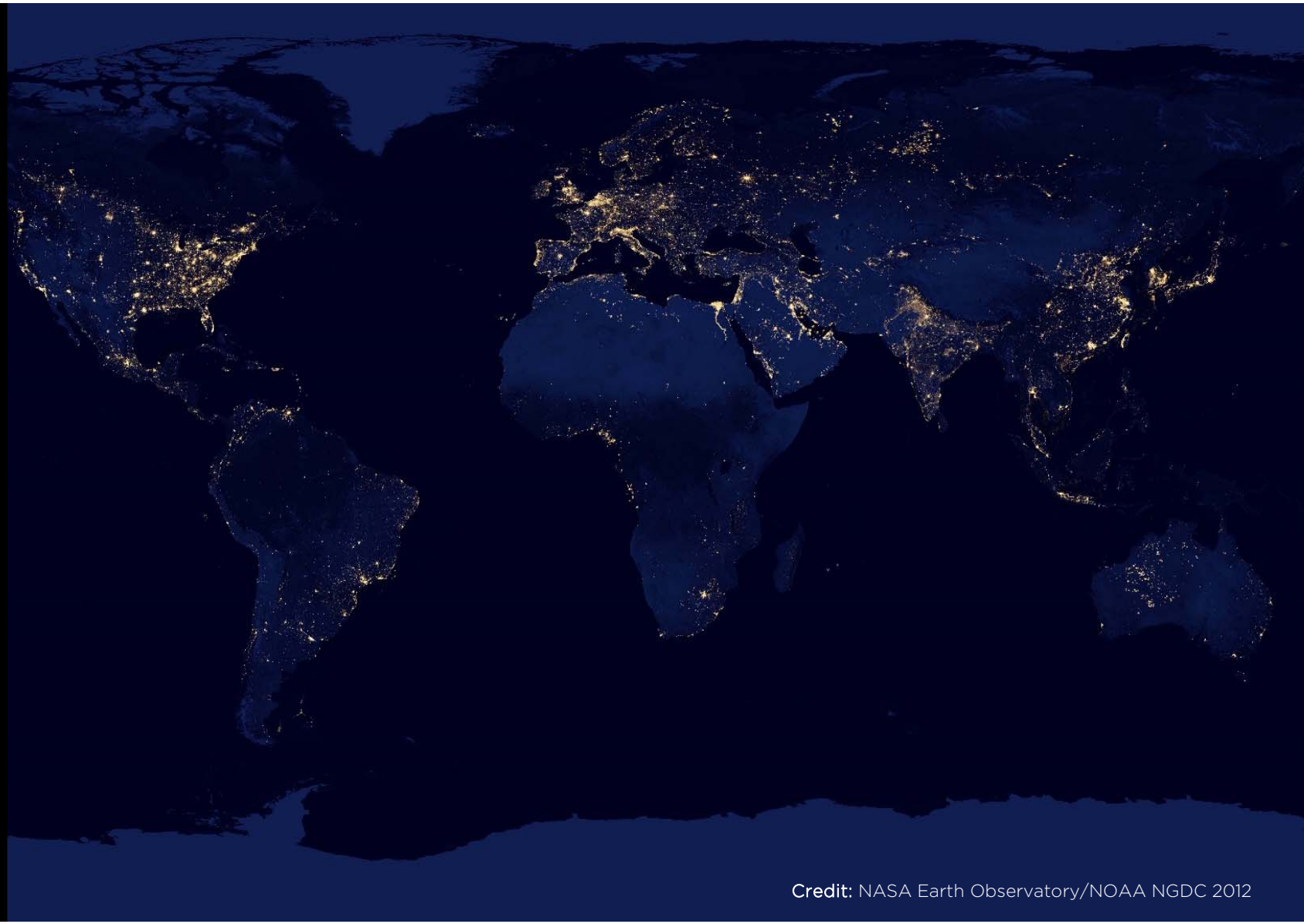
AFFORDABLE ENERGY FOR HUMANITY:

IF NOT NOW, WHEN?

Jatin Nathwani

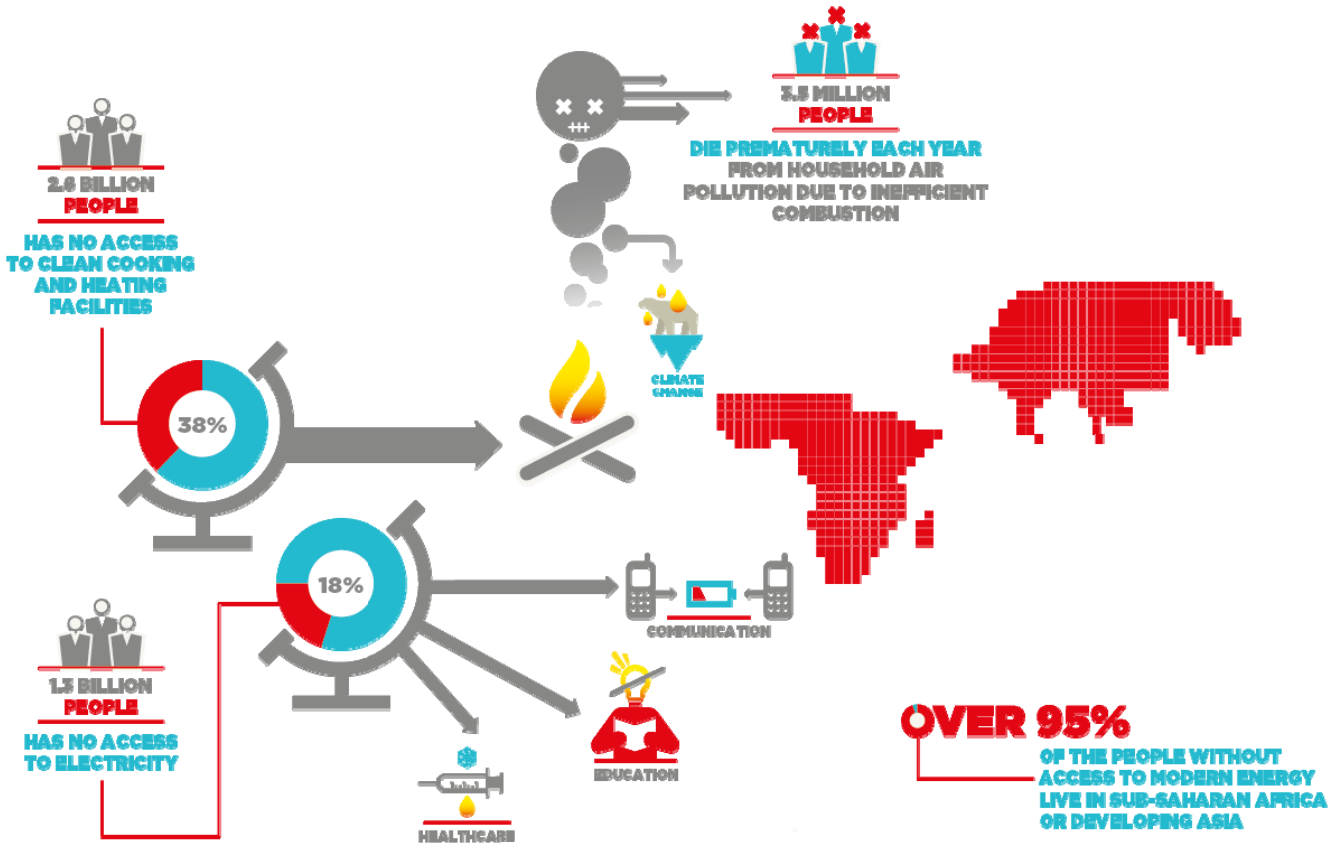
Royal Canadian Institute for Science
Science Talks
Toronto
Oct 30, 2016

THE WORLD AT NIGHT



Credit: NASA Earth Observatory/NOAA NGDC 2012

ENERGY INEQUALITY



Credit: IEA World Energy Outlook 2013

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IEA ENERGY ACCESS PROJECTIONS

	Without access to electricity		Without access to clean cooking facilities	
	2011	2030	2011	2030
Developing countries	**1 257**	**969**	**2 642**	**2 524**
Africa	600	645	696	881
Sub-Saharan Africa	599	645	695	879
Developing Asia	615	324	1 869	1 582
China	3	0	446	241
India	306	147	818	730
Latin America	24	0	68	53
Middle East	19	0	9	8
World	**1 258**	**969**	**2 642**	**2 524**

Credit: IEA World Energy Outlook 2013

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STUDYING UNDER STREETLIGHTS

Credit: Paul Romer/Marron Institute 2009

THEFT OF TIME

Credit: Creative Commons, Planterra.org

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Credit: Creative Commons

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POWER LINES BUT NO POWER

Credit: James Fontanella Khan

ENERGY'S LINK TO LIFE QUALITY

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ENERGY ACCESS TIERS

Capacity	**>3W**	**>50W**	**>200W**	**>800W**	**>2000W**
Services	Task Lighting, Radio, Cell Charging	+ General Lighting, TV, Fan	+ low-power appliances	+ medium power appliances	+ high power appliances

Credit: UN SE4All 2016

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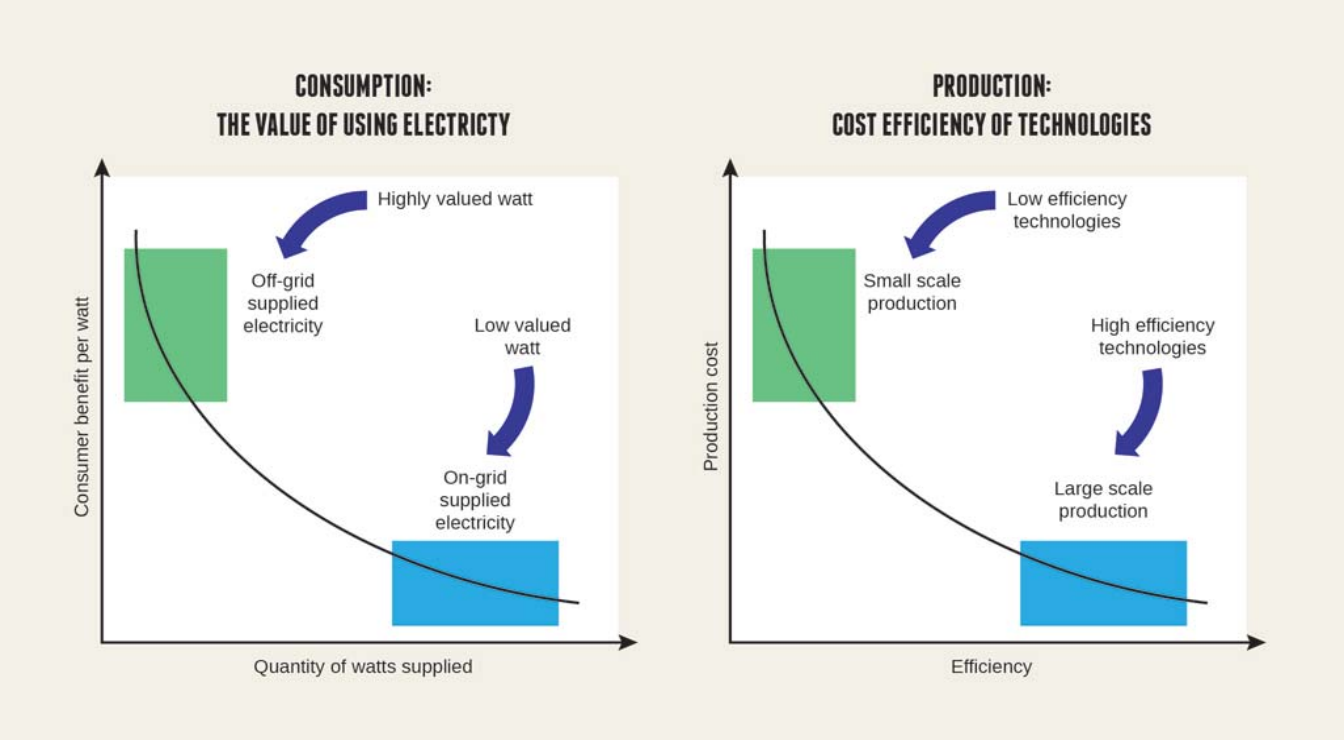
VALUE & COST OF ENERGY AT DIFFERENT TIERS



Credit: Waterloo Global Science Initiative 2011

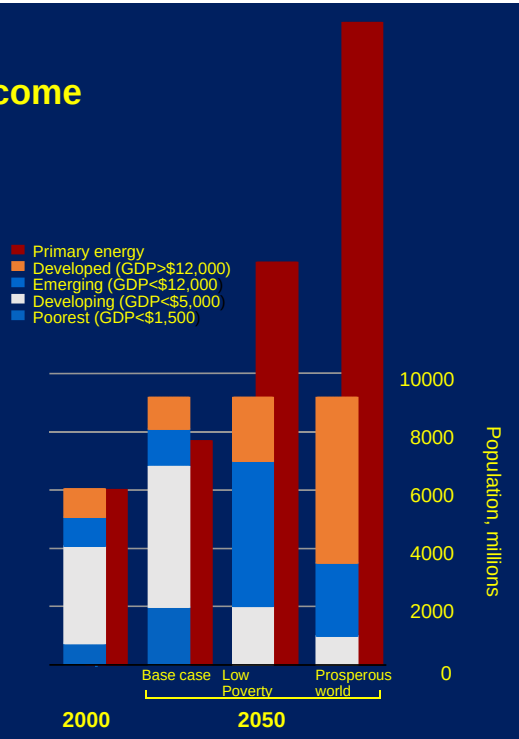
HUGE GROWTH IN ENERGY DEMAND PROJECTED GLOBALLY

Global population divided into income groups:

Population rise to 9 billion + by 2050, mainly in poorest and developing countries.

Shifting the development profile to a "low poverty" world means energy needs double by 2050

Shifting the development profile further to a "developed" world means energy needs triple by 2050



Source: WBCSD 2007 (Adaptation of IEA, 2003)

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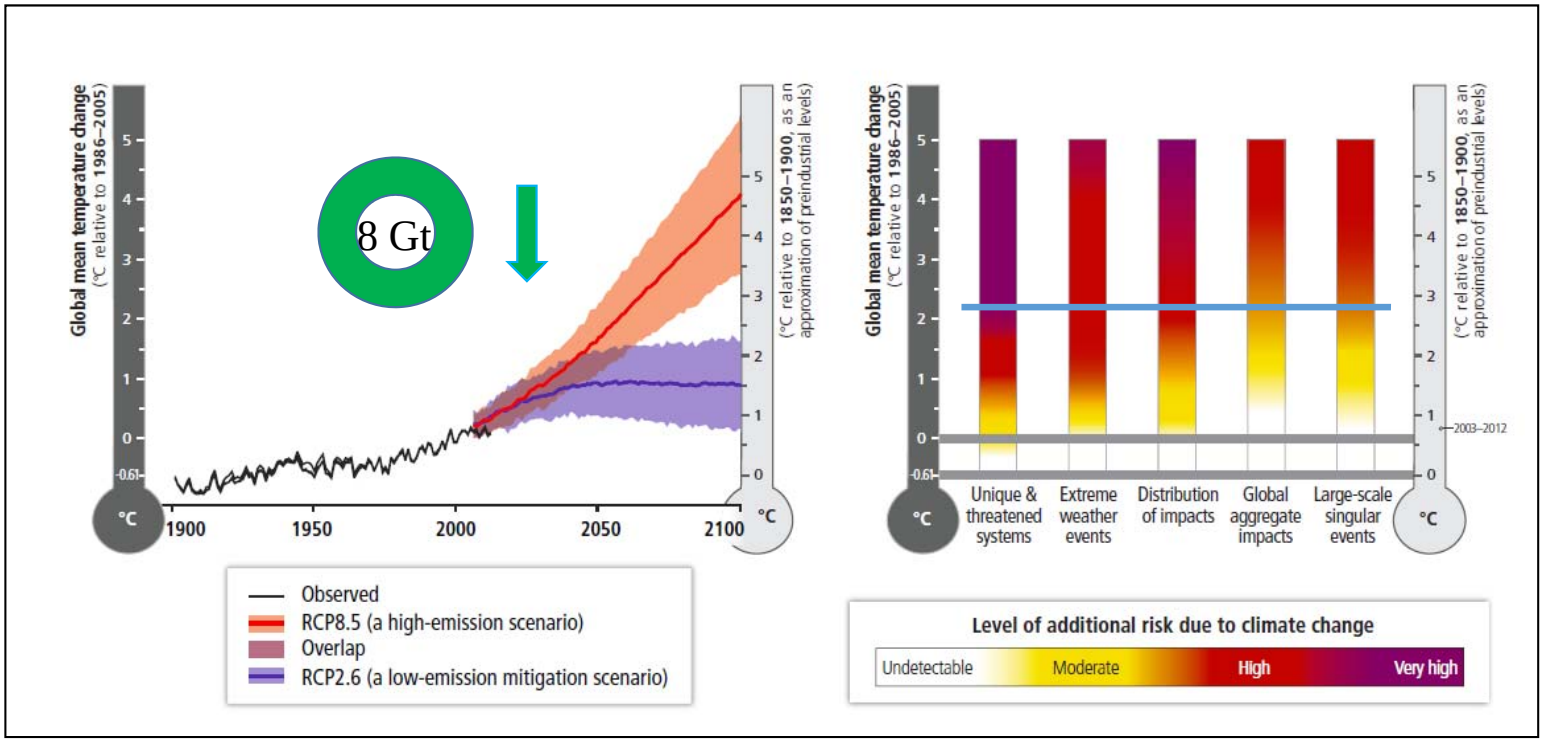
CLIMATE CHANGE & EMISSIONS REDUCTION



Source: IPCC Synthesis Report 2014

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ACCESS TO CLEAN ENERGY:
THE EPITOMIZING SUSTAINABLE DEVELOPMENT CHALLENGE

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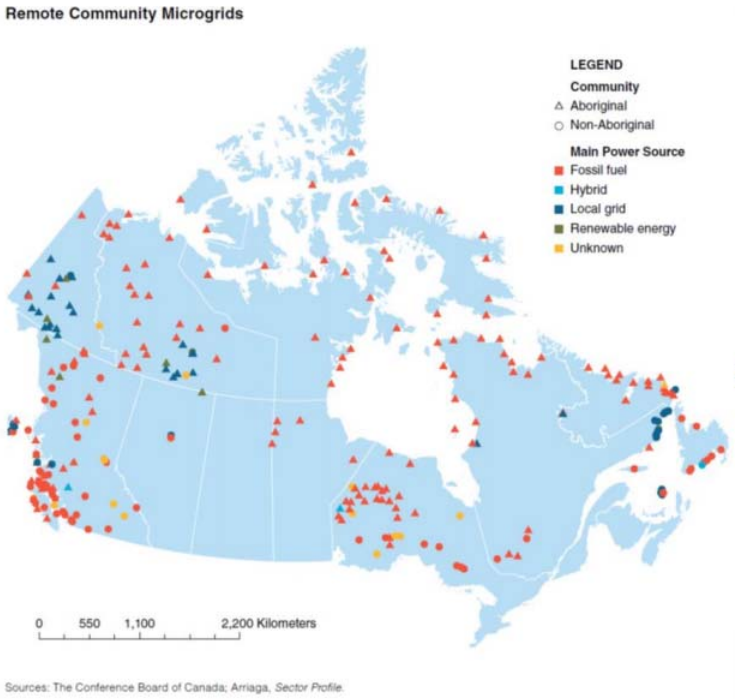
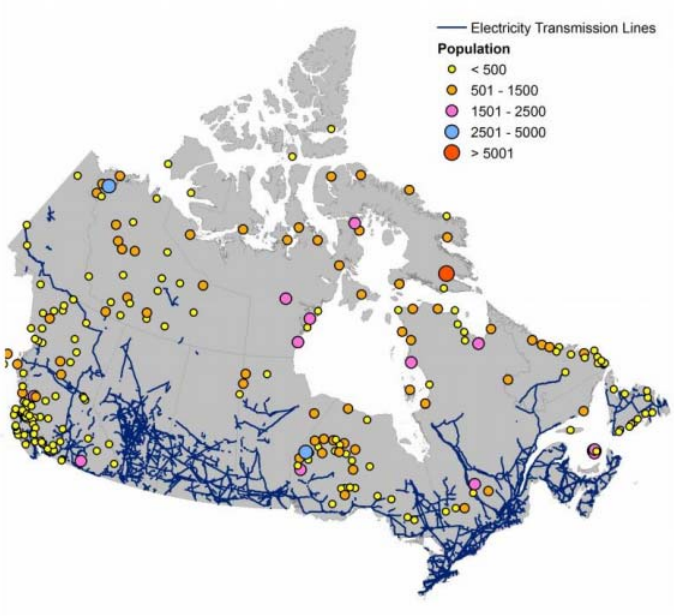
ENERGY POVERTY IN CANADA





Credit: Conference Board of Canada, Arriaga 2016

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ENERGY POVERTY IN CANADA

Credit: Toronto Star 2016

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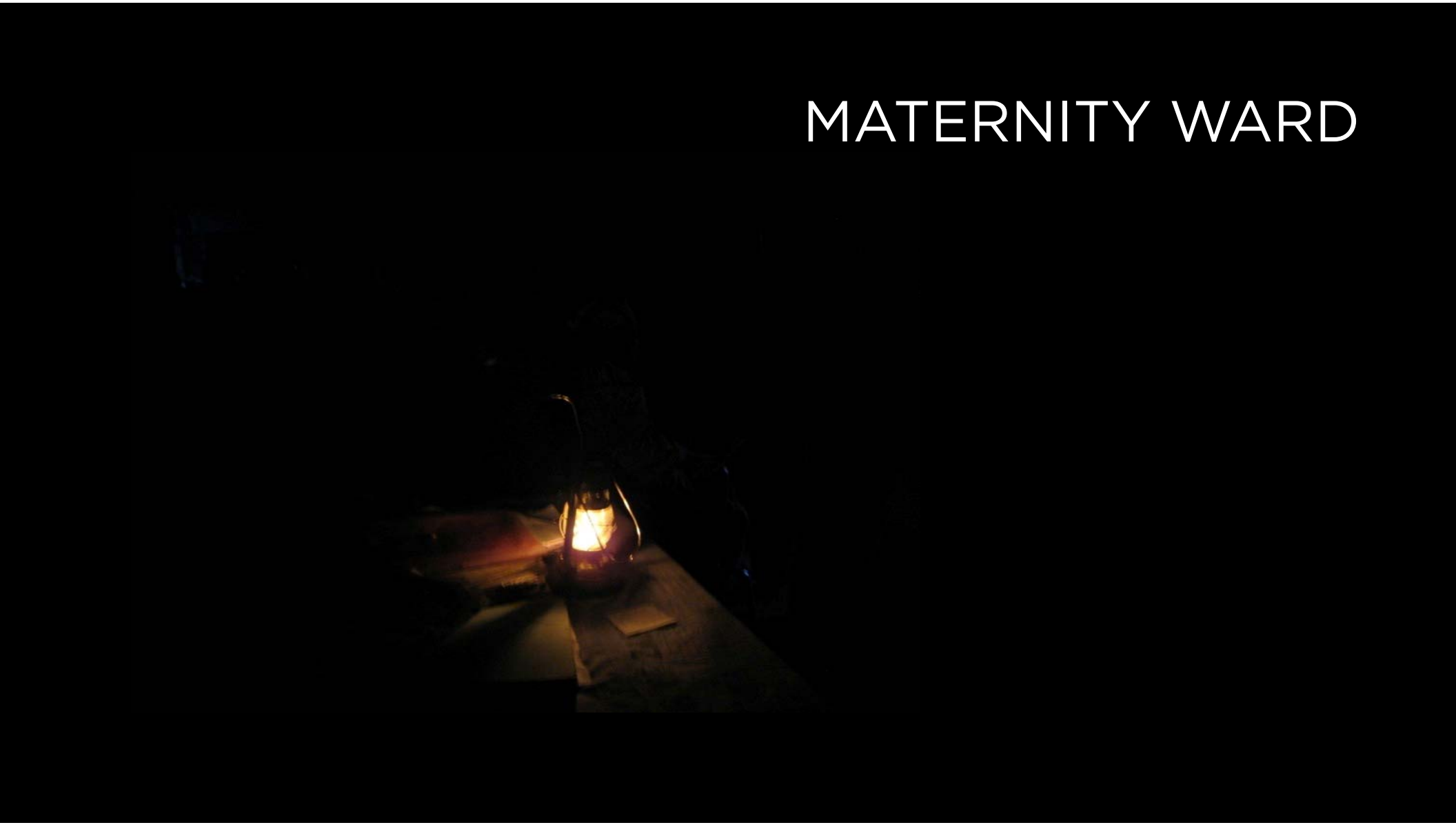
SOLUTIONS

Credit: Toronto Star 2016

MATERNITY WARD



OPERATING ROOM AT NIGHT

SOLAR SUITCASE

Source: We Care Solar 2012

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DESIGN SUCCESS FOR ENERGY ACCESS – TEN COMMANDMENTS

LOW COST
ROBUST
DURABLE
COMPACT
EASY TO INSTALL
EASY TO TRANSPORT
MODULAR & SCALABLE
LOW TECH ENTERPRISE
LOW MAINTENANCE – EASY TO OPERATE
LIMITED ADDITIONAL INFRASTRUCTURE

Source: We Care Solar 2012

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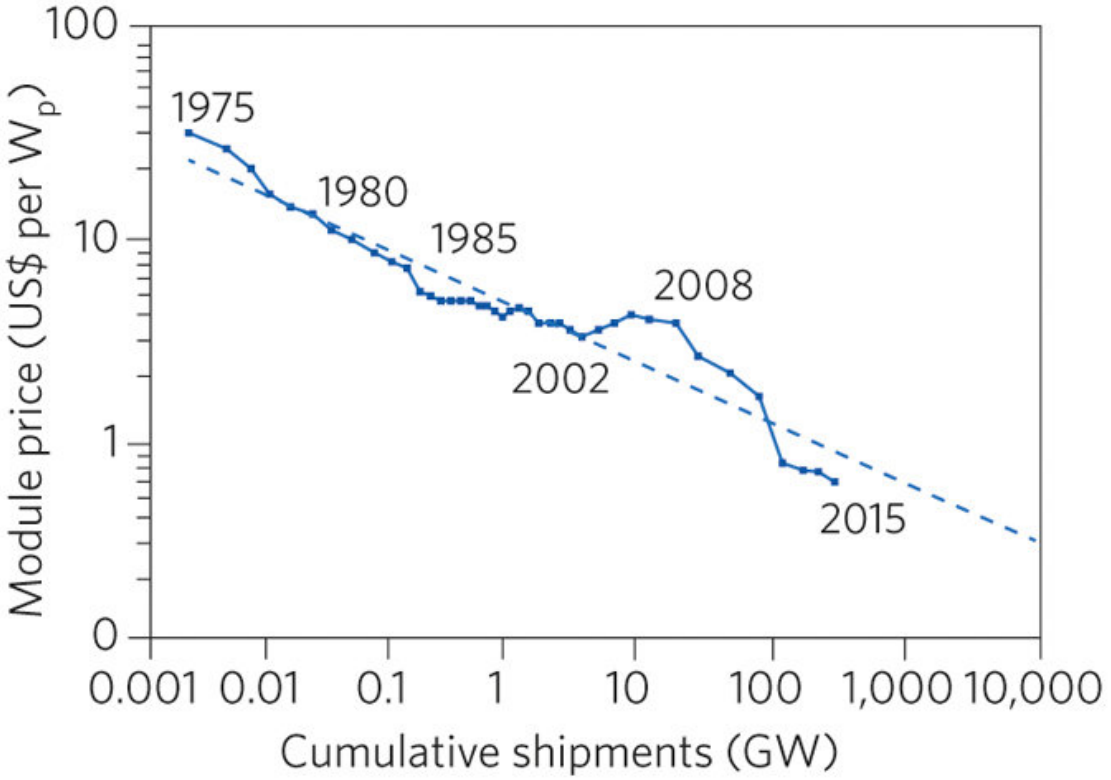
AFFORDABLE SOLAR



Source: Sivaram & Kann 2016, Nature Energy

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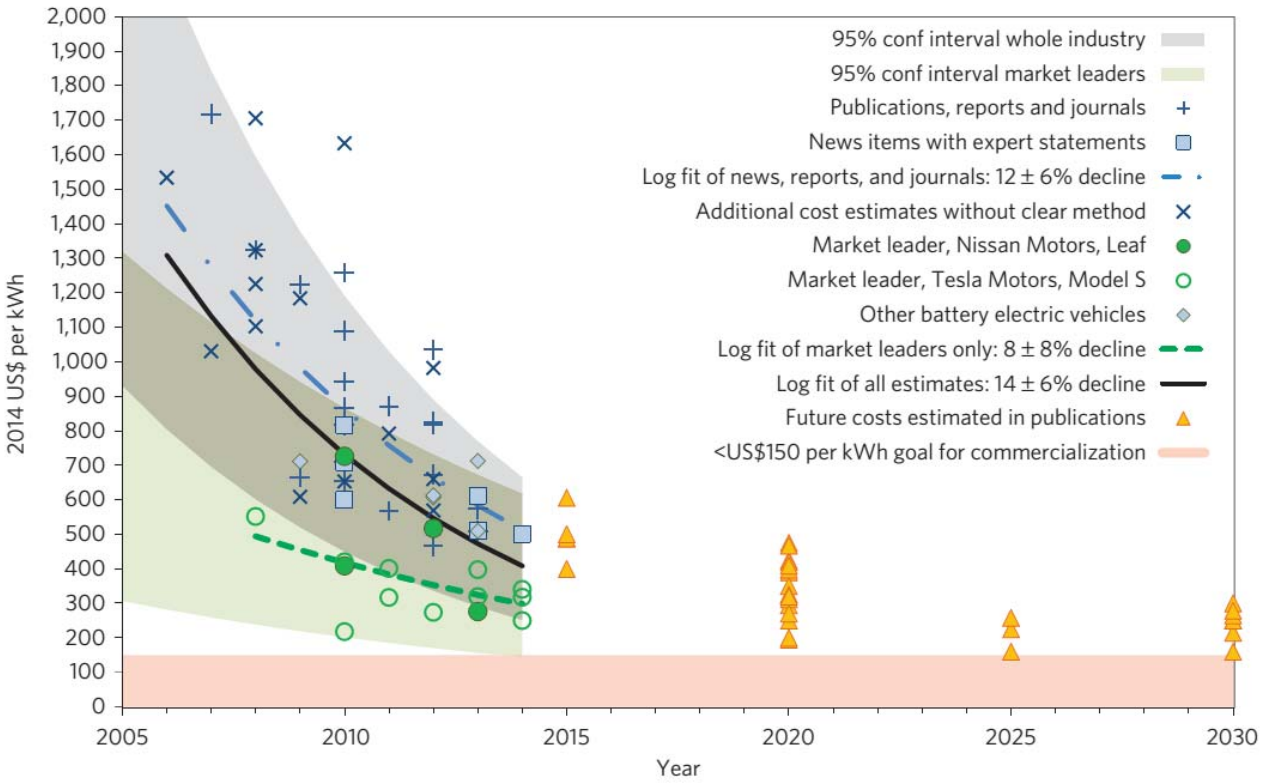
AFFORDABLE BATTERIES



Source: Nilsson 2015, Nature Climate Change

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AFFORDABLE ICT

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TIER 1:
SOLAR LANTERNS & PICO-POWER

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TIER 2-3:
SOLAR HOME SYSTEMS

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TIER 4-5:
RENEWABLE MICRO-GRIDS

Credit: UNDP Nepal 2016

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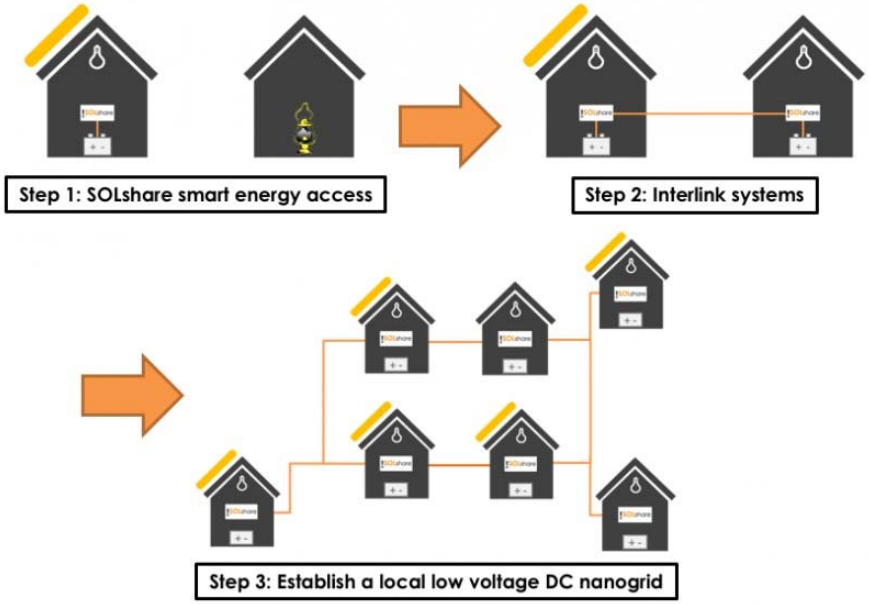
CONNECTING BANGLADESH'S SHS



Credit: UNDP Nepal 2016

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SOLAR PROJECTORS FOR EDUCATION

Credit: One Billion & Boond

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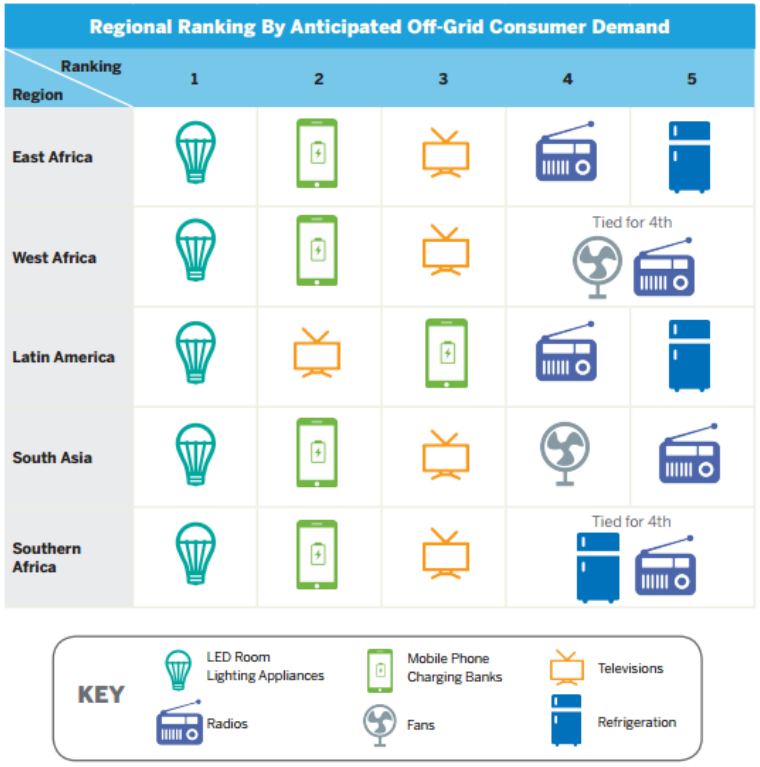
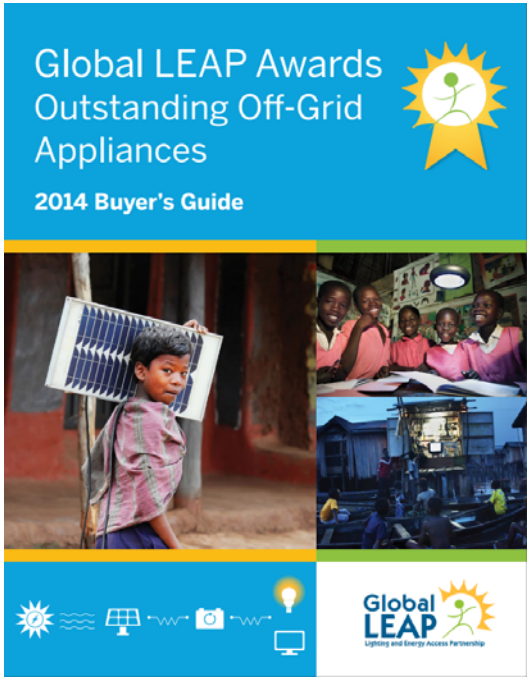
SUPER EFFICIENT DC APPLIANCES

MAKE THE MOST OUT OF EVERY WATT!

Table 2: Rankings of Household or SME Appliances by Region





Source: CLASP/Global LEAP

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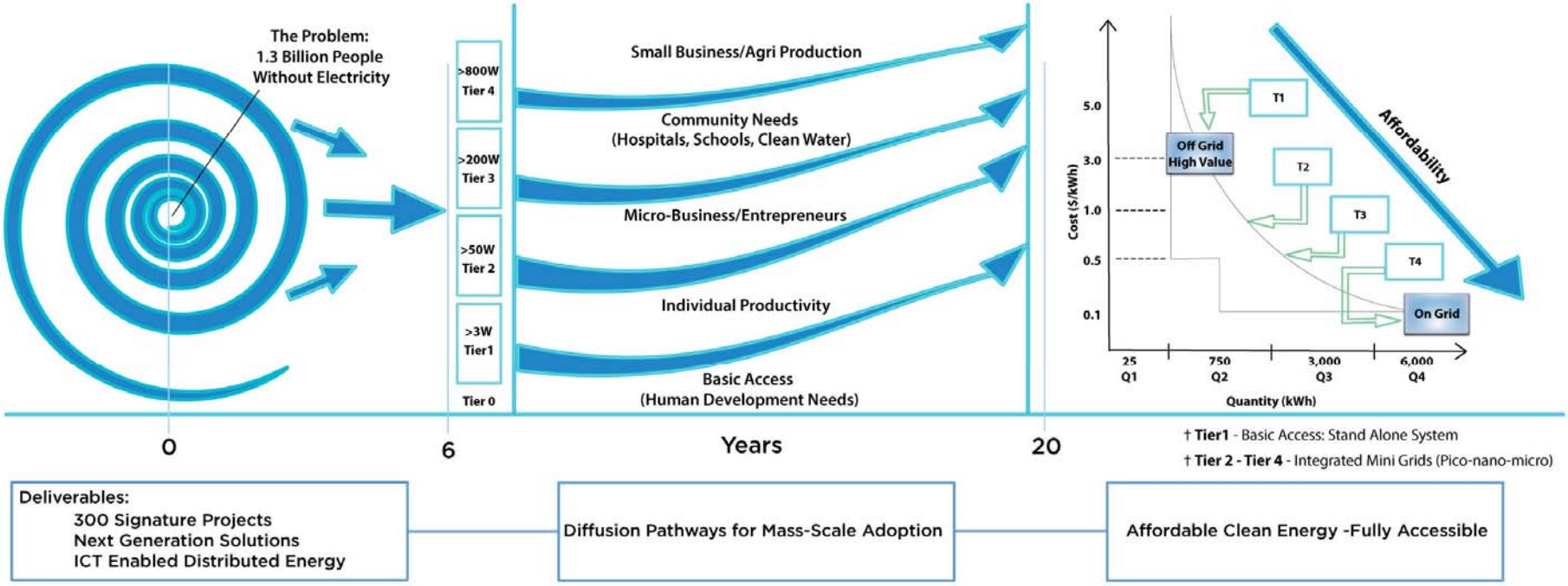
DRIVING A REVOLUTION IN AFFORDABLE ENERGY FOR HUMANITY



Deliverables:
- 300 Signature Projects
- Next Generation Solutions
- ICT Enabled Distributed Energy

Diffusion Pathways for Mass-Scale Adoption

Affordable Clean Energy -Fully Accessible

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RESEARCH DOMAINS FOR INNOVATIVE SOLUTIONS

Environmental & Human Dimensions of Energy Transitions

Generation, Devices & Advanced Materials

Micro-Grids for Dispersed Power

ICT for Energy System Convergence

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AFFORDABLE ENERGY FOR HUMANITY:

A GLOBAL CHANGE INITIATIVE

AE4H.org

AE4H
Global Change Initiative

KIT
Karlsruher Institut für Technologie

mobisol
plug in the world

UNIVERSITY OF CAMBRIDGE

UNIVERSITY OF OXFORD

MICRO ENERGY INTERNATIONAL

ASHESI

IASS POTSDAM

SUNFARMER

HARVARD UNIVERSITY

UNIVERSIDAD DE CHILE

Berkeley
UNIVERSITY OF CALIFORNIA

tta Trama TecnoAmbiental

PRACTICAL ACTION
Technology challenging poverty

ENVENTURE
creating sustainable enterprises

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