ELECTRIC KUBOTA

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ABSTRACT

This project is a continuation of the electrically converted Kubota RTV500, which was initially operated using petrol. This year, the primary objective of this project required resolving electromechanical issues faced upon its conversion and integrating a data monitoring system.

Upon electrification, four of its newly added lead acid batteries were held in the cargo bed, decreasing trunk functionality. Restoration of this space was attained by extending the frame between the vehicle trunk and cabin to accommodate two of the four batteries with the remaining situated on either side of the cabin.

The project scope also included the investigation of a blown 400-amp fuse due to continuous high amperage draw above the rated motor conditions. To combat this issue, the team has utilized a programmer to tune the controller's response to acceleration to ensure the vehicle operates safely within its design limitations.

Software upgrades to the vehicle include installation of a display to provide user's intuition of operating parameters necessary to maintain electric vehicle such as voltage and state of charge with additional metrics able to be viewed online for further study the economic and environmental impact of the electric RTV.

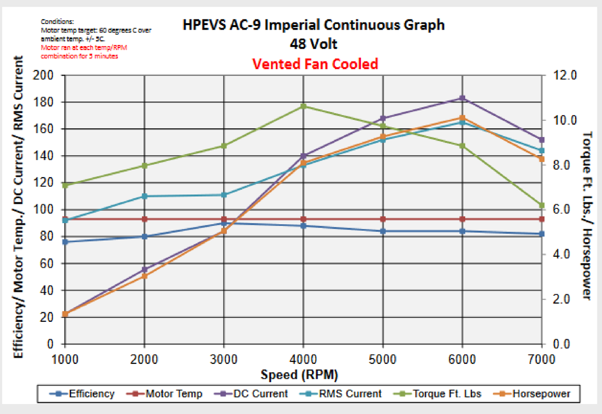
INTRODUCTION

Surging gasoline costs and net zero incentives has prompted the Yukon government to further investigate the practicality of electric vehicles in remote communities in northern Canada.

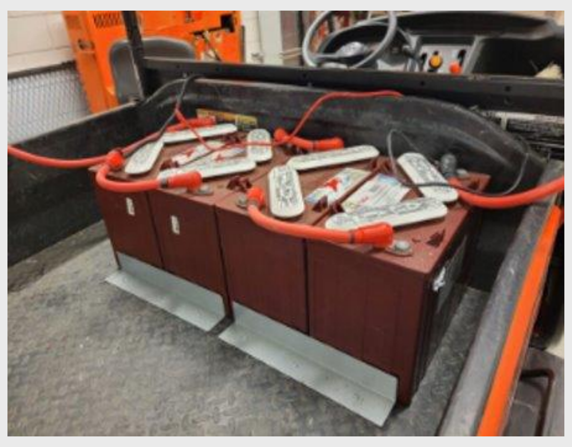
The Kubota RTV500 is an electrified utility vehicle used by the Kluane Lake Research Station (KLRS), a non-profit research and education institute just over 200km north of Whitehorse, Yukon Territories.

Optimization of the Kubota RTV500 is governed by:

- Malfunction Investigation and Solution
- Onboard Display
- Operating Time: 20 minutes minimum
- Towing/Payload Capacity: Maintained
- Trunk Functionality/Cargo Space: Increased
- Data Logging Capability to Yukon Government



HPEVS AC-9 Continuous Power Graph 450 A



Previous Battery Location

BLOWN FUSE INVESTIGATION

- **Existing Electrical System:**
  - *Curtis 1234 SE Controller*
  - *48V Lead Acid Battery*
  - *HPEVS AC-9 ACIM Motor*
  - *400 Amp Time Delay Fuse*

- **Rated Motor Continuous Amperage:** *80-100 Amps (DC)*
- **Tested Motor Continuous Amperage:** *150 – 300 Amps(DC)*

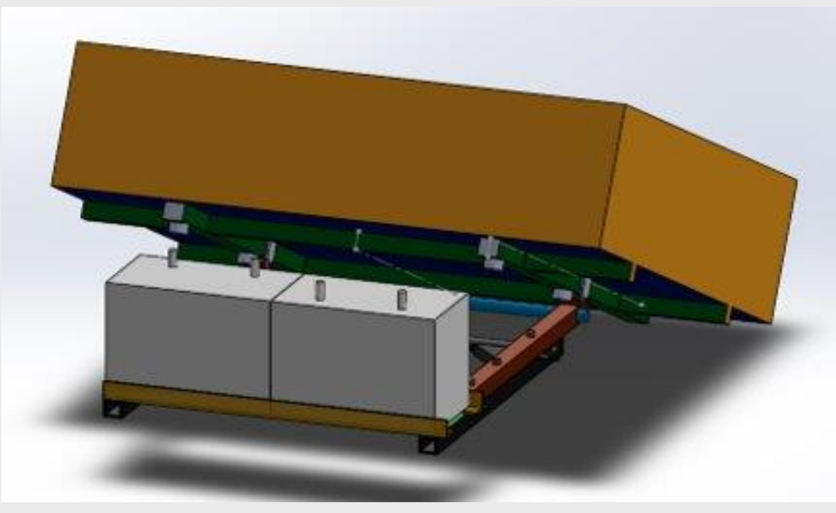
Our hypothesis concluded that the higher amperage led to a weakened fuse that caused the fuse to fail after a month of vehicle usage post electrification.

Potential Solutions:

1. Upgrade the motor and controller to increase the overall continuous power.
2. Throttle the Maximum Discharge Limit using the Programmer to protect the electrical system and improve the longevity of the components.

Battery Chemistry Evaluation

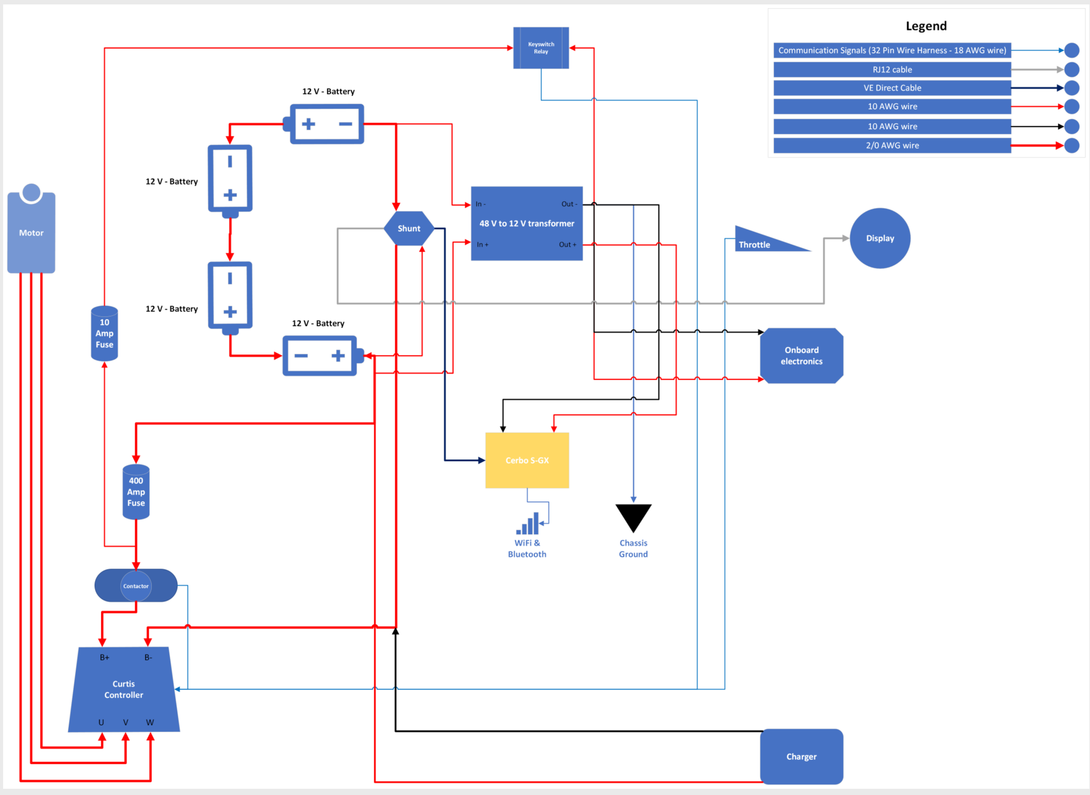
Parameter	Lead Acid (Flooded)	Lead Acid (AGM)	Lithium Ion	Details
Weight			✓	Lithium would provide 85-100kg of additional payload relative to Lead Acid.
Volume/Energy Density			✓	Lithium batteries have a much higher energy density (3x-4x) than lead acid batteries resulting much smaller size
Initial Cost	✓			Lithium batteries cost approximately up to 3.5x the cost of Lead Acid batteries.
Depth of Discharge	Up to 50%	Up to 80%	Up to 90%	Lithium batteries can sustain 90% depth of discharge.
Year-Round Operability			✓	Lithium batteries offer integrated self-heating systems (BMS) to withstand colder temperatures.
Maintenance		✓	✓	Due to the free liquid in flooded lead acid batteries, fluid levels need to be maintained
Mounting Versatility			✓	AGM Batteries may be oriented freely due to lack of liquid suspension. Lithium Ion batteries also share this characteristic in addition to its smaller size.



Battery Relocation Model

MECHANICAL DESIGN

- Reclamation of cargo space (+27%) and trunk functionality
- Augmented vehicle frame length (+8") and constructed EV battery housing
- Battery Relocation Cost: Less than $100



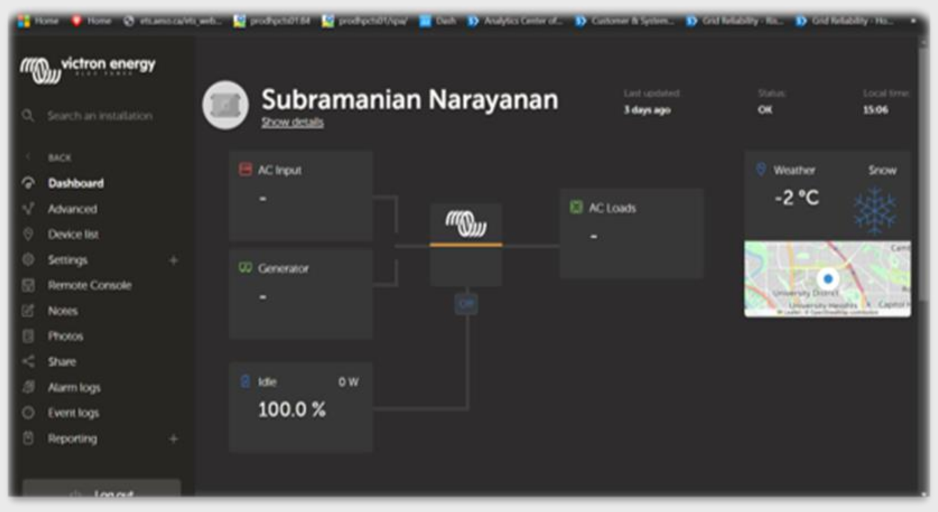
Circuit Diagram of Electrical System

ELECTRICAL SYSTEM

- Tuned motor controller to ensure amperage draw does not exceed the motor's rated value.
- Parameters such as voltage, state of charge, amperage, power draw and temperature can be communicated to users
- Due to blown fuse investigation, it is observed that the frame of the vehicle is split into three parts, and a local ground was implemented by connecting all parts of the vehicle frame

SOFTWARE

- Wi-Fi and Bluetooth connectivity via CERBO GX
- Utilized the Victron Remote Management Portal(VRM)
- Prepared an online dashboard to trend performance metrics remotely

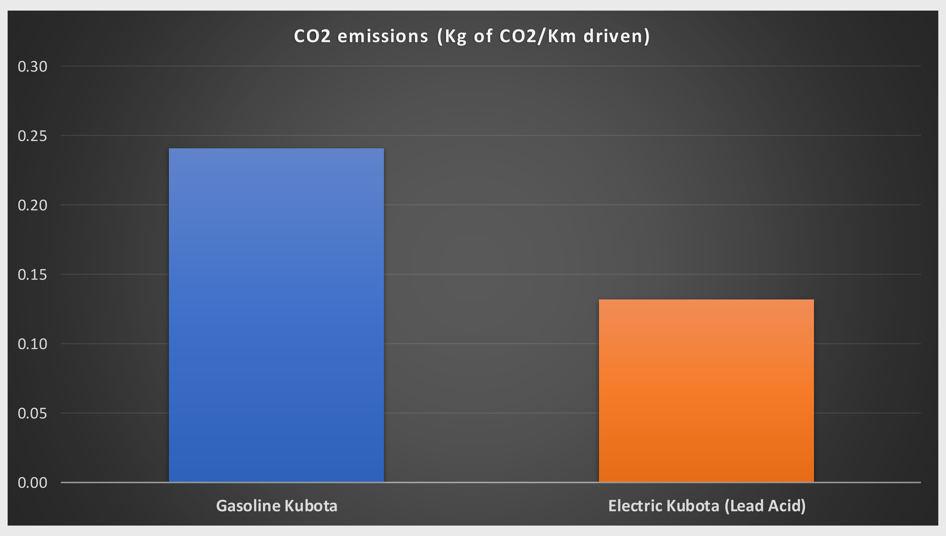


Online Dashboard displaying battery statistics

GHG EMISSIONS

The second largest source of the Government of Yukon's emissions is transportation, which made up 34 per cent of 2018 emissions [1]. The project aligns with the Government of the Northwest Territories' initiative to reduce emissions from transportation by 10% on a per person basis [2].

Our estimates based on the government regulations [3], show that we conserve about 45% of equivalent CO2 emissions when we switch from gasoline to electric drive in the Kubota.



Graph comparing the carbon emissions per km (excluding the manufacturing)

PROCUREMENT

Product			
Description	**Cerbo GX** • Data logging and transmission • WiFi and Bluetooth connectivity • Advanced analytics on state of charge, voltage and amperage of the circuit.	**Display** • Instant display for vehicle's electric drive • Displays state of charge, voltage, amperage pull, etc.	**Curtis Model 1311** • Provides interface to optimize the motor controller • Programs the motor controller to use the battery effectively

REFERENCES

[1] https://yukon.ca/sites/yukon.ca/files/env/env-government-yukon-corporate-greenhouse-gas-emissions.pdf
[2] https://www.inf.gov.nt.ca/sites/inf/files/resources/121_energyiniatives-actionplan_eng_web.pdf
[3] https://publications.gc.ca/collections/collection_2022/eccc/En81-4-2020-3-eng.pdf
[4] https://www.hpevs.com/hpevs_ac_electric_motors_power_graphs-ac_9.htm