Project Proposal and Statement of Work

Team Members: Jimmy Smith, Jr., Aileen Ulm, Xiaoxiang Gao
Jonathan Melton, Morgan Bublitz, James Harrell,
and Madanha Chibudu

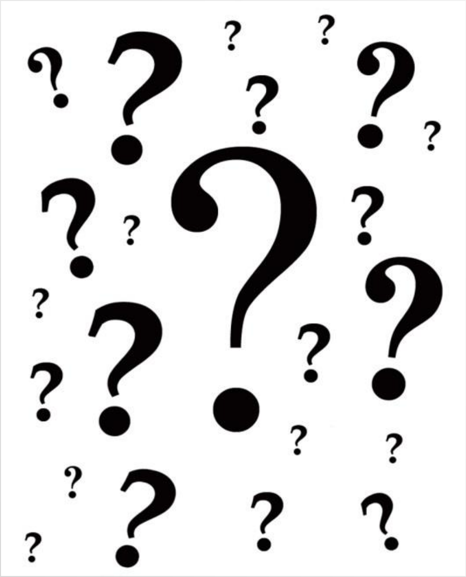
Senior Design Project Instructor: Dr. Michael Frank

Technical Advisors: Dr. Edrington & Dr. Ordonez

Problem Statement

. **Pressure Regulation**

pressure regulator



. **Energy Storage**

batteries

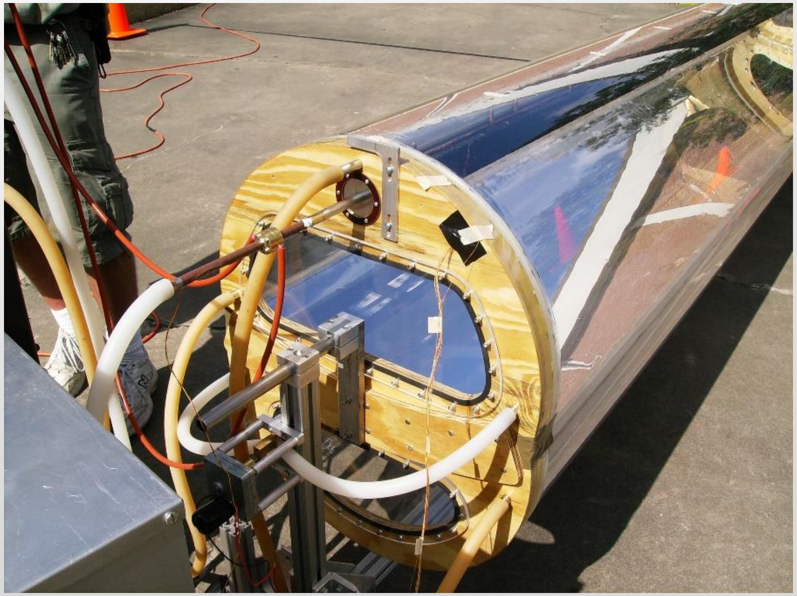
. **Cooling System for solar panels**

heat exchanger

Aileen Ulm

Intended Use(s) & User(s)

- Provides electricity and potable water to impoverished countries.
- Support a 1.5 kW load; scaled up version will support a small village



Jimmy Smith, Jr.

Assumptions & Limitations

Assumptions	Limitations
Components for the project will be inexpensive	$5,000 budget
Provide potable water	Scarce water sources
Project will be completed in two semesters	Unforeseen circumstances
Solar Sausage and Photovoltaic panel will both have a length of 10 feet.	Storing the Solar Sausage
Power output of 900 W/m^2	Ideal Sunlight
Water will be pasteurized from 65°C – 90°C.	Continuous water flow
Upper & Lower hemispheres will maintain a constant pressure	Morning dew
One axial rotation	Few moving parts to track the sun
Reflective material is convenient	The tension on both ends of the sausage

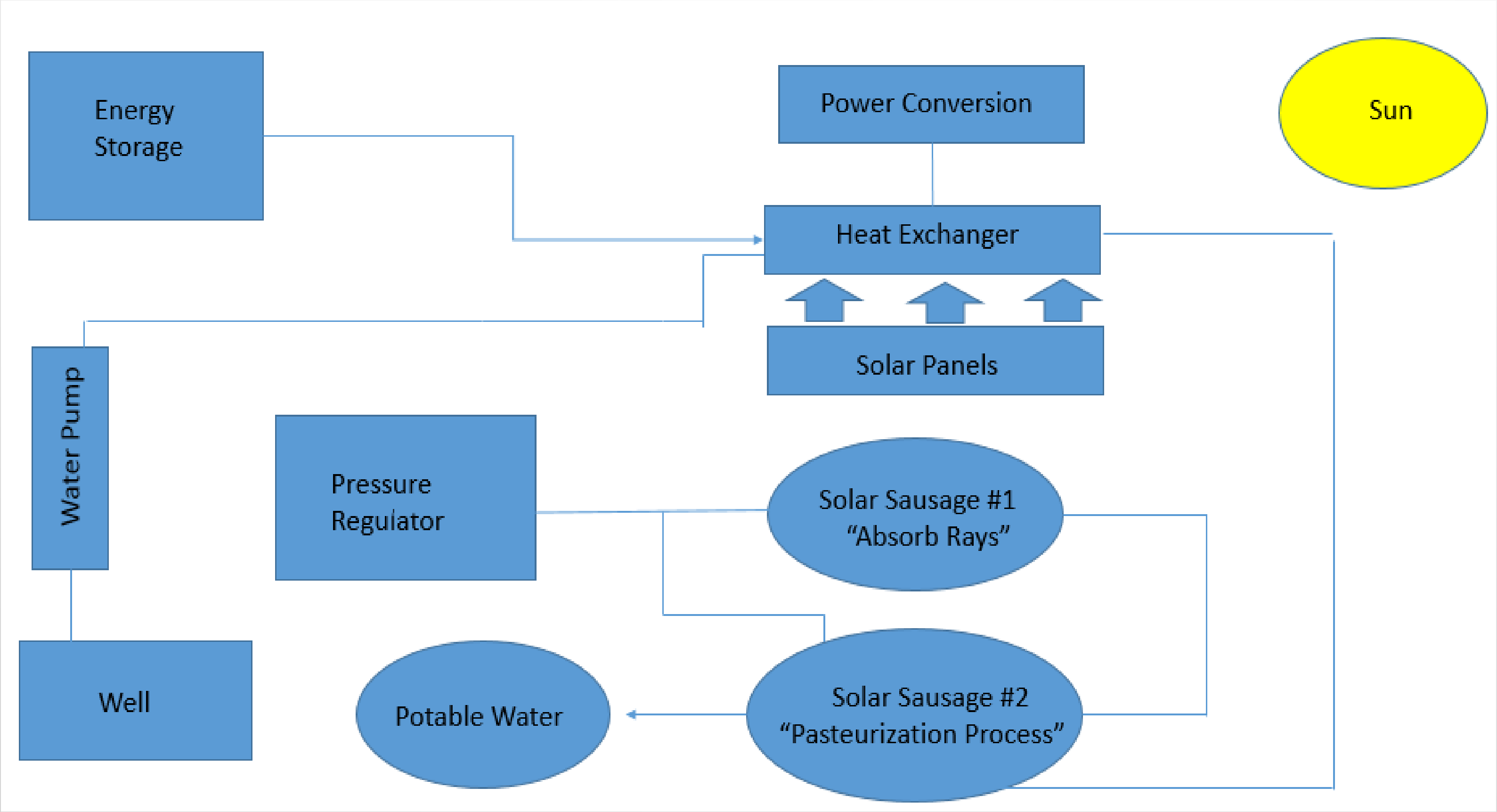
Jimmy Smith, Jr.

Risk Assessment

- Lack of understanding of client requirements or wants
- Scheduling issues may cause the whole project to fail to meet the deadline
- Designs may not hold up to certain specs given to the team by the client
- The temperature may not be controlled at a level to keep all of the equipment safely cool
- Undecided design routes for the overall project design
- Pressure stability could not be reached

Jimmy Smith, Jr.

Top level Design



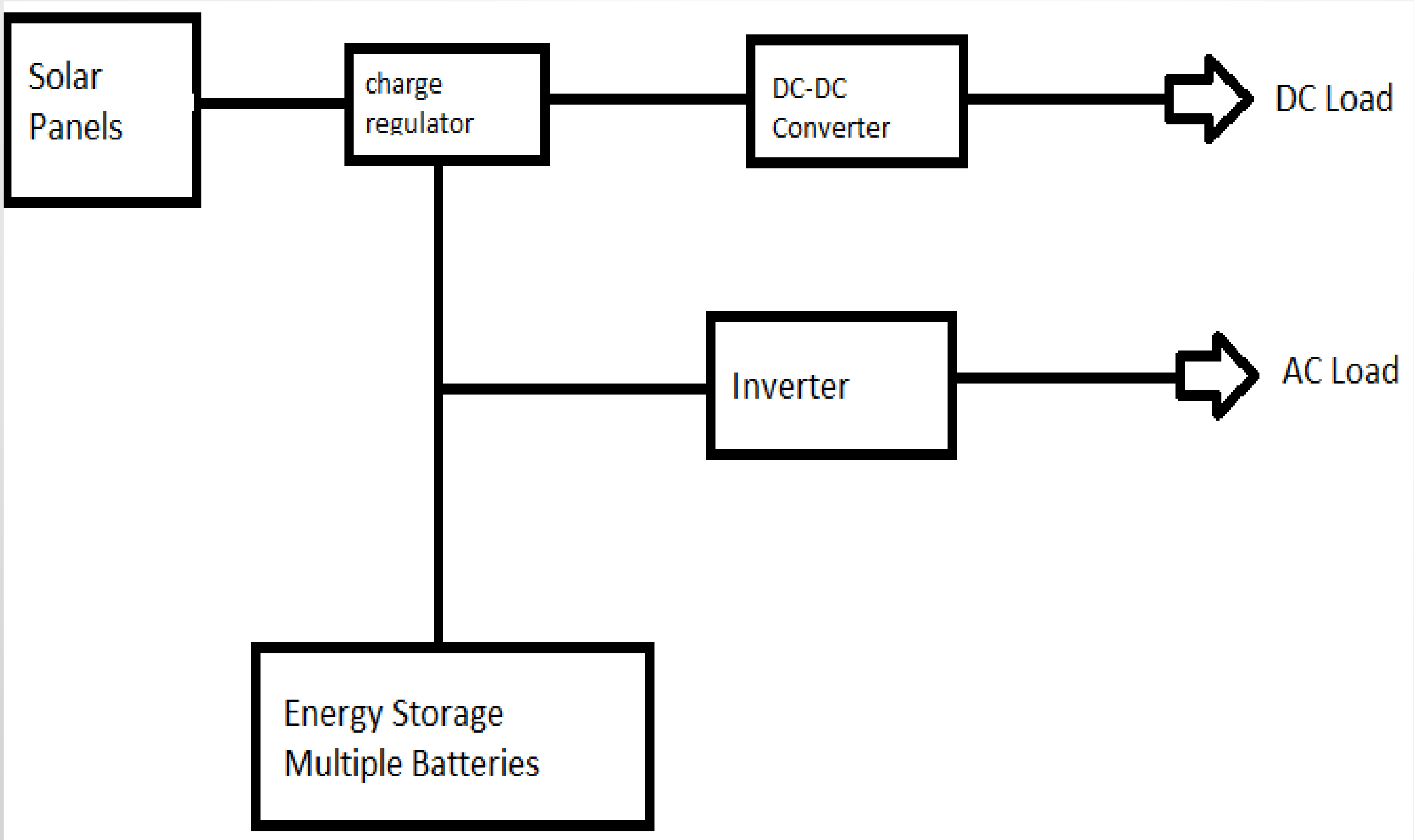
Jimmy Smith, Jr.

Operating Environment

- Hot & dry climates
- Basing our specifications to the environment of the country in Panama.

Jimmy Smith, Jr.

Power Conversion (Inverter)



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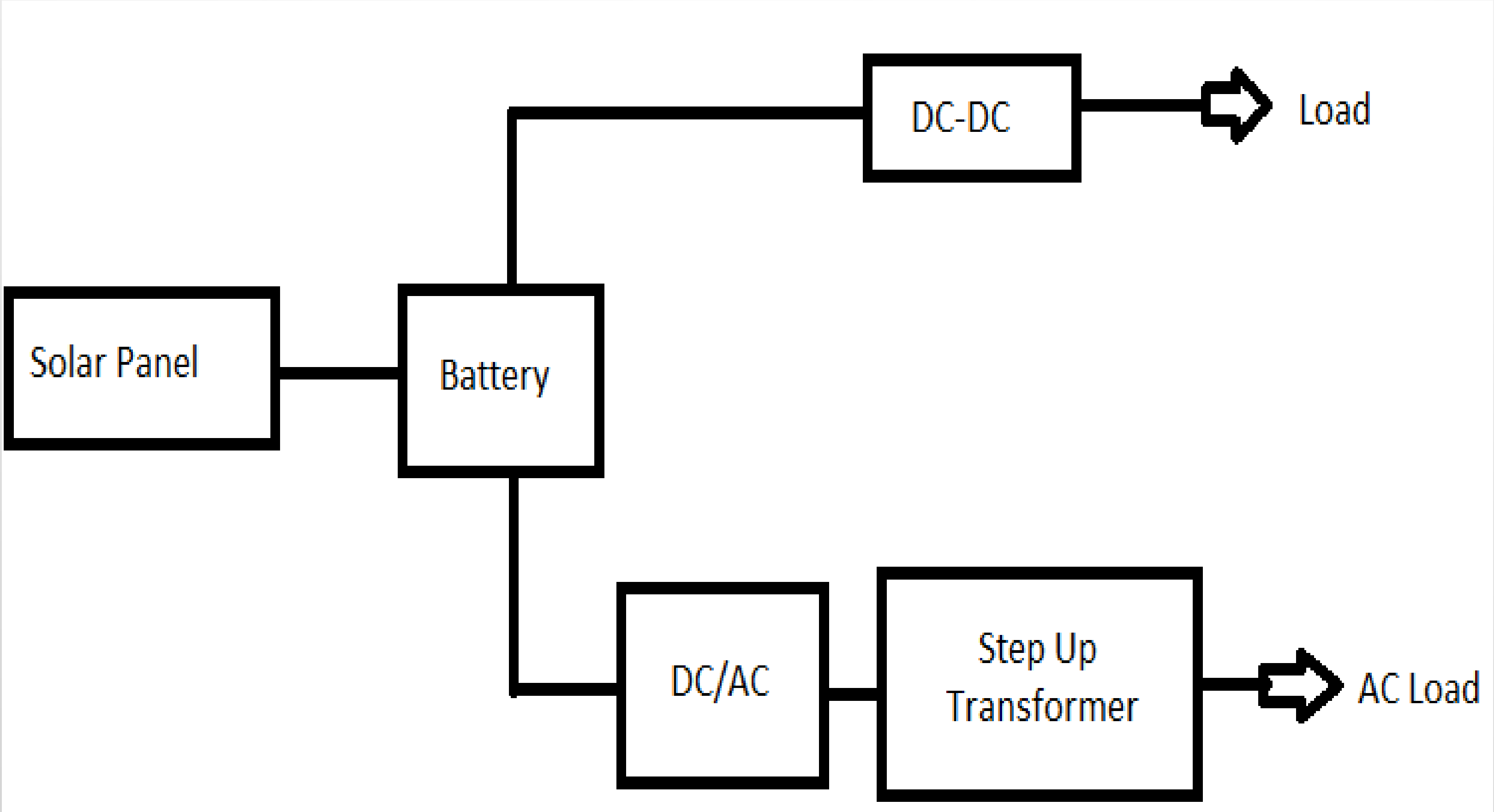
Power Conversion (step-up transformer)



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Water Purification

- Pumped from well
- Pasteurized
- Timing / Temperature
- Sensor

Aileen Ulm

Solar Tracking System

- Importance
  - Increases system output
    - About 30 percent more production
    - Less panels, less expensive
- Tracking Mechanism
  - Single axis adjustability
    - Monthly Locking Positions
    - Dual axis is not good for plumbing

Jonathan Melton

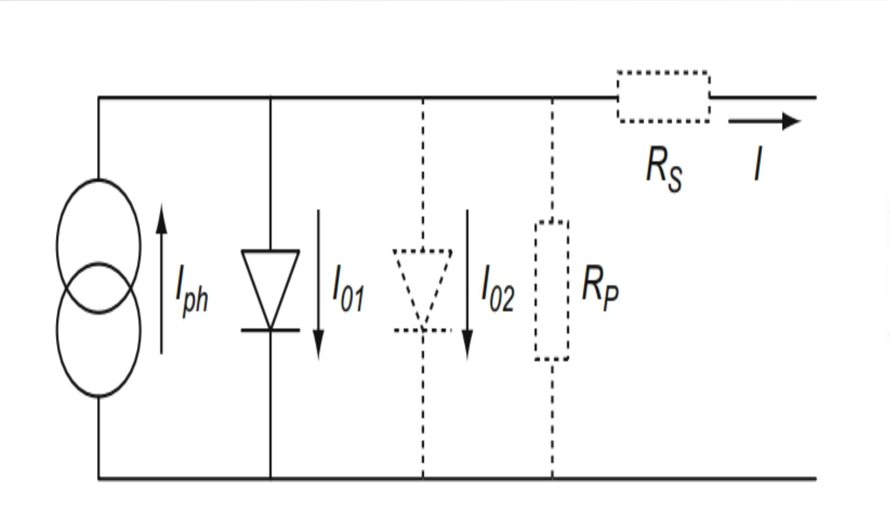
Solar Tracking Angles

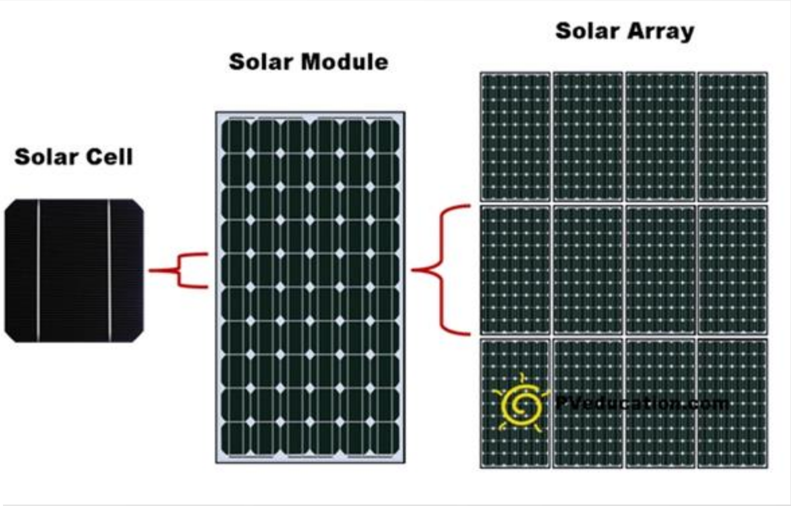
January 65°	February 73°	March 81°	April 89°	May 97°	June 104°
July 97°	August 89°	September 81°	October 73°	November 65°	December 58°

Jonathan Melton

Solar Panel

- Principle of Solar Cell Operation :





Solar Panel

- Principle of Solar Cell Operation :

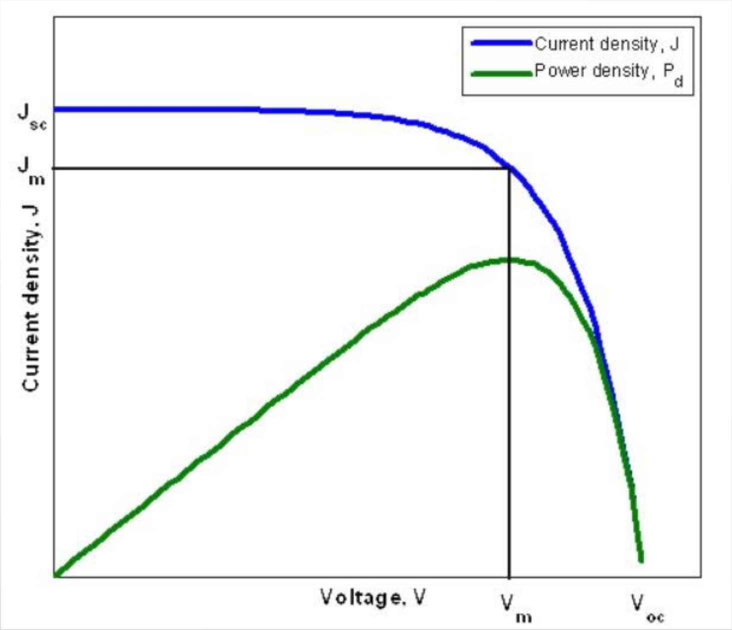
  - Every solar panel has their own

I-V curve, find the max power point

and fully make use of it.

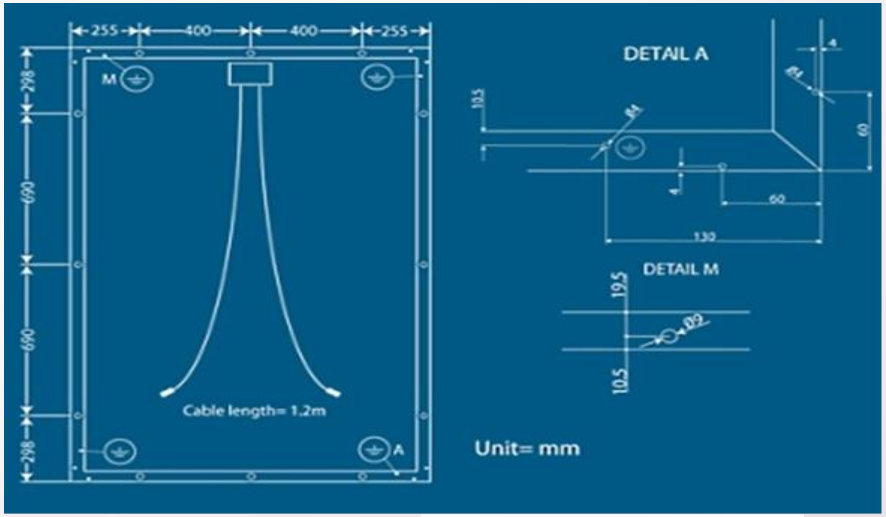
- Many things can influence the I-V curve,

Such as insolation, temperature, shaded



Solar Panel

- Helios 9T6 400W



Rated Power: 400W

MPP Voltage: 48.43V

MPP Current: 8.26A

Open Circuit Voltage: 59.8V

Short Circuit Current: 8.82A

Cells: 96 monocrystalline, 3 bus bars

Cells Dimensions: 156mm*156mm

Frame: Anodized aluminum

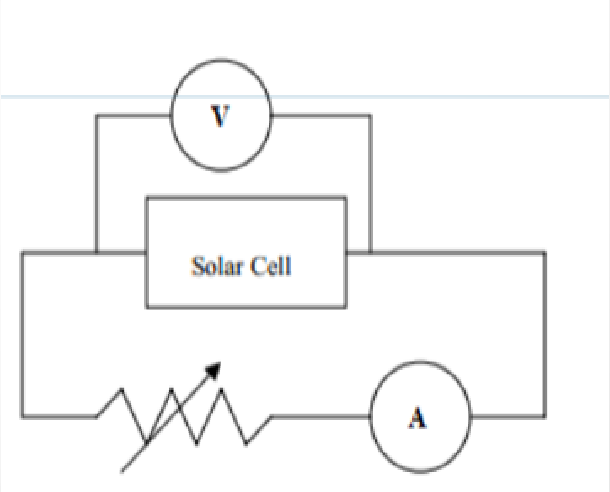
Cable: 2*1.2m solar cables with MC4 connectors

Module Temperature: -40 to 80

Xiaoxiang Gao

Test of Solar Panel

- Test Equipment:

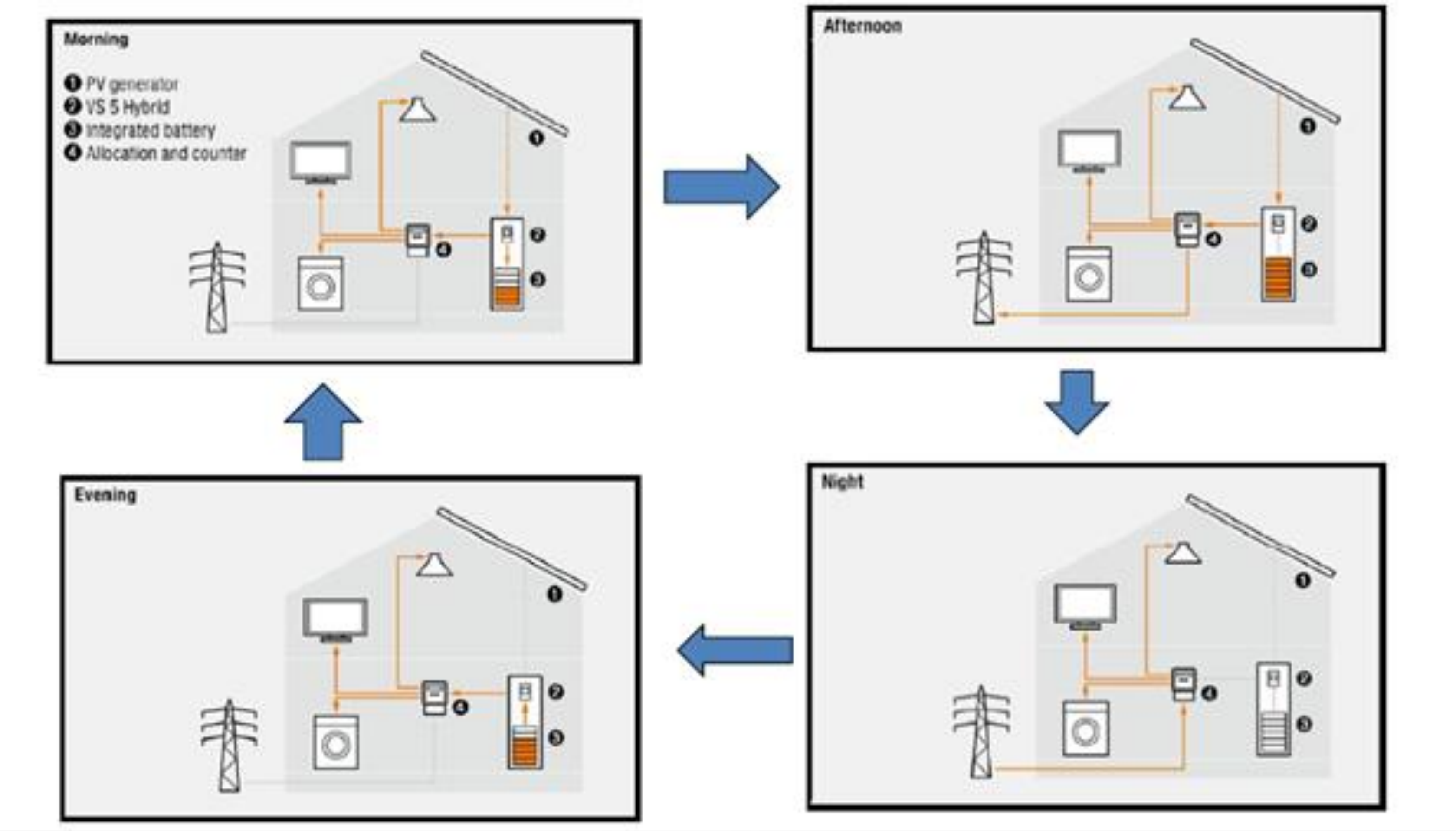


- Solar cell
- Protractor
- Light source
- Power source
- Ammeter
- Voltmeter
- Potentiometer

- Set the circuit as in the diagram above (Ammeter is in series, Voltmeter parallel)
- Measure the Short Circuit Current (by having maximum resistance) and Open Circuit Voltage (by disconnect ting the variable resistor)

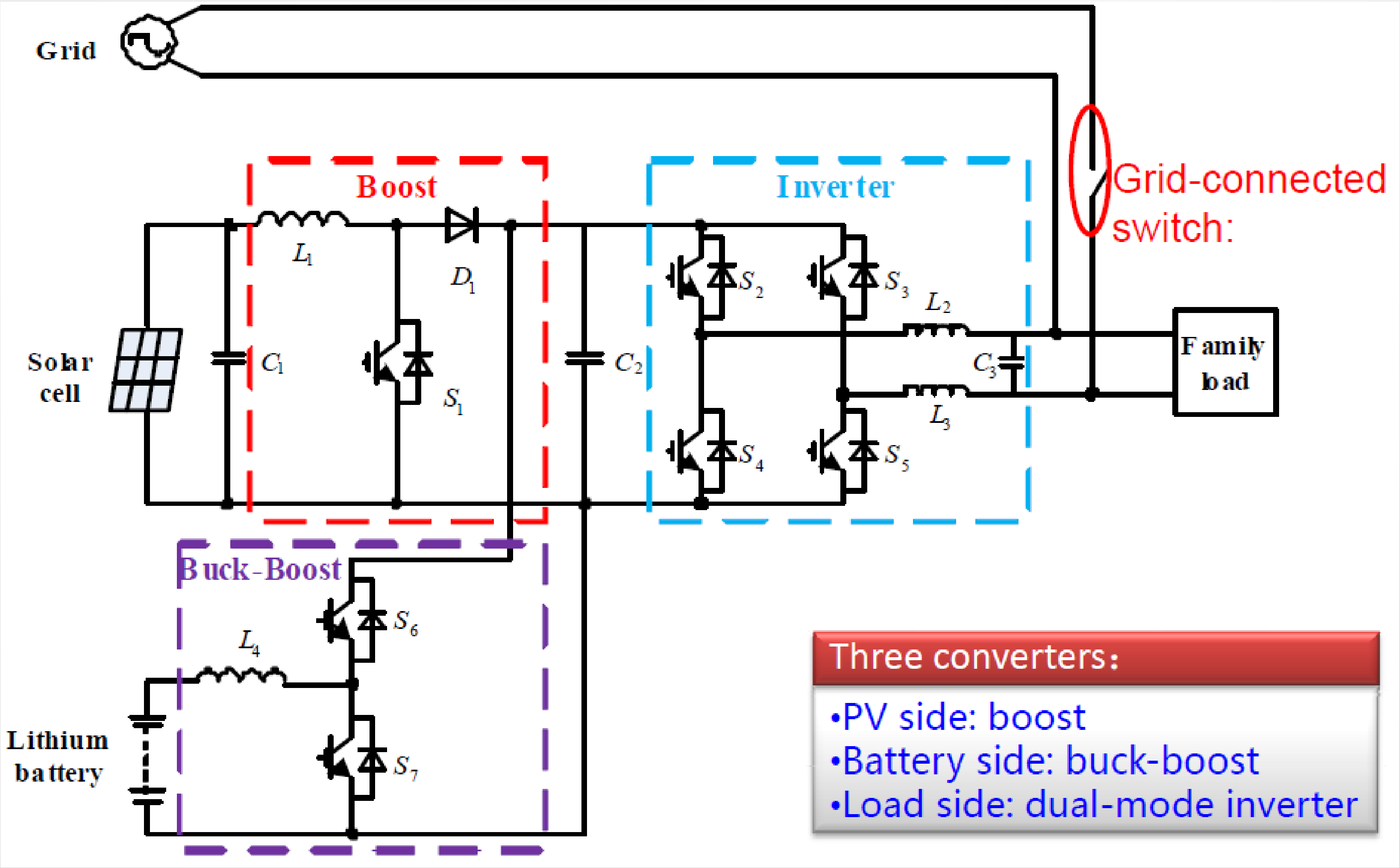
Xiaoxiang Gao

Energy Storage



Xiaoxiang Gao

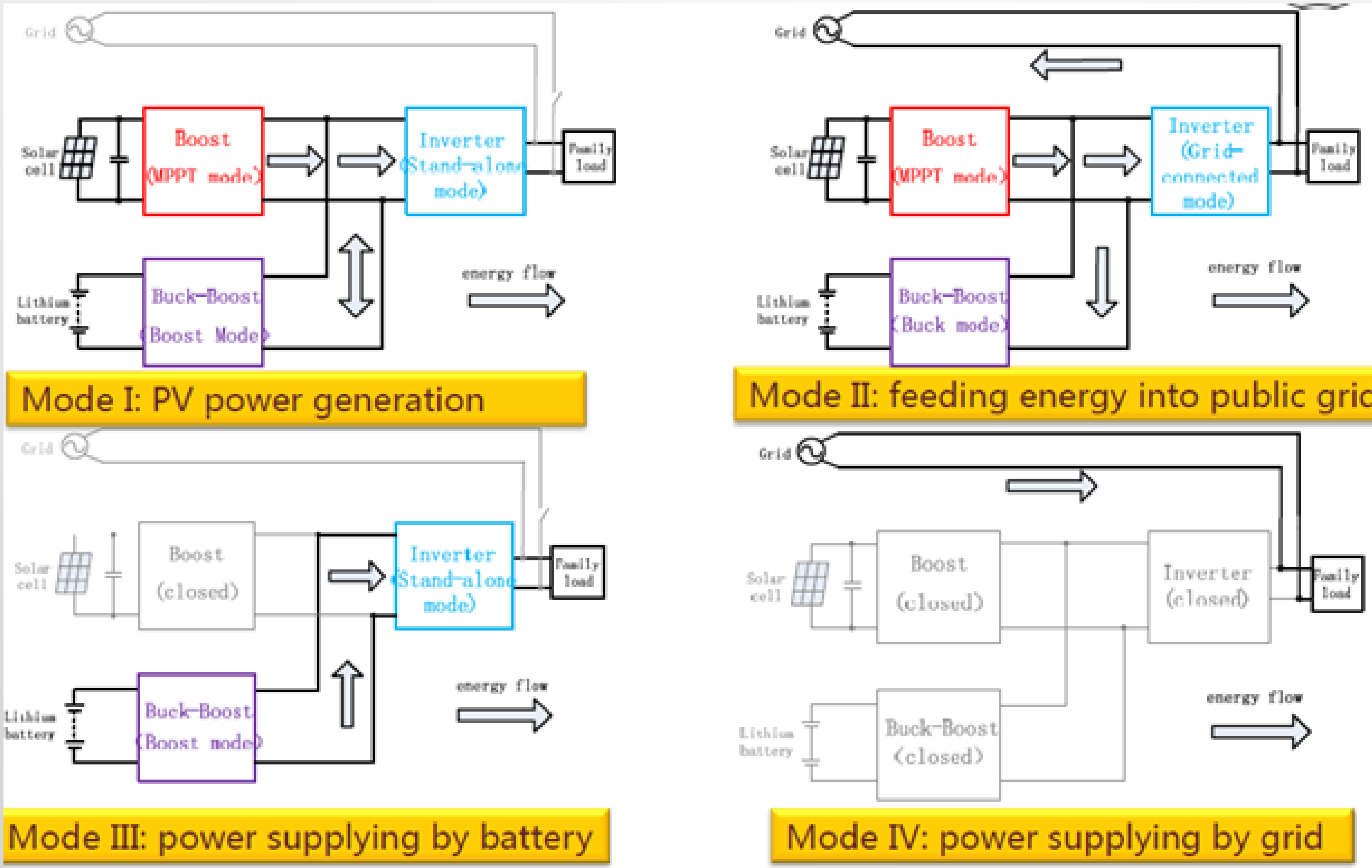
Energy Storage



Three converters:

- PV side: boost
- Battery side: buck-boost
- Load side: dual-mode inverter

Energy Storage



Xiaoxiang Gao

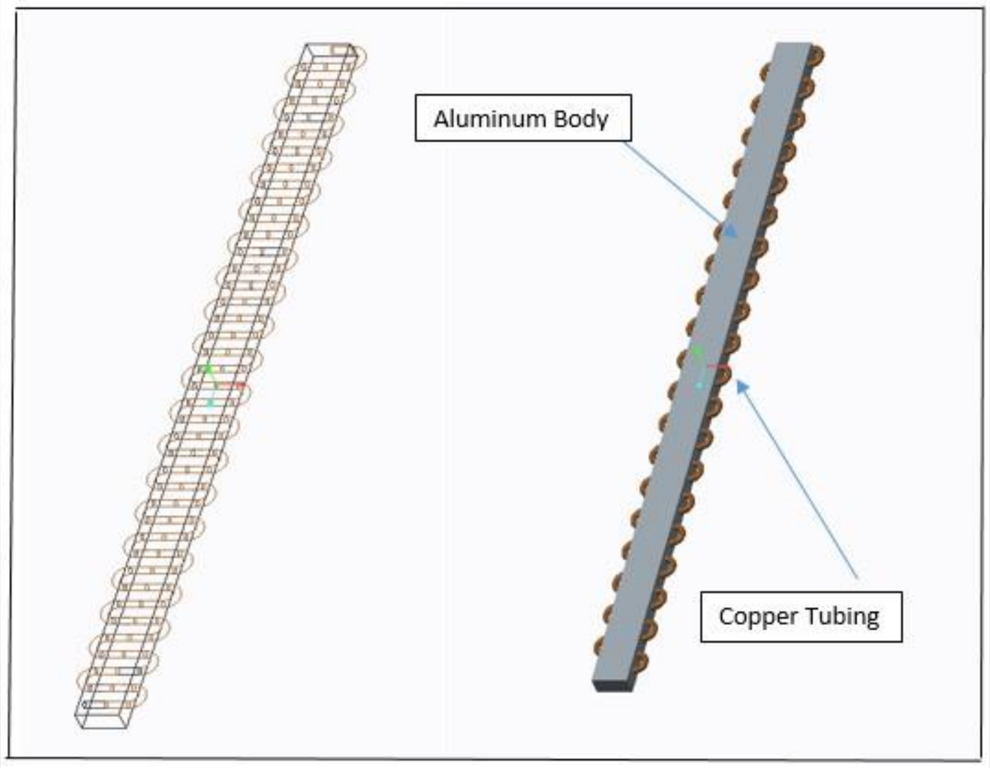
Energy Storage

Storage Devices (Batteries)

- Advantages:
  - Back up for night and cloudy days
- disadvantages:
  - Energy loss during the process
  - Adds to the expense of system
  - Finite lifetime : 5~ 10 years
  - Added floor space, maintenance, safety concerns

PV Panel Heat Exchanger Concepts

- Looped flow design
- 10ft long by 6in wide by 3in thick
- Body would be made from thermally conductive material
- Tubing would be made from a malleable, thermally conductive material
- Number of loops can be determined using a thermal analysis program

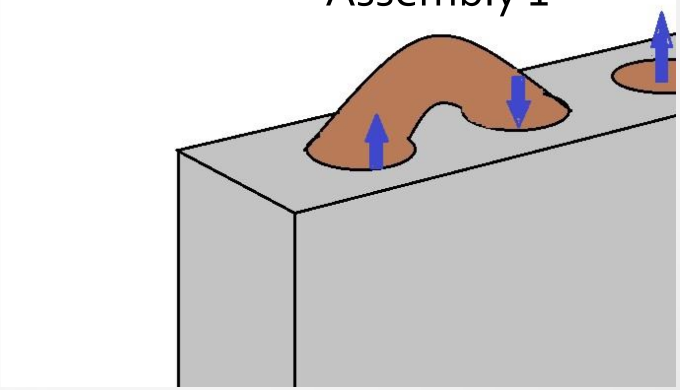


James Harrell

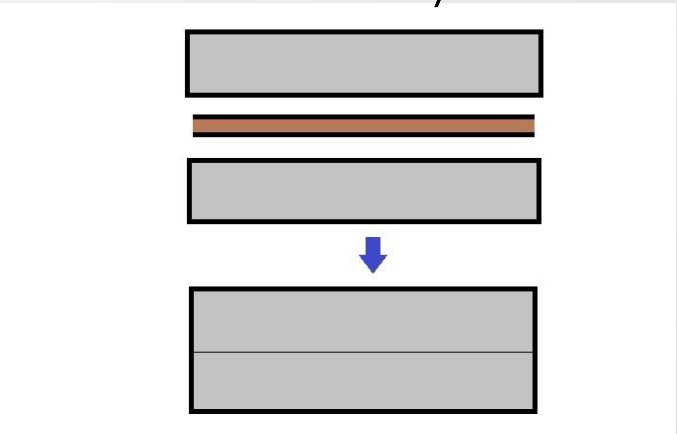
PV Panel Heat Exchanger Concepts

- Assembly 1 would require inserting copper tubing by machine
- Assembly 2 would come in three components
- Assembly 2 would require a weld for the upper and bottom half of the body

Assembly 1



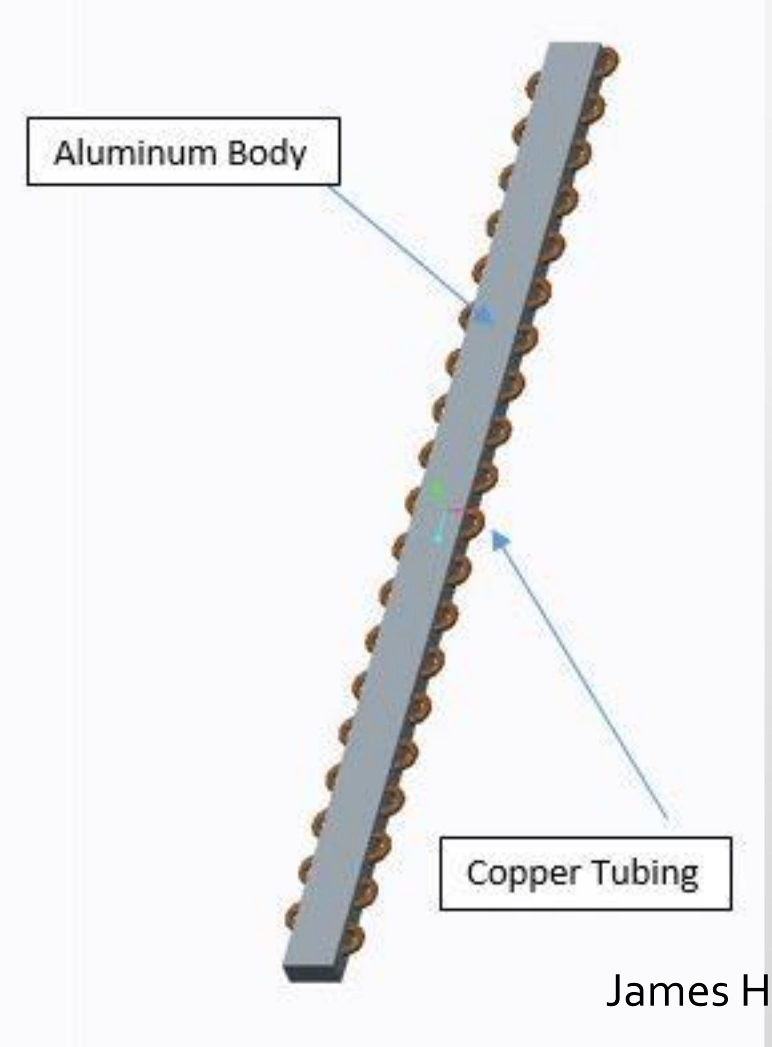
Assembly 2



James Harrell

PV Panel Heat Exchanger Concepts

- Would make the water hotter than a parallel tube design
- Pasteurization process will take less time
- PV panel means they will stay at a lower temperature without wasting water
- Less water will be required to operate this heat exchanger
- Lower energy consumption



James Harrell

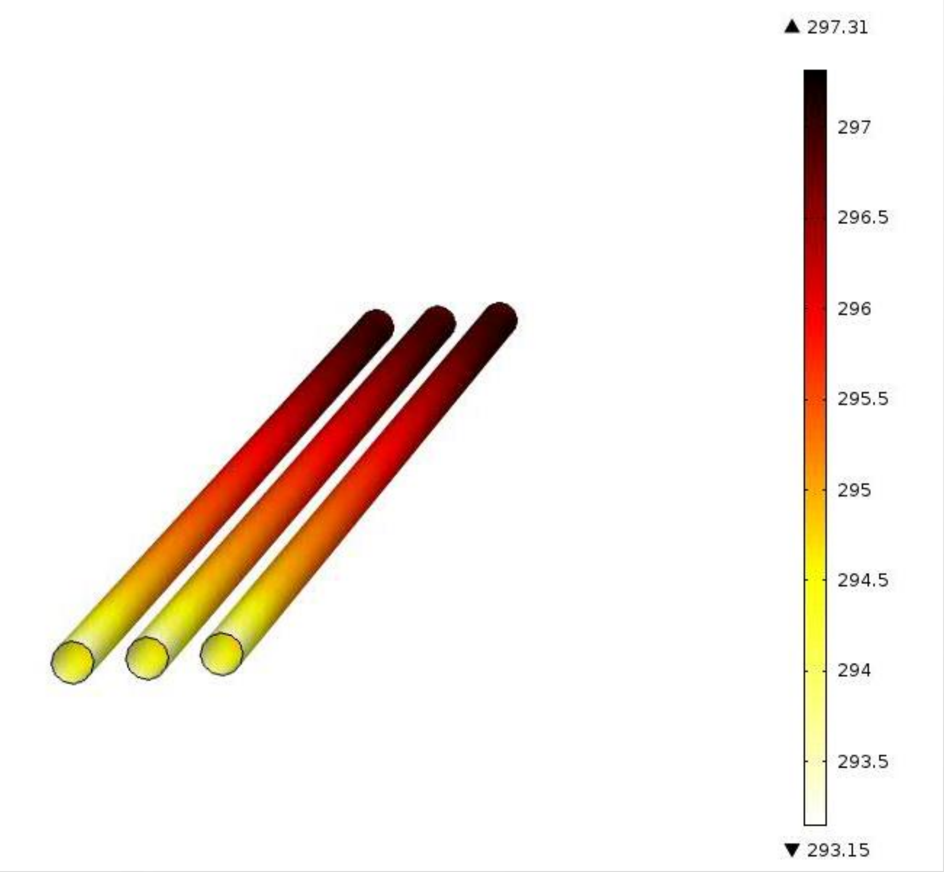
Heat Exchanger Idea

- Three Channel Flow
- Cools Photovoltaic Panels
- Preheats Pasteurization Water
- Aluminum Body
  - 3" X 6" X 120"
  - One inch diameter holes
  - Attached directly to back surface of PV Panel

Morgan Bublitz

Heat Exchanger Idea

- Flow Design*
  - Working Fluid
    - Water
  - Flow rate at one gallon per minute
  - Raises water 40 degrees Fahrenheit
    - 68 -> 108



* Initial design specifications

Morgan Bublitz

Pressure Regulator

- Use existing Pressure Regulator
  - For now
- Developing strategies for improved Regulator
  - Mechanical
  - Electronic

Morgan Bublitz

Pump Options

Red Lion 24 GPM Shallow Well Jet Pump:

- Specifications:
  - Voltage – 120 V/240 V
  - Flow rate – 24 GPM
  - Suction head – 25 ft.
  - Weight - 42.5 lbs.
  - Power - 1 HP
- Advantages:
  - Affordable
  - High suction head
  - Easy to install
- Disadvantages:
  - Cast iron has a high potential for rusting
  - High flow rate

Madanha Chibudu

Pump Options

Bum Cam Jet Pump

- Specifications:
  - Suction head – 25 ft.
  - Flow rate – 13.6 GPM
  - Total head lift – 65 ft.
  - Voltage 120 V/240 V.
  - Weight – 38 lbs.
  - Power – 1 HP
- Advantages:
  - Affordable.
  - No water to air contact eliminating rust.
  - No waterlogging.
- Disadvantages:
  - High flow rate.

Madanha Chibudu

Pump Selection

Objective:

- Pump the water from its source to the heat exchanger and the second solar sausage in the most efficient way.
- Determine the performance characteristics of the pump.
  - Water flow rate.
  - Efficiency of the Pump.

Approach:

- Find the mass flow rate and record the results .
- Find the suction head (TDH) and record the results.
- Find the discharge pressure of the pump and record the results.
- Use pump performances curves or efficiency equation to find the efficiency of the pump.

Madanha Chibudu

Pump Selection

Test Plan:

- **Measure and record the water flow rate.**
- **Observe how the water is discharged once it reaches the heat exchanger.**
- **Measure and record the pump discharge pressure.**
    - **Use a pressure gauge.**
- **Determine the overall efficiency of the pump.**

Outcome:

- **Selection of the most efficient pump.**
- **Achieve the desirable mass flow.**
- **Cost of running the pump under the conditions of the test.**

Madanha Chibudu

Schedule (Gantt)

Mode	Task Name	Duration	Start	Finish
	Milestone #1	7 days	Wed 9/10/14	Thu 9/18/14
	Milestone #2	13 days	Wed 10/1/14	Fri 10/17/14
	Milestone #3	11 days	Thu 10/30/14	Thu 11/13/14
	Build First Sausage	4 days	Tue 9/9/14	Fri 9/12/14
	Research and Design for System	148 days	Wed 10/1/14	Fri 4/24/15
	Heat Exchange Testing	**63 days**	**Mon 11/17/14**	**Wed 2/11/15**
?	Design model			
?	Calc. temp. to cool PV panels			
?	Testing: Make sure system cools effectively			
	Power Analysis	**36 days**	**Wed 11/26/14**	**Wed 1/14/15**
	Total output measurement	5 days	Wed 11/26/14	Tue 12/2/14
	Energy Storage	11 days	Tue 12/2/14	Tue 12/16/14
	Design DC-AC conversion	20 days	Thu 12/18/14	Wed 1/14/15

Aileen Ulm

Schedule

	Pressure Regulator Implementation	**40 days**	**Fri 11/28/14**	**Thu 1/22/15**
	Calculate psi for each chamber	3 days	Fri 11/28/14	Tue 12/2/14
	Design a device to read pressure	32 days	Tue 12/2/14	Wed 1/14/15
	Test system at calculated pressures	5 days	Wed 1/14/15	Tue 1/20/15
	Filter/ Pasteurization	**27 days**	**Mon 3/16/15**	**Tue 4/21/15**
?	Design process for pasteurization			
?	Test temperatures the process takes place			
?	Determine duration of pasteurization			
	Sun Tracking System	**51 days**	**Wed 1/7/15**	**Wed 3/18/15**
	Determine placement of system	4 days	Wed 1/7/15	Mon 1/12/15
	Track sun's movement in region	5 days	Mon 1/12/15	Fri 1/16/15
	Create design that will follow sun patterns	34 days	Fri 1/16/15	Wed 3/4/15
	Test movement of tracking system	11 days	Wed 3/4/15	Wed 3/18/15
	Water Pump	**18 days**	**Tue 3/10/15**	**Thu 4/2/15**
	Decide on location of water (well, surface, etc.)	2 days	Tue 3/10/15	Wed 3/11/15
	Design pump to effectively bring water to system	16 days	Thu 3/12/15	Thu 4/2/15

Aileen Ulm

Budget

A. Personnel				
Engineer	$/hour	hr/week	#weeks	Total Pay
Jimmy Smith	30	12	32	$11,520.00
Aileen Ulm	30	12	32	$11,520.00
Xiaoxiang Gao	30	12	32	$11,520.00
Jonathan Melton	30	12	32	$11,520.00
Morgan Bublitz	30	12	32	$11,520.00
James Harrell	30	12	32	$11,520.00
Madanha Chibudu	30	12	32	$11,520.00
			Subtotal	**$80,640.00**
B. Fringe Benefits			29%	**$23,385.60**
C. Total Personnel				**$104,025.60**
D. Expense				
	Quantity	**Cost**		**Total**
Inverter	1	$160.00		$160.00
Charge Regulator	1	$80.00		$80.00
Fuse	2	$2.50		$5.00
Batteries	1	$200.00		$200.00
Water Pump	1	$300.00		$300.00
Jet pump	1	$220.00		$220.00
Pressure Gauge	1	$150.00		$150.00
			Expense Total	**$1,115.00**
			Total Direct Costs	**$105,140.60**
	Overhead Costs		**45% of Total Direct**	**$47,313.27**
			Total OCO	**$152,453.87**

Aileen Ulm