Grid Independent Charging Station (GICS)

INDUSTRY/COMMUNITY PARTNER REPORT

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Developed for:

Taurean EV.

Grant Agency:

St Clair College.

Executive Summary

1. Introduction

The end goal of this section is to provide the reader with an overview of the background for the need/challenge of this project, what the focus of the project is, and lastly the goal(s) of the research project.

Note to writer: whenever you are adding a source/citation anywhere in the document, go to references in the top ribbon, select insert citation, and select add a new source. Then select what type of source you are citing and fill out the relevant fields. This will help you at the end of the document in the references section when uploading all of your sources used in the report.

1.1. Problem statement

Design a Grid Independent Charging Station (GICS) to service electric vehicles (EVs) travelling to or between locations that do not have access to a robust electric grid. This will allow electric vehicles to have a greater range to travel throughout Canada. In addition, it reduces 'range anxiety' and increases adoption of electric vehicles in Canada.[1]

1.2. Scope

The scope of this project is to create design documentation for the creation of a GICS. This will include mechanical and electrical calculations for the possibility of scaling to varying proposed locations. This includes taking into account peak sun hours, wind spin, elevation etc. Hardware recommendations for proposed energy generation, controls, energy storage and charging system will be included. CAD drawings and documentation will be disseminated to the industry partner and St. Clair College Knowledge Transfer Department[2].

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[1] Eric Ellis

[2] Eric Ellis

2. Research Methods and Results

2.1. Milestone 1: Remote Charging Station Level 3 (RCS) location.

To determine the optimal location for the RCS (Recharging Station), we took into account specific constraints outlined by our partner. These considerations were essential to guarantee the partner's ability to manage implementation logistics, conduct continuous on-site monitoring, and establish a strategic advertising presence for their company. The criteria for selecting the location were as follows:

- The chosen site must be situated in Ontario.
- There should be no Level 3 electric car recharging stations within a minimum radius of 50 km (approximately 31.07 mi).
- The selected location must feature a road with a daily traffic volume ranging from moderate to high for effective service provision.

Methods

In our investigation, we conducted an online search for Big Data and Analytics (BDD) information pertaining to meteorological data, various forms of energy in the province of Ontario, the accessibility of electric charging stations, and traffic patterns. Specifically, we accessed data from the Independent Electricity System Operator (IESO[3]) to ascertain the specific types of energy sources available in distinct regions of Ontario. For information on the location of unoccupied electric vehicle (EV) charging stations, we consulted Chargehub[4]. Google Maps[5] was employed to calculate distances between two given points, while the Ministry of Transportation library provided data on traffic volume for our analysis.

We utilized a diverse array of sources to obtain monthly weather[6] information and solar irradiation[7] data. Notably, for weather conditions, we obtained data from the nearest meteorological station, ensuring proximity for accurate representation.

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[3] https://www.ieso.ca/localContent/ontarioenergymap/index.html
[4] https://chargehub.com/en/Charging-Stations-Map.html
[5] https://www.google.com/maps
[6] Wind Speed - Annual data for Port Carling (weatherstats.ca)
Global Wind Atlas
Canada Weather Stats
https://power.larc.nasa.gov/data-access-viewer/
[7] SunCalc - sunrise, sunset, shadow length, solar eclipse, sun position, sun phase, sun height, sun calculator, sun movement, map, sunlight phases, elevation, Photovoltaic system, Photovoltaic

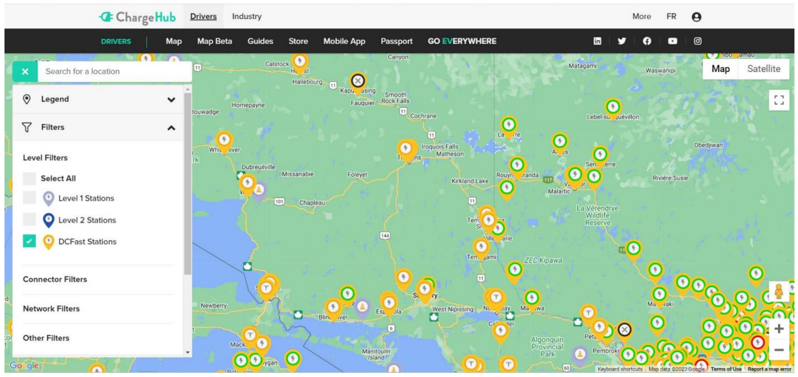

Figure xx: Ontario Charge Stations

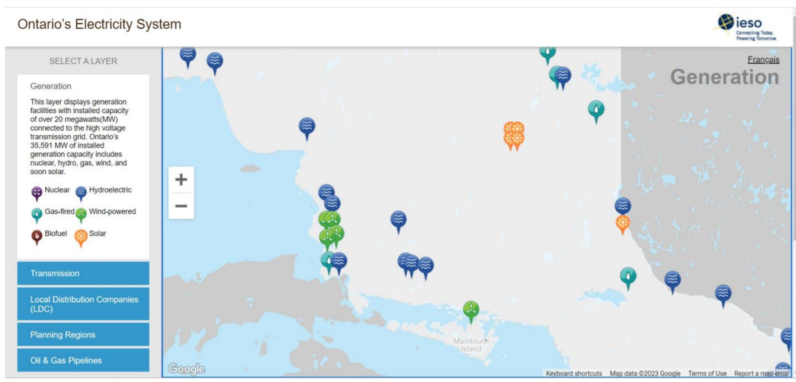

Figure xx. Ontario Sources of Energy.

2.1.2. Results of Milestone 1

A remote charging station means to us a location to which people are travelling but other chargers are more than 150 KM. Level 3 charging station is also known as DC fast charging. It can charge the electric vehicle within 30 minutes. Its power rating is more than 20KW. In most, the average battery capacity is 102 to 105 kWh, but the usable capacity is 98 kWh. Usable capacity is the capacity of the battery that is designed to run efficiently, and users have access to that range. As per car battery capacity, the maximum amount of energy it can store when fully charged to 100%. We never discharge the battery SOC (state of charge) below its threshold. Below its threshold rating might kill the battery or reduce the life span of the battery. In that range, several factors matter for the actual range of cars, like terrain, climate control, and driving style. Our client also considers the actual car range between 20 to 80% because level 3 charging or DC fast chargers are more efficient in this range. The electric car range number we consider is 250 to 270 Km.

Upon comprehensive consideration of the gathered information, we selected four options that align with the initial constraints:

Name	Pointeau Baril (Between Barrie and Grand Sudbury)											
Coordinates	45.59799415230149, -80.38415813868534											
Population	250											
Distance from the close charger station (km)	121Km											
Name of the road	69											
Rate cars per year (2019)	8200 (aprox 8500-year 2023)											
Year 2022	January	February	March	April	May	June	July	August	September	October	November	December
Day light (hhmm)	9h1m	10h16m	11h44m	13h23m	14h49m	15h40	15h26m	14h16m	12h42m	11h7m	9h37m	8h45m
Solar Constant w/m2	1413.5	1402.9	1384.6	1360.5	1339.6	1325.8	1323	1331.5	1349.8	1372.7	1395.5	1410.4
Air mass	3.08	2.285	1.702	1.546	1.337	1.278	1.312	1.427	1.663	2.118	2.442	3.149
Irradiance W/m2	747	847	930	943	969	971	962	945	914	853	819	738
Wind Velocity km/h	14.05	16	13.3	14.2	14.4	12.85	12.2	12.2	12.4	14.47	15.8	15.2
Temperature ºC	-16	-12.5	-5.3	2.4	13.2	15.9	18.2	17.9	13.5	6.77	0.6	-5.7
Garson, On for enviroment historic												

Table XX . Option 1.

Name	Watershed 144 (between Timmis and Grand Subdury)											
Coordinates	47.43999695645298, -81.87245801767568											
Population	Gas Station											
Distance from the close charger station (km)	109											
Name of the road	144											
Rate cars per year (2019)	1250 (aprox 1400- year 2023)											
Year 2022	January	February	March	April	May	June	July	August	September	October	November	December
Day light (hhmm)	8h48m	10h9m	11h43m	13h49m	15h0m	15h55	15h40	14h25m	12h45m	11h3m	9h27m	8h31m
Solar Constant w/m2	1413.3	1402.8	1384.5	1360.4	1339.5	1325.8	1323	1331.6	1350	1372	1395.7	1410.5
Air mass	4.606	2.892	2.074	1.407	1.252	1.185	1.189	1.286	1.544	2.074	4.414	5.938
Irradiance W/m2	625	787	887	985	1001	1005	1002	988	952	879	633	532
Wind Velocity km/h	13.1	13.7	13.5	14	11.2	12.4	10.7	10	9.8	6.6	14	12.9
Temperature ºC	-20	-16.7	-6.9	1.4	12.4	15.6	17.5	16.5	11.6	12.8	-1.8	-17.6
Timmins, On for enviroment historic												

Table XX . Option 2.

Name	Montreal River Harbour, Ontario (Between Sault Ste Marie and Wawa)											
Coordinates	47.23454971583702, -84.64982972836238											
Population	Twilight Resort											
Distance from the close charger station (km)	82											
Name of the road	17											
Rate cars per day	1950 (aprox 1950 - year 2023)											
Year 2022	January	February	March	April	May	June	July	August	September	October	November	December
Day light (hhmm)	8h46m	10h8m	11h42m	13h29m	15h2m	15h58m	15h43m	14h26	12h45	11h3m	9h26m	8h28m
Solar Constant w/m2	1413.4	1402.8	1384.5	1360.4	1339.4	1325.8	1323	1331.6	1350	1372.8	1395.7	1410.5
Air mass	4.291	2.759	1.997	1.384	1.232	1.168	1.173	1.267	1.515	2.019	4.069	5.395
Irradiance W/m2	643	797	893	985	1001	1004	1001	988	953	882	654	558
Wind Velocity km/h	15	15.1	16	16.3	13.1	13.4	11.8	11.1	11.4	12.5	15.3	17.47
Temperature ºC	-12	-10.7	-4.5	2.1	11.28	14.3	17.2	18.1	14.4	7.5	2.7	-3.16
SAULT STE. MARIE AIRPORT STATION for enviroment historic												

Table XX . Option 3.

Name	Blenheim (Intermediate Place between Weatley and Dutton)											
Cordinates	42.33890450779312, -81.99442154338078											
Population	4487											
Distance from the close charger station	51											
Name of the road	3											
Rate cars per day	20400 (aprox 20400 - year 2023) road 401											
Year 2022	January	February	March	April	May	June	July	August	September	October	November	December
Day light (hhmm)	9h22m	10h29m	11h46m	13h15m	14h30m	15h15m	15h2m	14h1m	12h38m	11h14m	9h54m	9h8m
Solar Constant w/m2	1413.4	1402.8	1384.5	1360.4	1339.5	1325.8	1323.4	1331.6	1350	1372.8	1395.7	1410.5
Air mass	3.507	2.444	1.869	1320	1.201	1.147	1.148	1.224	1.429	1.838	3.477	4.266
Irradiance W/m2	696	821	899	986	996	998	995	985	956	897	691	622
Wind Velocity km/h	18.6	21	17.4	17.1	16.7	14.2	13	14.5	13.3	15.4	17.8	17.5
Temperature ºC	-6.5	-3.3	1.5	6.2	15.2	18.9	21.8	21.5	17.7	10.4	5.6	-0.3
SARNIA CHRIS HADFIELD AIRPORT STATION for enviroment historic												

Table XX . Option 4.

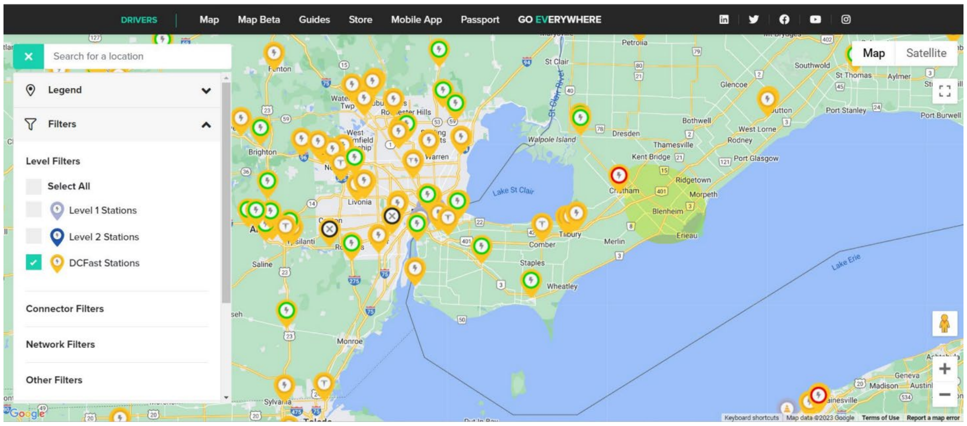

Figure xx. Location for the remote charger station.

Following a thorough analysis of the four available options, our decision leaned towards selecting the Blenheim point. The primary rationale behind this choice is its proximity to the operational base at St. Clair College and the headquarters of TaureanEV. Opting for Blenheim ensures a swifter response time in case of any configuration, repair, or adjustment needs, thereby enhancing operational efficiency.

2.2. Milestone 2: Tool for the dynamic design of solar and wind power arrays based on environmental site conditions for dimension the place and cost.

Given the abundance of available information, the imperative arose to organize and streamline it through a versatile tool facilitating decision-making. This tool must possess dynamic functionalities, accommodating the following key aspects:

- Battery Specifications:
  - Provide a platform for detailing and managing specifications related to the batteries employed in the project.
- Dynamic Configuration for Solar and Wind Energy:
  - Enable configurations that adjust based on the specific month, considering variations in energy generation from solar and wind sources throughout the year.
  - Facilitate comparative analysis of energy outputs for informed decision-making.
- Estimation of Land Size:
  - Include functionality to estimate the required land size for the project, taking into account factors such as energy production, equipment placement, and operational efficiency.
- Graphical Display of Results:
  - Incorporate a graphical representation of data and results for enhanced visualization and easier interpretation.

- Provide charts, graphs, and visualizations illustrating battery performance, energy configurations, and land size estimates.

By integrating these dynamic features, the tool aims to offer a comprehensive solution for organizing and interpreting the wealth of information available, ultimately aiding in effective decision-making for the renewable energy project.

2.3.1. Milestone 3 Research Methods

We developed a tool using Microsoft Excel that comprises five primary sheets: "Battery and Cars," "Wind Option," "Solar Option," "Mix Analysis," and "Terrain." Each sheet is designed to accommodate and organize specific information, ensuring that updates can be made as needed. This modular structure facilitates efficient management of data relevant to different aspects of the project across these dedicated sheets.

In the "Battery and Cars" sheet, the primary objective is to determine the dimensions of the battery array. To achieve this, we conducted an analysis of the traffic on the selected roads, utilizing data sourced from Statistics Canada[8] to estimate the number of electric vehicles (EVs) and plug-in hybrid electric cars in the vicinity. The calculations are based on the assumption of having 424 kW available. This capacity is designed to provide ample energy for a two-day period, accommodating the recharging needs of eight vehicles from 0 to 60%, especially in unfavorable weather conditions for recharging the station's batteries.

This sheet performs computations to ascertain the total area required for the battery array, considering factors such as size and weight. The calculated values are fundamental in determining the optimal specifications for the battery setup, ensuring it meets the energy demands of the designated number of vehicles under varying conditions.

Battery Charge Station Data

	Charge Station Battery		
	Total Power Battery	53000	W
*	% overall efficiency (out)	97	%
	Real Power Battery (out)	51410	W
*	Discharge Power max (out)	25705	Wh
	Time Discharge (out)	2	h
	Charge Power (in)	25000	Wh
	Time charge (in)	2	h
*	Charge (in)	98	%

Dimensions each big battery		
height	1.17	m
width	0.711	m
lenght	0.648	m
Volumen	1	m3
Area	0.5	m2
Area	5.0	ft2

One big Battery

Cars per day to charge (2)

Road average per day	4100	Overall cars
% EV and Hybrid plug in 2022	8.20%	%
EV on the road	336.2	EV
% cars to recharge (target)	1%	%
cars to recharge	3.362	Cars per day
roundup cars	4	Cars per day
Autonomy wished	2	Days
Car Battery (W)	80000	W
% charge battery car	60	%
Charge per car (W) 60%	48000	W
Big Batteries Needed	7.24528	Qty

Cars registred in Canada 2022

data entry for the user

Big Battery Estimated from (2) and (1)

	POWER BATTERIES		
	Number of big batteries	8	
	Total Power OUT	424000	W
	Real Power OUT	411280	W
*	Discharge Power max	205640	W
	Time Discharge (out)	2	h
	Charge Power (in)	200000	Wh
	Time charge (in)	2	h
*	Charge Power max	411280	Watt

Total dimensions min.		
Height	1.17	m
Area	4	m2
Area	39.7	ft2

Overall Batteries Calculation per batteries number

Figure xx. Battery and car sheet.

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[8] https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2010002401

The "Wind Option" sheet is dedicated to showcasing the average monthly energy output based on varying wind velocities[9]. This analysis is crucial for understanding the potential energy generation from wind sources. The sheet also provides insights into the number of wind turbines required to meet the energy demand. The information utilized in this calculation is derived from four distinct turbine models provided by the manufacturer TESUP[10]. It is important to note that data from these turbines, including specifications and performance characteristics, may be subject to updates. Additionally, the sheet considers the real-time wind velocity on the specific site, ensuring accurate and dynamic assessments of the wind energy potential. This adaptable approach allows for flexibility in the system design based on the most current and relevant turbine information as well as on-site wind conditions.

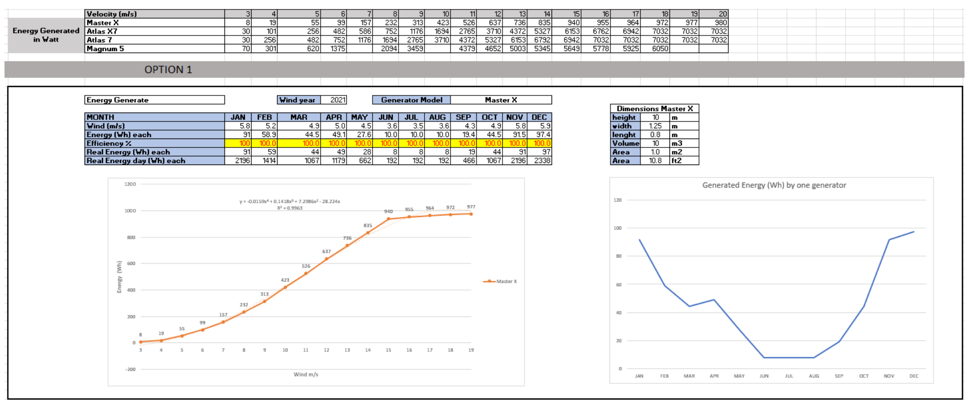


Figure xx . Wind option sheet.

The "Solar Option" sheet is designed to illustrate the average monthly energy output based on solar irradiation[11]. This analysis is instrumental in determining the potential energy generation from solar sources. The sheet also provides information on the number of solar panels required to meet the energy demand. The data used for these calculations is obtained from four different types of solar panels, sourced from manufacturers such as Luxpower and Znshinesolar[12]. It is important to acknowledge that information regarding these solar panels, including specifications and performance metrics, may undergo updates. Additionally, the sheet takes into account the dynamic nature of solar irradiation at the specific location, ensuring accurate and real-time assessments of the solar energy potential. This adaptability allows for flexibility in the system design, incorporating the latest data on solar panels and irradiation levels.

[9] https://globalwindatlas.info/en/
[10] https://tesup.com/
[11] https://power.larc.nasa.gov/data-access-viewer/
https://znshinesolar.gr/wp-content/uploads/ZXM7-SHLD144-min.pdf
https://www.justenergy.co.za/product/luxpower-5-5kw-sna-5000-48v-hybrid-inverter/

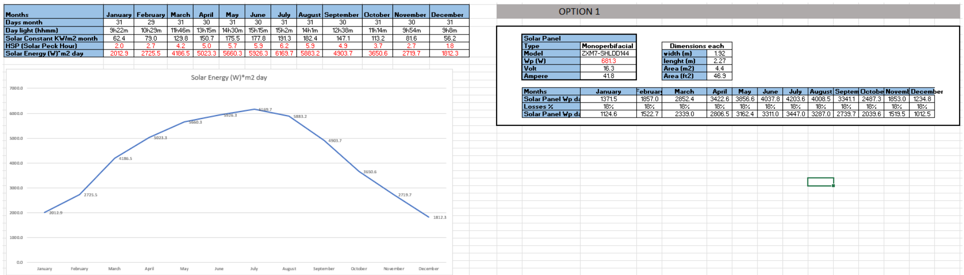


Figure xx . Solar option sheet.

The "Mix Analysis" sheet serves as a dynamic tool, enabling users to explore various combinations of solar and wind energy sources. The primary objective is to calculate the optimal combination that meets the energy requirements for the recharge station. Users can input different parameters and scenarios, and the sheet performs calculations to determine the most effective mix of solar and wind energy.

This interactive feature allows for a comprehensive analysis of different energy generation possibilities, considering factors such as solar irradiation, wind velocities, and the specific characteristics of the chosen solar panels and wind turbines. By offering flexibility in exploring diverse combinations, the "Mix Analysis" sheet aids in identifying the most efficient and reliable energy mix that aligns with the recharge station's requirements. This adaptability ensures that the system is tailored to harness the maximum potential of renewable energy sources in a way that optimally fulfills the station's energy needs.

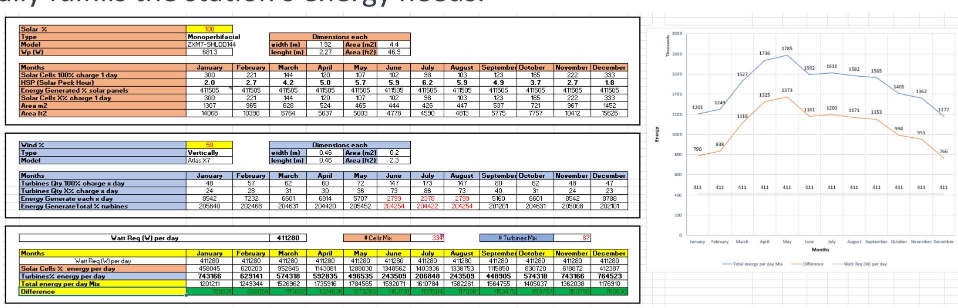


Figure xx. Mix Analysis.

The "Simply Budget Option" sheet is designed to streamline the budgeting process by optimizing the cost of various combinations, considering factors such as the area of terrain used and surplus energy generated. The objective is to find the most cost-effective solution that meets the energy requirements of the recharge station.

By inputting different parameters and scenarios, users can explore cost-efficient combinations of solar and wind energy sources. The sheet performs calculations to determine the optimal balance that minimizes costs while satisfying the station's energy needs. In this specific case, the analysis suggests that a 100% solar panel solution provides the most economical and efficient outcome, considering factors such as initial setup costs, maintenance, and energy output.

The "Simply Budget Option" sheet thus simplifies the decision-making process by highlighting the most financially advantageous solution based on the specified criteria and parameters.

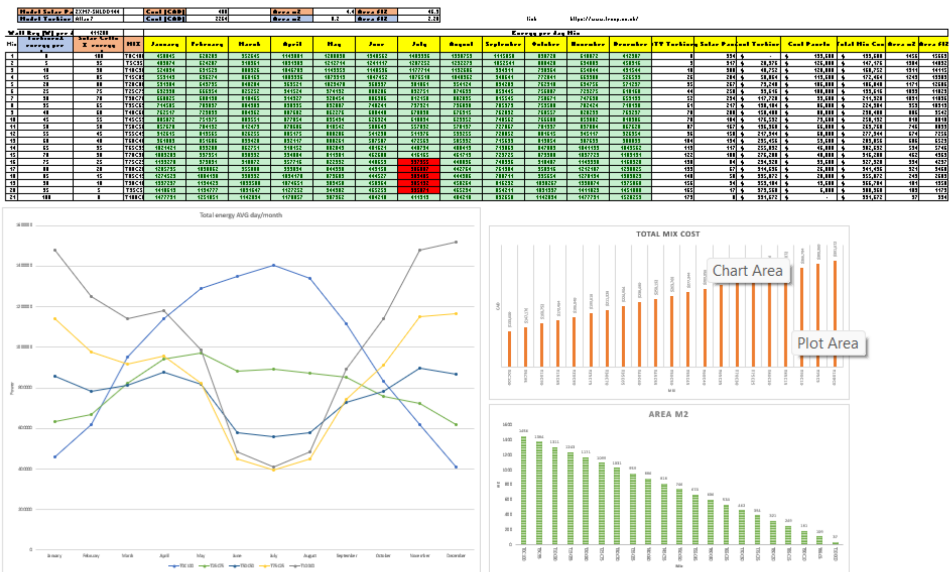


Figure xx . Simply budget option.

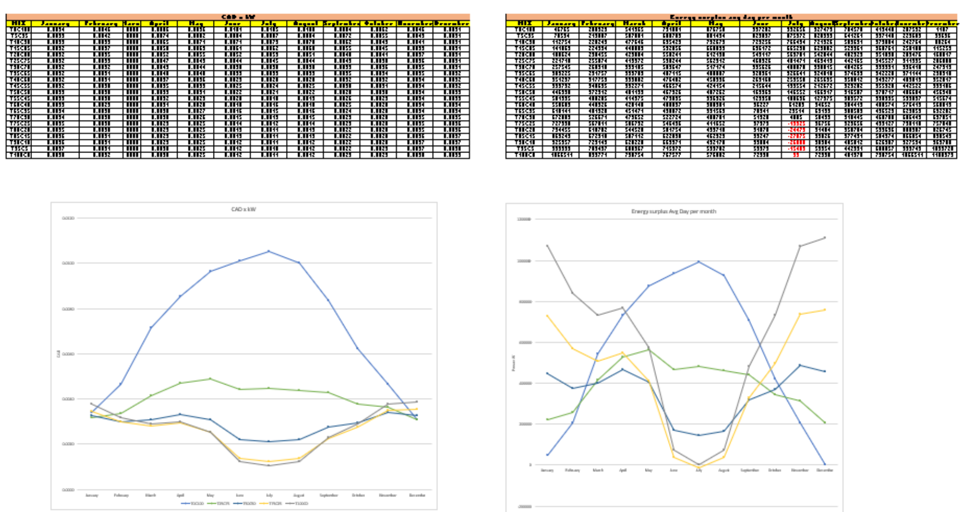


Figure xx. Mix Analysis.

The "Terrain" sheet is dedicated to calculating the required terrain for the solar panel system. It takes into account a crucial factor: the minimum distance between solar panels to prevent shading. Shading can significantly impact the efficiency of solar panels, so determining the optimal spacing is vital for maximizing energy generation.

By utilizing specific parameters and constraints, such as the dimensions of the solar panels and the acceptable distance to avoid shading, the sheet computes the total area of terrain needed for the solar panel system. This information ensures that the solar panels are strategically arranged to capture sunlight effectively and minimize shading effects.

The "Terrain" sheet thus plays a crucial role in the overall planning and design of the solar panel system, ensuring not only optimal energy generation but also efficient utilization of the available terrain.

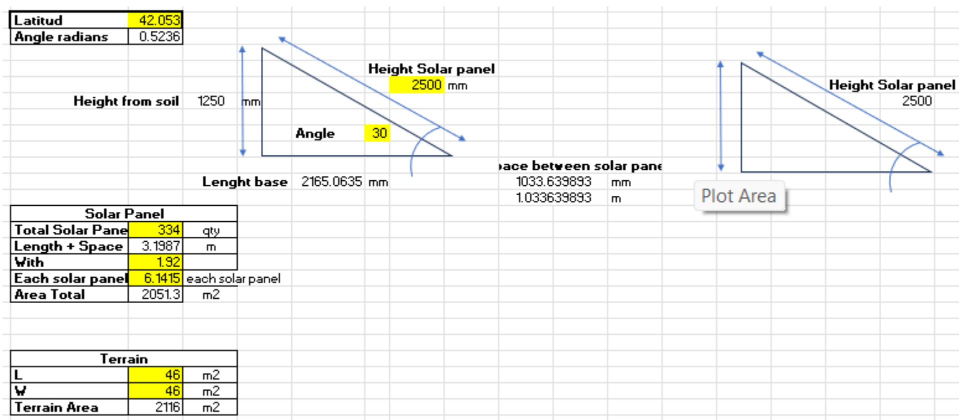


Figure xx. Terrain.

2.4. Milestone 4: Parking Solar Recharge Station CAD

2.4.1. Milestone 4 Research Methods

For visualizing and planning the distribution of the solar panel array and its accompanying control room, we employ CAD (Computer-Aided Design) software, specifically AutoCAD. AutoCAD is renowned for its robust capabilities in creating detailed and precise 2D and 3D designs.

In the CAD software, we can intricately map out the layout of the solar panels on the terrain, considering factors such as shading, spacing, and orientation to optimize energy capture. Additionally, the control room's placement and design can be meticulously drafted within the software, taking into account accessibility, infrastructure connections, and overall functionality.

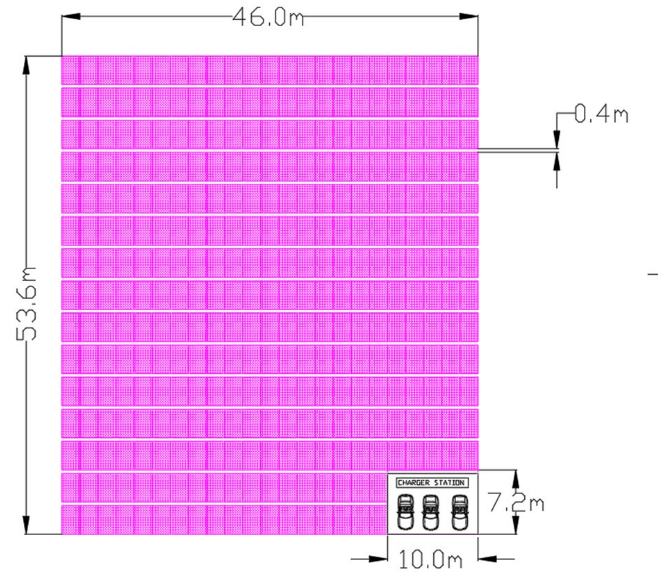
AutoCAD allows for a comprehensive representation of the solar panel system, offering a visual aid for decision-makers, stakeholders, and implementation teams. This CAD-based approach aids in the effective planning, communication, and execution of the renewable energy project, ensuring that the design aligns seamlessly with the established criteria and requirements.

2.4.2. Result of Milestone 4

Creating two CAD model options for implementing the remote solar station on a piece of land, along with a smaller-scale version and a control room, showcases a thoughtful approach to design and planning. These CAD models provide a visual representation of the proposed configurations, aiding in decision-making and communication. Here's an overview of the two options:

- **Remote Solar Station - Large Scale:**
  - This CAD model represents a larger-scale implementation of the solar station on the chosen land. It accounts for a comprehensive array of solar panels, optimizing energy capture and distribution.
  - The design considers factors such as terrain, shading, and panel orientation to maximize efficiency.
  - The control room is strategically located for accessibility and efficient monitoring of the solar station operations.
- **Remote Solar Station - Small Scale:**
  - This CAD model focuses on a smaller-scale version of the solar station, possibly suitable for a specific application or as part of a phased implementation strategy.
  - The solar panel array is designed proportionally to the reduced scale while maintaining efficient energy capture.
  - The control room is adapted to the smaller scale, ensuring it meets operational requirements while considering space constraints.
- **Control Room:**
  - The CAD model for the control room provides a detailed facility layout, considering equipment placement, workspace design, and infrastructure connections.

These CAD models serve as invaluable tools for stakeholders, allowing them to visually assess and compare the two implementation options. The detailed representations aid in decision-making processes, facilitating a thorough understanding of the proposed designs before the actual implementation phase.



Option 1 in land space. Figure xx

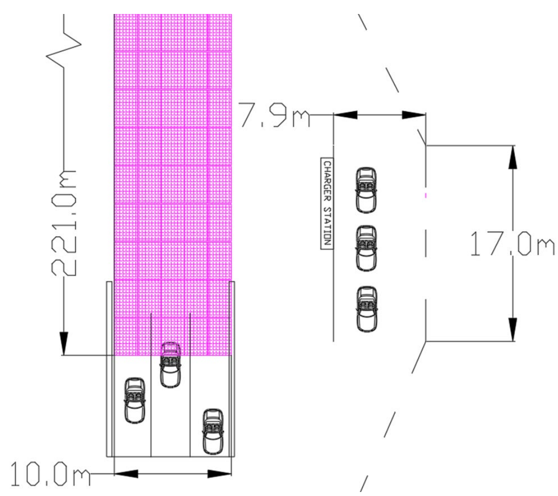


Figure xx. Option 2 road cover.

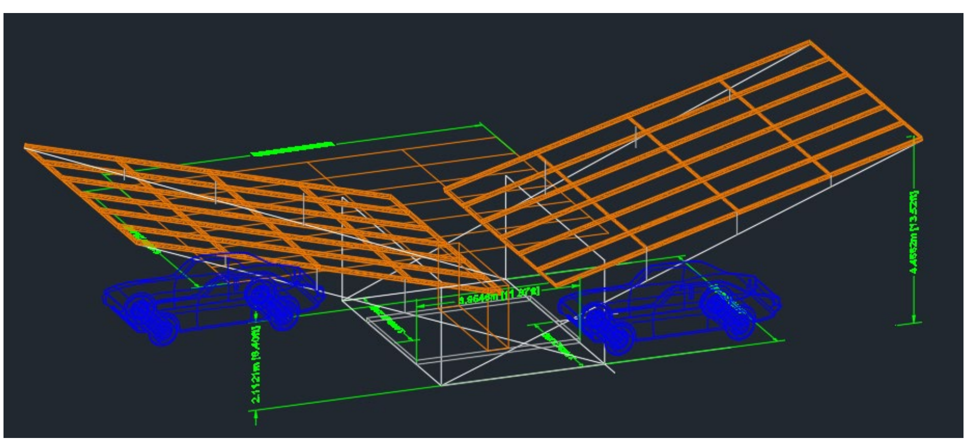


Figure xx. Option 3 parking cover.

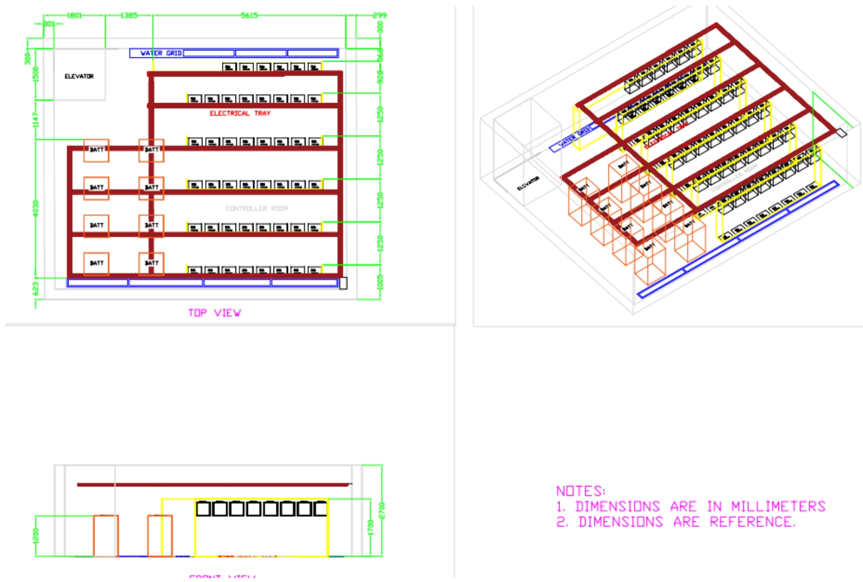


Figure xx . Controller room.

2.5. Milestone 5: Power Requirements

2.5.1.Milestone 5 Research Methods

We have 26.5 Kw rated power batteries, but we do not know charging rating and individual cell power rating. We need to figure it out first. How much power is needed to charge a cell? As per cell charging specification, we are required to calculate the battery charging rating, and as per the number of cars charging per day, we need to consider the number of batteries for remote charging stations.

2.5.2. Results of Milestone 2

These batteries are an especially important component in our project because they work as a power source for EV cars. Our plan is to use renewable energy to charge the batteries. These batteries will charge the EV car’s batteries, this way the consumer will get the power at any time. Renewable power sources are not able to give continuous power throughout the day or month. For example, solar power is available in day light furthermore it varies throughout the day. Maximum solar power we get in the afternoon rather than in the evening.

As per the battery's data sheet, individual module specification sheet, we figure out that individual cell continuous charging rating is 2.5 KW, and 12 modules are in series, and it makes 25 kw battery as per voltage divider rule. Cell nominal voltage is 50V, and the continuous charging current rating is 50A. As per the data sheet, we can charge the battery at 600 V and 50A.

The total power needed to charge the battery is 30KW as per the power formula. (P = V * I) Whereas P is the power, V stands for Voltage, I stands for current in the power formula. Bellow table 1 shows the power rating of the individual cell for your reference.

Module Specification KBM255 14S

Kokam's KBM 255 14S module can be connected in series and/or parallel to meet customer requirements.

Item	Specification	Remarks
Electrical		
Module Configuration	1P14S	Cell: 130255255G1 (100Ah)
Installed Energy	5.1kWh	-
Rated Energy	4.7kWh	@ 0.5P discharge, 25±5℃
Nominal Voltage	51.5Vdc	3.68V @ Cell level
Operating Voltage Range	46.2 ~ 57.8Vdc	3.3~ 4.13V @ Cell level
Max. Charge Power	10.2kW	@ 2P, 25±5℃, 1 Cycle
Max. Charge Current	200A	@ 2C, 25±5℃, 1 Cycle
Continuous Charge Power	2.5kW	@ 0.5P, 25±5℃
Continuous Charge Current	50A	@ 0.5C, 25±5℃
Peak Discharge Power	15.3kW	@ 3P, <10 sec, >SOC 50%
Peak Discharge Current	300A	@ 3C, <10 sec, >SOC 50%
Max. Discharge Power	10.2kW	@ 2P, 25±5℃, 1 Cycle
Max. Discharge Current	200A	@ 2C, 25±5℃, 1 Cycle
Continuous Discharge Power	5.1kW	@ 1P, 25±5℃
Continuous Discharge Current	100A	@ 1C, 25±5℃
Round Trip DC Efficiency	>95%	@ 0.5P, 25±5℃

Table xx - 100 AH Module Power Rating

2.6. Milestone 6: Electrical Drawing Phase

2.6.1.Milestone 6 Research Methods

For electrical drawing, we need to figure out the drawing of the battery power supply. We need to consider the present component of the battery that we have. We have power requirements, data number of car charger per day details and all necessary data. Accordingly, we need to make the block diagram and onwards, we require the wiring diagram for charging station.

2.6.1.Results of Milestone 6

As per the battery diagram from the data sheet, we have positive and negative side breakers, BMS Systems, and heater wiring through BMS to controller internal temperature of battery. Auxiliary 22V DC power needed to be battery to get the charging data from the battery as well as in case, if the entire battery discharged this power will use to run the BMS system.

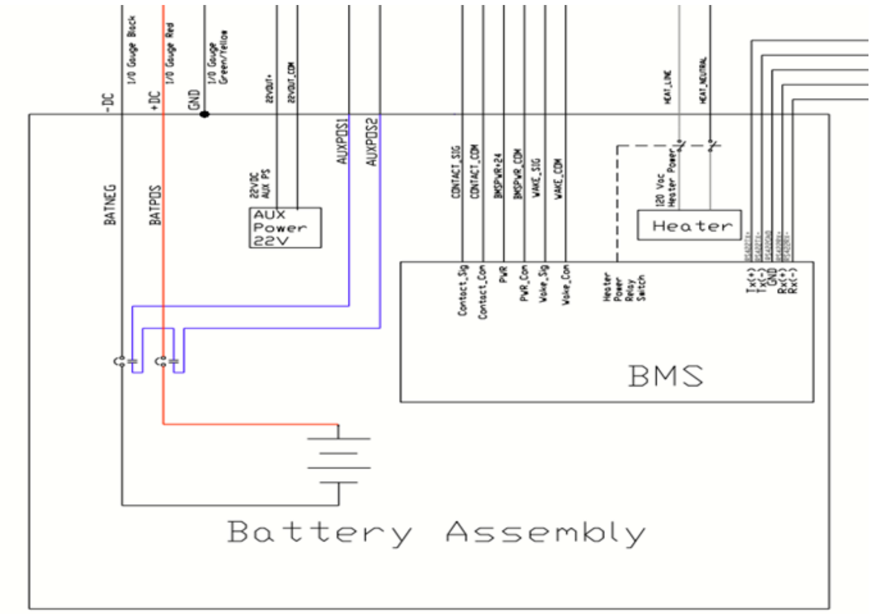


Figure xx - Battery Assembly

We made the basic block diagram for our system, which shows the direction of power generation and power consumption. Components are necessary for a system. Easly under stable who are not from electrical background.

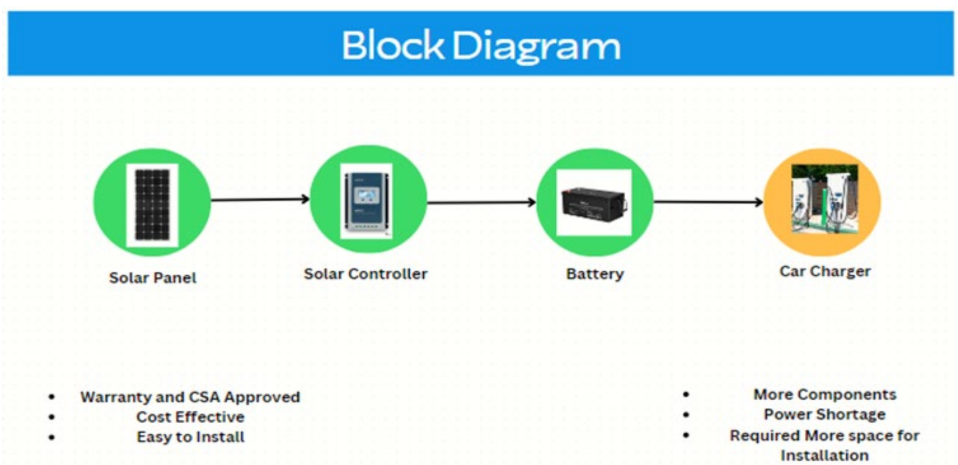


Figure 2 - Block Diagram

Here, we consider the solar panels that average voltage and current rating are 40.5V and 9.88A as follows. The total power rating is 400 W for each panel. 12 panels are in series and will generate 486V and 9.88 A as per voltage and current rule. Five rows of this combination will generate 24KW, and it requires 60 solar panels for that. These 60 panels connected to the MPPT controller (**Maximum Power Point Tracking**) will stabilize the solar panel power, and, like this, a total of eight MPPT controllers connect to master controller, and that will connect battery's bus bar as per drawing. Solar panels calculation shows more in table xx.

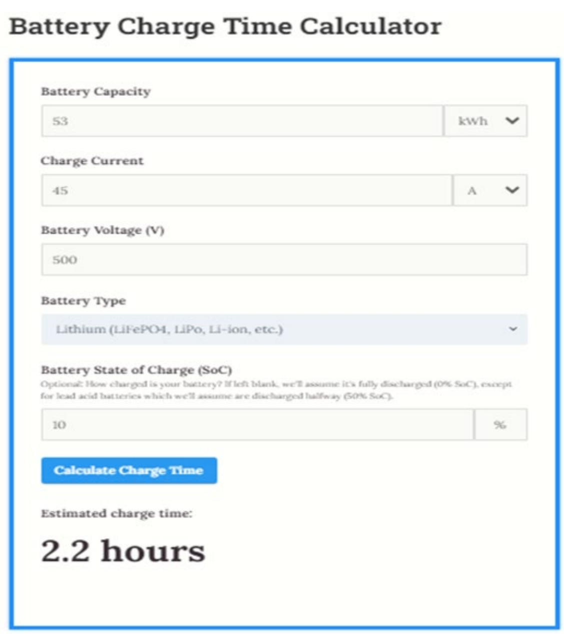
MPPT controller – This controller extracts the maximum power from the solar panel. This controller is necessary for our application because solar panel’s output power is not stable even in daytime. We have battery and other components in the system the required certain power for operation.

Master controller – This controller will stabilize the power from the MPPT controller to the battery’s power rating as shown in the drawing. Two batteries are connected in parallel as shown in drawing, this controller will deliver the power to bus bar and charge the battery.

Solar Panels Calucation	
Solar Panel Voltage rating	40.5V
Solar Panel Current rating	9.88A
Solar Panel Power rating	400W
Panels in Series connection	12
Series connected panels rows	5
Single row voltage rating	486V
Single row current rating	9.88A
Total 60 Panels power rating	24KW

Table xx - Solar Panels Calculation

As per the battery's charging current and voltage rating, the consider state of charge is 10%, and the above power rating will charge the single battery in between 2.2 to 2.5 hours as per the battery charge time calculator.


Battery Charge Time Calculator

Battery Capacity
53 kWh

Charge Current
45 A

Battery Voltage (V)
500

Battery Type
Lithium (LiFePO4, LiPo, Li-ion, etc.)

Battery State of Charge (SoC)
Optional: How charged is your battery? If left blank, we'll assume it's fully discharged (0% SoC), except for lead acid batteries which we'll assume are discharged halfway (50% SoC).
10 %

Calculate Charge Time

Estimated charge time:
2.2 hours

Table xx - Charge Time Calculator

As shown in the drawing bus bar connected the car charger, every car charger has two charging points. Every charger point reaches the DC fast charging capacity which is 45KW. All wire size mentioned in drawing are as per the wire size calculation table also take care for useable capacity for the wire which is 80%.

Will the power Requirements will fulfill by the solar power per day at location?

Here, we consider the worst environmental conditions. Sunlight available 9 hours, temperature -7 degree Celsius with no shading on any panels. As per solar panel data sheet, power rating and efficiency are as flows 400W and 20%. As per calculator value, we will generate 604 W per panel and 18,144 W monthly. As per drawing we have 480 panels, so we can generate 289,920 W per day. This 289,920 W power we can generate per day and our requirement is 235,000 W per day. As per calculation we will not only fulfill our requirement but also generate more energy which can be used somewhere else.

Power requirement vs generated power per day	
Panel efficency	20%
Temprature in celcius	-7
Panel Power in watt	400W
Required Power	**235000**
As per generated power from calulator	604W
Number of panel from drawing	480
Total Power = Genereted power * Number of panel	**289920**

Table 7 - Needed Vs Generated Power

Note to writer: Continue adding consistent headers, matching the headers in the styles section, throughout the report for however many more headings you need.

Note to writer: Below are example of tables and figures you can use to insert a graph, table, chart, picture, etc. Ensure that everything is captioned, and that its relevance is explained in the report. Hide all border once the table/figure is configured and a caption has been added. Ensure naming is in chronological order, and matches the section that the figure is in.

(insert picutre)
Figure #1: Type the figure caption here, hide the table lines when the figure is complete.

(a)	(b)
Figure 2.2: Type the figure caption here, hide the tables line when the figure is complete.	

(a)	(b)	(c)
Figure 2.3: Type the figure caption here, hide the tables line when the figure is complete.		

(a)	
(b)	
(c)	
Figure 2.4: Type the figure caption here, hide the tables line when the figure is complete.	

(a)	(b)	(c)
(d)	(e)	(f)
Figure 2.5: Type the figure caption here, hide the table lines when the figure is complete.		

Table 2. 1: Type the table caption here, hide the table lines when the figure is complete.		

This table is arbitrary, it is provided to show how a formatted table should like (i.e., which lines should be visible/hidden.

Table 2. 2 Type the table caption here, hide the table lines when the figure is complete.

Material	Elastic modulus, E [GPa]	Yield strength, σ_Y [MPa]	Tensile strength, σ_U [MPa]	Rockwell hardness HRC
AA6061-T6	68.9	277.5	320.2	N/A
AA7075-T6	71.7	503.0	572.0	N/A
4140 steel (400° F heat treat)	207.0	1737.5	1965.1	53
4340 steel (400° F heat treat)	207.0	1861.7	1978.9	53
D2 steel	205.0	2000.0	2190.0	60
Grade 8 steel (fasteners only)	207.0	896.4	1034.3	N/A

3. Discussion

The goal of this section is to explain and discuss with the reader what the results mean from your perspective based on your expert opinion. Throughout this section refer to your research methods and results.

4. Conclusion and Recommendations

Write a closing paragraph restating the objectives of the project and (briefly) how they were achieved. Include any recommendations that you may have for the industry partner based on the results of the research project.

The key findings from this investigation are as follows:

- Statement #1
- Statement #2
- Statement #3
- Statement #4
- Statement #5

5. References

Note to writer: Once your report is complete, the last step is to add all the sources you've cited in your document. Go to reference in the top ribbon, and ensure you are using the correct citation style, APA, or any style the leader research prefers. With your cursor, highlight the references heading above, then go to the references section in the top ribbon and select bibliography, then select references. This will upload all of the citations here that you have cited throughout the document.

Appendix

In this section, add any graphs, charts, models, pictures, etc. that relate to the project that didn't fit in the Research Methods section. This section is optional and project dependent, add as few/many appendices can be created as desired. Include subheadings and captions as needed.

Figure 0.1: Add figure caption here, note that this is a separate index for the appendices.

(a)	(b)
Figure 0.2: Add figure caption here, note that this is a separate index for the appendices.	