Ultra Low Cost Solar Water Heater

Concept Generation and Selection

10/29/13

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Overview

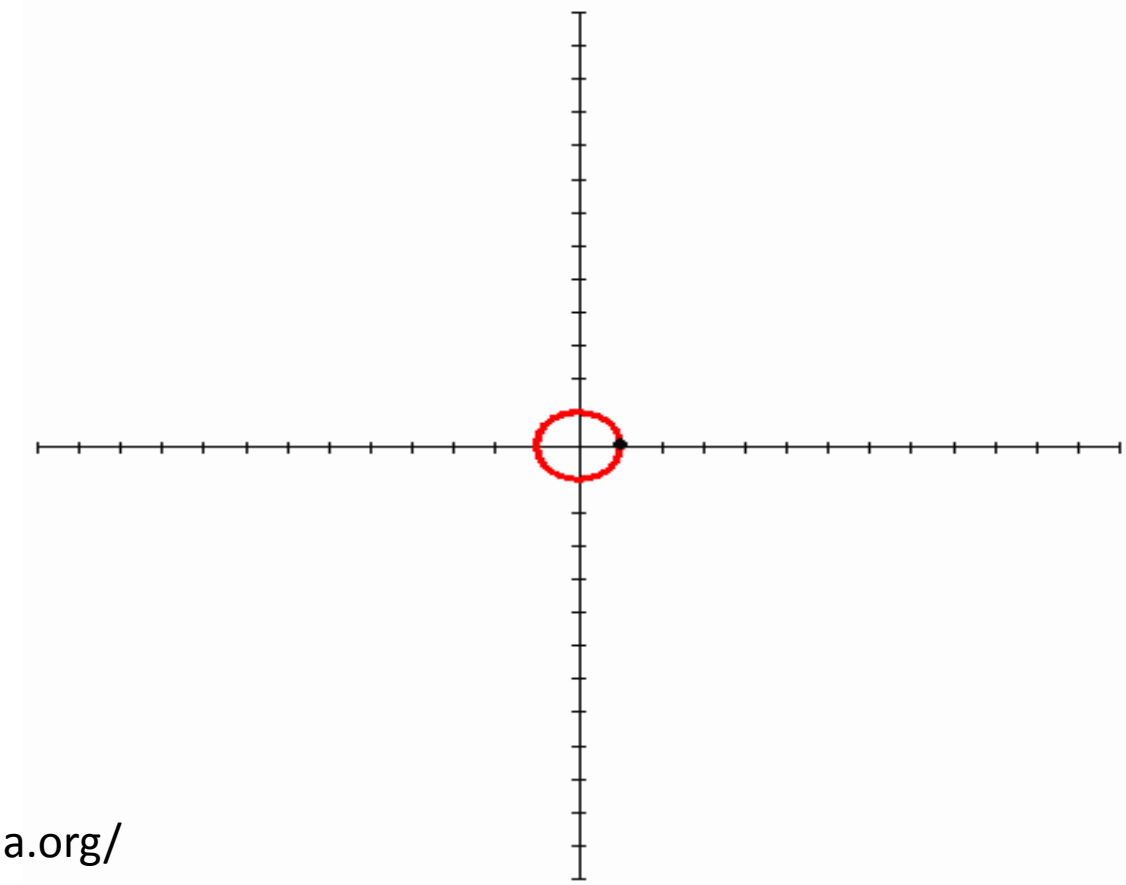
- Collector Designs
- Circulation Designs
- Integration
- Decision Matrix
- Timeline
- Conclusion

Collector Concepts

- Involute Collector
- Flat Plate Collector
- Bread Box Collector

Involute Collector

Involute Curve Animation

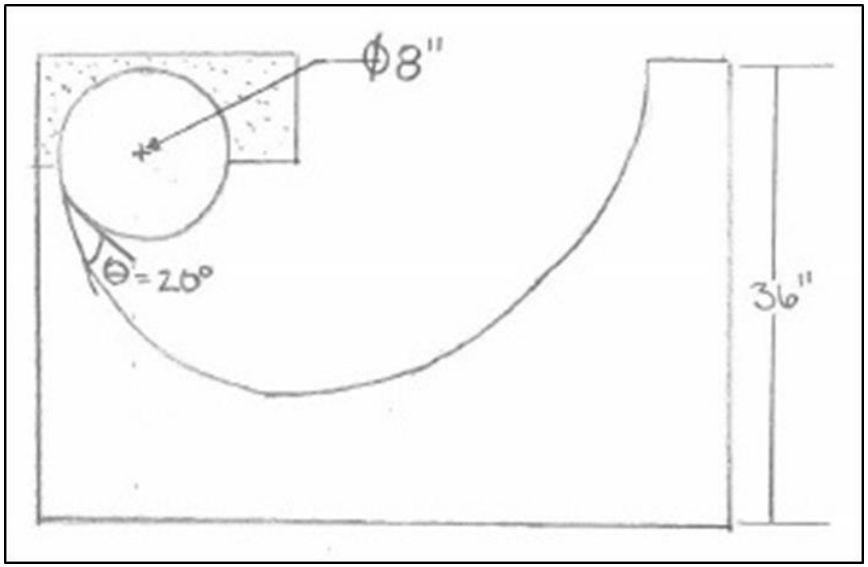


Courtesy of:
http://en.wikipedia.org/wiki/Involute

Involute Collector Continued

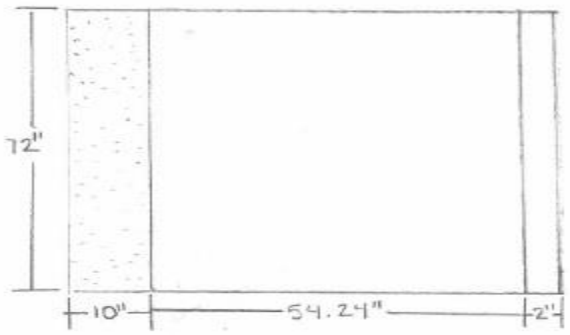
- Involute shape allows for all the solar radiation to be directed to absorber

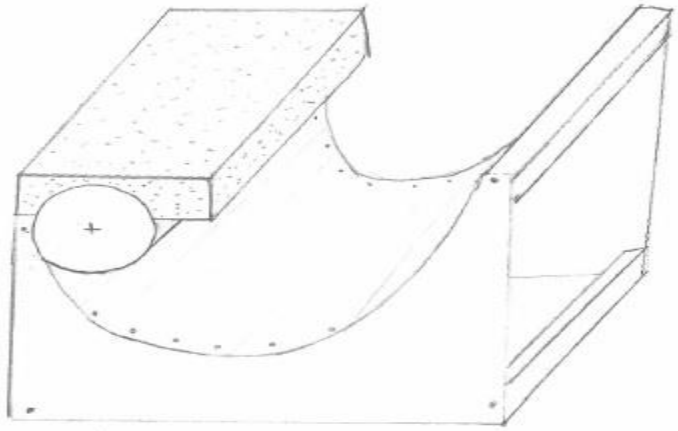
Involute Curve Collector



Design Drawings

Involute Curve Collector Design





INVOLUTE CURVE SWH

VOLUME	COST (USD)		EQUATIONS
2.09 ft³	1.) WOOD	$50	1.) $\vec{r} = r - s\vec{T}$ – INVOLUTE
15.63 GALLONS	2.) TIN FOIL	$6	2.) $\vec{T} = \frac{d\vec{r}}{dt} / \left\| \frac{d\vec{r}}{dt} \right\|$ – TANGENT VECTOR
	3.) PIPE	$10	3.) $S = \int\int \sqrt{\frac{1}{4} g^{11}}\, dt$
	4.) INSULATION	$15	

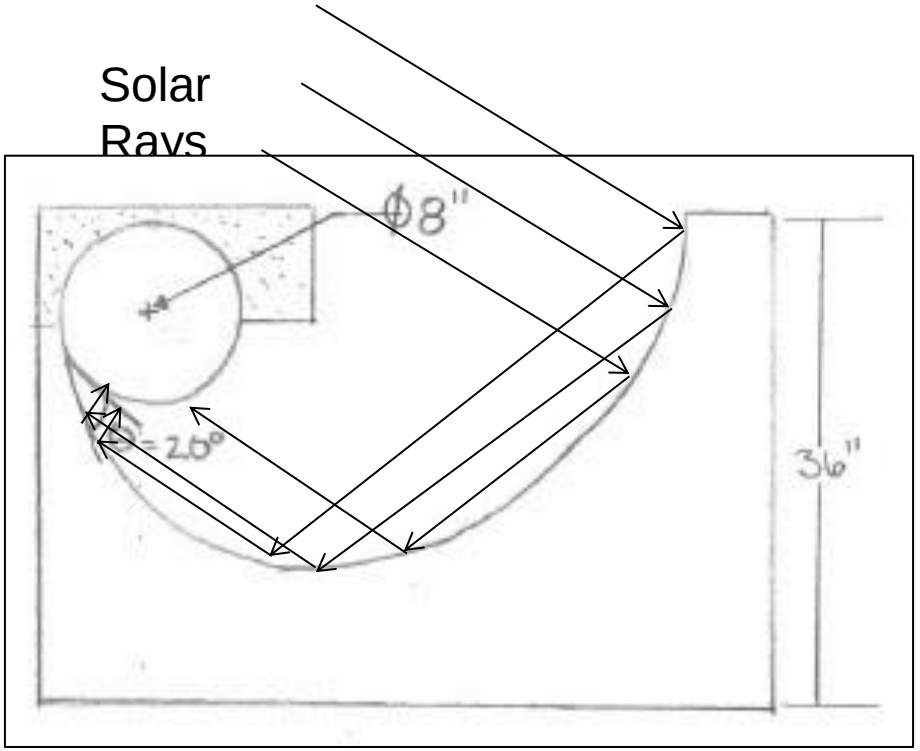
1. (2) PLYWOOD SHEETS
2. (~10) WOOD PLANKS
3. ( ) TIN FOIL
5. ( ) PIPE Φ8" x 6'
6. ( ) INSULATION - STYROFOAM

Design Drawing Continued

- Design is made of cost effective materials
- Should be easily constructed with do it yourself knowledge
- Insulated air trap improves efficiency

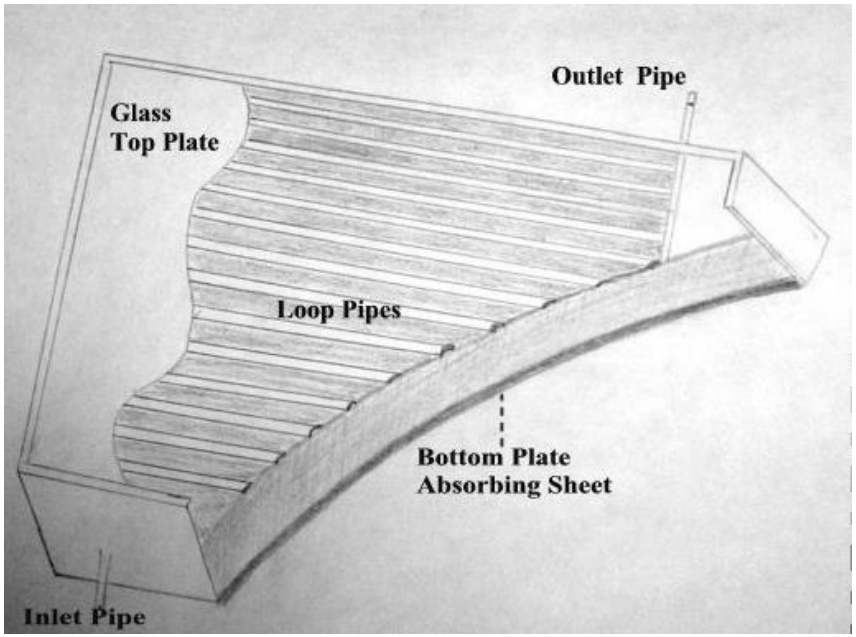
Design Functionality

Involute Curve Radiation Path



Flat Plate Collector

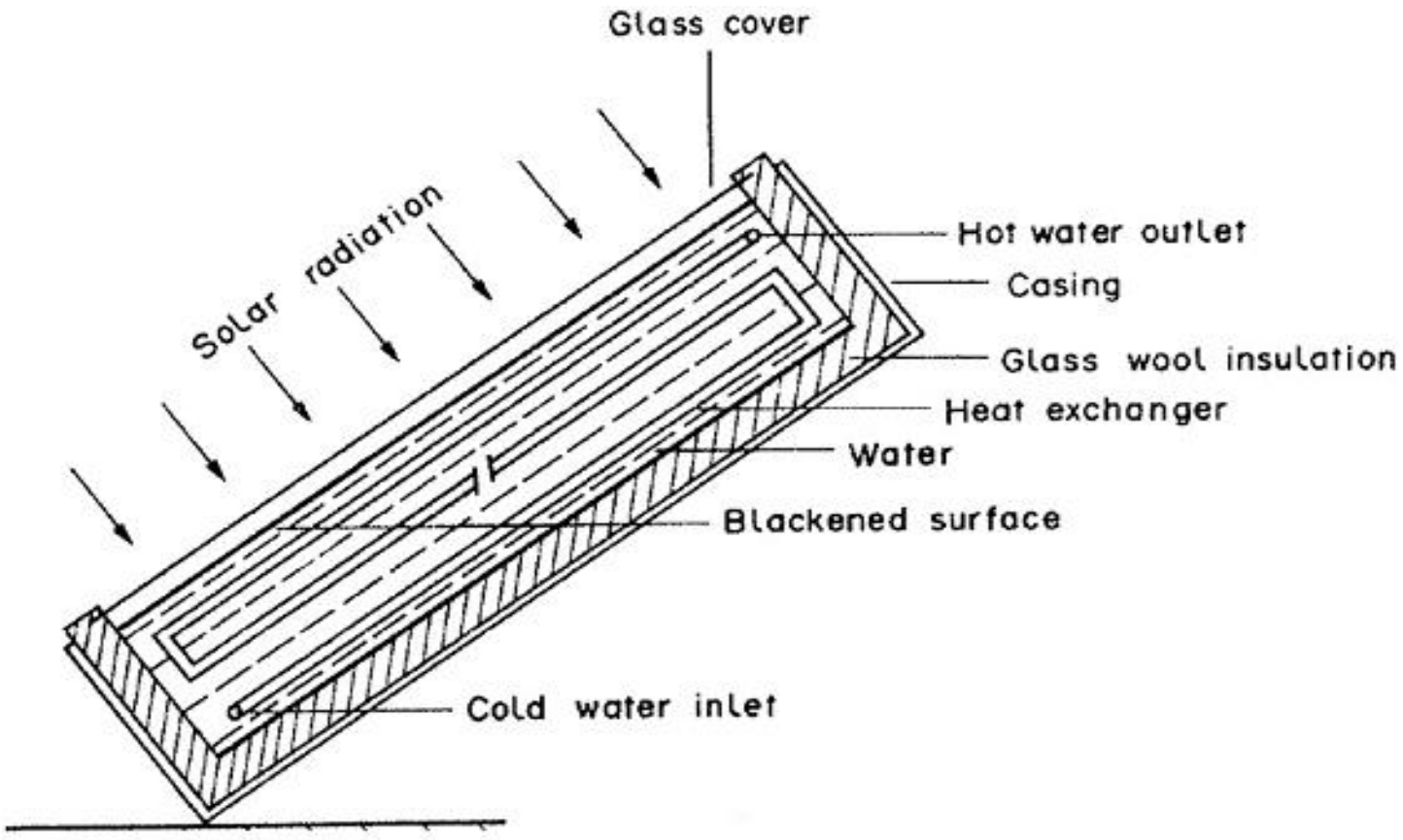
Flat Plate Collector



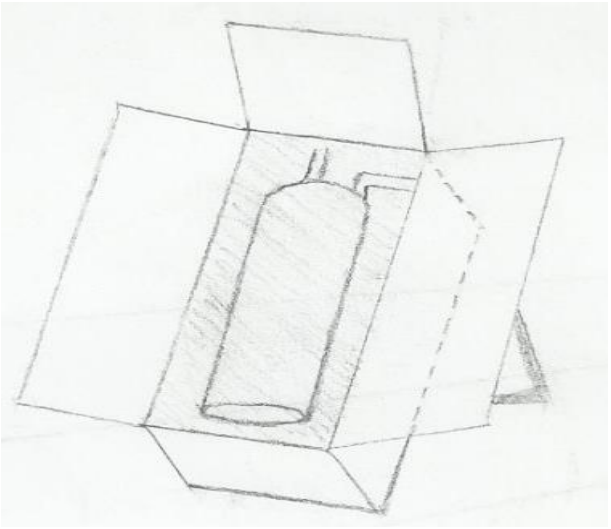
- Black pipes or flat background absorb radiation
- Possibly modular design
- Active or passive circulation

Design Variations

Flat Plate Collector Schematic



Bread-Box Design

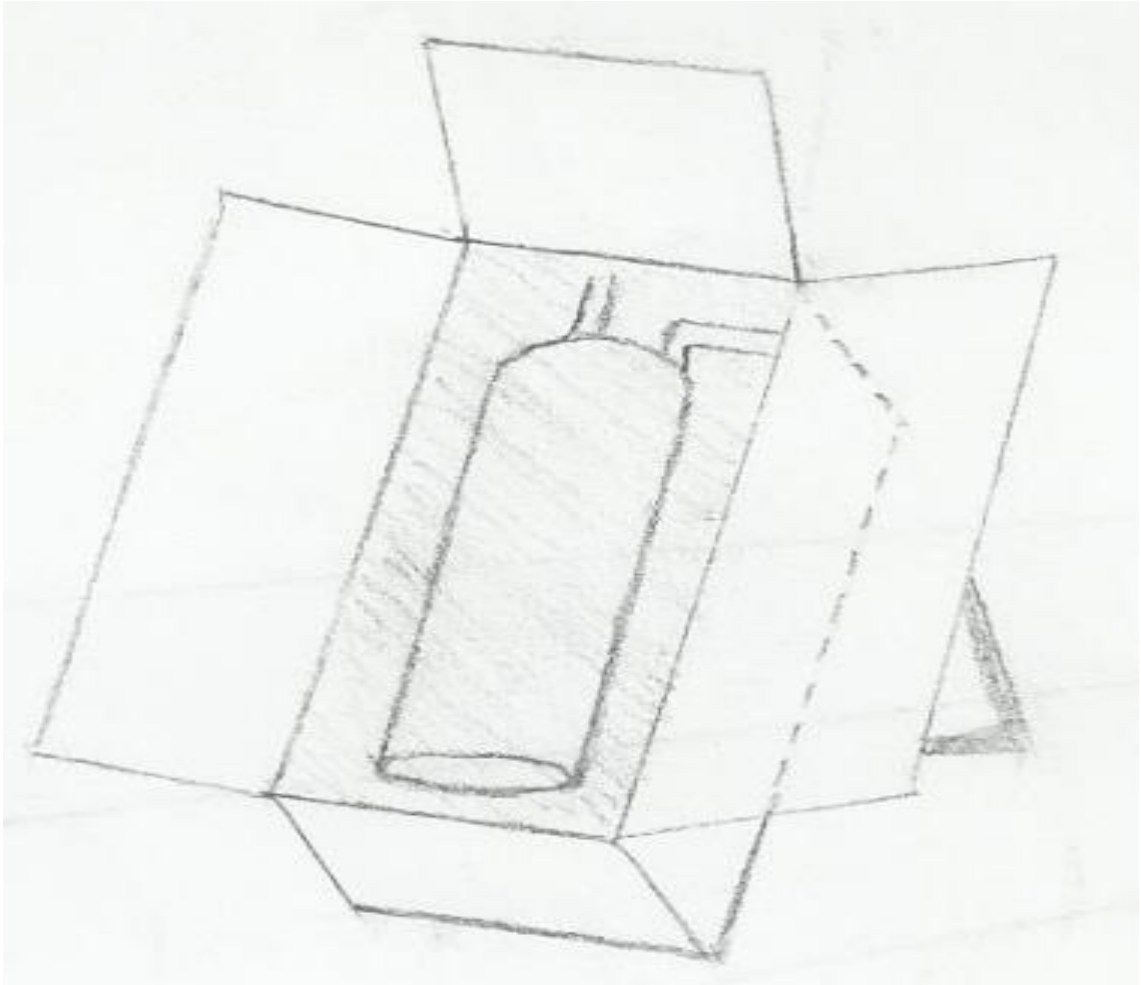


- Large black water tank
- Tank sits inside a fully insulated box
- Dual pane glass sits on top to capture solar radiation

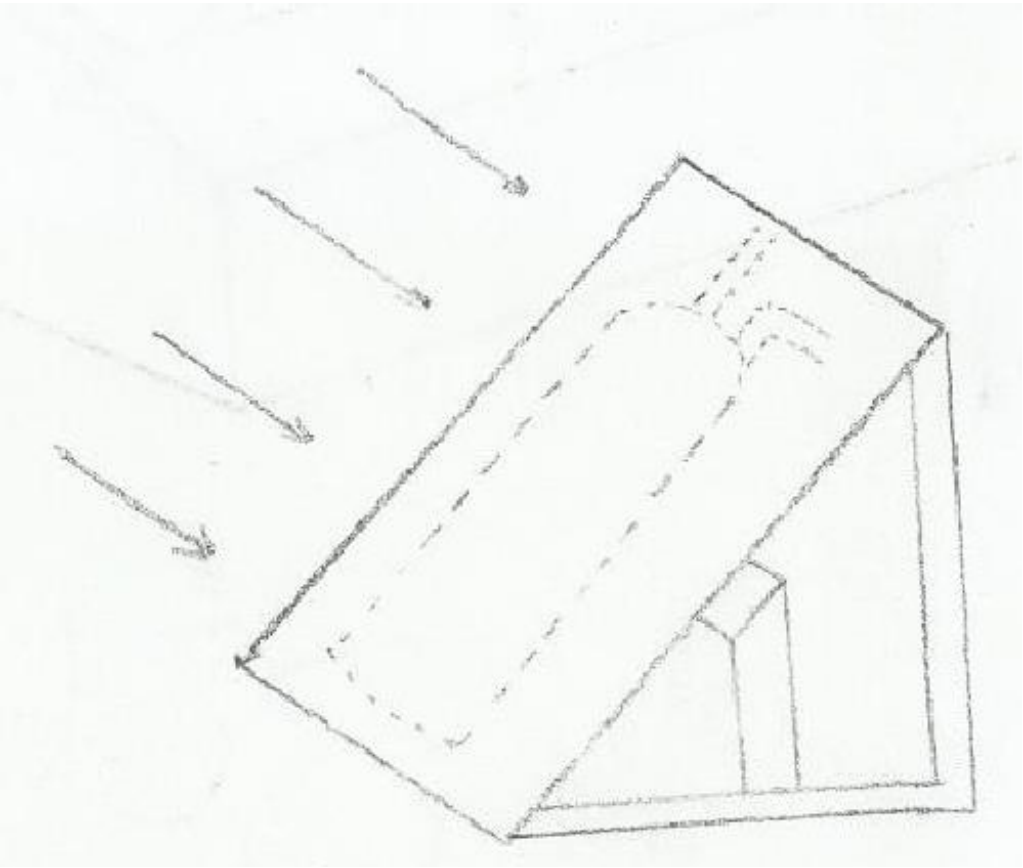
Bread-Box Design

- Angled fins sit around three sides to deflect more light into the collector
- Water pipes run cold water in at the bottom of the tank and hot water out of the top

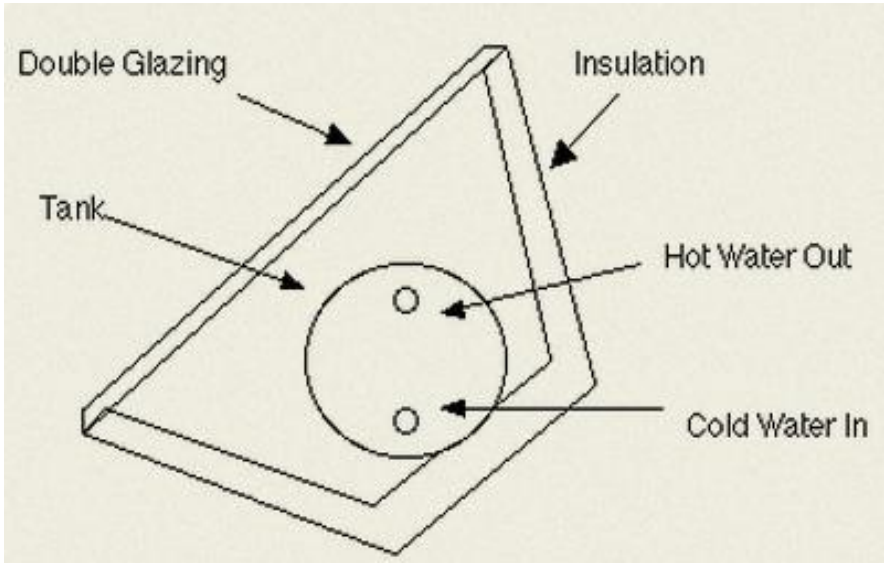
Bread Box Collector



Bread Box Collector Side View



Bread Box Collector Top View

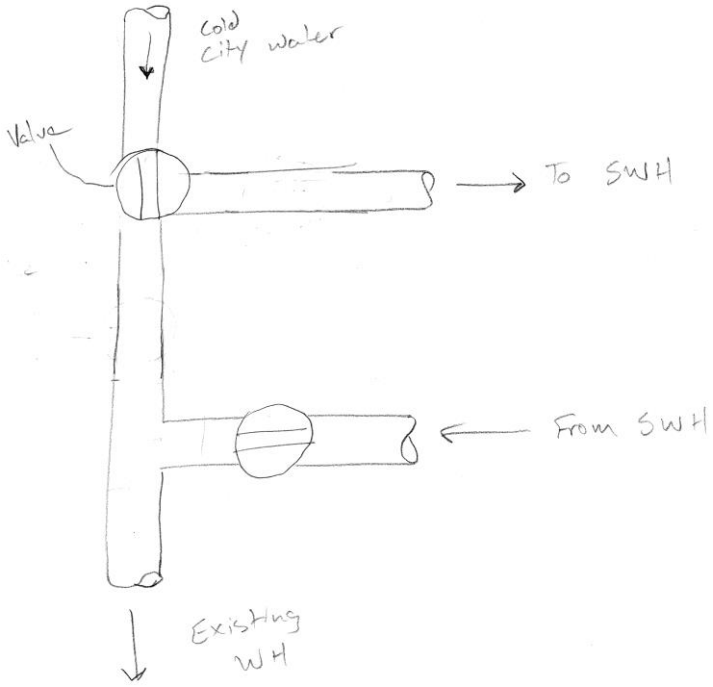


Circulation

- Integration
- Active Circulation
- Passive Circulation
- Bread Box Circulation

Integration Into Water Heater

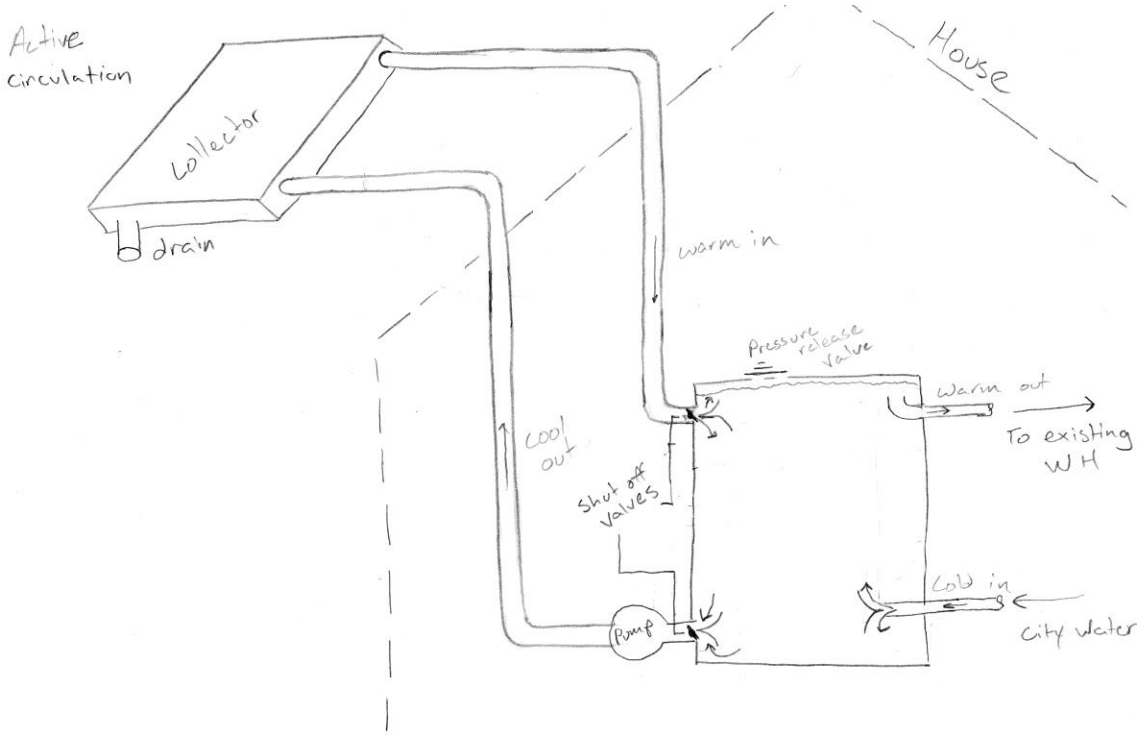
Integration Pipe Schematic



- Operator can choose to circulate water through SWH before Integration with home water heater or not at all.

Active Circulation

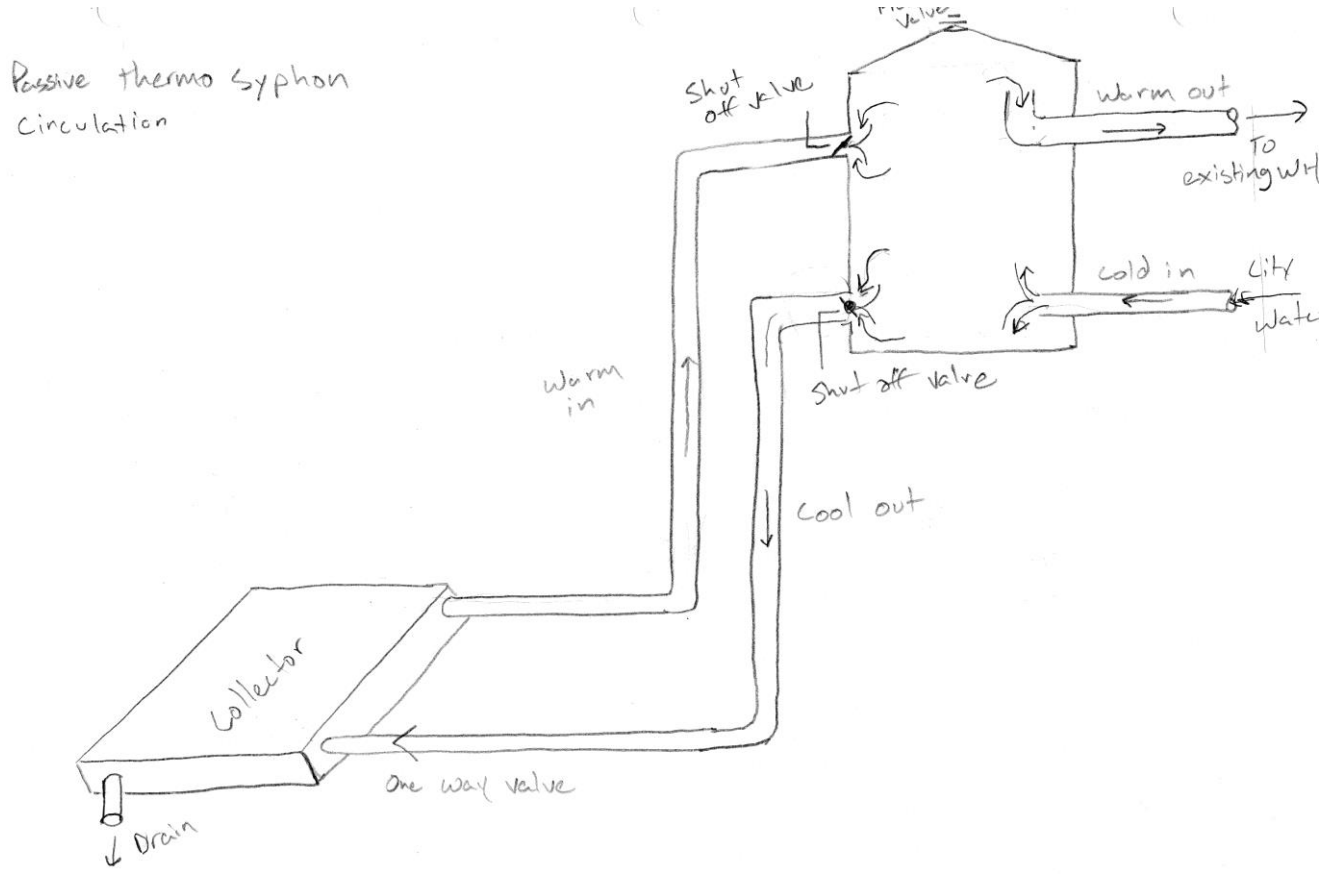
Active Circulation System



- Pumps water at the most efficient rate to absorb the maximum amount of sunlight.

Passive Circulation

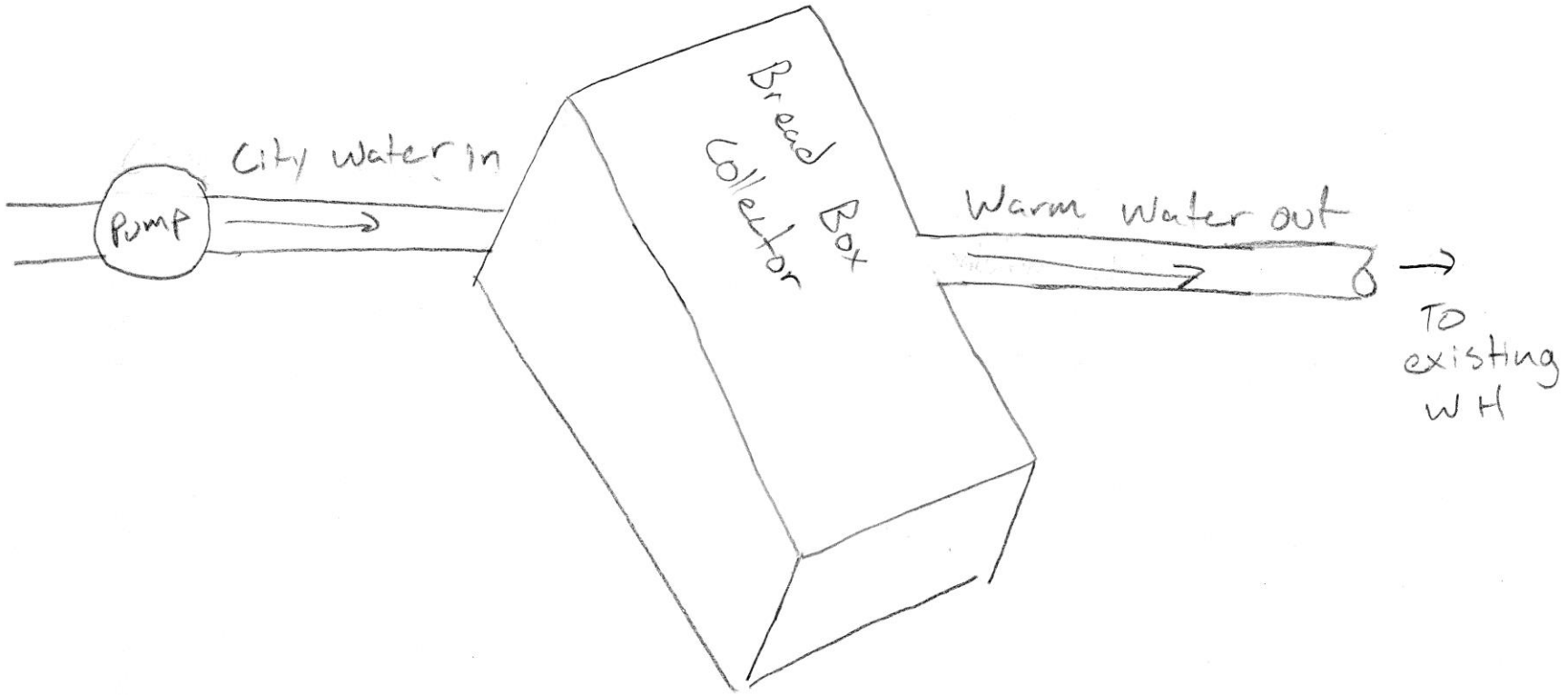
Passive Circulation System



- Thermosyphoning is used to circulate water

Bread Box Circulation

Bread Box Circulation System



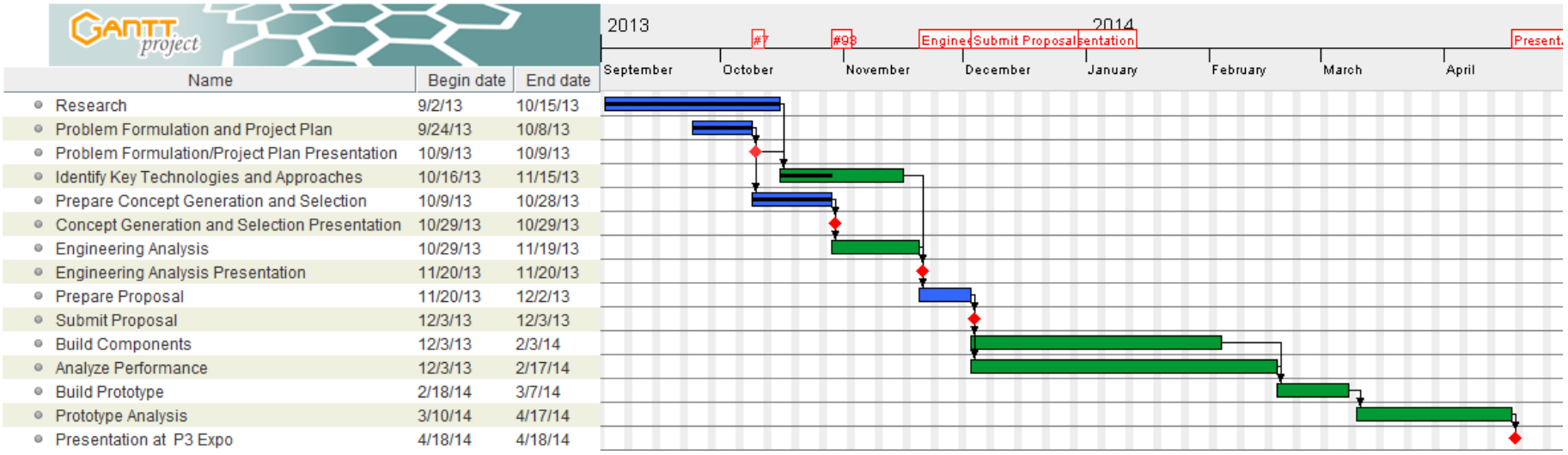
- City water pressure circulates water within collector as it is used.

Decision Matrix

	Weight	Involute (Active)	Involute (passive)	Parabolic (Active)	Parabolic (passive)	Flat plate (open /active)	Flat plate (closed /active)	Flat plate (open /passive)	Flat plate (closed /passive)	Bread Box
Absorbtion	9	9	9	3	3	3	9	3	3	9
Area	9	9	9	9	9	3	3	3	3	3
Cost	9	3	3	3	3	1	1	9	3	3
Buildable	5	1	1	3	3	9	3	9	3	9
System Size	3	9	9	9	9	3	3	3	3	1
	Raw	221	221	177	177	117	141	189	105	183
	Rank	**1**	**1**	**5**	**5**	**8**	**7**	**3**	**9**	**4**

Timeline

Gantt Chart



Name	Begin date	End date
Research	9/2/13	10/15/13
Problem Formulation and Project Plan	9/24/13	10/8/13
Problem Formulation/Project Plan Presentation	10/9/13	10/9/13
Identify Key Technologies and Approaches	10/16/13	11/15/13
Prepare Concept Generation and Selection	10/9/13	10/28/13
Concept Generation and Selection Presentation	10/29/13	10/29/13
Engineering Analysis	10/29/13	11/19/13
Engineering Analysis Presentation	11/20/13	11/20/13
Prepare Proposal	11/20/13	12/2/13
Submit Proposal	12/3/13	12/3/13
Build Components	12/3/13	2/3/14
Analyze Performance	12/3/13	2/17/14
Build Prototype	2/18/14	3/7/14
Prototype Analysis	3/10/14	4/17/14
Presentation at P3 Expo	4/18/14	4/18/14

Conclusion

- Involute collector shape utilizes high percentage of collected light
- Flat plate proven method of capture
- Bread Box is a simple, self contained system
- Active circulation is an expensive with high efficiency
- Passive circulation is a cheap circulation system yet sacrifices efficiency
- Involute, flat plate, and bread box collectors are the best options
- Team remains on set schedule

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