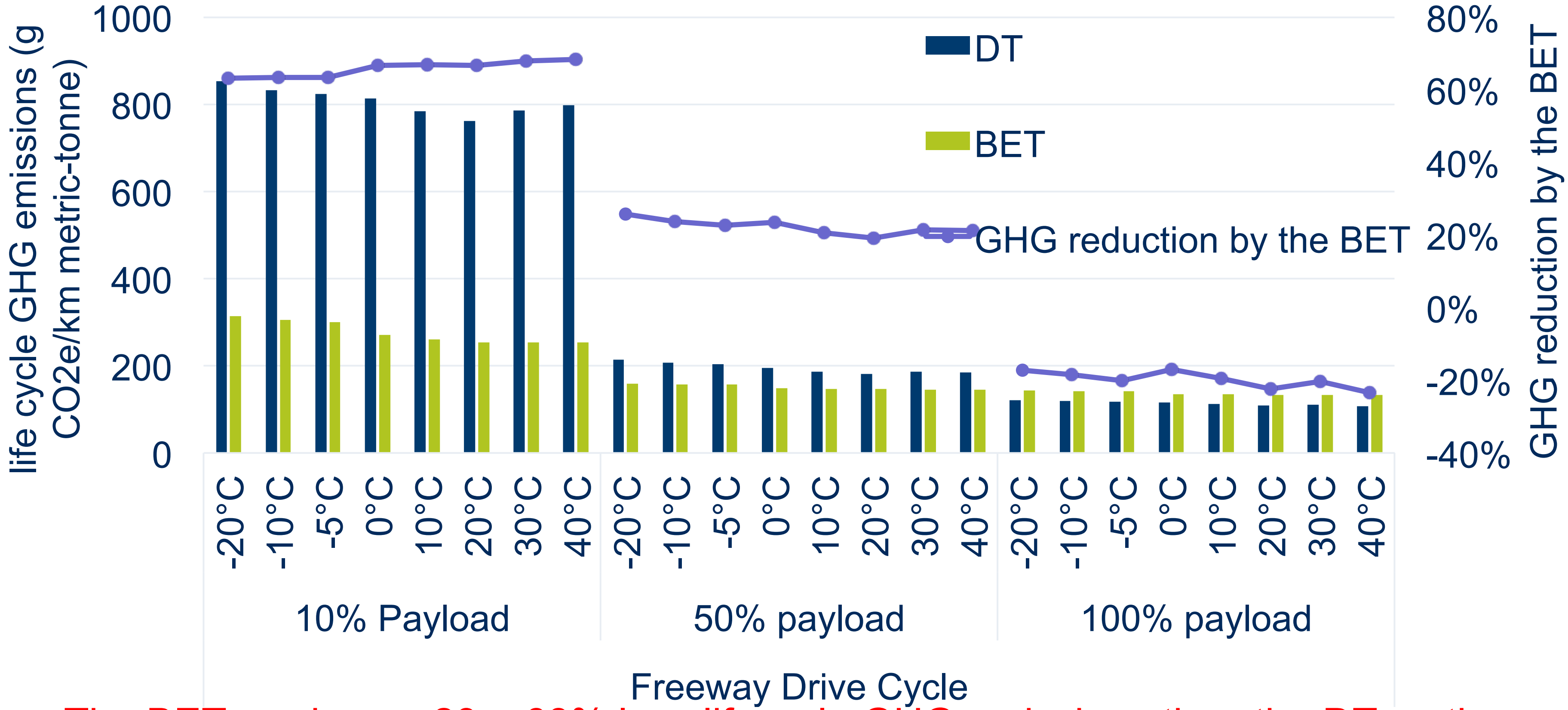
- The majority of life cycle GHG emissions for the DT comes from the vehicle operation cycle; while that for the BET is from the vehicle cycle

Results – Life cycle GHG emissions



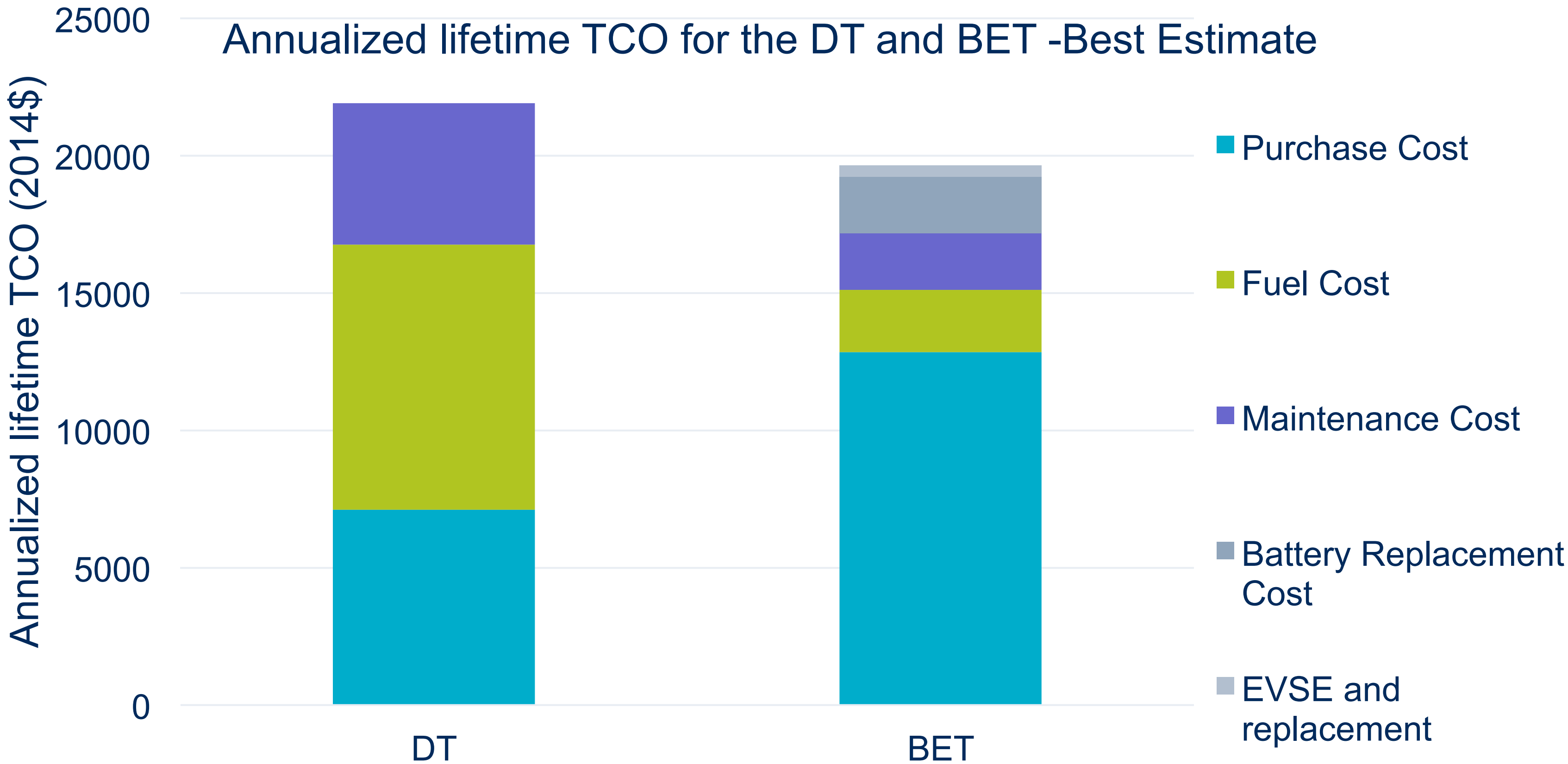
- The BET produces 31 – 82% less lifecycle GHG emissions than the DT on University Drive cycle

Results – Life cycle GHG emissions



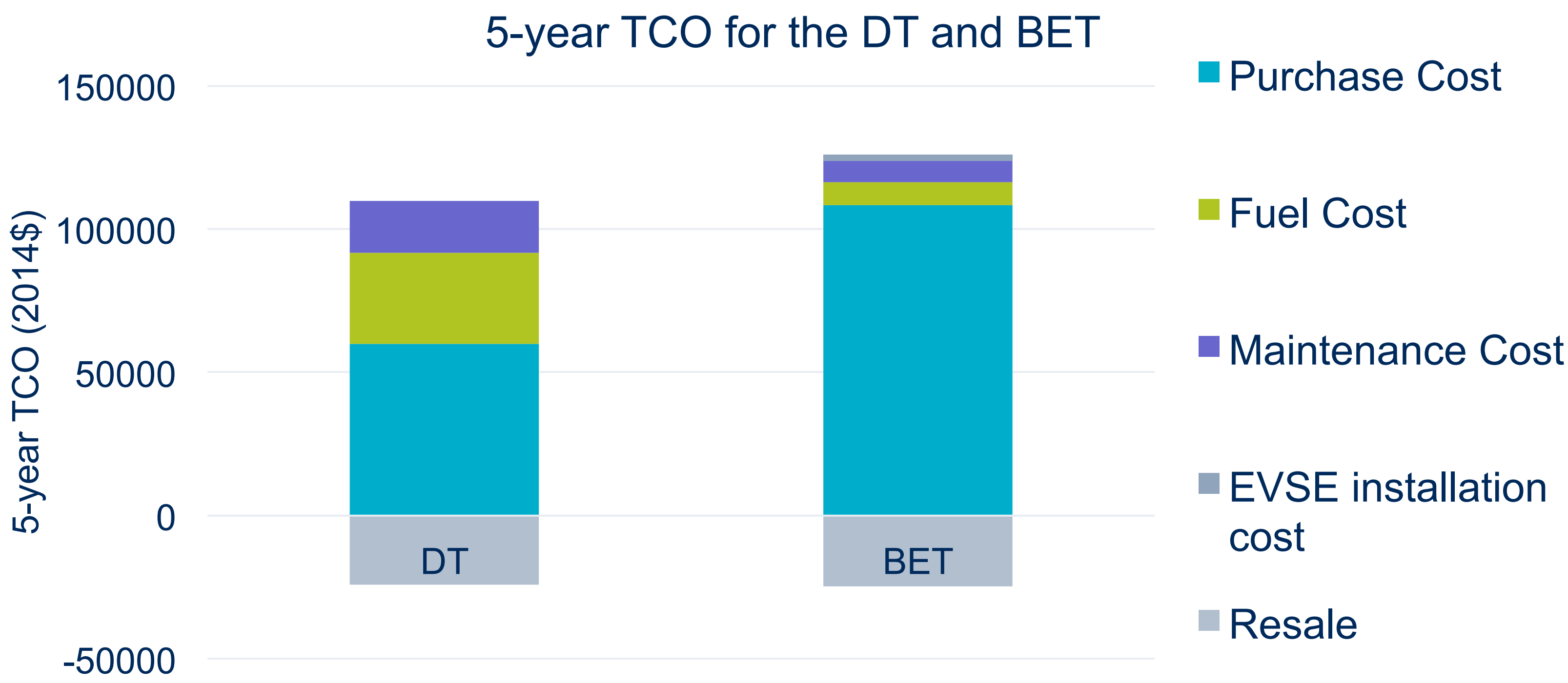
- The BET produces -23 – 68% less lifecycle GHG emissions than the DT on the Freeway Drive cycle
- The GHG emission advantages of the BET decreases as cargo weight increases.

Results - Lifetime Total Cost of Ownership



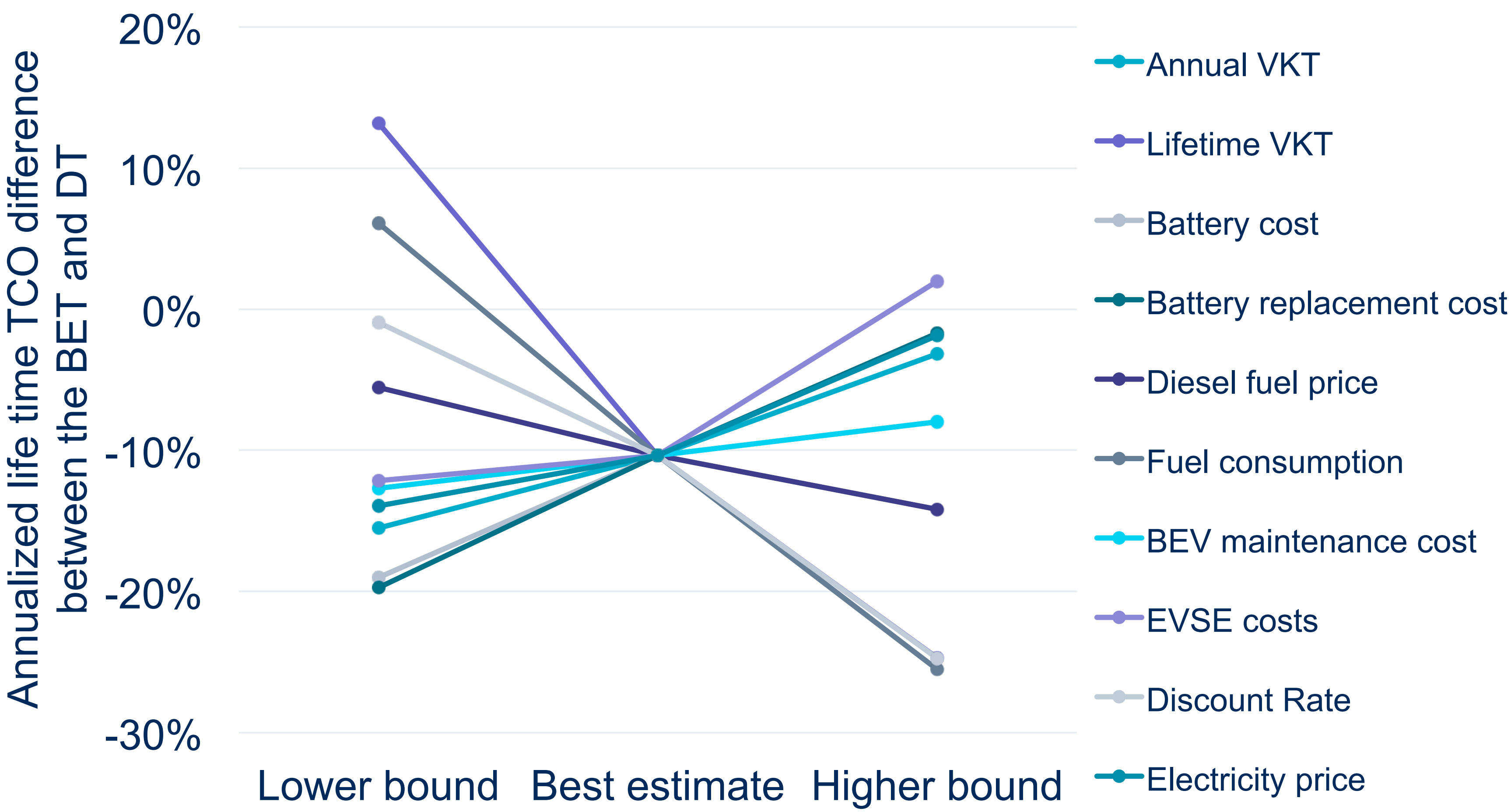
- The BET has 10% lower lifetime total cost of ownership than the DT

Results - Lifetime Total Cost of Ownership



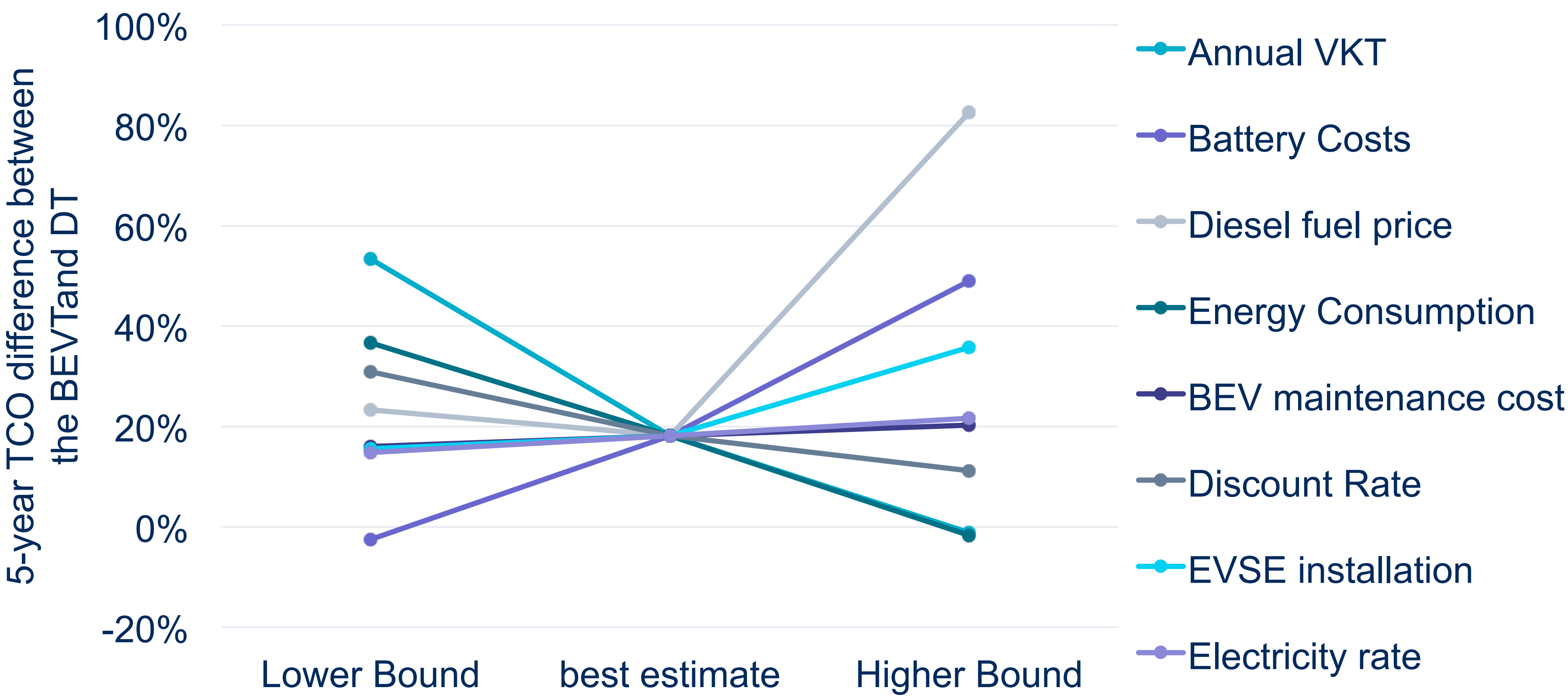
- The BET has 18% higher 5-year total cost of ownership than the DT

Sensitivity Analysis – Lifetime cost of ownership



- The cost difference between the BET and the DT is most sensitive to lifetime vehicle kilometers travelled, fuel consumption rate, and discount rate.

Sensitivity Analysis – 5-year cost of ownership



- The 5-year cost difference between the BET and the DT is most sensitive to annual vehicle kilometers travelled, battery costs and diesel fuel price.

Conclusions

- The BET has GHG emissions advantages over the DT, especially in the University drive cycle and in warm weather
- The BET has lower life time costs of ownership in most scenarios, even without any government incentives; but it has higher 5-year costs of ownership
- The government could promote the BET by coordinating with local fleet owners and give incentives to purchase to reduce the short-term ownership costs

Thank You

Questions?

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