Concept Generation and Evaluation

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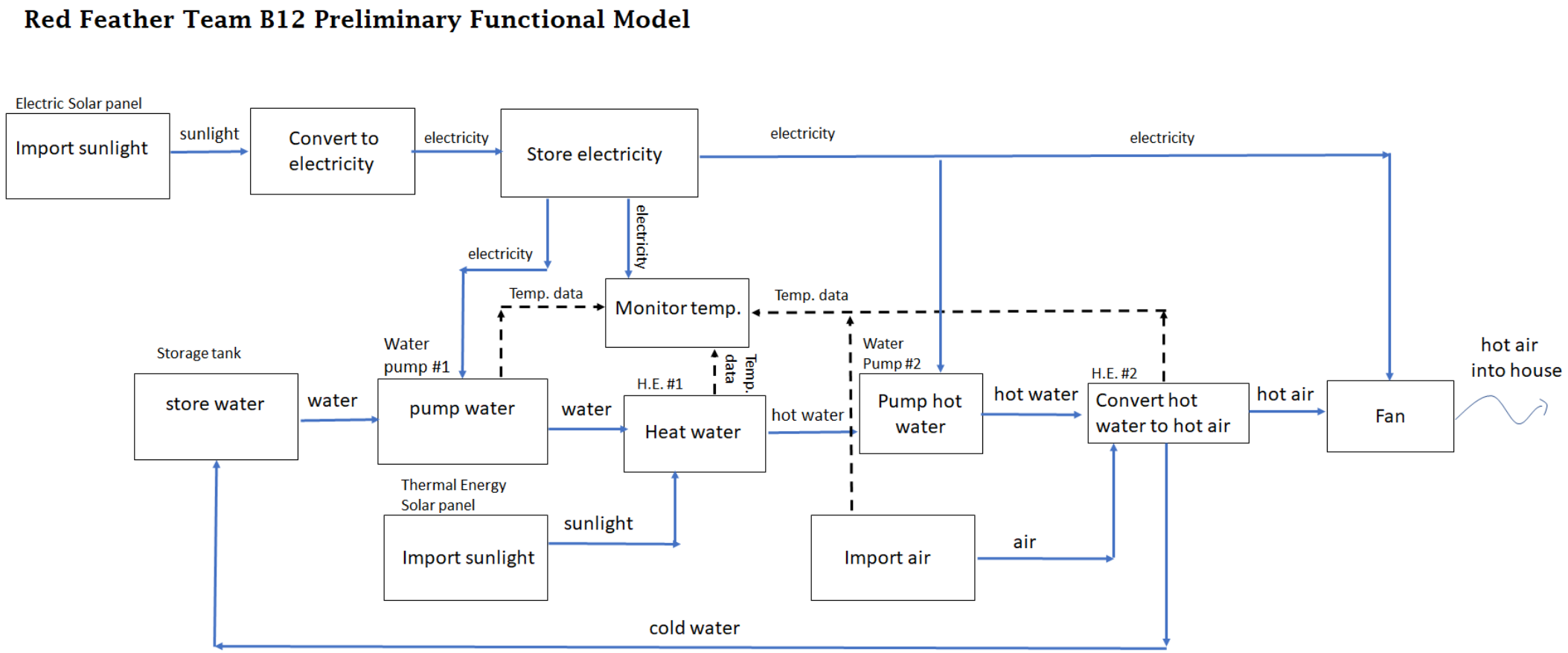
Project Description

- Many homes on the Navajo nation and Hopi Reservation don't have adequate sources of heat during the evening, many rely on coal or wood-fired stoves
- The project is to create a thermal solar furnace that can produce and store enough heat to warm a house at night.
- All the materials used must be locally sourced, easy and within the budget set by Red Feather
- The design for the solar thermal furnace needs to be straight forward and not too large
- It needs to be reliable and durable in the environment it is in

Black Box Model

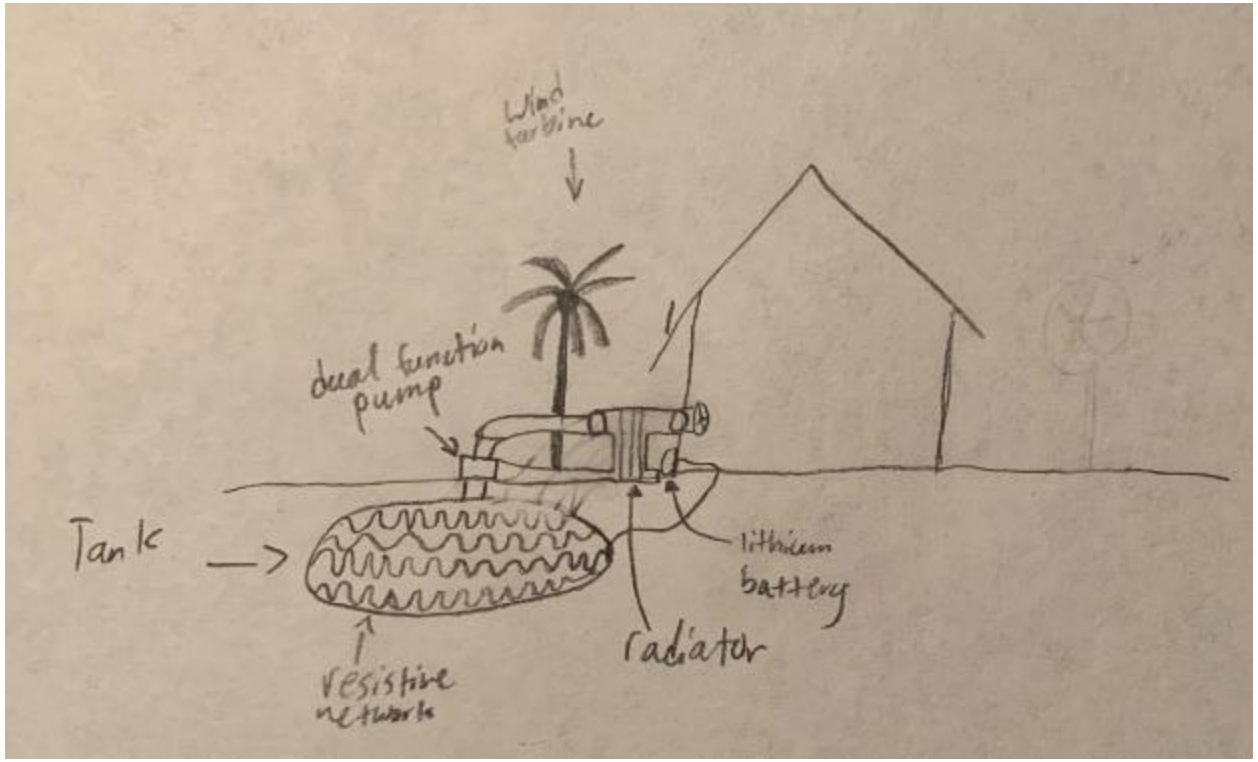
Functional Model

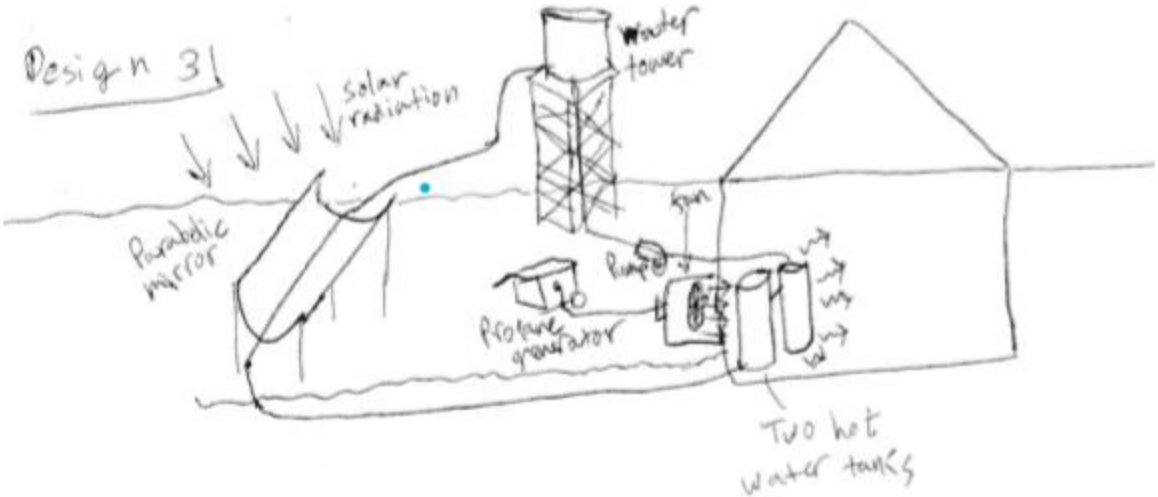


Concept Generation: Morphological Matrix

Sub-function	1	2	3	4	5	6
Thermal Storage	Phase Change Material	Single water tank	Rocks	Buried water tank	Raised water tank	Multiple wa tanks
Heat generation	Thermal panel	Resistive network	Heat up rocks (sun)	propane	Heating tubes	Parabolic mirror
Electricity Generation/Storage	Solar PV Panel + Li Battery	Wind turbine + Li battery	Stirling engine	Propane generator		
Heat Exchanger(s)	Radiator	Shell and tube heat exchanger	Plate heat exchanger	Air moves through hot water tank	Spiral heat exchanger	Cross flow
Water Pump(s)	1 pump to recycle – gravity fed	2 pumps	1 dual-function pump			

Concept Generation





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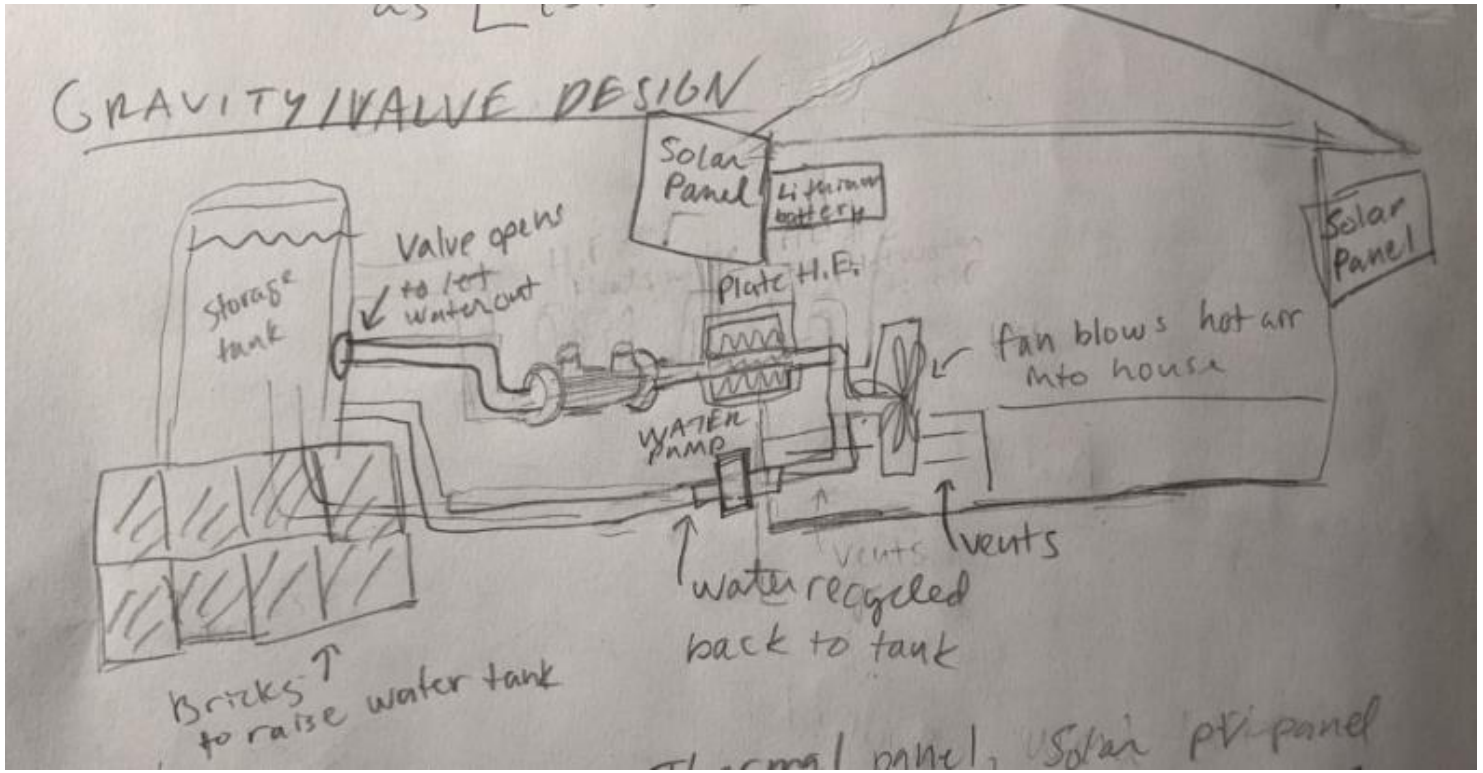

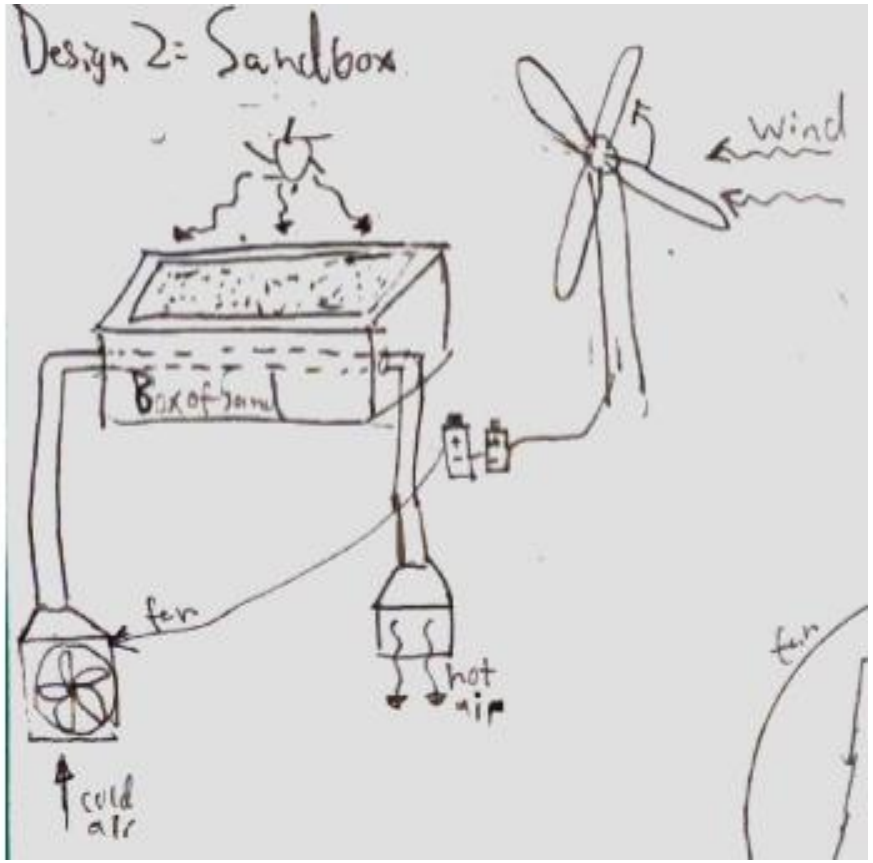

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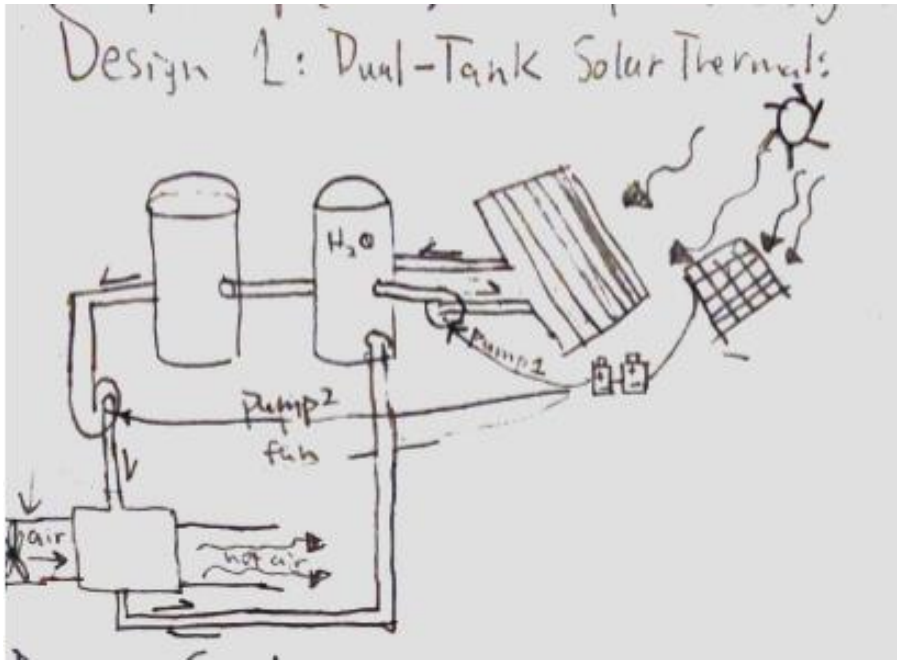
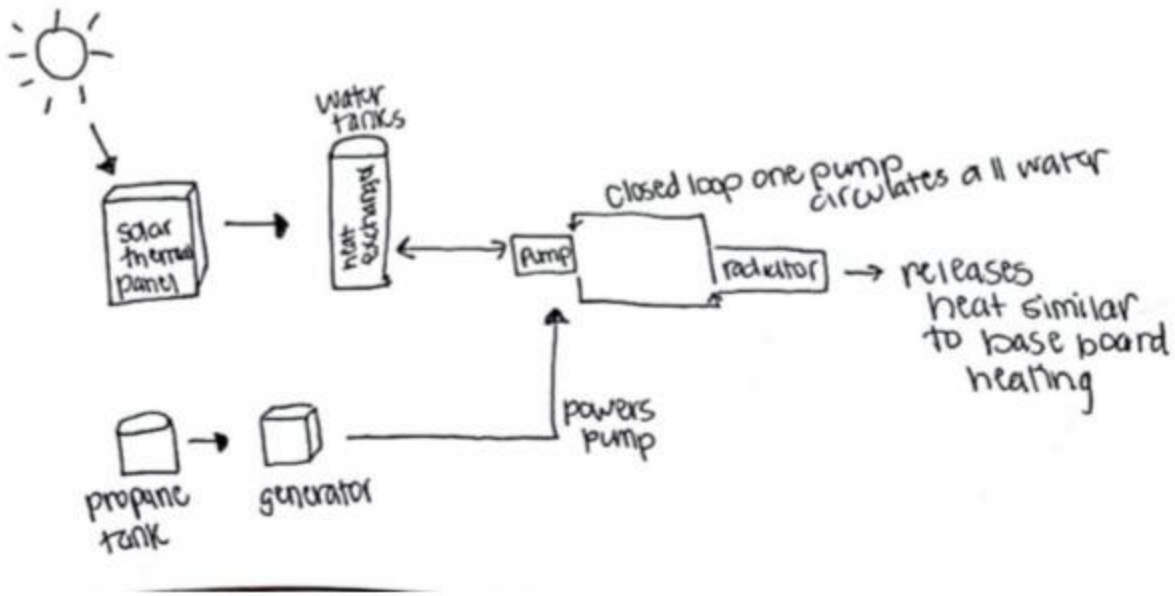


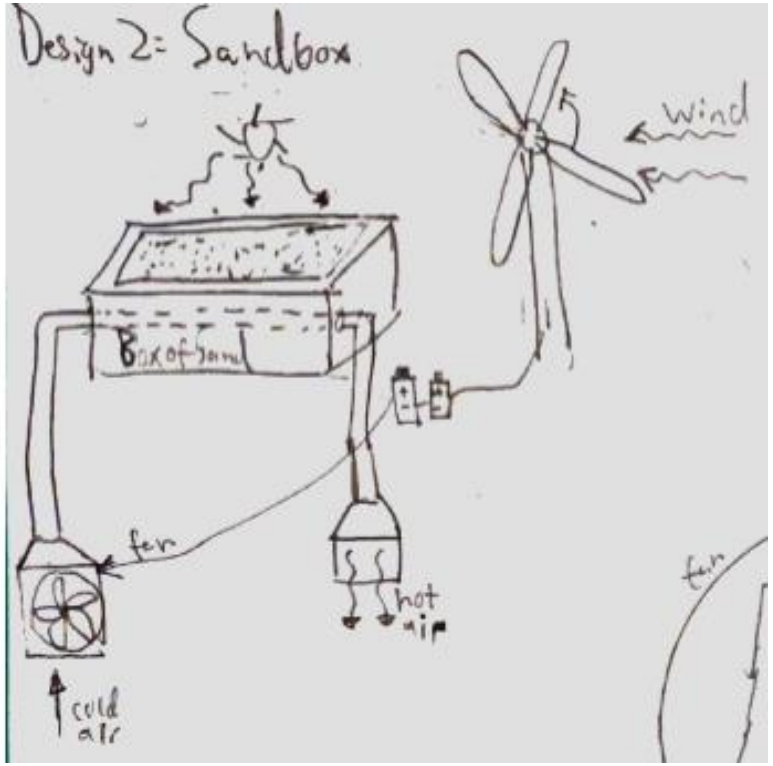


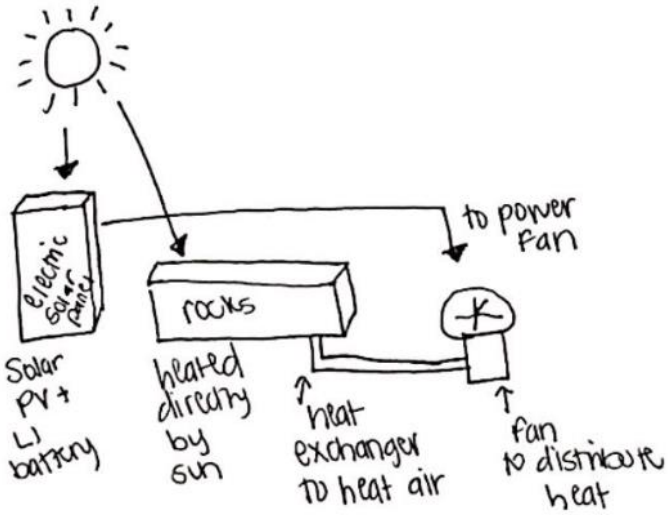
Concept Evaluation

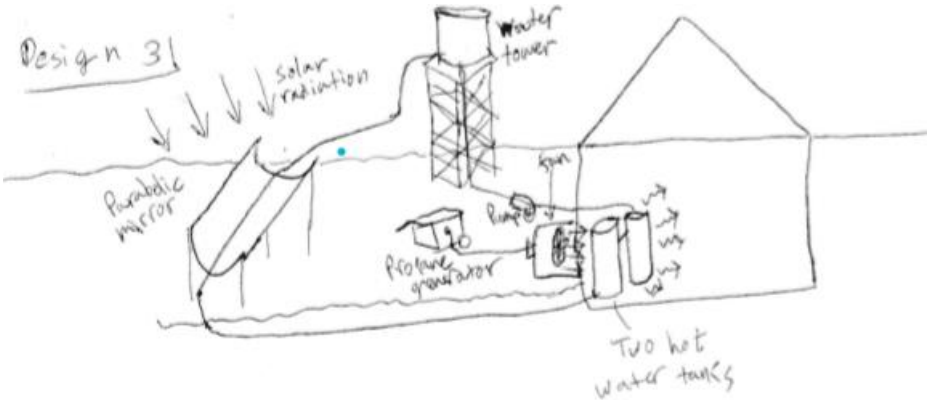
Decision Matrix

	105	186	148	90	76	76	33	120	60	105	999
	11%	19%	15%	9%	8%	8%	3%	12%	6%	11%	100%
Designs	indoor air temp. (°F)	heat transfer rate (BTU)	Device cost ($)	Number of parts (unitless)	Dimensions (ft^3)	Weight (lb)	Max material delivery time (hrs)	Outdoor temp. range (°F)	Force withstood (lbf)	Cycles without failure (unitless)	Score
Randall 1	4	4	2	2	3	2	3	4	3	4	3.20
Randall 2	3	2	3	4	3	3	3	4	3	4	3.13
Randall 3	3	3	1	1	1	2	2	4	3	3	2.38
Noah 1	4	3	3	2	3	3	3	3	3	4	3.12
Noah 2	1	1	4	4	2	2	4	2	4	3	2.48
Noah 3	3	3	1	2	4	4	1	4	1	2	2.59
Brittney 1	1	1	4	4	2	2	3	2	4	3	2.44
Brittney 2	4	3	3	2	3	3	3	3	3	3	3.02
Brittney 3	3	2	3	3	3	2	2	3	3	3	2.70
Jessie 1	3	2	3	3	3	3	3	3	3	2	2.71
Jessie 2	4	4	2	3	2	2	3	3	3	3	2.99
Jessie 3	4	4	2	2	2	2	2	4	3	2	2.88
Wesley 1	3	3	3	3	3	3	3	4	3	3	3.12
Wesley 2	2	3	4	4	3	3	3	3	3	4	3.24
Wesley 3	1	3	4	3	2	2	3	3	4	2	2.74

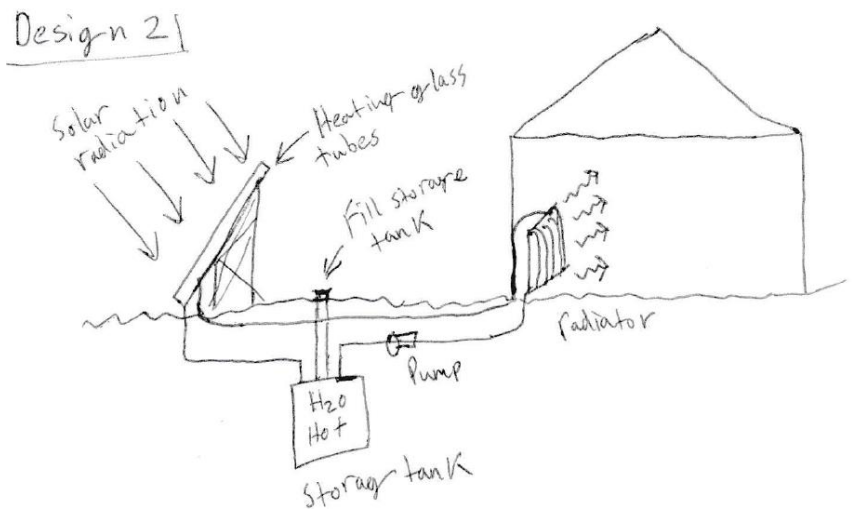
Low-Scoring Concepts

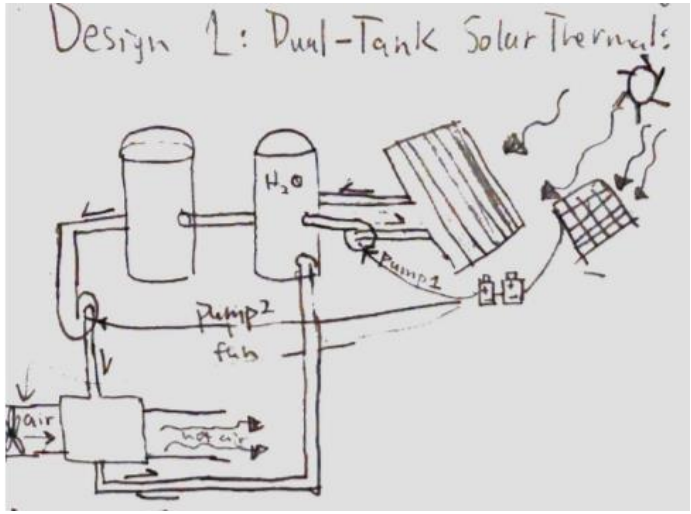


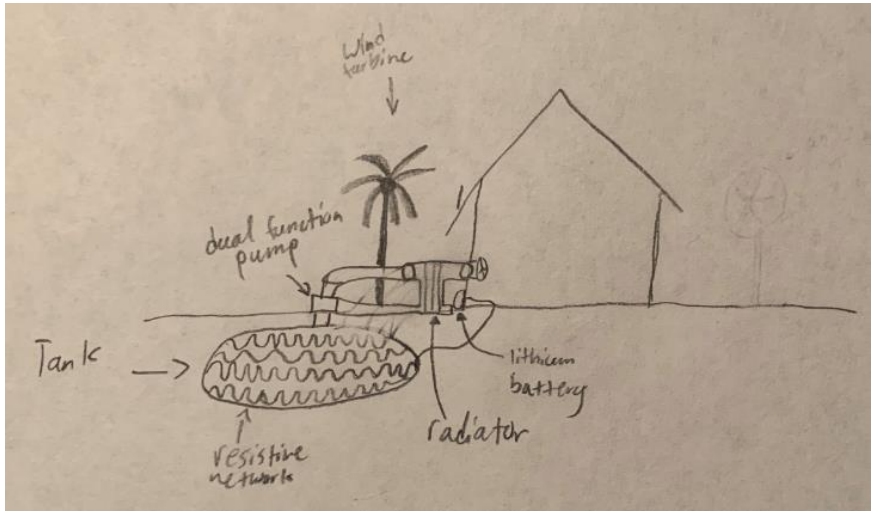




High-Scoring Concepts

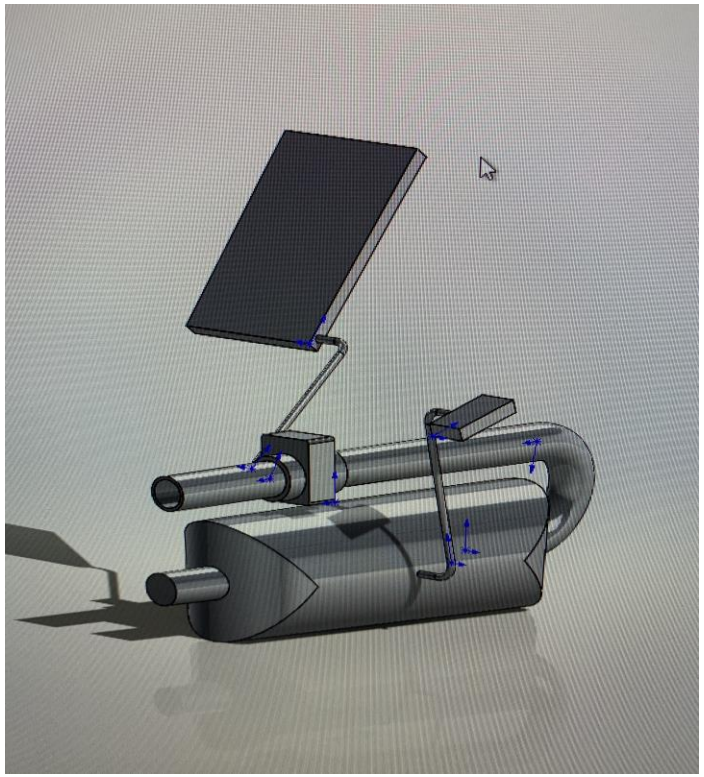




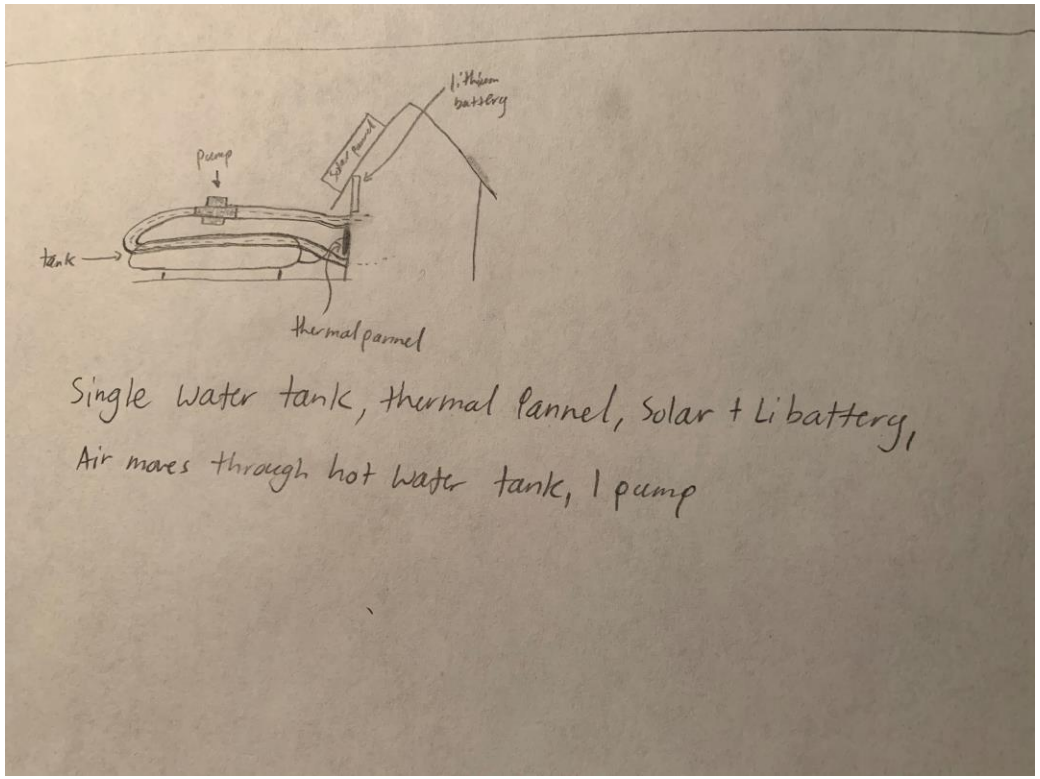


Top Design #1

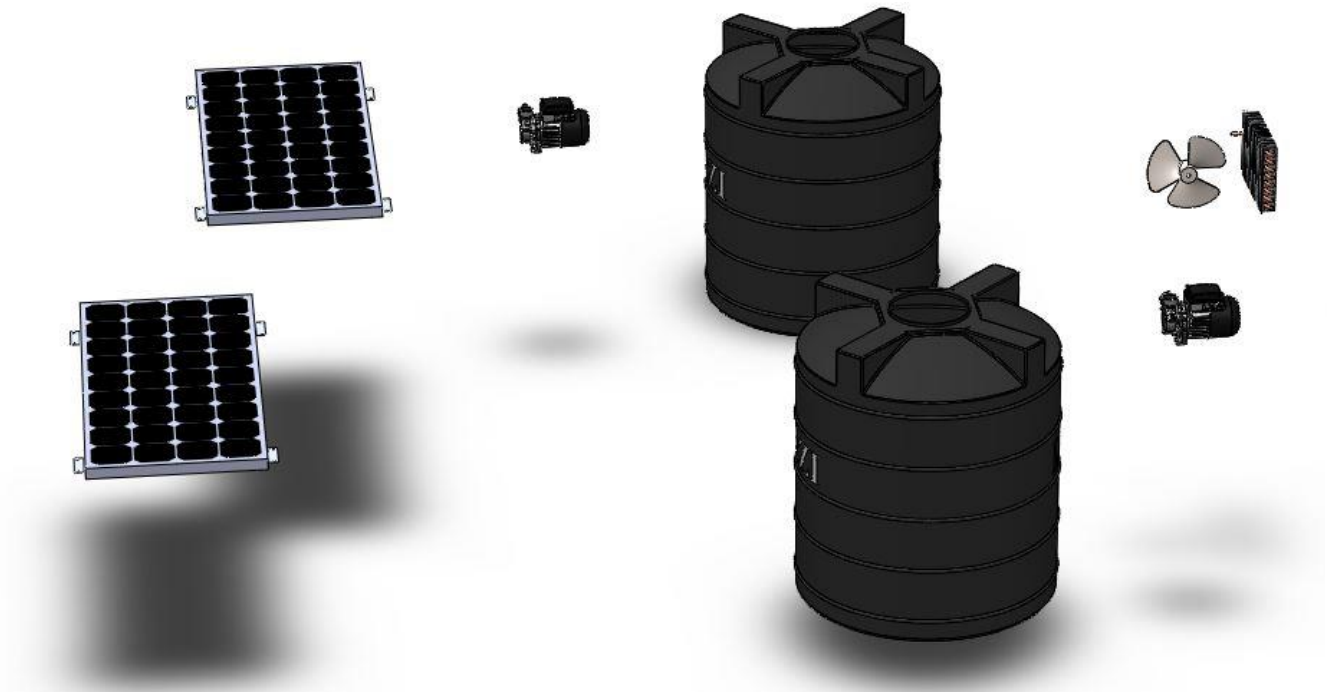
CAD Design

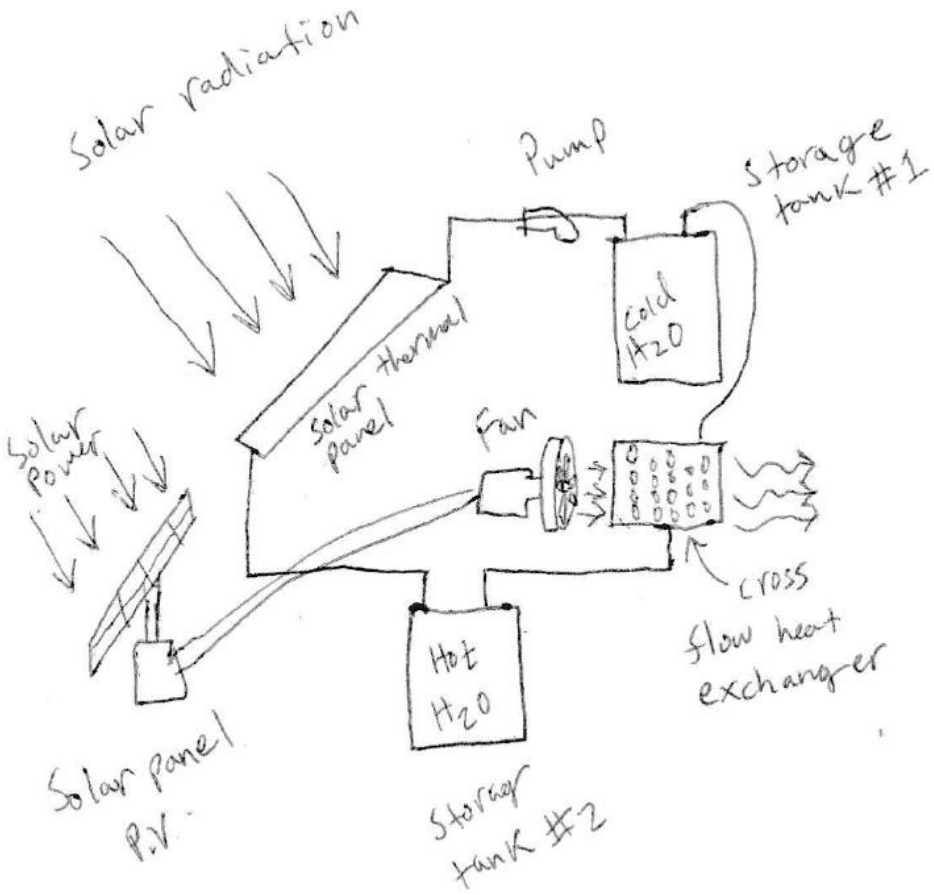


Sketch of design



Top Design #2




Solar radiation
Pump
storage tank #1
cold H20
solar thermal panel
Solar power
fan
cross flow heat exchanger
Hot H20
Solar panel P.V.
storage tank #2

Budget Planning

Bill of Materials				
Red Feather B12				
Part Name	Qty	Description and Function	Material	Cost
Water/Air Pump	1-2	Pump water or air throughout closed system	Plastic and Metal, electric wires	$100
Heat Exchanger	1-2	Heat water or convert thermal energy from hot water into hot air	Metals (Copper/Aluminum)	$250
Storage Tank	1-2	Store water for use in the closed system	Metal and Insulation	$160
Electric Solar Panel	1	Capture thermal energy to produce electricity for electronic system and electric-powered pumps and fan	Silicon, metal frame, glass, electric wires, plexiglass	$300
Thermal Solar Panel	1	Capture thermal energy to produce heat to heat the water in the system	Silicon, metal frame, glass, electric wires, plexiglass	$300
Lithium Battery	1	Store electricity to provide constant electricity to temperature monitoring system	Lithium, cobalt, nickel	$280
Fan	1	Blow hot air into the house	Plastic and metal	$35
Copper piping	varies	Transport hot water, minimizing heat losses	Copper	$20
PVC Piping	varies	Transport cold water	Plastic	$30
Arduino	2	Control Temperature Monitoring equipment, pumps, and fan	Electronics	$20
Temperature Monitoring Equipment	1	Measure temperature	Electronics	$25
			Total	$1,500

Questions?