



Energy, Engineering and Social Justice

18 June 2013
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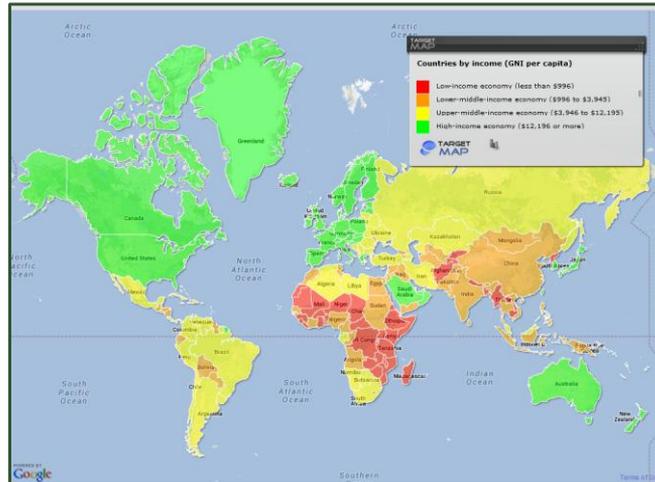


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Financial Poverty

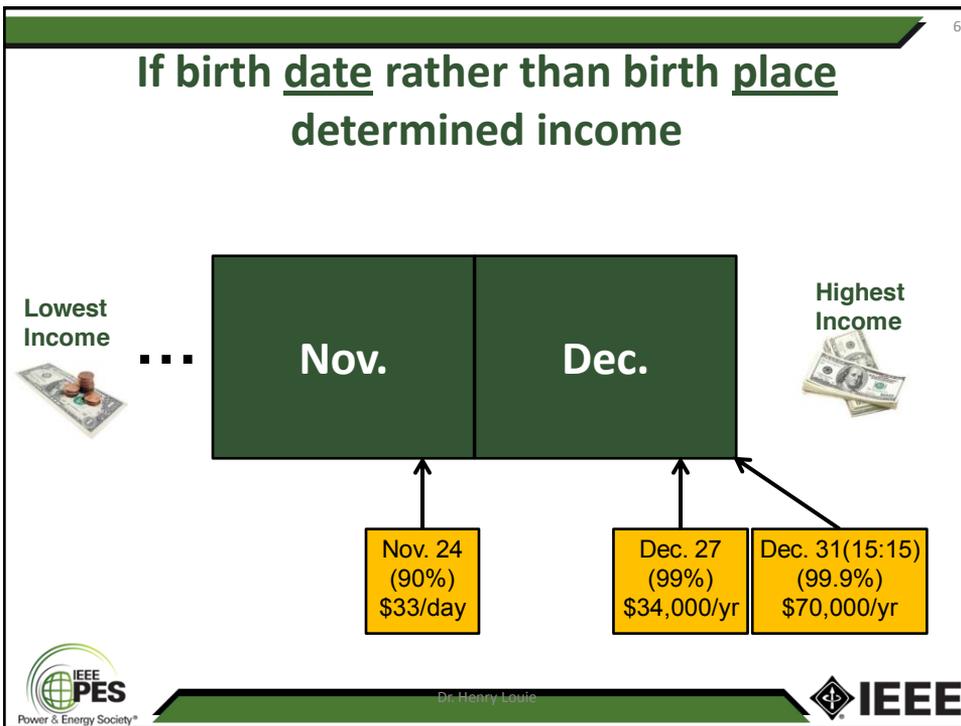
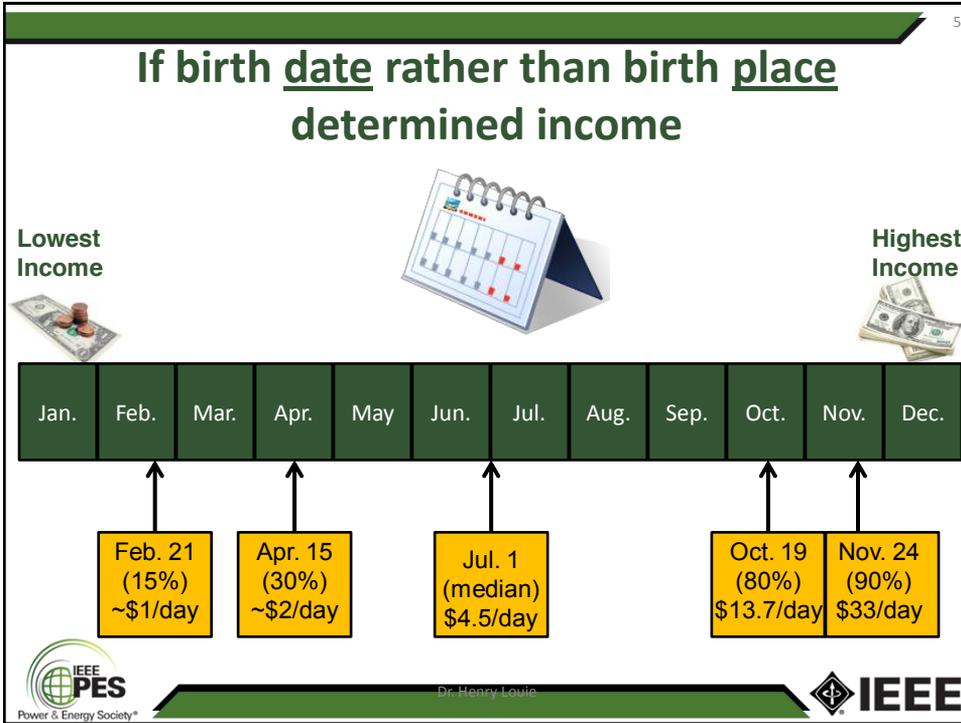
- UN Millennium Development Goal: halving poverty rate (~\$1.25/day) from 1990 levels (43%)
- 2010: poverty rate at 21% (1.2 billion people)
- Economic growth and income distribution are main factors in decreasing poverty
- Near-zero poverty by 2030?

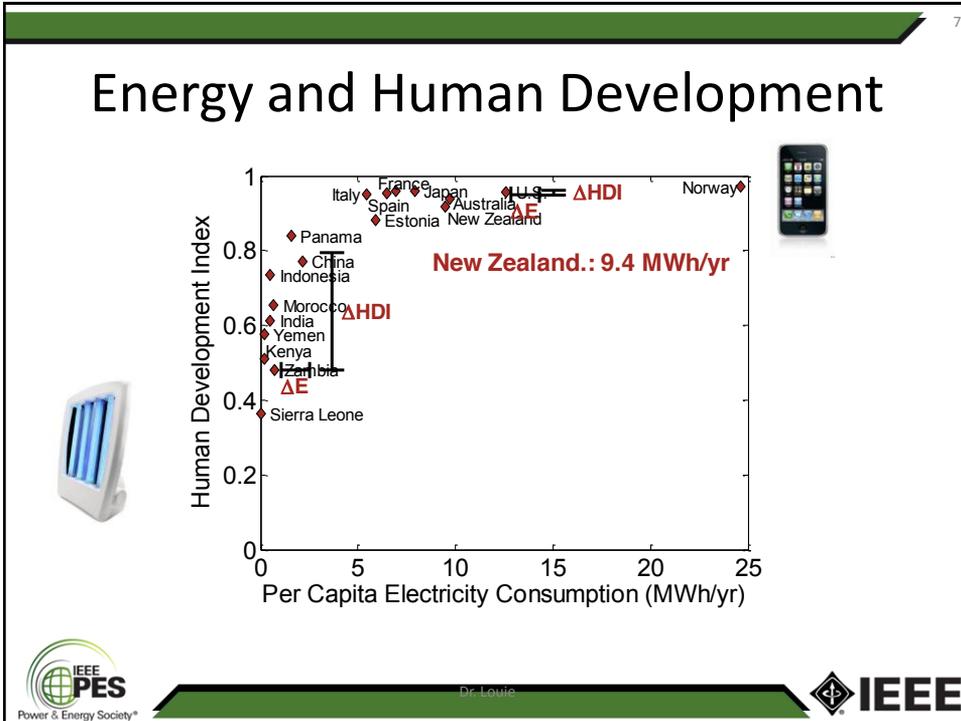
Financial Poverty



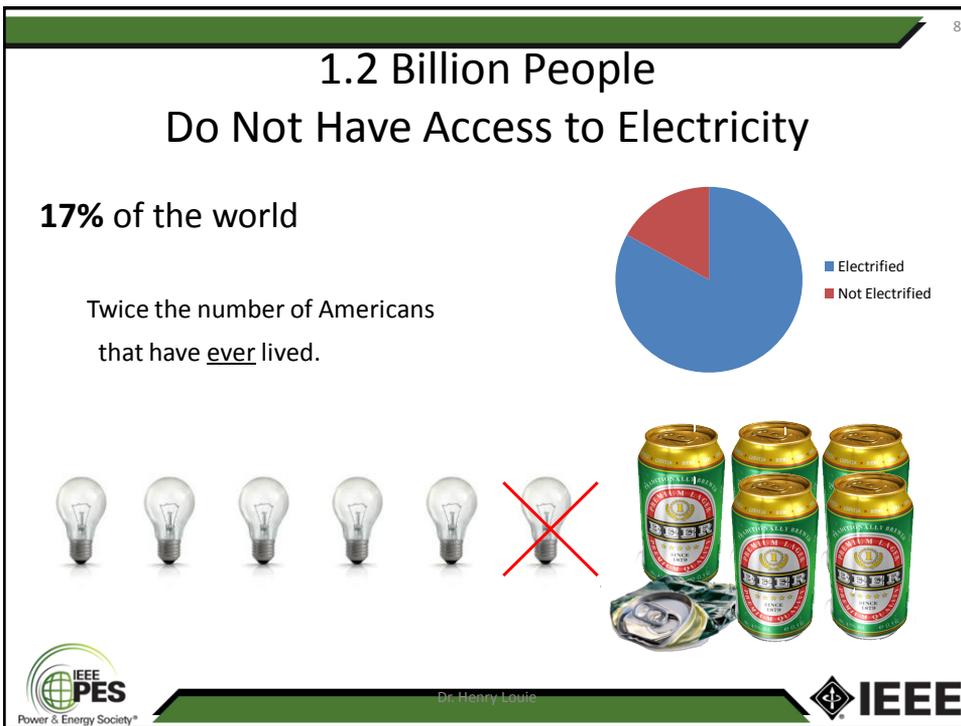
"One's income ... crucially depends on citizenship, which in turn ... means place of birth... it turns out that place of birth explains more than 60 percent of variability in global incomes."

--Branco Milanovic





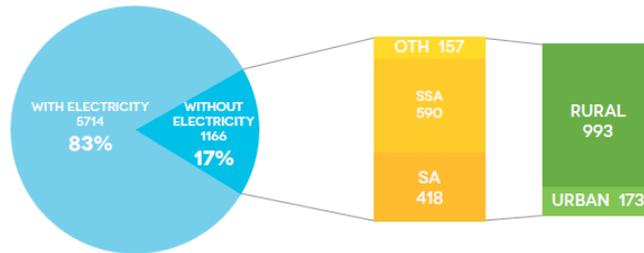
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Who Has Electricity, Who Doesn't?



Notes: in billions of people. SSA: Sub-Sahara Africa. SA: South Asia



Source: Sustainable Energy For All, Global Tracking Framework, Vol. 3

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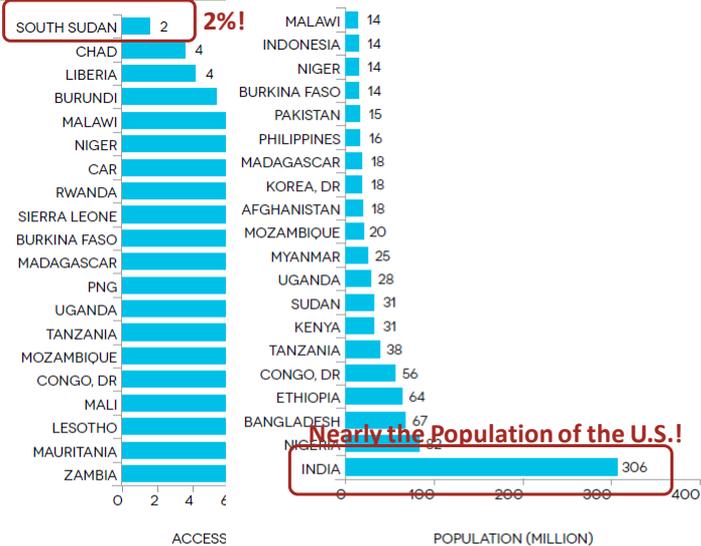


FIGURE 2.14A TOP 20 COUNTRIES WITH LOWEST ACCESS

FIGURE 2.14B TOP 20 COUNTRIES WITH LARGEST ACCESS DEFICITS

SOURCE: WORLD BANK'S GLC

SOURCE: WORLD BANK'S GLOBAL ELECTRIFICATION DATABASE 2012



Source: Sustainable Energy For All, Global Tracking Framework, Vol. 3



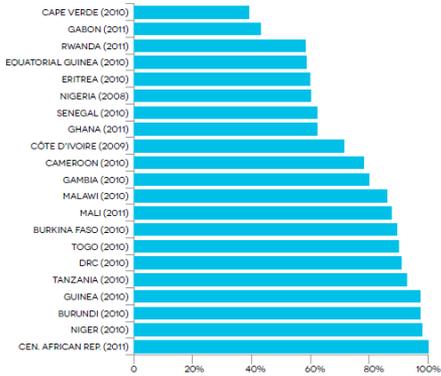


FIGURE 2.2A PUBLIC PRIMARY SCHOOLS WITHOUT ELECTRICITY

SOURCE: UNESCO INSTITUTE OF STATISTICS (UIS) DATABASE

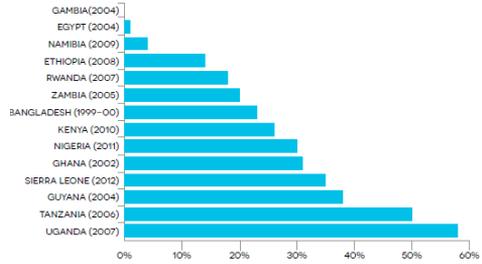


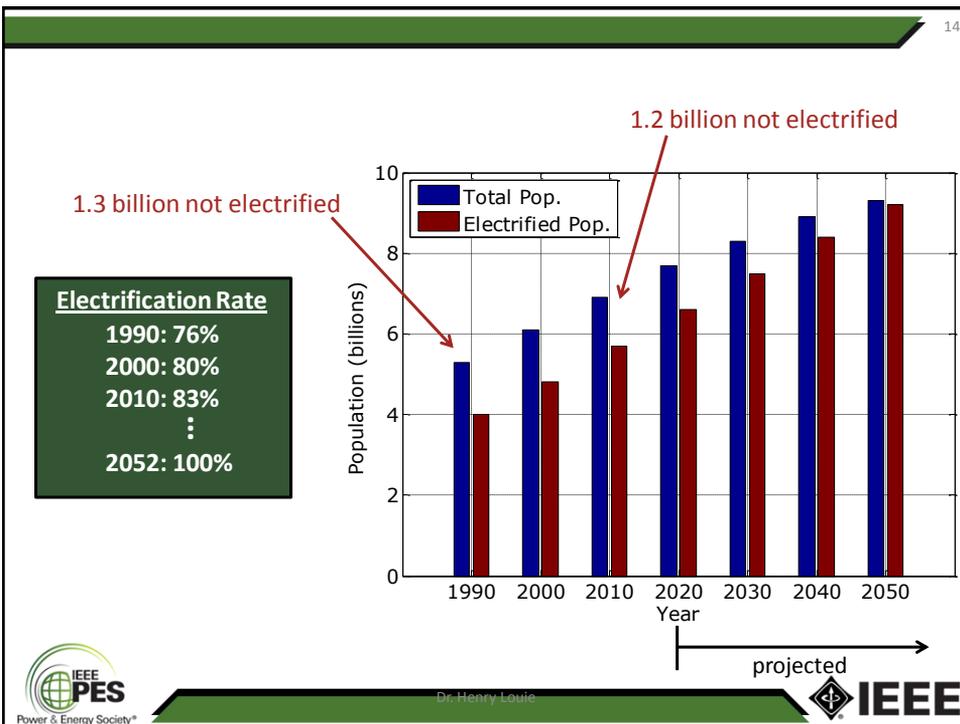
FIGURE 2.2B HEALTH CLINICS WITHOUT ELECTRICITY

SOURCE: WHO ENERGY IN HEALTH CARE FACILITIES DATABASE

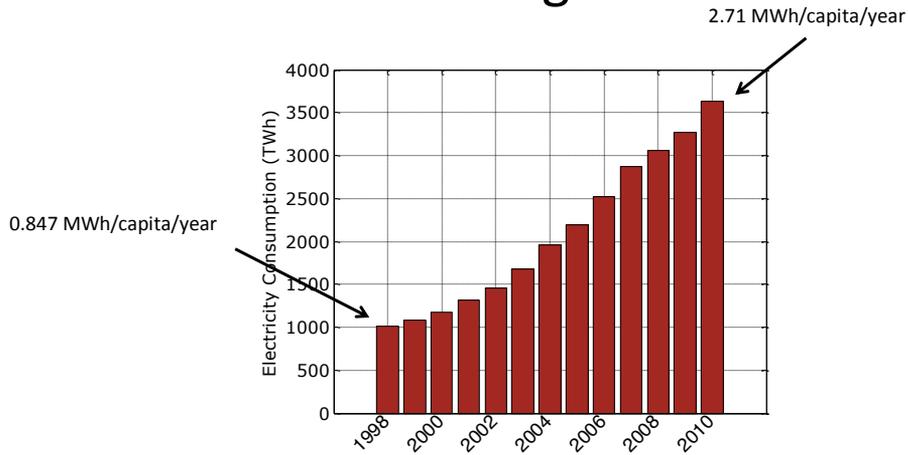


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China's Progress

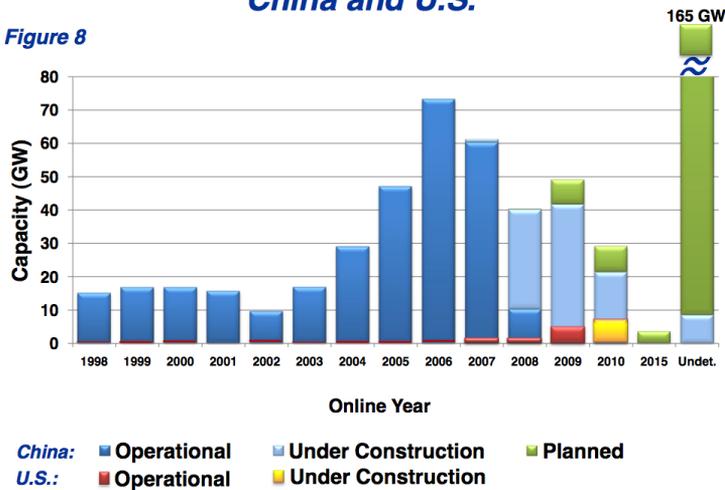


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Coal-Fired Build Rate China and U.S.

Figure 8



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If the 7 billion people in the world all used
9.4 MWh/yr...



We would need to build a 1000 MW power plant every day for the next 14.5 years ¹⁸

OR

China's maximum build rate for 74 years



If the population grows at its current 1% growth rate

2030: 8.4 billion people

Need to build 89
1000 MW coal plants that year

2050: 10.2 billion people

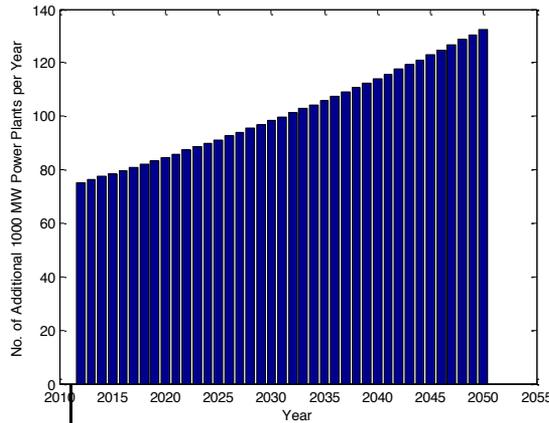
Need to build 109
1000 MW coal plants that year



What if per capita demand also increases?



Assuming 0.5% per capita demand increase per year and 1% population growth



Assuming we start with enough capacity



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Nearly all designers make products for the richest 10 percent of the world.

-paraphrased from Paul Polack

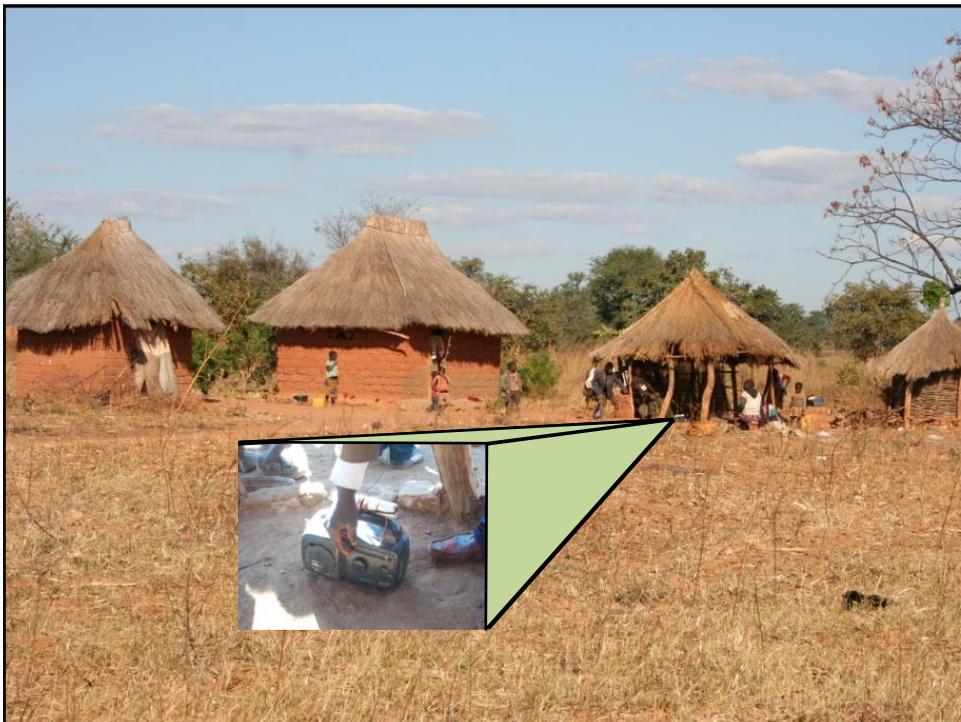


How Much Electricity is Needed?

- Various estimates
 - 96 kWh/person/year (rural India)
 - 288 kWh/person/year (urban India)
 - 120 kWh/person/year
- Sustainable Energy For All targets:
 - 50 kWh/person/year (rural)
 - 100 kWh/person/year (urban)
- U.S. Average: 4,517 kWh/person/year
 - Avg. American uses 100 kWh in less than nine days



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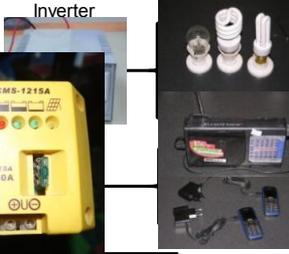
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Improved Rural Micro (pico?) Grid Systems

Solar Panel



Inverter



Generator



Battery



Spare Batteries



A central yellow **SIEMENS CMS-1215A SOLAR CONTROLLER** is shown with various ports and a meter. Wires connect the solar panel, generator, and battery to the controller, which then connects to the inverter.

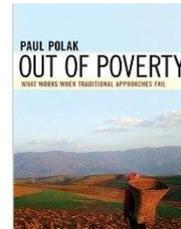






Polak's Rules

- Use a market-based approach
- Aim for people who earn less than \$1 per day
- Affordability isn't everything. It's the only thing.
- Must be **expandable**
- Must be **scalable**
- Must support **income generation**



Solar Trailer



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The Market

**Market Surveys Indicate Potential For
Viable Market**

(all prices are in gourdes; 40 gourdes/USD)

	Min	Max	Median
Willing to Pay Per Month for Electricity	15	1000	150
% of Income Spent on Electricity	10%	52%	15%
Cost to Use Charging Station	10	275	50
Cost to Charge Cellphone	5	75	15
Price of Generator Fuel (gourdes/gallon)	100	350	200
Monthly Cost of Candles	20	550	100
Monthly Cost for Kerosene	20	2000	170

Approximately \$10.50 US spent each month on electricity and lighting.



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The Technology

- 1.5 kW solar trailer
 - Six 245 W PV panels
 - Daily energy production:
7.2 kWh/day
- Used to charge battery packs





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The Technology

- Integrated battery pack
 - 9 AH @ 12 VDC
 - One light for 31 hours
 - Three lights for 9 hours
 - Charge cell phones
 - Charge laptop
 - Run radio 2 days
- Rent battery kits
- Cost: 80HTD (2USD)/month
 - Recharge battery up to once per day (charges in 3 hrs)





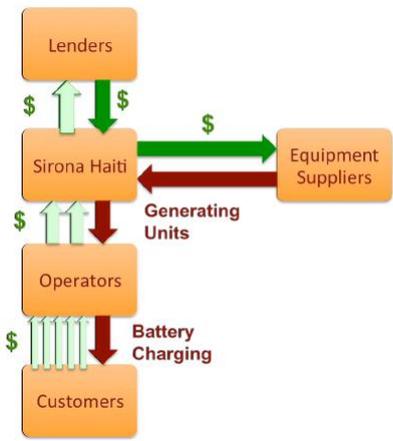




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The Business Model



```

graph TD
    Lenders[Lenders] -- "$" --> Sirona[Sirona Haiti]
    Sirona -- "$" --> Lenders
    Sirona -- "$" --> Equipment[Equipment Suppliers]
    Equipment -- "$" --> Sirona
    Sirona -- "Generating Units" --> Operators[Operators]
    Operators -- "Battery Charging" --> Customers[Customers]
    Customers -- "$" --> Operators
    Operators -- "$" --> Sirona
  
```






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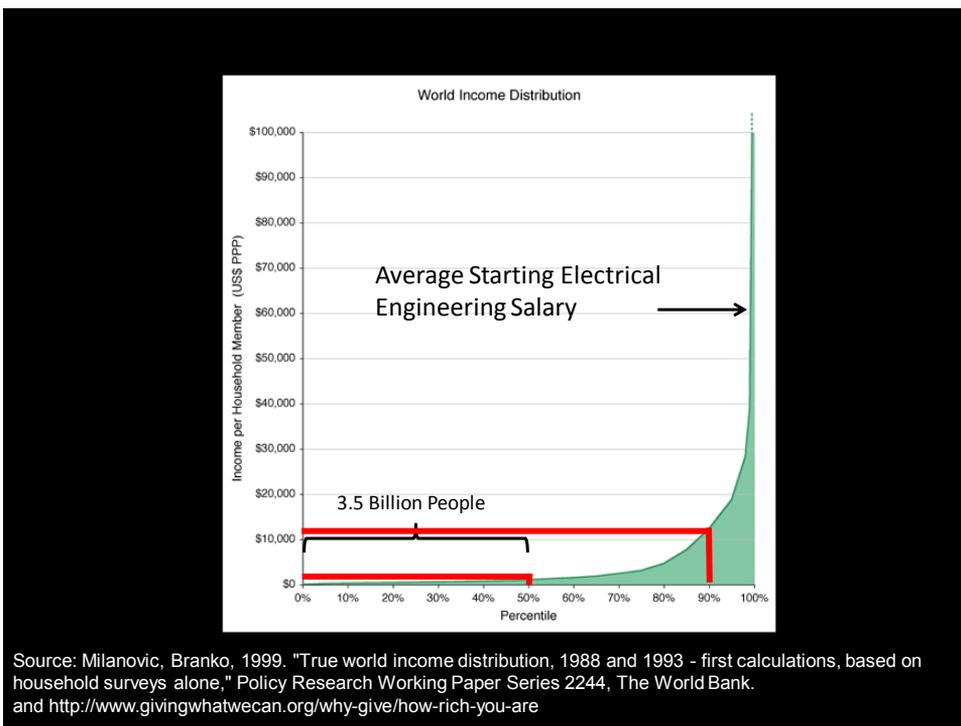
Results

- All six units operate as anticipated
- Over 1,400 people reached
 - +2,000 homes on waiting lists
- Reported biggest benefit: not having to use kerosene
- Many families use one light indoors, and one outside for the community
- Families wanted to buy the home units



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Questions?



For More Information

- www.communitysolutionsinitiative.org
- www.ieee-pes.org
- www.drhenrylouie.com



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