GreenCape

Electrification of municipal vehicle fleets

The City of Cape Town Fleet Management Department's electric vehicle pilot project has demonstrated a business case for the procurement of electric passenger vehicles for municipal fleets.

List of abbreviations

AC	alternating current
BMW	Bavarian Motor Works
CCT	City of Cape Town
CCAP	Climate Change Action Plan
CO_2	carbon dioxide
DC	direct current
EV	electric vehicle
GHG	greenhouse gas
ICE	internal combustion engine
kW	kilowatt
VW	Volkswagen

1 Key insights

Reduction in GHG emissions:

Electric vehicles (EVs) used in municipal fleets can reduce greenhouse gas (GHG) emissions, improve air quality in cities and save on fuel costs.

Decarbonisation lever:

There is a business case for procuring electric passenger vehicles for municipal fleets, which can be used as a decarbonisation lever in municipalities, if charged with renewable energy.

Charging network:

It is important that EVs procured by municipalities are fit for purpose and that a suitable charging network is developed to support operational requirements.

Operational costs:

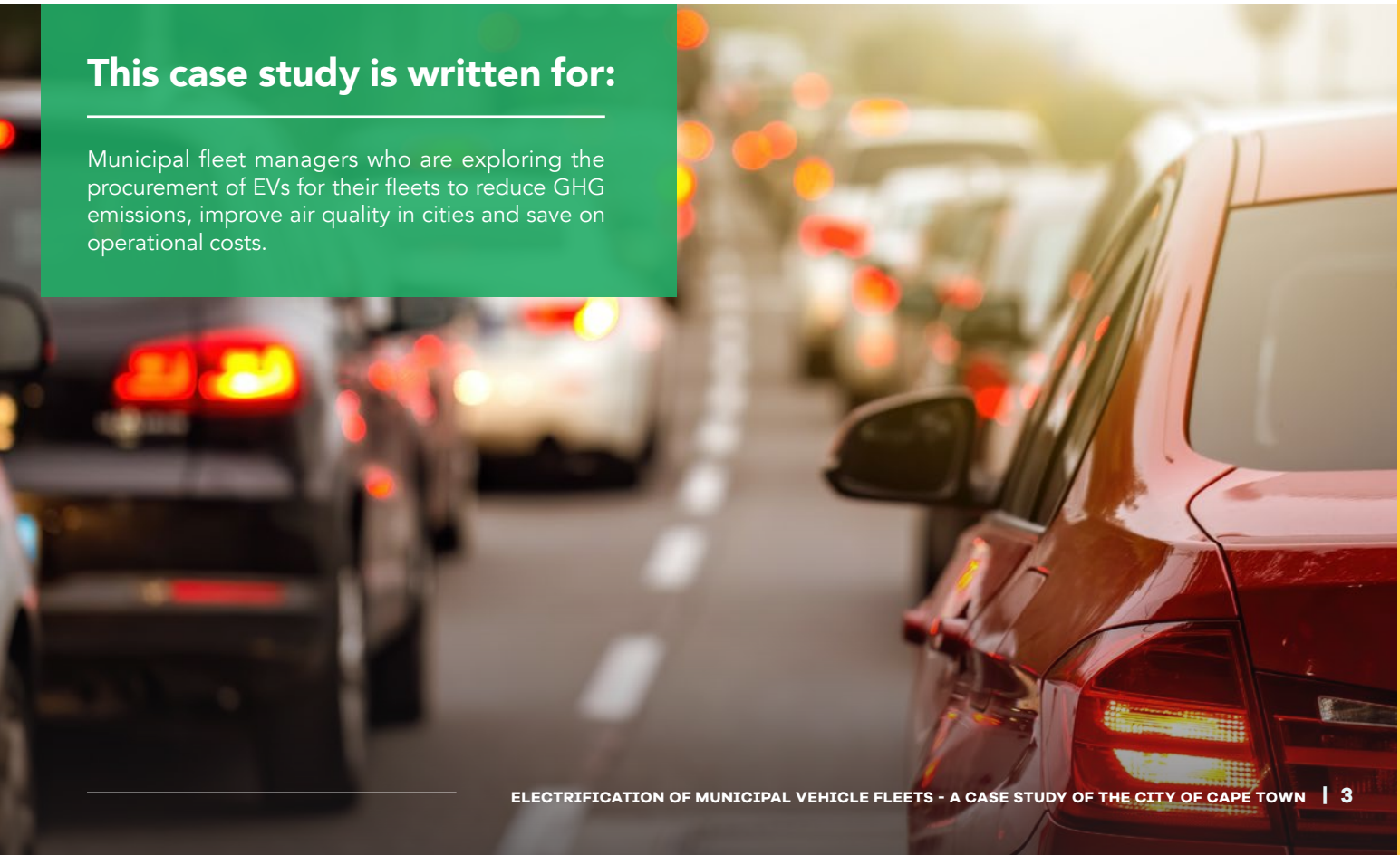
The CCT EV pilot project showed that the purchase price plus operational costs of electric passenger vehicles are more affordable than its internal combustion engine (ICE) vehicle equivalent.

2 Purpose

The case study presents the business case for the procurement of electric passenger vehicles in a municipal context. It reflects on cost saving insights from an EV pilot project in the CCT that has also shown GHG emission savings. It also highlights the importance of selecting a replacement EV that is aligned with the purpose of the fleet vehicle

This case study is written for:

Municipal fleet managers who are exploring the procurement of EVs for their fleets to reduce GHG emissions, improve air quality in cities and save on operational costs.



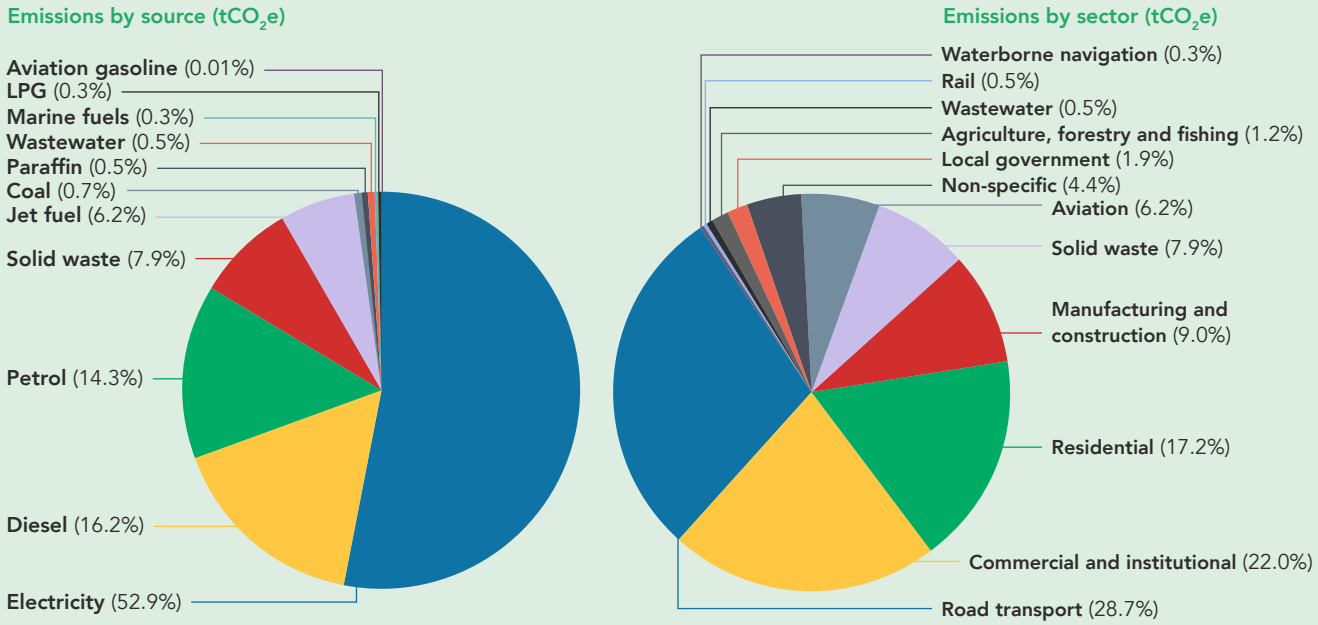
3 Background

The CCT has set targets and climate change commitments on carbon emissions reduction and the adoption of green energy technologies. This is outlined in the City's Climate Change Action Plan (CCAP) with a goal of carbon neutrality by 2050. Action 20.3 of the CCAP states that the CCT should show leadership and gather real-world data from EV pilot programmes, such as the installation of publicly accessible demonstration chargers and the procurement of EVs for the CCT fleet.

This resulted in the CCT implementing a pilot project in which five EVs and five ICE vehicles, with comparable performance figures, were tested in real-world conditions. This pilot project was completed over a period of three years from 2020 to 2022 by the CCT Traffic Services department, as this particular use case has a higher annual mileage which would improve the business case for electrification.

4 Opportunity

According to the Cape Town State of Energy and Carbon Report 2021, highlighted in Figure 1, road transport contributes towards 28.7% of Cape Town's GHG emissions. With regards to total energy consumption, road transport contributes towards 54.4% of Cape Town's total energy consumption. A transition to EVs charged with renewable energy is a potential decarbonisation lever which could assist Cape Town with reaching its carbon neutrality goals by 2050



Total GHG emissions (exluding oil refined, for consistency): 21,77 million tCO_2e
Estimated oil refining GHG emissions: 0,68 million tCO_2e. Electricity and non-specified categories include electricity losses

Figure 1: Breakdown of the CCT's carbon footprint (2018) (Source: Cape Town State of Energy and Carbon Report 2021)

The CCT has a total fleet size of 9 386 vehicles across various department fleets (Corporate Services, MyCiti BRT, Water and Sanitation, Urban Waste Management and Energy). The CCT vehicle fleet had a total on-road fuel consumption of 15.9 million litres of diesel and 6.4 million litres of petrol between October 2021 and October 2022. The total cost of on-road refuelling for the City's vehicle fleet during this period was approximately R465 million. The indicative, total annual CO_2 emissions for the CCT's vehicle fleet is 57 314 tonnes[1] of CO_2, based on the on-road fuel consumption data for October 2021 to October 2022.

There are approximately 477 hatchback passenger vehicles in the CCT fleet which have the potential to be replaced with an electric alternative, based on the outcome of the CCT EV pilot project. Passenger vehicles[2] have been identified as an opportunity for electrification due to the high annual mileage of this vehicle segment in the City's fleet. The average annual mileage for a passenger vehicle (sedans and hatchbacks) in the CCT fleet is 35 000 km.

The estimated annual fuel consumption of the 477 ICE hatchback vehicles is 1 769 670 litres of petrol with an estimated annual emissions amounting to 4 000 tonnes of CO_2. The annual cost of refuelling all of the ICE hatchback vehicles in the City fleet is approximately R40 million. EVs have lower operational costs and produce no direct tailpipe emissions at the point of operation. Therefore, the potential electrification of this vehicle fleet segment could assist to save both operational fuel costs and reduce GHG emissions.

[1] Source: Kornelius et al, 2022

[2] According to the World Bank, passenger vehicles refer to road motor vehicles, other than two-wheelers, intended for the carriage of passengers and designed to seat no more than nine people (including the driver).

5 Solution

The CCT designed an EV pilot project which involved evaluating the feasibility of using EVs for a small subset of the City's vehicle fleet. The CCT Traffic Services Department was chosen for the CCT EV pilot project due to the high average annual mileage of 50 000 km a year. It was hypothesised that the fuel savings accrued from electrifying this use case would represent a strong business case over a period of five to seven years.

Overview of the CCT EV pilot project

The CCT procured five BMWi3 EVs through an open public procurement process and conducted an EV pilot project with the CCT Traffic Services department over a period of three years from 2020 to 2022. Six CCT-owned EV charging stations were developed to facilitate the charging requirements of the five BMWi3 vehicles during periods of non-utilisation. Two of the EV charging stations located at Bellville Civic Centre and Somerset West Civic Centre respectively are solar-powered facilities.

The EVs were compared in operations to five VW Golf GTI ICE vehicles to evaluate performance with regards to mileage, energy consumption and range. The Golf GTI ICE vehicles had an average annual mileage of 50 000 km and an average fuel consumption of 10.6 litres of petrol per 100km. At the time of procurement, the BMWi3 was the cheapest electric passenger vehicle on the South African market (2020).

Results of the CCT EV pilot project

Telemetry tracking data obtained from the five BMWi3 vehicles used in the CCT EV pilot project was used to model the energy efficiency and cost per km of using EVs in the context of a municipal vehicle fleet.

Mileage Data Analysis: The EV pilot project was carried out with the CCT Traffic Services department and recorded high annual mileage due to the operational nature of the use case. City officials in the CCT Traffic Services department attain an average annual mileage of 50 000 km for a typical VW Golf GTI. The total mileage data collected over a period of three years for the five BMWi3 vehicles is shown in Figure 2, from 2020 to 2022.

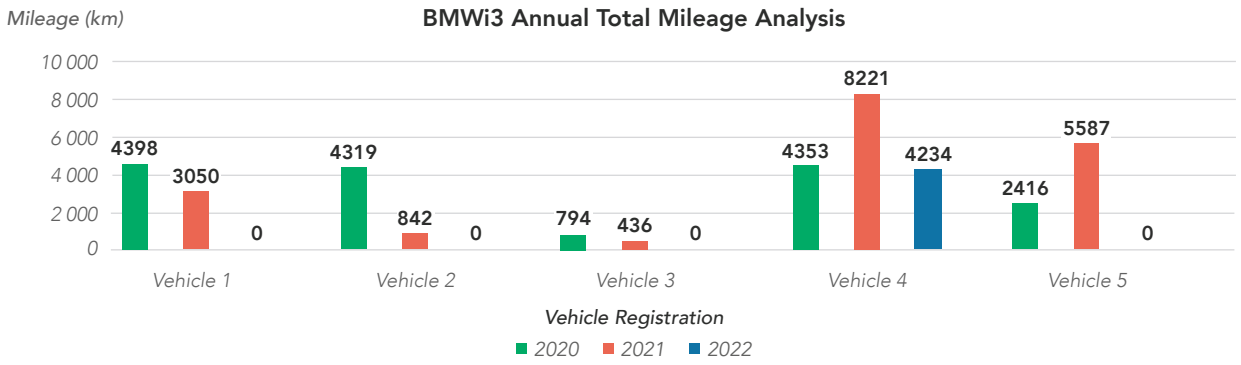


Figure 2: Mileage Analysis of CCT EV Pilot Project (Source: CCT)

Energy Consumption Analysis: Telemetry tracking data from the tracking units on the BMWi3 vehicles were able to record the energy consumption when charging. The total energy consumed from the charging of the five BMWi3 vehicles used in the EV pilot project over a period of three years from 2020 to 2022 and is shown graphically in Figure 3.

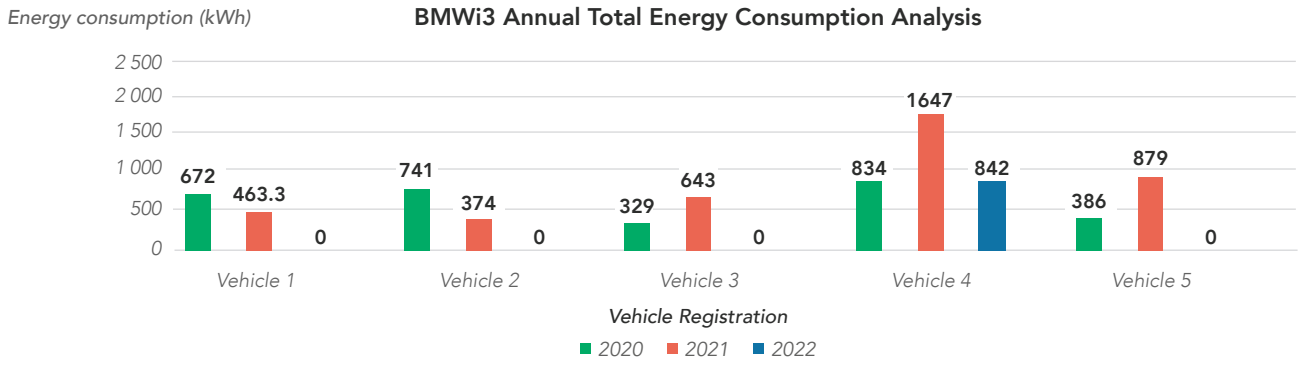


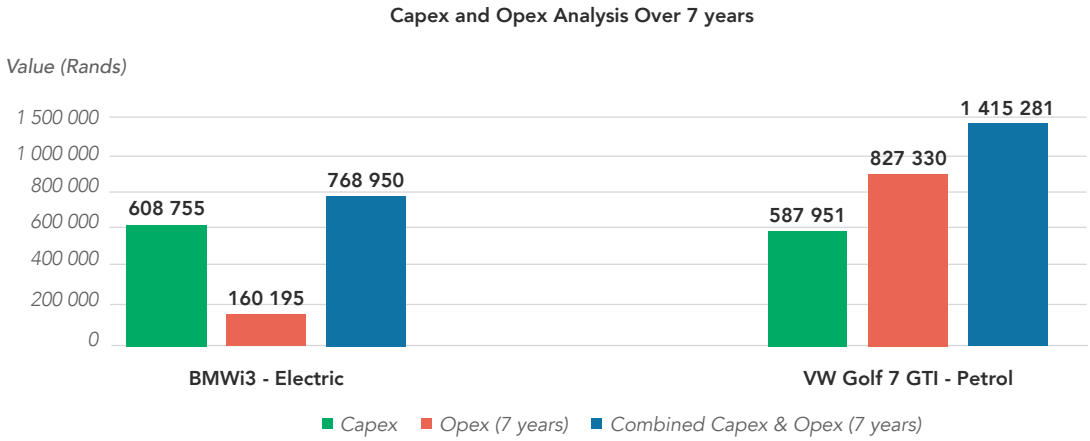
Figure 3: Energy Consumption Analysis of CCT EV Pilot project (Source: CCT)

6 Operational cost-benefit analysis

The CCT EV pilot project shows that there is a business case for municipal vehicle fleet electrification where EVs are fit for purpose and within price parity. This business case was demonstrated through the high fuel savings achieved through the use of electric BMWi3 vehicles used by the CCT Traffic Services department over a period of three years from 2020 to 2022.

The typical useful lifespan of a vehicle in the CCT fleet is around five to seven years. Therefore, a purchase price plus operational cost benefit analysis over seven years has been used for comparison between EV and ICE vehicle options. Maintenance plans were included in the total purchase price of the electric and ICE vehicles used in the CCT EV pilot project.

The BMWi3 EVs were purchased at a unit price of R608 755.00 through a public procurement process in 2020. Comparatively the ICE VW Golf GTI vehicles were procured at a unit price of R587 951.00. The operational cost per km of using the BMWi3 EVs was R0.35 to R0.46. The cost of electricity in Cape Town has been estimated at R2.30 per kWh. If the CCT Fleet Management Department spends R1 000 on electricity this would translate into 435 kWh of electricity or 3 319 km of EV range. Comparatively, the operational cost per km of using the VW Golf GTI is R2.36 per km. The cost of petrol has been assumed as R22.30 per litre. For every R1 000 that is spent on petrol by the CCT, this would translate into 45 litres of fuel or 735 km of driving range.



EV

Parameters

- 5 year maintenance plan
- Vehicle cost: R608 755.00
- Energy consumption: 0.199 kWh per km
- Range: 260 km
- Average annual mileage assumption: 50 000 km
- Electricity cost assumption: R2.30 per kWh

ICE

Parameters

- 5 year maintenance plan
- Vehicle cost: R587 951.00 (2020 Cost)
- Fuel consumption: 0.106 litres per km
- Range: ~600 km
- Average annual mileage assumption: 50 000 km
- Petrol cost assumption: R22.30 per litre

Figure 4: EV vs. ICE Business Case Analysis (Source: GreenCape analysis of CCT data)

Figure 4: EV vs. ICE Business Case Analysis shows that over a period of seven years, the purchase price plus operational costs of a BMWi3 EV was R768 950.00, which was lower over a period of seven years, compared to a VW Golf GTI ICE vehicle at R1 415 281.00. This indicates a strong business case for the electrification of the 477 hatchback vehicles in the CCT fleet, should suitable electric models be available on the South African market.

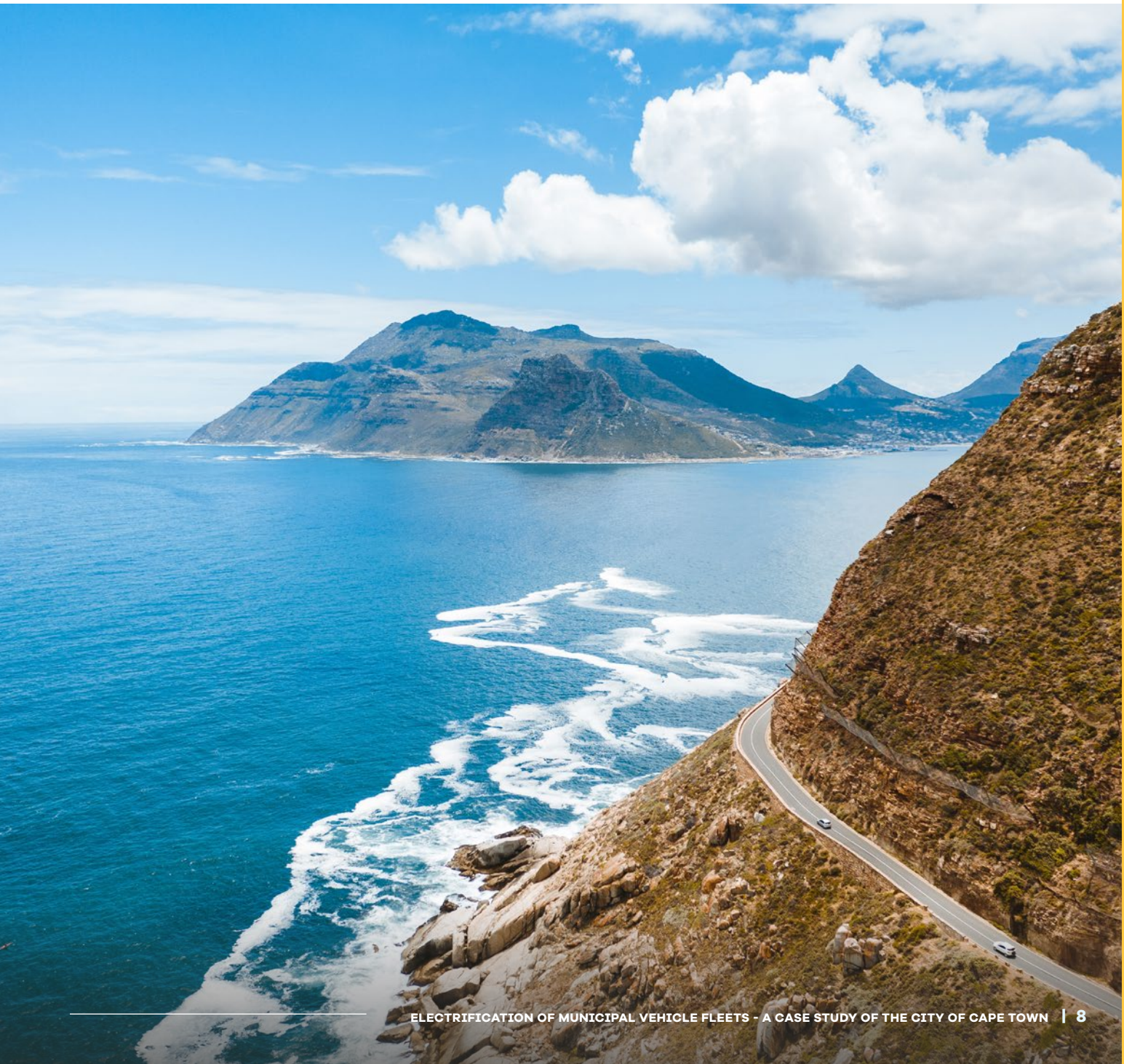
7 Lessons learned and future plans

The findings of the CCT EV pilot project show that there is a business case for the use of EVs by municipal fleets, if the EV alternative is fit for purpose and within price parity of existing ICE vehicles. The BMWi3 EVs were the cheapest EVs on the South African market and have been discontinued in 2023.

Recent market shifts by OEMs in South Africa suggest that further affordable EV models will be introduced into the South African market between 2023 and 2026 (when EVs are expected to officially reach price parity with ICE vehicles globally). An example of this is the GWM Ora electric hatchback which is set to be released in Q3 of 2023 in the South African market at a price of R716 900.00. This will be the cheapest EV in South Africa with an advertised battery range of 400 km and when charged using an 80kW DC plug, fills up from 10% to 80% in 41 minutes.

The battery range of the BMWi3 EV was 260 km at the time of purchase in 2020. Future, procurement of EVs by municipalities like the CCT should consider the operational requirements of where these EVs will be utilised to ensure that the battery range is suitable for the shift duration and daily distances travelled.

Further, a suitable fast DC charging network should be developed to enable staff to charge their vehicles during a shift if required.

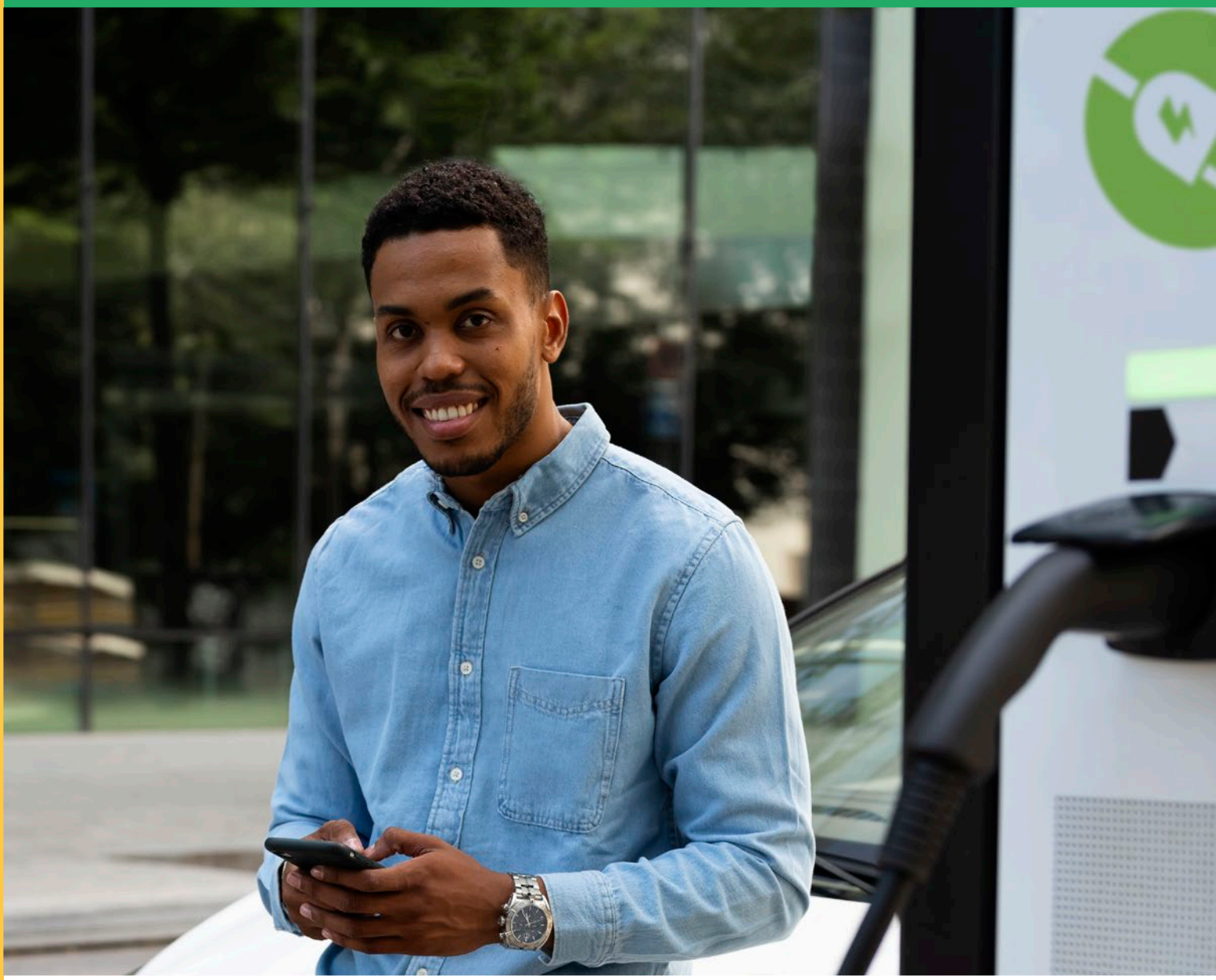


8 References

City of Cape Town (2021) State of Energy & Carbon Report 2021.

Available at: https://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/CT_State_of%20Energy_and_Carbon_Report_2021.pdf (Accessed: 31 May 2023).

Kornelius, G., Forbes, P., Fischer, T and Govender, M. (2022). Determination of country-specific greenhouse gas emission factors for South African liquid and gaseous fuels. Journal of Energy in Southern Africa. 33(3), [online], Available at:scielo.org.za/scielo.php?script=sci_arttext&pid=S1021-447X2022000300001. (Accessed: February 28, 2023).



This case study was made possible thanks to the support of the City of Cape Town

For more information and support contacts:

GreenCape: info@greencape.co.za | (021) 811 0250

CITY OF CAPE TOWN ISIXEKO SASEKAPA STAD KAAPSTAD | INVEST CAPE TOWN | RESILIENT CAPE TOWN | GreenCape Supporting the business of green