Guernsey Electricity Limited

LIFE CYCLE STUDY OF VEHICLE GHG IMPACTS IN GUERNSEY 2024

UK0041759.5432-VEHICLE STUDY
JULY 2025

PUBLIC

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TYPE OF DOCUMENT (VERSION) PUBLIC

PROJECT NO. UK0041759.5432

OUR REF. NO. UK0041759.5432-VEHICLE STUDY

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EXECUTIVE SUMMARY

Guernsey Electricity Limited (GEL) is an integrated utility that generates, transmits and distributes electricity across the island of Guernsey. It also manages an interconnector with France through which a large proportion of electricity is imported.

The study aimed to compare the whole life greenhouse gas (GHG) emissions from using different vehicles. For each vehicle, WSP included the following activities within the scope of whole life cycle GHG emissions calculations:

- Production
- Operation (including well-to-tank emissions for production of the fuel/energy)
- Maintenance
- End of life (and recycling)

Circa 95% of the emissions from the manufacture use and disposal of E-bikes is from their production. Despite the total lifecycle of E-bikes being 10% of that of a cars, emissions from the production, use and end of life of E-bikes are significantly lower than that of all cars regardless of the type of vehicle.

Internal combustion engine (ICE) (petrol and diesel) vehicles have higher emissions than battery electric vehicles (BEV), fuel cell electric vehicles (FCEV) and vehicles powered by HVO. While biofuels have lower life cycle GHG emissions than conventional fuels (circa 90%), this value is not zero due to the production of non-CO_2 GHGs upon the combustion of the biofuel, most notably methane and nitrous oxide. The CO_2 emissions produced upon combustion of biofuels are assumed to be '0' to account for the CO_2 absorbed by fast-growing bioenergy sources during their growth.

Production emissions from BEV and FCEV are higher than ICE vehicles because of the higher emissions from battery production for use in BEV and FCEV. The lower production emissions of other vehicles does not out way the very low operational emissions from BEV and FCEV powered by low emission electricity/low emission hydrogen. It should be noted that there is expected to be a steep reduction in the emissions from EV battery/fuel cell production in the next five to ten years through the introduction of regulation and circular economy initiatives; therefore, the lifecycle emissions from BEV and FCEV are expected to continue to reduce.

METHODOLOGY

The study aimed to compare the whole life greenhouse gas (GHG) emissions from using different vehicles. For each vehicle, WSP included the following activities within the scope of whole life cycle GHG emissions calculations:

- Production
- Operation (including well-to-tank (WTT) emissions for production of the fuel/energy)
- Maintenance
- End of life (and recycling)

A summary of the life cycle stages assessed are shown in Figure 1.

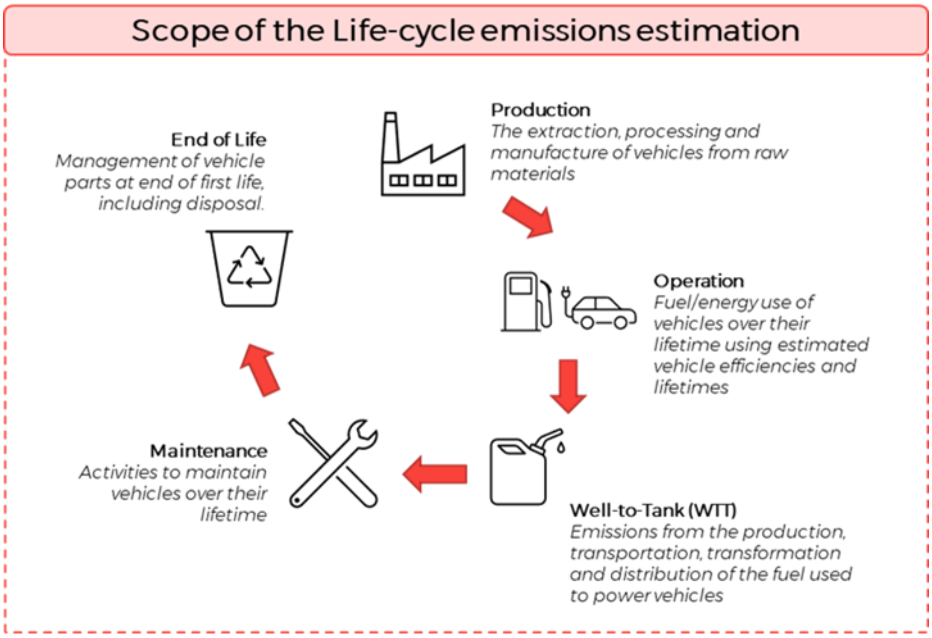

Figure 1 – Scope of the life cycle emissions estimation

PRODUCTION, MAINTENANCE AND END OF LIFE

A literature review was conducted to obtain GHG emission values for each vehicle that represents the production, maintenance and end of life stages of the vehicles life cycle. The full list of emission values for each vehicle's life cycle stage can be found in the Appendix along with the corresponding literature sources.

OPERATION AND WELL-TO-TANK

The below steps were taken to calculate the operational and WTT[1] GHG emissions for each vehicle. A literature review was conducted to obtain fuel efficiency/lifetime fuel usage, average lifetime, emission factors/intensities.

[1] Well-to-tank (WTT) emissions are from the upstream extraction (mining and drilling to extract the un-refined fuel from where it is located), refining (the transformation of the un-refined fuel to the fuel that can be combusted/used) and transportation (movement of fuel from its extraction point to the refining plant and then to the customer for use) of the fuels and prior to their combustion.

- **Emissions from energy usage (Equation 1)**

  Fuel/electricity efficiency x average lifetime usage x fuel combustion/electricity generation (including transmission and distribution loses) emissions factor
- **WTT emissions (Equation 2a)**

  Lifetime fuel usage x WTT fuel emission factor for fuel vehicles
- **Operational emissions (Equation 3)**

  Equation 1 + Equation 2

The full list of emission values, average lifetime usages, fuel efficiencies and emission factors can be found in the Appendix along with the corresponding literature sources. The methodology for estimating average lifetime usage, vehicle fuel efficiency and sources for the emission factors are provided below.

Average lifetime usage: According to available scientific literature, different brands of ICE vehicles, BEV and FCEV lifetimes range significantly depending on the study. Some studies show BEV and FCEV with longer lifetimes than ICE vehicles and others show ICE vehicles have longer lifetimes than BEV and FCEV. An average lifetime sourced from the Department for Transport was assumed for all vehicles in this study.[2] An average lifetime usage was used for all E-bikes.[3]

Vehicle fuel efficiency: Is defined as a measure of how much a vehicle will convert energy in fuel/electricity into kinetic energy to travel. Vehicle efficiencies have been sourced from a variety of sources which are summarised as part of the data summary in Table 2, found in the Appendix. The efficiency of a BOSCH E-bike was assumed to represent the average efficiency for all E-bikes.[2]

Emission factors: Emission factors for the WTT and combustion of fuels/electricity are sourced from the Department of Energy Security and Net Zero[4, 5] or provided by GEL.[6]

WHOLE LIFE CYCLE CALCULATIONS

The whole life cycle GHG emission were calculated using the following equation:

- **Life cycle emissions (Equation 4)**
  Operation emissions + Production emissions + Maintenance emissions + end of life emissions

For the purposes of comparison, the results of the study have been normalised to GHG emission per kilometre travelled by the vehicle.

[2] Ricardo, Lifecycle Analysis of UK Road Vehicles, Accessed May 2025
[3] Polytechnique insights, What is the carbon footprint of electric bikes?, Accessed May 2025
[4] Department for Energy Security and Net Zero, Greenhouse gas reporting: conversion factors 2024, Accessed May 2025
[5] Department for Energy Security and Net Zero, UK Hydrogen Strategy 2021, Accessed May 2025
[6] Guernsey Electricity Ltd, GEL Corporate GHG Emissions 2024_v1.0 15042025.xlsx, Accessed April 2025

VEHICLE TYPES

WSP selected representative internal combustion engine (ICE) vehicles, battery electric vehicles (BEV), fuel cell electric vehicles (FCEV) and E-Bikes for inclusion in this study. The vehicles incorporated in this study were:

- Petrol - Mercedez C-Class
- Petrol - Ford Focus
- Diesel - BMW 3 series
- Diesel - Peugot 308
- HVO - BMW 3 series
- HVO - Peugot 308
- FCEV - Hyundai NEXO [where the hydrogen is generated using the steam methane reformation without carbon capture method]
- FCEV - Hyundai NEXO [where the hydrogen is generated using an electrical electrolysis method with the average electricity from the UK Grid]
- FCEV - Hyundai NEXO [where the hydrogen is generated using an electrical electrolysis method with the electricity from a renewable source]
- BEV - Tesla M3 [where the electricity provided by the UK Grid]
- BEV - Tesla M3 [where the electricity provided by GEL's General Mix]
- BEV - Tesla M3 [where the electricity provided by GEL's Importation Mix]
- BEV - Fiat 500 eV [where the electricity is provided by the UK Grid]
- BEV - Fiat 500 eV [where the electricity provided by GEL's General Mix]
- BEV - Fiat 500 eV [where the electricity provided by GEL's General Mix]
- E-Bike [where the electricity is provided by the UK Grid]
- E-Bike [where the electricity provided by GEL's General Mix]
- E-Bike [where the electricity provided by GEL's General Mix]

ASSUMPTIONS AND LIMITATIONS

The assumptions and limitations apply to this study are outlined in the appendix alongside the full list of emission values and the corresponding literature sources.

RESULTS 2024

Figure 2 presents a comparison of life cycle emissions (gCO_2e/km) of different types of vehicles/modes of transport (some operating with various fuels). Table 1, which is found in the Appendix, contains the full set of results and associated sources.

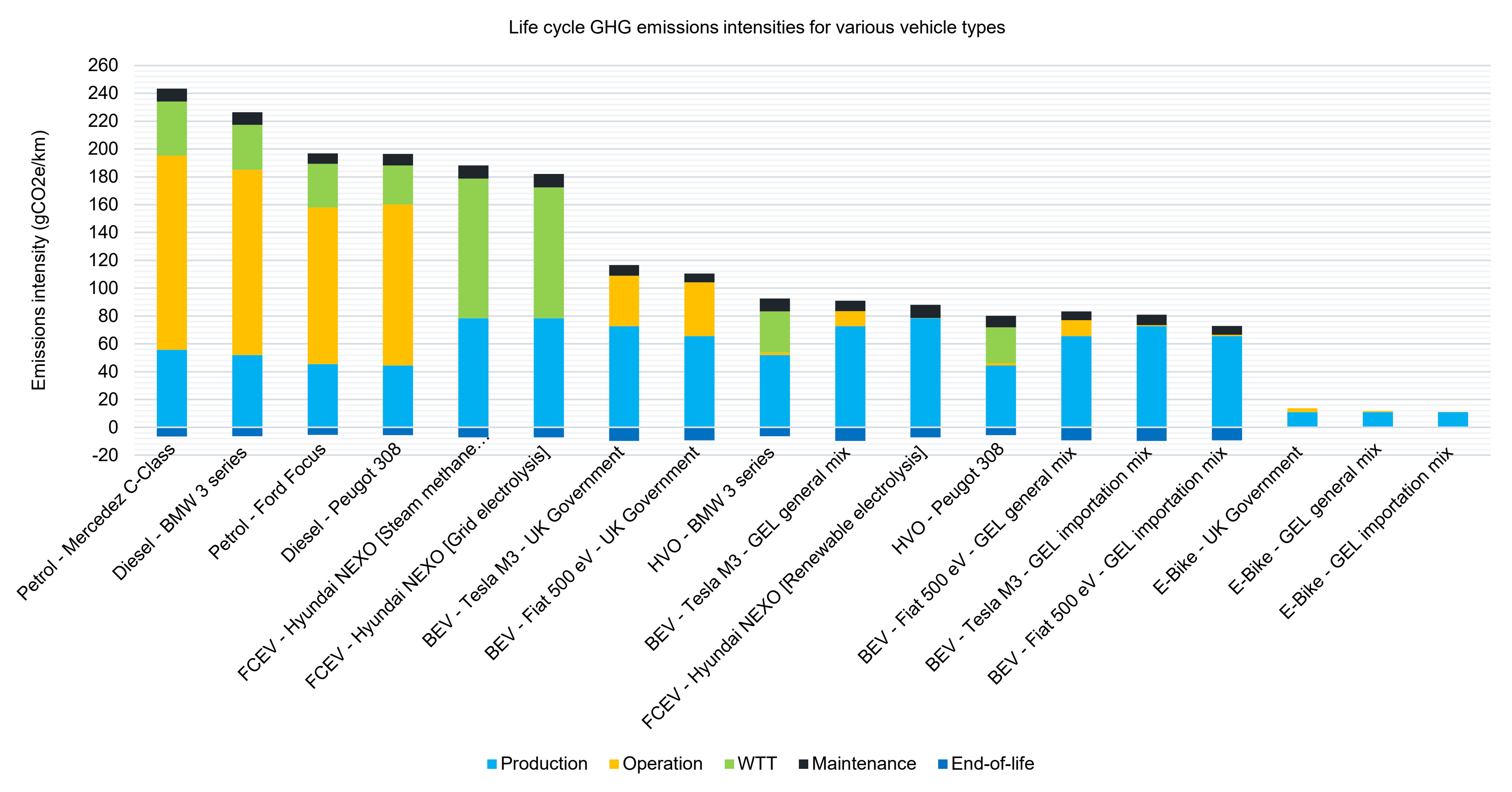

Figure 1 - Life cycle GHG emissions intensities for various vehicle types

Circa 95% of the emissions from the manufacture, use and disposal of E-bikes is from their production. Despite the total lifecycle of E-bikes being 10% of that of a cars, emissions from the production, use and end of life of E-bikes are significantly lower than that of all cars regardless of the type of vehicle.

ICE vehicles have higher emissions than BEV, FCEV and vehicles powered by HVO. While biofuels have lower life cycle GHG emissions than conventional fuels (circa 90%)[7], this value is not zero due to the production of non-CO_2 GHGs upon the combustion of the biofuel, most notably methane and nitrous oxide. The CO_2 emissions produced upon combustion of biofuels are assumed to be '0' to account for the CO_2 absorbed by fast-growing bioenergy sources during their growth[8].

Production emissions from BEV and FCEV are higher than ICE vehicles because of the higher emissions from battery production for use in BEV and FCEV[9]. The lower production emissions of other vehicles does not out way the very low operational emissions from BEV and FCEV powered by low emission electricity/low emission hydrogen. It should be noted that there is expected to be a steep reduction in the emissions from EV battery/fuel cell production in the next five to ten years through the introduction of regulation and circular economy initiatives; therefore, the lifecycle emissions from BEV and FCEV are expected to continue to reduce[8, 10].

[7] Supply Chain School, The Pros and Cons of HVO as a transition fuel to Net Zero Carbon: a Scope of Works for a Guidance Document, Accessed May 2025
[8] Department for Energy Security and Net Zero, Greenhouse gas reporting: conversion factors 2024, Accessed May 2025
[9] McKinsey & Company, The race to decarbonize electric-vehicle batteries, Accessed May 2025
[10] Department for Energy Security and Net Zero, Modelling 2050: Electricity System Analysis, Accessed May 2025

APPENDIX – FULL RESULTS

Table 2 – Life cycle emissions from the vehicles

Vehicle type	Emissions (gCO_2e/km)					
	Production	Operation	WTT	Maintenance	End of life	Total
Petrol - Mercedez C-Class	55.59	139.65	38.92	9.30	-6.69	236.77
Petrol - Ford Focus	45.38	112.56	31.37	7.50	-5.40	191.41
Diesel - BMW 3 series	51.86	133.18	32.38	9.10	-6.33	220.19
Diesel - Peugeot 308	44.53	115.59	28.11	8.20	-5.58	190.84
HVO - BMW 3 series	51.86	1.89	29.63	9.10	-6.33	86.14
HVO - Peugeot 308	44.53	1.64	25.71	8.20	-5.58	74.50
FCEV - Hyundai NEXO [Steam methane reformation without carbon capture]	78.41	0.00	100.32	9.50	-7.18	181.05
FCEV - Hyundai NEXO [Grid electrolysis]	78.41	0.00	94.08	9.50	-7.18	174.81
FCEV - Hyundai NEXO [Renewable electrolysis]	78.41	0.00	0.12	9.50	-7.18	80.85
BEV - Tesla M3 - UK Government	72.59	36.33	0.00	7.60	-9.82	106.70
BEV - Tesla M3 - GEL general mix	72.59	10.80	0.00	7.60	-9.82	81.17
BEV - Tesla M3 - GEL importation mix	72.59	0.82	0.00	7.60	-9.82	71.20
BEV - Fiat 500 eV - UK Government	65.62	38.53	0.00	6.30	-9.37	101.08
BEV - Fiat 500 eV - GEL general mix	65.62	11.45	0.00	6.30	-9.37	74.00
BEV - Fiat 500 eV - GEL importation mix	65.62	0.87	0.00	6.30	-9.37	63.42
E-Bike - UK Government	10.90	2.75	0.00	0.00	0.00	13.65
E-Bike - GEL general mix	10.90	0.82	0.00	0.00	0.00	11.72

Production, maintenance and end of life

- All vehicle production, maintenance and end of life emissions are from life cycle assessments collated by Greencap: https://www.greenncap.com/european-lca-results/
- All e-bike production, maintenance and end of life emissions are from a review by the Institute Polytechnique de Paris: https://www.polytechnique-insights.com/en/columns/energy/what-is-the-carbon-footprint-of-electric-bikes/%20e-bikes/

Operation and WTT

- Described in Table 3.

Table 3 – Efficiencies and emission factors for the vehicles

Type	Efficiency	Efficiency unit	Operation (emission factor)	Operation (emission factor unit)	WTT (emission factor)	WTT (emission factor unit)
Petrol - Mercedez C-Class	0.07	litres/km	2.08	$kgCO_2e$/ litre	0.58	$kgCO_2e$/ litre
Petrol - Ford Focus	0.05	litres/km	2.08	$kgCO_2e$/ litre	0.58	$kgCO_2e$/ litre
Diesel - BMW 3 series	0.05	litres/km	2.51	$kgCO_2e$/ litre	0.61	$kgCO_2e$/ litre
Diesel - Peugeot 308	0.05	litres/km	2.51	$kgCO_2e$/ litre	0.61	$kgCO_2e$/ litre
HVO - BMW 3 series	0.05	litres/km	0.04	$kgCO_2e$/ litre	0.56	$kgCO_2e$/ litre
HVO - Peugeot 308	0.05	litres/km	0.04	$kgCO_2e$/ litre	0.56	$kgCO_2e$/ litre
FCEV - Hyundai NEXO [Steam methane reformation without carbon capture]	0.01	kg/km	n/a	n/a	10.03	$kgCO_2e$/kg
FCEV - Hyundai NEXO [Grid electrolysis]	0.01	kg/km	n/a	n/a	9.41	$kgCO_2e$/kg
FCEV - Hyundai NEXO [Renewable electrolysis]	0.01	kg/km	n/a	n/a	0.01	$kgCO_2e$/kg
BEV - Tesla M3 - UK Government	0.13	kWh/km	0.28	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor
BEV - Tesla M3 - GEL general mix	0.13	kWh/km	0.08	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor
BEV - Tesla M3 - GEL importation mix	0.13	kWh/km	0.01	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor

Type	Efficiency	Efficiency unit	Operation (emission factor)	Operation (emission factor unit)	WTT (emission factor)	WTT (emission factor unit)
BEV - Fiat 500 eV - UK Government	0.14	kWh/km	0.28	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor
BEV - Fiat 500 eV - GEL general mix	0.14	kWh/km	0.08	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor
BEV - Fiat 500 eV - GEL importation mix	0.14	kWh/km	0.01	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor
E-Bike - UK Government	0.01	kWh/km	0.28	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor
E-Bike - GEL general mix	0.01	kWh/km	0.08	$kgCO_2e$/ kwh	Included in operation emission factor	Included in operation emission factor

Efficiency

- The efficiencies of all vehicles are from life cycle assessments collated by Greencap: https://www.greenncap.com/european-lca-results/
- The efficiencies of all e-bikes are from a review by the Institute Polytechnique de Paris: https://www.polytechnique-insights.com/en/columns/energy/what-is-the-carbon-footprint-of-electric-bikes/%20e-bikes/

Operation and WTT

- The operational and WTT emission factors for ICE vehicles (including HVO) and electric vehicles and e-bikes where the electricity is provided by the UK Grid are from the Department for Energy Security and Net Zero (DESNZ), Greenhouse gas reporting: conversion factors 2024: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024
  - The electricity operation figure is calculated by WSP and is the sum of the following emission factors:
    - UK electricity, Electricity generated, 0.20705 $kgCO_2e$/kWh
    - Transmission and distribution, T&D- UK electricity, 0.0183 $kgCO_2e$/kWh
    - WTT- UK electricity, WTT- UK electricity (generation), 0.0459 $kgCO_2e$/kWh
    - WTT- UK electricity, WTT- UK electricity (T&D), 0.00397 $kgCO_2e$/kWh
- The operational and WTT emission factors for electric vehicles where the electricity is provided GEL are from GEL: GEL Corporate GHG Emissions 2024_v1.0 15042025.xlsx
- The operational and WTT emission factors for FCEV are from the Department for Energy Security and Net Zero's Hydrogen Strategy: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1175494/UK-Hydrogen-Strategy_web.pdf

Vehicle lifetimes

- According to available scientific literature, different brands of ICE vehicles, BEV and FCEV lifetimes range significantly depending on the study. Some studies show BEV and FCEV with longer lifetimes than ICE vehicles and others show ICE vehicles have longer lifetimes than BEV and FCEV. An average lifetime of 200,000km sourced from the Department for Transport was assumed for all vehicles in this study. https://assets.publishing.service.gov.uk/media/623b0fb28fa8f540f3202c12/lifecycle-analysis-of-UK-road-vehicles.pdf
- An average lifetime usage (20,000 km) was used for all E-bikes. https://www.polytechnique-insights.com/en/columns/energy/what-is-the-carbon-footprint-of-electric-bikes/%20e-bikes/

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