

REACT Kick-Off Symposium



Can We Improve the Human Habitat with Global Engineering?

December 7, 2015

Singh Center for Nanotechnology
3231 Walnut St, Philadelphia PA 19104

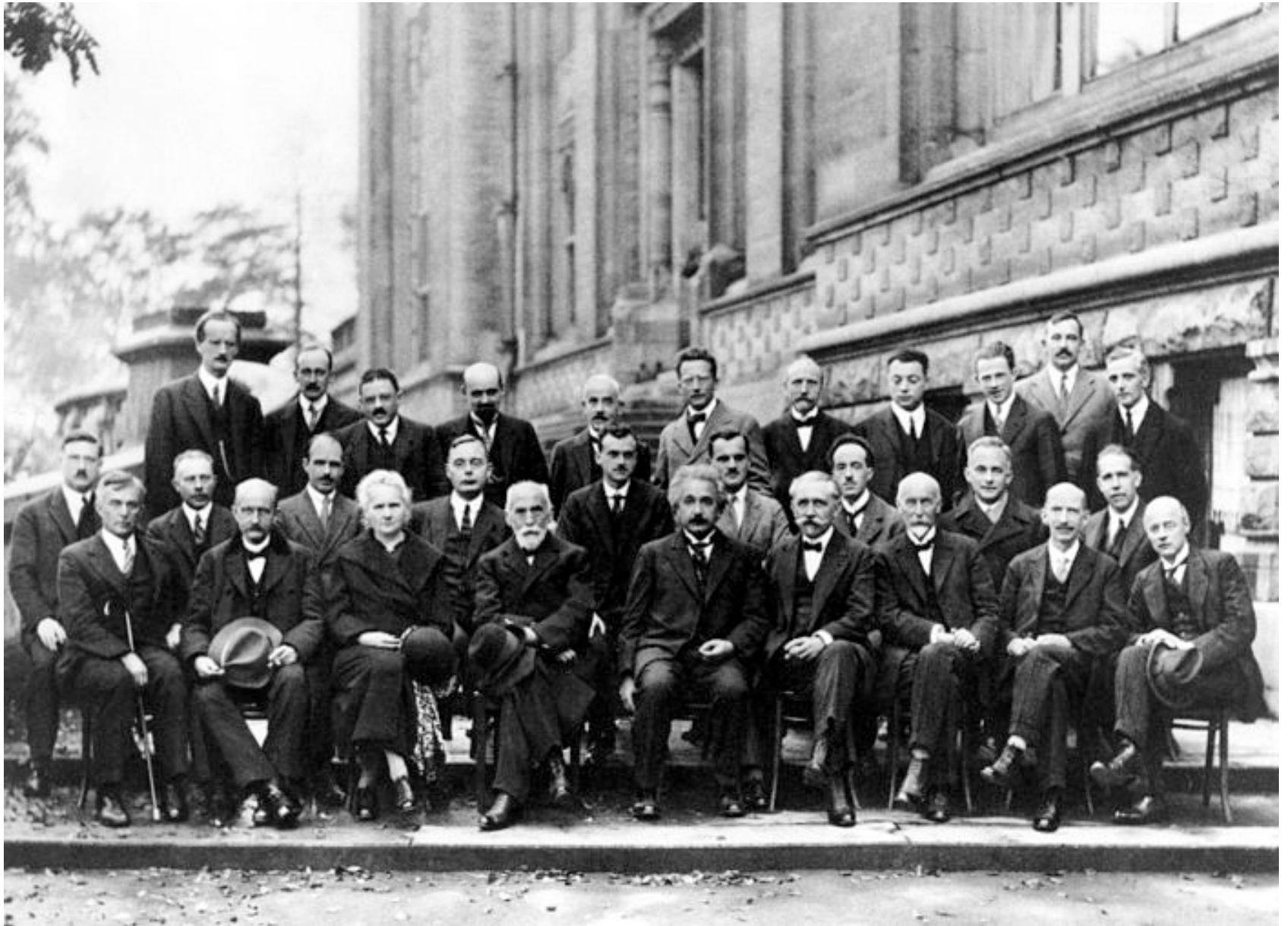
Harvey Rubin, MD, PhD
University of Pennsylvania

Thanks to the Organizers



Penn Engineering
React team
Solvay
French colleagues

As successful as that Solvay conference 89 years ago



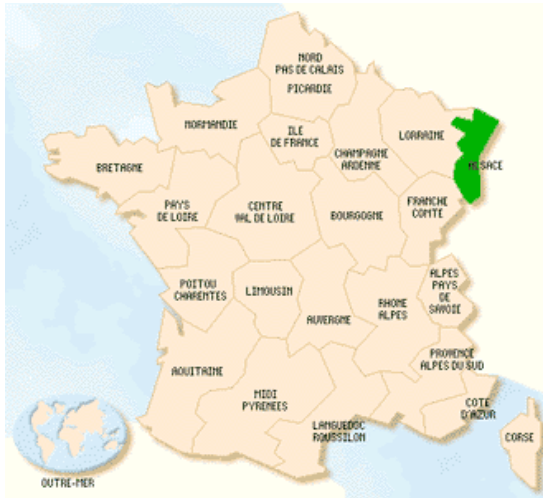
The Fifth Solvay Conference, 1927

What is the Human Habitat?

What is global Engineering?

**Why Care About Water, Infection and
Energy**

The Human Habitat Is Many Things



Humans differ in their personal microbial cloud

James F. Meadow^{1,2}, Adam E. Altrichter^{1,2}, Ashley C. Bateman^{1,2},
Jason Stenson^{1,3}, GZ Brown^{1,3}, Jessica L. Green^{1,2,4} and
Brendan J.M. Bohannon^{1,2}



“fecal sampling might identify patterns of gut microbes that contribute to obesity”

“Our results confirm that an occupied space is microbially distinct from an unoccupied one, and demonstrate for the first time that individuals release their own personalized microbial cloud.”

GRAND CHALLENGE

Improve the Human Habitat with Global Engineering

Will show you one example in the human health domain

HERE ARE THE OTHERS.....



SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY



2 ZERO HUNGER



3 GOOD HEALTH AND WELL-BEING



4 QUALITY EDUCATION



5 GENDER EQUALITY



6 CLEAN WATER AND SANITATION



7 AFFORDABLE AND CLEAN ENERGY



8 DECENT WORK AND ECONOMIC GROWTH



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



10 REDUCED INEQUALITIES



11 SUSTAINABLE CITIES AND COMMUNITIES



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



13 CLIMATE ACTION



14 LIFE BELOW WATER



15 LIFE ON LAND



16 PEACE, JUSTICE AND STRONG INSTITUTIONS



17 PARTNERSHIPS FOR THE GOALS



SUSTAINABLE DEVELOPMENT GOALS

Table 1: The Ten Global Risks in Terms of Likelihood and Impact

Top 10 global risks in terms of Likelihood	Top 10 global risks in terms of Impact
1 Interstate conflict	1 Water crises ←
2 Extreme weather events	2 Spread of infectious diseases ←
3 Failure of national governance	3 Weapons of mass destruction ←
4 State collapse or crisis	4 Interstate conflict ←
5 Unemployment or underemployment	5 Failure of climate-change adaptation ←
6 Natural catastrophes	6 Energy price shock
7 Failure of climate-change adaptation	7 Critical information infrastructure breakdown
8 Water crises	8 Fiscal crises
9 Data fraud or theft	9 Unemployment or underemployment
10 Cyber attacks	10 Biodiversity loss and ecosystem collapse

Source: Global Risks Perception Survey 2014, World Economic Forum.

Insight Report

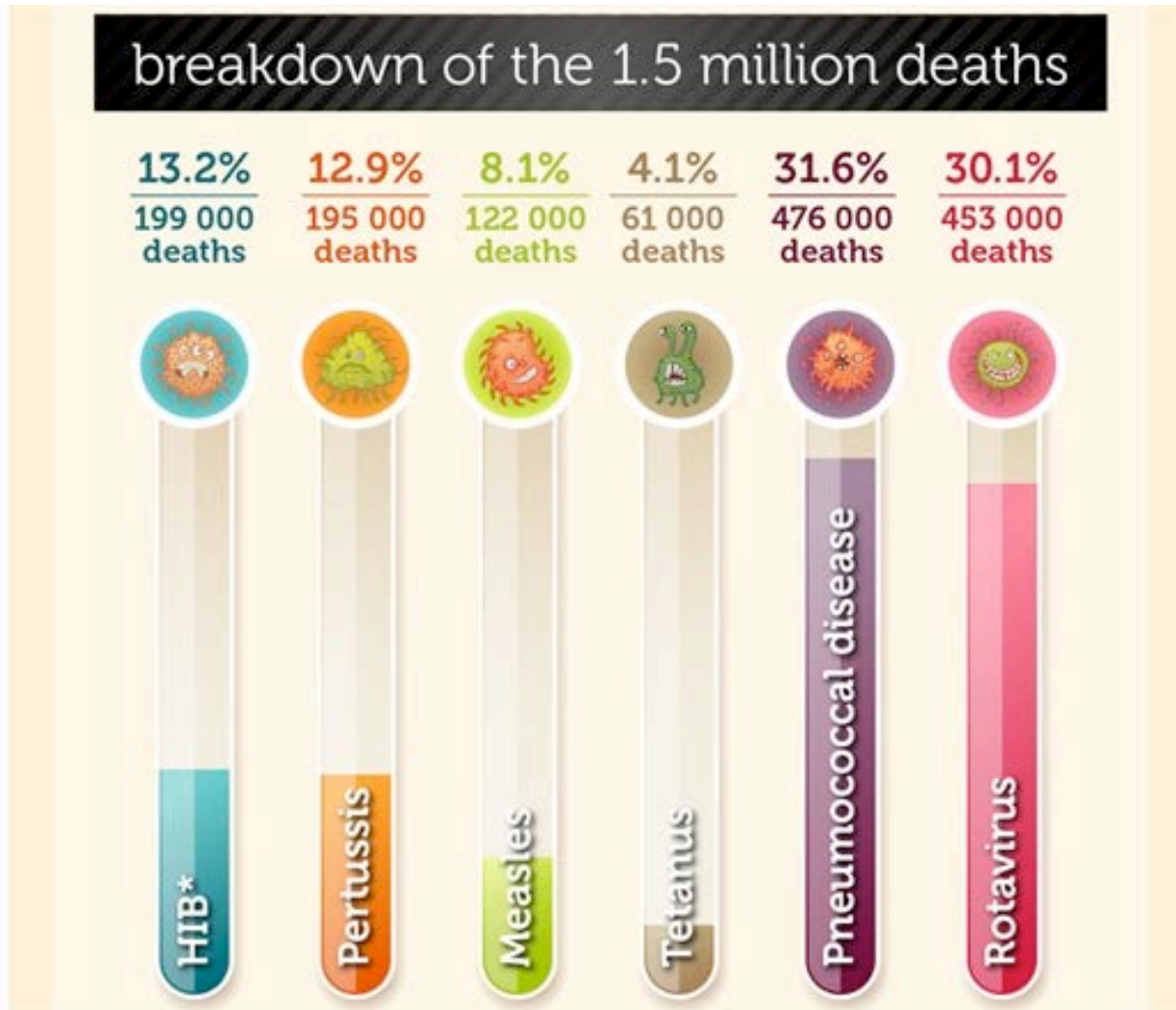


Global Risks 2015 10th Edition

Imagine living in a habitat where...

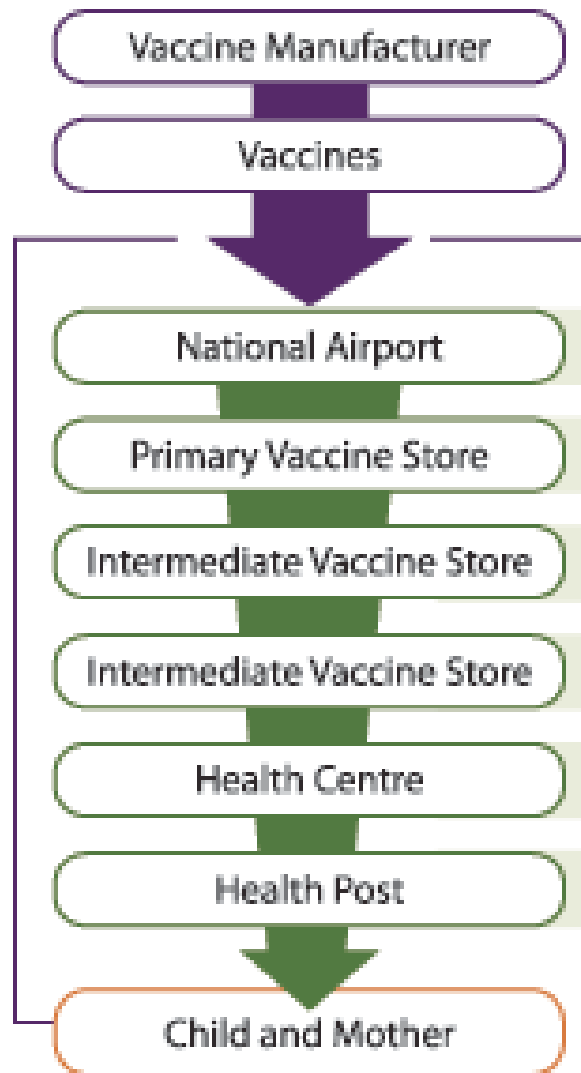


Millions of children die every year from vaccine-preventable diseases



Problem: The Cold Chain

Keeping Vaccines between 2°C - 8°C (35.6°F - 46.4°F)



Vaccines save lives

and have enormous economic, social, political, and moral impact on education, work force, growth of GDP

Public health benefits

- Empowerment of women
- Promoting economic growth
- Enhancing equity
- Promoting peace

Societal benefits

- Health-care and other savings for society
- Preventing development of antibiotic resistance
- Extending life expectancy
- Safe travel and mobility



Vaccination greatly reduces disease, disability, death and inequity worldwide
Bulletin of the World Health Organization, 86, 81-160, (2008) Andre FE, et al.

The logical proposition

IF

vaccinating children is so important

AND

keeping vaccines at the appropriate temperature
is so important

THEN

just plug in a refrigerator and get going!

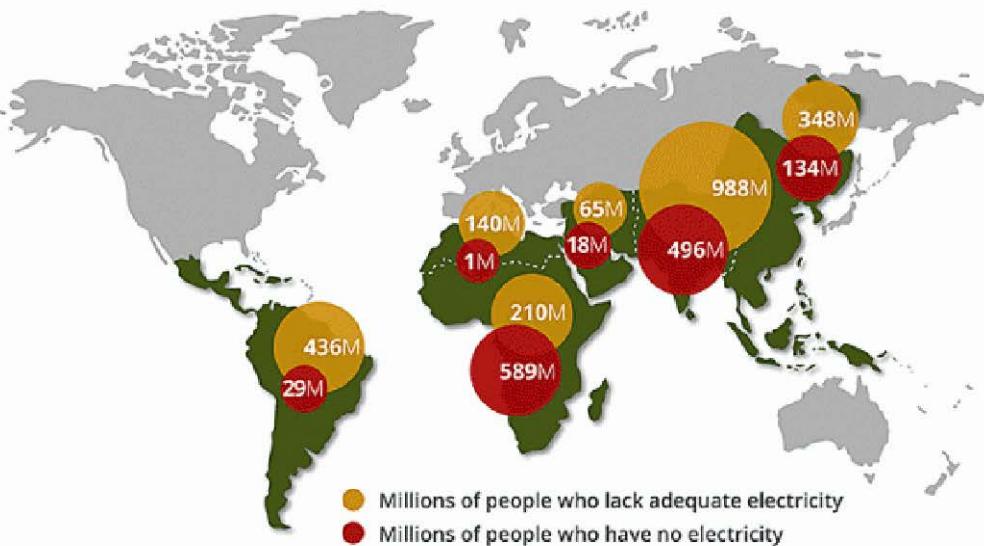


Not so fast---



Energy Is a Human Right and a Rapidly Rising Need

3.5 BILLION people lack proper access to electricity



Source: Analysis of International Energy Agency, World Energy Outlook, 2012; The World Bank, World Development Indicators, 2012, CIA World Factbook, 2012 data.

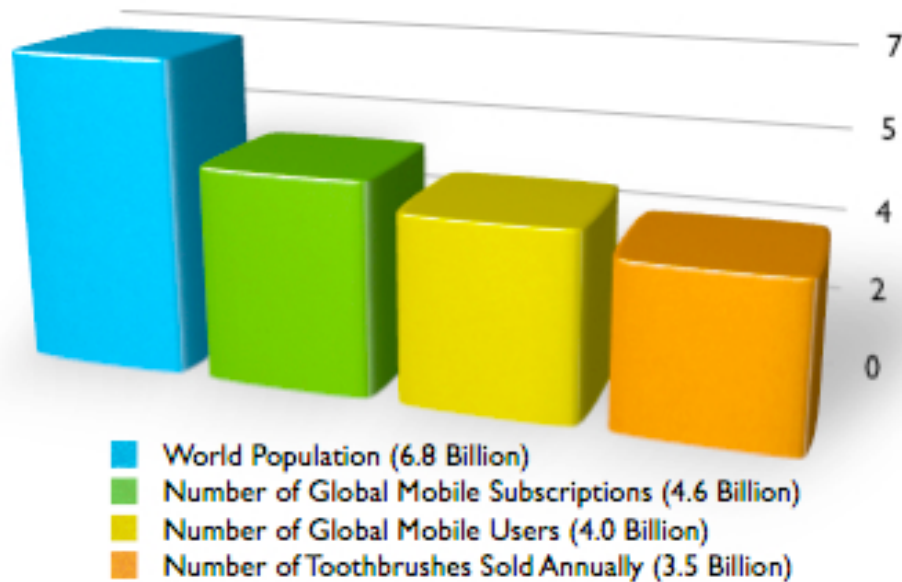


Global Engineering Can Have a
HUGE Impact

and here is an example ---

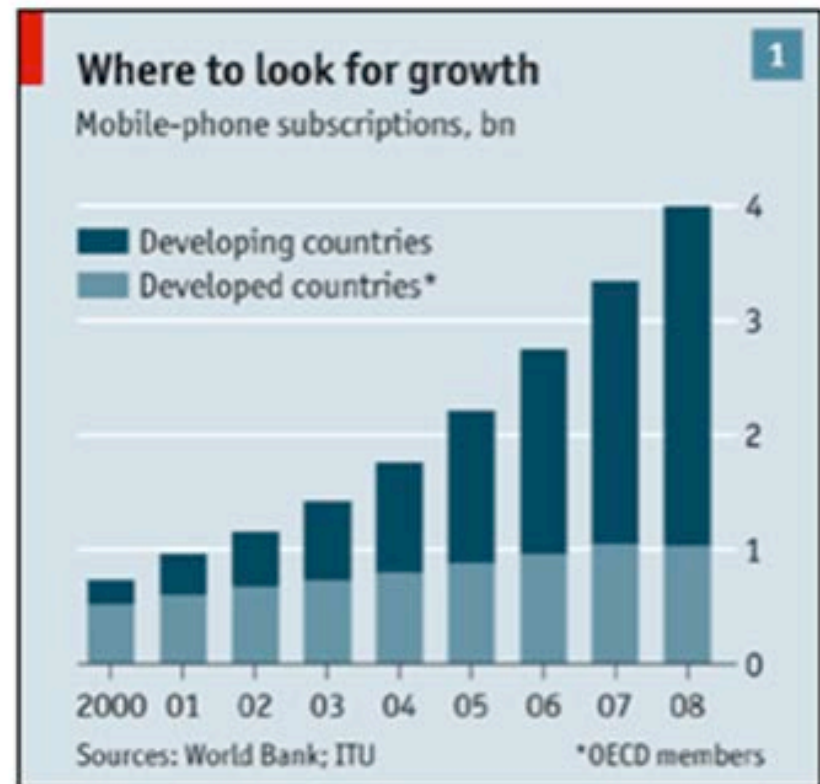
No power? But

Mobile Phones vs. Toothbrushes (Billions)



Source: 60SecondMarketer.com

60second
marketer



To solve the cold chain problem---

co-locate refrigeration systems with cell towers

***This solution is financially
and environmentally
sustainable, scalable,
continuously monitored and
locally managed.***



the Crafty Blog Struck



Our Solution

Towers of strength

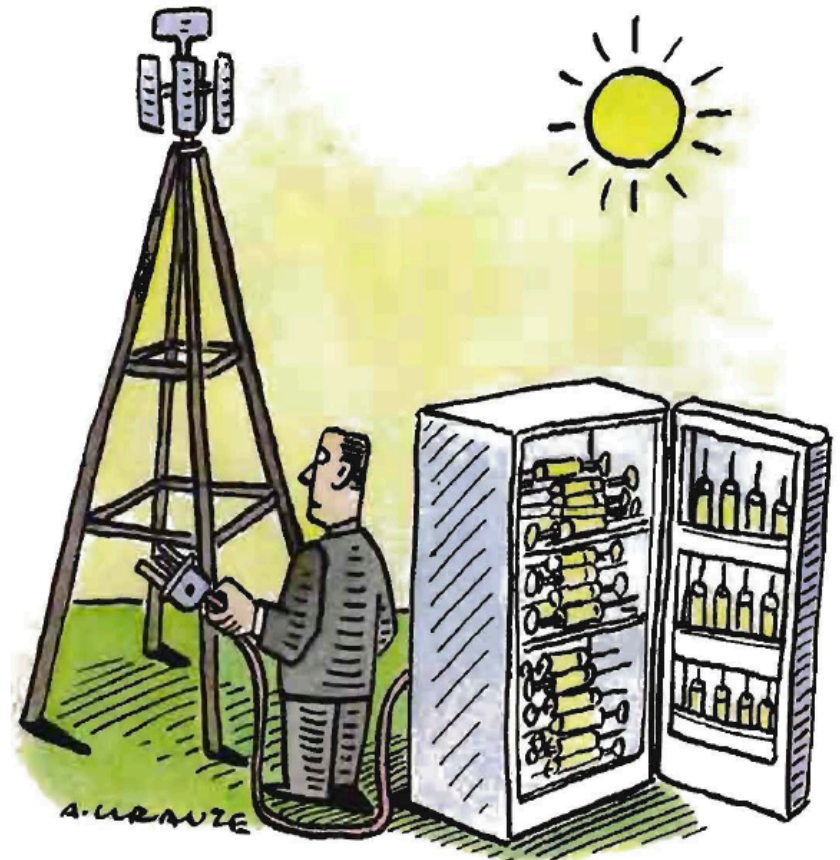
Surplus electricity from cellphone towers could be used to save 5 million lives every year, many of them children, say **Harvey Rubin** and **Alice Conant**

EVERY year, at least 2 million people die from vaccine-preventable diseases such as polio, measles and hepatitis. A further 3 million die from diseases spread by unclean water. Both of these big problems ultimately come down to the same thing: a lack of energy infrastructure in the developing world. We propose a solution that could be implemented immediately.

The 2 million vaccine-preventable deaths do not occur for lack of vaccines, but because of inadequate distribution. To work properly, most vaccines must be kept cold. That means constant refrigeration from the point of manufacture to the point of delivery, often a rural location. The series of storage and mobile refrigeration units required to achieve this is called the “cold chain”.



Sept 2010



The Strategy Works--Zimbabwe

Econet Wireless

111 sites installed with
remote monitoring units



**111 operational sites, 58 sites under construction
100 sites being planned**



Current site locations are indicated in a red H

How it works....

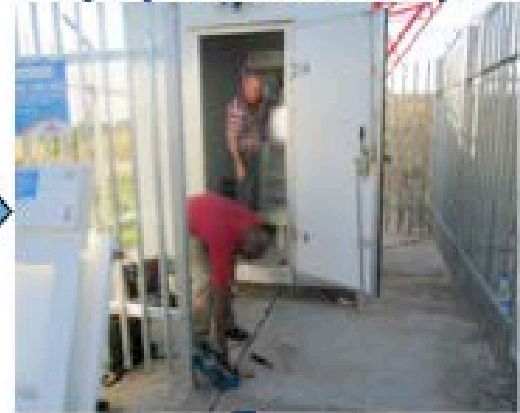
Site Assessments



Sites Construction



Equipment Set Up



Site Hand-Over



Site Inspection



Complete Site



Remote Monitoring System

Data Logger



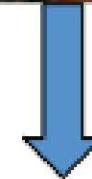
Temp



Alarm



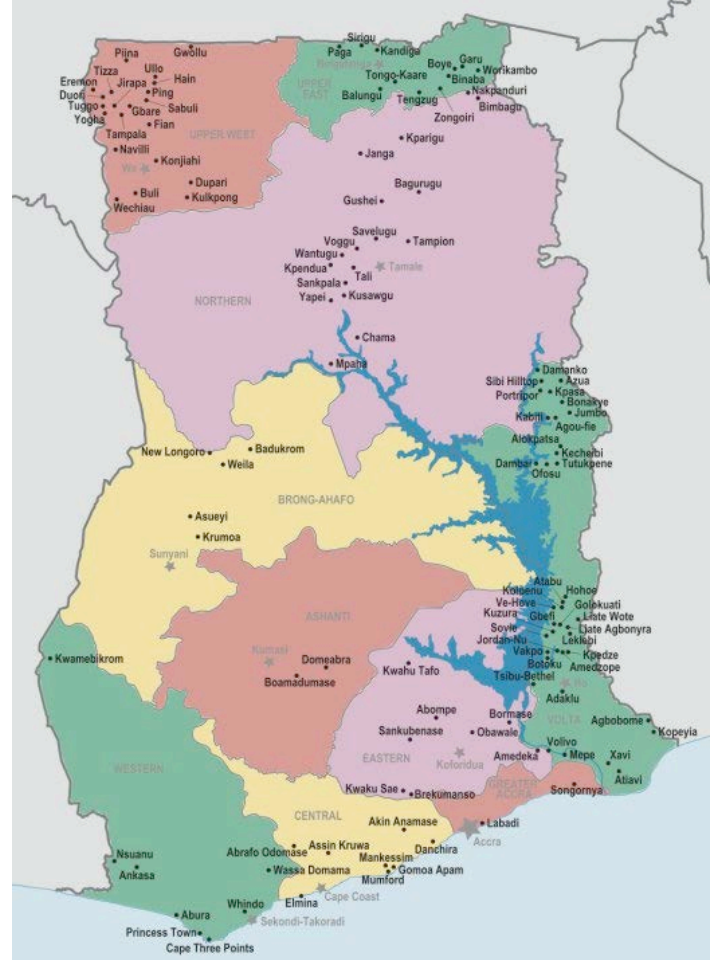
Reaction



- Remote Monitoring of Sites to central point.
- Real time Internal & External Temperature.
- Duration the fridge door has been opened.
- Sends texts and email to responsible persons.
- Automating report generation.



Ghana Plans—30 pilot sites
Upper east, Upper West, Volta
Major Partners: American Tower
Corp. USAID Ghana, EPI Ghana



HABITAT: Xevikpotame, Volta Region, Ghana
2013. Unicef

IT IS A PATH OPTIMIZATION PROBLEM



Roll out plans

partners: American Tower, Econet Wireless, USAID, Health Ministries



2013-2014



2014-2015



2016---->

children vaccinated:

250,000

500,000

1,000,000

Field Progress: India

Rajasthan



Karnataka



Bottom Line

INSIGHT Cold chain



Off-grid, sun to the rescue

Tower power saves lives

Keep vaccines cool in poor countries with electricity from cellphone masts

STAFF at Morganster Hospital, which serves a remote community in Zimbabwe's Masvingo province, used to sleep fitfully. If the power failed and a back-up generator was offline – common problems in the impoverished nation – they would have to jump out of bed and drive for 26 kilometres to stash their stock of life-saving vaccines in a fridge in the provincial capital.

But those days are over, thanks to a pilot project that is testing a simple idea floated in the pages of *New Scientist*. In that article, infectious disease specialist Harvey Rubin of the University of Pennsylvania in Philadelphia and Alice Conant, then a student at Harvey Mudd College in Claremont, California, suggested using surplus power from cellphone towers to run the refrigerators needed to keep perishable vaccines cool (18 September 2010, p 24).

22 | NewScientist | 26 May 2012

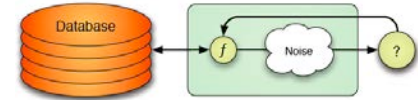
Energize the Chain - Rerouting
power, Reshaping lives

Next Step—Energize the Chain Labs: High Impact Technology Solutions (HITS)

How do we keep track of the millions of infants?--
infant biometrics



How do we establish and query databases safely and securely?--*differential privacy algorithms*



How do we carry out real-time inventory?



Can we autonomously carry out infectious disease surveillance and then autonomously deliver supplies to vaccine refrigerators?



GRAND CHALLENGE

Improve the Human Habitat with Global Engineering

SHOWED YOU ONE EXAMPLE IN THE HUMAN HEALTH DOMAIN

THE OTHER PROBLEMS REMAIN



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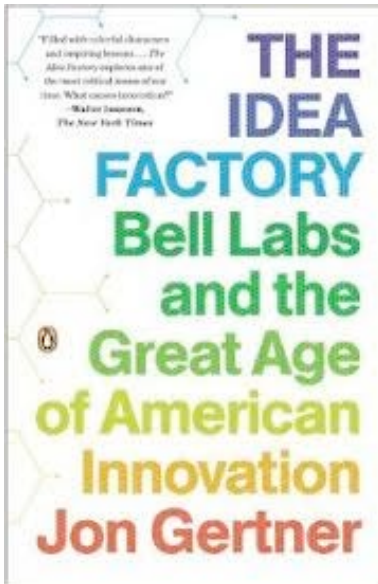


17 PARTNERSHIPS FOR THE GOALS

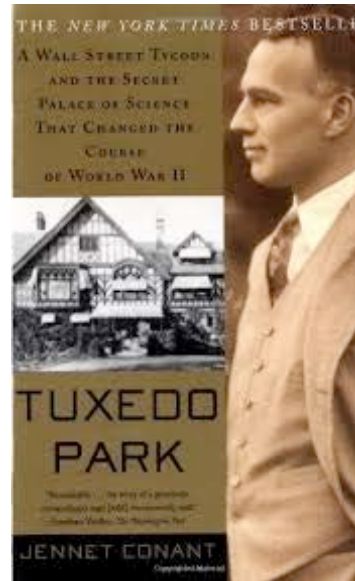


HOW ARE WE GOING TO MEET THE CHALLENGE?

reAct is a great start, now we need public, private, NGO partners--



+



+



Call it the xxxx High Impact Technology park
(HIT Park)

Who or what will step up and be xxxx ???

Thank You, Merci!



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www.energizethechain.org

