INTRODUCTION

Having thousands of electric buses and chargers connected to its fleet management platform, across the world, makes ViriCiti one of the market leaders in the telematics sector. Our aim is to provide our clients with insights into their fleets in order to help them manage and improve their operations.

To increase the reliability of our research, we chose to only look at a compact sample of around 100 e-buses in the Netherlands, where the country’s flat landscape allowed us to compare the vehicles without having the topography influencing the parameters observed.

In this report, we investigate two parameters that can directly indicate the efficiency of e-buses: average distance driven and average consumption. Field data from our customers shows that an e-bus has the capacity to drive up to 500 km/day, similar to a diesel bus. But are operators using their buses to their full potential?
METHODS

To conduct this research, we used anonymized data from real customers located in the Netherlands. We analyzed data from 100+ electric buses gathered over a period of 10 months, from June 2019 until the end of March 2020. The country’s flat landscape allowed us to compare buses that run in different cities and routes, without the topography influencing the results significantly in terms of distance driven and consumption. The buses were split into two categories based on their length: 79 12-meter buses and 27 18-meter buses were taken into consideration. All buses included in the analysis were introduced in the ViriCiti database before June 2019.

To make sure that our data sample is as representative as possible, we analyzed only buses that drove more than one third of the days included in the examined period. Additionally, we excluded the values for the days when the buses ran less than 40 km.

We know that outside temperature can directly influence the performance of e-buses. Therefore, to analyze the consumption of the e-buses, we also took into account the average daily temperatures, as follows. Temperature data were split into 3 buckets: cold, normal, and high:

- **Cold** temperatures are in the range of -10 – 14 °C (14 – 57 °F)
- **Normal** temperatures are in the range of 15 – 19 °C (58 – 67 °F)
- **High** temperatures are in the range of 20 – 29 °C (68 – 84 °F)

We started by calculating the weighted average of the daily temperatures from 7 different Dutch cities in which the buses observed operate. This weighted average is used as the daily temperature trends on the graphs displayed in the results section. Therefore, for each bus, we looked at its daily consumption and made an average per temperature bucket. Finally, the average consumption for all buses observed was calculated per temperature bucket.
RESULTS

AVERAGE DAILY DISTANCE DRIVEN

The results indicate that the average distance driven of the 12-meter buses analyzed is 218.02 km (135.47 miles) per day. For the 18-meter buses, the average is 164.32 km (102.10 miles) per day. To contextualize these findings, some of our customers in The Netherlands reported being able to drive their e-buses for as much as 500 km (310 miles) per day.

CONSUMPTION

Consumption increases for both 12-meter and 18-meter buses during the colder months of the year — with an average of 14% for 12-meter buses, and 21% for 18-meter buses. The same trend is noticed for the summer months, when consumption also increases with 9% for the 12-meter buses, and with 12% for the 18-meter buses.

We see the difference in consumption is greater for both bus sizes from cold to normal, than from warm to normal temperatures, although both extremes cause a change in consumption. A possible explanation could be that this happens due to the prolonged warm-up period for the buses during the colder months of the year, the extensive power drain of an electric heater for warmth in the winter (larger than the power drain of an air conditioner in summer), and the higher amount of drag between tires and the road. The latter applies mostly for driving in non-urban areas, where speed is greater and there are fewer obstacles.

Therefore, trends of consumption for 12-meter and 18-meter buses are very similar. As expected, the main difference lies in the amount of energy consumed per driven km for the two categories. In optimal weather conditions, with normal temperatures*, 18-meter buses consume on average 1.35 kWh/km (2.17 kWh/mile), whereas 12-meter buses consume 0.99 kWh/km (1.59 kWh/mile).

The average values for the entire 10-months observed are slightly higher, but follow the same trend — 18-meter buses consume 1.63 kWh/km (2.63 kWh/mile), while 12-meter buses consume 1.15 kWh/km (1.85 kWh/mile).

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Table 1: Summary Statistics of consumption differences for two categories of buses

<table>
<thead>
<tr>
<th>Time period: 01/06/2019-31/03/2020</th>
<th>Number of buses</th>
<th>Difference in consumption between Normal and Cold temperatures</th>
<th>Difference in consumption between Normal and High temperatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>12m buses</td>
<td>79</td>
<td>14% ▲ in cold temps</td>
<td>9% ▲ in high temps</td>
</tr>
<tr>
<td>18m buses</td>
<td>27</td>
<td>21% ▲ in cold temps</td>
<td>12% ▲ in high temps</td>
</tr>
</tbody>
</table>

*when the average outside temperatures fall into the ‘normal’ temperature bucket as described in the Methods section
Average distance driver for 12-meter buses is **218.02 km per day** (135.47 miles) per day and for 18-meter buses is **164.32 km per day** (102.10 miles).

Average consumption for 12-meter buses is **1.15 kWh/km** (1.85 kWh/mile) and for 18-meter buses is **1.63 kWh/km** (2.63 kWh/mile).

Figure 2, 3: Consumption has the same trend for both 12m and 18m buses. Lower consumption is spotted during normal and high temperatures, while it increases as we approach the colder months of December, January and February. The results also align with the difference in average consumption among the different temperature buckets presented above.
CONCLUSION

By using a vast amount of anonymized data from our database, we showed a strong correlation between outside temperature and electric bus consumption.

Perhaps more importantly, we showed that the average distance driven of various electric buses is lower than the distance e-buses could actually run — empirical field data from various Dutch operators shows that with optimized infrastructure and operational processes, electric buses are able to run as much as diesel buses (up to 500 km/day). We expect this number to grow in the future as more operators incorporate new learning points into the daily operation.

While this report offers only a brief snapshot into the operation of electric buses, the ViriCiti platform has the capability to offer a much more detailed overview. We provide and examine both real-time & historic data for driving behavior, battery conditions, and battery state of charge, among others.

We have over 8+ years of experience in the e-mobility sector, and we help hundreds of operators around the world to monitor and optimize their daily operations.

Would you like to get more actionable insights for your fleet?
Please have a look at our website www.viriciti.com or send us an email at info@viriciti.com.

LIMITATIONS

We acknowledge that this research has its limitations, as we didn’t take into consideration other factors that can influence the consumption. Other impactful factors could be the load of the bus, the traffic load, the driver’s experience, and the route conditions. Additionally, we did not differentiate between different battery types and years of manufacturing.

Although the conclusions of this report have been empirically known before, we think it is nevertheless important to have numbers and field data that can add more depth to these insights.