

2040 Challenge

Team Healios



Healios

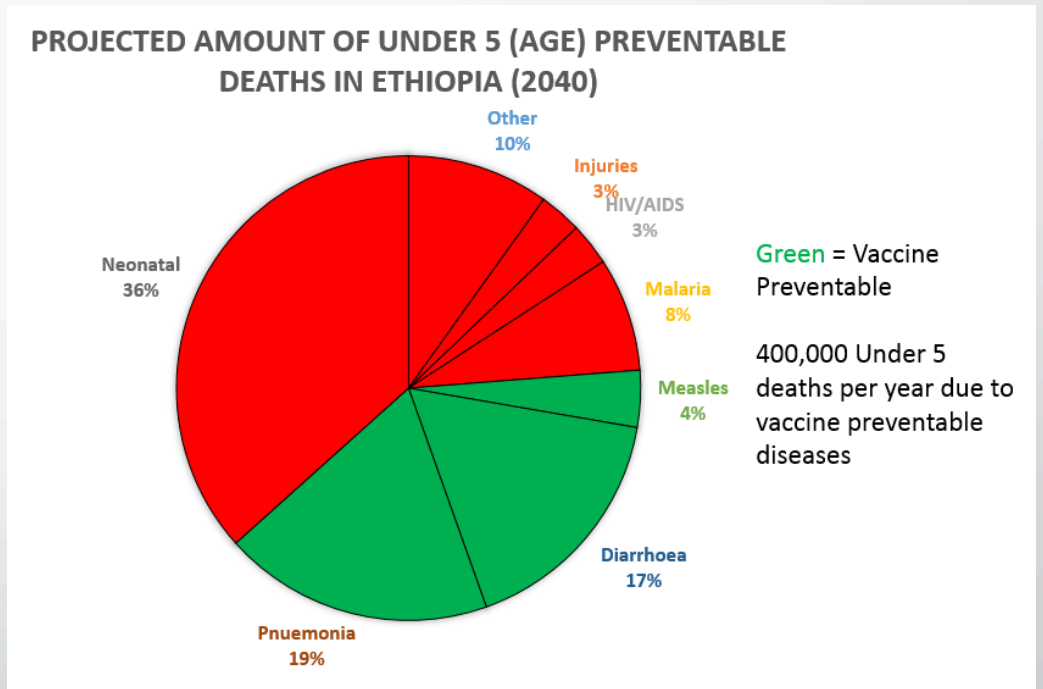


An Unfortunate Reality



There are many others just like Bekele

- 1,100 children under 5 die each day in 2040 Ethiopia alone from VPD¹
- In 2015, 80% of children received the full vaccine profile
 - Studies show that up to 35% of administered vaccines drop below required efficacy rates
- Current U5 Vaccination Rate: 74%
 - Adjusted U5 Vaccination Rate: 56%
 - Herd Immunity Threshold: 90%



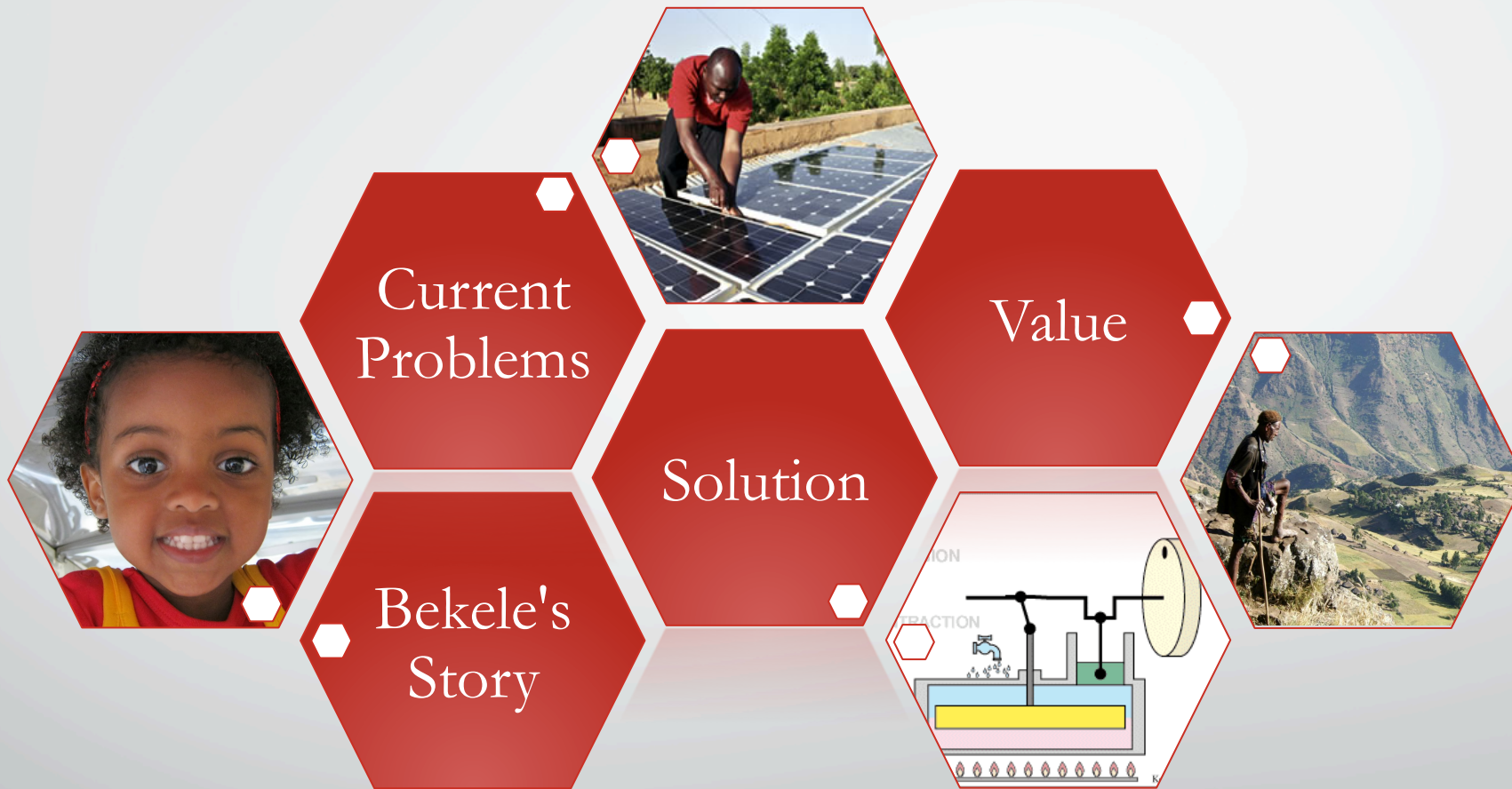
Source: National Strategic Health Development Plan (NSHDP) 2010 - 2015

¹<http://www.prb.org/Publications/Articles/2015/vaccine-preventable-disease-progress.aspx>

What would save Bekele besides a vaccine?

- Devices missing from many Sub-Saharan clinics
 - X-Ray Machines
 - Sterilized Medical Instruments
 - Refrigerated Medicines
 - Microscopes
 - Night-time Operating Room
 - Computer access





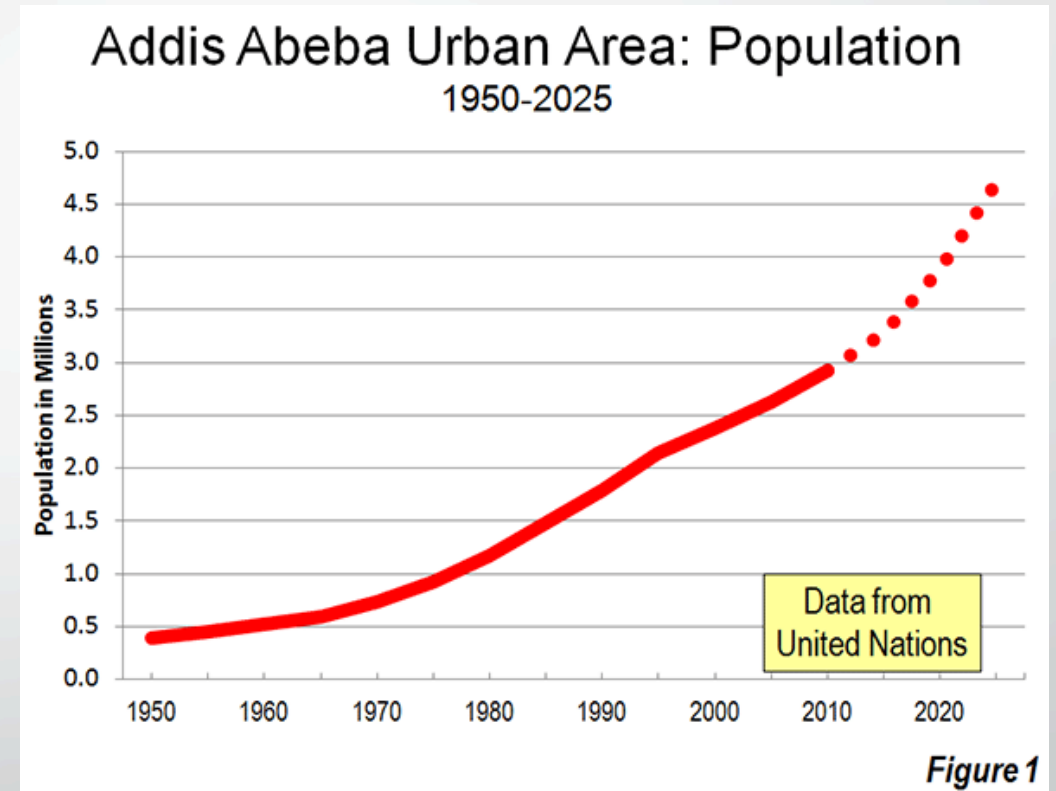
Target Location

- Region: Sub-Saharan Africa
- Target Nation: Ethiopia
- Representation of 2040 Ethiopia
 - 2016 Nigeria by GDP per capita
- Durability Considerations
 - Sand
 - Wildlife
 - Theft
 - Shock



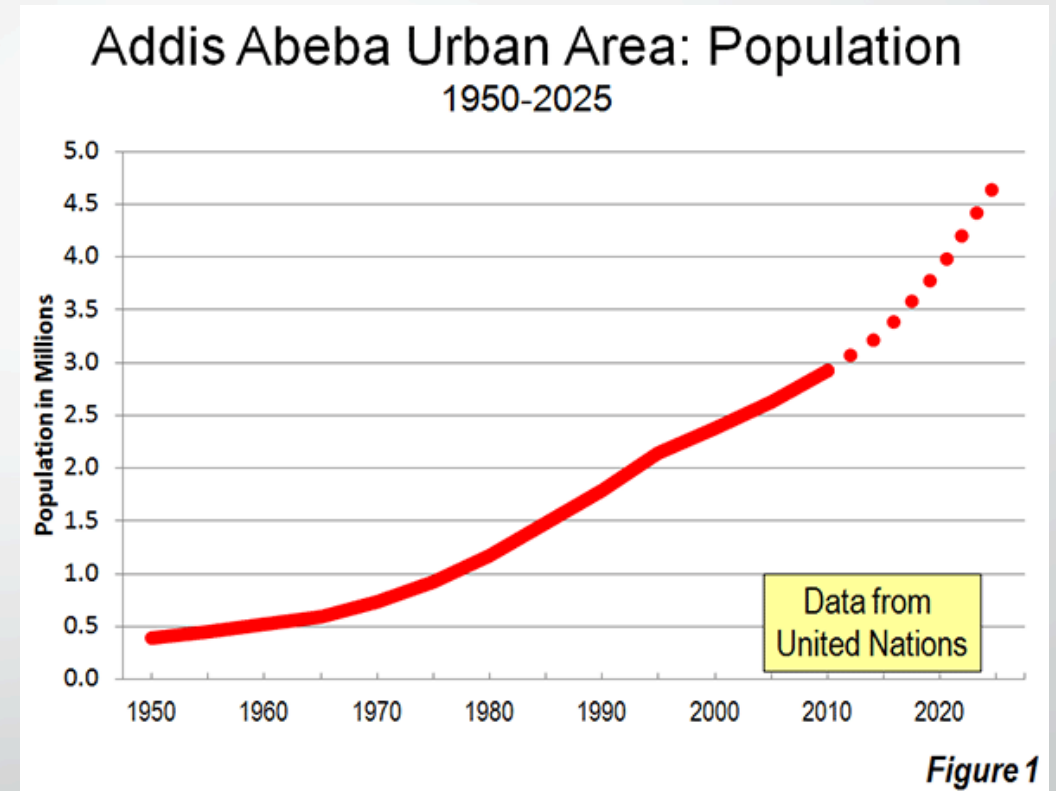
Trends and Expected 2040 Situation

- Scenario in 2040
 - New and more advanced energy technology will be available
 - Clinic power needs increased
- Expected changes
 - Rural population reduced from 60% to 45%
 - Power requirements for clinics increases 50%
 - More category 2 and 3 clinics in suburban areas



Ethiopia 2040 Scenario

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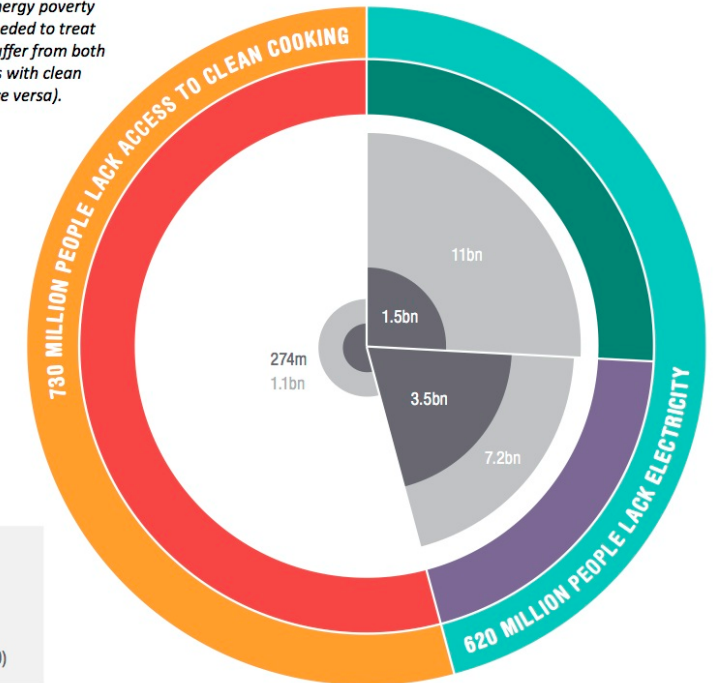
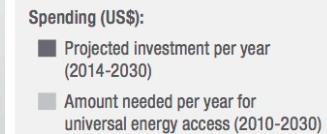
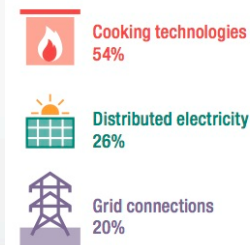


Ethiopia 2040 Scenario

- Infrastructure will still be lagging due to underfunding
 - Projected funding of \$1.5B from 2016 to 2030
 - \$9.5B short of projected required funding to provide universal energy access
- Climate change
 - Increase in diseases such as malaria due to an increasing mosquito population

Figure B: Incidences of energy poverty in sub-Saharan Africa and the technologies and investment needed to secure universal access

This figure breaks down incidences of energy poverty and the technologies and investment needed to treat each incidence. Many households will suffer from both forms of energy poverty, but households with clean cooking will still need electricity (and vice versa).





Who to Help?

- Poorer sub-urban neighborhoods and rural areas
- Targeting rural category 1 clinics that still exist
- Shift focus to category 2 and 3 clinics in denser populated areas



How to Help

Target Customer

- Non-Profits and NGOs.

Jobs to Be Done

- To allow use of basic, necessary devices that run on electricity
 - ⚡ For medical use
 - ⚡ For residential use
- Eliminate energy uncertainty



Problems with Current PV Systems

- PV-battery systems have an efficiency of 20%
- Easy to steal
- PV-battery system is easily damaged
- PV cells need replacing every 20 years, battery every 5 years.



Problems with Diesel Generation

- Need to replace every 10 years
- Expensive to fuel and maintain
- Fume Health Hazard
- Diesel creates more emissions than other fuels



Additional Factors

- Kerosene Lamps¹
 - Used for small scale indoor/outdoor lighting
 - Inhalation of Fumes is equivalent to two packs of cigarettes per day
 - Extremely detrimental for clinic patients



¹<http://www.bbc.com/news/business-18262217>

Prototype Background

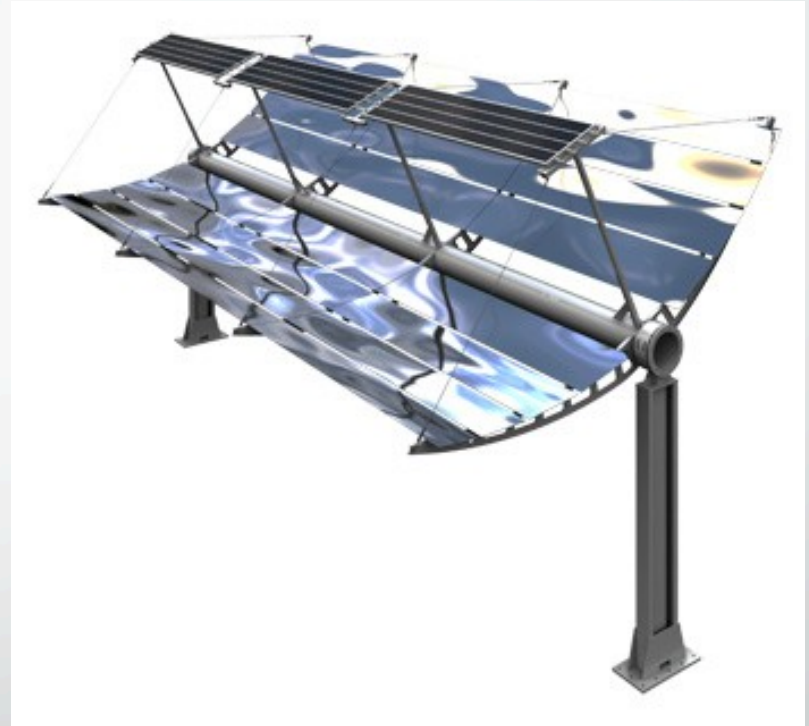
Solar Collector Molten Salt System

- Type of Prototype: Functional
- Hypothesis: If we can store energy in a hybridized system, then people will have a more stable power supply which will enable these communities to advance socially
- Output: Projected 43 kWh per day

CERN Intellectual Property

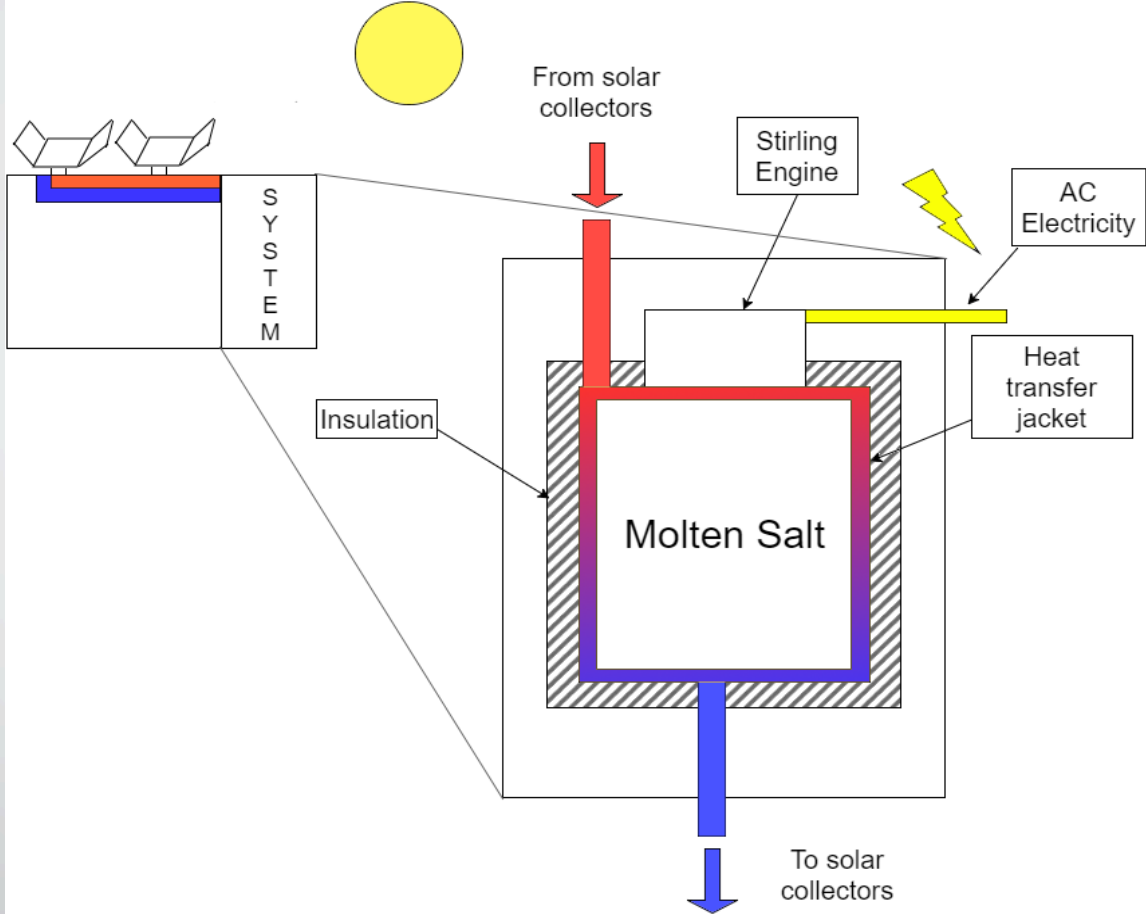


Graphite-Molybdenum Heat Conductor



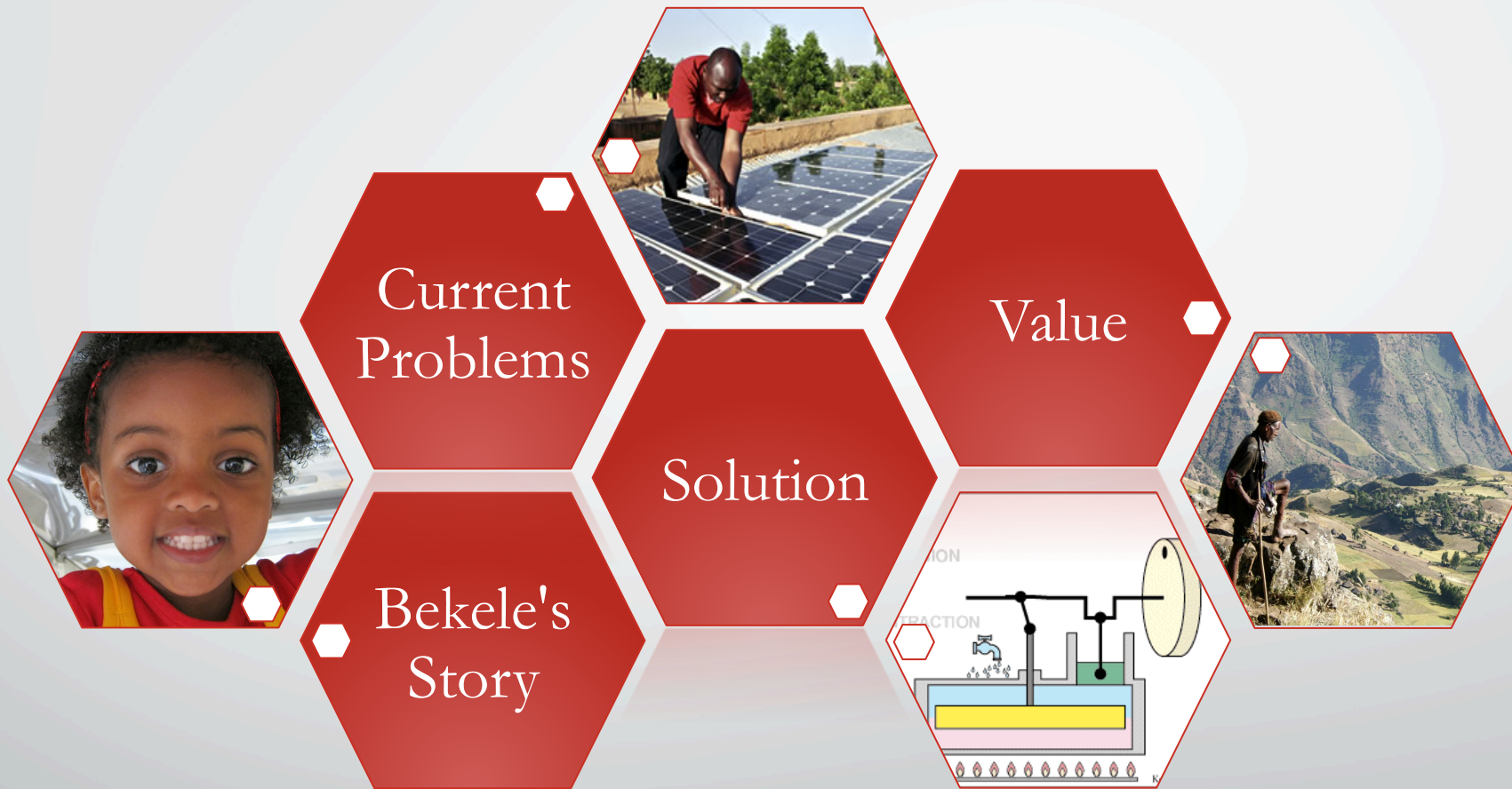
Solar Collector

Our Solution



Technical Advantages

- Solar Collector
 - Higher efficiency than similar size PV-Battery systems
- Molybdenum Graphite
 - Increased thermal conductivity reduces
- Stirling Engines
 - More efficient and safer than steam and internal combustion engines
- Molten Salts
 - High melting points store energy more efficiently



How We Create Value for NGOs

- Provide a durable, reliable, and cost effective energy solution
- Basic cost comparison estimates

	Healios system	Photovoltaics	Diesel
Upfront cost	\$6,100	\$12,000	\$2,000
Upfront cost savings	\$0	\$5,900	-\$4,100

- Considerable upfront cost savings compared to PV
- Diesel appears to be cheaper

How We Create Value for Clinics

- Provide low maintenance and consistent power source with low operating costs

	Healios system	Photovoltaics	Diesel
Operating costs per year	\$200	\$650	\$2,000
Operating savings (10 years)	\$0	\$4,500	\$18,000

- Funds can be used for health resources instead of powering the clinics
- Operating savings equivalent to 9000 meningitis vaccines
- Better and more doctors to help serve patients



Additional Benefits

- Human lives saved
- Preventative medicine costs vs treatment costs
 - Meningitis treatment: \$90
 - Meningitis vaccine: \$0.50
- Meningitis has a 20-40% mortality rate¹



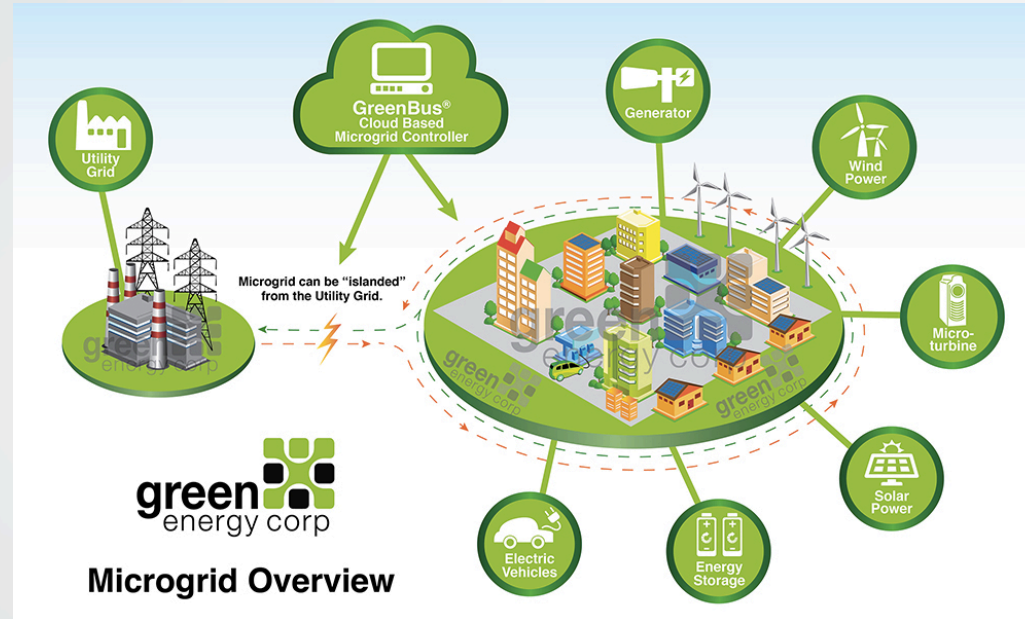
¹Meningitis Vaccine Project

Partnerships and Manufacturing

- SRB
- Sourcing from target region
- Unknowns
 - Resource availability
 - Manufacturing capabilities



Other Markets: Microgrids



- Expanding urban areas and villages will bring more people closer to clinics
- Use our clinics as exemplars for our solution
- Sell expansions from our power system to surrounding shops and homes

Risk Assessment: Strategy

Energy Generation Technology

- Threat: New localized energy technology allows cheap, clean, and portable energy generation on a per household scale
- Response: Scale solution to larger business/organization power generation and storage methods. Focus on reliability advantages.

Grid Extension

- Threat: There are major grid improvements including renewable energy sources that expand to rural health clinics
- Response: Integrate with grid to provide uninterrupted power in case of brown outs or black outs. Look into mobile power applications for industrial tools.

Other Risks

- Transportation into rural areas
- Durability and maintenance issues
- Availability of funds for NGO's won't scale with Africa's health and energy needs



Reflections

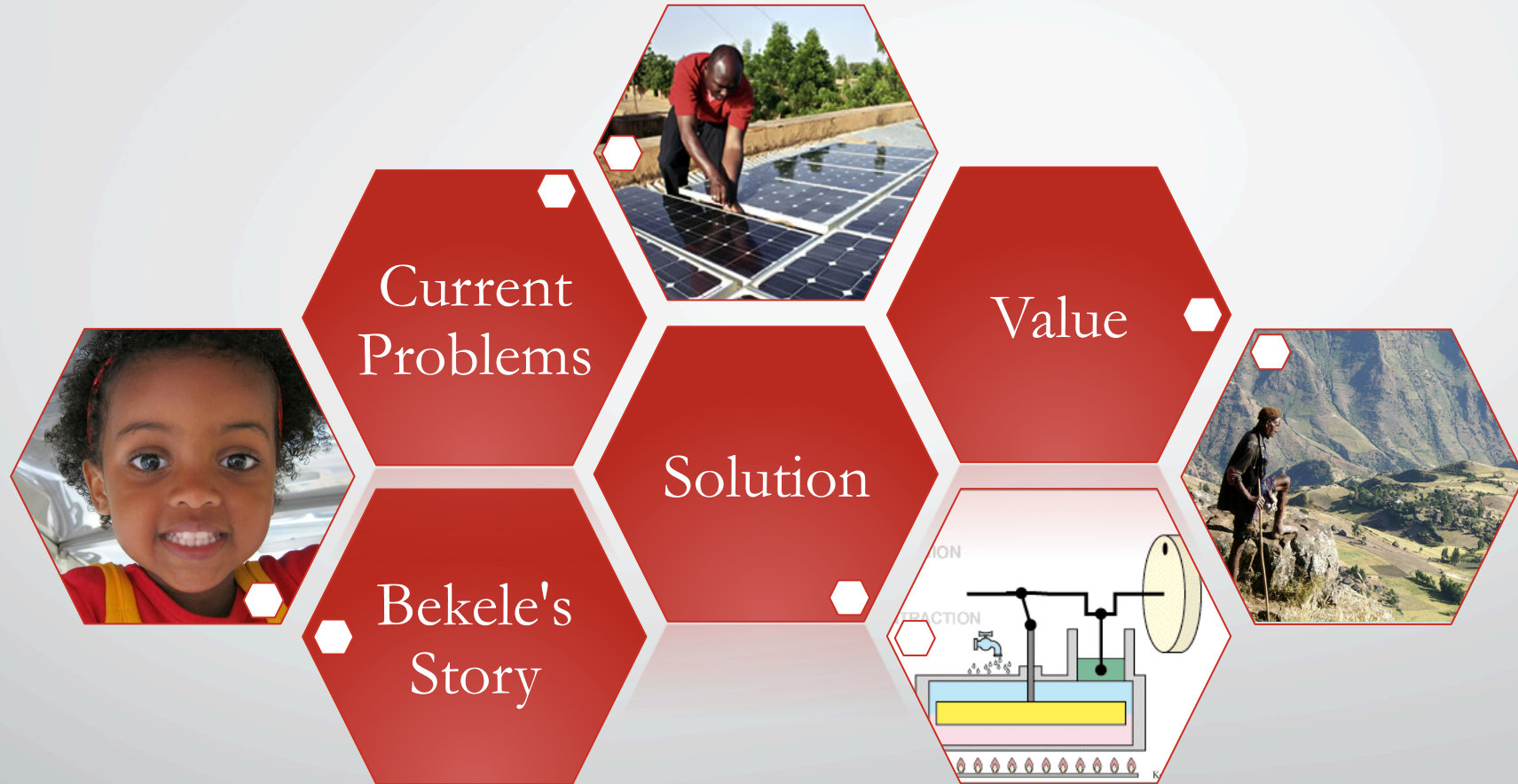
- Most Challenging: Anticipating energy technology 25 years out
- Proudest of our final product concept
- Additional skills: Decisive decision making
- Helping Hand: Water



Carnot in Intense Reflection



Questions?



Rural Power Electrification of Sub-Saharan Africa

Utilizing advanced technologies from CERN to address rural Africa's health and power crises

- Steven Back
- Devin Chen
- Kevin Ikeda
- Tom Krajnak
- Collin Stipe

