

01 Wonders of the Solar System

WE CARE SOLAR – LAURA STACHEL

ABSTRACT

The two weeks obstetrician Laura Stachel spent in a Nigerian state hospital made her life's mission clear. She was looking at why maternal mortality was so high in Nigeria – 1 in 23 women died in their reproductive years from pregnancy-related complications – and was stunned by what she witnessed. Most expectant mothers arrived at the hospital with severe complications. But the hospital's sporadic power supply meant deliveries were conducted in near-darkness, hospital messengers couldn't locate doctors, hemorrhaging women couldn't receive blood transfusions, and emergency surgeries were postponed or cancelled. Women and infants were dying from conditions routinely treated in the United States.

To Laura, it was unacceptable that women and children were dying in hospitals simply because of a lack of electricity. Together with her husband, solar educator Hal Aronson, she launched We Care Solar – Women's Emergency Communication and Reliable Electricity. Their initial goal was to improve conditions in one hospital. But when surrounding clinics requested solar power for their labour rooms, We Care Solar needed a scalable solution.

Laura returned to Nigeria with portable solar electric kits tucked in her suitcase: efficient LED lights, walkie-talkies, and robust electronics powering medical lighting and mobile communication. Media attention spurred international requests for these Solar Suitcases.

Laura and Hal initially assembled Solar Suitcases with volunteers and financed the deployments with small donations. To meet growing demand, Laura built a core team and a broad network of partnerships to tackle regional deployments of Solar Suitcases. Today, We Care Solar delivers 'Solar Suitcases' to 'first' mile health centres to increase survival prospects for expectant mothers and their newborns. They have distributed more than 1,300 Solar Suitcases and spearheaded large projects in several countries in Africa and Asia, driven by their conviction that no woman should die giving life.

Why me?

In my obstetrical practice in the United States, I loved being a part of the birth process, and considered it a privilege to be included in the intimacy of childbirth. It was my duty to support and empower the women I cared for. During labour, I often imagined an ancestral line of women who had given birth, each bearing the next generation, leading to this moment in time.

It wasn't until I spent time in the darkened maternity unit of a Nigerian hospital that I began to struggle deeply with the complexity of what is medically known as maternal mortality – women dying in childbirth. For most pregnant women, the idea is an anachronism. But in the developing world, particularly in sub-Saharan Africa, death from 'complications of childbirth' happens hundreds of times a day.

As an obstetrician, I am trained to solve problems in pregnancy and labour. I analyze what I see and chart a course of action. But the problems I confronted on my first trip to Africa – the erratic electricity, surgical delays because of poor lighting and lack of mobile communication, the scarcity of medical instruments, the inadequate staffing and limited training – were symptoms of a systemic failure. Maternal care was in dire straits for reasons far beyond any medical techniques I could offer. Poverty, lack of infrastructure, gender inequity, illiteracy and politics all conspired against the health and survival of pregnant women. Within the hospital, lack of reliable electricity stood out as a major obstacle to providing effective maternal care.

I never expected to be a social innovator in the developing world, let alone an advocate for solar energy for maternal health care. But as I witnessed women struggling to survive childbirth in Nigeria, and health workers trying their best to provide care in darkened maternity wards, I knew I couldn't turn my back on this problem.

My background

My first passion in life was music and dance. At the age of 17, I entered Oberlin Conservatory and College to study for a career as a concert pianist and modern dancer. I devoted myself to practice, spending eight hours a day in the music conservatory and dance studio.

In my sophomore year, my doctor discovered an irregularity with my ovaries. Without surgery, he couldn't discern whether this was cancerous or not. As I was wheeled into the operating room for diagnostic surgery, my doctor informed me, 'If it is cancer, you'll wake up with a big bandage and all your reproductive organs will have been removed. If it is benign, you'll only have a small bandage.'

In the recovery room, I reached for my abdomen before opening my eyes. A small bandage. I hadn't lost my ovaries. But the surgery prompted a lot of questions. So many, in fact, that my gynaecologist quipped, 'If you have so many questions, why don't you become a doctor?'

It was a thought that had never occurred to me, but the idea resonated. Medicine would allow me to blend traits from my father (a scientist) and my mother (a clinical social worker). In my junior year, I left the familiarity of music and dance studios and enrolled in my first science classes. Medicine was a far cry from piano and dance, but

the discipline I had developed in my artistic pursuits proved to be helpful in my classes. I studied alongside pre-med students who understood formulas and concepts that were absolutely foreign to me. It was a struggle, but I persisted.

My interest in medicine and healthcare deepened. I took an active role in women's health issues on the Oberlin campus. I became a volunteer peer counsellor at the college 'Sexual Information Center', co-taught a course on the 'History and Politics of Women's Health Care', organized campus-wide health education events, and worked with the Oberlin College Health Plan Board to expand student access to reproductive health services. These initial activities in health policy and education were immensely formative. An idea took shape in my mind – to become a physician who would have the power to make changes within the health care system.

After finishing up my pre-med requirements in the summer following college graduation, I spent a year in a research lab at the University of Chicago. I applied to medical schools all over the United States and was thrilled to be accepted at the University of California, San Francisco. As I moved through clinical rotations with my classmates, I found myself drawn to psychiatry – why people behave the way they do – and women's reproductive health, especially obstetrics. I also loved surgery, and believe that my years as a pianist endowed me with a manual dexterity that was an asset in the operating room.

At San Francisco General Hospital I had the privilege of conducting deliveries under the tutelage of seasoned midwives, and learned about natural childbirth, as well as the complications that could threaten the health of mother and baby. I was honoured to witness and participate in the miracle of childbirth. When it came time to select a specialty, I chose obstetrics and gynaecology, which allowed me to be part of the birth process, as well as to practice surgery. The field also satisfied my desire to connect deeply with my patients at such an important and vulnerable time in their lives.

I stayed at the University of California, San Francisco for my obstetric residency – four years of non-stop training that occupied up to 130 hours each week. At the time it was believed that arduous working hours, including 36-hour shifts, were necessary to prepare young obstetricians to handle any situation. The hours were intended to expose us to a wide range of complicated cases. As an intern, I remember being so tired on one occasion that I tried to decline my supervisor's request to assist with a cesarean section. I was told that if I refused, I would be denied future opportunities to gain valuable experience in surgical skills.

My first full-time job was at a progressive holistic women's practice in Oakland, California, where I worked in tandem with midwives and nurse practitioners. From the start of my clinical practice I subscribed to the midwifery model – pregnancy as a state of health – rather than the traditional Western medical model – pregnancy as a time of risk, fraught with peril. This outlook would make it all the more jarring, years later, when I encountered women dying from complications of pregnancy and birth that I knew need not be fatal events.

As my career unfolded I had three children of my own, gaining first-hand experience of pregnancy and motherhood. It was quite a juggling act. My children recognized that their mother could be abruptly summoned out of the house to attend to a woman in labour. Family time together was often interrupted by an emergency call prompting me to bolt out of the door. My practice was extremely busy, and the

thousands of patients who identified me as their doctor knew that there could be a six-week wait for a routine appointment. I gained a reputation as a caring physician who loved to talk with her patients and include family members in the process of birth, often encouraging them to help with the delivery. In my practice, complications of pregnancy were unusual and tragic outcomes were rare. Joy and happiness infused my work every day.

In 2002 I was plagued by persistent back pain that eventually radiated to my neck and arms, sometimes delivering an electric-shock feeling to my hands. During one particularly arduous delivery, a searing pain tore down my back, and I knew something was very wrong. An MRI revealed the cause – severe degenerating disc disease in my cervical spine, compressing the nerves to my right arm. I was told I had to stop doing deliveries, and later, to stop my practice altogether.

My hectic life as a physician came to a halt. No more piles of charts with messages needing my attention, emergency rooms calling for consultations, phone calls in the dark of night alerting me to impending deliveries. I was the patient, and my job was to get better.

A year after I had taken leave from my practice it became obvious that I needed a vocation that would be less physically stressful. What I initially viewed as a devastating setback, I now consider the beginning of the most fulfilling chapter of my life.

I had a long-held interest in population health, and enrolled in the School of Public Health at University of California, Berkeley. Sitting up for classes wasn't easy, but I loved being a student again, and was excited to be introduced to new fields of study. Through weekly physical therapy my physical endurance improved. Four years later, when an opportunity came to consult on a maternal health research project, I jumped at the chance. At that time, half a million women died each year in childbirth, 99 per cent of them in developing countries.

Maternal mortality in the developing world

Today, maternal mortality worldwide accounts for more than 287,000 deaths a year, with 99 per cent of these occurring in underdeveloped countries. At the time I first began learning about this problem, the statistics were even more sobering – 500,000 maternal deaths each year. Most deaths occur in Africa and Asia, most often in regions without reliable electricity. Maternal mortality rates in Nigeria are among the highest in the world. Nigeria has 2 per cent of the world's population and accounts for 11 per cent of the world's maternal deaths.

Major causes of maternal death include obstetric haemorrhage, obstructive labour, eclampsia and sepsis. These emergencies cannot always be predicted, nor are they always preventable. But with prompt, appropriate and reliable medical care, they need not result in death.

Rural and impoverished women are most at risk. They are often illiterate and unable to access prenatal care or skilled birth attendants. When these women encounter complications at home, the risks are enormous. They need immediate care from skilled providers at medical facilities equipped to handle emergencies.

The erratic supply of electricity to hospitals and other health centres impairs the function of surgical wards, delivery wards, essential hospital equipment and hospital communications. This compromises the ability of health workers to provide safe, appropriate and timely medical care. Labour and delivery nurses cannot quickly notify on-call physicians of emergencies. Midwives and physicians often make treatment decisions without the benefit of necessary diagnostic tests or equipment. Obstetric procedures and emergency surgeries are conducted under grossly suboptimal conditions, and can have tragic consequences.

Driven to action

In 2008, I obtained a research fellowship from the Bixby Center for Population, Health and Sustainability to work with doctors at the Ahmadu Bello University Hospital in northern Nigeria. Daniel Perlman, a medical anthropologist from UC Berkeley, was spearheading the Nigerian research efforts, and he shared with me the ‘verbal autopsies’ conducted by local research fellows – interviews with family members about the sequence of events leading to maternal death. Reading these transcripts introduced me to the depth of the challenges facing these pregnant women in need of emergency care. The obstacles they listed are known as the ‘three delays’, an extremely helpful framework for understanding the high rates of maternal mortality.

The first delay begins at home. Impoverished, far from a medical facility, and typically without decision-making authority, rural women often are reluctant to ask for help until labour is seriously compromised. Culturally, the male head of the household is the one to make the decision to seek medical care, a move that is likely to involve spending a significant sum of money on clinic fees and transportation costs. Much time is lost as the family weighs these factors.

Transportation is the second delay, as more time is lost trying to find public transportation, a car or a motorcycle to transport the woman. It was the third delay, though, that troubled me the most.

According to the field notes from Nigeria, many women who sought medical care for severe complications of labour were turned away from health facilities – as many as four or five health centres – in their quest to get care. Some of those who were finally admitted to an appropriate facility were so critically ill that little could be done to save them. But the reports suggested that sometimes the health facilities failed to provide timely care.

Daniel Perlman was looking to conduct research *inside* the hospitals to understand more about hospital delays. Being an obstetrician in a public health school made me uniquely qualified to help. I was invited to meet with the Nigerian team and conduct participant observation at a Nigerian hospital.

In March 2008 I boarded a plane to Abuja, Nigeria. It was my first time in West Africa and I was eager to utilize my obstetric knowledge in some way. I knew little about what to expect. As an anthropologist, Daniel suggested I keep an open mind and avoid excessive literature review in advance of my visit. My job was to observe obstetric care, and to report on what I learned.

We drove four hours from Abuja to Zaria, a predominantly Muslim city in the Nigerian state of Kaduna. Daniel introduced me to the principal members of the research team – the Population Reproductive Health Partnership – obstetricians and family health physicians who were committed to improving maternal health research and outcomes. Soon he planted me in Kofan Gayan State Hospital, a large state hospital on the border of Zaria's 'Old City'.

Inside the metal gates I took note of the layout of hospital. Each medical ward had its own building. Most of the divisions – maternity, gynaecology, male medical and surgical, female medical and surgical, and paediatric – were familiar to me as an American doctor. What wasn't familiar was the 'VVF' ward, occupied by women suffering from vesico-vaginal fistula – a dreaded complication of prolonged obstructed labour.

For my research, I was drawn to the maternity ward – a single storey building containing the labour and delivery room, the maternity room and the eclampsia room. The maternity room had 12 patient beds in two rows and a nurse's station at the other. Newborn babies shared their beds with the mothers. I learned that 150 deliveries occurred in this hospital each month, with significant loss of life.

I was immediately struck by the grim conditions. The labour room had four bare metal delivery tables, a limited collection of obstetric instruments, a newborn incubator that hadn't worked in years, a broken lamp, two newborn scales in poor condition, and little else. There were no mattresses, sheets, bright lights or electronic monitors characteristic of an American hospital. Most striking were the frequent power outages that left the hospital in darkness, creating an immense barrier to care.

I learned that electricity was rationed in Nigeria, that the public utility grid in Kaduna operated only a portion of each day – at most, 12 hours. When the hospital had power, it could use its lights, refrigerator, surgical suction and other energy-dependent devices. When the power was down, the hospital was incapacitated.

FIGURE 1.1 Maternity ward in Nigeria with a nurse working in near-darkness



Courtesy Laura Stachel

A diesel-fuel generator tried to compensate during evening hours, but fuel was expensive, and the generator was used sparingly.

I had not predicted the challenges facing my Nigerian colleagues. At night, I observed maternity care, watching helplessly as doctors and midwives struggled to treat critically ill pregnant women in near-total darkness. The dim glow of kerosene lanterns often provided the only illumination. Without electricity, doctors had to postpone Caesarean sections and other life-saving procedures. When the maternity ward was in darkness, midwives were unable to provide emergency care and, on occasion, would turn patients away from the labour room door, despite their critical need for care.

The most upsetting example of this was when a woman in labour was brought to the hospital door late at night, bleeding heavily. She had a critically low blood pressure. The presumed diagnosis was uterine rupture – a life-threatening condition requiring immediate surgery. The hospital was in darkness, unable to conduct surgery or provide the immediate blood transfusion necessary to save the woman's life. The midwife advised the family to go elsewhere to get care, and the family was sent back into the darkness. It was hard to imagine she would survive.

One night, I witnessed an emergency that set me on the path to where I am today. The labour room was in near darkness, and I settled at the foot of the bed of a seriously ill pregnant woman with eclampsia. Brought to the hospital unconscious, she had suffered several seizures at home in labour, according to the family members who hovered at her bedside. Although she had been given a single dose of anti-seizure medication at the hospital, the woman had another convulsion; her family attempted to hold her body down. When the seizure was over, she lay still, her breathing abated, and I thought she had died. Tears welled in my eyes.

Anyone would have found this woman's suffering disturbing, but as an obstetrician, I found it intolerable. Eclampsia, although serious, was an eminently treatable complication of pregnancy. I stood by the bed, feeling helpless. The woman stirred. Still alive.

I thought about all the women like her, suffering in obscurity, unable to access life-saving care that I had always considered routine. I vowed to change this.

I described the desperate hospital conditions in an e-mail to my husband, Hal Aronson, who had taught solar energy technology in California for more than 10 years. Hal immediately focused on solar power as a way to provide electricity to the hospital.

The birth of a solar innovator

When I returned home to Berkeley, Hal sketched a design for a solar electric system to help the Nigerian hospital. He recommended installing four stand-alone solar electric systems targeting areas of the hospital important to maternal survival: the maternity ward, the labour room, the operating room and the laboratory, where we would install a solar blood bank refrigerator. In each system, solar panels would generate electricity that would be stored in a sealed lead-acid battery for night-time use. Each system had a charge controller to regulate electricity going into and out of the battery, as well as a load centre to power appliances. Included were 12V DC

lights, a charging station for walkie-talkies, and power for other devices, such as surgical suction in the operating room and a blood bank refrigerator in the laboratory. With these systems, labouring women – and their care providers – would no longer have to be in darkness.

The project was compelling, but we needed funds. A campus-wide competition at UC Berkeley advertised a \$12,500 grand prize for a technology offering a social good. The deadline for a proposal was 11 days after my return from Nigeria, and provided great incentive to draft a paper and engage the talents of two other Berkeley graduate students: Melissa Ho, from the IT department, and Christian Casillas, from Energy Resources Group. I submitted a ‘white paper’ on our project and crossed my fingers. A few weeks later, we learned that our project was one of 12 finalists. All of us joined forces to prepare a poster for the competition finals. Melissa and I, along with my seven-year-old daughter, Rachel, dressed in African fashion at the event as we displayed a solar panel, two-way radios, and photos of scenes I had observed at the Nigerian hospital. Our efforts yielded an honourable mention, which carried a \$1,000 award, but it wasn’t enough to fund my dream.

I came home from the competition, dejected, and called Nigeria to speak to Dr Muazu, the head of Kofan Gayan Hospital. ‘We didn’t win enough money to do the project’, I apologized. Dr Muazu was unfazed. ‘Don’t worry, Laura’, he assured me. ‘You planted a seed, and from this a great tree will grow.’

A few hours later, I received a call from Thomas Kalil, a campus official who had been at the competition. ‘You should have won’, he told me. ‘How much do you need for your project?’ I knew that our true budget exceeded the competition prize, and hastily doubled the amount originally offered as grand prize. Within three weeks, Kalil had found us funding through the Blum Center for Developing Economies.

We could start. The project that would later become We Care Solar had begun.

We set to work mapping out the details of our installation. Our plan was to hire a Nigerian solar company to install solar equipment using Hal’s design. We conducted research over the internet, contacted seven companies, interviewed key representatives by phone, and arranged to meet with one promising solar installer in Nigeria.

I wanted to include my Nigerian hospital colleagues in our planning. Would they like to use walkie-talkies for mobile communication to reduce delays in assembling a surgical team? Would the LED lights we found be bright enough for surgery? Would doctors and nurses find our headlamps (powered with rechargeable batteries) acceptable for clinical care? Their responses would guide our design.

As I planned a return trip to Nigeria I wanted something tangible to show my colleagues – something compact enough to fit in my suitcase. I didn’t want the hassle (or potential danger) of explaining our project to customs officials at the Abuja airport. I needed this to be discreet.

Hal’s solution was a demonstration solar kit to take on my next journey. He packed my suitcase with compact solar panels, a solar electric control board, a sealed battery, high-efficiency LED lights, headlamps and walkie-talkies. And he invited me to take a workshop on solar energy that he was teaching to educators.

When I returned to Nigeria, I unpacked the case in front of the surgical staff and hospital administrator. I attached the wires and plugged in the battery as Hal had taught me. A doctor flipped the switch and the lights turned on, bringing wide smiles

to the hospital staff. The light was indeed bright enough for an operating room. The rechargeable walkie-talkies meant that a surgical team could be assembled in minutes instead of hours, avoiding lengthy searches for doctors and surgical technicians on the hospital grounds. The headlamps with rechargeable batteries were immediately put to use.

FIGURE 1.2 Unpacking the first Solar Suitcase in a Nigerian Hospital



Courtesy We Care Solar

I met with the Nigerian solar installer whom Hal and I had interviewed by phone, and together we surveyed the hospital, measuring the power requirements for various medical devices. Dr Muazu approved of our plans for a larger installation in six months. But one operating room technician, Aminu Abdullahi, had another idea. ‘You must leave your suitcase here’, he insisted. ‘This will help us save lives now.’ Aminu convinced me that he would care for Hal’s equipment in my absence. Indeed, Aminu took charge of the solar devices, dutifully setting the solar panel outside each morning, taking it in at night, and using the system to keep batteries charged for headlamps and two-way radios. The first We Care Solar Suitcase had found a home.

Six months later, I returned to conduct the larger hospital installation, including procurement of a blood bank refrigerator for the laboratory. The hospital was immediately transformed. Midwives could perform obstetric procedures throughout the night, surgical teams were assembled in minutes rather than hours, Caesarean sections were conducted regardless of time of day, and patients were no longer turned away for lack of power. We celebrated the solar installation with a community event, including a ribbon-cutting ceremony from the Kaduna State Minister of Health. Though the hospital staff were clearly pleased with their facility upgrade, staff at one nearby medical clinic felt left out.

'We conduct deliveries in the dark as well,' the clinic manager lamented. 'Why are you only helping the hospital?'

I was initially a bit defensive, explaining that we only had funds for the hospital. However, it soon occurred to me that the suitcase-size system Hal had made for the hospital demonstration could be transplanted to the clinic. We brought the cobbled-together system to the clinic, much to the delight of midwives who no longer needed to rely on candles and kerosene at night.

I continued to conduct research at Kofan Gayan hospital, returning every few months to observe care. It wasn't long before additional local clinics asked for the 'solar doctor' and the suitcase that would light up maternity care. Hal was glad to accommodate these requests, and started assembling small solar kits for each clinic. On each trip to Nigeria, I would include a Solar Suitcase or two in my luggage.

FIGURE 1.3 Bringing an early Solar Suitcase prototype to a Nigerian clinic



Courtesy We Care Solar

Word continued to spread, and I was invited to talk about our experience at several US conferences. At one of these meetings, *New York Times* writer Nicholas Kristof gave a stirring keynote address. After his talk, I told him how his own articles had inspired our work in Africa. The next day, Kristof wrote about our mission in his online blog, and requests for We Care Solar Suitcases arrived from around the world. The need for reliable electricity for maternal health care extended far beyond Nigeria.

Each time I returned to Nigeria I visited the clinics using our solar equipment, making note of any failures as well as the successes. Incorporating feedback from our field installations, the design of our Solar Suitcases became increasingly refined. The suitcase components became more rugged and easier to use. Bare wires needing screwdrivers for installation were replaced with plug-and-play connectors. Safety fuses were replaced with breaker switches. Our simple wooden board was swapped for a plastic panel. And seeing how dirty our equipment became after months of use prompted us to enclose our components in a plastic protective case.

Hal enlisted local volunteers to help with assembly in our backyard. Soon, our Solar Suitcases were travelling to midwives in Burma, clinics in Tibet and doctors in Tanzania. Solar Suitcases would reach their destination by volunteer couriers who would arrive at our home for training, and then personally transport a Solar Suitcase to a remote clinic or hospital.

When the devastating Haiti earthquake struck in 2010, we had no choice but to get Solar Suitcases into the field as quickly as possible. Medical relief groups made numerous requests for our portable solar power stations, and many small donations poured in as well. In four days, Hal had assembled a team of volunteers to assemble the Solar Suitcases, which we promptly dispatched to several medical groups.

FIGURE 1.4 Hal Aronson leading the backyard assembly of Solar Suitcases for Haiti



Courtesy Laura Stachel

As the Solar Suitcase was introduced to new countries, we worked to adapt the suitcase configuration to meet local requirements. Sometimes we learned the hard way. We discovered, for example, that an initial design short-cut – using an American AC-style outlet for our DC lights in Nigeria – was confusing in Haiti, where AC wall outlets accepted (and overpowered) our 12V DC lamps. We redesigned the outlets, and I flew to Haiti with a volunteer engineer, Brent Moellenberg, to retrofit our Solar Suitcases with the new design.

After our experience in Haiti it became clear to us that our programme was gaining traction. Hal and I dived into the project, converting our home into a Solar Suitcase assembly line. Equipment was strewn all over the house and the living room became our shipping and packing line. We juggled a steady stream of part-time volunteers, including many who were quite talented, but none who could sustain a hefty long-term commitment without remuneration.

Eager to gain increased exposure and support, we entered several competitions, enlisting the support of a talented UC Berkeley MBA student, Abhay Nihalani, and a recent MBA graduate from Duke, Michael MacHarg. In 2010 we applied for (and won) 10 competitions and fellowships, including the Global Social Benefit Competition at UC Berkeley, the Ashoka Changemaker's *Healthy Mothers, Strong World Award*, the Global Social Benefit Incubator at Santa Clara University, and a Pop!Tech Fellowship.

This whirlwind year brought me into contact with other social entrepreneurs and mentors, and helped me gain perspective about ways to extend our reach. As I shared our limited experience in Nigeria and Haiti with social entrepreneur groups, we were asked to scale up our operations.

Hal and I had no experience in this realm. Hal had been a solar educator for years, initially creating hands-on solar electricity projects for students, and later, developing a curriculum for educators. My career in medicine demanded clinical and surgical acumen, not project management skills. We needed a thoughtful approach to scale up.

Some advisers suggested the best approach would be mass production of a simplified prototype. They encouraged us to immediately strip down some of the more costly features of our early design, and to manufacture a cheaper, less ambitious version of our product. 'Fewer bells and whistles', we were told.

We were worried about this approach. The design of the Solar Suitcase had evolved to meet the needs of health workers working in unfathomable conditions. We didn't want to downgrade the functionality of our product, and we weren't ready to commit to one particular design without more field research.

Our dream was to create an optimized version of the suitcase incorporating existing feedback from our field installations, and to conduct further research on this model in a limited number of health facilities. Since our formative experience began in northern Nigeria, we thought this would be a good testing site. But we knew this would require staff, time and money.

Structure, sustainability and scale

We decided to incorporate as a non-profit organization in order to ensure that under-resourced health centres would have access to reliable electricity. We recognized there was not a functional market for solar electricity in public health facilities in the countries most in need of our product. Our beneficiaries were government health workers and the impoverished mothers they served. We would need to seek funding from third parties that were eager to support our mission.

The World Health Organization invited us to pilot a small Solar Suitcase programme in Liberia, funded by UBS Optimus Foundation. Around the same time, The MacArthur Foundation funded us specifically to bring our innovation to scale. In awarding us a coveted grant, the foundation recognized the potential for our Solar Suitcases to 'bring light' to an area of maternal health care that had previously been largely ignored. Our grant targeted four areas – technology design, educational

programming, field research and scale-up of operations. We received additional support from the Blum Center for Developing Economies. We were on our way.

Our learning curve was steep. We had never run a non-profit organization, managed international programmes, or interacted with contract manufacturers or government officials. We asked for help wherever we could find it, thankful to receive mentorship from business consultants, lawyers, industrial engineers, designers, social entrepreneurs and academicians. We are fortunate to be based in the San Francisco Bay Area, which enabled us to collaborate with a diverse talent pool: students and professors from UC Berkeley and Stanford, scientists from Lawrence Berkeley National Laboratory, other technology-oriented non-profits, and advisers from Silicon Valley.

Hal and I devoted ourselves full time to We Care Solar. We hired consultants to help lead operations and provide financial oversight. Brent Moellenberg, the engineer who had led our technical activities in Haiti, was brought on board full-time. As our organizational capacity expanded, we developed systems for accounting, data management and inventory. Hal and Brent met with lighting designers, solar manufacturers and contract manufacturers. Our aim was to ‘design for manufacturability,’ which meant making user-friendly, rugged Solar Suitcases in a factory rather than our house! We found that our mission – to use solar light and power to improve maternal health – attracted generous in-kind support. So we were able to accomplish a great deal with a limited budget.

FIGURE 1.5 Brent Moellenberg, Hal Aronson and Christian Casillas preparing version 2.0 of the Solar Suitcase



Courtesy Laura Stachel

We realized that the technology alone was not sustainable without proper usage and long-term maintenance. In addition to developing photo-rich user manuals, we printed bright laminated posters, recognizing from our site visits that in rural clinics, posters were the most common form of written information. We created educational programmes for health workers, and a basic curriculum on solar energy and optimal use of the Solar Suitcase. We prepared more advanced materials on installation and maintenance for technicians. And we piloted this programme in Liberia with 60 health providers before extending our capacity-building workshops to Nigeria, Sierra Leone, Uganda and Malawi.

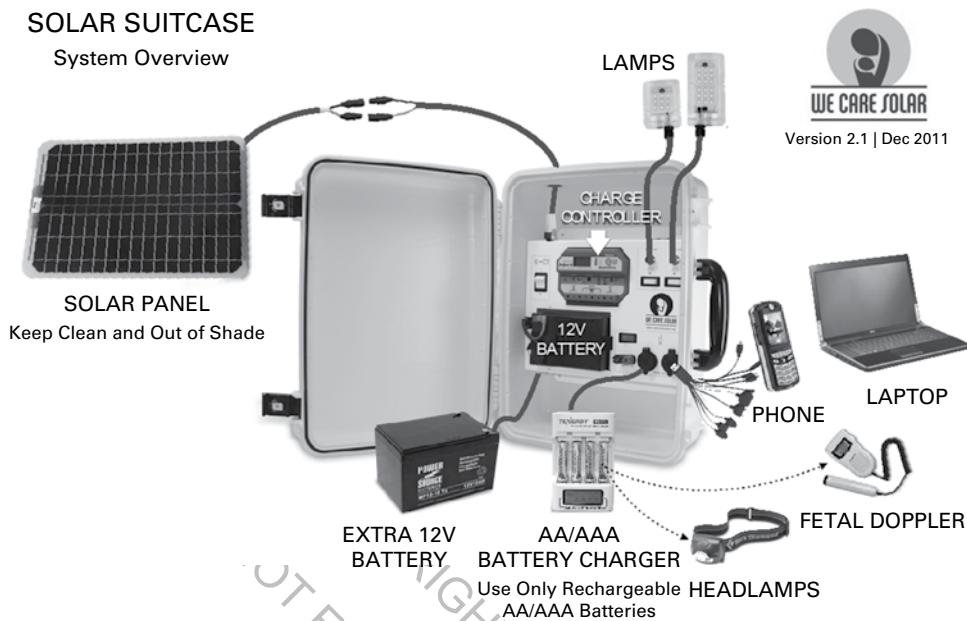
FIGURE 1.6 Training Nigerian health workers to use the Solar Suitcase



Courtesy We Care Solar

As we travelled from country to country, we conducted facility assessments at diverse health centres which exposed us to variations of health facility layout, construction materials and energy needs. As a result of our research, we expanded the capacity of the Solar Suitcase, and included hardware and tools to facilitate installation. Our newer version could accommodate larger solar panels and batteries, included a fetal heart rate monitor, and had the option for additional lights that could be plugged into a 'satellite' receptacle.

FIGURE 1.7 Poster of the first manufactured Solar Suitcase



Courtesy We Care Solar

Meeting demand and measuring impact

We responded to inquiries from a range of countries. Sometimes the requests were for programmes with dozens of health centres, leading to partnerships with international NGOs and UN agencies. Other times the requests were from individuals who wanted to hand-carry a Solar Suitcase to individual clinics.

To date, we have deployed more than 1,300 Solar Suitcases across 27 countries. We have conducted programmes with 20 agencies and trained more than 5,000 health workers in our technology. Our partners have included UNICEF, the World Health Organization, Pathfinder International, AMREF, and Save the Children. We estimate that more than 400,000 mothers and babies have been served by health centres using our Solar Suitcases. And our technology has promoted environmental health as well as safe deliveries; by displacing kerosene lanterns and diesel fuel generators, our Solar Suitcases have averted 9,237 tons of CO₂.

A seal of approval from healthcare workers

Solar Suitcases enable health workers to perform procedures throughout the night. Specifically, midwives explained that it was easier to conduct routine and complicated

deliveries, treat bleeding mothers, administer medication at night, keep phones charged for emergency referrals and resuscitate newborn babies. Many clinics stayed open longer hours, and patients were more likely to seek skilled care in a facility that they knew had light. We heard again and again that reliable lighting and phone charging improved health worker morale and reduced the fear that used to go hand-in-hand with working in a darkened health centre.

FIGURE 1.8 Liberian health workers receiving a Solar Suitcase at night



Courtesy Laura Stachel

We were surprised to receive requests for Solar Suitcases from large maternity wards and hospital operating theatres in need of reliable power. Even though we explain that our Solar Suitcases have a limited light supply not intended for larger rooms, hospital administrators insist that our Solar Suitcase lighting is vastly superior to the candles and kerosene lanterns that are the only source of lighting when the power grid is down. The Solar Suitcase is seen as an essential back-up source of power to the utility grid.

Indeed, when we visited eastern Uganda in the summer of 2012 to evaluate the impact of the Solar Suitcase, I was privy to a night-time Caesarean section during which the main power stopped functioning. With a Solar Suitcase light above the operating table, the surgery continued without interruption. The doctors told us the Solar Suitcase lights were better for surgery than their usual lights, and there was no longer the need to send patients to distant hospitals when night falls.

Each small success has been celebrated, but we have so much more work to do. The biggest challenge has been in designing programmes to scale up distribution and maintenance in countries with poor physical and political infrastructure. As our programmes have expanded in size, the logistical demands have increased. We partner with larger agencies that have the capacity to manage programmes serving as many as 150 health centres in a region. Their collaboration enables us to import our equipment, select appropriate health centres, schedule and conduct formal training programmes,

FIGURE 1.9 A Ugandan surgeon uses a Solar Suitcase light to conduct an emergency c-section



Courtesy Jacqueline Cutts

engage health technicians from local ministries to install Solar Suitcases and train midwives, and monitor our programmes. We developed a Women's Solar Ambassador programme to help lead our international training programmes. These teach our local partners how to install Solar Suitcases, teach health workers and maintain our equipment. And we are now looking at hiring local staff members to oversee our programmes, service our Solar Suitcases and promote sustainability.

The power of stories

Sometimes the pressure feels overwhelming. We have a limited staff and we are tackling an enormous problem. As we approach our breaking point, we often receive an inspiring story of how the Solar Suitcase is helping a health provider, or a clinic, or saving a life.

One such story came from Dr Jacques Sebisaho, a New York-trained doctor who operates a clinic on the island of Idjwi in the Democratic Republic of the Congo. The village had no power and at nighttime it was impossible to provide adequate medical

care. Dr Sebisaho returned to his village clinic armed with a Solar Suitcase, and it was quickly put to use to illuminate a twin delivery.

However, Dr Sebisaho's arrival coincided with the onset of a cholera epidemic. The clinic was flooded with patients needing intravenous fluids, antibiotics and constant monitoring. The clinic could not house all the patients in need of care, and mats were placed outside on the ground, creating a makeshift open-air infirmary. The Solar Suitcase lighting was carried from patient to patient, and enabled the team to provide constant monitoring.

Although Dr Sebisaho feared many lives could be lost, he and his team achieved something they considered a near-miracle. All the patients treated that month survived – not a single man, woman or child was lost despite the severity of many of the cases. He had expected 50 per cent of the patients to die, and said that 80 per cent of deaths occur at night.

In the case of Dr Sebisaho, the Solar Suitcase was a lifesaver, boosting the morale of health workers and inspiring the entire community.

I believe the light was the force behind everything. I have no words to describe how confident we all were, knowing we could do anything anytime (day or night). This sounds obvious to a person here (in the USA), but the light meant the world there.

We are witnessing what light can do in a community and how it can save lives in regions where night means death if (you are) sick or in need of emergency care after the sun goes down.

FIGURE 1.10 Dr Jacques Sebisaho (orange t-shirt) on Idjwi Island introducing the Solar Suitcase



Courtesy Jacques Sebisaho

The stories of Dr Sebisaho, and hundreds of midwives, nurses and doctors who are grateful for the light they need to do their work, infuse us with the energy we need to continue our journey. So despite the sacrifices, the endless challenges, and the constant stream of work ahead, we continue to move forward.

We realize that the problem of reliable electrification of health facilities extends to hundreds of thousands of health facilities, and a broad range of solutions are needed. We have actively worked to put sustainable electricity on the global health agenda, and have used our success to engender broader policy initiatives. The UN began promoting its Sustainable Energy for All (SE4A) initiative in 2011. I was fortunate to play an early leadership role in the UN Foundation's Energy Practitioner's Working Groups as part of SE4A, co-chairing the group on health and energy. Through associations that were made in the working group, we were able to convene a workshop in 2012 in Washington DC on Renewable Energy for Healthcare. We invited colleagues from the World Health Organization (WHO) as well as a diverse group of stakeholders from engineering, global health and development. The meeting helped to forge a partnership between WHO and the UN Foundation, and helped to foster a platform for the United Nations called the 'High Impact Opportunity' on Energy for Women and Children's Health, bringing together the UN Foundation, WHO, UN Energy, UN Women as well as members of Civil Society, like We Care Solar. One of the most satisfying achievements was participating in the launch of this initiative both at the World Bank and later at the United Nations.

UN Secretary-General Ban Ki-Moon commended our work at Rio+20, and WHO Director-General Margaret Chan called We Care Solar 'Sunshine saving lives.' And perhaps most exciting was when UN DESA (the UN Department of Economic and Social Affairs) awarded us their inaugural 'Powering the Future We Want' award in late summer 2015. Speaking at the United Nations as I accepted this award on behalf of childbearing mothers and health workers around the world, I was overwhelmed with the knowledge that our mission to light up health care was receiving international recognition and support.

Just as I could not have predicted how my life would unfold at 17 when I was a dancer and pianist, nor at 40 when I could no longer continue my beloved medical practice, so too I cannot predict the journey that lies ahead for We Care Solar. What I do know is that every day women and their infants are struggling in childbirth in the dark, in remote (and not so remote) corners of the world. It is within our reach to bring them light and power for essential medical services – through our Solar Suitcases and through advocacy for reliable energy as vital for improving health.

When no mother has to give birth alone in the dark, we will have fulfilled our mission.

Lessons learnt

- 1 *Be open to discovering the unexpected.* I purposely did *not* read a lot about the topic of Nigerian maternal hospital care before my first trip. By becoming a participant observer, I was able to share the experience of my Nigerian colleagues and see things from a new vantage point, not someone else's.

- 2** *Failure is an important teacher.* There is so much to learn from making mistakes. The first Solar Suitcases needed many improvements. Seeing what parts of the Solar Suitcase failed in the field helped us to design a better Solar Suitcase.
- 3** *Perfect is the enemy of good.* Although I am by nature a perfectionist, Hal's drive to get Solar Suitcases into the field – even if they didn't look pretty or have the best user interface – gave us valuable experience. If we had waited for the perfect Solar Suitcase to be designed, I am not sure whether we would have ever conducted a field trial. By having health workers in Africa and Haiti use our early prototypes, we obtained important feedback that was incorporated into our final design.
- 4** *Don't travel solo. Surround yourself with the best team you possibly can.* We have learned so much from other social entrepreneurs, from mentors, and from partnerships we created around the world. There is so much to learn from other people and other organizations. Recognize your strengths and weaknesses and find talented people to complement your skills.
- 5** *Non-profits face many of the same challenges as for-profits.* We Care Solar was born into a very similar environment to many start-ups. We had to ask the same kinds of questions: How do we scale and continue to serve customers? Who are our competitors? How to we communicate our message effectively to attract investors (donors)? We were also faced with a highly dysfunctional market. The clinicians we visit don't have even the funds for medications. They are our beneficiaries but *not* our target customers. In our case, our customers are the governments, UN Agencies, international NGOs and foundations that support the work of these underserved health centres.
- 6** *Choose something that ignites your passion, because the work is really hard.* Trying to do business in Africa and Southeast Asia is hard. The infrastructure that we come to rely on in the United States or the United Kingdom is not there. You can't guarantee you will find roads, or the internet, or phone service, or even proper tools. The logistical challenges we face would give anyone nightmares. We are placing the Solar Suitcases in health centres with no practice of maintaining medical equipment – so coming up with a plan for sustainability is even harder. But the people we meet are wonderful, appreciative and eager to learn. And solving these challenges is deeply fulfilling.
- 7** *Start small.* If you are passionate about a problem that needs solving, you don't need to map out an entire master plan at the beginning. Take small steps. Each time you cross a threshold, you'll get some results and the opportunity to make new decisions and new choices. By making a series of small steps, your path may become clearer. Small things can lead to big things. They did for us.
- 8** *Don't underestimate the power of a good story.* Much of our support we received over the years was the result of learning to effectively communicate our mission. Forget about traditional slide decks filled with long narrative and multiple bullet points. Tell stories accompanied by photos that illustrate your mission and emotionally connects your audience. Let your users speak for you.

- 9 *One size does not fit all. Our approach in one country may not be easily replicated in another.* Even though we may now understand how to do things in Uganda, this doesn't mean we understand the market in the Philippines. Each country has specific cultural issues, regulations and internal systems. To achieve success in different locales, we need to conduct research in each country and adapt our processes to the local context.
- 10 *Not everything can be strategically planned, especially for an early stage company.* It was great to have some idea about the direction we were heading, but much of our success was dictated by unexpected events and opportunities, chance encounters, and our ability to pivot midstream. Being a small enterprise allowing us to be nimble has been one of the most fun parts of this work, and recognizing when nimbleness turns to chaos one of the most challenging.

Discussion questions

- 1 Can you identify ways in which We Care Solar did not follow traditional rules of business?
- 2 What were the risks and benefits of introducing a range of early Solar Suitcase prototypes into the field?
- 3 What do you think might be the total energy needs of health centres? In that light, what are the benefits and limitations of the Solar Suitcase?
- 4 Several investors encouraged We Care Solar to incorporate as a for-profit business rather than a non-profit business. How would that have influenced our trajectory?
- 5 What would be the most effective ways for We Care Solar to replicate its model in new countries? What might be some of the challenges they'd face?
- 6 The Solar Suitcase provides health workers with medical lights, phone charging and fetal monitors. What other interventions are needed to improve obstetric care for mothers and babies in rural health centres? Should the Solar Suitcase be placed in health centres that lack these other interventions?
- 7 The UN adopted the Sustainable Development Goals in 2015 and aim to lower maternal mortality worldwide to less than 70 deaths per 100,000 live births. What are effective strategies to lower maternal mortality worldwide?

Further reading

www.wecaresolar.org [accessed 10 December 2015]
PBS Newshour: www.pbs.org/newshour/bb/globalhealth-jan-june12-solarsuitcase_04-04/ [accessed 10 December 2015]
KQED: www.youtube.com/watch?v=3h_Quso1QyM

CNN: www.cnn.com/SPECIALS/cnn.heroes/2013.heroes/laura.stachel.html
[accessed 10 December 2015]
www.cnn.com/2013/03/01/world/cnnheroes-solar-suitcase/index.html [accessed 10 December 2015]
TED WOMEN: www.youtube.com/watch?v=bz8V-qUs_2w
UN DESA Acceptance Speech: www.youtube.com/watch?v=eEjvtg0f2B4&feature=youtu.be

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