Solaire Rider - Electric Commuter Car

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Agenda

- Motivation/Objective
- Project Description and Goals
- Technical Specifications
- Design Approach
- Codes and Standards
- Schedule
- Marketing and Cost Analysis
- Current Status
- Group Member Roles
- Top-Level Electrical Overview

Motivation/Objective

- Today's vehicles are getting larger and larger, needing more non-renewable fuel to travel the same distance as smaller vehicles.

- This project looks to remedy this by creating an alternative that anyone could easily adopt.

- The solution is to create a small vehicle that runs solely off electricity for short daily commutes around town.

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Project Description

- The team will design an electric powertrain system to replace an existing internal combustion engine on a two-seater go-kart.

- The new powertrain will consist of:
  - DC Electric Motor
  - Lithium-ion Battery Module
  - Charging Circuit
  - Solar Panel
  - Simulated Electronic Gearbox

- The motor will also be configured to function as a generator, able to regain energy to the battery when the vehicle needs to slow down.

Goals

- **General**
  - Reach a minimum range of one kilometer
  - Able to seat two people
- **Motor**
  - Able to achieve a cruising speed of 30 miles per hour
  - 2-3 horsepower
  - 2-3 kilowatts
- **Battery**
  - Output enough power to drive a 24 V, 2 horsepower electric motor
  - Enough capacity to drive for at least 1 kilometer
  - Able to be safely charged and discharged
- **Electronic Gearbox**
  - Allows manual control of the motor’s torque and speed through six separate states/gears

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Technical Specifications

Table 1. TESLA BATTERY SPECIFICATIONS

Features	Specification
Capacity	232 Ah, 5.3 kWh
Height	3.1 in
Width	11.9 in
Length	26.2 in
Weight	55 lbs.
Bolt Size	M8
Voltage nominal	3.8V/Cell, 22.8V/Module
Charge voltage cut-off	4.2V/Cell, 25.2V/Module
Discharging cut-off	3.3V/Cell, 19.8/Module
Maximum Discharging Current (10 sec.)	750 A

Table 2. SOLAR-PANEL SPECIFICATIONS

Features	Specification
Size (Height x Width x Length)	40 x 1 x 27 in
Amperage	5.6 A
Material	Polycrystalline Silicon
Weight	3.5 lbs.
Solar Panel Type	Monocrystalline
Voltage	24V
Wattage	100 W
Number of Panels	3
Features	Flexible, Outdoor, Weatherproof

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Technical Specifications

Table 3. SOLAR-PANEL CONTROLLER SPECIFICATIONS

Features	Specification
Size (Depth x Height x Width)	9.37 x 6.81 x 2.85 in
Amperage	30 A
Voltage	24 V
Wattage	780 W

Table 4. MOTOR SPECIFICATIONS

Features	Specification
Size (Length x Width x Height)	35 x 15 x 15 cm
Weight	17 kg
Output Power	4 kW
Voltage	24 V
Type	DC Motor
Torque	10 N*M
Speed	3100 RPM

Table 5. GO KART BODY SPECIFICATIONS

Features	Specification
Size (Length x Width x Height)	58.5 x 43 x 36 in
Weight	330 lbs.
Wheelbase	50 in
Weight Capacity	400 lbs.
Ground Clearance	4 in

Note: Since provider hasn't give us the specification of the product, this is the specification of similar product.

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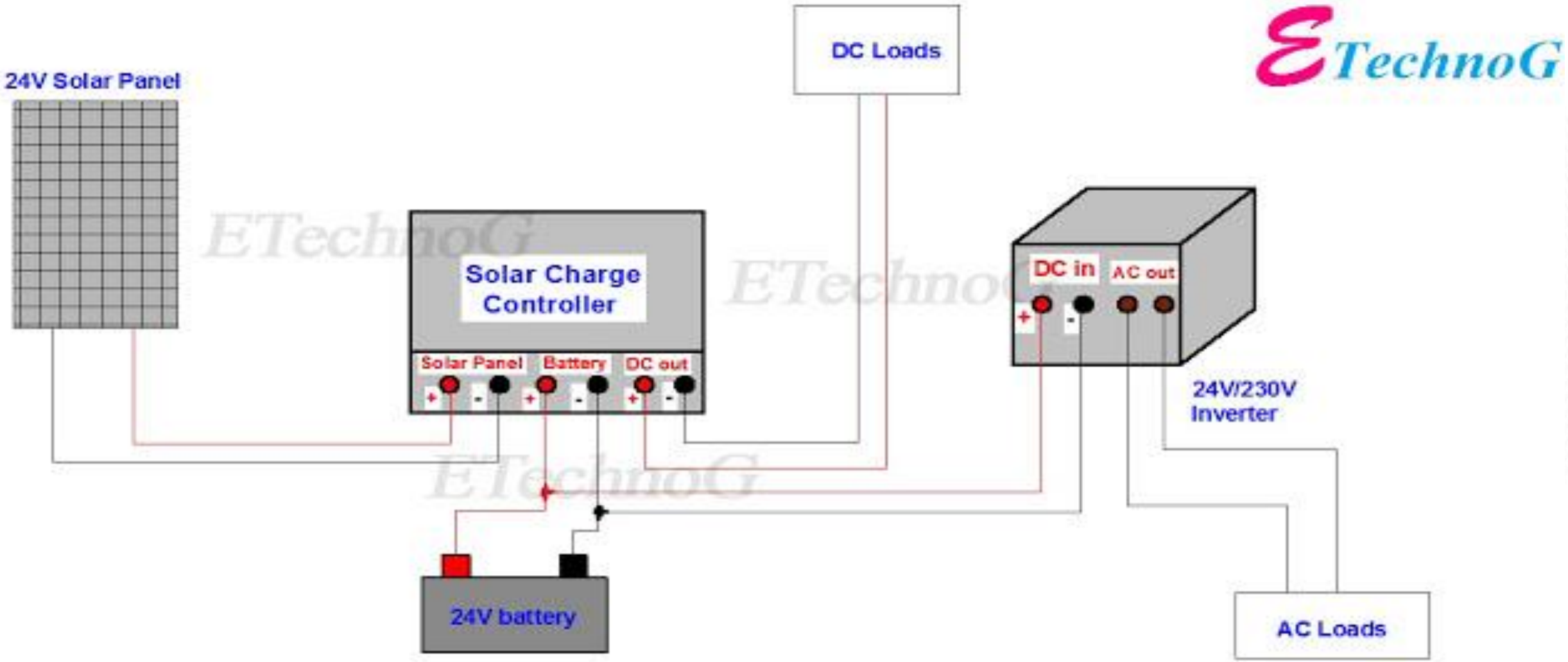
Design Approach



[1] Wiring Diagram of Solar Panel

Design Approach-Choosing components

- **DC Motor? AC Motor?**
  - Solar panel generates DC output
  - AC motor needs inverter->Increase overall weight->Affect the drive range
    - **DC motor**

- **Pre-built? Build own solar panel charging controller?**
  - Possibility of failure
  - Lack of time to build perfectly
  - Economic efficiency
    - **Buy a pre-built**

Design Approach-Calculations

- **Charge/Discharge time(hr) = Battery Capacity(Wh)/Wattage(W)**
  - Battery capacity : 5.3kWh, Three solar panel charge rate : 100W*3 = 300W
  - Total estimated charging time : 17.67hrs

- **Circumference(miles) = 2π*Radius**
  - Radius : 5.5inch
  - Circumference : 0.00054miles

- **Go Kart Speed(Mph) = Motor Speed(RPM)*Circumference(miles)**
  - Motor Speed : 3100 RPM, Circumference : 0.00054miles
  - Go Kart Speed : 45.35mph

Code and Standards

- **According to the Georgia Department of Driver Services, all commercial vehicles less than 25 years old must include:**
  - Service Brakes
  - Parking Brake
  - Steering Mechanisms
  - Lighting Devices and Mechanisms (headlights, blinkers, etc.)
  - Horn
  - Windshield
  - Windshield Wipers
  - Coupling Devices (alignment)
  - Rear Vision Mirrors
  - Emergency Equipment (airbag, seatbelt, etc.)
  - Doors
  - Frame
  - Tires (must have at least 4/32 of an inch of tread on front tires and at least 2/32 of an inch of tread on all other tires.)

Code and Standards

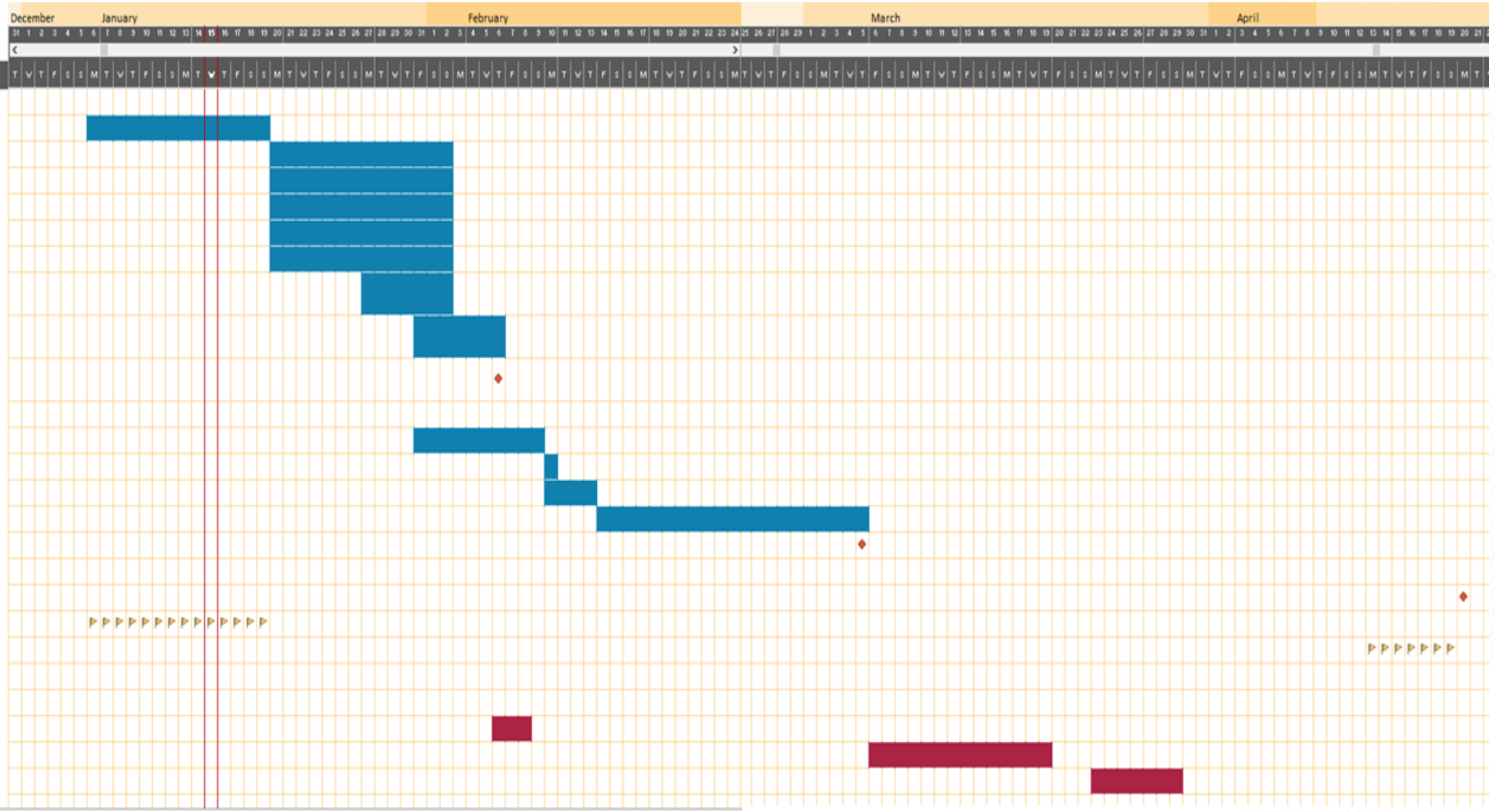
Table 6. SPEED LIMITS IN GEORGIA

Area	Speed (MPH)
Urban or Residential Districts	30
Unpaved County Roads	35
Rural Interstate	70
Urban Interstate or Multi-Lane Divided Highway	65
Other	55

Schedule

Scrolling Increment: 42

Letter	Milestone Descript	Category	Prerequisite	Progress	Start	No. Days
	Design					
A	Decide Purchase Parts	On Track		25%	1/6/2020	14
B	Purchase & Shipping	On Track	A	0%	1/20/2020	14
C	Charging CKT	On Track	B	0%	1/20/2020	14
D	Feedback Control	On Track	B	0%	1/20/2020	14
E	Virtual Gearbox	On Track	B	0%	1/20/2020	14
F	Power Flow	On Track	B	0%	1/20/2020	14
H	Individual Part Testing	On Track	B-F	0%	1/27/2020	7
I	Re-design using the measured non-ideal parts	On Track	H	0%	1/31/2020	7
J	Design Completion	Goal	I	0%	2/6/2020	1
	Assembly					
K	Find Workspace on Campus	On Track	H	0%	1/31/2020	10
L	Get the Kart on Campus	On Track	K	0%	2/10/2020	1
M	Strip Kart	On Track	L	0%	2/10/2020	4
N	Assemble Prototype	On Track	M	0%	2/14/2020	21
O	Prototype Completion	Goal	N	0%	3/5/2020	1
	Milestones					
P	Expo	Goal	R		4/20/2020	1
Q	Oral Presentation	Milestone	S		1/6/2020	14
R	Final Demo	Milestone	V		4/13/2020	7
S	4011 Project Proposal	Goal			11/19/2019	1
	Test					
T	Calculate Design Parameters	High Risk	J		2/6/2020	3
U	Design Verification/Tuning	High Risk	N		3/6/2020	14
V	Test Drive	High Risk	U		3/23/2020	7



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Marketing and Cost Analysis

- Target market: individuals traveling short distances (with minimal cargo) and favor renewable energy
- The total cost for the parts is $3,213. (cost breakdown in next few slides)
- Estimations were made for the microcontroller, cables, and packaging

Marketing and Cost Analysis: Prototype

Table 7. PROTOTYPE COST

Part	Cost ($)
Go-Kart Body	965 [7]
Tesla Model S Battery Module	1,580 [8]
WindyNation Solar Panel	233 [9]
Alibaba DC Motor	135 [10] bulk=130
Microcontroller & Booster Pack	50
Cables/Miscellaneous	150
Packaging/Shipping	100
Total Part Cost	3,213

Marketing and Cost Analysis: Development Hours

Table 8. DEVELOPMENT HOURS PER ENGINEER

Labor	Number of Hours
Weekly Meetings	50
Report Preparation	45
Research	5
Software Design	25
Hardware Design	40
Assembly	10
Testing	10
Total	185
Cost at $34/hr [11]	6,290

- Labor costs were determined by using the average hourly pay for an entry level electrical engineer of $34/hr. Multiplying the labor cost for four engineers comes out to be $25,160

Marketing and Cost Analysis: Total Development Cost

Table 9. TOTAL DEVELOPMENT COST

Development Component	Cost ($)
Parts	3,213
Labor	25,160
Fringe Benefits, % of Labor	7,548
Subtotal	35,921
Overhead, % of Material, Labor, & Fringe Benefits	43,105
Total Development Cost	79,026

- Table 9 shows the total development cost of $79,026 for the project assuming 30% fringe benefits of labor and 120% overhead on materials/labor/fringe benefits.

Marketing and Cost Analysis (continued)

Assumptions:

- The production run will run five years, in which 5000 units will be sold
- The parts cost is estimated at a 10% bulk discount
- The labor cost is based on a technician getting paid $20/hr to assemble and test the unit.
- The marketing and advertising for the Solaire rider will be roughly 10% of the total input cost.
- The amortized development cost is the total development cost of $79,026 divided by 5,000 units to result in $16.

Marketing and Cost Analysis: Price Per Unit

Table 10. DECISION OF PRICE PER UNIT (based on 5,000 unit production)

Aspect of Development	Cost ($)
Parts Cost	2988
Assembly Labor	40
Testing Labor	20
Total Labor	60
Fringe Benefits, % of Labor	18
Subtotal	3066
Overhead, % of Material, Labor, & Fringe Benefits	3679
Subtotal, Input Costs	6745
Sales Expense	675
Amortized Development Costs	16
Subtotal, All Costs	7,436
Profit	2,562
Selling Price	$10,000

Current Status

- Motor and Motor Controller have been decided and need to be ordered next week, Tuesday January 21, 2020.

- Battery and Solar Panel will be borrowed from ECE Senior Design Lab.

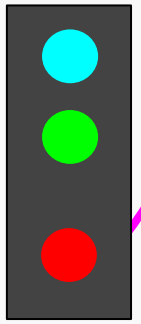
- Meetings will take place on Wednesday and Friday at 11:00 AM

- Need to prepare the new meeting space.

Group Member Roles

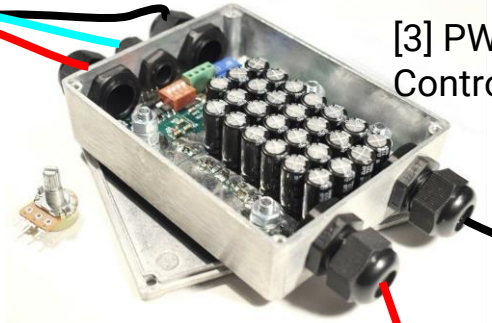
Team Leadership	Christopher Hooper
Project Management	Moongyu Kang
Webmaster	Hong Yee Cheah
Expo Coordinator	Christopher Hooper
Documentation Coordinator	Daniel Bruce
Real-Time Coding	Hong Yee Cheah
Analog Design	Daniel Bruce
Mechanical Design and Assembly	Moongyu Kang

Top-Level Electrical Overview

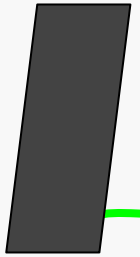


Simulated Manual Gearbox Selector

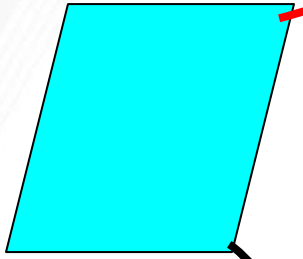
[4] ARDUINO UNO



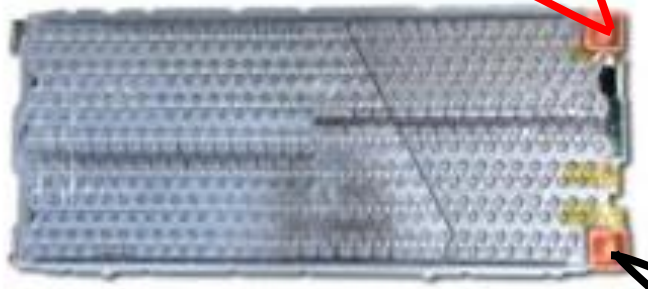
[3] PWM DC Motor Speed Controller



Potentiometer Pedal



Solar Panel + Controller



[1] Tesla Model S Battery Module

Electric DC Motor 24 V 4 kW 3,100 RPM [2]

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Design Approach
Image Sources

[1] “Wiring Diagram of Solar Panel with Battery, Inverter, Charge controller and Loads.,” ETechnoG. [Online]. Available: https://www.etechnog.com/2019/01/wiring-diagram-of-solar-panel.html. [Accessed: Nov. 18, 2019].

Top-Level Electrical Overview Image Sources

[1] “Tesla Model S Lithium Ion Battery 18650 EV Module - 22.8 Volt, 5.3 kWh,” EV West - Electric Vehicle Parts, Components, EVSE Charging Stations, Electric Car Conversion Kits, Feb. 24, 2017 [Online]. Available: https://www.evwest.com/catalog/product_info.php?products_id=463&osCsid=rp0cj2i33tp2j88tnj80dto4e5. [Accessed: Nov. 18, 2019].

[2] “Electric Dc Motor 24v 4kw 3100Rpm,” Alibaba. [Online]. Available: https://www.alibaba.com/product-detail/Electric-Dc-Motor-24v-4kw-3100Rpm_60817220057.html?src=sem_ggl&mark=shopping&cmpgn=1666259716&adgrp=66971409960&locintrst=&locphyscl=1015254&ntwrk=g&device=c&dvcmdl=&position=1o2&pla_adtype=pla&pla_mrctid=140283378&pla_channel=online&pla_prdid=60817220057&pla_country=US&pla_lang=en&pla_group=293946777986&pla_localcode=&gclid=Cj0KCQiAtrnuBRDXARIsABiN-7C8lPhxTP3S4O5fa9S8Kfq-zz8r75fN7H3nBC5at0lhaEYrLn2YX3QaAlh1EALw_wcB#shopping-ads. [Accessed: 18-Nov-2019].

[3] “200A limit 50V 12V 24V DC motor Speed Controller PWM waterproof Arduino RS232,” eBay. [Online]. Available: https://www.ebay.com/itm/200A-limit-50V-12V-24V-DC-motor-Speed-Controller-PWM-waterproof-Arduino-RS232/183088343577?_trkparms=aid%3D555021%26algo%3DPL.SIMRVI%26ao%3D1%26asc%3D20191002091506%26meid%3D1cc4fc95efa54badbe9ec52e7cf04b7f%26pid%3D101103%26rk%3D2%26rkt%3D5%26mehot%3Dag%26sd%3D183220731414%26itm%3D183088343577%26pmt%3D1%26noa%3D0%26pg%3D2332490&_trksid=p2332490.c101103.m3021. [Accessed: 15-Jan-2020].

[4] “ARDUINO UNO R3 [A000066],’ Amazon. [Online]. Available: https://www.amazon.com/Arduino-A000066-ARDUINO-UNO-R3/dp/B008GRTSV6. [Accessed: 15-Jan-2020].