JIBEBE INTERNSHIP 2022

WEEKLY REPORT WEEK 8

ELECTRIC TEAM

AMOS WANENE

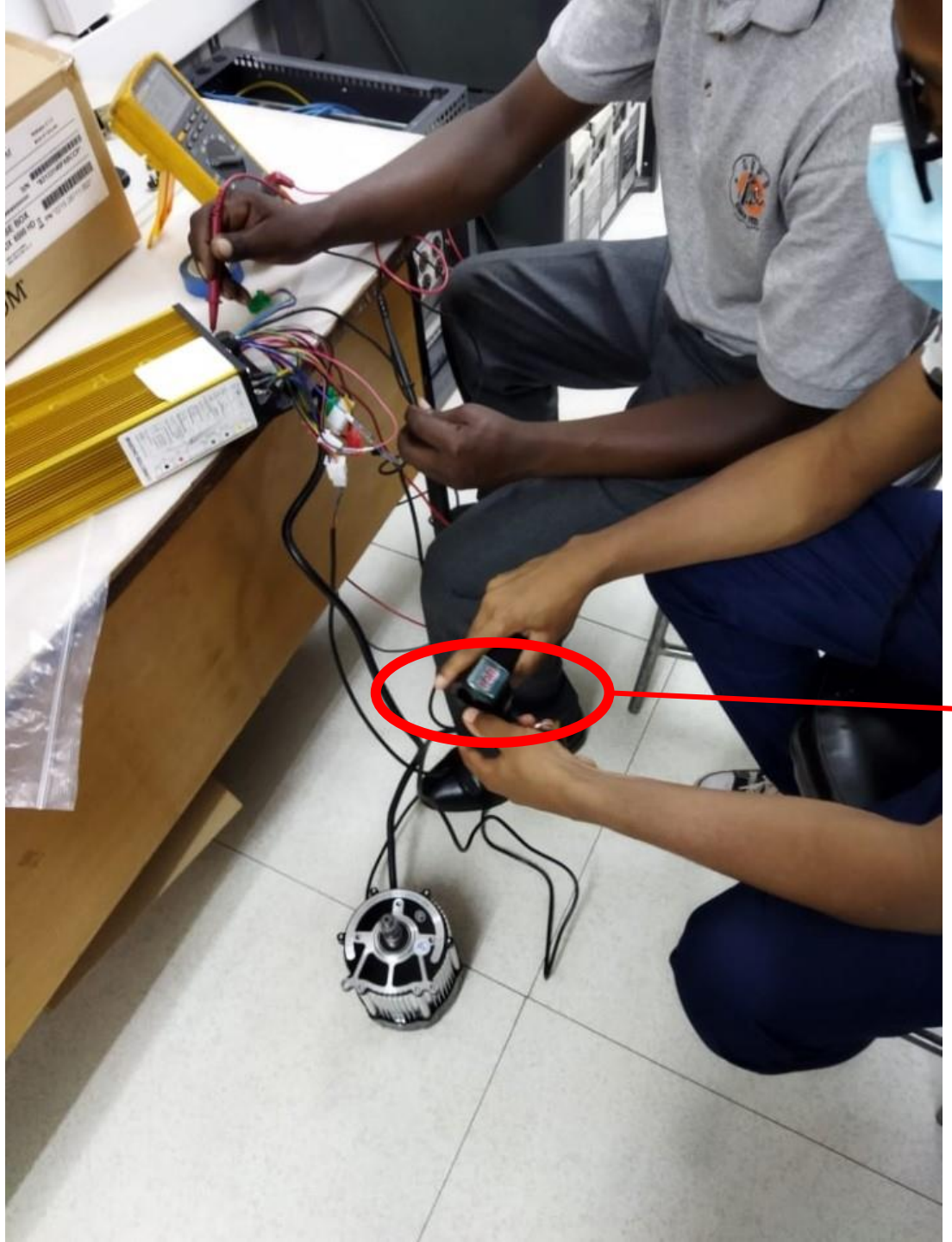
Tasks completed last week

[#53] Calibration of the throttle: The acquired throttle was found to be compatible with the available Electronic speed controller. With Mr. Kanja's help, the electric team was able to successfully calibrate the throttle to control the full span of motor speed through voltage regulation.

[#68] Research on graph plotting for the EV tractor program: Research was conducted on how to effectively plot for motor power, load, efficiency and torque.

[#69] Sourcing for quotations for the battery and motor for the e-tractor.


POLYCOM



System A

Clyte H3540

Hubmotor / Middrive

96V 0.2Ω 200Ah c

35A 70A 0.03Ω V

Throttle (Auto) 100 %

Show Advanced

Vehicle Parameters

26" Wheel

MTB, Upright

650kg (1433lbs) c

Human Power

0 W

Grade 0 %

Reset | Simulate

Run Simulation Set

Open System B →

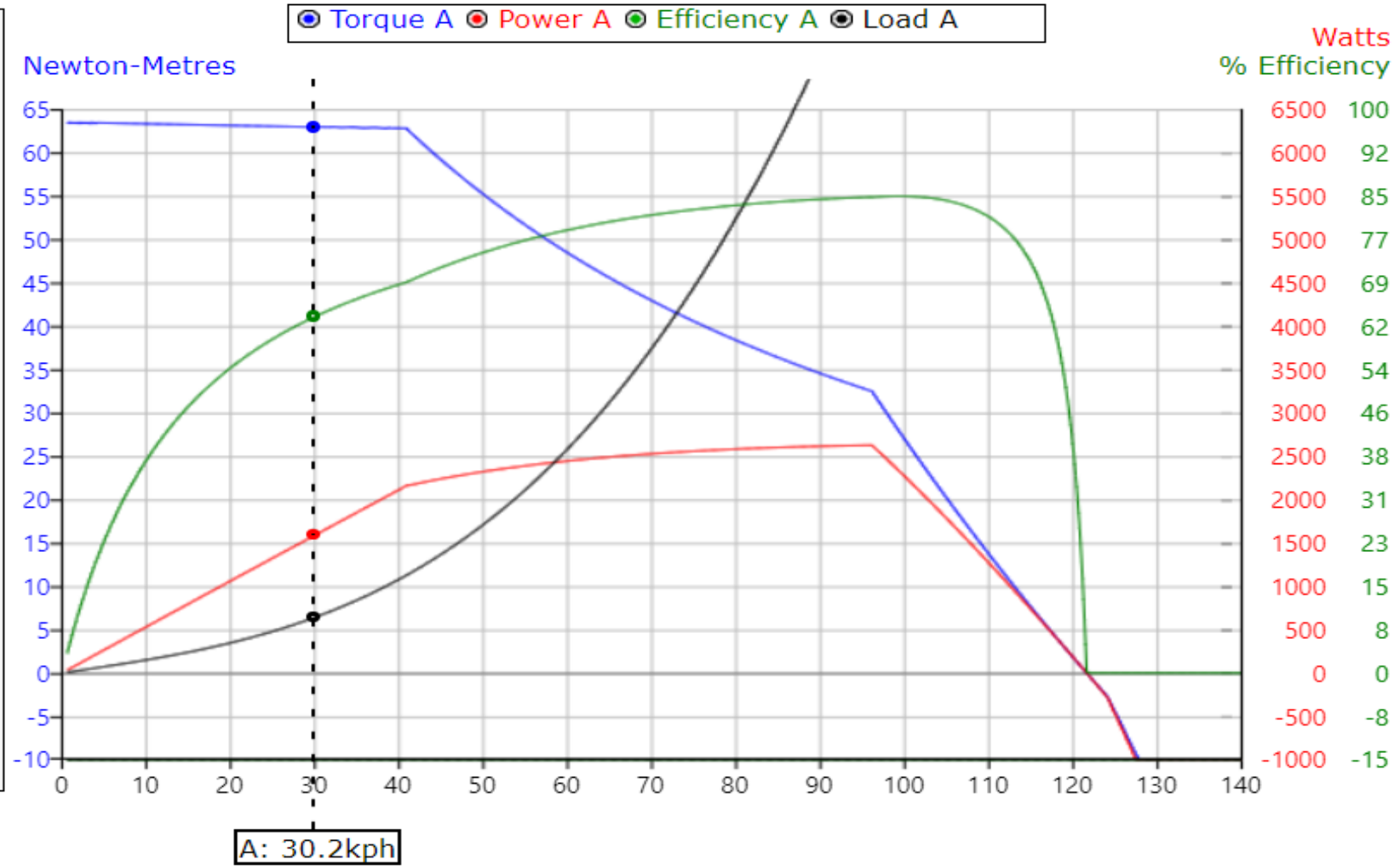


Chart Options

X Axis units: Km/h

Blue Curve: N-m Torque

Black Curve: Load Line

Graph	Syst A
Wheel Torq	63.0Nm
Mtr Power	1600W
Load	649W
Efficiency	63.3%
RPM	242.7 rpm

Electrical	Syst A
Mtr Amps	69.8A
Batt Power	2528W
Batt Amps	28.0A
Batt Volts	90.4V

Performance	Syst A
Acceleration	0.63 kph/s
Consumption	83.7 Wh/km
Range	216 km
Overheat In	3.7 minutes
Final Temp	>250 °C

System A

Clyte H3540

Hubmotor / Middrive

96V 0.2Ω 200Ah c

35A 70A 0.03Ω V

Throttle (Auto) 100 %

Show Advanced

Vehicle Parameters

26" Wheel

MTB, Upright

650kg (1433lbs) c

Human Power

0 W

Grade 2 %

Reset | Simulate

Run Simulation Set

Open System B →

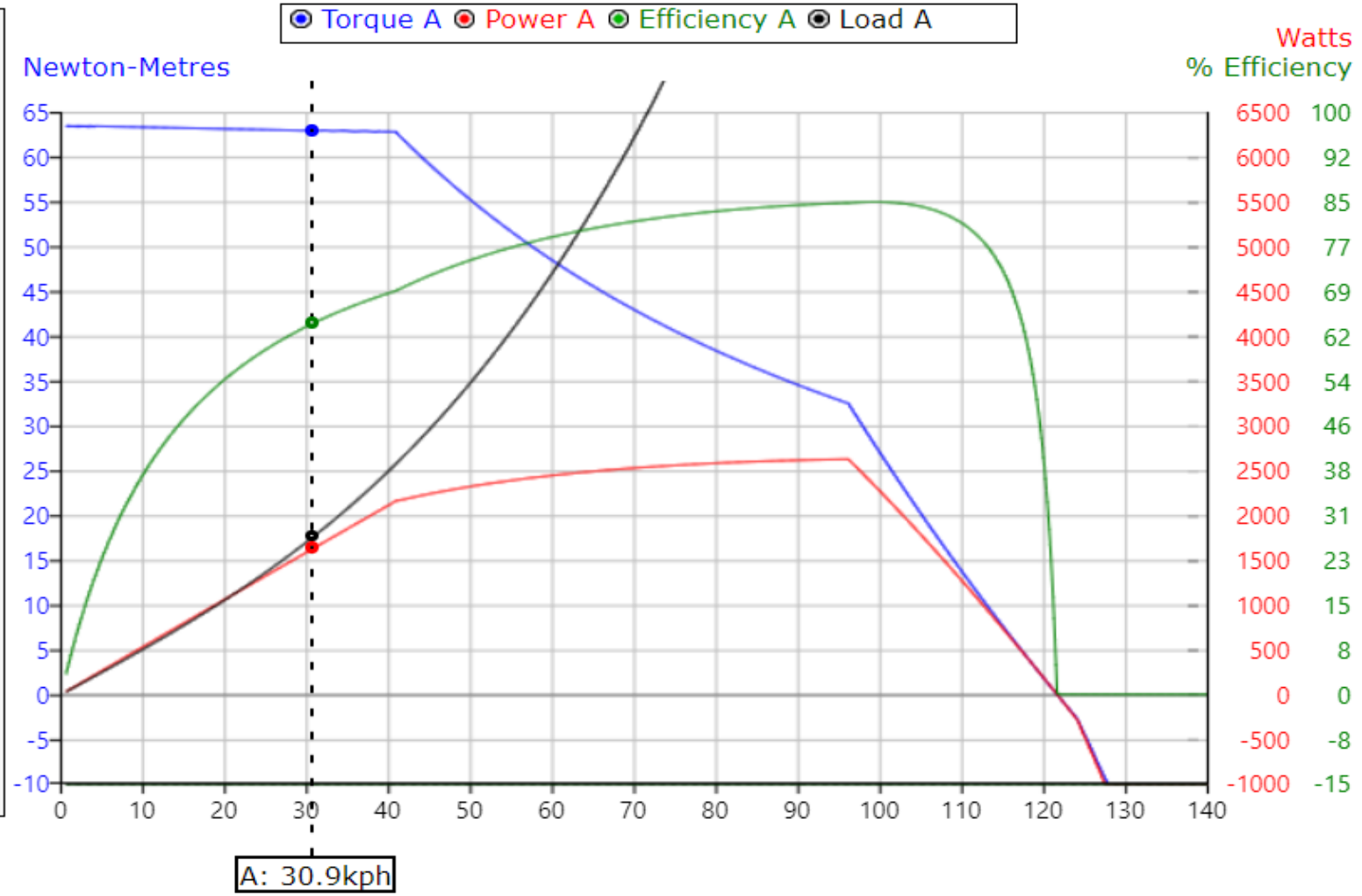


Chart Options

X Axis units: Km/h

Blue Curve: N-m Torque

Black Curve: Load Line

Graph	Syst A
Wheel Torq	63.0Nm
Mtr Power	1637W
Load	1769W
Efficiency	63.8%
RPM	248.4 rpm

Electrical	Syst A
Mtr Amps	69.8A
Batt Power	2566W
Batt Amps	28.4A
Batt Volts	90.3V

Performance	Syst A
Acceleration	-0.08 kph/s
Consumption	83.0 Wh/km
Range	217 km
Overheat In	3.7 minutes
Final Temp	>250 °C

The actual model in SimulatorV2 is substantially more complicated, taking into account the commutations that happen on a regular basis as a function of the speed and number of poles of the hub motor, and determining the resulting current waveforms that are produced when this is applied to the inductive motor windings.

$$Torque = I_{motor} K - (A_0 + A_1 \omega + A_2 \omega^2)$$

The power is calculated simply as this output torque times wheel speed:

$$Power = Torque * \omega$$

The efficiency is calculated from the input power to the controller divided by the output power (it does not take into account the losses internal to the battery pack):

$$Efficiency = \frac{Power}{(V_{OC} - R_{batt} I_{batt}) I_{batt}}$$

Finally, the road speed is calculated based on wheel size. The simulator also correctly shows the regen currents and negative power when the wheel is spinning faster than the unloaded voltage, so the axis go slightly in the negative region to show this.

Accuracy and Limitations

The parameter values that are chosen for the motor model are based on directly measured data that we have compiled from tests using a custom built dynamometer made for the task.

Our original 2005 dynamo setup pictured above was limited to a maximum loading of about 5 N-m, but we have since built two newer devices, one of which allows for continuous load testing of the hub motors of over 50 N-m of torque. This has enabled us to verify the mathematical model above to the measured output performance with a high degree of accuracy and over a wide speed and power range.

Tasks in this week

[#18] Assembly of the e-tricycle
[#67] Alpha testing of battery for the e-tricycle

Total estimation of weeks: 12

Week	Tasks	Reporting	Hrs	Month
5 - Requirements review				
5.1	Finalize on battery acquisition for the Tricycle	None	20	Feb
5.2	Finalize on motor and torque requirements for the Tractor	None	8	
5.3	Clarify best choice for motor orientation for use in Tractor to allow for automation	Team meeting to review the best course of action	5	
6 - Research				
6.1	Research and recommend best motor for our specific use case in the Tractor	Electric Team Meeting	20	Feb
6.2	Get experimental data for motors and run simulations for verification	None	20	
7 - Testing				
7.1	Alpha testing of newly arrived battery for the tricycle.	Electric Team Meeting	20	Feb
7.2	Testing of integration with other components of the electric subsytem	None	25	
8 - Deployment				
8.1	Deployment of the electric subsystem of tricycle to finalized Tricycle	None	20	March
8.2	Fixing of any issues that may arise during Integration	None	20	
9 - Testing				
9.1	Alpha testing of newly arrived components for the tricycle.	Electric meeting	16	March
9.2	Getting experimental resuts of the components and NDT to validate correct operation and performance under load	None	24	

10 - Integration				
10.1	Integration with other subsystem	Team meeting	40	March

11 - Testing				
9.1	Alpha testing of entire assembled tractor	Team meeting	40	March

12 - Deployment				
12.1	Deployment of Shujaa Tractor	Team meeting	40	April