SOLAR ENERGY MONITORING SYSTEM

The #1 solution for standalone solar energy monitoring!

Senior Design Project
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Client: Invention Planet

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Overview

- Problem and Proposal
- Requirements
- Technical Overview and Software Design
- Budget and Schedule
- Tests
- Data
- Application
- Conclusion

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The Problem

The Proposal

To design and implement a low cost standalone solar power monitoring system to determine solar viability of potential investors.

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Current Options

ENPHASE

solaredge

Requirements

Marketing Requirements (MR)

MR1. Low Cost

MR2. Portable

MR3. 24 Hour Monitoring

MR4. Web Accessible

MR5. Weatherproof

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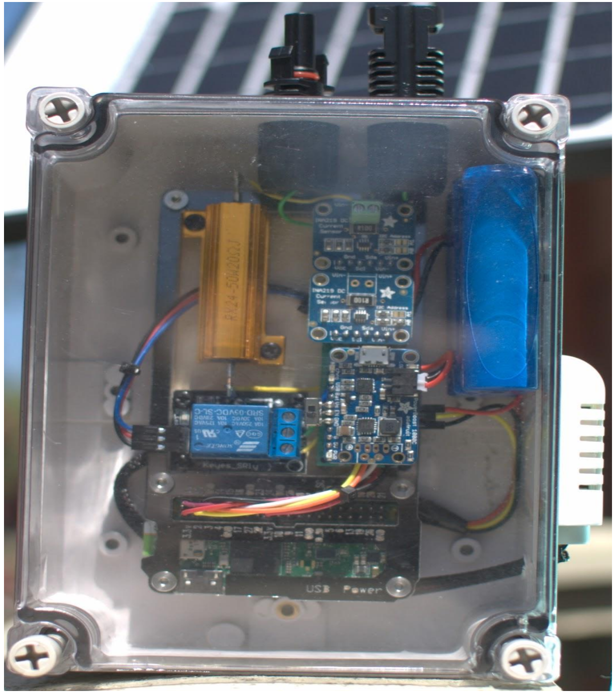
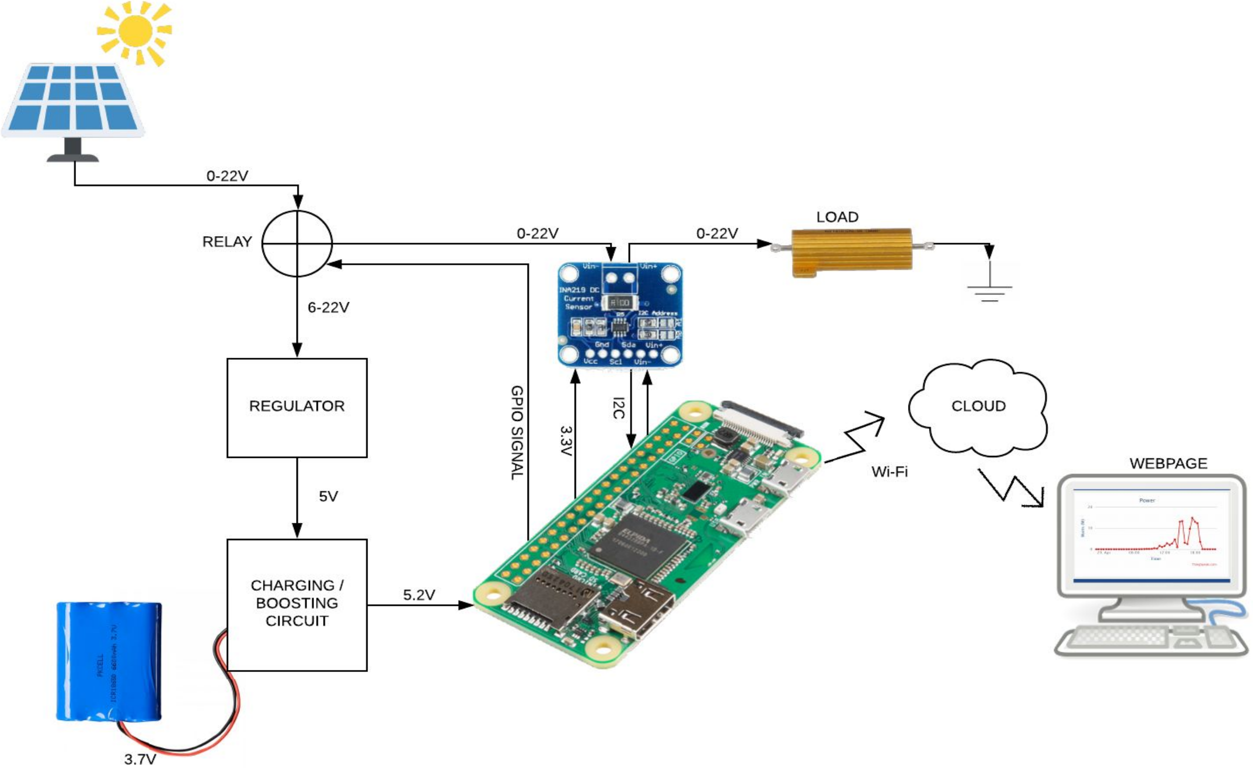
Requirements

Marketing Requirements (MR)	Engineering Requirements (ER)
MR1. Low Cost	ER1. 25 Watt Solar Panel [MR1]
MR2. Portable	ER2. 6-22V to 5V Regulator
MR3. 24 Hour Monitoring	ER3. Raspberry Pi Zero W [MR1, 2, 4, 5]
MR4. Web Accessible	ER4. 6600 mAh Li-Ion Battery Pack [MR3]
MR5. Weatherproof	ER5. Li-Ion Charging Circuit with Booster
	ER6. IP65 Weatherproof Case [MR5]

Technical Overview





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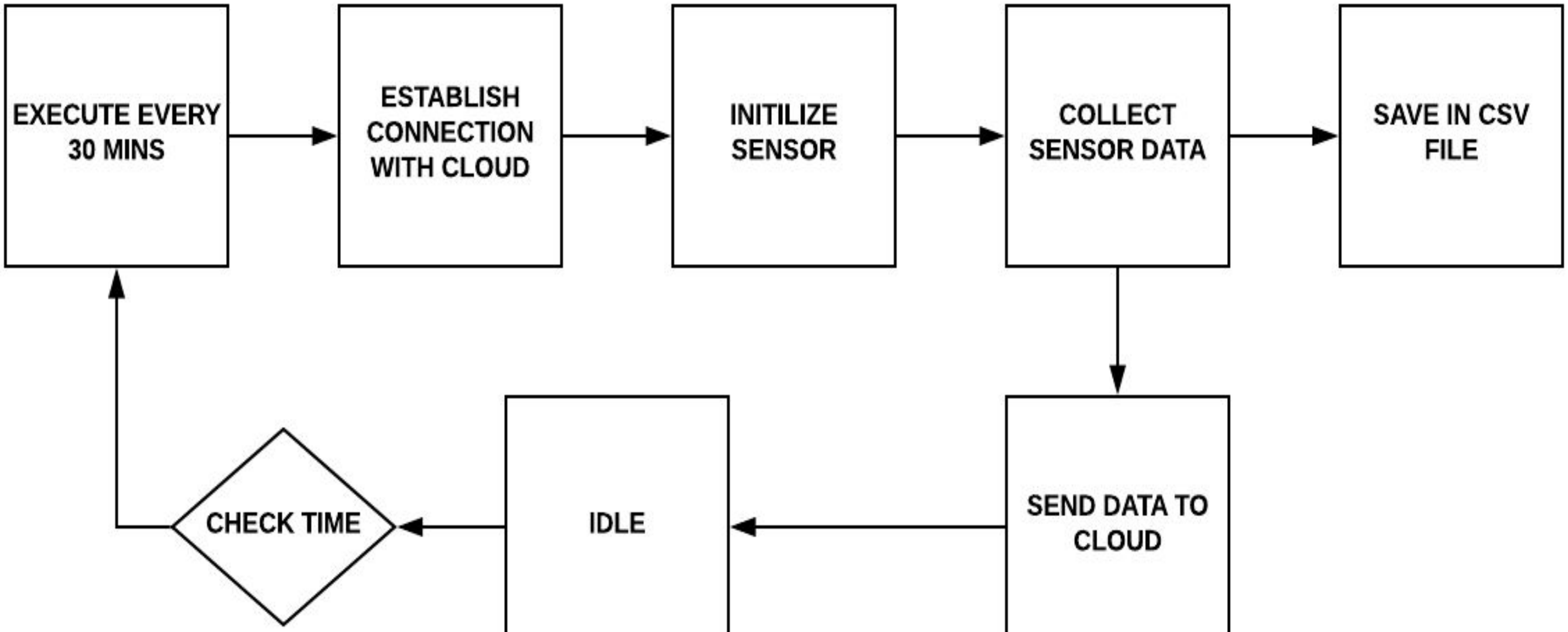
Software Design



Budget

ITEM	MANUFACTURER	PART #	SUPPLIER	PRICE
25 W Solar Panel	Aleko	SP25W12V	Amazon	$40.00
Relay	Tolako	BJ-DT0Y-0001	Amazon	$6.00
Regulator	Traco Power	TSR 1-2450	Adafruit	$15.00
Charger/Booster	Adafruit	1000C	Adafruit	$20.00
Li-Ion Battery	Adafruit	ICR18650	Adafruit	$30.00
Current Sensor	Adafruit	INA219	Adafruit	$10.00
Load Resistor	Electronics Salon	R-A50W/20-2	Amazon	$5.00
Raspberry Pi Zero W	Raspberry Pi	Zero W	Adafruit	$10.00
Weatherproof Case	Toyogiken	DS-AT-1217	Adafruit	$20.00
			Total Price	$156.00

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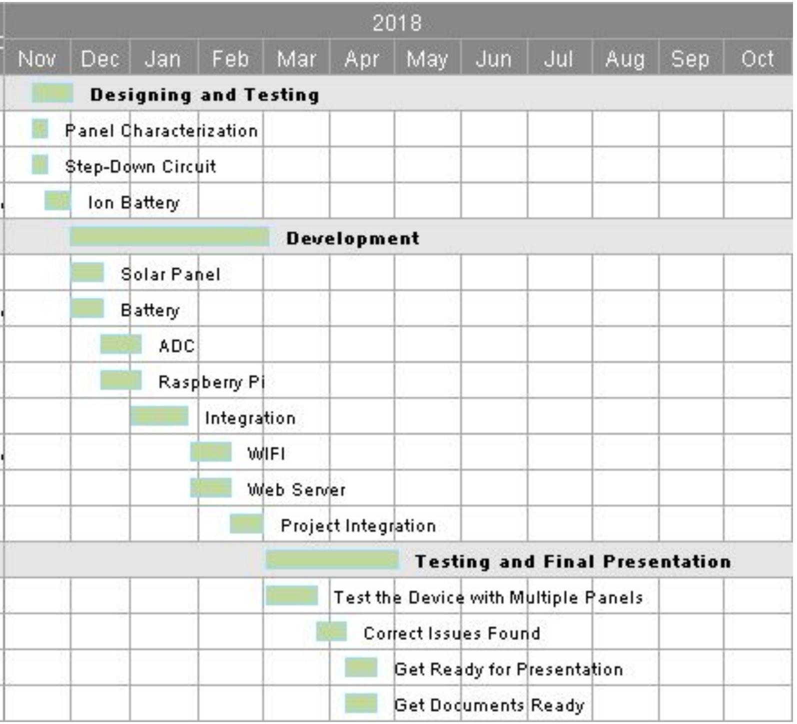
Initial Schedule

	Task Name	Start Date	End Date	Assigned To
1	**Designing and Testing**	**11/14/17**	**12/01/17**	
2	Panel Characterization	11/14/17	11/20/17	Randy
3	Step-Down Circuit	11/14/17	11/20/17	Randy
4	Ion Battery	11/20/17	12/01/17	Giovanni Azp
5	**Development**	**12/01/17**	**03/02/18**	
6	Solar Panel	12/01/17	12/15/17	Randy
7	Battery	12/01/17	12/15/17	Giovanni Azp
8	ADC	12/15/17	01/01/18	Randy
9	Raspberry Pi	12/15/17	01/01/18	Randy
10	Integration	01/01/18	01/26/18	Both
11	WIFI	01/29/18	02/15/18	Giovanni Azp
12	Web Server	01/29/18	02/15/18	Randy
13	Project Integration	02/16/18	03/02/18	Both
14	**Testing and Final Presentation**	**03/03/18**	**05/02/18**	
15	Test the Device with Multiple Panels	03/03/18	03/25/18	Both
16	Correct Issues Found	03/26/18	04/07/18	Both
17	Get Ready for Presentation	04/08/18	04/21/18	Both
18	Get Documents Ready	04/08/18	04/21/18	Both



Challenges

- Power consumption
- Wi-Fi connectivity
- Sensor configurations
- Scheduling

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Revised Schedule

	Task Name	Start Date	End Date	Assigned To
1	**Designing and Testing**	**11/14/17**	**12/01/17**	
2	Panel Characterization	11/14/17	11/20/17	Randy
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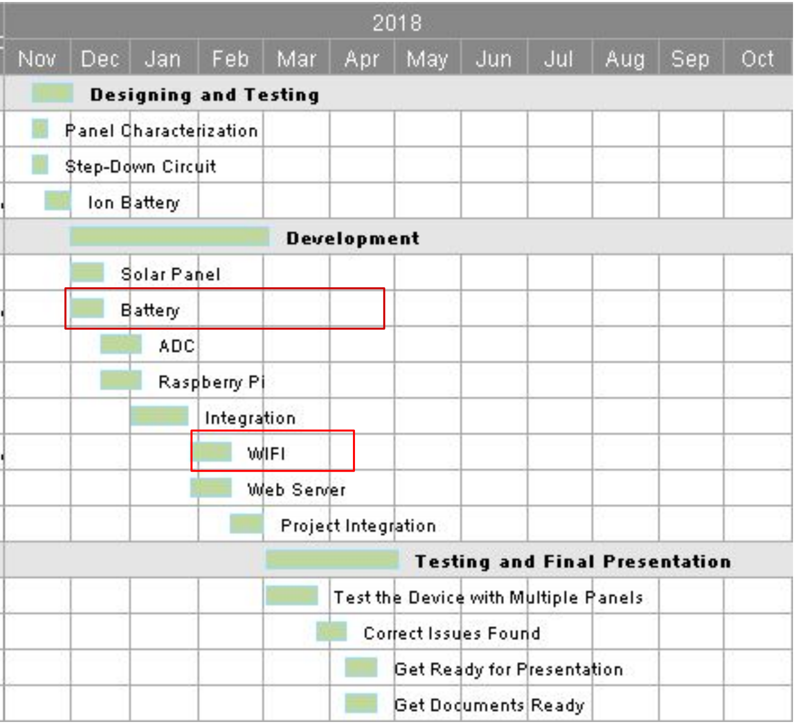
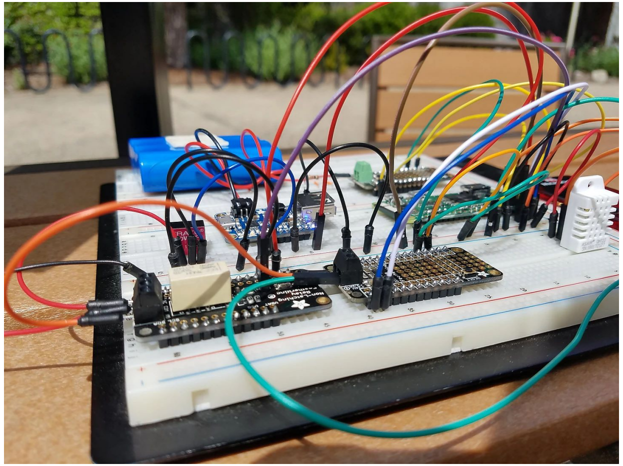
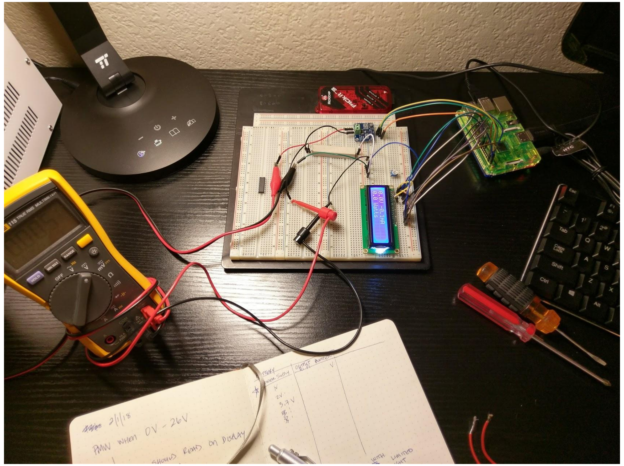
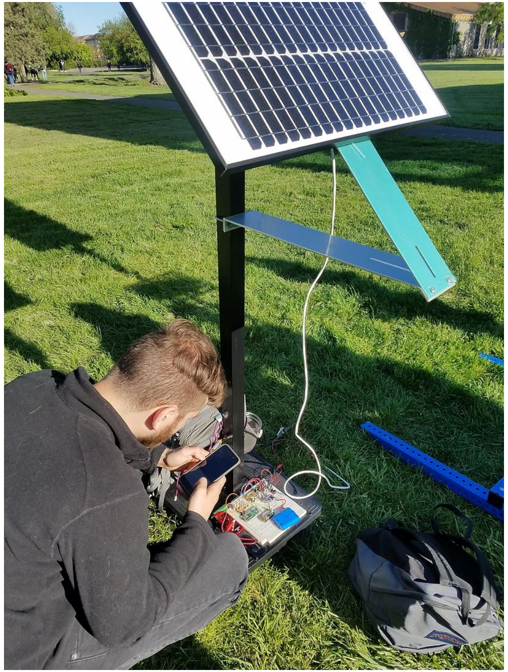


List of Tests

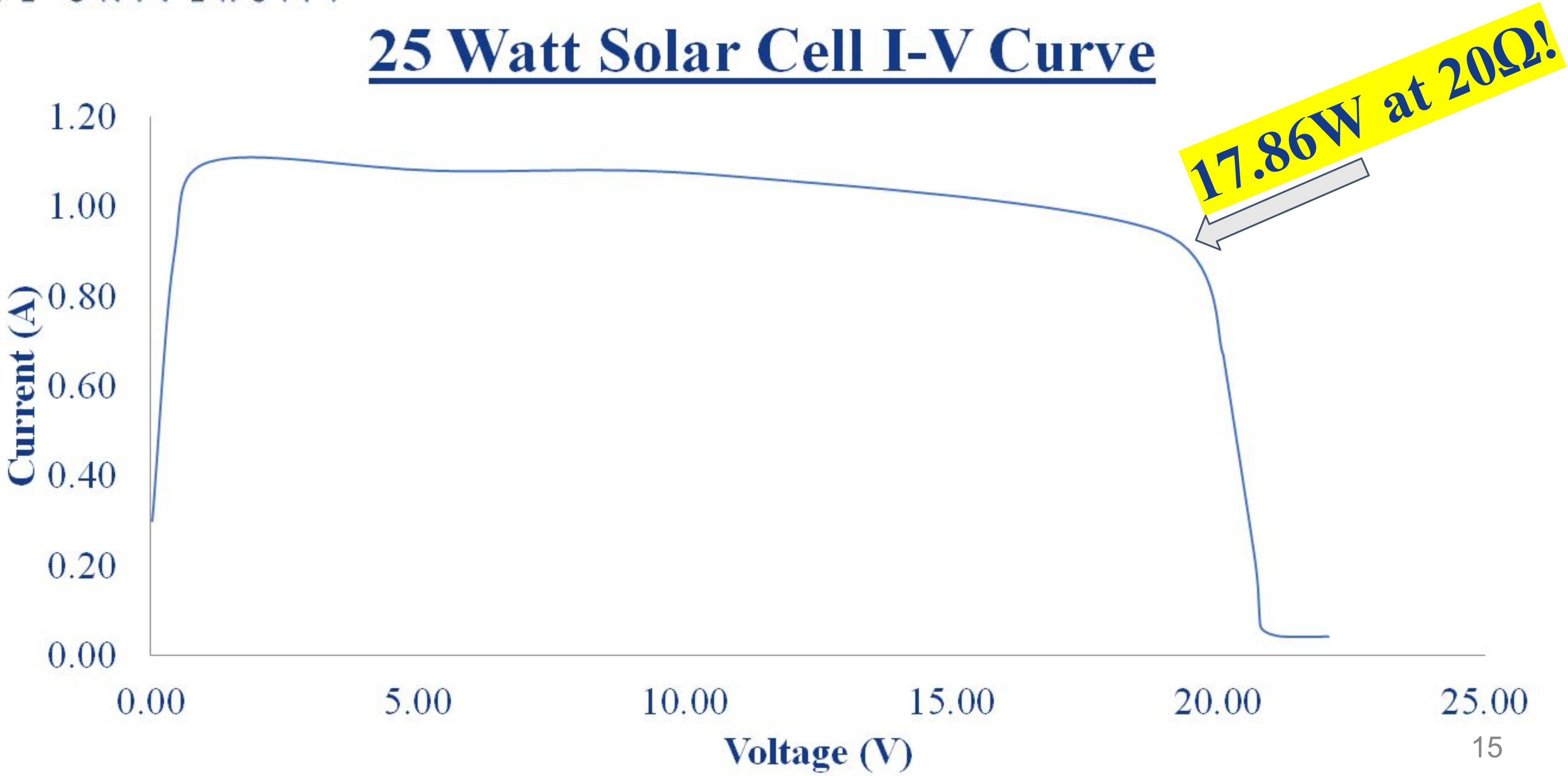
- Characterize 25W Solar Panel
- Power Measurement Accuracy
- Li-Ion Battery Charging
- Raspberry Pi Power Consumption







Characterize 25W Solar Panel



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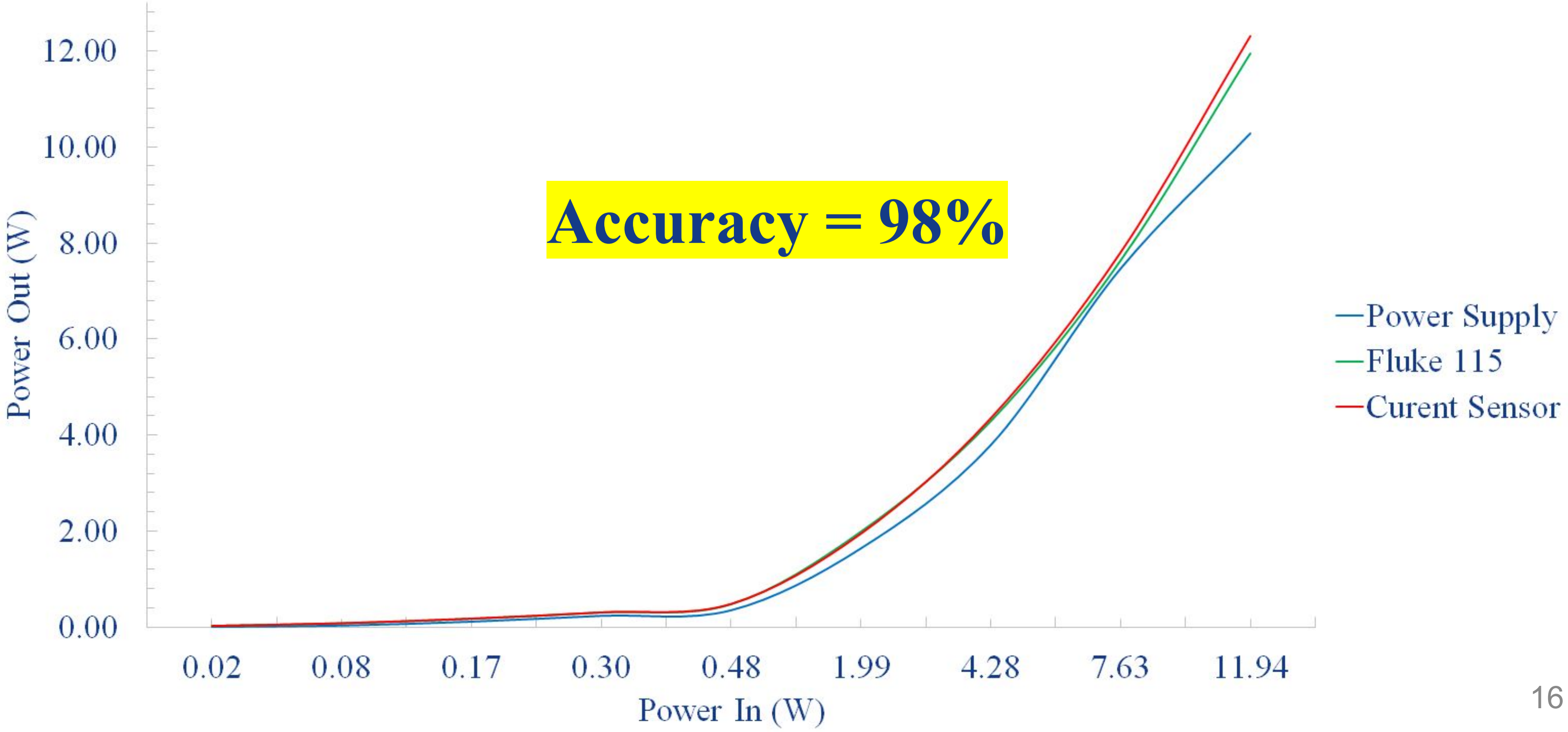
Power Measurement Accuracy

Power Measurements



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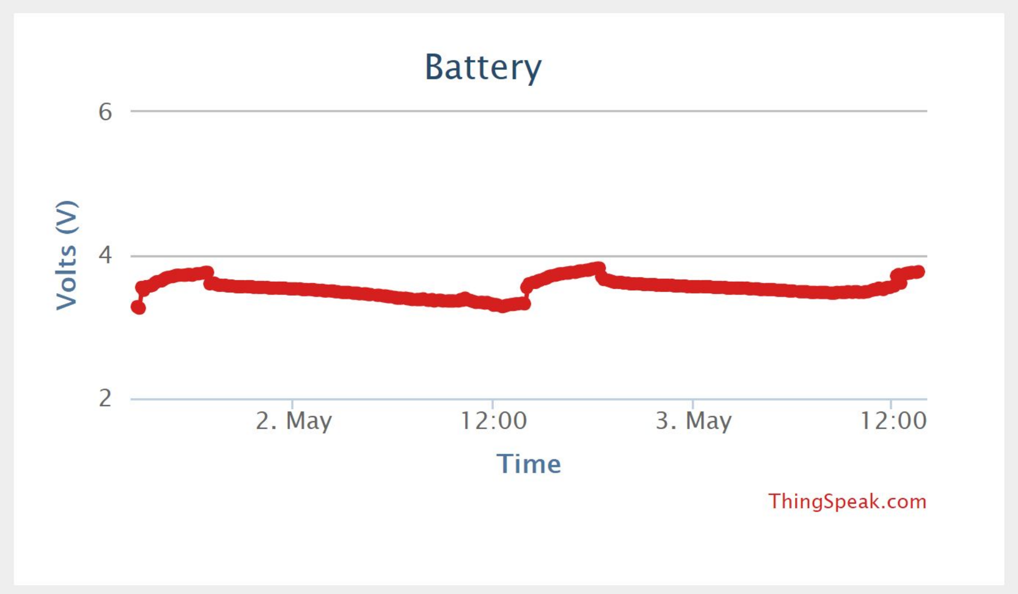
Li-Ion Battery Charging



Average system current = (0.14 A_{IDLE} x 1795 s) + (0.4 A_{LOAD} x 5 s) / 1800 s = 0.141 A

Estimated battery life = 6600 mAh / 141 mA = 46.81 Hours

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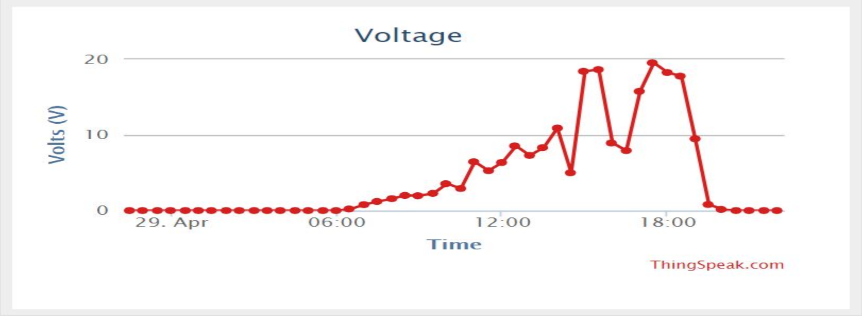
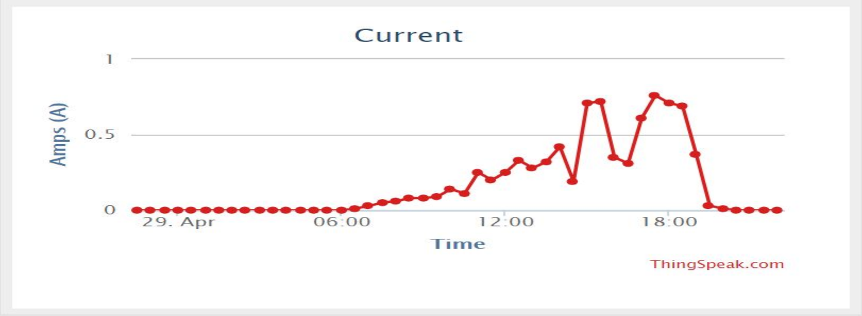
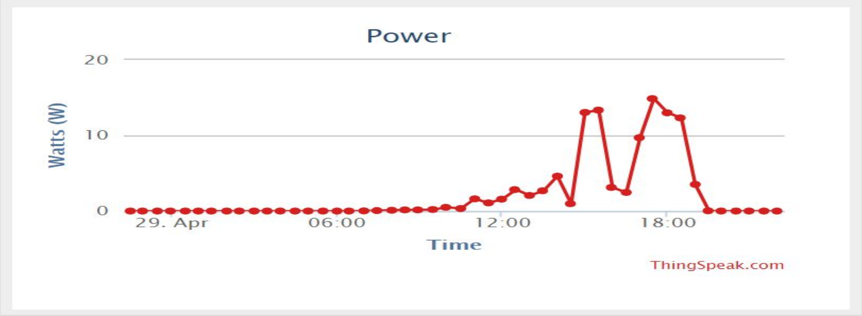
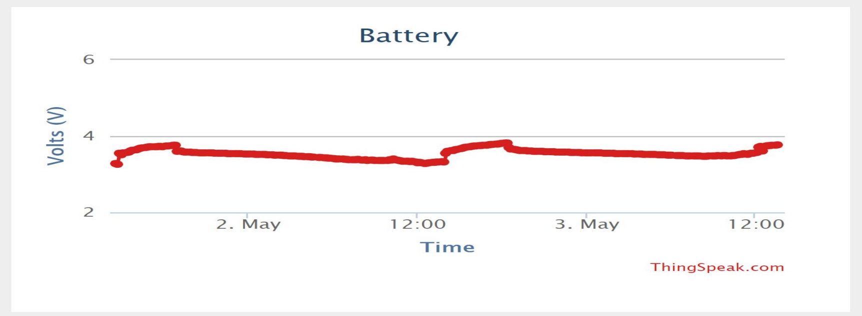
Raspberry Pi Power Consumption

Visualized Data









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Website

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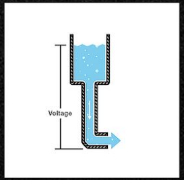
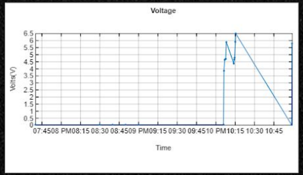
VOLTAGE

We define voltage as the amount of potential energy between two points on a circuit. One point has more charge than another. This difference in charge between the two points is called voltage. It is measured in volts
When describing voltage, current, and resistance, a common analogy is a water tank. In this analogy, charge is represented by the water amount, voltage is represented by the water pressure, and current is represented by the water flow. So for this analogy, remember:

- Water = Charge
- Pressure = Voltage
- Flow = Current
- Now, Consider a water tank at a certain height above the ground. At the bottom of this tank there is a hose.

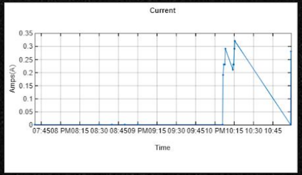




VOLTAGE DATA

CURRENT

We can think of the amount of water flowing through the hose from the tank as current. The higher the pressure, the higher the flow, and vice-versa. Curren t is measured in Amperes



CURRENT DATA

Application

Application

The standard solar system uses 250W panels.

We used a 25W solar panel.

250W = 10 x 25W

Application

Our solar panel produced an average of **77Wh per day.**

Application

Our solar panel produced an average of 77Wh per day.

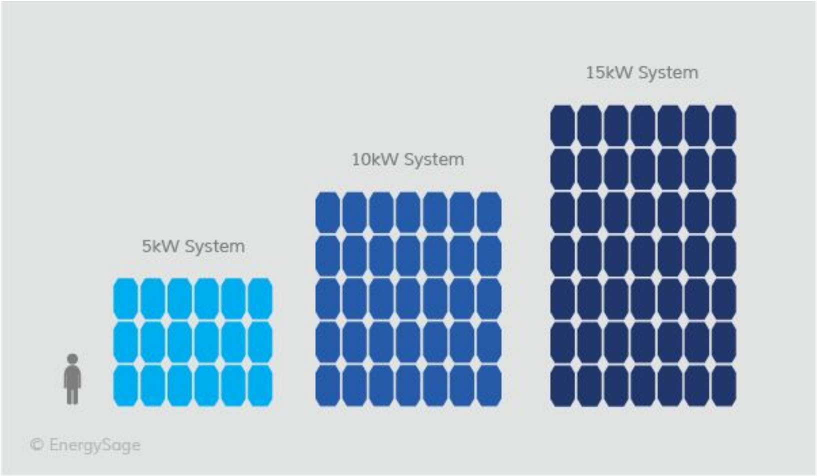
Using our ratio:

250W panel = 770Wh per day.

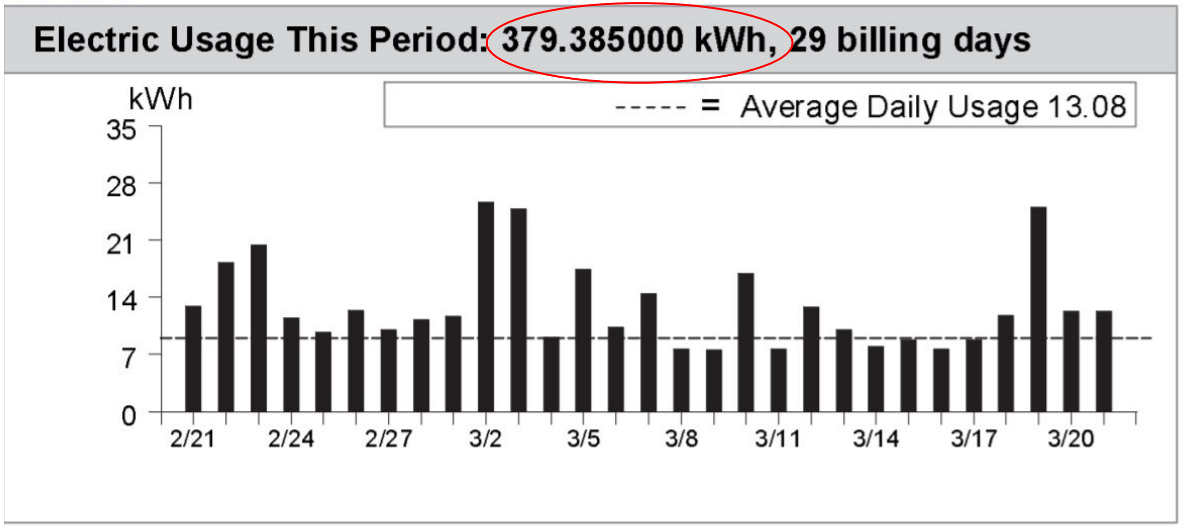
Application

The average 5kW solar system uses 20 panels.

20 x 770Wh = 15,400Wh = 15.4kWh per day



Application



15.4 kWh x 29 days = 446.6kWh

Application

Let’s say…

$150 Electrical Bill

$1,800 per year

$10,000 investment paid off in 5.5 years!

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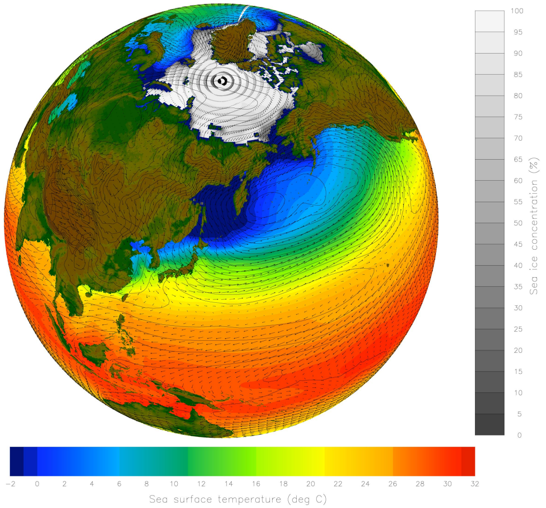
Future Work

Link with PG&E SmartMeter

Computer Simulation



Conclusion

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References

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QUESTIONS/COMMENTS