SELECTION OF BATTERY

The following are the type of batteries available in market and that satisfies our needs. Their weight, lifetime and charge cycle are discussed below.

Lead Acid (SLA) batteries

They're the heaviest of the three with the shortest overall lifetime. A Lead Acid battery will last about 300 full charge cycles before it needs to be replaced. Their advantage is the fact that they're relatively commonplace and the least expensive to replace, periodic maintenances are not needed cost is effectively very low compared to other two.

Nickel Metal Hydride (NiMH) batteries

A big jump up from SLA batteries, they're much lighter and have a better overall lifetime. A NiMH battery will last about 500 full charge cycles before it needs to be replaced.

Lithium Ion (Li Ion) batteries

The newest technology in batteries. They're pretty comparable to NiMH batteries, with the exception of these two differences: Lithium Ion batteries are a little bit lighter, and a Lithium Ion battery will last about 800 full charge cycles before it needs to be replaced. Lithium Ion batteries are the most expensive of the three.

Our solar cart utilizes lead acid battery of following specification. The reason for choosing this battery will be discussed further below.

Type:	Lead Acid (VRLA)
Voltage:	12×4 (volts)
Current:	33 (Ah)
Length:	175 mm
Height:	125 mm
Width:	166 mm
Weight:	9.2×4 kg
Manufacturer:	Exide (12EC33R)

- The above mentioned four lead acid batteries will be connected in series for driving a hub motor (48v, 750W) through a controller.
- To maintain the stability of the cart in the best possible way the batteries are split up into four and placed in the most comfortable region.
- The batteries are charged with 48V, 2.5A, charger circuit which is powered by solar panel (1000W).

Image:

Reason for choosing VRLA batteries:

Battery-based renewable energy systems vary greatly in size and design based on the purpose and location of the installation. Unlike many other battery applications, our battery-based renewable energy applications are unique because the batteries in these systems can be discharged and charged in an unpredictable manner due to variations in sunshine. They are also subjected to seasonal variations due to the presence of self-resealing pressure valve and can result in the batteries having to operate in a partial state of charge for considerable lengths of time. These factors can cause the batteries to result in frequent deep discharges and lack of charge. Consequently, the most important requirement for batteries used in renewable energy systems is long cycle life. **Deep-Cycle Valve-Regulated Lead-Acid Batteries (VRLA)** or sealed battery is the best choice for renewable energy applications but we also recognized that there are different types having strengths and weaknesses which influence their suitability and life.

ADVATAGES OF VRLA BATTERIES:

Maintenance is low that is no need of periodic adding of chemicals.

- ✓ Can be mounted in any orientation.
- ✓ Less expensive than deep-cycle Gel batteries.
- ✓ Wider temperature tolerance range.
- ✓ Slowest self-discharge rate.
- ✓ Best shock/vibration resistance.
- ✓ Maintains a constant voltage throughout the discharge cycle.

CHARGING SET-UP

The following key points are ensured while charging the battery for better lifetime of the battery.

- ✓ Charging time= Battery capacity/Charging current.

- ✓ Charging potential should be little greater than battery potential (for 12v battery, charging voltage should be between 13.5v to 15v).
- ✓ Minimum charging current required is 10% of battery rating.
- ✓ For good maintenance, charging current should be between 10% to 30% of capacity. If essential up to 40%.

CALCULATIONS:

Input voltage: We use four 24V batteries which are connected in parallel; hence the input voltage should be **48V** at the minimum.
Input voltage = 4×12
= 48 volts.
Since the charging potential should be greater than battery potential we boost up the voltage level to **50V** or more.

Input current: The minimum charging current should be 10% of rated battery current.
Input current =10% of 33
= (10/100) × 33
=3.3 amps.
Considering the lifetime of battery the charging current is also boosted up to **3.5A** or more.

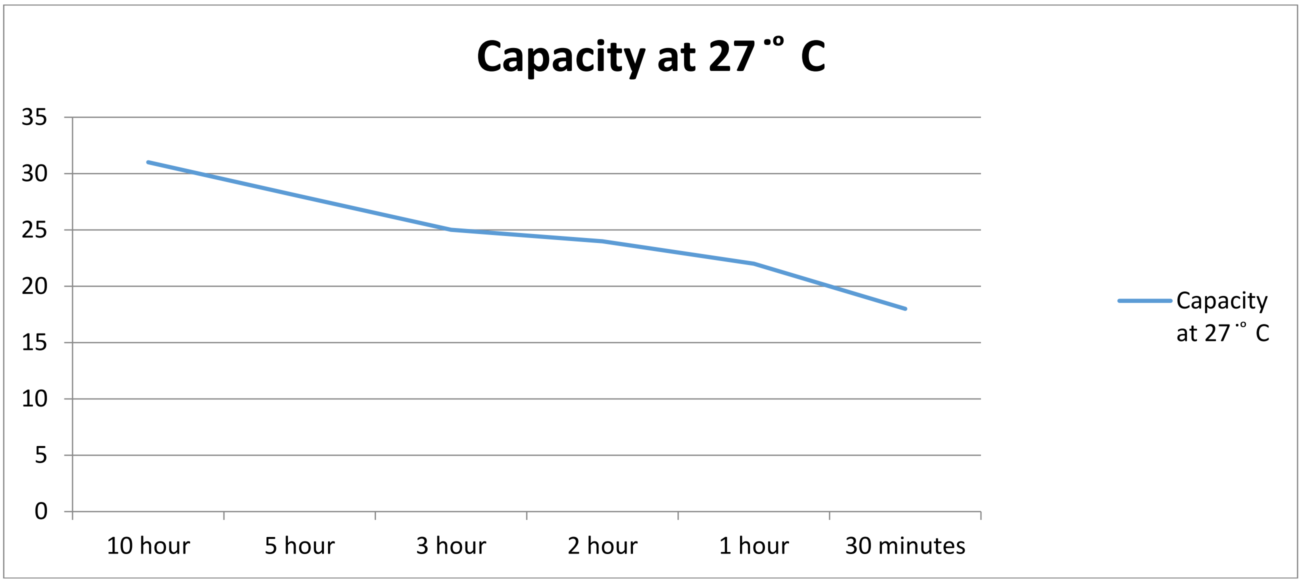
Charging time: The time taken for the batteries to charge along with their efficiency is shown below
Battery capacity=33AH
Charge rate current=3.5mA
Maximum time to full charge (considering no loss) = 33000/3500
=**9.4 hours**
However it is impossible to charge the battery without any efficiency loss hence the following table shows the time taken to charge with efficiency loss.

Maximum Time To Full Charge (10% Efficiency Loss)	10.3 Hours
Maximum Time To Full Charge (20% Efficiency Loss)	11.3 Hours
Maximum Time To Full Charge (30% Efficiency Loss)	12.4 Hours
Maximum Time To Full Charge (30% Efficiency Loss)	13.4 Hours
Maximum Time To Full Charge (No Efficiency Loss)	9.6 Hours

Discharging time: The time taken to discharge depends on the load current.
The maximum current that the motor will draw under full load is 16.6A
Capacity (amp-hr) = 33 Ah
Discharge rate = 16.6A
Discharge time = (33/16.6)0.6

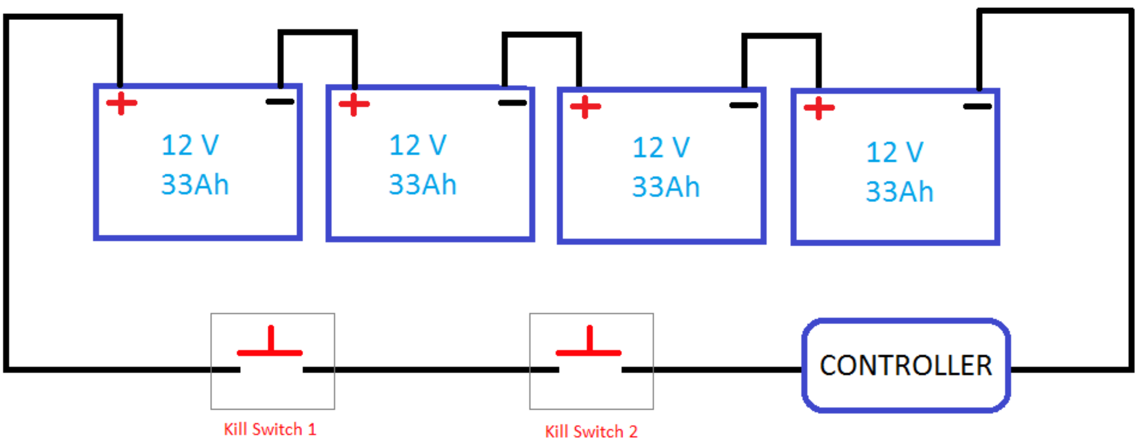
= 1.16 hours (on full load).

Capacity at 27 degree Celsius: The following graph is plotted to show the capacity of battery at different charging interval.

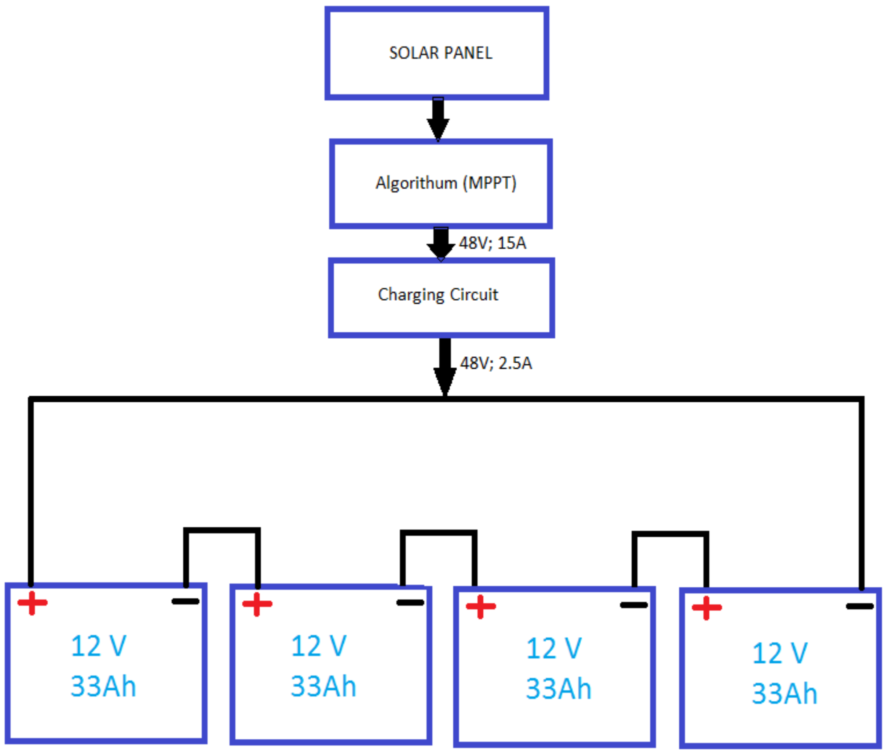


CONNECTION:

From battery to controller



From panel to battery


SOLAR PANEL
Algorithum (MPPT)
48V; 15A
Charging Circuit
48V; 2.5A
12 V
33Ah
12 V
33Ah
12 V
33Ah
12 V
33Ah