

# Lessons from the Field:

## Setting up a Windmill Based Business in Rural Kenya

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### Abstract

Students from various disciplines at Penn State University, Bowling Green State University, University of Nairobi, and Kochia Development Group (a Community Based Organization in Kenya) collaborated to develop a robust and sustainable hybrid power system for rural communities in western Kenya. The objective was to build the system in Kenya using Kenyan resources and set up a profit-driven business around it to ensure economic sustainability. The model developed for this project emphasized building strong relationships between all the involved parties and incorporated multidisciplinary engineering design, business development, and social sciences to make the project truly successful and sustainable. The guiding philosophies, program, and business models for this project are discussed in this paper. The various observations and lessons learned during the planning and execution of this project are presented with suitable examples.

### Introduction

Penn State University has a very active student chapter of Engineers for a Sustainable World (ESW). The purpose of ESW is to facilitate activities for Penn State students with a shared interest in the development and implementation of appropriate engineered solutions in developing communities. Every year, multiple social entrepreneurship and service learning projects targeting developing communities overseas, as well as areas in the US are offered. Various academic courses support students involved in ESW projects as they participate in design/research projects during their four-year stay at Penn State. Most projects have a strong entrepreneurial flavor and all projects culminate with the implementation of their design/research solution(s) in the host community.

One of the core ESW projects targeted an extremely impoverished community on the shores of Lake Victoria in western Kenya. Survey results showed that most of the people in Kochia (about ten kms from Homa Bay in Nyanza Province) were sustenance farmers with an average monthly per capita income of \$10. Most of the homes in this region have never had electricity or access to clean drinking water. Just ten kms from the shore of Lake Victoria (one of the largest fresh water lakes), people are malnourished because they have no means of irrigating their land. Western Kenya has a very high HIV/AIDS population (Integrated Regional Information Networks, UN Office for the Coordination of Humanitarian Affairs) and Kochia is no exception. A significant number of people in this region are either HIV+ or are caring for someone who has HIV/AIDS. Very few people have access to antiretroviral drugs.

This region has bountiful but grossly underutilized resources, like proximity to a huge source of water for irrigation. There is significant potential for harvesting solar and wind energy because of its location on flat plains, at the equator, next to a large water body—perfect formula for good winds. Analysis of wind speed, wind direction, and solar flux data collected over a year by a weather station installed at the site confirmed our hypothesis. The region grows a lot of sisal but the people do not have access to sisal decorticators, which are required to extract the fibers and make twine and handicrafts. Kochia has a fairly low crime rate and a well-educated (high school level) trainable workforce—yet most people are unemployed or underemployed. Concerned citizens (mostly women) resolved to pull themselves out of the vicious cycle of poverty and hopelessness by organizing themselves and forming a group called the Kochia Development Group (KDG).

Penn State has multiple ongoing relationships with the University of Nairobi (UoN). KDG approached the University of Nairobi for assistance in community development and poverty reduction, which was conveyed to Penn State. Penn State, University of Nairobi, and KDG agreed to work together on a project focusing on alternative energy in Kochia. A faculty member in the Entrepreneurship department at Bowling Green State University (BGSU) also joined the project.

Students and faculty members from various disciplines in Engineering, Business, and Social Sciences at Penn State, BGSU, and UoN collaborated with community members and businesspeople of KDG. Within Penn State, there were multiple teams of students working on the engineering and business aspects of the projects. The efforts on the various activities and sub-projects were integrated into the student's formal education by way of credit courses, independent study credits, and senior design projects. However, the most active (and inactive) students working on this project were ESW volunteers. The involvement of so many individuals from different backgrounds necessitated a compatible mission, vision, and values. Guiding philosophies were articulated to establish a common ground.

## Guiding Philosophies

- **Relationships are critical to long-term success:** We adopted a relationship-based model as opposed to a project-based model. We built strong relationships with partnering entities by way of multiple projects and various academic activities.
- **Harambe:** *Harambe* is a Swahili word that roughly translates to “Let’s all work together.” The spirit of *harambe* is supported by the Chinese proverb, “Tell me and I’ll forget; show me and I may remember; involve me and I’ll understand.” We strived to work together and involved everyone in the decision making process.
- **Holistic view:** The ultimate objective of this project in regards to the target community was to help them improve their quality of life.
- **Student-led initiative:** We envisioned this project to be a student-led, faculty-mentored social entrepreneurship venture designed to provide an international, intercultural, immersive, collaborative, multidisciplinary active-learning experience for the students.
- **Sustainability:** We espoused the Triple Bottom Line concept (Elkington 1998). It was essential that the significant time, money, and energy expended on this project by the students and their mentors result in non-trivial sustainable value-addition to the target community. To make the solution sustainable, it had to be technologically appropriate, robust, environmentally benign, socially acceptable, and economically sustainable.
- **Equality, Respect, and Harmony:** Equality and respect were emphasized due to the extreme diversity of the individuals and organizations involved. Equity from and between all the stakeholders was stressed to ensure harmony.

## Project Goals

- Design and construct an alternate energy (solar and wind) hybrid power system for rural communities in western Kenya. The system should be manufactured (and assembled) in Kenya by Kenyans with resources available in Kenya.
- Develop a profit-driven business in Kenya to ensure economic sustainability of the system.
- Provide the resources/training for local entrepreneurs to start micro-businesses that exploit the availability of electricity.
- Identify resources, markets, and champions and connect them with the goal of setting up a profit-driven manufacturing plant for the power systems in the future.

## Market Identification: Our Customer Profile

We identified three market segments in Kochia:

- I. **Community Members:** We conducted comprehensive surveys of twenty households to understand their financial situation and gauge their energy needs. Electricity for domestic lighting surfaced as the primary need.



Telephone Operator (uses car battery)



Entertainment Center (uses car battery)



Small Tools in Furniture Shop



Bicycle Repairman

2. Small Business Owners: We interviewed numerous small business owners in Kochia to understand their energy needs. The pictures above show a telephone operator and entertainment center owner, both of who use batteries to operate their telephone and music system respectively. They travel six kms to get their battery charged. The furniture shop needed light to work after dusk and power to operate small tools. If the bicycle repairman had adequate light to work after dusk, he could charge his customers a premium to get their bicycles fixed in the evening (so they don't lose wages next morning). A read-in-only library owner was willing to pay us \$18/month to get four hours of light (adequate for reading) every evening for a month!
3. Prospective Entrepreneurs: A number of small businesses can ride on the (minuscule amount of) electricity that we can provide. Sisal decortication (for making handicrafts), handyman services, and cell phone charging are small businesses that can be started by locals. Pineapple processing and fish processing are more futuristic but rewarding opportunities.

## Project Execution

- **December 2005:** A month-long relationship-building and fact-finding mission was undertaken by the author. The project site was identified and a weather station to log wind and solar parameters was installed. Customers were identified and surveyed and resources and constraints were identified. Legal clearances and goodwill were obtained.
- **Spring 2006:** NCIIA Advanced E-Team funding was sought and obtained. Design commenced.

- **Fall 2006:** An appropriate windmill and battery-based distribution system was designed for Penn State conditions with Kenyan constraints in mind (technical details may be published at a later date). A comprehensive business plan for Kenya was developed. Additional fundraising was done by selling calendars with photos taken by the author in Kenya and other means with a Kenyan cultural connection.
- **Spring 2007:** The windmill design was adapted for Kenyan conditions. Prototyping of the system to be built in Kenya was started but could not be completed due to time constraints. The business plan was critiqued and improvised in Kenya. Two volunteers (one American and one Australian) were identified, oriented, and deployed on the ground in Kenya for a period of three months. The volunteers performed numerous critical activities like identifying sources for raw materials, working with Kenyan students, creating awareness about the project in and around the target community, etc.
- **Summer 2007:** Three students from Penn State and the author traveled to Kenya for a month to construct the pilot system and implement the business plan. Most sub-systems were constructed by the team in Nairobi, Homa Bay, and Kochia. Some sub-systems had to be purchased off-the-shelf in Nairobi. Many people have cell phones and GSM coverage at home but travel up to ten kms to get their battery charged. Small solar panels to charge cell-phones were also provided to KDG to start a cell phone recharge business.

## Business Model

The pilot windmill is operated by KDG and supervised by the Board of Directors drawn from KDG, UoN, and Penn State. The customers come from a wide geographical area, and running wires from the windmill to the customers was not feasible from a technological, legal, social, and most importantly, business perspective. Deep cycle batteries are used to store/provide power to the customers. Most customers own batteries and also have the option of renting one from KDG.

KDG charges money when:

- Customers get their deep cycle battery charged from the windmill.
- Customers get their cell phone charged from the (three) solar panels.
- Customers rent charged batteries for special occasions (weddings, funerals, etc.).

The actual cost of the charging services was determined collectively after considering the competition. An individual nominated by KDG is responsible for charging the batteries and the day-to-day maintenance of the windmill and solar panels. This is a six-month volunteer position. As a goodwill gesture, KDG provides a deep-cycle battery and free battery recharging to the volunteer for the duration of his/her tenure. Receipts are issued for all transactions. The money is deposited into a joint bank account at the Co-operative Bank of Kenya. Although anyone can deposit money into the account, multiple signatures are required to withdraw money from it. The Board of Directors looks over the bank account and approves each and every withdrawal from the account (only critical expenses are permitted at this time). The objective is to use these funds for maintaining the system and scaling up in the future. With a conservative estimate of fifteen customers a week paying 50KSh (\$0.77) each to recharge their batteries, we should break even on the capital cost of about \$1,800 in about three years. The initial system is grossly over-engineered due to liability concerns. Our studies show that our system can be mass-manufactured for less than \$600, in which case the Return on Investment (ROI) will be about one year. Accurate models are hard to develop due to the unreliable and volatile nature of market conditions, raw material prices, labor costs, and the individuals managing the system.

The next section contains the thrust of the paper: the observations and lessons learned during the planning and execution of this project over the last three years. The purpose of sharing these lessons is to help faculty and students engaged in service-learning programs that focus on the design and implementation of appropriate technologies in developing countries with a view to further global sustainability. These lessons are not conclusions based on scientific research. These observations and lessons are based solely on the author's (and team's) experiences and bear the burden of their biases, prejudices and ideologies. The lessons are not arranged in any particular order.

## Lessons Learned

**Lesson 1: Outsource sub-projects:** Numerous credit courses offered at Penn State are project-based. Students work on an overarching project over the course of the semester with help from course instructor(s). Suitable projects are identified by the course instructor and championed by the students. The significant thrust on internationalizing the curriculum at Penn State encouraged us to define and pitch related sub-projects to the instructors and students of appropriate courses in the engineering and business schools. The response was overwhelmingly positive and most instructors were very excited about having their students involved in this project. This concept is called “Commissioned Assignments” and is very popular in the field of technical writing (Leonhard Center Technical Writing Initiative 2003).

A critical sub-project was the development of the business plan. This was executed by a student team from the Finance Honors course at Penn State. An optional sub-project was executed by a student team from an Engineering Leadership course at Penn State. The student team was given a comprehensive orientation on the philosophy and goals of the project. Over the course of the semester, the team analyzed the mission, vision, and policy framework of the United States Agency for International Development (USAID) and ESW to determine the correlation between them. Based on this, they prepared a presentation targeted at USAID persuading them to fund organizations like ESW, which are trying to set up business incubators and sustainable enterprises in developing and underdeveloped countries, as opposed to organizations that just give handouts to people. The students involved in this sub-project had an excellent learning experience and contributed in their own little way to the project. We also tapped into the faculty member’s expertise. This approach helped increase awareness about social entrepreneurship, service-learning, and international issues amongst students and faculty.

**Lesson 2: Incentivize faculty and student participation:** Recruiting committed faculty and students on this project at Penn State was fairly easy. However, we found it very challenging to get faculty members and students at UoN to participate in this project in spite of their prior commitment. Administrators at UoN were very interested in this project and provided numerous resources including students (academic credit by way of year-long capstone design project), faculty mentors, access to machine shop, local transportation, etc. The faculty member who actually initiated this project and was responsible for mentoring the students proved to be more of a liability than an asset. The replacement faculty member identified by UoN when the primary faculty member stopped communicating was not responsive either, and the students at UoN were left stranded with no direction from their mentors. There was no direct motivation for the faculty members or students to be involved in this project. Finding the right champion at UoN was a major challenge. When we did find some potentially strong champions, we did not pursue it due to the fear of straining the relationship with the existing person. Incentivizing participation of faculty and students abroad (largely by material gains) in such projects is critical to collaboration. This has to be done in a sensitive manner to ensure that the relationship is still perceived as a “collaboration” and not “employment.” Frequent in-person meetings can help mitigate the problem, but this is not realistic. Finding local sources of supplementing faculty salaries, getting MNCs to provide jobs and/or scholarships to students and, most importantly, educational and travel opportunities are some practical incentives.

**Lesson 3: Ensure everyone understands the business model:** KDG is essentially a women’s group that is involved in HIV/AIDS education, collective farming, and collective savings projects. The members of the group stand to benefit directly from this project and hence we involved them with the design of the system and the business logistics. The communication overhead was significant because of the English–Luo translations and the fact that the KDG office holders (more educated, including a Reverend) were not entirely honest and transparent in their dealings.

One of the major challenges was to inculcate business sense in the community and explain the business model and logistics. Repeated anecdotes and dramatized passionate speeches by the community leaders and Penn State and UoN faculty members (“Don’t ask what Kochia can do for you; ask what you can do for Kochia”) helped to explain the business model and the need for transparency and accountability. Repeated one-on-one conversations about the business model (different stories, different words) and informal quizzes for the community members were essential to make sure that everyone understood the system. At business launch, most community

members had a very good understanding of the business model due to the reiteration of the concepts/model multiple times.

**Lesson 4: Plan a public relations campaign:** As word got out about the project, we got numerous requests from neighboring (and distant) communities about bringing the project to their community. We realized that other communities were making false assumptions about the project and that this could lead to conflict between the communities, vandalism to the windmill or even personal harm to the KDG members. It was important to have a PR campaign targeting government officials, local chiefs, and neighboring communities to explain the business we were setting up in Kochia. We reassured them that we were not gifting anything to anybody in Kochia and if the Kochia project succeeded, we might come to their community after a few years! This statement helped reduce micro-jealousy and the probability of conflict. This also put pressure on KDG officials to work honestly and transparently. However, significant time and energy were expended in speaking to various people, especially the government officials who do not like to make appointments.

**Lesson 5: Ensure equity:** In western Kenya, there are countless churches and NGOs that offer “miracle services” and give significant handouts to the people. This adversely affects the work ethic of the people. The major capital cost for this initiative was the design and construction of the windmill, which was borne by Penn State, BGSU, UoN, and the NCIIA. One of guiding principles of the project was to ensure that the money/time/sweat expended by the universities was in some proportion matched by money/time/sweat put in by the locals. For this project to survive, it was critical for the community members to have a sense of pride and ownership of the system and view us as “empowerers” and not “employers.”

The average reported per-capita income of the community was about \$10/month. It was not possible for them to have money equity in the capital cost of the project. People had to work through the day to be able to get a meal in the evening. KDG is a women’s group and the old women could not assist directly with the construction. Under these circumstances, time and sweat equity from the community members was not practical either. We negotiated a two-point plan with the community members:

- For every day a community member volunteered with the construction of the system, he/she got a discount of about \$2 on the battery. The maximum discount was \$10 for working on all five construction days. The discount was not redeemable for cash.
- We bought groceries for everybody (about thirty individuals) for the daily meal, which was cooked by the old women.

With this scheme,

- EVERYONE was actively working on the project in whatever way he or she could (carrying steel, mixing concrete, babysitting, or cooking a ram).
- The people had a sense of pride and ownership of the system and realized how the money they would pay for charging the batteries would indirectly go into their own pocket because it will be used for maintaining the system and scaling up.
- We built part of our customer base for the battery charging business without giving any batteries for free (which was expected initially) or subsidizing their cost (which could have resulted in people selling the batteries for instant cash). The negotiated discount was based on our research into the “pain point”—the maximum amount people could afford and were willing to pay for the batteries.
- Making the batteries community-owned was initially proposed by the business student team. In that case, the batteries would certainly have been misused and mismanaged by some members (e.g., a common technique is putting an iron nail in the battery to give immediate power; it results in significant damage to the battery). Individual ownership was a better solution and the \$10 discount offered to volunteers made the batteries affordable to the community members.
- We cooked and dined together to reinforce the spirit of camaraderie and unity.

**Lesson 6: Minimalist designs survive:** An observation during the author's first trip was that many people used batteries that were leaking acid. Little kids would be running around naked and playing with the batteries, or worse, sitting on them. Acid burns have no instantaneous symptoms, but result in nasty burns in few hours/days. Most people did not realize that the leaking batteries were causing those burns. This heart-wrenching observation was recounted to the engineering student team that came up with the innovative concept of a "Battery Hat."

A Battery Hat fits on top of a battery and adds a layer of safety by blocking direct access to the (leaking) battery terminals. It makes the battery easy to transport. It also includes a LED lamp "discharge indicator" to inform the user that the battery needs to be recharged. The Battery Hat has sockets for people to directly plug into their approved appliances and for the battery-charging technician to plug in the charging cable. We used different kinds of plugs/sockets for the Battery Hat and the twelve-Volt CFL lights (different than the standard power plug/socket in Kenya) to make the system easy to use and ensure that people would not plug in regular appliances into the Battery Hat, or worse, try to charge the battery from the 230VAC power outlet (in Homa Bay town).

The Battery Hat raised the cost of the battery by about \$10. This was not acceptable to the users because they did not see the need for it. The plugs/sockets picked by the students in Nairobi were not available in Homa Bay and required soldering some wires. We realized that when some wire would come off, the users would just throw away the Battery Hat and start using the battery directly. We could have trained the technician to solder, but he would have to go to town to be able to operate the soldering iron. Finally, we concluded that neither the Battery Hat nor special connectors were feasible in our circumstances. We decided to go back to battery cables with clamps and directly wired lights (with an inbuilt switch). We did a few just-in-time safety awareness sessions and instructed KDG officials to conduct more safety sessions. It helps to have a barebones system that can be easily manufactured and maintained locally. Human beings can be trained; repetition helps.

**Lesson 7: Prepare students to lead:** Penn State students were prepared for their trip to rural western Kenya over an extended period of time with the help of numerous pictures and anecdotes of the people and places. They studied the historical, geo-political, cultural, and economic context of the region. On the ground, they had no major culture shocks and actually mixed wonderfully with the locals. However, their orientation was lacking in one major cultural difference—most of the locals would not take the lead. They needed to have precise instructions for the assigned tasks. Penn State students waited on the locals to take the initiative and work together, and were not comfortable delegating tasks to the locals.

Due to the generous equity deal, we had numerous volunteers during the windmill structure construction phase. Significant labor was needed to transport steel, cement, and other heavy materials for long distances over rough terrain under adverse weather. Additional labor was required for the steel to be sandpapered and painted, concrete mixed, etc. Most of the volunteers were underutilized because they were not assigned tasks. The students ended up working a lot more than they should have and were upset about not being able to "think together and act together" with the Kenyans. Student orientation should include practical lessons (through role-play or other active-learning methodology) on how to lead, delegate, and get work done in a respectful and harmonious manner on the ground.

**Lesson 8: Awareness of opportunism and corruption issues:** In developing countries, it is not unusual for foreigners to be overcharged. Students frequently construe this kind of opportunism as racism. Making the distinction between opportunism and racism could be a good topic for the pre-trip orientation that would help reduce the heartburn of "getting cheated" that many students experience in the unfamiliar and uncomfortable circumstances on the ground.

Small supplemental payments made to expedite the execution of certain tasks (by people who are already paid to perform those tasks) or offered as *baksheesh* (gifts) to acknowledge their work are a way of life in much of the developing world. This is a form of institutionalized legal corruption that exists in many countries including Kenya. The "bribe" is generally a small amount but expectations can go up if foreigners are involved. A major myth in the United States is that it is illegal for US entities to give bribes in foreign countries. The Foreign Corrupt Practices Act (US Department of Justice 2007) makes a distinction between giving huge bribes and

making “grease payments.” Huge bribes (to government officials) are illegal, grease payments are not. They are required to get work done in developing countries and on an ethical level (of the author) are more akin to tips than bribes. Paying everyone to get work done is an extremely bad idea; sticking to ideology and refusing to pay the bribes/tips when absolutely essential does not help either. When bribes have to be given, they should preferably be negotiated by the locals and given without any ill-feelings. Tip with smiles; bribe with compassion.

**Lesson 9: Do your best; detach:** Students (and mentors) often hope to change the world (or at least the community they are working with) with their project...in just one trip. Needless to say, that’s not realistic and can cause significant frustration when things simply don’t go as planned. Things might not go as planned for a multitude of reasons. One extremely frustrating aspect could be the internal politics, tension, and scheming in extremely impoverished communities; foreigners might feel it but not understand it due to communication barriers.

We used democratic processes (with a little bit of engineering) to elect the Board of Trustees, the windmill support team, the battery-charging technician, the chairperson and the treasurer. The elected treasurer was someone we considered very honest, whereas the integrity of the chairperson was a little questionable. After getting government clearances, we set up a co-operative bank account with the chairperson and treasurer as signatories. Only after we left Kochia for good, were we informed by the UoN faculty member that the elected treasurer did not have his passport-size photographs with him and so he was conveniently replaced with another person as the signatory with money withdrawal privileges. This new person unfortunately happened to be a confirmed dishonest person! Alas, when we learnt about this, we had already left Kochia and there was nothing we could do to reverse it.

Here’s some wisdom from the Bhagavad Gita: “*Karmanye vaadhikaraste ma faleshu kadachana, ma karma fala hetur bhurmatey sangostva akarmani,*” which can be roughly interpreted and translated from Sanskrit to English as, “Do your duty and be detached from its outcome; do not be driven by the end product, enjoy the process of getting there.” Keep working, keep trying to change the world, assess the impact of your work and keep improving, but realize that there are factors beyond your reach and detach yourself from the outcome (to a certain extent). You might actually achieve more without getting frustrated.

**Lesson 10: A few micro-lessons...ready to go:**

- Make a detailed local map of the area of work (in developing countries). The map is extremely important and making one is more difficult than it sounds. It is not available in a shop and cannot be googled up.
- Lots of people (from the “developed” world) want to volunteer (even long-term) on social entrepreneurship projects like these. Many pay exorbitant fees to placement agencies which get them connected to NGOs. These volunteers can be of immense help on the ground (for a longer term). Recruit them directly through your project website and/or through popular travel sites like the Thorn Tree Forum on lonelyplanet.com.
- Beware of wild fluctuations on the prices of certain goods. We witnessed a 25% increase in the price of steel in two days. Budget ahead!
- Establish a protocol to sustain communication. What happens when your team leaves the site? How do you contact the community members? How do the community members contact the host university? How do the community members contact the North American university?
- Recruit your team based on passion, not just on skill-set.
- Don’t promise more than you can deliver.
- Publish your observations and lessons.

## Concluding Remarks

This paper discusses the program and business model for a social entrepreneurship venture undertaken by Penn State, Bowling Green State University, University of Nairobi, and Kochia Development Group in an extremely impoverished region in western Kenya. Initial assessments of this area showed that a dependable power source

could significantly help to advance the underdeveloped economy, improve the quality of life for the residents, and serve as a beacon of hope and pride.

A windmill was collaboratively designed for Kochia and constructed at the pilot site. Various market segments were identified and a business model that would reach all the segments was developed and implemented to make the project economically sustainable. Regular updates are received from the project site. Four months after installation, the system has been working perfectly and the profits from the business are being deposited in a co-operative bank account. Assessment of the project's success as a profit-making venture and its impact on the target community will be performed one year after project completion (next summer). Setting up a manufacturing unit would be a very ambitious project and will be ventured into only if strong champions to spearhead the effort are found in Kenya. Various observations and lessons learned by the author over the three years of planning and execution of this project are presented in this paper. Making generalizations about countries, races, cultures, and attitudes based on these observations might be tempting but unintended and inappropriate. The lessons are simply one person's view of his experiences expressed in simple terms to help others in similar situations.

This project was an excellent learning opportunity for the approximately 100 students at the three universities who were associated with it over the three years. Student assessment was done on the sub-projects and commissioned assignments. On the ground in Kochia, individuals from three races, four religions, five countries, numerous languages, numerous disciplines, and extremely diverse life experiences came together to explore opportunities, create value, benefit society, develop personally and professionally, and make meaning in their own way. The students involved in this project over a long duration metamorphosed from myopic engineers (with a certain major) to creators, entrepreneurs, problem-solvers, activists, leaders, world-class engineers and (the mentor's) co-conspirators with a burning passion to change the world to a freer, friendlier, fairer and more sustainable planet.

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