"Learning beyond the Light Bulb" among Least Developed Countries based on a Sustainable PV Solar Utility Model

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***Abstract*— Sustainable provision of off-grid solar electricity for Less Developed Countries (LDC) is a basic first step toward enabling a range of *Beyond the Light Bulb* initiatives. The off-grid electricity program of the Community Solutions Initiative (CSI), still at an early stage of development in several countries, is focused now on demonstrating sustainability and scalability. Initial steps to *incubate* ideas as well as design, deploy, and lease SunBlazer units have honed CSI's understanding of more holistic approaches to community empowerment. Effective product design requires in-country value chain economics whereby local franchisees *demonstrate* added value in their own context and marketplace. Lessons learned from the process of incubating and demonstrating the success of businesses owned by and for LDC communities contributes critically to a learning platform to *educate* on just and sustainable development practices. Thus the guiding principle of CSI is to *incubate, demonstrate*, and *educate* (*I-D-E*) across age groups to grow human capacity and community empowerment. This paper describes CSI accomplishments in sustainable community entrepreneur-based businesses to date and describes the need for broader INGO and community partnerships for "learning beyond the light bulb."**

Keywords—sustainability, community empowerment, INGO, partnership, CBOC,* and *value chain economics.

I. Introduction

We all know the numbers. 1.4 billion people lack access to reliable grid electricity. This population is commonly called base of pyramid (BOP) and these communities most likely live in a less developed country (LDC) that faces interrelated challenges of physical, geographic, economic, and/or socio-political insecurity. How might IEEE engineers respond? This paper covers the IEEE Community Solutions Initiative (CSI) initial incubation of SunBlazer units. It then demonstrates CSI's sustainable market-based solar electricity franchise system in Haiti that is now expanding to several African countries. Finally, it considers progressive education as our requisite step toward CSI and partners learning and sharing about community development and a better future.

For starters, though, picture a CSI-partnering community. Say the SunBlazer deployment, franchisee training modules, and electrical services have all worked perfectly. Another off-grid community thereby enjoys reliable power and access! Now picture this same community 30 years in the future. If community members were to hold up a local newspaper three decades from now, what might its headlines and articles cover? Would they celebrate advances made by local youth, entrepreneurs, teachers, health workers, farmers, elders, and engineers? Would critical analysis recount how 2014 provision of off-grid electricity led to many empowering steps, including Internet access, linked global learning, and life choices for a once marginalized community? Hold this image. CSI's story is just in its introductory chapter. Its real measure of success will be known some time from now as newly minted human-centered incubation, demonstration, and education show how LDC and developed country learning may coincide and empower reciprocally.

Since 2010, CSI has pioneered a solar electricity business model for LDCs that is demonstrably sustainable once established with one-time philanthropic seed funding and IEEE volunteer development support. First deployed in post-quake Haiti, this model has now been introduced to several African countries. Off-grid communities are obtaining access to power, light, and opportunity that had once been denied to them. But while light is a basic need, it is not sufficient for the growth of individual and community capacity. Hence as CSI continues to *incubate* design and deployment of solar electricity, so too it must *demonstrate* a business model that works according to local value chain economics. And if there is to be any scalability of positive advances, a community will need to *educate* on just and sustainable development. CSI proposes, therefore, to link its members, partnering communities, franchisee entrepreneurs, and non-profit organizations via a curriculum based on integrated development lessons. Some of these modules will feature lessons gleaned from the work of engineers. Others will derive from development practitioners of other disciplines. Still other lessons will be posited by the very LDC communities that survive and thrive despite enormous challenges. Taken together, CSI will *incubate, demonstrate,* and *educate* (I-D-E) near and far on best practices in community-based development. There is the temptation to race ahead and just *educate* others as to how modern development should unfold. CSI proposes, instead, an I-D-E

cycle that steadily connects newly electrified and changing communities of LDC and developed country contexts.

After several years of cross-cultural and technical incubation, CSI now proffers a standardized charging station called the SunBlazer. It is a mobile platform with up to 80 portable battery packs (PBKs) and home lighting kits per station. The standardized business plan is based on CSI donating equipment and expertise to help establish a franchise that is owned and operated by local community entrepreneurs. CSI's initial philanthropic funding is similar to the United Nations Millennium Development Goal (MDG) campaign, which seeks donated seed funding from developed nations based on a fraction (0.7%) of their Gross Domestic Product (GDP) for the infrastructural improvements of LDCs. The MDG model assumes that from this bottom rung of the ladder upward a community or country can achieve self-sustenance and growth on its own. The MDG program engages major corporations and government agencies to jump-start national infrastructure. This, in turn, is expected to support trickle-down national economics that will align with transnational flows of capital, business, and growth. While CSI's approach does rely on IEEE institutional and member support to seed indigenous franchisee-run solar electricity service, its SunBlazer approach differs from MDG modeling from this point forward.

Each CSI start-up thinks big but is grounded in local context, ecology, economics, and learning. Drawing upon concepts introduced and tested over thirty years by Paul Polak and iDE (International Development Enterprises), recipient of GHTC's first annual Global Humanitarian Engineering Project of the Year Award in 2013, CSI's I-D-E process listens and responds to indigenous marketplaces, cultures, and consumers. (1) If we genuinely *incubate* appropriate human-centric design and deployment, and *demonstrate* product/service value in local economies, then no one is a BOP poverty victim who idly sits and waits for U.N. personnel or global north experts to lift and place them on the bottom rung of a development ladder! Rather, all people are consumers who may vet products and services. Among these consumers are some entrepreneurs. And there are citizen scientists of local ecology and demography. So, too, there are communities eager to grow their own human capacity through learning. Some of these people will emerge as respected contributors to broader sustainability goals. All of us in this enterprise of just and sustainable development have the potential to *educate*. In each country of deployment, the SunBlazer model seeks to bring basic electricity to at least one million people, which means electrifying approximately 167,000 homes that rely on 2,000 SunBlazer systems. CSI strives for immediate impact directly on impoverished off-grid rural communities by planting profitable start-ups owned and operated by an in-country company and local franchisee entrepreneurs. As explained in the next section, this model is a demonstrated success in Haiti and is being standardized for application in any country that shows its ability to support such a business model and engage in further education on sustainable development. The CSI cycle of I-D-E proceeds.

II. Recent Progress

A. Haiti & Afrcia Programs

In 2010-12, new initiatives were launched in fifteen villages in Haiti, and in 2012 three new African partners began developments in Cameroon, Nigeria and South Sudan. In late 2012, the Haiti systems experienced technical difficulties which contributed to a loss of revenue and the need for an aggressive retrofit program of the battery pack Low Voltage Protection circuit board and the addition of charger boosters on each of forty-eight 12V Sub-Chargers on each SunBlazer. Since then the Haiti program has been stabilized. In late 2013, the latter expanded on its own (see below). Note that Haiti was the first implementation of the project where the expected bugs were being worked out of the system.

The Africa projects have not yet received SunBlazers due to a lack of funds to build the planned ten systems for each. However, all three already had or were building charging stations of their own design, so CSI made an early contribution of funds for PBK-HKLs so testing of the village business model could progress. All three resourceful partners conducted market surveys and secured customers for pilot runs. Steady progress is being made in evaluating and adjusting individual sustainable business models despite the temporary lack of SunBlazers.

In addition to these original Africa partner initiatives, a fourth initiative is underway by Seattle University CSI members and EWB-USA (Engineers without Borders) team to electrify a school near Lake Tanganyika in Kenya. After completion of this solar-plus-wind generation station and wiring of the school scheduled for August 2014, the supply of electricity to surrounding villages by the SunBlazer–PBK model is scheduled to be analyzed.

In terms of people reached with electricity, Sirona Haiti now has SunBlazer capacity for 1,162 homes or 6,972 people at six per household but also has secured a UNEP grant for 3,100 more homes with PBKs and HLKs or 18,600 people, while the three new Africa groups are projecting to exceed 10,000 people by yearend 2014. This reaches a grand total of over 35,000 people served. This work beyond Haiti depends on new CSI seed funds and is just getting off the ground in 2014.

Note that the three Africa initiatives have collectively raised over $400,000 on their own to expand their systems considerably based on the CSI business and technical model. These initiatives will be reporting independently at GHTC 2014. A portion of these funds was recently matched by CSI to begin constructing six new SunBlazer IIs in Cameroon.

Fig, 1. SunBlazer design deployed in Haiti (SB-I)

B. SunBlazer II (SB-II)

Major milestones of 2013-14 were further incubation and completion of the new design, construction and field testing of SunBlazer II as well as refined Standard Operating Procedures that incorporate lessons learned from deployment of the SunBlazer I in Haiti. Chief among these improvements was delivery in kit form instead of a complete plug-and-play assembly on a trailer. This enables more efficient transport in a shipping cargo container. It also allows for SunBlazer II carriage in separate pieces over the "last mile" of deployment where roads may turn into trails that are impassible by a vehicle. Additional goals were lighter weight, simpler and more versatile solar panel mounting, better station battery security, and lower cost. The tradeoff for the new design is a four-hour final assembly deployment time for three people once at the site compared with less than an hour with two people for SunBlazer I. The two models are shown in Figs.1-3 and the PBK and light kits in Fig. 4.

The first SunBlazer II was demonstrated at the IEEE Power and Energy Society Transmission and Distribution Show in Chicago in April 2014, immediately after which it was air-shipped to Cameroon to begin extensive field trials with the CSI partner Torchbearer Foundation.

C. New PBKs and Light Kits

A total of 572 surplus portable battery kit cases that IEEE paid for but were never used are being retrofit in Haiti with new LVDs, batteries and a new more reliable charging connector used on the SB-II. In addition, new light kits to match are being built by a Haitian contractor, DSA/Luminex. All units will be shipped directly to Cameroon for use in Africa. This step further nurtures a local value chain that positively churns the Haitian economy rather than a distant country's GDP. Presently, sets of both units will be shipped directly to Cameroon for use in Africa. But as in Haiti the eventual goal is for African countries to grow their own production and economic process.

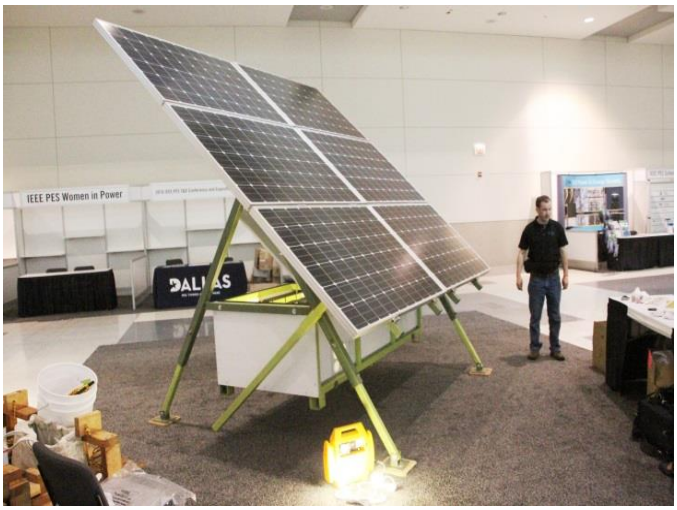


Fig. 2. SunBlazer II at Chicago T&D Show, April 2014

D. New Potential Partners

Interest continues to grow with more than a dozen potential partners emerging in new countries. IEEE CSI has set a goal to initiate new startups globally at the rate of *ten per year,* based on a standardized business plan, financial model and operating procedures modeled on the Haiti developments which incorporate the experience gained. The remainder of this paper will describe the standardized products, business plan, operating procedures, education models, and funding plans necessary for success.

Fig. 3. SunBlazer II in Rickshaw Mode with temporary wheels

Fig. 4. Portable Battery Kit (PBK and Home Light Kit. (HLK). Two 4W LED bulbs are each equivalent to 25W incandescents

E. Standard Operating Procedures (SOPs)

A standardized easily replicable business model needs the critical component of Standard Operating Procedures which codify in detail every operation needed to form and operate the company, and then track the status of each operation on a weekly basis to quickly see the health of operations. SOPs track the major categories of Suppliers, Processes, Franchisees and Outputs, each with a detailed list of sub-categories. The master list is shown in Figure 5.

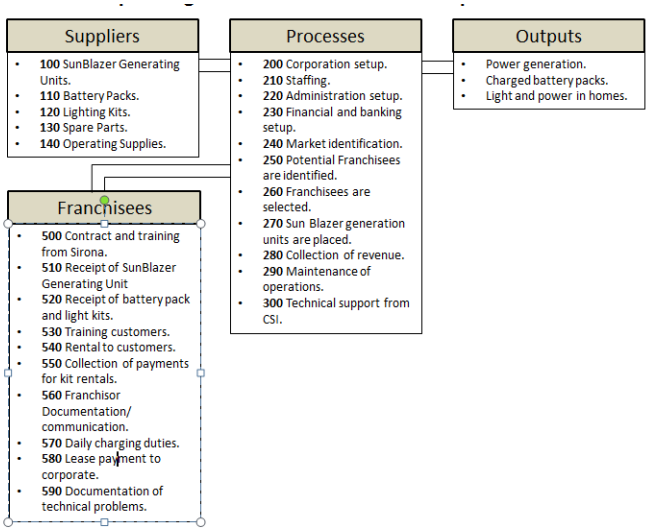
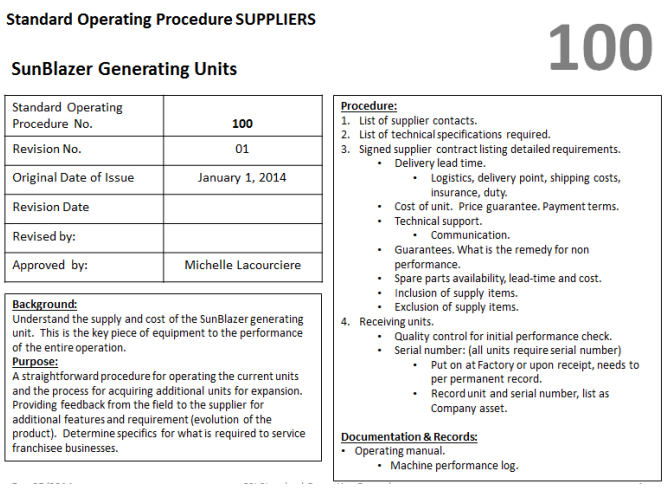


Fig. 5. Standard Operating Procedures Core Process Map.

Each of the sub-categories is a separate SOP. An example for Suppliers is shown in Fig. 6, and expanded sections in Figs.7 (Suppliers). Fig. 8 is the expanded list of Franchisee and Processes SOPs. Filling in details of SOPs continues as a work in progress and can be customized beyond these lists as needed.



Standard Operating Procedure SUPPLIERS **100**

SunBlazer Generating Units

Standard Operating Procedure No.	**100**
Revision No.	01
Original Date of Issue	January 1, 2014
Revision Date	
Revised by:	
Approved by:	Michelle Lacourciere

Background:
Understand the supply and cost of the SunBlazer generating unit. This is the key piece of equipment to the performance of the entire operation.
Purpose:
A straightforward procedure for operating the current units and the process for acquiring additional units for expansion. Providing feedback from the field to the supplier for additional features and requirement (evolution of the product). Determine specifics for what is required to service franchisee businesses.

Procedure:
1. List of supplier contacts.
2. List of technical specifications required.
3. Signed supplier contract listing detailed requirements.
   - Delivery lead time.
     - Logistics, delivery point, shipping costs, insurance, duty.
   - Cost of unit. Price guarantee. Payment terms.
   - Technical support.
     - Communication.
   - Guarantees. What is the remedy for non performance.
   - Spare parts availability, lead-time and cost.
   - Inclusion of supply items.
   - Exclusion of supply items.
4. Receiving units.
   - Quality control for initial performance check.
   - Serial number: (all units require serial number)
     - Put on at Factory or upon receipt, needs to per permanent record.
     - Record unit and serial number, list as Company asset.

Documentation & Records:
- Operating manual.
  - Machine performance log.

Fig. 6. Typical SOP for Suppliers, 1 of 5

F. The Operations Dashboard

A synopsis of all operations is shown in the Dashboard of Fig. 9. This summarizes the health indicators compactly so that variances can be quickly detected for remedial action. Four key Company statistics that report the health of the business are continuously monitored:

1) How much revenue is possible vs. actual collected for total Company.
2) How much revenue is possible vs. actual collected by Franchisee
3) Total number of battery kits rented by total Company, by Franchisee
4) Total number of battery kits collected for by Franchisee (i.e. health of Franchisee business)

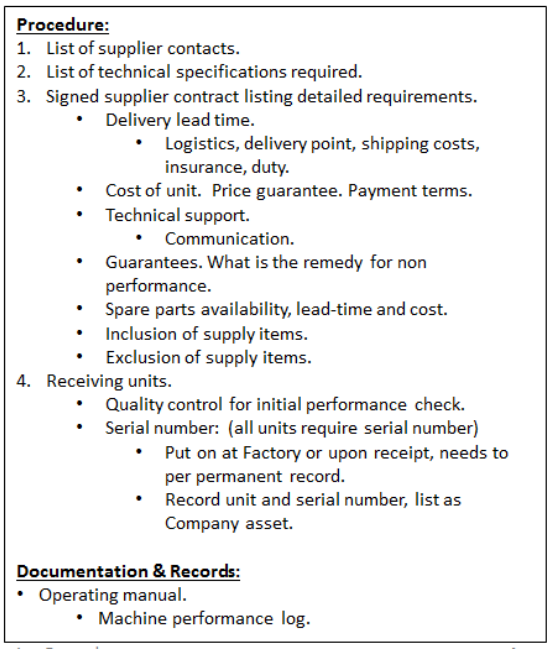


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Fig. 7. Detail of Fig. 6, SUPPLIERS Procedure, Documentation and Records

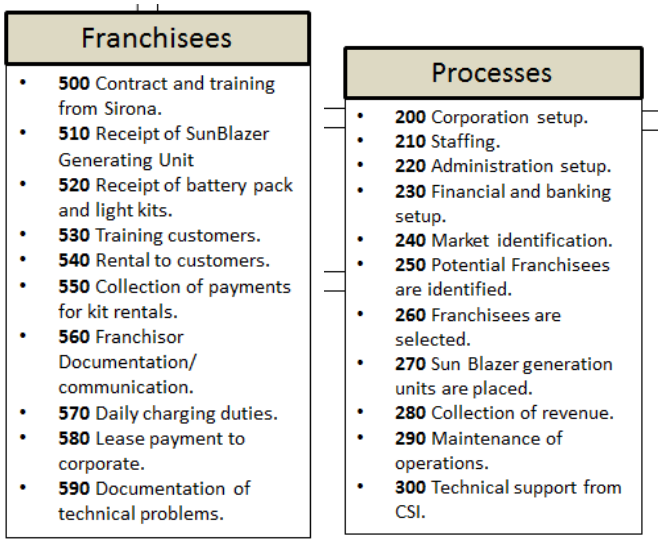

Fig.8. Expanded list of FRANCHISEES & PROCESSES SOPs.

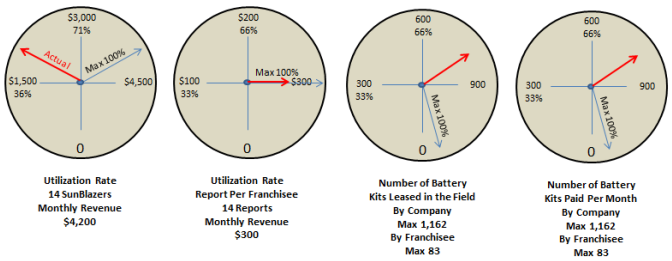

Fig. 9. Four Dashboard parameters from SOP date give instant reading of corporate health. See details in text.

Global issues are immediately communicated with utilization rates. The standard operating procedures create the activities that gather the data reported on the dashboard. The company discipline of reporting all statistics regularly is essential to realizing the value of the tool.

III. DEMONSTRATING SUSTAINABILITY

A. Analysis based on Haiti Actuals

The Haiti operation has been studied over the past year by the CSI Implementation Advisory Committee, headed by an experienced entrepreneur running his own highly successful startup, and conditions for sustainable operation determined with a newly structured business model using a targeted capital cost of $15,000 for quantity production for the SB-II with eighty-three PBKs and HLKs. The model was tested against actual performance in Haiti during the first eight months of operation before technical and operations problems developed. The model clearly shows sustainable operation when the company reaches a size of twenty systems to amortize the fixed costs of salaries of the in-country manager, technician, office rental, travel and bookkeeper costs. The fourteen units currently deployed in Haiti will generate enough cash to operate sustainably; but this amount is slightly short of accumulating enough capital to cover the replacement of PBK batteries, estimated to be needed soon for the six stations deployed in 2011. This situation is perfectly normal for any startup company at this early stage of development. Various quantity assumptions are summarized in Table 1 below.

Table 1: IRR and NPV vs. No. Units. 5 units will lose $33k/year. 10 units is sustainable but does not cover depreciation. 20 units is sustainable with positive cash flow. 100 units make enough to build 1 new unit per month; 200 units 2 new units per month. System lifetime of 10 years is highly conservative; 20 is more realistic; Ref. D. Welbourn.

Units	Capital Value $K	Discount %	Lifetime Yrs.	IRR	NPV $K
1*	15	5.0	10	14,0	6.02
5	75	2.5	10	NA	-33.3
10	150	2.5	10	NA	-85
20	300	2.5	10	0	-210
100	1,500	2.5	10	3.46	73.5
200	3,000	2,5	10	5.24	428.8

*Calculated without overhead, demonstrates contribution margin

Like all the CSI partners, Sirona Haiti will have to raise additional capital to expand operations. It would be possible to raise prices for the lease of the PBK and HLKs; however, the current $6.25 per month was based on the equivalent expense that families spend in Haiti on a monthly basis for kerosene and candles.

At twenty SunBlazer systems, however, the model calculates that the company will be firmly at breakeven with a small positive cash flow that will enable the project to operate in perpetuity including replacing capital equipment. Currently Haiti has only fourteen systems, having lost one in a tragic fire in early 2013, which means six more are needed for the entire system to break even at current operating rates and costs.

B. Africa Projects Sustainability

The Africa partners have all modeled sustainability scenarios based on Haiti experience and insights as well as their own experiences with microgrid operation in Cameroon and Nigeria. In all three countries the price people seem willing to pay appears 30% or more higher than Haiti, for reasons that are not totally clear, which ongoing pilot programs in all three regions will soon clarify. Also affordability varies with time and circumstance; as prices come down demand for quantity of electricity will increase and vice versa. The next year should yield solid sustainability data but calculations are already close to the Haiti experience.

C. CSI Startup Seed Funding Plan& Performance

The current plan for CSI seed funding is ten units per new initiative, judged to be enough to demonstrate stable operation and competency of the management and operations team. Since the market surveys in the three African countries indicate a higher price tolerance than in Haiti, ten units may

well be enough for breakeven. For example, if $10.00 per PBK/HLK is charged all other parameters staying the same, ten operating SunBlazers will provide a positive Internal Rate of Return (IRR) of 4% and Net Present Value (NPV) of $10,000. Upon completion of surveys and the determination of pricing, a startup budget and capital plan can be completed. Additional grants and subsidized expenses during start-up are a desirable option.

Upon demonstrating ten units in full operation over a period of six months the company should be well positioned to begin to raise social investment capital or loans to grow to an estimated 200 units and achieve self-sustainable growth. The capital investment to achieve this point is an estimated $3M and Net Present Value and Internal Rate of Return will be $428,000 and 5.25% respectively. It is important to note that this is based on supplying electricity at the same price as inferior equivalent kerosene and candles.

The revenue stream at this point indicates that the company will be making enough to be building two to three more units per month on its own. This is a growth rate of about 10% per year. However to reach 2,000 SunBlazers and a million people in ten years will require all startups to raise capital for a growth rate of an estimated 200 units per year. This must be a controlled ramp to be manageable, but with a successful fully documented standard franchise model and a successful track record it is achievable and makes economic sense. The company will grow exponentially and its own exponentially growing revenue stream will help offset some of the outside investment needed.

IV. IEEE FOUNDATION AWARDS CSI SIGNATURE PROJECT STATUS

The ability to execute the ambitious expansion plans depends first on CSI and its partner(s) ability to raise the necessary CSI/NGO seed funding or contributions in kind. The in-country partner company has to match this donation with a significant effort on its own to secure potential franchisee operators, have those local entrepreneurs conduct community meetings and market surveys, secure potential customers and receive business and technical training prior to arrival of CSI donated equipment. The company needs to prepare its own business plan and franchise business application for CSI and IEEE vetting and approval before formal agreements are consummated.

In June 2013, CSI began working the Power Energy Society (PES), IEEE Foundation, and Nuclear & Plasma Sciences Society (NPSS) to launch an IEEE-wide fundraising program called a Signature Program. IEEE has many separate funds but a Signature Project brings special handling, publicity and professional fundraising staff additions. PES donated funds for a consulting company to determine the feasibility of a $10M fund for seed funding, ramping up to be able to support ten new startups per year by 2017, and has also donated a generous kick-start fund for 2014. Signature Project approval was granted in June 2014. On the strength of this, CSI plans to build at least sixteen new SB-IIs in 2014; six units will be built in Cameroon with matching funds from the partner, and the ten units will go to priority Africa partners. As new funds become available the number of new SunBlazers will be increased accordingly. The long-term goal for production is to assemble at least all the mechanics in the countries of the new startups. New partner agreement criteria are being drafted for review. Meanwhile the first seed unit electronics package will be built in the United States. Supply chain delays are a major issue especially for Africa when parts have to be shipped from China.

V. BEYOND THE LIGHT BULB ROADMAP: EDUCATION

Developing broader *Beyond the Light Bulb* international NGO (INGO) partnerships is based on CSI tenancy and membership in the new Posner Center for International Development in Denver, Colorado. Chartered in 2013, the Posner Center houses seventy INGOs and for-profit businesses working in more than 100 countries on challenges of poverty and human capacity. Its space is a renovated 1872 municipal barn that once served Denver's original horse-drawn trolley system. [3] While approaching poverty and human capacity challenges from sixteen disciplines, the tenant/members are dedicated to global sustainable development. CSI endorses the mission statement of the Posner Center, which is to "grow a community of innovators who seek lasting solutions to global poverty." CSI's presence at the center also joins in its vision "to become the epicenter of global community empowerment." Thus CSI's first goal at the center is to continue building relations among many of the other sixty-nine development organizations. A spectrum of engineers (energy, electrical, mechanical, transit, civil, agricultural, and water) works alongside practitioners from these other development sectors and entry-points: Agriculture & Food Security, Children, Climate & Environment, Disaster Relief & Humanitarian Aid, Education & Schools, Entrepreneurship & Business Development, Gender Equality, Governance & Institution-Building, Health, Human Trafficking, Peace and Justice Policy and Research, Refugees & Asylees, Technology & Innovation, Water & Sanitation, and Women & Girls. CSI's goal is to live and learn beyond its long-standing IEEE expertise in energy and electrification … "learning beyond the light bulb."

Second, CSI is collecting data and case studies from these organizations and the communities with which they work to build a holistic community-based education system. The delivery system will be what CSI calls a *Community-Based Online Curriculum* (CBOCs). Progress on a CSI three-year development proposal with demonstrations and case studies is under consideration by the IEEE Education Activities Board. In addition, separate technical education proposals are underway for the Cameroon and Kenya deployment programs. However, to put a broad and holistic community-based education rationale into context the academic underpinnings need to be understood. CSI starts with *incubating* ideas and products, *demonstrating* their value in the marketplace, and

educating coherently on the basis of diverse lessons learned in the pursuit of just and sustainable development. The Posner Center is deploying two global classrooms capable of "pushing and pulling" pertinent sustainable development modules for and among LDC and developed country "communities of learning." The latter, for instance, may include a CSI partner institution connected to a SunBlazer franchise. Or it may include IEEE members globally. Or it may reach North American students who approach challenges of just and sustainable development via engineering and other disciplines.

A. Incubating Ideas and Community Outcomes

Alongside Polak's paradigm of thinking big, another development luminary impacting CSI's work is Bangladeshi Nobel Laureate in Economics Amartya Sen. His integrated approach for human and community empowerment is based on exhaustive empirical study of the success and failure of both empires and impoverished countries. He posits that there are five key and simultaneous variables of human capacity, which comprise the freedom to make sound choices about development. These variables are the basis of community empowerment. Communities and individuals must develop and enjoy meaningful economic roles, and not be mere cogs in some other country's or multinational corporation's wheel. There must be transparency and access to information, and today this includes basic Internet connectivity. Interrelated social opportunities (health, education, shelter, nutrition) are requisite. Physical security from natural and human threats must be assured by state and society. And fifth, citizens must have received sufficient education to think critically and participate politically. [4] To be sure, CSI franchisees of solar electricity service do not stand alone, nor do they lead every cause. But they are essential catalysts amidst broader change, even as they enjoy the *meaningful economic role* of entrepreneurs who can now earn good incomes for bringing light to unlit homes and communities. Their service of electrification enables others to acquire meaningful economic roles, too. And it is part and parcel of all five of Sen's factors for "development as freedom."

B. Catalyst Role & Impact of Community Entrepreneurs

Entrepreneurs provide a means for connectivity so that *transparency* and *social opportunities* – news, education, health services, and financial transactions – become a rural community's daily reality and not just another's comparative advantage. Their provision of off-grid power enables other forms of power and energy, such as the human energy and collective will to face change, incubate ideas, pursue local and global knowledge, take calculated risks, grow local leadership, forge protection from outside threats, hold governments and militaries accountable, reason critically for the future, and communicate a vision for one's own people and the broader world. These franchisee entrepreneurs, acting in concert with CSI and its partners, provide hope in countries and villages that are multiply wounded by past colonialism, modern globalization, natural geography, and particular socio-political challenges. Standard approaches to "problem-solving" – the bread and butter skill set of any good engineer – may fail if they do not take into account the deeper challenges and complexities of deeply traumatized LDC countries. As challenging as these realities are, they are also hopeful, and it is indeed positive community empowerment when people have light and then "learning beyond the light bulb" for purposes of crafting their own future.

C. Essential Basics of Community Empowerment

Wangari Maathai, a Kenyan Nobel Laureate of Peace, reinforces Sen's five basic variables of empowerment and liberating development with a clarion call for indigenous solutions for the particular context, culture, economy, and dreams of a people, if not their continent. She lampoons the MDG vision for LDCs that it is not the United Nation's or any western expert's vision to proclaim. In the case of Africa, she laments how 19th Century "white hunters wanted to 'bag' … on safari … a rhino, a leopard, a lion, a buffalo, and an elephant." [5] These big five trophies of yesteryear have their 21st Century counterpart, namely "a set of multipronged investments in development that can help communities climb the ladder out of extreme poverty. They are agricultural inputs; investments in basic health; improvements in education; more efficient and regular power, transport, and communication services; and the provision of clean drinking water and proper sanitation." [6]

D. How Not to Empower Communities

It is the proclivity of western experts, including engineers working among teams of highly educated and well-compensated development practitioners, to identify and monetize development needs, design and implement solutions, provide clearly essential needs (food, power, water, health, roads, connectivity), and yet create even more LDC dependency and vulnerability. John Dryzek and Robert Chambers describe how urban, western-trained experts direct the world's discourse on development from their own perspective of modern, capitalist, industrialized answers that begin and end with developed global north interests and logic. [7] While western expertise is clearly essential, it more helpfully advances LDC community-based empowerment via an I-D-E cycle if it is augmented (even corrected) by the broader discourse and pluralism that Dryzek and Chambers propound.

E. Successful Empowerment Example

Bridging the discourse of these two worlds is Leymah Gboyee, whose experience, insight, and spirit in guiding Liberia to post-war freedom, peace, and development brought her a Nobel Laureate of Peace. She, alongside another Nobel honoree and newly elected Liberian President Ellen Sirleaf Johnson, was instrumental in bringing down the tyrannical and murderous Charles Taylor. Gboyee attributes this success to culturally incubated ideas that were demonstrated to work in the ravaged Liberian context and marketplace, and then taken to scale through creative, soulful, and risky education; this is I-D-E essentially. [8] Gboyee's education was as much Liberian as western, and as culturally particular as universal.

Her course of community empowerment – not unlike Sen's proposed five steps – connected to the ideas, reality, hope, and relations of other marginalized and threatened communities across many boundaries. She valued her connection to advanced U.S. education, but only as it complemented, clarified, and challenged that which she learned first in Liberia and across West Africa.

F. Lesson for CSI and IEEE

Incubating ideas is as much a technical strength of CSI engineers as it must become a cross-cultural, inter-disciplinary, and community-engaging venture for CSI actors and its partners worldwide. The SunBlazer must work under diverse circumstances. And it must fit the state-societal "sweet spot" of particular cultures, conflicts, and challenges. A brilliant SunBlazer is of greatly diminished use in an LDC community that is prostrate before incapacitating forces.

VI. Education Roadmap

To "learn beyond the light bulb" means that CSI and IEEE incubation of ideas and demonstration of community- and market-based success is admirable but not enough standing alone. This approach to learning invites us to incubate and demonstrate ideas of, by, and for LDC individuals and communities. Education is to nurture what Bill McKibben calls "hopeful human landscapes" among community and development partners in some of the most marginalized and devastated places on earth. This is *not* "fix-it" problem-solving – again, something at which engineers excel – but rather I-D-E among potentially rich new relations. [9] It is transformative living by observing, examining, testing, and scaling up sustainable ideas … and these lessons may emerge anywhere! McKibben's examples come principally from LDCs but also from promising community enterprises in the United States.

A. CSI Goals at the Posner Center

CSI will focus on three modes of education in this mix of INGOs and for-profit enterprises that work in more than 100 countries and relate to several hundred communities facing significant change.

First, CSI is beginning to develop curricular modules based on case studies from the "*incubate* and *demonstrate*" lessons learned from its engineers, partners, and communities in the field. CBOC – "community-based online curriculum" – will be facilitated by CSI staff and instructors at the Posner Center global classroom. These courses do not replace, but critically augment existing curricula in LDCs and on global north campuses. These modules have four learning objectives: sound development practice in a challenged, diverse, and resilient world; language capacity-building in a world whose universal tongue is English; critical thinking and relational skills for applied work in challenging circumstances globally; and reciprocal contributions from engineers, scholars, entrepreneurs, development practitioners, policy makers, and communities worldwide. All of these functions connect "communities of learning" via online LiveStream and field-based research, development, and service.

Second, the CSI Ambassador Program works in two directions. One, it trains North American college and graduate school students with integrative skills in sustainable development. This includes product design, environment and climate, business of nonprofits and for-profits, entry points and skills sets for community-based and government-driven development, public and global health, and policy making. It also prepares them for a different reality as introduced steadily by their online student and instructor colleagues from around the world. Two, it trains LDC students and entrepreneurs seeking advanced and holistic education for global development practice. *In situ* courses will be held twice a year at the Posner Center, and may be offered to CSI partners and other universities with development students. All classes will be filmed, edited, archived, and available for asynchronous instruction.

Third, CSI provides specific training for its SunBlazer franchisee entrepreneurs. This includes the mechanics of unit maintenance as well as business practices, leadership skills, and sustainable development sensibility. Such programs are already under development in the Cameroon and Kenya initiatives and will be implemented in all new start-ups.

VII. Summary and Conclusion

Since the publication of "The CSI Story" presented at the 2013 GHTC in San Jose, significant progress has been made! CSI is building its Standard Sustainable Business Model and Standard Operating Procedures. Its partners have added significantly to the number of people being served under community empowering business models. CSI began major program under PES and NPSS sponsorship to launch a Signature Program for seed funding under the IEEE Foundation, ramping up to raise $10M for seed funding new initiatives by 2017. The *Learning beyond the Light Bulb* vision for education is launching and advancing with critique from the IEEE Education Activities Board. A broad range of collaborative initiatives with the Posner Center for International Development are envisaged and discussions are underway with six potential partnering INGOs at the Center. SunBlazer II was completed, field tested, shown to the PES community in Chicago and flown to Cameroon for extensive operational service to eighty homes. Seven new potential partners came forward at the Chicago show advancing CSI toward as many as eighteen partners by the end of this year.

This summary represents a strong and growing commitment across IEEE toward new humanitarian initiatives and CSI is recognized as a key innovator and contributor. But it does not act alone.

VIII. Acknowledgment

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IX. REFERENCES

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[2] These new countries of interest include Brazil, Cambodia, Congo, Dominican Republic, Ghana, Grenada, India (4), Kenya, Malawi, Namibia, Rwanda, Senegal, South Africa, Tanzania, Uganda, and Zambia (19 in all).

[3] *See* www.posnercenter.org.

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