Welsh Government Zero Emissions Waste and Recycling Programme:

Vehicle Performance Insights: Bucher MaxPowa V65e eSweeper

21st March 2023

Introduction

This document presents information on the performance of a specific model of electric Sweeper (eSweeper) under different operating situations.

The insights in this report were developed as part of the Welsh Government Zero Emissions Waste and Recycling Project to assist Local Authorities with planning the deployment of zero emission waste vehicles. Data was combined from one deployed sweeper in a Welsh Local Authority area, and seven additional MaxPowa models operated across locations across Europe over a period of 5 to 21 months per vehicle.

The headline figures in this document help to give a broad idea of the typical operating hours possible under different circumstances with this model of eSweeper as observed in vehicles deployed in Wales and across Europe. A more detailed insight into the variation of vehicle performance can be found by use of the "16t Bucher MaxPowa V65e eSweeper Energy Model" Excel Sheet available on the project website here:

[Ultra-Low Emission Waste and Recycling Vehicles - Cenex]

This model was created to allow a user to input their own round characteristics and get an understanding of the potential performance of an eSweeper on their rounds.

Vehicle details

The insights presented in this document are based on data gathered from a single model of electric sweeper: the Bucher MaxPowa V65e. While some aspects of the eSweeper's performance will likely be common across different manufacturers and models, the exact trends presented here relate specifically to this model and weight of vehicle. A summary of details for the MaxPowa are shown in the table below.

Bucher MaxPowa V65e		
	Gross Vehicle Weight:	16t
	Battery Size:	200kWh (200kWh usable)
	Charging Capability:	50kW 3-phase charger, approx. 5 hour recharge time
	Typical Range*:	25-50 miles (duty cycle dependent) or 6-10 hours operation
*Vehicle range on a single charge based on observed operating routes in Wales. Estimated range was calculated as the miles possible using from 100% to 10% charge based on vehicles' stated battery capacity.		

Vehicle performance window

Data collected from deployed vehicles showed that the characteristics of the round that an electric Sweeper is used for will impact the energy consumption and possible range. One of the most significant factors impacting energy consumption of the sweeper is the amount of the route spent travelling versus actively sweeping, also called *stem distance*. For illustration, two typical rounds have been visualised below: one with relatively low stem mileage and one with a higher relative stem mileage. These rounds were based on the observed behaviours of the sweeper deployed in Wales.

Low Stem Mileage Sweeper Routes

Low stem mileage routes are characterised here as having a shorter total distance travelled during a day, but with a larger amount of the vehicle's operating time spent actively sweeping. Typically for the vehicle observed in Wales, these routes covered more residential town or city areas.

The graph in Figure 1 shows the estimated maximum number of operating hours possible on a single battery charge based on a typical low-stem round observed in the Wales deployment. This round covered a distance of 22 miles over 5.8 hours of vehicle operation, with approximately 65% of the vehicle's operating time actively sweeping. The baseline scenario assumed use of average fan speed settings and a daily temperature of 9°C. The current model predicts that both fan speed settings and time spent with sweepers on have a significant impact on the possible operating hours. The influence of temperature was relatively low in the data gathered to date.

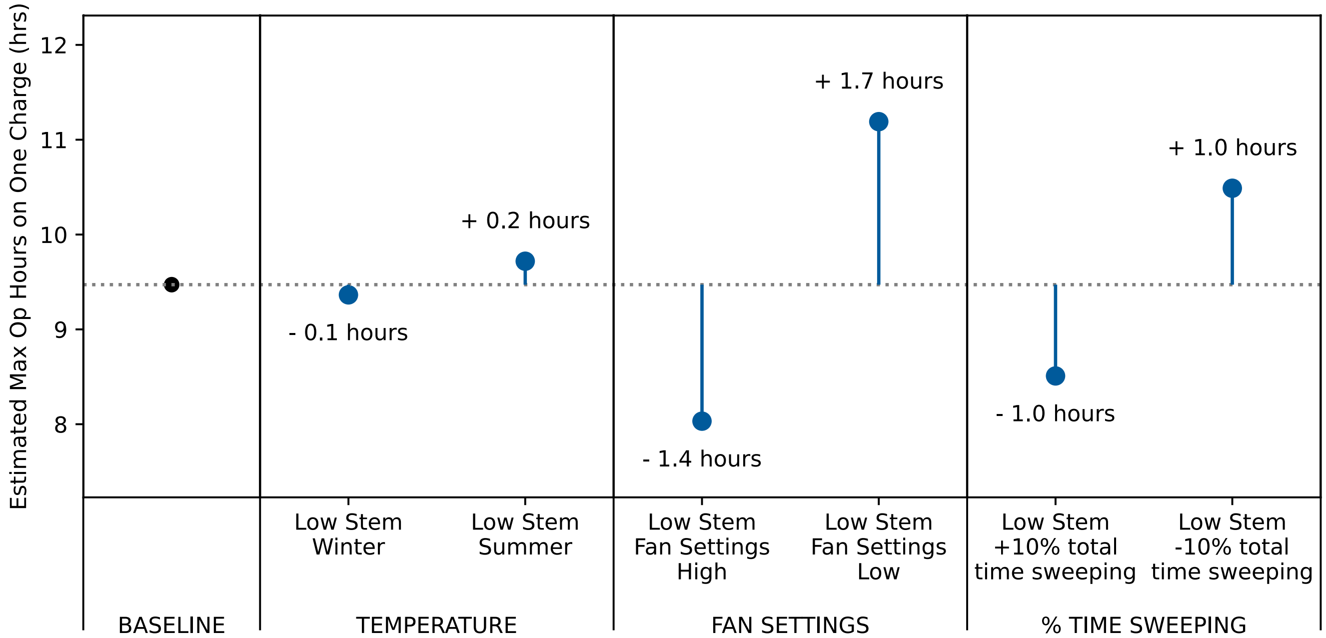

Figure 1: Estimated Impact of Duty Cycle Variations on Vehicle Operating Hours during a Low Stem Mileage Route.

High Stem Mileage Sweeper Routes

Higher stem mileage routes are characterised as having a long travel distance before sweeping begins, or a series of larger travel distances between short sweeping events. This type of route may be more likely in sweeping targeting specific areas of an accident on a motorway, for example.

The graph in Figure 2 shows the estimated maximum number of operating hours possible on a single battery charge based on a typical high-stem round observed in the Wales deployment. This round covered a distance of 34 miles over 6.5 hours of vehicle operation, with approximately 30% of the vehicle's operating time actively sweeping. The baseline scenario assumed use of average fan speed settings and a daily temperature of 9°C. As with the low-stem round, the current model predicts that both fan speed settings and time spent with sweepers on have a significant impact on the possible operating hours. As previously, the influence of temperature was relatively low in the data gathered to date.

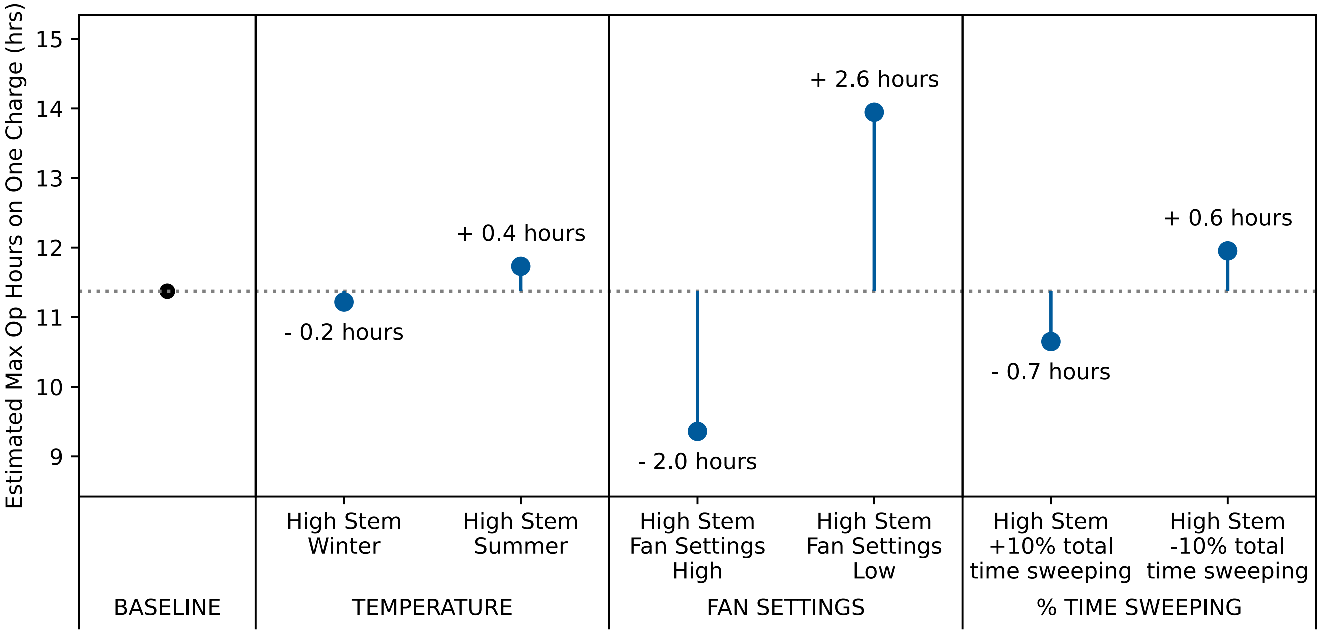

Figure 2: Estimated Impact of Duty Cycle Variations on Vehicle Operating Hours during a High Stem Mileage Route.

Vehicle Planning Model

Model Introduction

The vehicle planning model is a statistical model built from measuring the daily energy use from existing Bucher MaxPowa V65e sweepers across deployments in Europe. By collecting data from a range of different route characteristics and varying external conditions, the model can build up a more accurate view of how different factors affect the energy use of the vehicle.

This model allows users to explore the estimated energy use and possible range of an eRCV round in more detail than the general performance windows described above.

Where to Find the Model

The model can be found on the Cenex project website for the Welsh Government Zero Emissions Waste and Recycling Programme.

[Ultra-Low Emission Waste and Recycling Vehicles - Cenex]

How to Use the Model

The model can be used by opening the Excel file "**16t Bucher MaxPowa V65e eSweeper Energy Model**". The first worksheet describes how to use the model, and the second worksheet contains the data input cells and model results.

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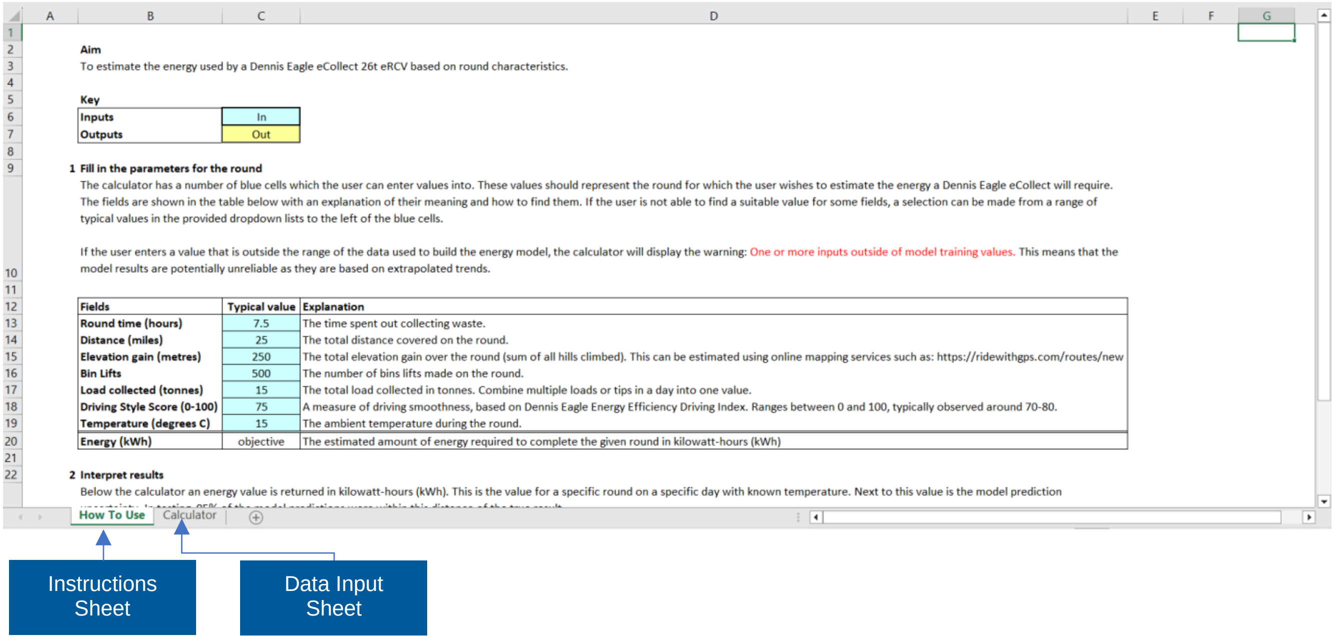
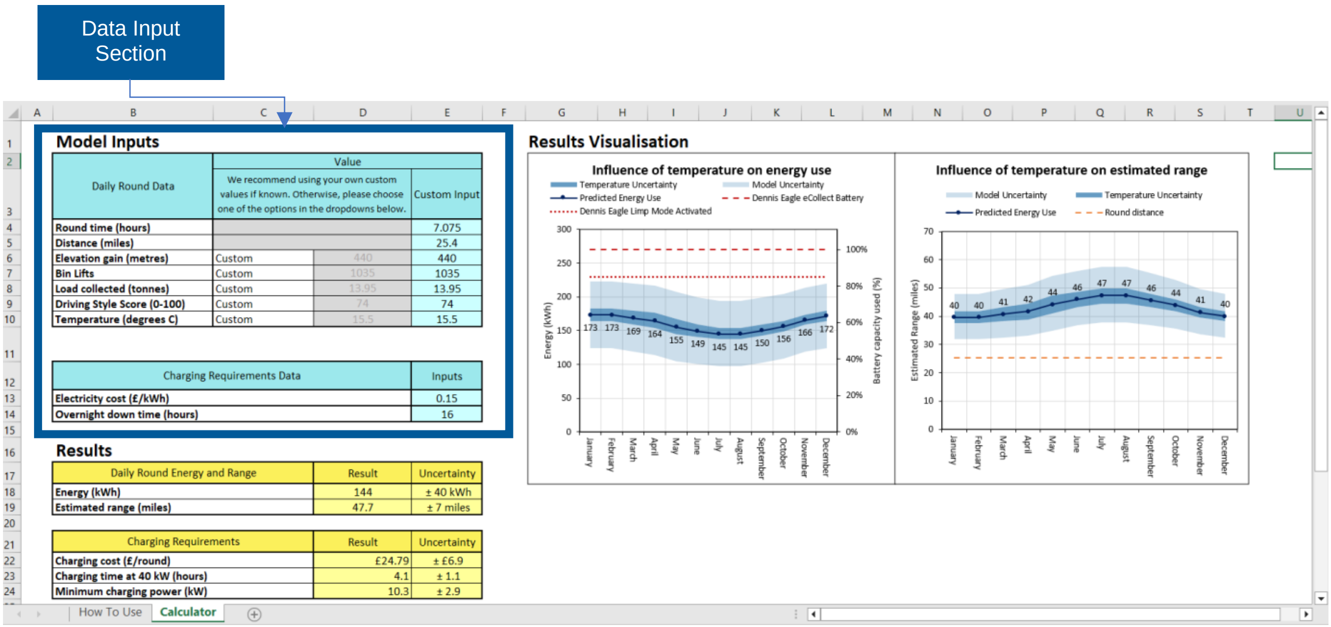


In the Calculator worksheet, the section for inputting round characteristics is highlighted in blue. Here, a user can input the following characteristics for their daily round:

- Round time (hours)
- Distance (miles)
- Ratio of Sweeping to Total Use Time
- Average Fan Speed (rpm)
- Daily Temperature (deg C)

It is preferred that users can provide a specific value for all of the above inputs. However, if some values are not known, estimate inputs are available via dropdown lists to the left of the input cells.



After round characteristics have been entered, the model will update its results and graphics. The model will calculate the estimated total energy used per daily round with the given characteristics. It will also display a measure of the uncertainty of the model. In testing, 95% of the model predictions were within this distance of the true result.

To the right of the results section are graphs showing the estimated variation of the input round over the span of an average year. These graphs use the average temperature for Wales over the year to show the variation in energy required and estimated range as the external temperature changes. Colder months tend to require more energy than warmer months and so the maximum operating hours decrease. This graph uses the input round characteristics only, and does not take seasonal collection trends into consideration.