Guernsey Electricity Limited

LIFE-CYCLE STUDY OF VEHICLE CARBON IMPACTS IN GUERNSEY

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WSP

4th Floor
6 Devonshire Square
London
EC2M 4YE

Phone: +44 20 7337 1700

Fax: +44 20 7337 1701

WSP.com

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GUERNSEY ELECTRICITY LIFE-CYCLE CARBON INTENSITY

WSP UK were commissioned by Guernsey Electricity Ltd. (GEL), to conduct a study into the life-cycle greenhouse gas (GHG) emissions intensity of different types of passenger cars. This study was to be conducted to provide a comparison between the battery electric vehicles (BEV) and conventional internal combustion engine (ICE) vehicles using petrol, diesel or renewable diesel as the fuel. The objective of this study was to calculate the average GHG emissions released per kilometres (km) driven, taking into account the GHG emissions across the complete lifecycle of production and usage of both ICEs and EVs.

GEL is an integrated utility that generates, transmits and distributes electricity across the island of Guernsey. GEL also undertakes operations that use electricity including works power, office activities and the charging of electric vehicles.

WSP included in its study the life-cycle emissions from EV using GEL's electricity. WSP calculated the carbon intensity of production and operation per kilometre of an average BEV and compared them with an average vehicle using petrol, diesel and renewable diesel. The study further compares the life-cycle carbon intensity with popular models of EV and conventional vehicles sold in the UK during 2020.

METHODOLOGY

For this study, WSP assessed the emissions resulting from the production, operation and end-of-life lifecycle stages of each vehicle. The production emissions encompass those arising from raw materials extraction and processing, whilst the operation emissions included the emissions generated due to the combustion of fuel as petrol or the generation of electricity; vehicle maintenance activities; and well-to-tank emissions from the production of each fuel. For EV charging, the life-cycle intensity of GEL's electricity supply was considered, in comparison to the standard UK electricity grid.

A literature review was carried out to obtain GHG emission values for each stages of vehicle production and operation. For the purpose of this study, an average factor for emissions during production[1], average lifetime kilometres driven as well as fuel efficiency factors for an average diesel, petrol and battery electric vehicle were assumed based on available literature.

The assessment of life-cycle emissions for vehicles in Guernsey entailed the following key steps:

1 https://d1v9sz08rbysvx.cloudfront.net/ricardo/media/media/news%20assets/lowcvp%20study%20demonstrates%20importance%20of%20whole%20life%20co2%20emissions.pdf

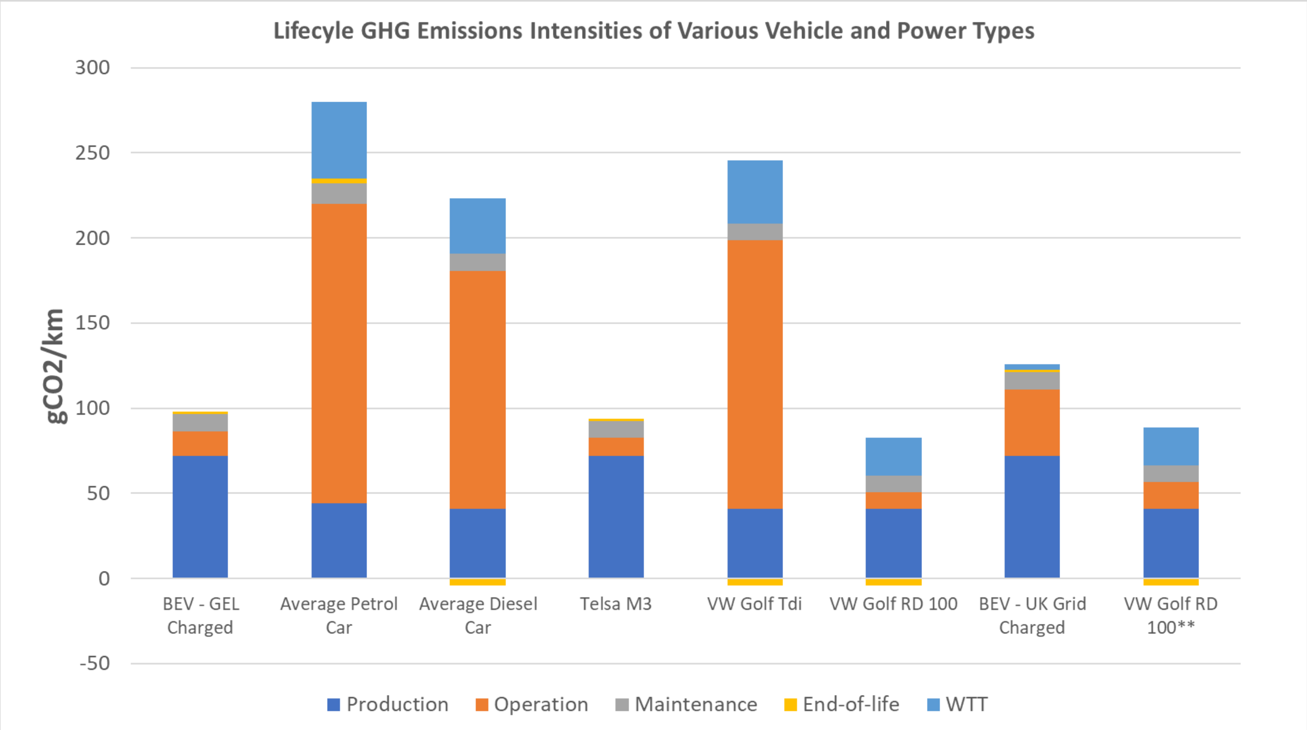
1. **Vehicle types**: Based on the available literature,[2] and vehicle sales statistics in the UK[3], Tesla M3 was considered for a comparison with Volkswagen Golf as two of the most popular electric car models in the UK in 2020. Additionally, an average car running on diesel, petrol and electricity was also compared.
2. **Efficiency and lifetime usage**: Based on the available scientific literature[4], vehicle fuel efficiency and average lifetime usage was assumed for an average car. Also based on the literature, fuel and energy efficiency for Volkswagen and Tesla[5] were assumed respectively.
3. **Life-cycle emissions estimation**: The life-cycle emissions from the chosen vehicle types in Guernsey were calculated by first multiplying the efficiency of the vehicle, the average lifetime usage in km and fuel emissions factor[6]. This gives the overall operation emissions which was then added with the production, end-of-life and maintenance GHG emission estimates to arrive at the total life-cycle emissions as represented in the equations below. Production, maintenance and end-of-life emissions values were taken directly from life-cycle assessment results detailed in scientific research papers.[4]
    1. Emissions from energy usage =
        a. Vehicle fuel efficiency x average lifetime usage x fuel emissions factor (Equation 1)
        b. Vehicle electricity efficiency x average lifetime usage x GEL electricity intensity or UK average grid emissions intensity (Equation 2)
    2. WTT emissions = Lifetime fuel used x WTT fuel emission factor (Equation 3)
    3. Operation emissions = Emissions from usage of fuel + WTT emissions of fuel + maintenance activity emissions (Equation 4)
    4. Life-cycle emissions = Operation emissions + Production emissions + End-of-life emissions (Equation 5)

[2] https://www.eea.europa.eu/publications/electric-vehicles-from-life-cycle/at_download/file
[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/985555/vehicle-licensing-statistics-2020.pdf
[4] https://www.mdpi.com/2071-1050/12/22/9390/htm
[5] https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/62/e3sconf_icbte2019_01009.pdf
[6] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

RESULTS

The chart below presents a comparison of life-cycle emissions of different types of conventional vehicles and battery electric vehicles operating with various fuels in Guernsey. It can be observed from the chart that a conventional vehicle operating on RD100[7] fuel is the least emission intensive option whilst a car running on petrol is the most emission intensive. However, it should be noted that, the data around the emissions intensity RD100 is not readily available in the public domain. Therefore, the emission factors of general biodiesel were assumed to estimate the emissions from using RD100.

The chart also presents the life-cycle emissions of a BEV operating with electricity from GEL and electricity from UK grid, with a Tesla M3 and average BEV powered by GEL electricity representing the 3rd and 4th lowest GHG emissions-intense vehicle options. With GEL preparing for further decarbonisation of its electricity generation, the BEV GHG emissions intensities would also decline in the future and would likely surpass the RD100 options to become the least emissions intensive options.



ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations apply to this study

[7] https://rubis-ci.co.uk/motor-and-aviation/rd100/

1. In the absence of Guernsey-specific data on average lifetime usage of a car 150,000 km[8] was assumed, based on estimates available from the literature.
2. Due to unavailability of specific CO_2 emission factor for RD100, the emission factor for biodiesel from BISE[9] is used for the estimates.
3. Additionally, based on the information available that RD100 emits 90% less emissions than conventional diesel, this was used to estimate the lifecycle GHG emissions of RD100 in the other calculation scenario for a car using this type of fuel.[10]

APPENDIX – FULL RESULTS

Emissions estimation	Total (gCO2/km)					
Type	Production	Operation	Maintenance	End-of-life	WTT	Total
BEV - GEL Charged	72.00	14.53	10.10	1.33	0.00	97.96
Average Petrol Car	44.00	175.91	12.00	2.67	45.40	279.98
Average Diesel Car	40.67	139.77	10.10	-4.00	32.56	219.09
Telsa M3	72.00	10.44	10.10	1.33	0.00	93.87
VW Golf Tdi	40.67	157.78	10.10	-4.00	36.75	241.30
VW Golf RD 100	40.67	9.73	10.10	-4.00	21.94	78.44
BEV - UK Grid Charged	72.00	38.93	10.10	1.33	3.35	125.72
VW Golf RD 100**	40.67	15.78	10.10	-4.00	21.94	84.49

Emissions estimation	Total lifetime (tCO2e)					
Type	Production	Operation	Maintenance	End of Life	WTT	Total
BEV - GEL Charged	10.80	2.18	1.52	0.20	0.00	14.69
Average Petrol Car	6.60	26.39	1.80	0.40	6.81	42.00
Average Diesel Car	6.10	20.97	1.52	-0.60	4.88	32.86
Telsa M3	10.80	1.57	1.52	0.20	0.00	14.08
VW Golf Tdi	6.10	23.67	1.52	-0.60	5.51	36.19
VW Golf RD 100	6.10	1.46	1.52	-0.60	3.29	11.77
BEV - UK Grid Charged	10.80	5.84	1.52	0.20	0.50	18.86
VW Golf RD 100**	6.10	2.37	1.52	-0.60	3.29	12.67

[8] https://www.nbcnews.com/id/wbna12040753#.XHdpzC2ZMWo
[9] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2020

[10] https://rubis-ci.co.uk/motor-and-aviation/rd100/

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6 Devonshire Square
London
EC2M 4YE

wsp.com