MILESTONE 3: SYSTEM-LEVEL DESIGN REVIEW

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PROBLEM STATEMENT

. **Pressure Regulation**

pressure regulator

. **Energy Storage**

batteries (simplified previous idea)

. **Cooling System for solar panels**

heat exchanger

Aileen Ulm

PRESSURE REGULATOR

Performance Requirements:

- The upper half of the solar sausage will have pressure of 0.5 psi.
- The lower half will have a pressure of 0.495 psi.
- A differential pressure of 0.oo5 psi should be maintained at all times.
- Must perform well under all weather conditions.

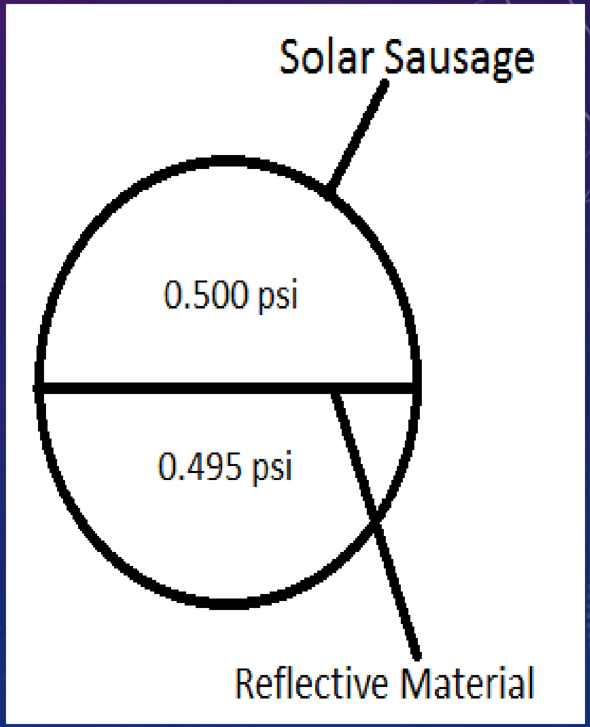

Figure 1: Shows the pressures inside the solar sausage

Madanha Chibudu

PRESSURE REGULATOR SELECTION

Differential Pressure Transducer

- Manufacturer – Omega
- Price - $700 (Expensive)
- High Resolution
- Pressure range – 0 to 2.5 kpa
- Ideal for low differential pressure ranges.

Figure 2: Omega PX663 Pressure Transducer

PRESSURE REGULATOR SELECTION

Manometer Pressure Regulator

- Manufacturer- FSU Physics
- Low differential pressure ranges
- Cost – Moderately inexpensive
- Immediate Availability

Figure 3: Shows manometers connected to the solar sausage

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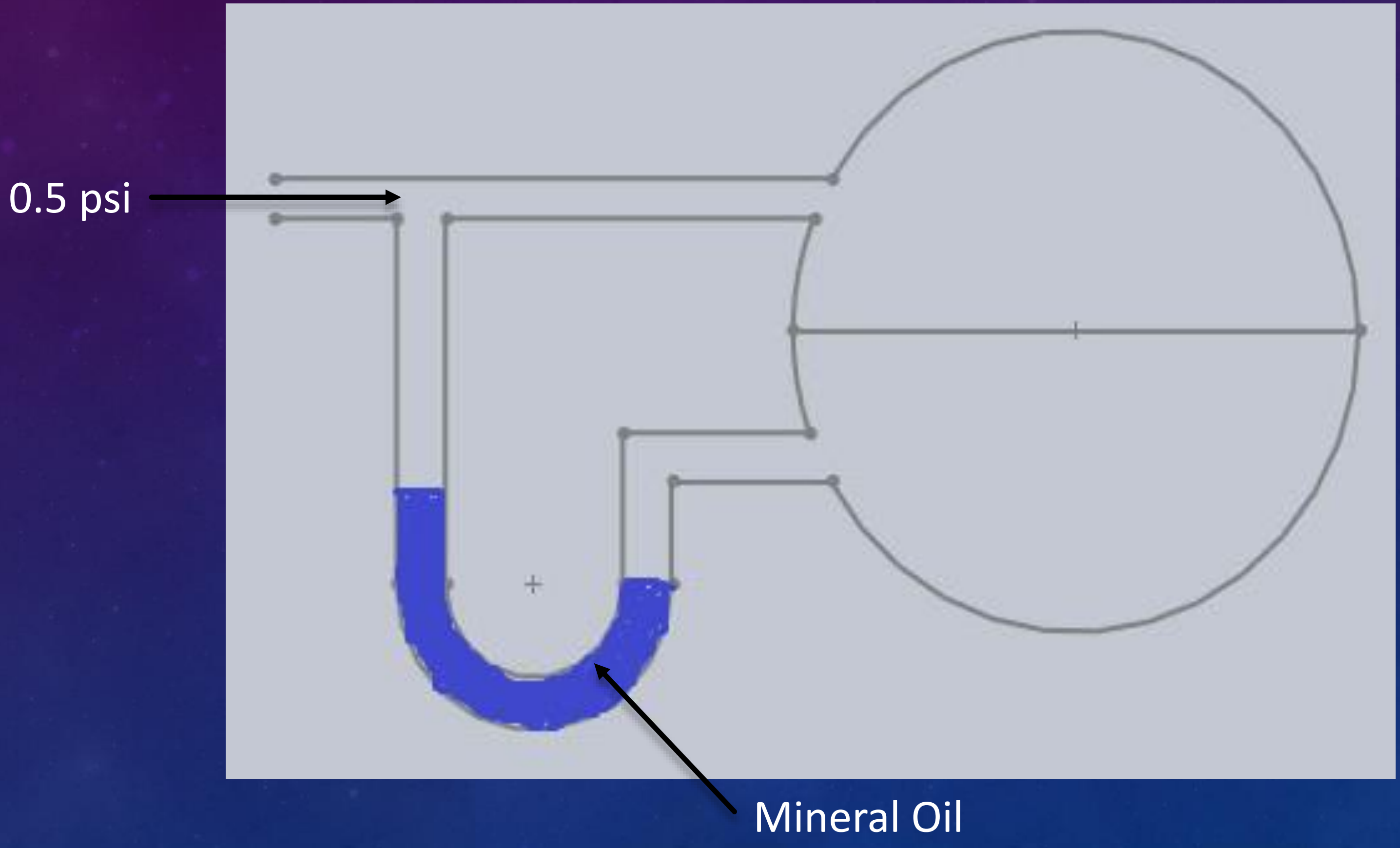
PRESSURE REGULATOR SELECTION

Manometer Pressure Regulator



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PRESSURE REGULATOR DECISION MATRIX

Decision Factors		Opition 1	Opition 2
Criteria	Wt.	1	2
Cost	4.0	1	2
Accuracy	2.5	2	1
Availability	1.0	1	2
Durability	2.0	1	1
Weighted Scores		12.0	13.5

Which Pressure Regulator Should We Use?

Criteria	Definition
Cost	How expensive is the product
Accuracy	The precision of the results
Availability	How accessible is the product
Durability	How long does the product last

Madanha Chibudu

HEAT EXCHANGER – DECISION MATRIX

Weighted Decision Matrix - Which Heat Exchanger?

Decision Factors		Design 1	Design 2	Design 3	New Design
Criteria	Wt.	1	2	3	4
Weight	2.0	1	1	1	2
Ease of Manufacturing	2.0	1	1	2	4
Ease of Maintenance	1.0	2	1	0	3
Cost	1.0	0	1	2	4
Efficiency	1.0	0	1	2	3
Weighted Scores		6.0	7.0	10.0	**22.0**

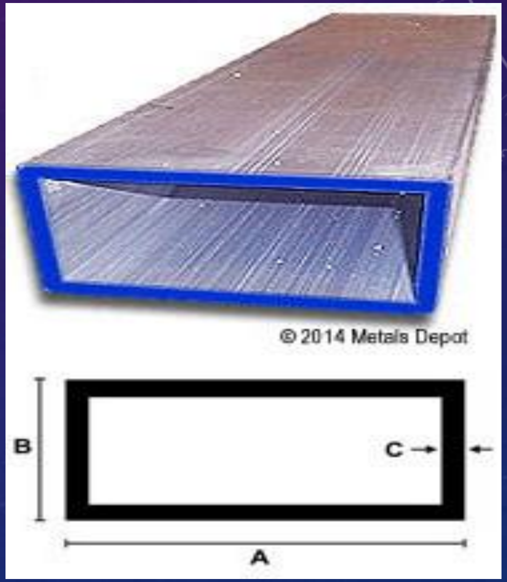
Which Heat Exchanger Design Should We Use?

Criteria	Definition
Weight	How heavy is the design
Ease of Manufacturing	How easily the design can be manufactured with common manufacturing techniques
Ease of Maintenance	How easily the design can be maintained
Cost	Up-front costs and ongoing costs (e.g. payment to developer)
Efficiency	How efficiently and effectively the design transfers heat to the water

Morgan Bublitz

HEAT EXCHANGER – MANUFACTURING

- Design 1:
    - Solid Block of aluminum 6" X 3" X 120"
    - Drill three 1" holes through entire length
- Design 2:
    - Solid Block of aluminum 6" X 3" X 120"
    - Drill three 1" holes through entire length
    - Feed 1" copper piping into each hole
- Design 3:
    - Solid block of aluminum 6" X 3" X 120"
    - Drill 1" holes along length across width of material spaced 3" apart (C-C)
- New Design:
    - Rectangular pipe of aluminum 6" X 2" X 120" with 1/8" thick walls



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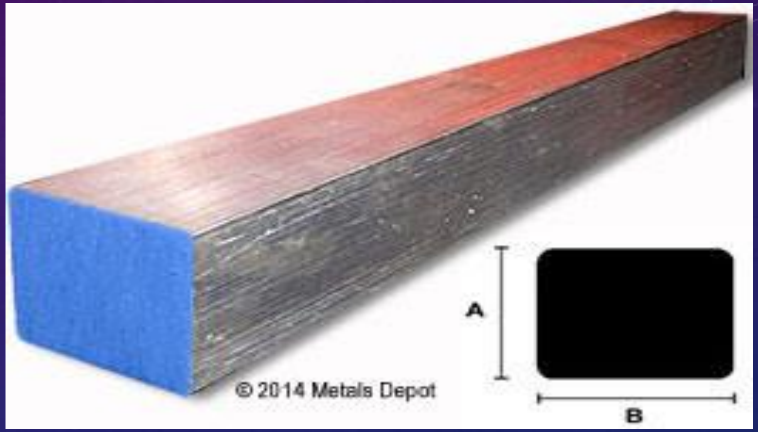
HEAT EXCHANGER – COST ANALYSIS

- Design 1:
  - $900 for aluminum body
- Design 2:
  - $900 for aluminum body
  - $120 for copper piping
- Design 3:
  - $900 for aluminum body
  - $120 for copper piping
  - $400 for copper fittings
- New Design:
  - $160 for aluminum body
  - $25 for end plates



**Prices from:
-Metals Depot
-Home Depot

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PRESSURE REGULATOR DECISION MATRIX

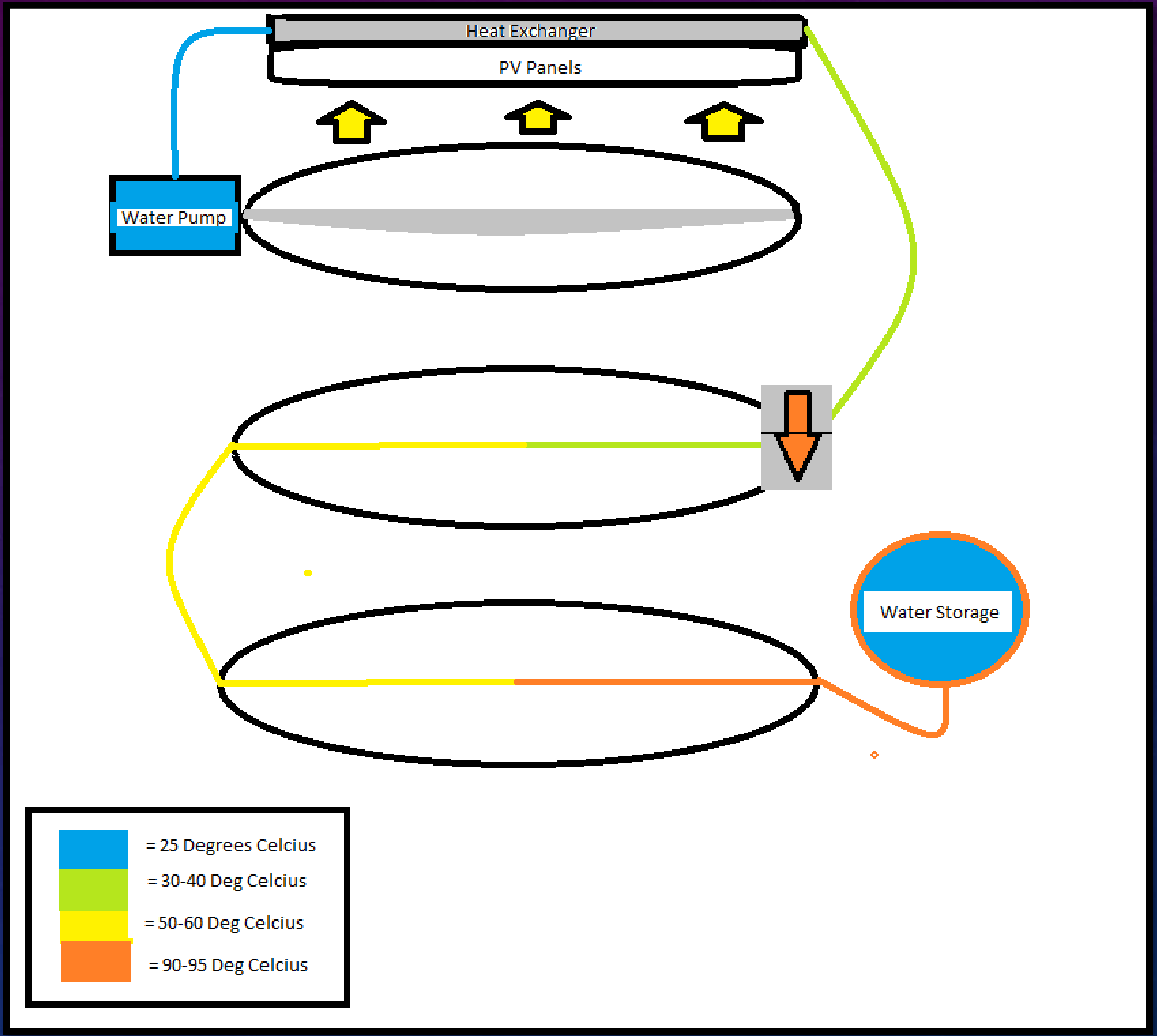
Decision Factors		Opition 1	Opition 2
Criteria	Wt.	1	2
Cost	4.0	1	2
Accuracy	2.5	2	1
Availability	1.0	1	2
Durability	2.0	1	1
Weighted Scores		12.0	**13.5**

Which Pressure Regulator Should We Use?

Criteria	Definition
Cost	How expensive is the product
Accuracy	The precision of the results
Availability	How accessible is the product
Durability	How long does the product last

Madanha Chibudu

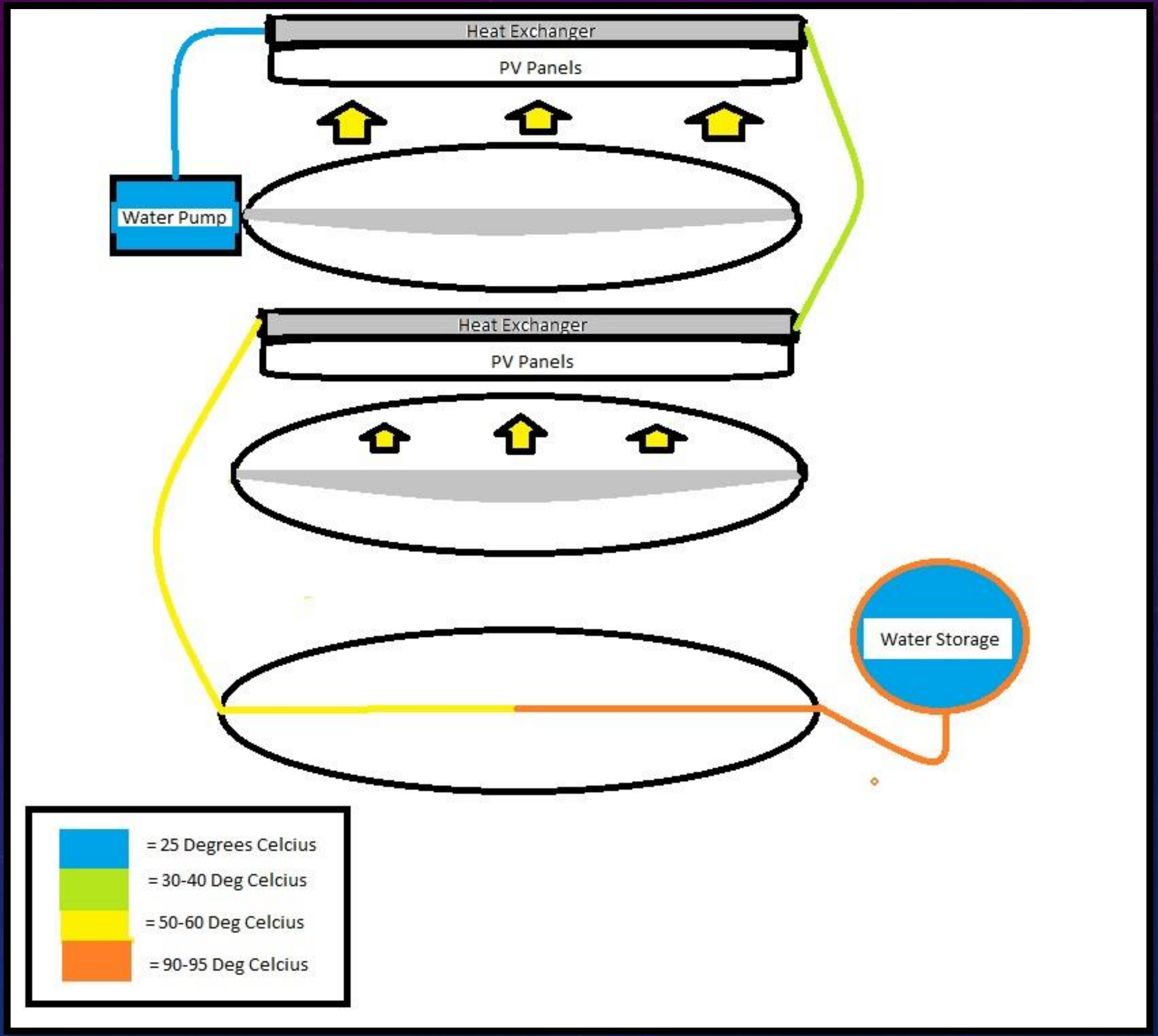
PASTEURIZATION PROCESS – IDEA 1



- One Solar Sausage for energy production
- Two Solar Sausages for Pasteurization

James Harrell

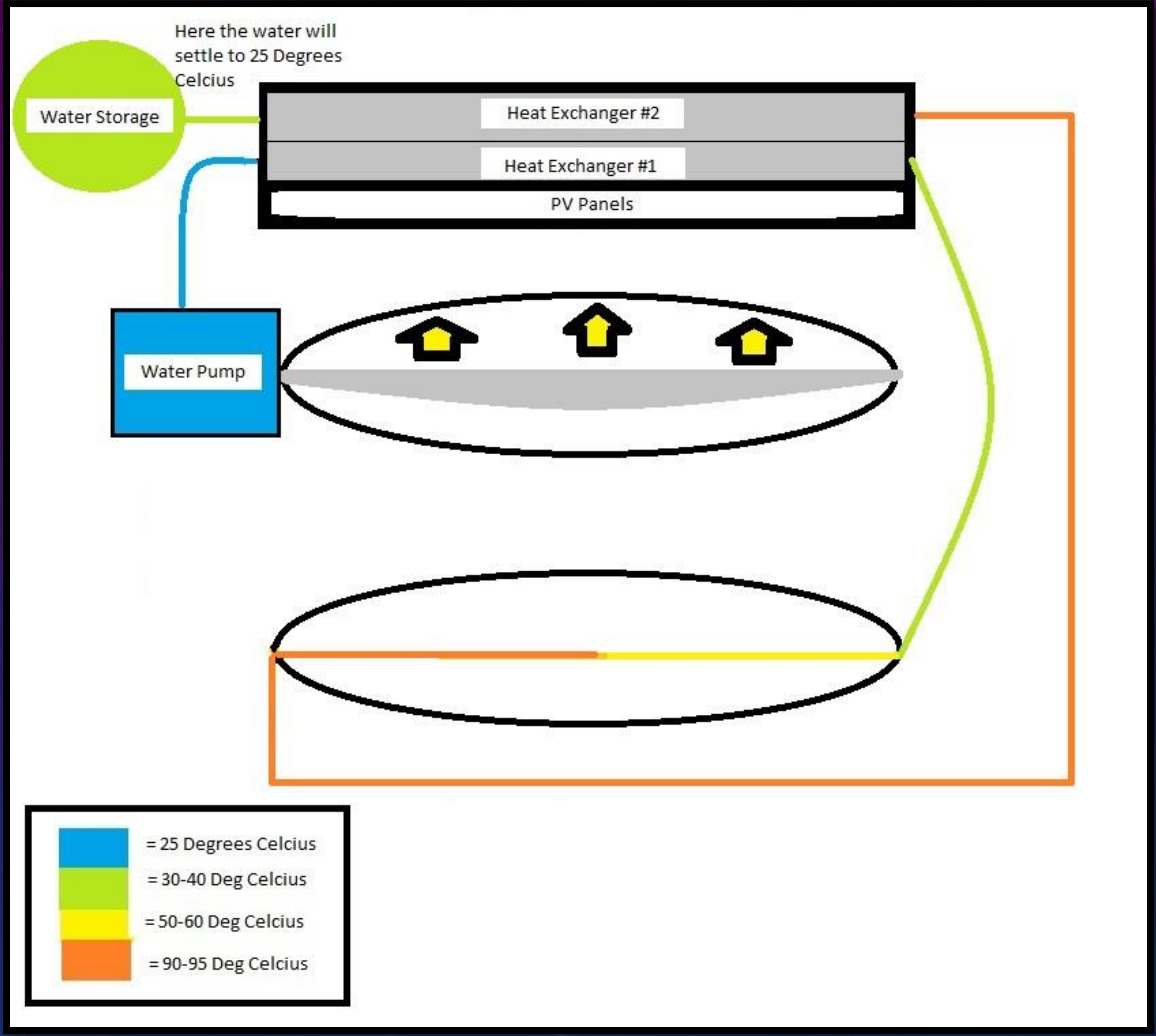
PASTEURIZATION PROCESS – IDEA 2



- Two Sausages for energy production
- One sausage for pasteurization
- Water would enter storage at 90-95°C

James Harrell

PASTEURIZATION PROCESS – IDEA 3



- Counter Flow Design Heat exchanger
- One Sausage for energy production
- One sausage for pasteurization

James Harrell

PASTEURIZATION – CHOSEN PROCESS

Weighted Decision Matrix - Which Pasteurization Process?

Date last saved: Nov-20 2014

Decision Factors		Design 1	Design 2	Design 3
Criteria	Wt.	1	2	3
Safety	3.0	1	1	2
Ease of Manufacturing	1.0	2	1	0
Ease of Maintenance	1.0	2	2	2
Cost	2.5	2	0	1
Efficiency	1.0	0	1	2
Weighted Scores		12.0	7.0	12.5

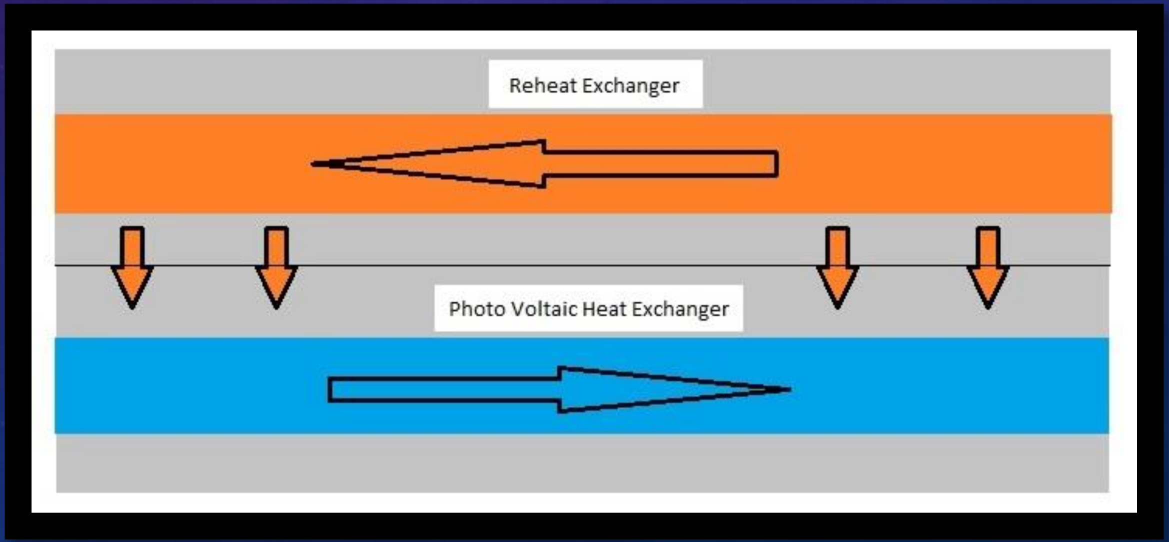
Which process Should We Use?

Criteria	Definition
Safety	Safety of the overall design
Ease of Manufacturing	How easily the design can be manufactured with common manufacturing techniques
Ease of Maintenance	How easily the design can be maintained
Cost	Up-front costs and ongoing costs (e.g. payment to developer)
Efficiency	How efficiently and effectively the design transfers heat to the water

James Harrell

PASTEURIZATION –PROCESS 3

- The counter-flow heat exchanger design will be safer for the consumer.
- Increases the efficiency by using a reheat cycle similar to those found in steam power plants.
- Relatively easy to accomplish - Stacking an identical heat exchanger on top of the photovoltaic heat exchanger.
- Increased flow rate – More water could be pasteurized over time.
- Decrease the size of the pasteurization sausage



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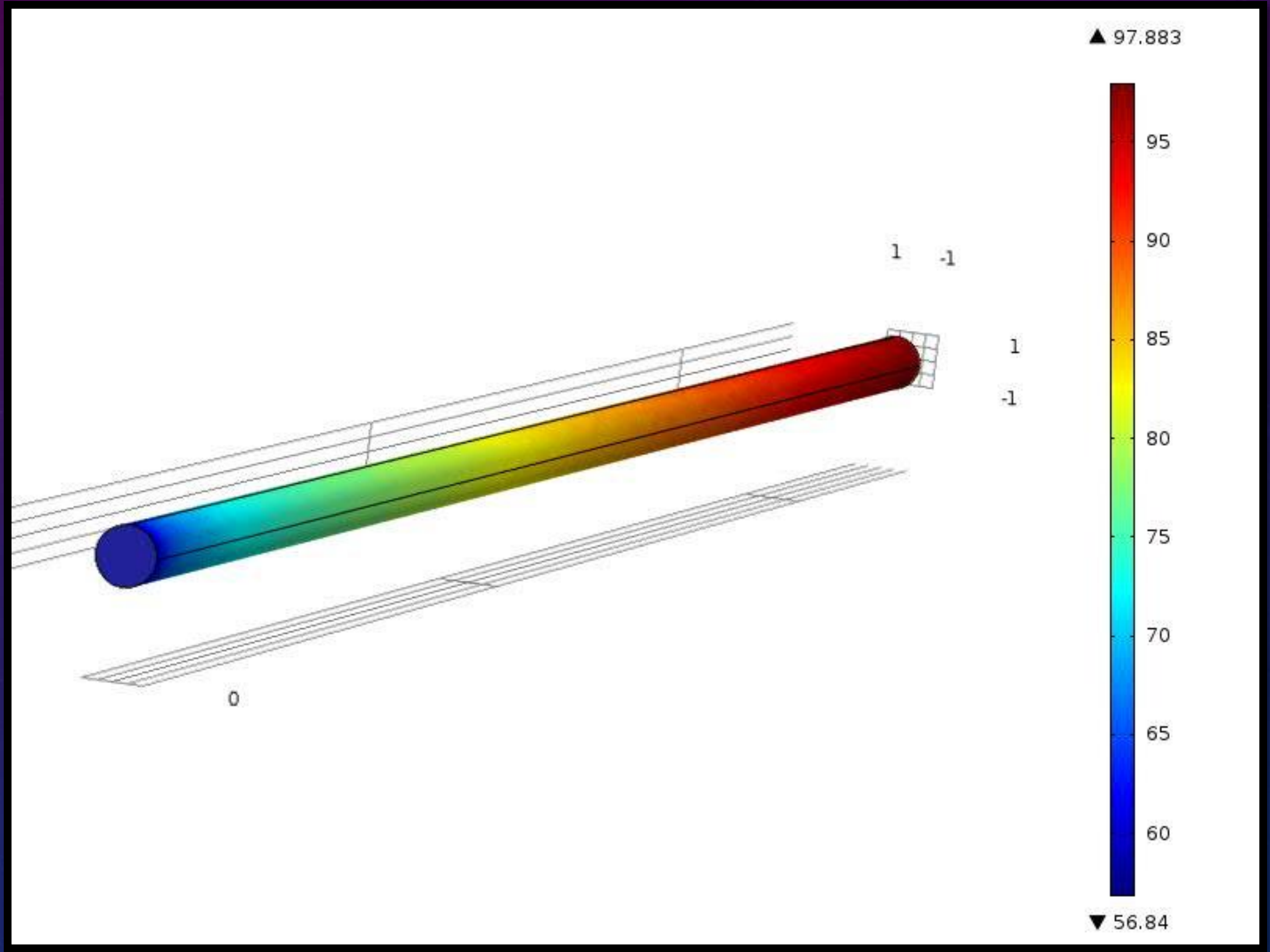
PASTEURIZATION –COMSOL ANALYSIS



- One Pasteurization sausage will increase temperature from 55°C to about 97°C
- This concludes that one pasteurization sausage will be adequate

James Harrell

CHARGE REGULATOR

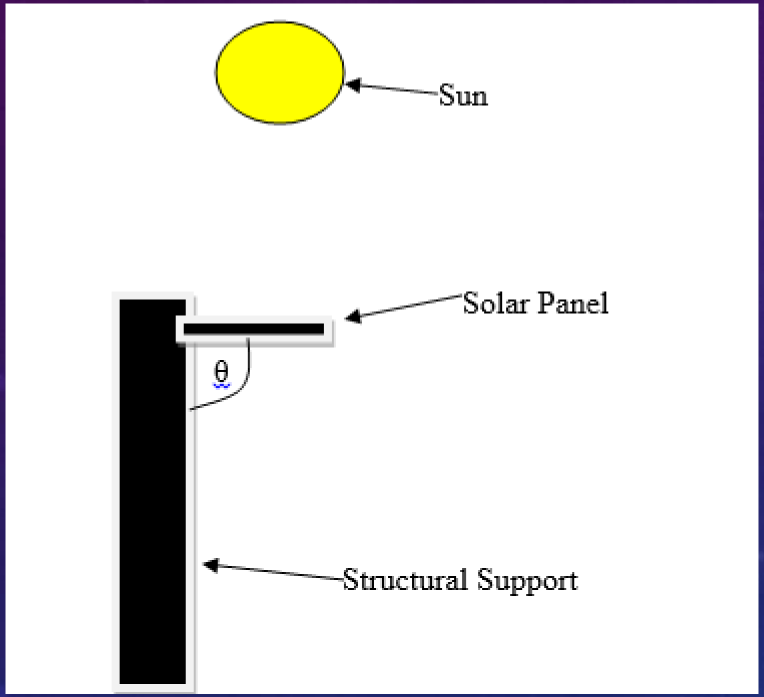
Xiaoxiang Gao

LOAD

- O2-Cool Table Fan
- 2 Speed (High/Low)
- 12V and 1 A (High)
- 7V and 0.5 A (Low)
- DC

Jonathan Melton

SOLAR TRACKING



- Single axis tracking
- Increases efficiency by up to 77%
- Monthly tracking
- 7 Different Locking Positions
- Angle is measured from the negative Y axis

Jonathan Melton

SOLAR TRACKING ANGLES

Month	Angle (θ)
January	65°
February	17°
March	81°
April	83°
May	97°
June	104°
July	97°
August	89°
September	81°
October	73°
November	65°
December	58°

Charge Regulator

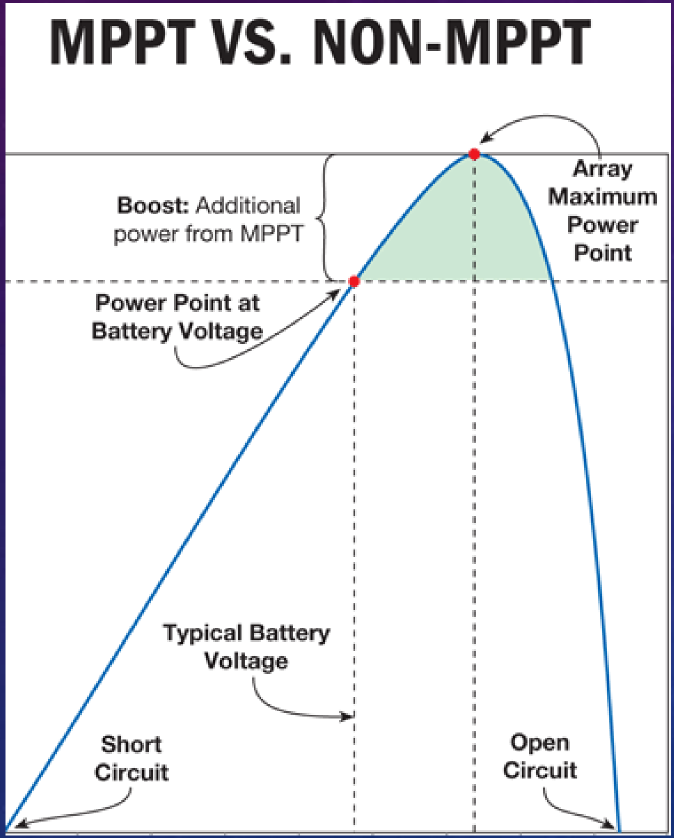
Function of Charge Regulator

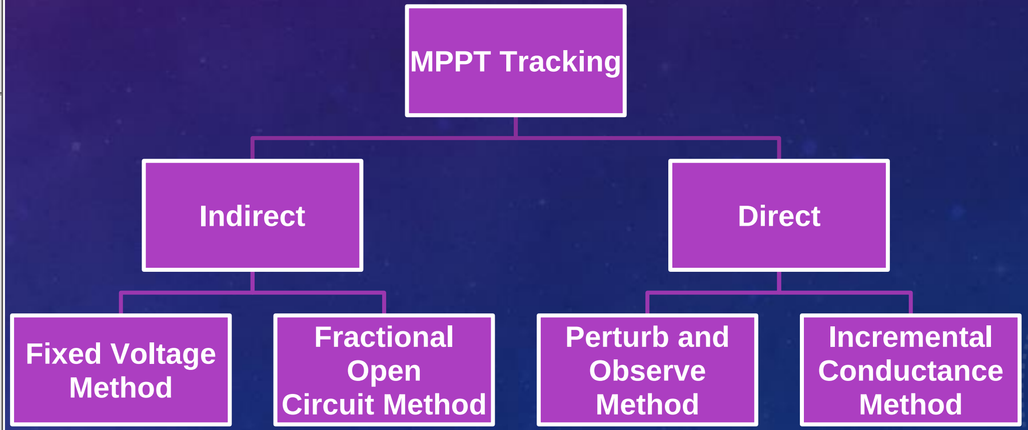
1. Prevent the battery from over-charging and over-discharging
2. Prevent the battery from reverse charging to solar panels during nights.
3. Reverse Polarity Protection for Battery
4. Reverse Polarity Protection for Solar Panels
5. Thunder protection

Xiaoxiang Gao

CHARGE REGULATOR

Maximum Power Point Tracking (MPPT) Techniques





Source: Lighting Research Center, Rensselaer Polytechnic Institute

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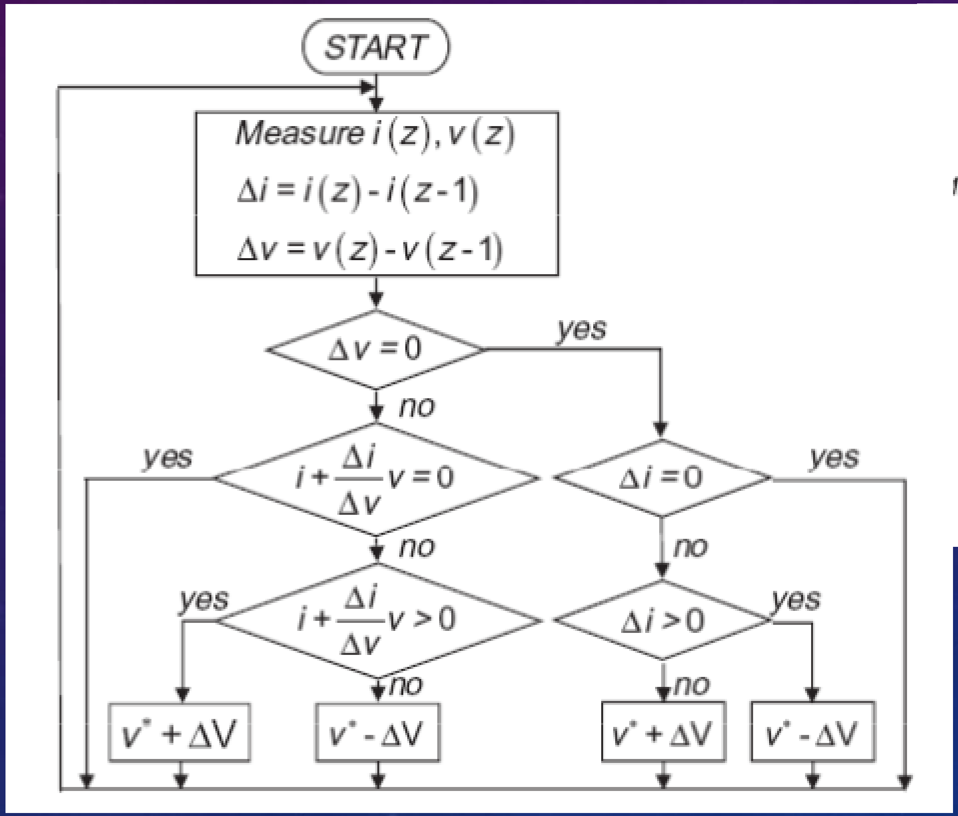
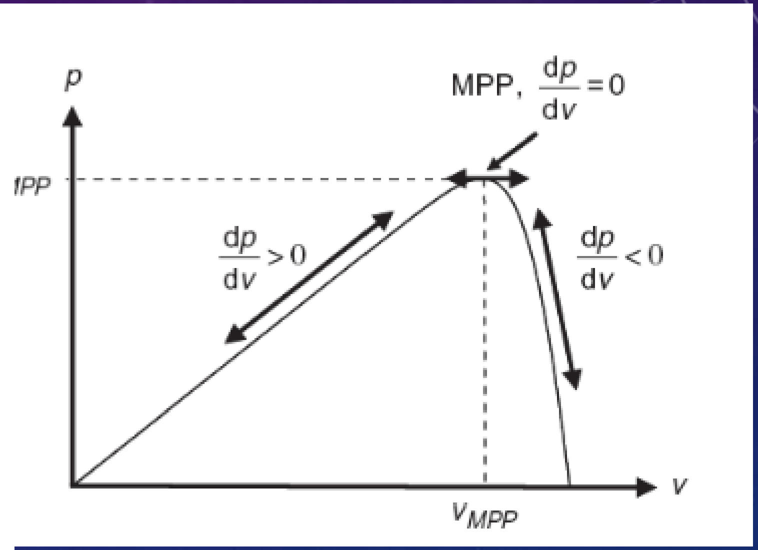
CHARGE REGULATOR

Maximum Power Point Tracking (MPPT) Techniques

- Incremental Conductance Method





Source: K. H. Hussein and I. Mota, “Maximum photovoltaic power tracking: An algorithm for rapidly changing atmospheric conditions,” in IEE Proc. Generation Transmiss. Distrib., 1995, pp. 59–64

Xiaoxiang Gao

ENERGY STORAGE

- Executed by connecting the charge regulator to a battery.
- Republic of Panama frequently has inclement weather.
- Temperature isolation, and shading are factors that can effect ideal sunlight.
- Choosing the right battery is important.

ENERGY STORAGE CONTINUED……

Exide EP1229W 12V 7Ah Sealed Lead Acid Battery AJC-D7S-A-1-159072	
Voltage	12 Volt
Capacity	7Ah (7000mAh)
Chemistry	Sealed Lead Acid (AGM)
Length	5.9 inches
Width	2.6 inches
Height	3.7 inches
Terminal	Copper

Fig 3.9 Battery: Exide EP1229W 12V 7Ah Sealed Lead Acid Battery AJC-D7S-A-1-159072

SOLAR PANEL

- Attract sunlight to produce cost effective electricity.
- Optimum power output is 100W
- 10'' portable fan will be the load.
- Design can be scaled for a small village.

RISK ASSESSMENT

Scheduling Risks:

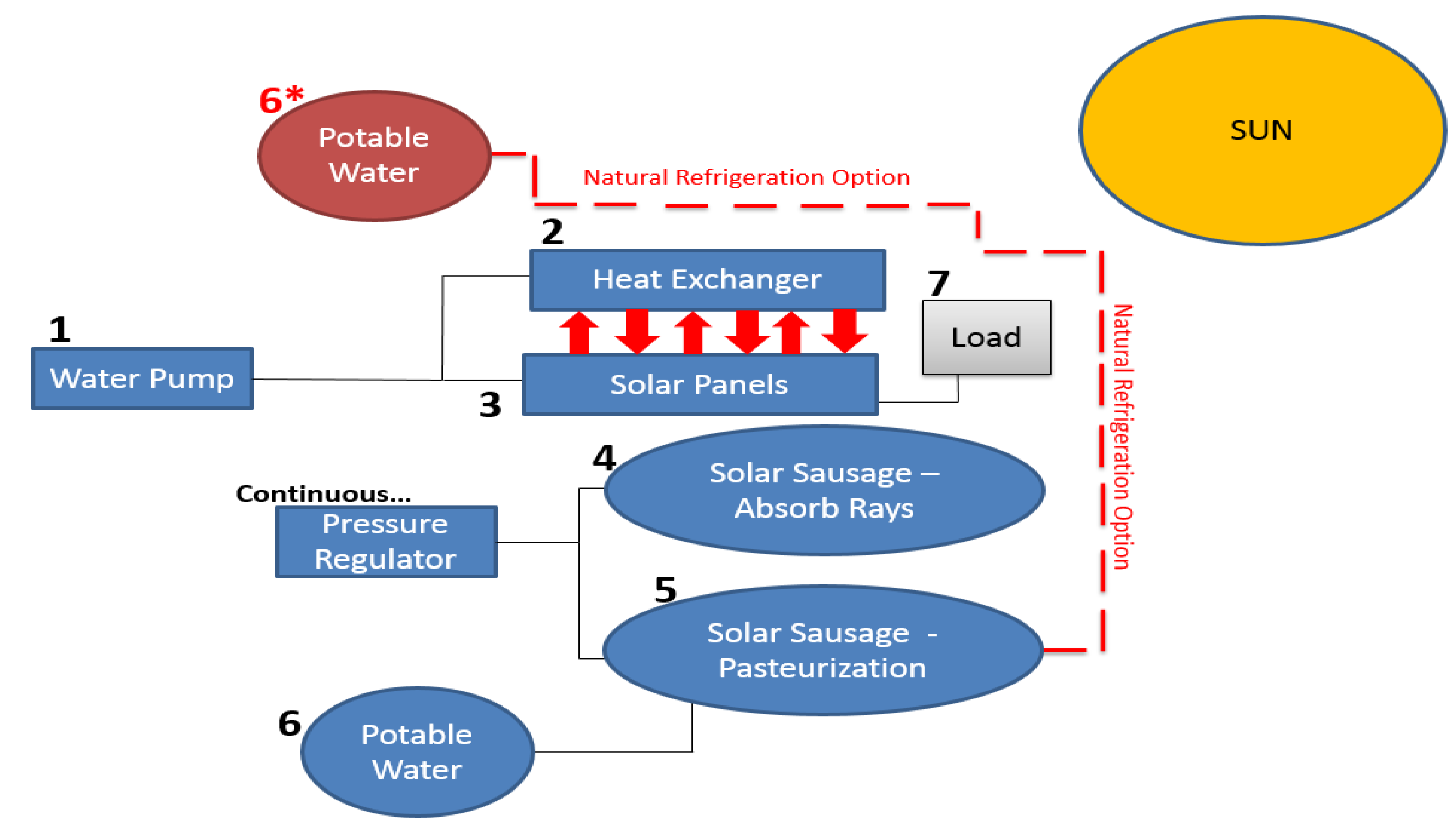
- Overconfident Scheduling
  - Bumps and Hiccups exist
- Change of Delivery Date
  - High consequence
- Excessive Scheduling
  - Adding too many components to design
- Omissions
  - Probability Low: The group knows what aspects would be a waste of time
- Delay in Task Completion
- Overcomplicating

Aileen Ulm

TECHNICAL RISKS

- Electrocution
- Battery Life

TOP LEVEL DESIGN



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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. Personal				
Engineer	$/Hour	hr/week	#Weeks	Total Pay
Jimmy Smith Jr.	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. Fring Benefits			29%	$23,385.60
C. Total Personnel				$104,025.60
D. Expense				
	Quantity	Cost		Total
Load - 12V Fan	1	$30.00		$30.00
Charge Regulator	1	$100.00		$100.00
Battery	1	$15.00		$15.00
Heat Exchanger	1	$400.00		$400.00
			Expense Total	$545.00
			Total Direct Costs	$104,570.60
	Overhead Costs		45% of Total Direct	$47,056.77
			Total OCO	$151,627.37

Aileen Ulm