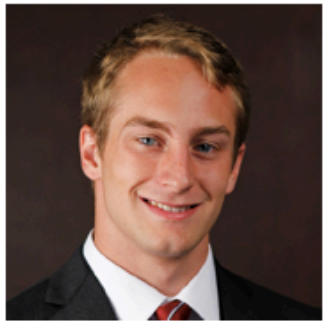
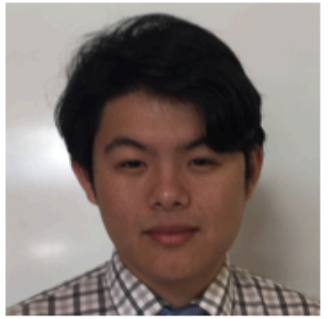
Healios

Kevin Ikeda



Steven Back

Tom Krajnak



Devin Chen

Collin Stipe

THE OHIO STATE UNIVERSITY
INTEGRATED BUSINESS AND ENGINEERING

CERN
Ideas

A New World

60
Year Life Expectancy

20x
More likely to die before age of 5

100km
To nearest doctor/ clinic

This place is a reality for some

Prototype
Solution
Problem
Opportunity
Business Plan

Characterizing Africa

26.6%

Electrification rate in Ethiopia*

< 1:10,000

less than one physician for every 10,000 people**

2,313,000

Africans die every year from preventable diseases***

35%

of administered vaccines are ineffective****

* data.worldbank.org/indicator
**our-africa.org/ethiopia/poverty-healthcare
***africacheck.org/factsheets/factsheet-the-leading-causes-of-death-in-africa/
****prb.org/Publications/Articles/2015/vaccine-preventable-disease-progress.aspx

Regional Considerations

Transportation

Sand and grit

Theft

Ethiopian Clinics

Category I Clinics: < 60 Beds

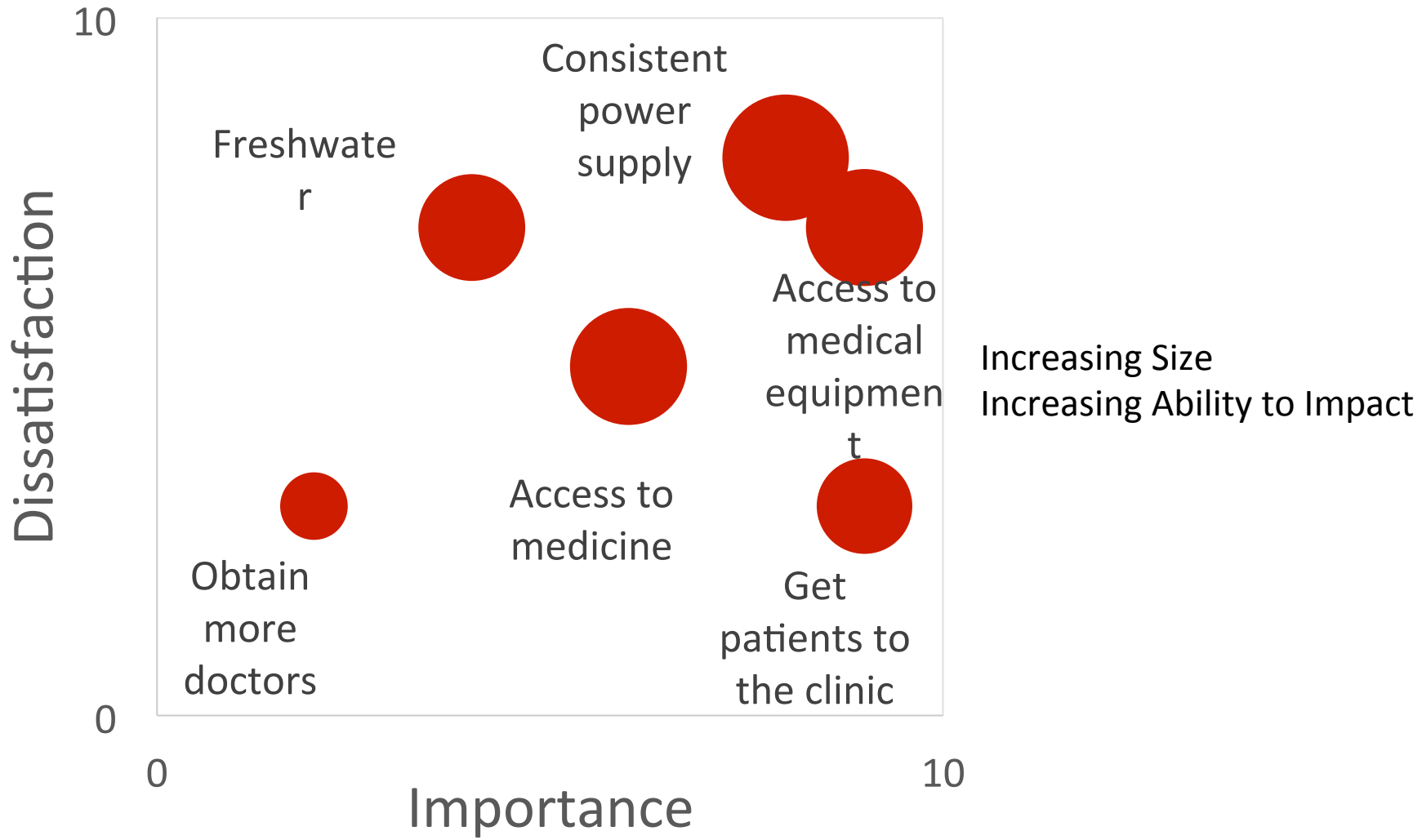
Power Needs

Lighting

Devices for Maintaining the Cold Chain

Basic Medical Equipment

Examining Clinic Needs



Current Electrification Solutions

- Diesel
- PV

Pros

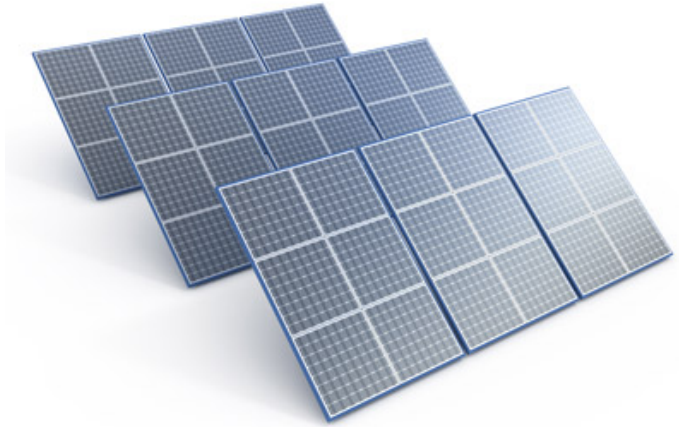
- Cheap initial cost
- Easy to obtain

Cons

- Heavy operating costs
- Durability and longevity
- Pollution and noise

Current Electrification Solutions

- Diesel
- PV



Pros

- No fuel costs
- No moving parts

Cons

- Theft
- Expensive initial cost
- Battery replacement

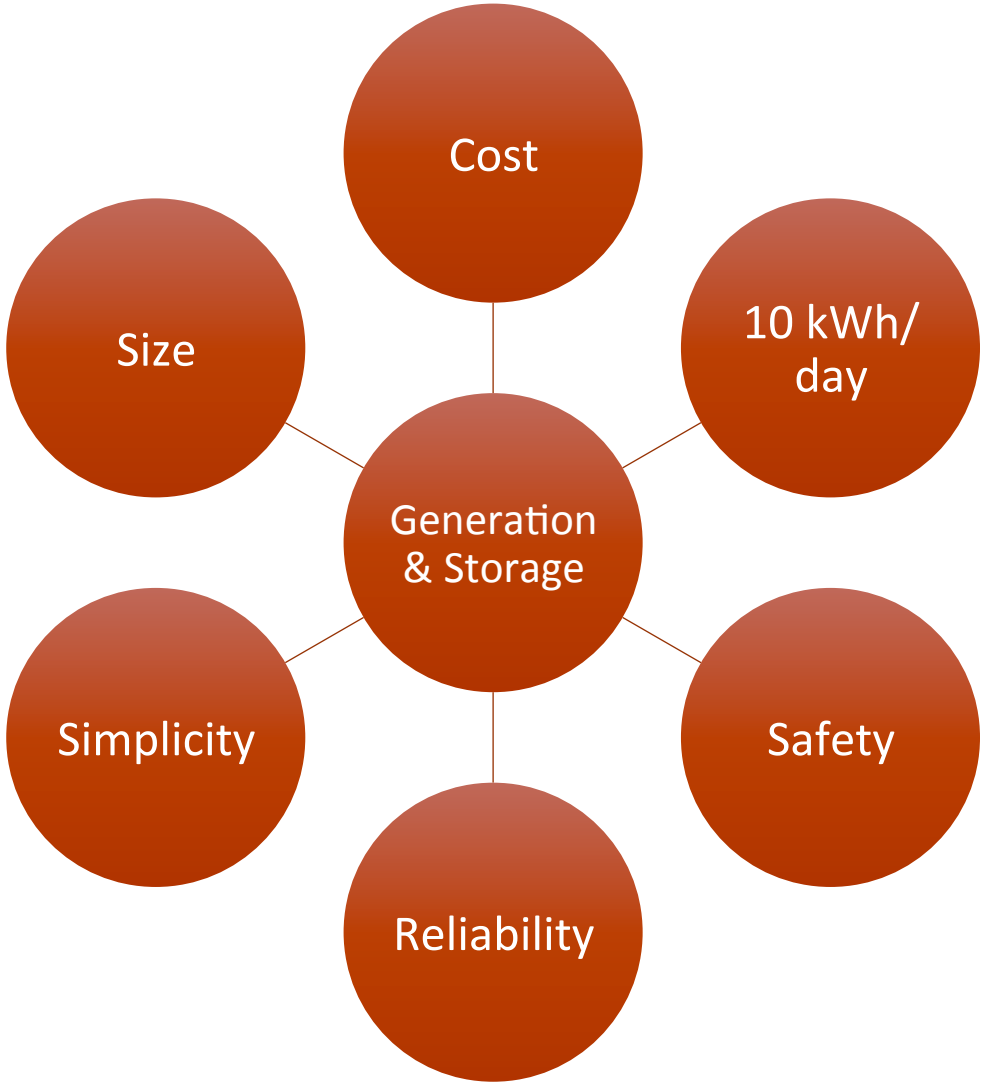
Prototype
Opportunity
Business Plan
Solution
Problem

Jobs to be Done

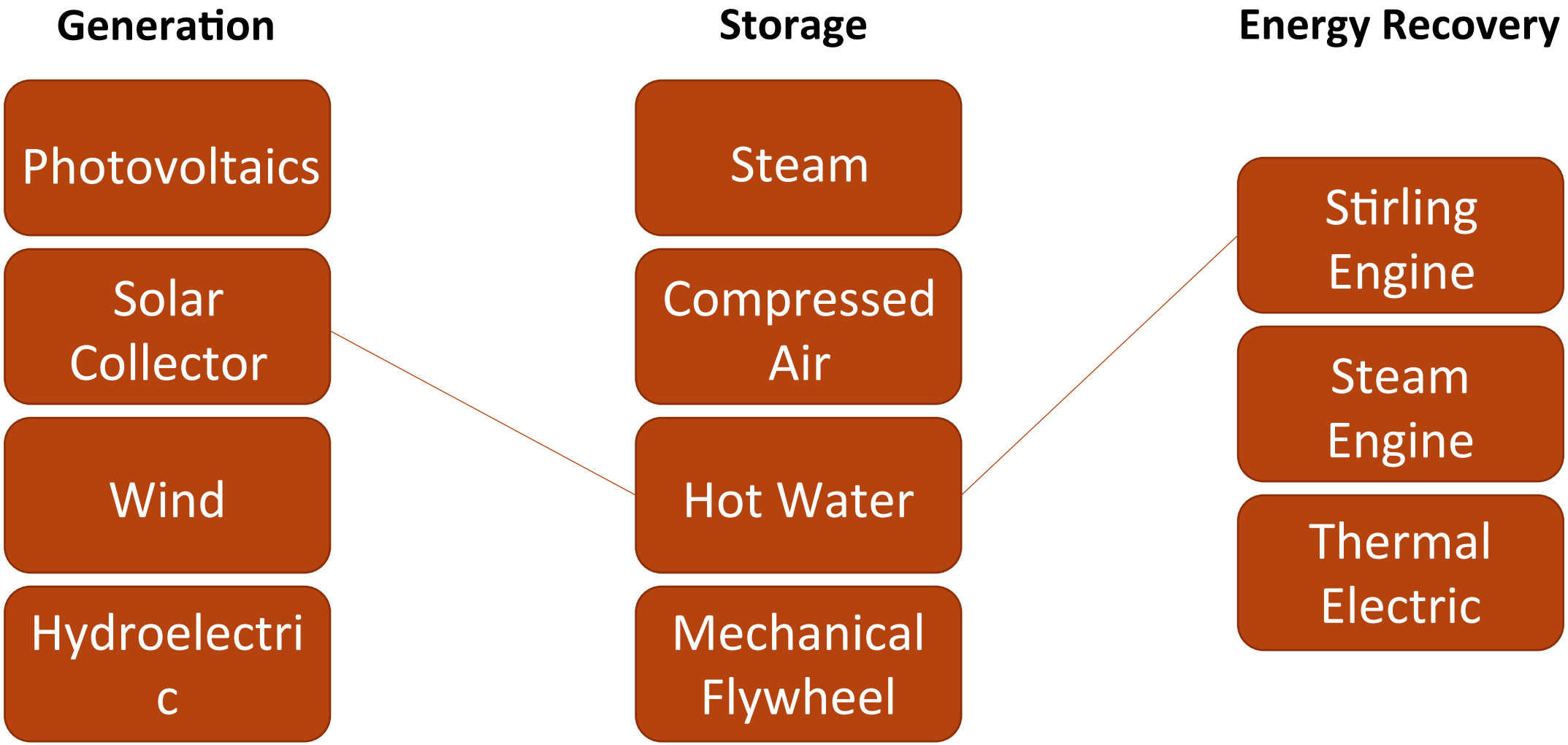
1) Provide a consistent power supply

2) Allow clinics to use basic medical devices

Narrowing Scope

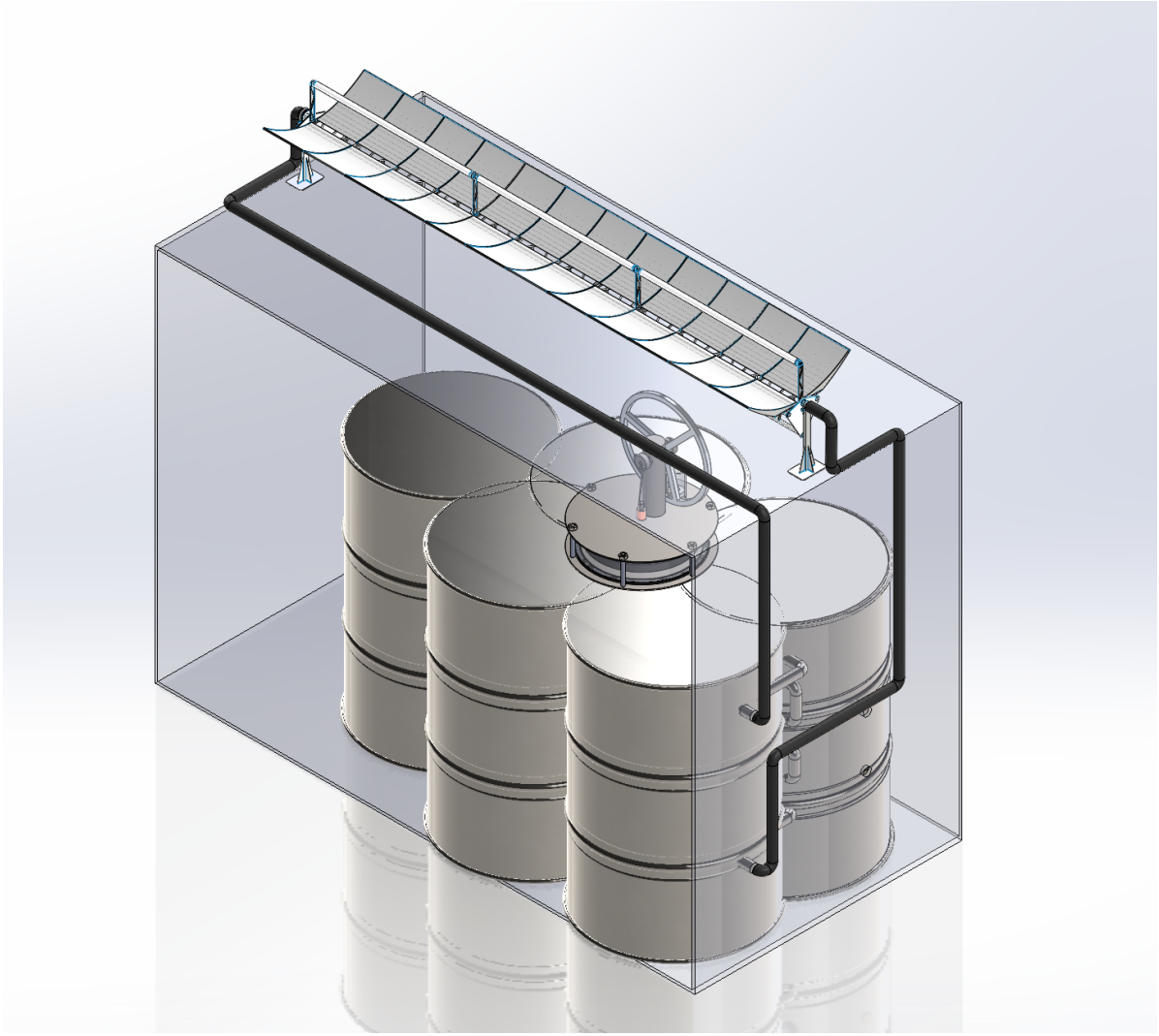


Narrowing Scope

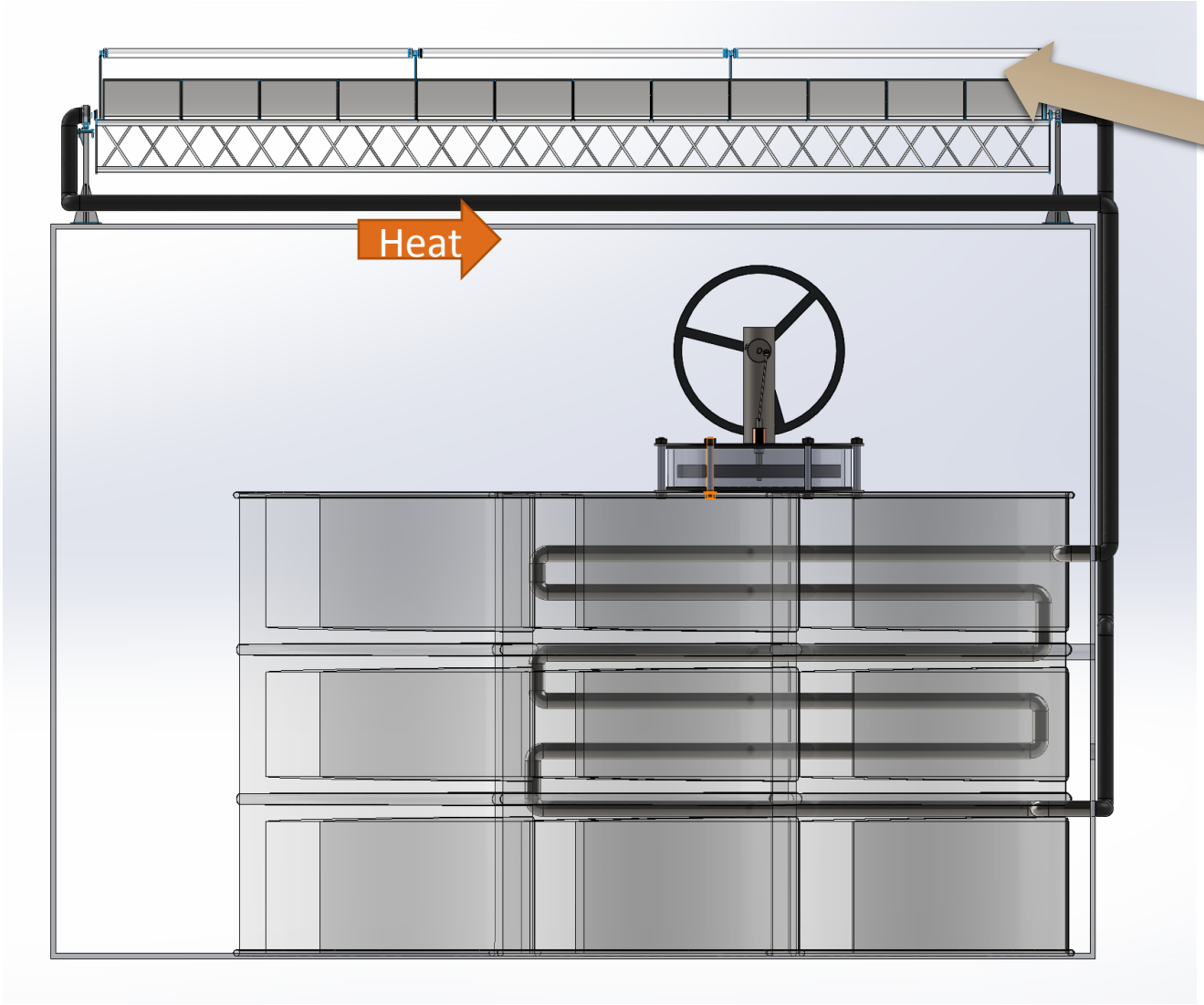


Prototype
Opportunity
Business Plan
Solution
Problem

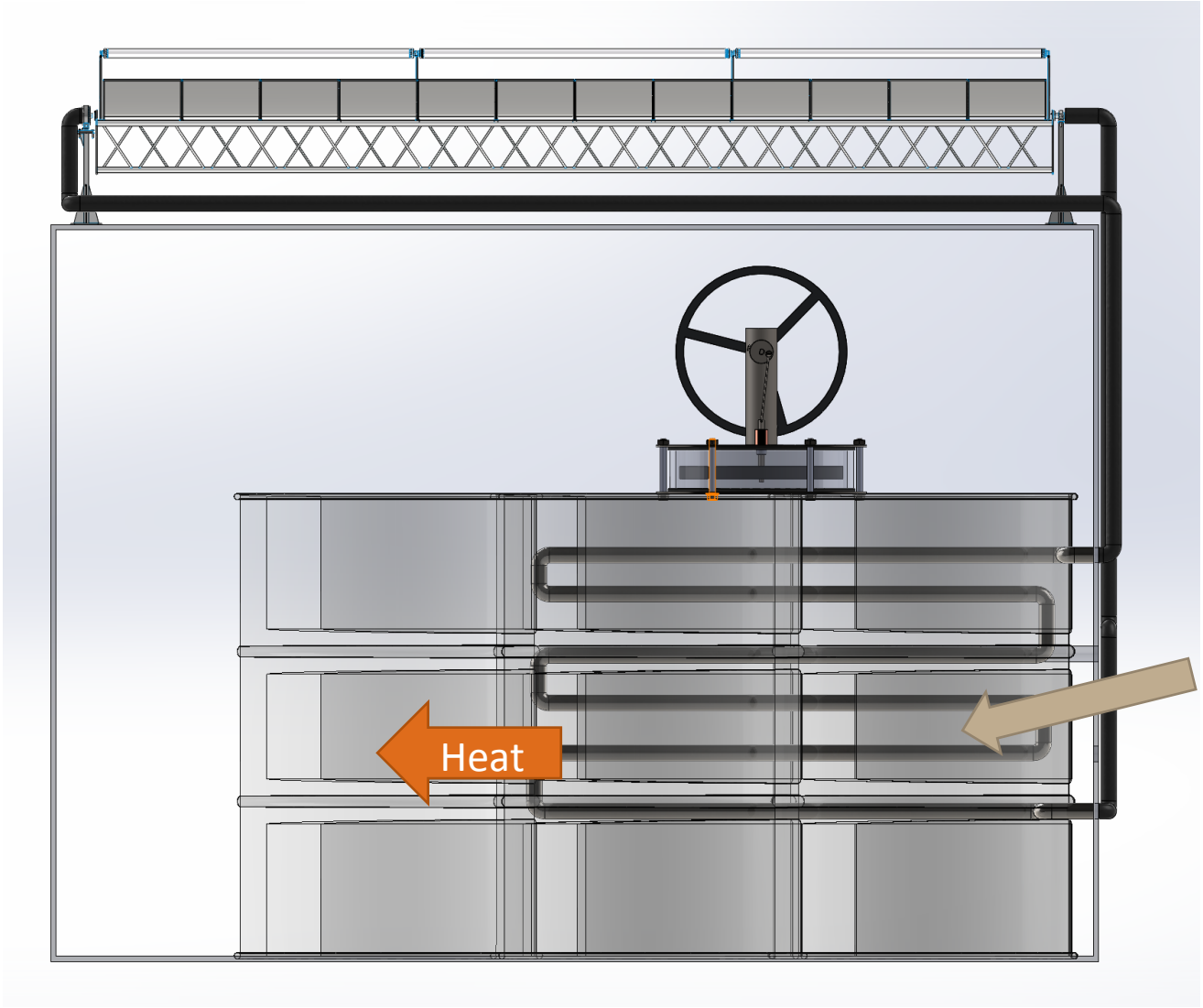
Solar Collector Water Thermal Energy Storage System



How it works



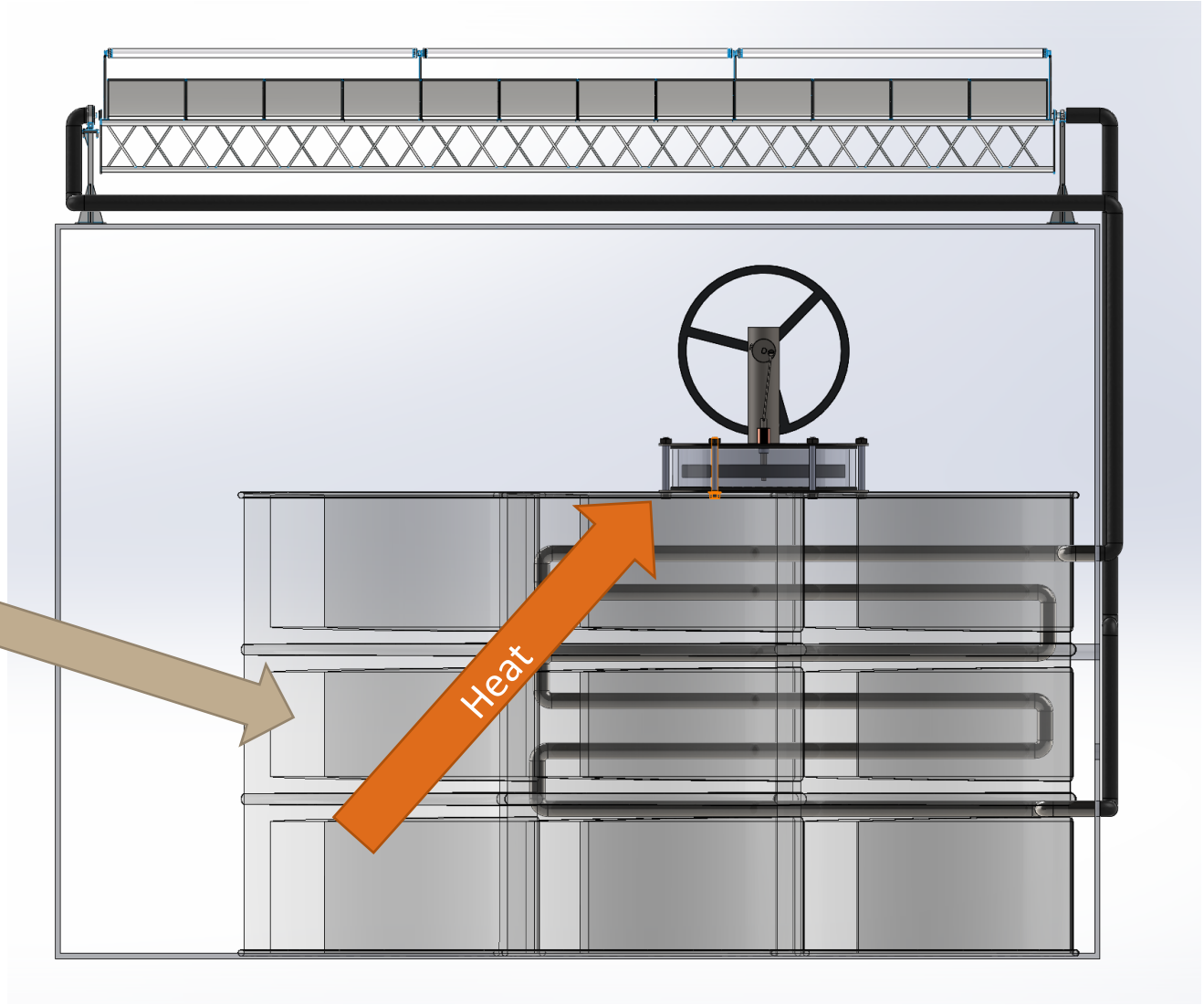
How it works



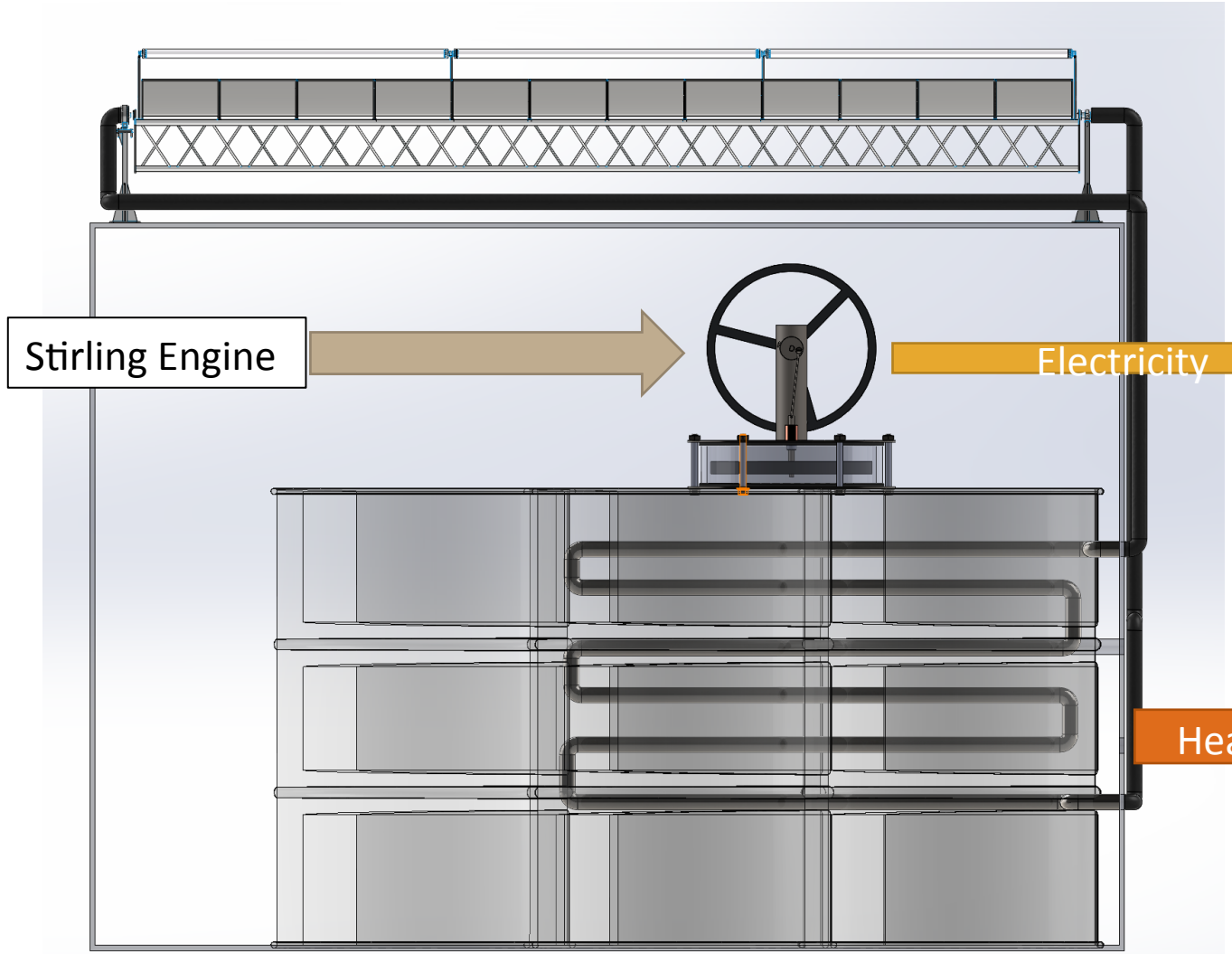
Shell and Tube Heat Exchanger

How it works

Hot Water Thermal Energy Storage

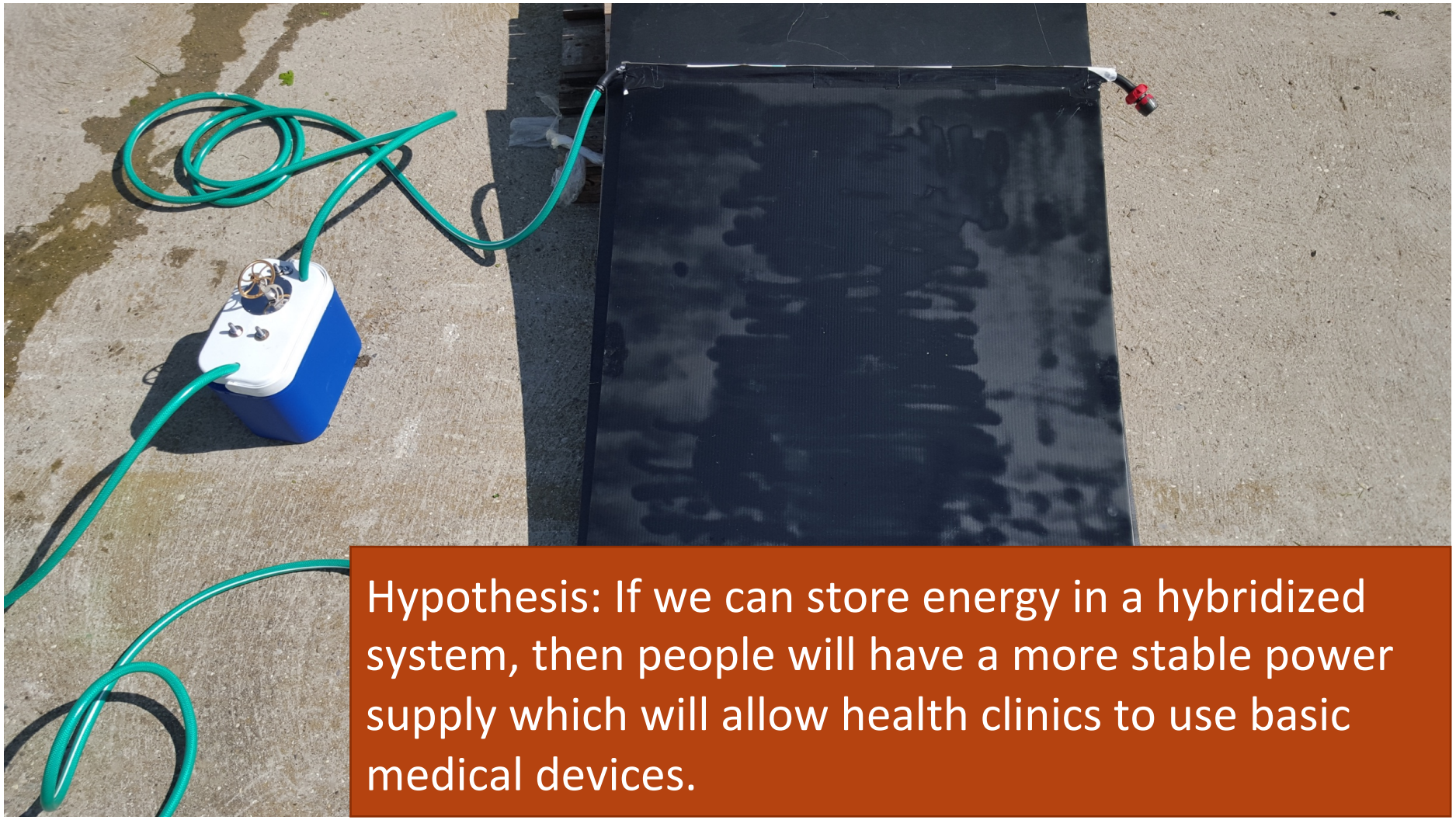


How it works



Reduces Power Requirement by 70%

Conceptual Prototype



Hypothesis: If we can store energy in a hybridized system, then people will have a more stable power supply which will allow health clinics to use basic medical devices.

Addressing Regional Problems

Durable

Lower Risk of Theft

Regionally Sourced Parts

Prototype
Opportunity
Business Plan
Solution
Problem

Value Creation

Customer (NGO) Value Creation

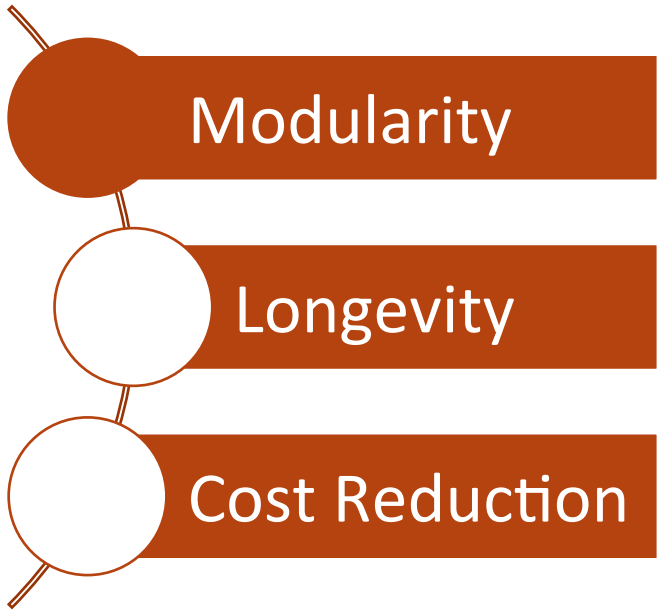
- Modularity
- Longevity
- Cost Reduction

Modularity

Varying needs from location to location

Power capacity upgrades as technology advances

Value Creation



Longevity

45% of currently implemented solar and diesel solutions are not operational after 5 years*

Our Solution

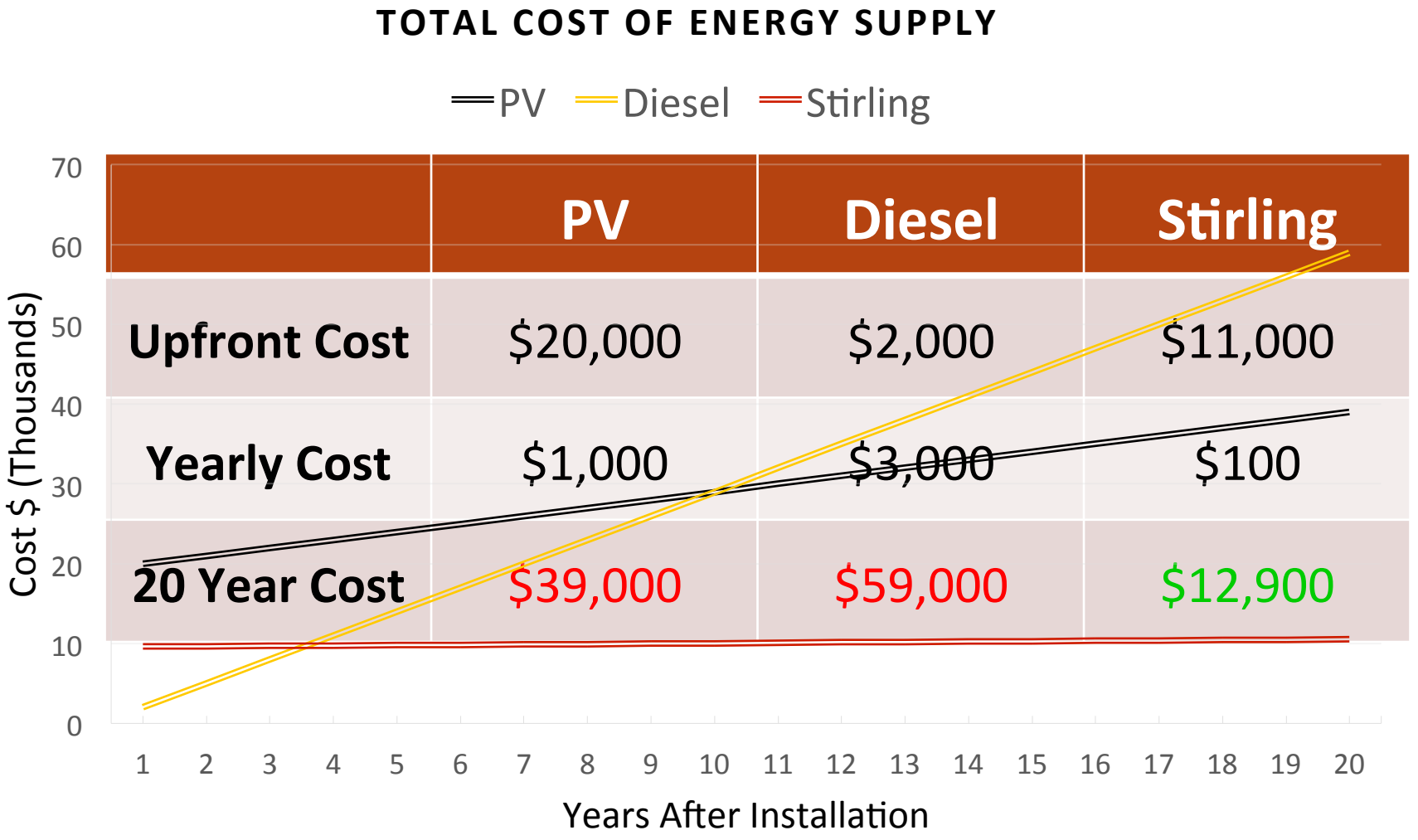
Lifetime of low-maintenance Stirling Engine is 20 years*

Corsair, HJ. "Causes of Success and Failure of Stand-alone Solar Electric Systems in Rural Areas." *Causes of Success and Failure of Stand-alone Solar Electric Systems in Rural Areas*. Johns Hopkins, 2013. Web. 14 May 2016.

Sunpower – Portable Stirling Power (1.4 kW Engine)

Value Creation

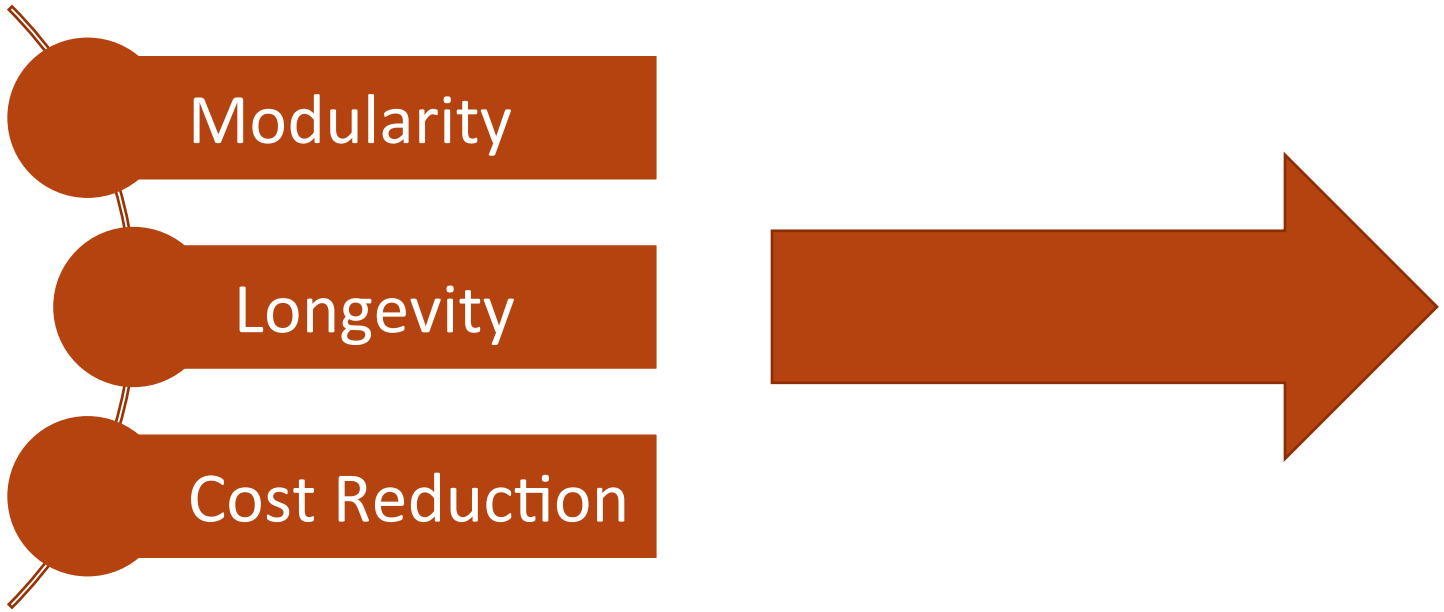
- Modularity
- Longevity
- Cost Reduction



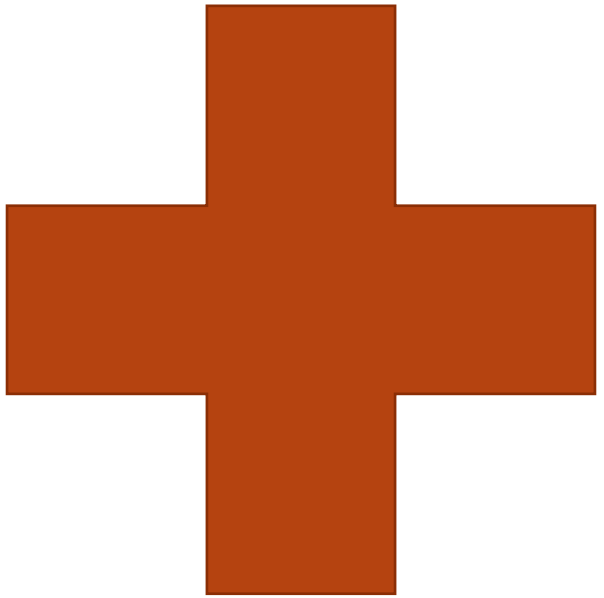
	PV	Diesel	Stirling
Upfront Cost	$20,000	$2,000	$11,000
Yearly Cost	$1,000	$3,000	$100
20 Year Cost	$39,000	$59,000	$12,900

Value Creation

Customer Value Creation

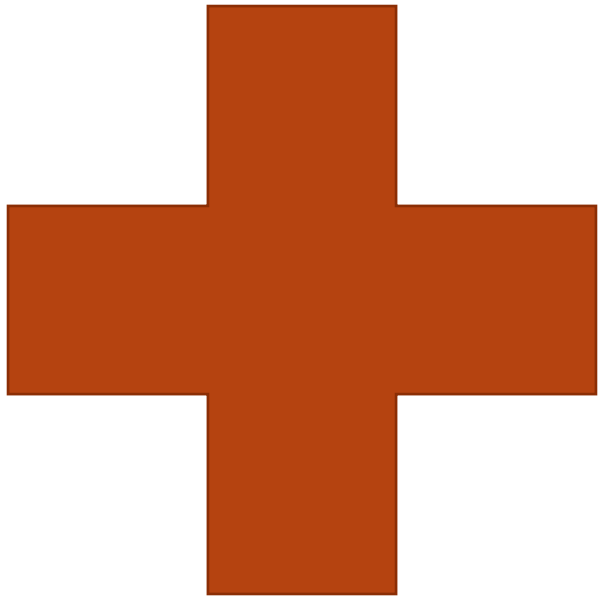


User (Clinic) Value Creation



Value Creation

Clinic Value Creation



Additional Services

- 24 Hour care
- Additional power for life-saving machines

Reliability

- Vaccine Cold-Chain
- Patient Maintenance Care

Thermal Services

- Instrument Sterilization
- Incubator for Neo-Natal Care and Samples

Value Creation

Additional Services

- 24 Hour care
- Additional power for life-saving machines

Can diagnose HIV and diarrhea
15% Of deaths in Ethiopia*

Reliability

- Vaccine Cold-Chain
- Patient Maintenance Care

77% Base Infant Inoculation Rate**
35% Vaccine Inefficiency
27% Infants not developing immunity

Thermal Services

- Instrument Sterilization
- Incubator for Neo-Natal Care and Samples

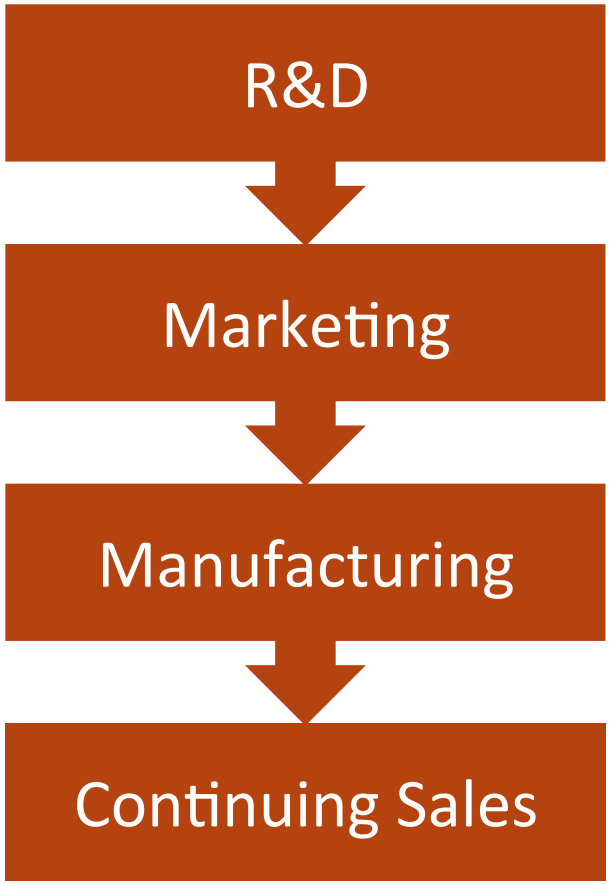
4.9% Infant mortality rate***

*CDC 2015
**VBI Vaccines and CDC
***CDC 2014

Prototype
Opportunity
Business Plan
Solution
Problem

Business Strategy

Path to Market



R&D

↓

Marketing

↓

Manufacturing

↓

Continuing Sales

Base Strategy

- [illegible] duce and [illegible]
- Tailor solut Default Strategy tomer's [illegible]
- [illegible] to major urban centers

Logistics Issues Demand er Support

- [illegible] Africa [illegible]
- [illegible] Contingent Strategy [illegible]
- [illegible] chain in Africa

Key Partners

Suppliers

GREIF

SRB ENERGY

Genoastirling s.r.l.

Partners

CERN

Knowledge Transfer

World Courier

AmerisourceBergen

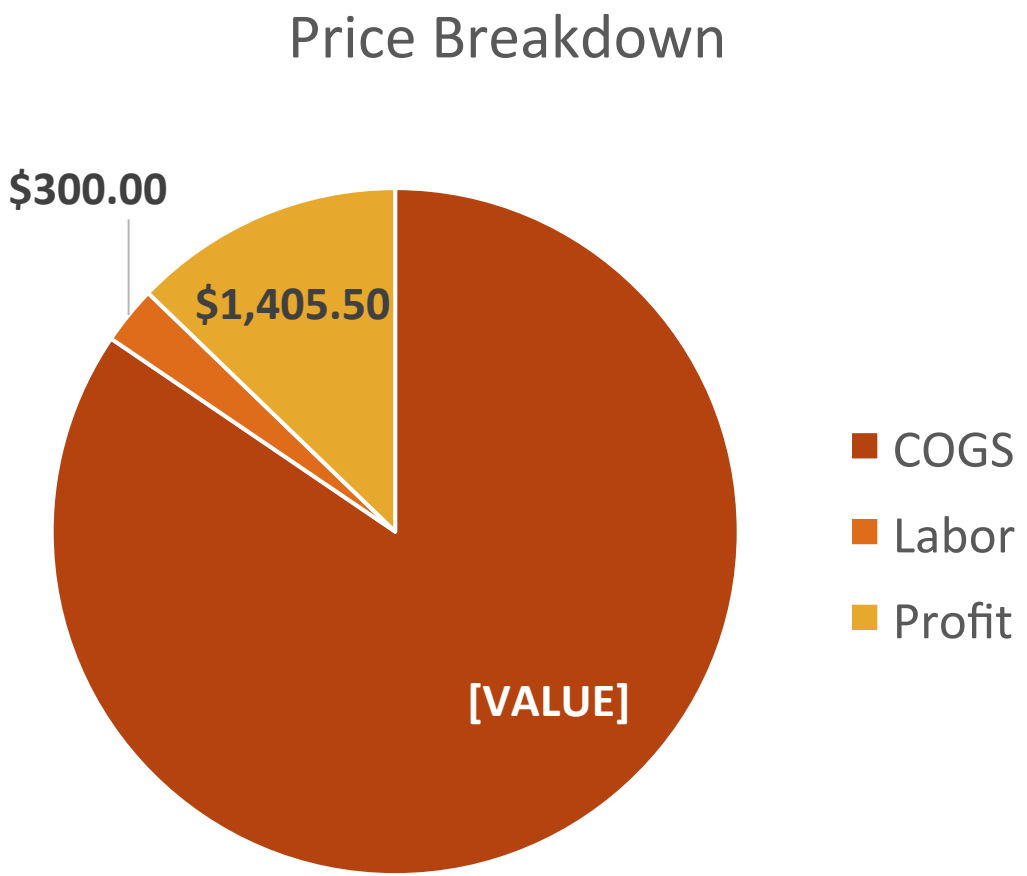
Cost Structure and Revenue Stream

Price

- Unit Price: $11,000
- Profit Margin: 12%

Revenue

- Market Size: 221,800 systems
- First Year Sales: 100 systems
- First Year Revenue: $1,10,000



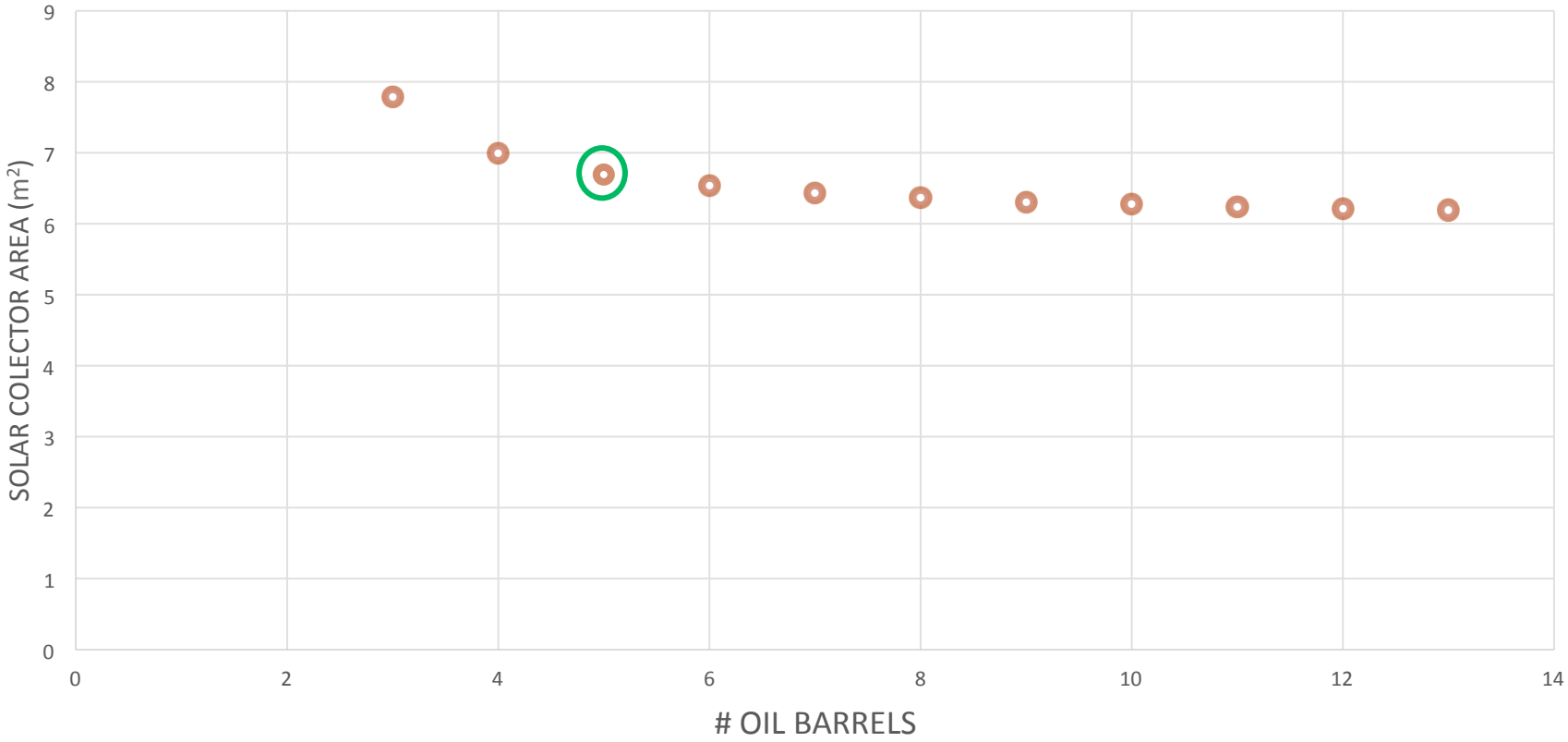
Reflections

- Biggest Challenge: Building a working prototype
- Proudest of: Novel system design
- Missing Skill: Social entrepreneurship
- Helping Hand: Recycling

Questions?

Appendix

Solar Collector Area vs # Of Oil Barrels



Narrowing Scope - Generation

	Photovoltaics	Solar Collector	Wind	Hydro-Electric
10 kWh/day 1.5 kWh peak	✓	✓	✓	✓
Efficiency	✗	✓	✗	✓
No Moving Parts	✓	✓	✗	✗

Narrowing Scope - Storage

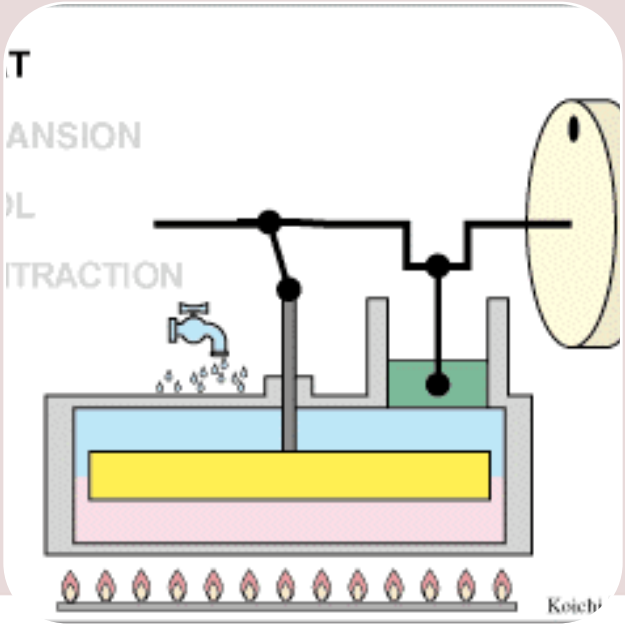
	Steam	Hot Water	Compressed Air	Mechanical Flywheel
Energy Density per Volume	✗	✓	✗	✗
Retained Power	✓	✗	✗	✓
Safety Concerns	✗	✓	✗	✗

Narrowing Scope - Regeneration

	Thermo-electric	Stirling	Steam Engine
No Moving Parts	✓	✗	✗
Conversion Efficiency	✗	✓	✓
Upfront Costs	✗	✓	✓

Conventional Technology

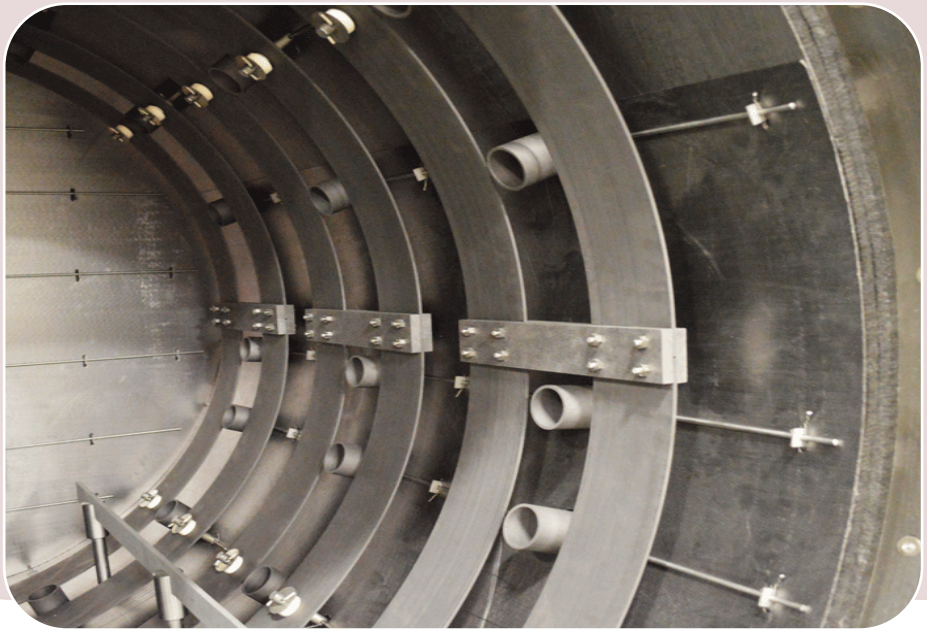
Water Thermal Energy Storage



Beta Configuration Stirling Engine

Shell and Tube Heat Exchanger

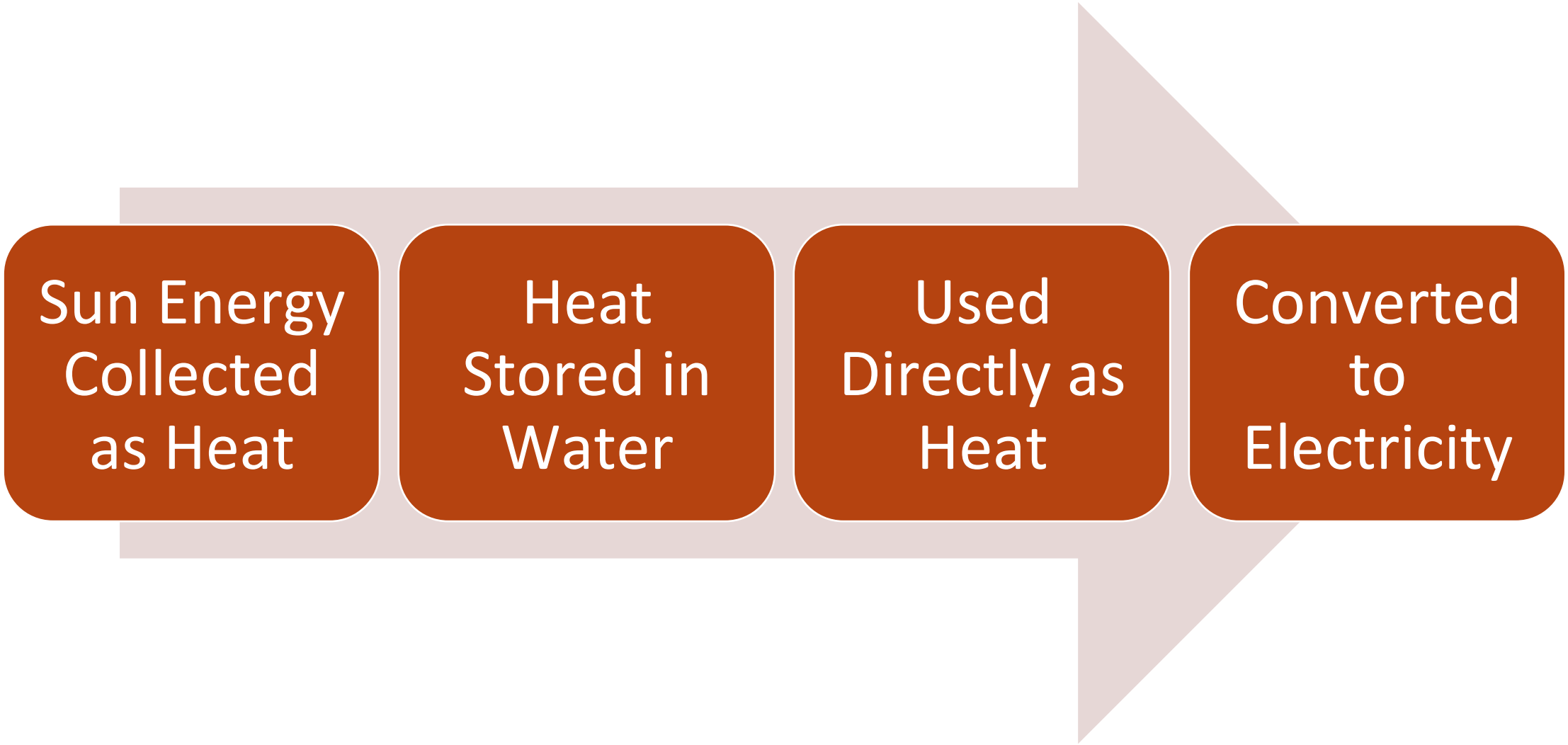
Conventional Technology



Graphite-Molybdenum Heat Conductor

UHV Solar Collector

Concepts of Solution



End Product Production

Total Cost Calculation

	Cost per unit ($)	Number of Units	Total Costs
Solar Collector (1 m^2)	1000	6.695501794	6695.501794
Stirling Engine	300	1	250
R-60 Insulation (4.05 m^2)	68	3	204
55 Gal Oil Drum	20	5	100
A/C Voltage Regulator	200	1	200
Shipping From Europe (per kg)	2	250	500
Shipping From Addis ababa (per kg)	1.5	270	405
A/C Generator	500	1	500
Piping (per meter)	3	30	90
Heat Sink for stirling engine	50	1	50
Small Water Pump	50	1	50
Container for Everything	200	1	200
Set up labor fee	300	1	300
Thermal Paste (Molybdemun Graphite)	50	1	50
Total Cost			9594.501794

Total Cost
$9594.50

Water vs. Steam

Ambient Temp (K)	303		Carnot Eff	0.1876675603
Sat Steam Temp (K)	373			
Latent heat of steam (kJ/kG)	2256.54			
Latent heat of steam (kJ/mol)				
Specific volume of Sat Steam (m3/kg)	1.6733			
Specific Volume of Sat Water (m3/kg)				
Required Elec Energy (kJ)	36000			
Required Heat Energy (kJ)	191828.5714			
Required amount of steam (kg)	85.01004699			
Required amount of steam (m3)	142.2473116			

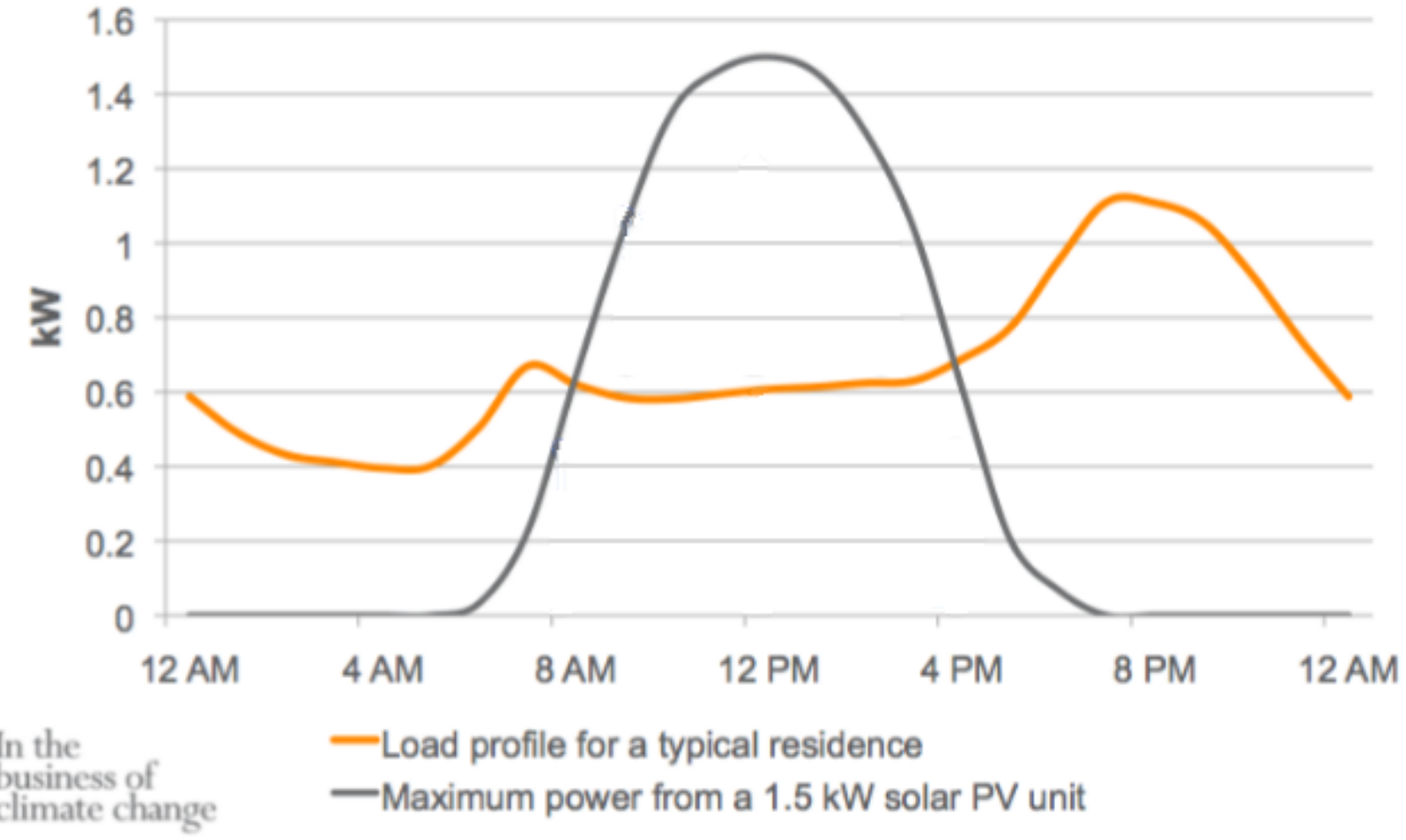
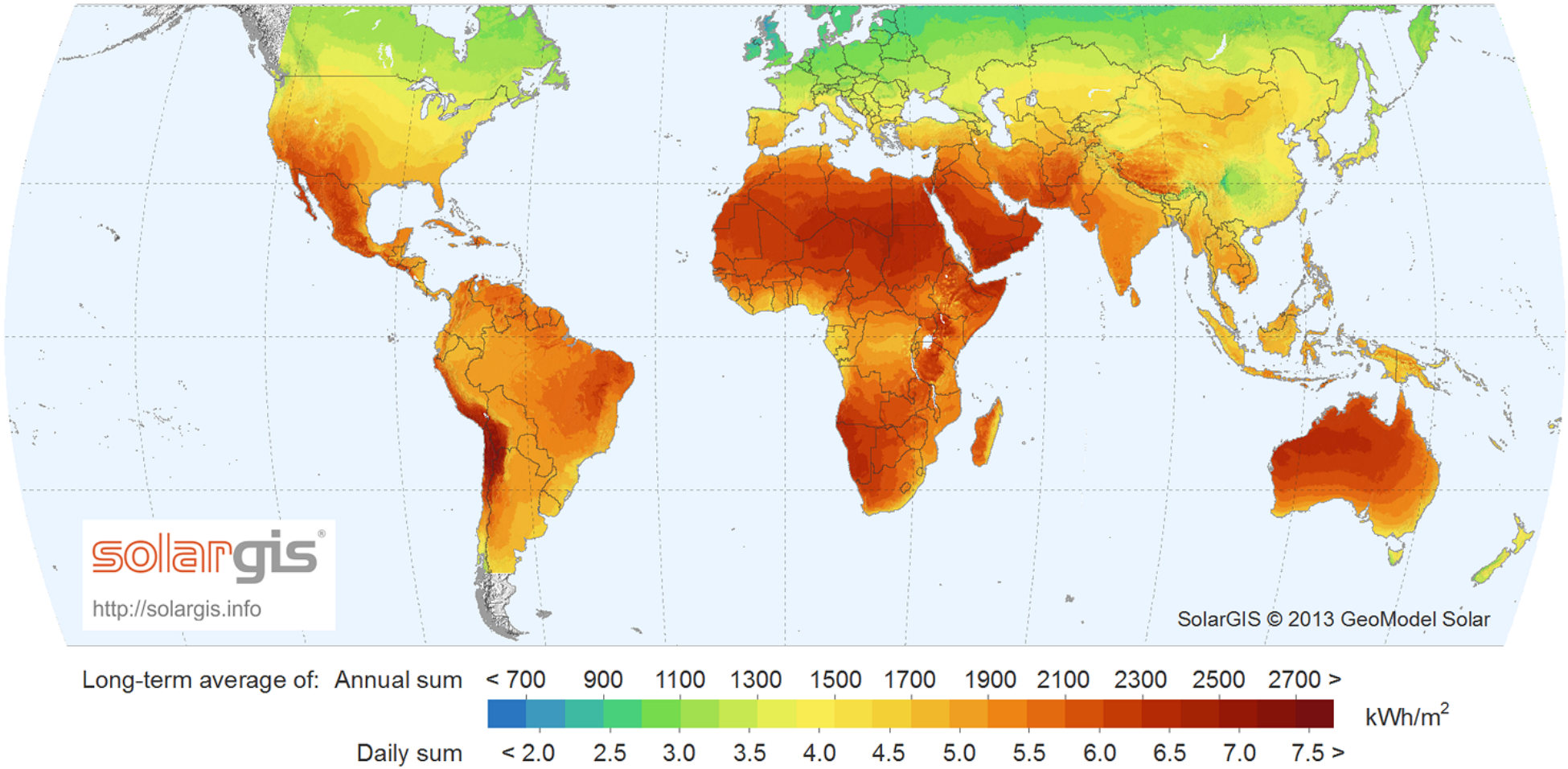
Steam
116 m^3

Water
1.66 m^3

Category I Clinics

Category I Health Clinic Power and Energy Consumption		A	B	C = AxB	D	E = CxD	F = E/1000
		Quantity	Power (Watts)	Total Watts	On-Time (watt hours/day)	Wattage (hours/day)	kWh/day
Description of Devices	Vaccine Refrigerator/Freezer	1	60	60	6.0 - 12.0	360 - 720	0.36 - 0.72
	Small Refrigerator (non-medical use)	1	300	300	5.0	1,500	1.5
	Centrifuge	1	575	575	1.0 - 1.5	575 - 862.5	0.575 - 0.8625
	Hematology Mixer	1	28	28	1.0 - 1.5	28 - 42	0.028 - 0.042
	Microscope	1 - 2	15	15 - 30	3.0 - 4.0	45 - 120	0.045 - 0.12
	Lighting	2	10	20	2 - 10	40 - 200	0.040 - 0.2
	Incubator	1	400	400	2.0 - 12.0	800 - 4,800	0.8 - 4.8
	Water Bath	1	1,000	1,000	1.0 - 2.0	1,000 - 2,000	1 - 2
	Communication via VHF Radio	1					
	Stand-by		2	2	12.0	24	0.024
	Transmitting		30	30	1.0 - 2.0	30 - 60	0.030 - 0.060
	Total			**2,430 - 2445**		**4,402 - 10,328.5**	**4.4 - 10.3**

Load vs. Time of Day



Solar Radiation