ELP305 Design and Systems Laboratory

Semester 2, 2021-2022

Tribe E

2. **SUNERGY Specifications**

The GitHub repository that our tribe is using is linked here [1].

In the following document, we give a brief on various specifications of the components that we will be using in our off-grid living solution. We also mention their properties and why we have chosen them along with the best quotation available for each component.

NOTE: These specifications may change as the design work progresses further.

2.1 **Electrical Specifications**

2.1.1 Battery

Luminous Red Charge RC 25000 200 Ah battery

- For heavy-duty application with excellent overcharge tolerance, superior performance during long frequent power cuts, and minimum maintenance
- Fast battery charging with adaptive battery charging control technology to prevent overcharging

We select a battery bank such that we can ensure ample power for upto 24 hours. For this, a suitable choice is 4 batteries of 12V, 200 Ah rating connected in series.

Specifications	Value
Brand	Luminous
Nominal Voltage	12V
Rated Capacity(at room temp.)	200 ah
Protections	Dust & water proof with heavy plastic body
Charging Current(Boost mode)	20.2A(starting), 10.1A(finishing)
Charging Current (Trickle mode)	672 mA(max), 168 mA(min)
Weight	60 Kg (34.4 Kg dry weight)
Dimensions	50.2 X 44 X 19.1 cm (L X W X H)
Electrolyte Volume	19.9L
Water Level Indicators	6
Cost	₹14,780 X 4 = ₹59120

Product Link

2.1.2 Backup Generator

The generator size should be of 3kW. In our system, generator will mostly be needed during winter when there is a lack of solar energy production. So the power calculation will be done under winter conditions. And since this is a backup system the below power consumed is assumed to be calculated under maximum load when running backup generator.

Total Instantaneous Power Consumed = 0.036*4(light)+1.5(house heater)+0.15(fridge)+1(misc.) = 2.8kW

Note: Here the misc. includes TV,PC, and other appliances that we might/might not use under emergency situation. The generator should be able to run under the above conditions for 12hr. Spare fuel should always be kept in case of emergencies.

Specification	Value
Manufacturer	Techno Machineries
Fuel	Kerosene(Run), Petrol (Start)
Consumption	1L/hr under full load
Capacity	12L
Rated voltage	220V+-15
Rated output power	2.8kW
Peak output power	3kW
Weight	40kg
Dimensions	630x500x600mm
Cost	₹32,900

Product Link

2.1.3 Hybrid Solar Inverter (Built in Solar Charge Controller)

5KVA/ 48 V off Grid Solar Inverter

FlinFuzion Solar Hybrid Inverter 5kVA/48V is an off grid hybrid solar inverter which supports lead acid and lithium batteries both. It comes built in with an mppt technology based Solar Charge Controller that converts solar energy into electricity and stores power.

- Off grid hybrid solar inverter with lithium battery / Lead acid battery support functionality.
- 5 kva system with 5000 watt solar panel support
- super efficient as low conversion loss from battery
- LCD Battery Monitoring system with display parameters such as Input Power, Output power load, battery health, battery percentage
- Surge warnings, safety alarms and troubleshooting Fault Codes
- Included battery monitoring software with USB and RS232 Data Ports

Specification	Value
Brand	Flin Energy
Rated Power	5kVA
Waveform	Pure sine wave
Output Voltage Regulation	230VAC ± 5%
Output Frequency	50 Hz
Battery Voltage	48 VDC
Battery Overcharge protection	63 VDC
Battery Equalization	Yes
Maximum AC Charge Current	60 A

Specification	Value
Peak Efficiency	93%
Overload Protection	5s@≥150% load; 10s@110%~150% load
Surge Capacity	10kVA for 5 seconds
No Load Power Consumption	<35W
Dimensions	D x W x H (mm) 100 x 300 x 440
Net Weight	10 kg
Cost	₹78,800

Solar Charge Controller

Charge controllers are used to control the amount of current fed into the battery by the solar panels. This ensures the batteries are not overcharged during the day and don't leak current back to the panels during the night. So, Solar Charge Controller must be compatible with solar panel and the battery bank. Our Hybrid inverter comes built in with an MPPT Charge controller which is more efficient at DC Conversion compared to older PWM technology.

Sizing

Sizing of a controller depends on three factors

- Solar panel array's maximum open-circuit voltage (Voc)
- Total Power rating of Solar panel array
- Battery Bank Voltage

Required Ratings

- **Solar panel array's maximum open-circuit voltage (Voc)**: The 8 solar panels are arranged in a 2x4 array, such that 4 pairs of solar panels are in parallel, with each pair in series. Each Solar panel has a open circuit voltage of 49V. So, the maximum open circuit voltage of solar panel is 49x2= 98V.
- **Total Power rating of Solar panel array**: Since, we are using 8 solar panels with 440 W power rating.Hence, the total power rating of Solar panel array is 3520W.
- **Battery Bank Voltage**: Battery Bank Volatge of our system is 48V.

Now, from power rating and battery bank voltage, we can calculate the required Ampere rating of the controller, which is equal to (power rating/Bank Voltage). So, the required Ampere rating is 73.33A. The required maximum input Voc of controller = maximum open circuit voltage of solar panel.

Hence, Our Controller must have atleast 98V input Voc rating and 73.33A current rating. We select the controller such that these two figures slightly exceed the requirements to build a safety margin.

Specifications of the in-built charge controller

Specification	Value
Brand	Flin Energy
Type	MPPT
Maximum Solar Charging Current	80A
Maximum PV Array Power	5 kW
Operating Voltage Range	120-450V
Nominal PV Voltage	240V
Maximum PV VOC	500V

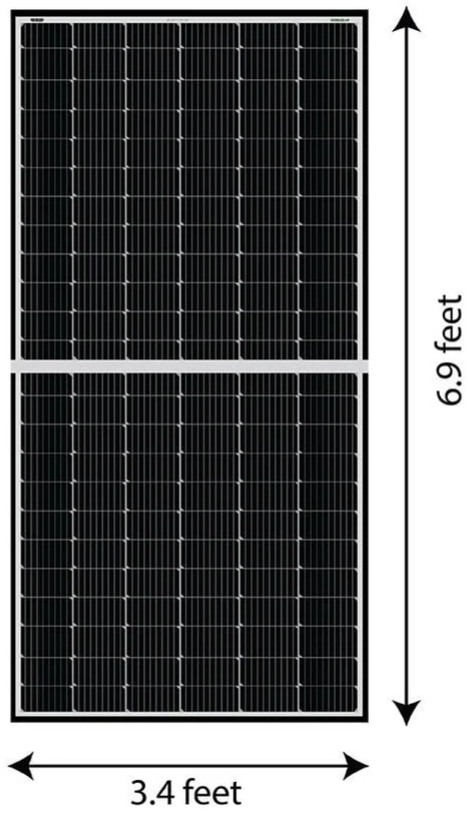
Product Link

2.1.4 High Efficiency Solar Panels

Solar panels collect clean renewable energy in the form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads.

The panels which we're using, are based on mono PERC cells, which results into higher electricity generation due to higher light absorption per unit area, when compared to traditional panels.

It also paves the way for more power output per panel, which means less number of panels are required for a given power requirement. It means less expenditure for panel mounts.



We'll be using 8 such panels in our system.

Specification (Single panel)	Value
Cost	₹20,000
Operating Voltage	24V
Dimensions	6.9ft X 3.4ft
Manufacturer	Loom Solar
Rated Output Power (Peak)	440W
Output Voltage at max. power	42V
Output Current at max. power	10.5A

Above electrical data is for, Irradiance: 1000W/m² and Cell Temperature:25°C

Product Link

2.1.5 Wires

Solar DC Cable

DC Solar Panel cables are required to connect the array of solar panels in series with each other and then carry the output DC Current to the Solar Charge Controller.

When choosing DC Solar Panel wires, some things should be kept in mind

- The wires should be of sufficient diameter to ensure that no overheating occurs
- The wires should be of adequate current rating
- UV resistance to ensure longevity

Specification	Value
Brand	Microtek
Current carrying capacity	80 A
Cross Sectional Area	10 mm^2
Length	15m Red and 15m Black
Cost	₹1990

Product Link

Household connection wires

Connecting wires would be used to connect different appliances in the energy grid. Hence they should be able to carry high current and be well insulated.

Specification	Value
Brand	Havells
Length	90 m
Cross-sectional area	2.5 sq mm
Current carrying capacity	28 A
Voltage Grade	1100 V
Insulation material	HRFR PV
Conductor material	ETP Grade Annealed Copper
Cost	₹2,871

Product Link

2.1.6 Safety Measures

AC Circuit Breaker

A separate AC Breaker between the AC Input and Inverter is required to ensure tha the inverter can be securely disconnected during maintenance and secured from AC Input over current

Specification	Value
Brand	Siemens
Current Rating	63 A
No. of Poles	4
Dimensions	7.1 cm X 7 cm X 9 cm
Weight	660 g
Material	Polycarbonate
Color	White
Cost	₹ 1500

Product Link

DC Circuit Breaker

A DC Circuit breaker between the Solar Panels and Inverter is required for disconnecting the solar panels safely for maintenance or replacement. The Circuit breaker also protects the inverter from over current damage

Specification	Value
Brand	FEEO
Circuit Breaker Type	Standard
Current Rating	63 A
No. of Poles	2
Voltage	800 V (DC)
Dimensions	7.1 cm X 3.6 cm X 8 cm
Cost	₹999

Product Link

DC Surge Protection Device

The DC Surge Protector protects the inverter and panels from any unforeseen voltage surges in instances such as Lightning strikes

Specification	Value
Brand	Kenbrook Solar
Overvoltage Rating	600V
No. of Poles	2
Dimension	9 cm X 6 cm X 3.5 cm
Weight	245 g
Cost	₹799

Product Link

Porcelain Fuse

Specification	Value
Brand	Anchor
AC Adapter Current	32 A
Voltage	415 V
Material	Ceramic
Dimensions	10 cm X 5 cm X 5 cm
Cost	₹185

Product Link

2.1.7 MC4 Connectors

MC4 Solar Panel Connectors

MC4 Connectors are required for a safe and convenient connection between the solar panel arrays.
The Kenbrook Solar MC4 Connectors are UV resistant, waterproof and anti-flame boasting an estimated life of upto 25 years and thus require minimum maintenance.

Specification	Value
Brand	Kenbrook
Material	Copper (Tin Plated) | PPO + PA (Outer Covering)
Dimensions	6 x 4 x 2 cm
Quantity	10 Male + Female MC4 Connectors
Cost	₹449

Product Link

4 in 1 T4 Connector

T4 Connector is required to connect the 2x4 parallel solar panel array to the solar charge controller. The T4 connector also comes with UV Resistance, anti flame and water resistance

Specification	Value
Brand	Kenbrook

Specification	Value
Material	Copper (Tin Plated) | PPO + PA (Outer Covering)
Dimension	17 x 17 x 2 cm
Quantity	2 sets
Cost	₹799

Product Link

2.2 **Mechanical Specifications**

2.2.1 Solar Panel Mounts

Panel mounts are used to fix solar panels on surfaces like roofs, building facades, or ground. The panel array is mounted with each panel aligned at an angle. This angle is variable and mounts should be bought according to the type of rooftop. We'll be using ones with 25° inclination.

We'll be using 2 such mounts for our system, which consists of 8 panels.

Specification (Single unit)	Value
Cost	₹12,000

Specification (Single unit)	Value
Inclination	25°
Dimensions(Leg)	150cm X 60cm
Manufacturer	Loom Solar
Weight	50kg
Material	Galvanised Iron
Holding Capacity	4 Panels

Product Link

2.2.2 Prefabricated portable Biogas Plant

With a biogas plant, organic waste and side streams are converted into income by producing renewable energy and organic fertilizer cost-effectively. Produced biogas can be utilized for electricity and heat production. Biogas can be also upgraded to biomethane that can be used as vehicle fuel or fed into the natural gas grid as a substitute for fossil gas.

Specification	Value
Cost	₹23,599
Plant Capacity	2 m^3
Area to be covered	3m X 3m
Company	Gujarat Renewable Energia
Body Material	PVC Coated Fabric

Specification	Value
Shape	Round
Color	Gray

Product Link

2.3 **Documentation Statistics** [2]

- **Word count**: 2637
- **Total number of unique words**: 922
- **Total number of repeated words**: 1715
- **Total number of sentences**: 49
- **Total number of characters**: 22879
- **Total number of characters without spaces**: 16198
- **Total number of syllables**: 4471
- **Average number of words per sentence**: 54
- **Average number of characters per sentence**: 467
- **Average number of characters per word**: 6.1
- **Average number of syllables per word**: 1.69

The above results were obtained using https://wordcounter.net/.

2.4 **Document Readability indices** [3]

- **Flesch Reading Ease score**: 58
- **Dale-Chall Readability score**: 8.3
- **Flesch-Kincaid Grade level**: 8
- **The Coleman-Liau Index**: 16
- **Automated Readability Index**: 12
- **SMOG Formula score**: 12
- **Spache Readability score**: 4

The above scores were obtained using Visual Studio Code extension called Readability Check by jemcclin.

2.5 **References**

[1] GitHub - Off Grid Energy Design - Tribe E

[2] WordCounter - Count Words & Correct Writing

[3] Readability Check - Visual Studio Marketplace