

ENERGY WITHIN REACH

A Rocky Mountain Institute and Carbon War Room Proposal

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What is the problem?

1.3 billion people around the world live without basic access to electricity, including 900 million in sub-Saharan Africa and India.[i] Bringing light to these people currently in the dark is an acute, urgent humanitarian and economic development challenge for these countries that have ambitious goals. Energy is the cornerstone that supports both, yet forecasts suggest we'll make little progress in the years ahead.

An estimated 1.7 billion people are expected to gain electricity access by 2030, yet these gains will be virtually negated by forecasted population growth (1.4 billion). In sub-Saharan Africa and India, the International Energy Agency's *World Energy Outlook*[ii] estimates an increase (from 600 to 645 million) in the number of people in sub-Saharan Africa without electricity access[iii] and a decrease (from 300 to 147 million) in India.[iv] That still leaves nearly 800 million people without electricity across the region.

Yet providing electricity access to these hundreds of millions and supporting developing countries' broader economic development goals mustn't happen by building more coal-fired power plants and expanding an already dirty and unreliable grid. The result would be a projected 141-percent increase in carbon emissions for these areas of the world by 2040.

Instead, solar energy can lift these people out of energy poverty, enable and support meaningful economic growth, and prevent significant increases to global coal consumption and carbon emissions that drive climate change. Decentralized solar energy can provide reliable, low-carbon electricity; help stimulate local economic activity; avoid the negative health consequences of fossil-fueled generation and kerosene lamps; provide increasingly affordable energy access; and be infinitely scalable to power communities large and small.

A solar-based energy ladder—with each rung in reach of the next—can enable families to climb out of energy poverty to energy access, support economic development and halt coal's expansion—from solar lanterns, to home solar systems, to mini and microgrids.

We've already seen encouraging successes on the lower rungs of the ladder (e.g., lanterns, small home systems). As of mid-April 2015, the International Renewable Energy Agency estimates that more than 8 million solar lanterns have been deployed across Africa.[v]

Now, our task is threefold: 1) develop optimized solutions that bridge from lanterns and small home systems to mini and micro grids supporting real commerce, 2) overcome barriers including capital cost, reliability, modularity, interoperability, "last mile" supply, and poor quality that undermines consumer trust and confidence, and 3) scale solutions at all rungs of the energy ladder through effective supply chains and local businesses.

How will Rocky Mountain Institute and Carbon War Room solve the problem?

Rural households need robust, low-cost, higher-power solar offerings paired with energy storage to move up the metaphorical "solar ladder" out of energy poverty. Many successful and growing entrepreneurs around the world currently offer solar lanterns and small-scale, stand-alone home systems. Now we must bridge from these and make them modular and interoperable, plus add functionality so they can interconnect and scale as the buildings blocks of larger mini and microgrids.

Picture a small, 100-watt PV panel (two feet by four feet) paired with a 30 watt-hour battery (half of a laptop's capacity) capable of providing enough power for 4–6 hours of LED lighting and charging cell phones. Multiple households combining such systems could then enable new entrepreneurial activities, ranging from water purification to running a wood lathe or sewing machine—all while still using the solar system for lighting and cell phone charging.

Some renewable mini-grids do currently operate in places like Monte Trigo (Cape Verde) and Odisha (India), but they have yet to reach scale because of large gaps—technical, cost, and other—to the energy ladder's lower rungs.

What's the pathway to this solution? And how will we overcome barriers?

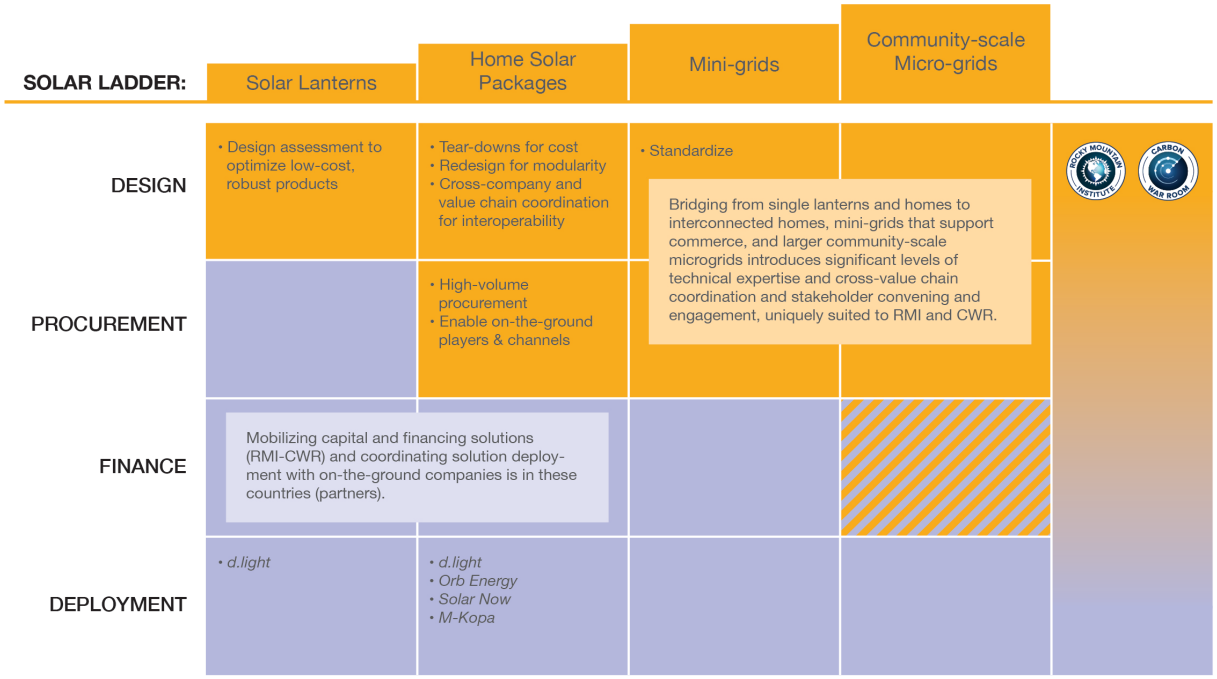
We will forge solutions by pursuing two primary strategies:

1. **Transform current solar energy solutions into rungs on a scalable energy ladder—**ensure that home solar and other solutions are modular, combinable, and scalable to form renewable power systems capable of providing a fuller suite of energy services.
2. **Enable access to and migration up the ladder's rungs—**use large-scale procurement, competitive financing, and optimized supply chains to ensure that channels to market (e.g., energy companies and institutions focused in this space) have a strong and smoothly functioning value proposition.

To get from the current landscape to a scaled solution, we will focus relentlessly on four things:

1. **Standardized design solutions** of existing, modified, and to-be-developed products to increase modularity, enable interoperability, and lower cost,
2. **Large-scale procurement** to lower costs and reduce supply chain inefficiencies,
3. **Financing solutions** in the supply chain and for deployment that work for developed-country investors and the rural poor consumers alike, and
4. **Deployment solutions** that can scale rapidly within the limits of existing infrastructure and do not add significantly to other external cost.

Rocky Mountain Institute and Carbon War Room will launch Energy Within Reach in collaboration with partners, whose track record of successful investment in on-the-ground companies and deployment of solutions throughout the region demonstrates the power of the first rungs of the energy ladder. Over the course of the next 36 months and beyond, the organizations' complementary strengths will build out the solar energy ladder and dramatically increase the positive impact of those trying to climb the ladder.



1. *Standardized design solutions*

- Perform tear-down analyses of existing products to identify and drive cost reductions.
- Use RMI-CWR network and resources coupled with whole-system approaches to optimize or design a standardized product offering that ensures interoperability and modularity, reduces the total cost of ownership, increases reliability, requires low skills, and improves safety. Leverage on-the-ground experience and insight from partner companies.
- Deliver field-tested products that meet the needs of the market, by first prototyping and then piloting in collaboration with partner companies.

2. *Large-scale procurement*

- Enable world-class procurement and supply-chain capabilities to ensure low costs, fast time to market, high reliability, and alleviated bottlenecks. Key activities include understanding supplier leverage points, performing “should cost” analysis, issuing competitive RFPs, optimizing bid packages, and creating strategic supplier agreements.
- Collaborate with partners to identify on-the-ground channels for customer acquisition driven by solar entrepreneurs.

3. *Financing*

- Convene international financing experts to identify what factors make upstream financing successful in specific developing countries/regions, and what financing mechanisms can successfully be matched to the required scale.
- Create a large-scale, multilateral financing mechanism to fund both supply-chain working capital and capital cost associated with local deployment. Instruments may include concessionary financing from manufacturers, multi-agency financing facility, standardized contract terms, securitization, and/or yieldcos.
- Collaborate with partners to evaluate and scale existing low-cost micro-financing and payment mechanisms (mobile phone payments, internet-enabled transactions, local banks, etc.).

4. *Deployment*

- Select specific market segments, test prototype solutions, iterate and optimize designs and features, and develop channels to market.
- In collaboration with partners, create scalable business models (e.g., franchise), industry standards, training, and online tools that accelerate local industry growth.
- Create a standardized set of policies and regulations that enable faster local deployment. In collaboration with local entrepreneurs and multilateral agencies, advocate for such policy frameworks on a country-by-country basis.
- Develop a robust support model for financing, additional supply-chain optimization, the procurement best practices, and any aftermarket sales and servicing needs.

What is the value proposition?

Building a viable solar energy ladder creates several important impacts. Electrification supports human well-being and long-term economic development, while *solar-based* electrification prevents new coal plants and expanded carbon emissions as these populations electrify and their economies grow.

Access to clean, affordable, reliable, high-quality energy can dramatically improve standards of living, including education, health, time, and new economic opportunities. For example, an electric sewing machine generates 600–1,000 stitches per minute, roughly a 20-fold productivity increase over sewing by hand. A small 200-watt wood lathe can shape a piece of wood in minutes rather than hours. And a small 50-watt pump can move gallons per minutes versus gallons per hour.

In newly electrified communities, jobs emerge where none previously existed. A Kenyan welder noted "since I got electricity, I was able to start my own business and increase my income by 10,000 shillings per month."[1] In another case the local mill expanded to serve 50 customers per day.

Studies show that when communities are electrified additional benefits accrue:

- *Overall health improves*: the 780 million women and children who breathe kerosene fumes inhale smoke equivalent to smoking two packs of cigarettes a day (IFC, 2010);[vi]
- *Childhood safety improves*: kerosene lanterns cause half the burns that are the number two cause of childhood injury or death in southern India (USAID, 2014);[vii]
- *Literacy rates and grades improve*: when a village in Sudan received solar power, the number of students passing exams doubled (World Bank, 2011);[viii]
- *Female employment improves:* rural electrification in South Africa more than doubled female employment (by 9.5 percentage points over a baseline employment of 7%);[ix]
- *Entrepreneurship increases*: when non-electrified communities in Ghana received electricity, the number of microenterprises more than doubled (World Bank, 2008);[x]
- *Income goes up*: In Vietnam, rural electrification increased income 46%. School enrollment increased 31% and 66% for boys and girls, respectively.[xi]

Meanwhile, Energy Within Reach would directly provide 15 million people in Africa and India with access to energy in the next three years, preventing 6 million metric tons of carbon emissions. Moving beyond the direct, near-term impacts, this initiative will set the stage for much greater business and customer-driven adoption, with the opportunity to provide up to 360 million people with access to energy. Reaching that scale will prevent 35 coal-fired power plants (10.5 GW of capacity) and prevent up to 145 million metric tons of carbon emissions by 2025.

Why can Rocky Mountain Institute and Carbon War Room succeed?

We don't pretend that forging solutions will be easy or quick. But it is important. The challenges are inherently complex, multi-stakeholder, and multi-cultural, yet the reward is great. Success will require deep technical expertise; intense collaboration across supply chains, stakeholder groups, and countries; proven partnering ability; and long-term dedication.

Rocky Mountain Institute and Carbon War Room bring more than 30 years of experience driving the cost-effective shift away from fossil fuels, and toward energy efficiency and renewable energy. Our rigorous, analytical, whole-systems thinking generates design breakthroughs and novel insights. We champion market-based solutions that make as much sense economically as they do for the climate. As an independent, non-partisan, nonprofit organization, we convene and collaborate with diverse stakeholders—corporations, governments, NGOs, researchers, customers, and more—to tackle together difficult barriers no single actor can overcome alone. And our staff ranks include business consultants, engineers, economists, policy analysts, researchers, designers, and project managers; all with sought-after technical expertise in fields such as solar PV, battery energy storage, electricity markets, finance, supply chain optimization, and product commercialization.

[1] Equivalent to $105 USD, or approximately the Kenyan GDP per capita per month.

Our track record of success and accomplishments includes:

Whole-Systems Design and Technology Cost Reduction

- **Hypercar—**Pioneered a radically fuel-efficient vehicle design employing principles (e.g., powertrain electrification, aerodynamics, lightweighting) now seen in production autos
- **Solar Balance of Systems—**Identified solar PV's non-module "soft" costs as a major cost-reduction opportunity, influencing the U.S. Department of Energy's Sunshot targets
- **Empire State Building—**Energy-efficiency breakthroughs unlocked annual energy cost savings of $2+ million, exceeding targets and reducing energy use by ~40%

Integrating Economic Development and Carbon Reduction Goals

- **Reinventing Fire—**Landmark analysis identified a cost-effective pathway ($3 trillion NPV savings) to 80% renewables, 80% GHG reductions, 158%-bigger U.S. economy
- **Reinventing Fire: China—**Multi-year analysis in partnership with U.S. and Chinese agencies identified the maximum share of efficiency and renewables that could support China's forecasted economic growth
- **Ten Island Challenge—**Proving low-carbon economies by transitioning Caribbean island-nations from dirty, expensive, imported fossil fuels to efficiency and renewables

Multistakeholder Convening and Collaboration

- **Electricity Innovation Lab (e⁻Lab)—**Convenes diverse and sometimes at-odds stakeholders (e.g., regulators, utilities, solar companies, nonprofits, advocacy groups) to address complex system challenges and opportunities facing the electric grid
- **Business Renewables Center—**After winning a Bloomberg New Energy Finance FiRe award for the idea in April 2014, launched a platform to scale corporate purchasing of renewable energy with founding corporate members representing more than $430 billion in annual revenue
- **Trucking Efficiency—**Mobilized fleet owners and operators and industry trade group the North American Council for Freight Efficiency to improve fuel economy

Finance

- **Solar PV and Batteries—**Groundbreaking analysis pivoted investors and banks (e.g., Bank of America, Barclays, Citigroup, Fitch Ratings, Goldman Sachs, Morgan Stanley, UBS) to reevaluate the financial viability of current utility business models
- **truSolar—**With industry partners, launched a FICO-like risk screening consortium and standard for commercial solar projects; now being used by Distributed Sun's beEdison, which won a Bloomberg New Energy Finance FiRe award in April 2015
- **PACE—**Pioneered the first commercial property assessed clean energy financing for building efficiency retrofits
- **Shipping Efficiency—**Secured multiple channels (e.g., tax incentives, loan criteria, PACE-like methods) for financing to improve fuel economy of the globe's maritime fleet

Who is our team?

"RMI was the secret sauce in our work at the Empire State Building project. They brought the possibilities, reduced them to numbers, drove the analytical process, and helped structure our contracts so that vendors had to deliver in a monitorable and verifiable fashion. RMI drove collaboration across all the companies involved in the project to deliver innovation and unprecedented results. Stephen Doig was a transformational leader who incorporated our commercial approach to the bottom line in his work, and I am sure he can do it again on this critical opportunity." –Tony Malkin

RMI managing directors Stephen Doig, Hervé Touati, and Curtis Probst will lead the initiative.

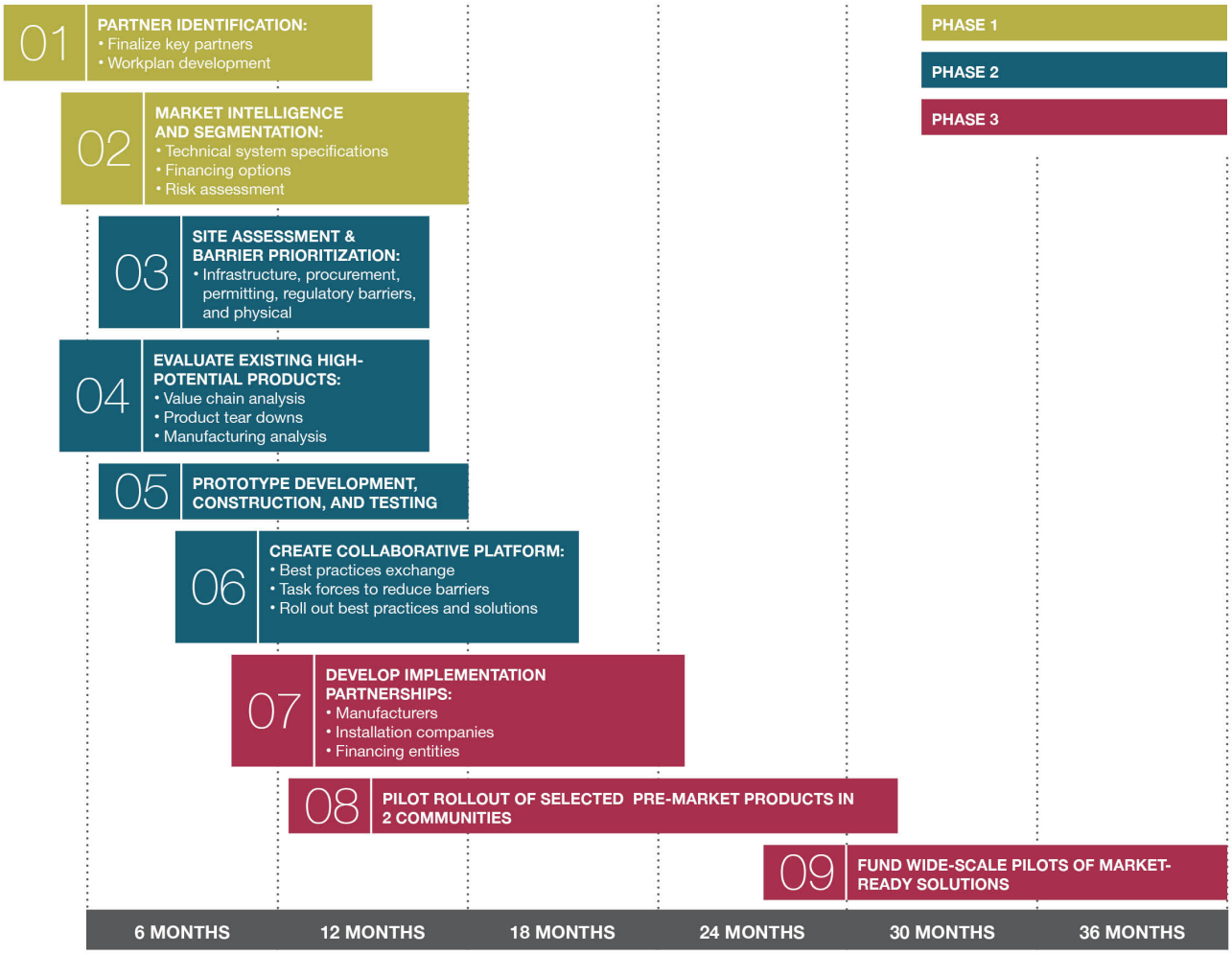
- Stephen Doig first joined RMI in 2007 after more than a decade at McKinsey & Co., where he was a Senior Leader in the Sustainability and Resource Productivity Practice. He focused on energy efficiency and energy productivity, including breakthrough design concepts and "green" product development, including solar PV cost reductions.
- Hervé Touati was previously COO of the non-wind renewable businesses at E.ON, Germany's leading utility. Hervé was founder and CEO of E.ON Connecting Energies, E.ON's new distributed solar business. Earlier, he worked at McKinsey & Co. serving the financial and energy sectors.
- Curtis Probst spent 15 years at Goldman Sachs, most recently as a Managing Director in the investment banking division. He led Goldman's energy efficiency and renewable energy financing group, and before that worked at Salomon Brothers.

Who are the partners?

Ambition of this magnitude will require collaboration with other partner NGOs and businesses. Working with them will shorten the time to deploy solutions that could exponentially transform the energy opportunity for those on the lower rungs of the energy ladder. Other potential partners include:

PARTNER GROUP	INTERNATIONAL ORGANIZATIONS & RESEARCHERS	ENTREPRENEURS & STARTUPS	FINANCE SPECIALISTS	RENEWABLE ENERGY DEVELOPERS	INNOVATIVE DESIGNERS
DESCRIPTION	Multilateral organizations and efforts currently tackling the challenge of developing world electrification	On the ground, in-country businesses with experience deploying off-grid solutions	International micro-finance & innovative financing experts	Renewable energy developers offeing both on- and off- grid solutions and microgrid developments	Expert design firms experienced in large scale manufacturing and integrative design
ROLE	Bring holistic knowledge about what is currently going on in this space, and the efficacy of different methods at different scales	First hand knowledge of barriers, challenges and strategic opportunities on the ground	Support financing methods that can unlock further access to solar	Bring to bear expertise on scale, construction, and all develoment-related aspects of project	Tear-down analysis and design support to identify cost reduction measures
TARGETED PARTNERS	- CCI Solar (CalTech) - CGI - The Earth Institute: Millennium Village, Shared Solar - Global Off-grid Lighting Association - Lighting Global - Power Africa - IEEE Smart Vilage	- BBox - Devergy - Fenix International - Powerhive - SELCO - SELF	- Grameen - Heifer Internation - IDB - IFM - World Bank	- Aqueon - EcoNet Renewable Energy - NRG Renew - Princeton Power - SunEdison - SunPower	- IDEO - Munroe & Associates - Otherlab - LBNL/LANL

What is the workplan?

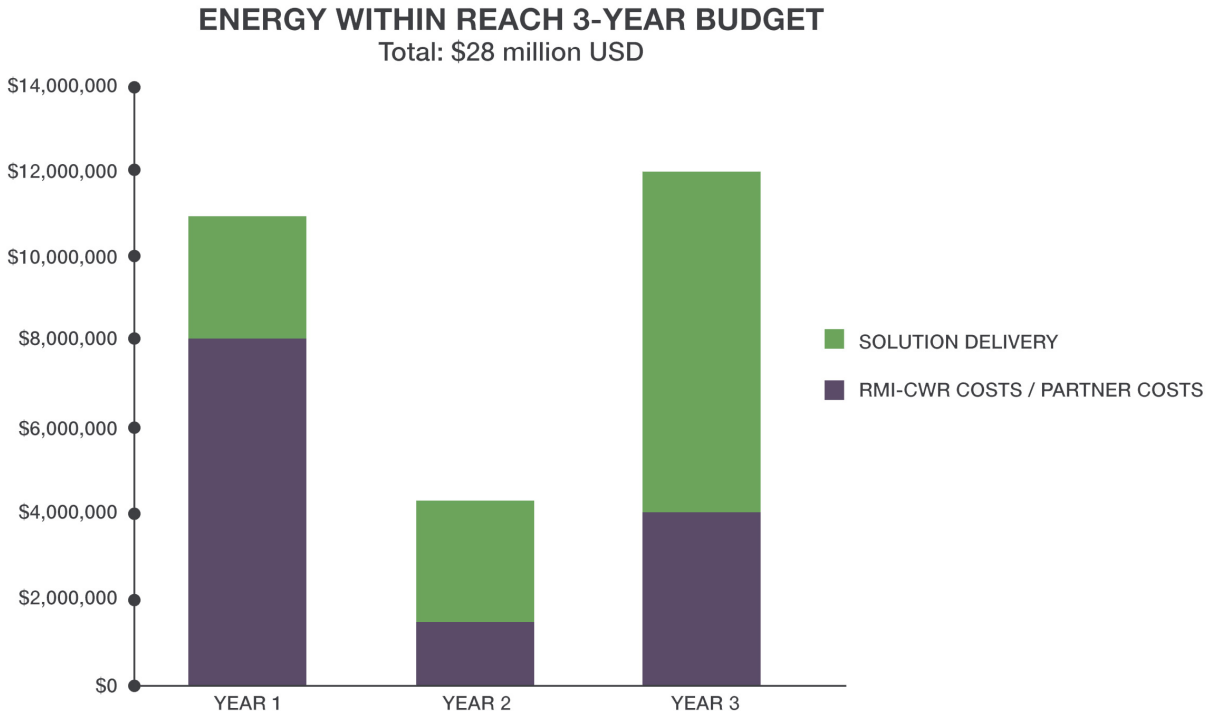


What is the budget?

The initial phase will cost ~$3.8 million, and the platform development and design optimization process will cost ~$6.1 million. The final phase of implementation (in the last year of the grant) will cost $17.9 million. Delivering solutions will first occur mid-way in the grant, and continue through the full three years. After the three-year period, we expect to have:

- Reliable, deployed energy solutions delivered at low cost (less than $150 per home system)
- Working systems that have been field tested and optimized
- High initial market uptake in selected regions
- Clear path to scaling in subsequent years
- Investment funding and financing lined up for explosive growth

In the three years funded by this grant, RMI-CWR will spend 50% of the budget on product delivery, providing solar systems to customers in real-world conditions but not yet at scale economics. We believe this design-build-test-improve approach will speed finding tractable solutions before driving full-scale implementation; a pitfall that many startups fall into.



What is the integrated budget and detailed workplan?

PHASE	ACTIVITY	PARTICIPANTS	TOTAL COST	PHASE COST
PHASE 1: Market, site, and partnership assessment	a) Partner identification and collaborative workplan development	RMI-CWR, Partners (e.g., EcoNet, d.light, WakaWaka, Powerhive, etc.)	$310,000	$3,790,000
	b) Market intelligence (including system specifications, financing options, and risk assessment)	RMI-CWR, SE4All partners, SELCO-India, SunFunder, Millennium Villages	$2,230,000	
	c) Site assessment and barrier prioritization (including infrastructure, procurement, permitting, regulatory barriers, and physical surveys)	RMI-CWR, SE4All, in-country vendor partners, installers	$1,250,000	
PHASE 2: Create platform to optimize solutions and product redesign	a) Evaluate existing high-potential products, value chain and manufacturing analysis, and tear-downs	Partner Org. (e.g., Munroe and Georgia Tech)	$800,000	$6,110,000
	b) Prototype development, construction, and testing (iterative process)	RMI-CWR, Partners (Munroe, IDEO Partners, IEEE, d.light, GOGLA, etc.)	$2,900,000	
	c) Create collaborative platform to enable best practices, create task forces to reduce barriers, and roll-out best practices and solutions	RMI-CWR, and select partners	$2,410,000	
PHASE 3: System and business model implementation	a) Define financing and determine financing partners, manufacturing partners, deployment, and installation partners	RMI-CWR	$600,000	$17,940,000
	b) Pilot rollout of selected pre-market products (2 communities)	RMI-CWR, Partners (prototype developers and other local vendors)	$4,940,000	
	c) Fund wide-scale pilots of market-ready solutions	Local vendors	$12,400,000	
Partner Deployment	Customer identification, acquisition, and service	Participants	TBD with Partners	TBD with Partners
	Maintenance of existing systems and upgrades (stackable)	Participants	TBD with Partners	
	Publicize the program and enroll customers	Participants & RMI-CWR	TBD with Partners	

Endnotes

[i] World Bank shows that 75% of people in India DO have electricity access. We calculated 25% of India's 1.252 billion = 313 million (http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS). The IEA estimates 587 million in Africa do not have access to electricity (http://www.worldenergyoutlook.org/resources/energydevelopment/accesstoelectricity/)
587m + 313m=900m

[ii] http://www.worldenergyoutlook.org/

[iii] https://www.iea.org/publications/freepublications/publication/africa-energy-outlook---executive-summary.html

[iv] https://www.iea.org/publications/freepublications/publication/India_study_FINAL_WEB.pdf

[v] https://twitter.com/irena/status/588310880955142147

[vi] http://www.ifc.org/wps/wcm/connect/a68a120048fd175eb8dcbc849537832d/SolarLightingBasePyramid.pdf?MOD=AJPERES

[vii] http://www.usaid.gov/news-information/frontlines/energy-infrastructure/lighting-lives-rural-poor

[viii] http://www.worldbank.org/en/news/feature/2011/02/08/in-sudan-where-there-is-power-there-is-development

[ix] The Effects of Rural Electrification on Employment: New Evidence from South Africa. P. 20. http://www.princeton.edu/rpds/papers/dinkelman_electricity_0810.pdf

[x] http://siteresources.worldbank.org/EXTRURELECT/Resources/full_doc.pdf

[xi] Welfare Impacts of Rural Electrification: Evidence from Vietnam. Table 7. P. 32. http://siteresources.worldbank.org/EXTEAPASTAE/Resources/ASTAE-Benefits-of-Rural-Electrification-Vietnam.pdf