POWERING AGRICULTURE:
AN ENERGY GRAND CHALLENGE FOR DEVELOPMENT

INNOVATORS
The United Nations Food and Agriculture Organization projects that by 2050 global food production will need to increase 70 percent over 2005–2007 levels to meet the demand of a growing world population expected to reach 9.6 billion people.

For food production to keep pace and feed the world, there will need to be an increase in agricultural production resulting in an increased demand for energy. Already the agri-food supply chain accounts for 30 percent of the world’s energy consumption as reported by the International Renewable Energy Agency.

The negative consequences of this increased need for energy include a vulnerability to fluctuating energy prices that can negatively impact food production especially in the developing world, and a significant growth in greenhouse gas emissions within the agricultural sector from the use of primarily fossil fuels to generate the needed electricity.

**An Energy Grand Challenge**

In 2012, *Powering Agriculture: An Energy Grand Challenge for Development* was launched by its Founding Partners—the United States Agency for International Development, the Government of Sweden, Duke Energy Corporation, the Government of Germany, and the Overseas Private Investment Corporation—to catalyze resources and focus attention on the lack of access by many farmers and agribusinesses in developing countries to reliable, affordable and clean energy. This limits their ability to adopt modern agricultural practices, increase food production, improve efficiency of their operations and benefit from broad-based, low-carbon economic growth.
Barriers to Growth
The Powering Agriculture Founding Partners recognize that many farming communities face substantial barriers in incorporating clean energy solutions into their operations. Often farmers are not aware of what technology is available, the technology that is available does not match the performance characteristics or price points required in emerging markets, or there is little appropriate financing to assist in paying the relatively high, up-front capital costs of new technology.

Leveraging Funds for a Lasting Impact
Powering Agriculture: An Energy Grand Challenge for Development utilizes the financial and technical resources of its partners to promote new ideas and innovation at the point where clean energy and agriculture intersect—the clean energy/agriculture nexus.

Powering Agriculture: An Energy Grand Challenge for Development supports the design and expansion of sustainable business models that link clean energy enterprises with farmers and agribusinesses in developing countries. This is achieved by:

- Providing small grants ($500,000–$2,000,000) to entities to design, pilot and deploy clean energy solutions to different points along the agricultural production cycle—from obtaining agri-inputs, planting, irrigation and harvesting to processing, transportation and storage.

- Leveraging funds for a global financing facility to provide guarantees to encourage private sector equity and debt investments within the clean energy/agriculture space.

- Identifying and supporting clean energy solutions that can be brought to commercial scale, and integrated within regional/national agriculture production and food security programs.

- Hosting an online knowledge management platform to document lessons learned, promote effective technologies and business models, and foster continued engagement among stakeholders interested in exchanging ideas about the clean energy/agriculture nexus.

A New Approach to Solving Development Problems
Powering Agriculture: An Energy Grand Challenge for Development is the third in a series of six Grand Challenges for Development that USAID has initiated with international partners. The Grand Challenge for Development (GCD) model is designed to focus global attention and resources on specific, narrowly defined international development problems, and to promote innovative approaches to solving them. GCDs encourage solutions that build on physical and social science research and technological advancements, and aim to engage new actors that might otherwise not receive support through traditional international development programs. Importantly, the model supports solutions with the potential to achieve scale in low resource settings by, among other things, leveraging commercial investment and financing.
Powering Agriculture’s Current Clean Energy Solutions: Latin America and the Caribbean

- Solar-Powered Pumps for Improved Irrigation
- Smart Grid on Main Street: Electricity and Value-added Processing for Agricultural Goods
- Private Sector Financed Community Solar Microgrids and Agricultural Accelerators
Powering Agriculture’s Current Clean Energy Solutions: Africa and the Middle East

- A Hydroponic Green Farming Initiative
- PV-Integrated Drip Irrigation and Fertigation Systems
- Biomass-Powered Thermal Processing of Bamboo
- Improving Coffee Production and Quality Using Infrared Technology
- Biomass and Solar PV Hybrid Minigrids for Off-Grid Farming Communities
- Micro-Solar Utilities for Small-Scale Irrigation
- Building Markets for Efficient Biomass Power Provision
- Biogas-Powered Evaporative Cooling for the Dairy Industry
- Solar-Powered Pumps for Improved Irrigation
- Scaling the Distribution of Tailored Agro-Solar Irrigation Kits
- SunChill: Solar Cooling for Horticultural Preservation
- End-to-End Distributed Renewable Energy Solutions for Horticulture
- Biogas Milk Chilling to Increase Productivity and Incomes of Dairy Farmers
- SUNFLOWER: Asset-Financed Solar Irrigation Pumps for Smallholder Farmers
- Solar-Powered Refrigeration for Dairy Farms
- Affordable, High-Performance Solar Irrigation for Smallholder Farmers
Powering Agriculture’s Current Clean Energy Solutions: Asia and the Pacific Islands

- Field Evaluation of a Passive Aeration System for Aquaculture
- Renewable Microgrids for Off-Grid Fish Hatcheries and Surrounding Communities
- Reducing Milk Spoilage through Solar Powered Chilling
- Low-Cost Pay-Per-Use Irrigation Using Solar Trolley Systems
- Hybrid Vehicles with Exportable Power for Community-Based Agriculture Mechanization
# Powering Agriculture’s Current Clean Energy Solutions:

<table>
<thead>
<tr>
<th>2013 INNOVATORS</th>
<th>PROJECT</th>
<th>INNOVATION STAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivo Engineering</td>
<td>Hybrid Vehicles with Exportable Power for Community-Based Agriculture Mechanization</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>ECO Consult</td>
<td>A Hydroponic Green Farming Initiative</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>The Earth Institute at Columbia University</td>
<td>Micro-Solar Utilities for Small-Scale Irrigation</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>International Development Enterprises (IDE)</td>
<td>Solar-Powered Pumps for Improved Irrigation</td>
<td>4. Early Adoption/Distribution</td>
</tr>
<tr>
<td>SunDanzer</td>
<td>Solar-Powered Refrigeration for Dairy Farms</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>Rebound Technologies</td>
<td>SunChill: Solar Cooling for Horticultural Preservation</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>University of Georgia Research Foundation</td>
<td>Biogas-Powered Evaporative Cooling for the Dairy Industry</td>
<td>2. Research &amp; Development</td>
</tr>
<tr>
<td>African Bamboo</td>
<td>Biomass-Powered Thermal Processing of Bamboo</td>
<td>4. Early Adoption/Distribution</td>
</tr>
<tr>
<td>EarthSpark International</td>
<td>Smart Grid on Main Street: Electricity and Value-Added Processing for Agricultural Goods</td>
<td>3. Initial Piloting</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2015 INNOVATORS</th>
<th>PROJECT</th>
<th>INNOVATION STAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>KickStart International</td>
<td>Affordable, High-Performance Solar Irrigation for Smallholder Farmers</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>Claro Energy</td>
<td>Low-Cost Pay-Per-Use Irrigation Using Solar Trolley Systems</td>
<td>2. Research &amp; Development</td>
</tr>
<tr>
<td>Institute for University Cooperation (ICU)</td>
<td>PV-Integrated Drip Irrigation and Fertigation Systems</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>SunCulture</td>
<td>Scaling the Distribution of Tailored Agro-Solar Irrigation Kits to Smallholder Farmers</td>
<td>4. Early Adoption/Distribution</td>
</tr>
<tr>
<td>SimGas</td>
<td>Biogas Milk Chilling to Increase Productivity and Incomes of Dairy Farmers</td>
<td>2. Research &amp; Development</td>
</tr>
<tr>
<td>Horn of Africa Regional Environment Center and Network</td>
<td>Improving Coffee Production and Quality Using Infrared Technology</td>
<td>2. Research &amp; Development</td>
</tr>
<tr>
<td>University of Toronto</td>
<td>Field Evaluation of a Passive Aeration System for Aquaculture</td>
<td>2. Research &amp; Development</td>
</tr>
<tr>
<td>Village Infrastructure Angels (VIA)</td>
<td>Solar Agro-Processing Power Stations</td>
<td>4. Early Adoption/Distribution</td>
</tr>
<tr>
<td>Universidad del Valle de Guatemala (UVG)</td>
<td>Private Sector Financed Community Solar Microgrids and Agricultural Accelerators</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>International Development Enterprises (IDE) Bangladesh</td>
<td>Renewable Microgrids for Off-Grid Fish Hatcheries and Surrounding Communities</td>
<td>3. Initial Piloting</td>
</tr>
<tr>
<td>Ariya Capital Group</td>
<td>Powering Agriculture with Renewable Energy</td>
<td>4. Early Adoption/Distribution</td>
</tr>
<tr>
<td>Husk Power Systems</td>
<td>Biomass and Solar PV Hybrid Minigrids for Off-Grid Farming Communities</td>
<td>5. Market Growth</td>
</tr>
<tr>
<td>CLEAN ENERGY SOURCE</td>
<td>AGRICULTURAL FOCUS</td>
<td>PRODUCT SEGMENT</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Hybrid</td>
<td>Irrigation, Cold Storage, Processing, Decentralized Power</td>
<td>Aquaculture, Dairy, Horticulture, Staple Crops</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Irrigation</td>
<td>Horticulture</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Irrigation</td>
<td>Horticulture</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Irrigation</td>
<td>Horticulture</td>
</tr>
<tr>
<td>Energy Efficiency, Solar Photovoltaic</td>
<td>Cold Storage</td>
<td>Dairy</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Cold Storage</td>
<td>Dairy</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>Cold Storage</td>
<td>Horticulture</td>
</tr>
<tr>
<td>Biogas</td>
<td>Cold Storage</td>
<td>Dairy</td>
</tr>
<tr>
<td>Biomass</td>
<td>Processing</td>
<td>Agro-Forestry Products</td>
</tr>
<tr>
<td>Biomass</td>
<td>Decentralized Power</td>
<td>Agro-Forestry Products</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Decentralized Power</td>
<td>Staple Crops</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Irrigation</td>
<td>Horticulture</td>
</tr>
<tr>
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<td>Irrigation</td>
<td>Horticulture</td>
</tr>
<tr>
<td>Biogas</td>
<td>Cold Storage</td>
<td>Dairy</td>
</tr>
<tr>
<td>Biogas</td>
<td>Processing</td>
<td>Fruit</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>Processing (Aeration)</td>
<td>Aquaculture</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Processing</td>
<td>Staple Crops</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>Decentralized Power</td>
<td>Horticulture</td>
</tr>
<tr>
<td>Solar Photovoltaic, Wind</td>
<td>Decentralized Power</td>
<td>Aquaculture</td>
</tr>
<tr>
<td>Solar Photovoltaic, Wind</td>
<td>Decentralized Power</td>
<td>Horticulture</td>
</tr>
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<td>Biomass, Solar Photovoltaic</td>
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<td>Staple Crops</td>
</tr>
</tbody>
</table>
Motivo Engineering specializes in connected electro-mechanical systems to solve complex challenges across diverse market segments. Motivo’s partner, the KVK Foundation, will draw on their extensive rural development experience in India to introduce new technologies to rural villages.

Today, 2.6 billion people earn their livelihood from agriculture and there are 1.2 billion people who lack access to electricity. As our population expands, farms and agribusinesses need to produce, process and transport an increasing amount of food. The agricultural sector needs an easy way to access and use energy in order to increase farm productivity. Farmers across the world need low cost, infrastructure-less electrification and mechanization.

Motivo is developing a “Swiss-Army Knife” system—the Hybrid Agriculture/Road Vehicles with Electricity Storage and Transformation (HARVEST)—that solves a wide range of agricultural mechanization and power-related problems. HARVEST is a multi-purpose platform that provides power for plowing, well-drilling, cold storage, and transporting crops to market. The system utilizes power from varied energy sources such as solar panels, wind turbines, micro-hydro turbines, or the grid to enable increased productivity all along the agriculture value chain. The entire system is operated at the community level, and facilitated by mobile communication technology for scheduling, billing, and payments.

INNOVATOR:  
Motivo Engineering, LLC  
(United States)

COLLABORATORS:  
The KVK Foundation (India)

LOCATION APPLIED:  
Rangareddy, Telangana, India

INNOVATION STAGE:  
3. Initial Piloting

CLEAN ENERGY SOURCE:  
Hybrid

AGRICULTURAL FOCUS:  
Cold Storage, Decentralized Power, Irrigation, Processing

PRODUCT SEGMENT:  
Aquaculture, Dairy, Horticulture, Staple Crops

WEBSITE:  
www.motivoengineering.com/harvest-mobile-power-platform
Impact
HARVEST democratizes opportunity in agriculture by making available to entire communities huge gains in productivity that are enabled through mechanization and reliable power. Varied energy sources will reduce reliance on increasingly-expensive imported diesel, and the system itself will create new skilled jobs for men and women in rural areas in deploying, managing, and maintaining the HARVEST equipment.

Progress Update
Motivo's HARVEST prototype is now functional and undergoing testing in California. The HARVEST prototype is being tested in small fields and nurseries. Motivo continues to work on upgrades to make the tractor more functional and is close to deploying HARVEST to Indian farmers.
Organization
Established in Jordan in 1995, ECO Consult is a leading development firm with more than 15 years of experience working in Jordan and the Middle East. Past work includes projects in public sector reform, private sector development, local governance and development zones, energy, water, and environment.

Problem/Opportunity
Jordan is considered to be one of the ten most water-scarce countries in the world. As water becomes scarcer, its availability for agriculture is expected to decrease. Hydroponic technology, an intensive form of agriculture, uses much less water than conventional farming and offers an excellent opportunity for farmers to increase their income while reducing their water use. Although farmers have expressed their interest in this new technology, its application in Jordan is still limited.

Clean Energy Solution:
ECO Consult has developed an integrated model of hydroponic and photovoltaic farming to compete with conventional greenhouse technology and drip irrigation systems. To make the technology attractive to large-scale commercial farms, ECO Consult will retrofit a multi-span greenhouse with advanced hydroponic technologies and photovoltaic panels to generate enough power to operate the lighting, pumping, and air moderation systems.
Impact
ECO Consult’s beneficiaries include large commercial farms as well as small household farms. As more farms adopt these new technologies, the value of their agricultural produce will increase, while their use of scarce natural resources will decrease. Simultaneously, as more rural households adopt this technology at a small-scale, they will realize additional sources of income and new employment opportunities for women and youth.

Progress Update
ECO Consult organized a national advisory group in Jordan for hydroponic farming. As part of USAID’s Powering Agriculture program and Hydroponic Green Farming Initiative, they have designed indigenous hydroponic systems, incorporating materials readily available in Jordan. To date, ECO Consult has installed the hydroponic systems at four sites on a cost-share basis with the owners. A demonstration hydroponic pepper farming greenhouse was established to show systems that can be adopted for large and small-scale farming. Other crops being grown at the demonstration sites include thyme, lettuce, and other vegetables.
Micro-Solar Utilities for Small-Scale Irrigation

Organization
The Earth Institute at Columbia University harnesses scientific research, education, and practical solutions to create a more sustainable world through innovation and critical thinking. Earth Institute has partnered with The MDG Center West and Central Africa (WCA)—an organization established to assist WCA countries to develop and implement operational strategies aimed at achieving the Millennium Development Goals.

Problem/Opportunity
In Senegal, farmers currently use two practices for watering crops: the labor intensive method of flood irrigation with wells and buckets, or the cost- and energy-intensive method of using diesel-powered motor pumps. Neither of these options is ideal in a country with immense solar resources that can be harnessed and used to transform irrigation practices in the country and region.

Clean Energy Solution
Earth Institute’s solution will enable a small group of farmers to use a central solar energy unit to power multiple alternate current (AC) pumps for irrigation. The proposed solution takes advantage of the benefits of solar without the high costs associated with direct current (DC) powered pumps and battery storage. This power will be accessed by farmers with prepaid electricity cards issued by a micro-utility, and sold through local vendors who will benefit from a small commission. Recognizing that a major obstacle to technology adoption is financing, a tariff-based financing model will allow customers to cover their appliance loans in small payments added into their micro-utility bills.
Impact
This innovation will reduce the price of energy for irrigation significantly, while reducing the carbon intensity of irrigation and the labor expended on it. These benefits are particularly powerful when looking at the demographics of Senegal’s agricultural workforce, which is more than 85 percent women.

Progress Update
The Earth Institute has installed three pilot solar PV pumping systems, which will serve seven farmers each (21 total) from a single, centralized array. Farmers on the first system have been paying for the service since early 2015 with high satisfaction. The next two pilot systems have been installed in Senegal and are awaiting pump installations. These latter two systems have solar tracking systems designed to optimize pump usage by increasing the time period during a day which the solar panels are collecting the maximum amount of energy (normal to the sun’s rays).
Organization
iDE has over 30 years’ experience creating business opportunities that spread transformative products and services through the developing world. In rural agriculture, iDE develops appropriate agricultural products and engages the private sector to supply these products to smallholder farmers, improving long-standing agricultural practices. iDE has reached over 23 million people across Africa, Asia, and Latin America. This project is implemented in partnership with PRACTICA Foundation—a Dutch organization that has a focus on the commercial application of technology in the field of water and energy—and Futurepump Ltd.—a UK manufacturer of efficient renewable irrigation pumps.

Problem/Opportunity
Globally, there are more than 800 million smallholder farmers, many of whom manually lift and haul over four tons of water daily to irrigate their farmland. These farmers can drastically decrease their labor and expand their irrigable area by employing motorized pumps. Currently, the most accessible and affordable pump solutions are small engine pumps powered by increasingly expensive fossil fuels. Consequently, many farmers are either unable to provide sufficient irrigation to their crops, and/or must allocate a sufficient portion of their income to environmentally-hazardous fossil fuels.
Clean Energy Solution
To increase agricultural productivity, incomes, and livelihoods of smallholder farmers, iDE and its partners have developed a Clean Irrigation Solution that will provide smallholder farmers across the developing world the opportunity to mechanize their farming with zero carbon emissions. The system uses the Sunflower pump, an efficient, versatile, and cost-effective piston pump powered by a PV panel, which is coupled with iDE’s affordable, ultra-low pressure drip irrigation kit to maximize the agricultural output and value of each drop of water pumped.

Technology development is only one component of bringing the Sunflower pump to scale. iDE has identified five key factors needed to bring a Clean Irrigation Solution to scale:

Appropriate Technology—iDE is working with the PRACTICA Foundation to develop a low-cost solar pump called the Sunflower pump.

Viable Business Plan—iDE is partnering with Futurepump, a private company that will be responsible for the manufacturing and global distribution of the Sunflower pump.

Accompanying Finance Model—iDE is identifying finance models to bring down the high upfront costs that currently make the Sunflower pump cost-prohibitive to smallholder farmers.

Established Supply Chain—iDE is identifying national and sub-national level retailers to bring the Sunflower pump to different markets. iDE is working through its last-mile distribution network to provide installation and repair services.

Marketing and Educational Resources—iDE is developing training manuals for field technicians and using demonstration plots to convey the benefits of the Sunflower pump for smallholder farmers.

Impact
By the end of this project, iDE’s goal is to have a commercially available solar pump product for farmers irrigating up to 2,000 square meters of high-value dry season vegetables.

Use of the Sunflower pump instead of a fossil fuel engine can reduce annual carbon emissions by half a ton. With a ten-year lifespan, each pump reduces CO₂ emissions by five tons.

Progress Update
iDE and its partners have established a manufacturing facility in India. Pumps for field testing have been installed in Nepal, Zambia, and Honduras. The feedback from these field tests informed future design iterations to the pump. The field testing sites have become demonstration sites, and iDE is laying the groundwork for sustainable sales and distribution of the pump in these three countries.
Promethean Power Systems designs and manufactures refrigeration systems coupled to their thermal batteries for agricultural commercial refrigeration applications in off-grid and partially electrified areas of developing countries. Promethean is working in partnership with the Hatsun Argo—India’s largest private dairy company, and Orb Energy—a leading solar energy system provider in India.

Problem/Opportunity
In India, $10 billion worth of perishable foods are wasted annually because of unreliable cold-chain supply networks. A major obstacle in setting up cold chain networks is the lack of reliable electricity to run refrigeration systems in villages and farming areas. Diesel generators are often used to provide electricity for milk chilling, a non-ideal solution with high operating costs and negative environmental impact.

Clean Energy Solution
Promethean’s refrigeration solution uses a thermal energy battery pack that charges on intermittent power sources such as solar power and/or a few hours of grid electricity. This provides cold storage around the clock despite inconsistent access to electricity. Dairy processors can collect raw milk from remote dairy farmers and keep it cold in a rapid milk cooler, reducing the time that milk is unchilled by 75 percent. Promethean will design and deploy the refrigeration systems in collaboration with India’s largest private dairy and one of India’s largest solar installers.
Impact
India is the largest producer and consumer of milk in the world. Increasing access to milk while decreasing bacteria and spoilage supports food security and consumer health in India, where 42 percent of children under the age of five are malnourished. This project will improve access to forward markets, higher income for the dairy farmers, and wealth creation through increase in herd size.

Progress Update
Promethean has deployed and commissioned over 100 milk chillers coupled to its patented Thermal Battery. To date, none of the 100 Promethean chillers have required a diesel generator. Without Promethean’s Thermal Battery, a traditional milk chiller would have run diesel generators to chill milk in these villages. As deployment of the chillers continues, Promethean has been able to adapt the solar design to address specific logistical needs of dairy partners.
Organization
SunDanzer has 15 years of experience with off-grid refrigeration needs, including developing the world’s first battery-free solar powered refrigerator. Winrock International is a leader in agricultural development and has more than a quarter century of experience with renewable energy based rural electrification. It has supported the installation of more than 80,000 rural renewable energy systems around the globe and has three offices in Kenya.

Problem/Opportunity
Due to limited electrification in rural areas, 85 percent of Kenya’s 800,000+ dairy farms do not have access to refrigerated storage and transportation. This deficiency in the distribution chain results in less than half of the milk produced reaching dairy processors. Of the milk that is processed, up to 30 percent of it may spoil without appropriate cold-storage options. Consequently, many dairy farmers and processors unnecessarily may lose significant earning potential from their operations.

Clean Energy Solution
Recognizing the need for affordable cold-chain technologies, SunDanzer has developed a small-scale portable cooling system tailored for use in the Kenyan dairy market. The system comprises a photo-voltaic refrigerator (PVR) that uses solar energy to cool a chest refrigerator. This uses phase-change materials—substances which are capable of storing and releasing large amounts of energy—as energy storage. SunDanzer also developed milk can blankets to retain the cold temperature as farmers transport the milk to the collection site.

INNOVATOR:
SunDanzer (United States)

COLLABORATORS:
Winrock International (United States)

LOCATION APPLIED:
Nakuru Region, Kenya

INNOVATION STAGE:
3. Initial Piloting

CLEAN ENERGY SOURCE:
Solar Photovoltaic

AGRICULTURAL FOCUS:
Cold Storage

PRODUCT SEGMENT:
Dairy

WEBSITE:
www.sundanzer.com
www.winrock.org
Impact
This clean energy solution aims to increase dairy farm productivity and income by significantly decreasing milk spoilage. Effective cold-chain storage lowers bacteria count and improves milk quality for consumers. These improvements can play a major role in the livelihoods of approximately one million smallholder dairy farming families in Kenya.

Progress Update
SunDanzer has delivered and installed 40 solar milk cooling refrigerators in Kenya. Of these 40 refrigerators, 38 units were installed at dairy farmers whose product feeds two cooperatives; 1 was installed at Egerton University; and 1 was installed at the Mogotio milk cooperative.
SunChill: Solar Cooling for Horticultural Preservation

Organization
Rebound Technologies develops tailored refrigeration technologies designed to meet global energy market dynamics while reducing fossil fuel dependence. To successfully design, build and deploy SunChill™ technology, Rebound will leverage critical partnerships. The Energy Institute’s (Colorado State University) product development experience will support R&D, TechnoServe’s business solutions focus will drive host nation outreach/support, and Mozambique Organicos research farm will provide the primary venue for SunChill™ deployment and in-field testing.

Problem/Opportunity
Post-harvest, physiological obstacles such as ethane production, respiration and microbial attack make getting high quality horticultural products to market a significant challenge. Removing field heat from these products can double shelf life and reduce spoilage rates that often exceed 40 percent in developing countries. Unfortunately, current off-grid cooling technologies are expensive, energy intensive, and difficult to maintain.
Clean Energy Solution
SunChill™ is a novel, off-grid refrigeration solution enabling increased agricultural productivity by: (i) removing field heat from crops immediately following harvest, and (ii) providing continued product cooling at local markets and/or central processing facilities. This clean energy solution transforms 50°C solar thermal energy into 10°C refrigeration using solid refrigerants and local, non-precision components. These characteristics enable production of a low cost, low-maintenance technology that reduces spoilage and benefits smallholder farmer livelihoods.

Impact
SunChill™ is one of the first developing world technologies that reliably removes field heat without a high-cost electrical supply. The low-cost system enables increased horticultural production both for domestic and export consumption, generating additional income for smallholder farmers and increased access to nutritional fruits and vegetables while generating both manufacturing and service based employment.

Progress Update
Rebound completed testing of the SunChill™ prototype April 2015. In June 2015, members of the Rebound team deployed to test technology in field conditions in Mozambique. The prototype is being assembled, using mostly locally available materials, at a for-profit farm, which also serves as an incubator to teach farming skills to local women. Feedback received during the demonstration will be incorporated into future designs.
Organization
The University of Georgia Research Foundation (UGARF) is a nonprofit entity housed within the University of Georgia in the United States that enhances UGA’s excellence as a research and higher education institution. Smallholder Fortunes is a small scale demonstration dairy farm located in Wakiso District, Uganda.

Problem/Opportunity
Throughout sub-Saharan Africa, the dairy industry suffers from lack of proper refrigeration options. Large dairies cannot export milk to neighboring markets due to international standards requiring milk be cooled within four hours of production. Small farmers may lose 20–50 percent of milk to spoilage due to lack of cold-chain facilities. There is limited access to electricity for refrigeration units, and kerosene and solar-powered options have proved too expensive and difficult to operate.

Clean Energy Solution
UGARF has developed a two-component device (branded as “EvaKuula”) powered by biogas—which is extracted from cow manure. The device delivers a mild heat treatment followed by gentle evaporative cooling process that keeps the milk fresh overnight. Partnered with Smallholder Fortunes, UGARF is refining the design of the refrigeration device, and testing it with farmers in Uganda. UGARF is working with local manufacturers to field-test the device and will secure financing and bring production of the units to commercial scale.
Impact
This project has numerous social, economic, and environmental benefits. The refrigeration device will benefit dairy farmers by decreasing milk spoilage and increasing production and profits. A fraction of the captured biogas can be used for lighting and cooking—saving income that would otherwise be spent on kerosene, and replacing the use of wood and charcoal for cooking. Also, by extracting biogas from cow manure, greenhouse gas emissions from fermenting cow manure are mitigated.

Progress Update
UGARF has completed a baseline study and identified smallholder farmer households to participate in their study. They have continued to perfect performance of the device and installed a demonstration unit at a partner site in Wakiso District. The initial stages have begun for the manufacture of 25 units that will be deployed among the participants. UGARF has also developed training materials that will be used to train participants before systems are installed on their farms.
Organization
African Bamboo is a forestry, wood, and bio-energy company located in Addis Ababa, Ethiopia, among Africa’s largest reserves of bamboo. African Bamboo develops innovative applications for bamboo, particularly for industrial and commercial uses. The company was established in 2012, as a subsidiary of Fortune Enterprise PLC which, since 1961, has been a manufacturer of wood and metal products in Addis Ababa.

Problem/Opportunity
In Ethiopia, there are more than one million hectares of bamboo. Recognized as a fast-growing and largely sustainable raw material, there is an increasing global demand for bamboo as a wood substitute for a variety of construction and furnishing applications. However, bamboo resources are often poorly managed. Most in the industry have limited knowledge of modern value-added processing techniques, which limits their earning potential.

Clean Energy Solution
African Bamboo is developing an environmentally friendly bamboo thermal modification process called ThermoBoo. Through this chemical-free process, decay factors such as rot and insects are virtually
eliminated, and the thermally-modified bamboo fiber can be further processed into sturdy panels that can be marketed to a range of domestic and international buyers. The ThermoBoo process involves the combustion of biomass dust—a technological approach that is completely new to Ethiopia. Through the project’s successful implementation of a pilot processing facility, African Bamboo envisions developing a replicable model that can lead to prospective business opportunities throughout the region.

Impact
The success of this project will lead to new opportunities for export, employment, and manufacturing in Ethiopia. In addition to its socio-economic impact, bamboo cultivation of native species plays a significant role in reforestation by stabilizing soil. African Bamboo uses environmental impact assessments to ensure the continued promotion of bamboo’s environmental benefits, and the minimization of the company’s ecological footprint.

Progress Update
Over the past two years, African Bamboo has completed the system design and engineering for the thermal modification facility. Remote-sensing technology has been utilized to take stock of the bamboo resources available in the project area. Thirty farmer cooperatives (more than 2200 farmers) have been established in order to give small-scale farmers a voice. An additional 50 farmers have been added as bamboo suppliers. Construction of three factory halls began in July 2015, with completion scheduled for March 2016. The commercial factory will be operational in 2017. Five contracts were issued to undertake the final phase of testing and certification at a commercial scale.
Camco Clean Energy is a sustainable energy development company with offices across Africa. It is experienced in providing rural electrification through solar, biomass, small hydro, and biofuel technologies, addressing traditional charcoal production and consumption. Camco will co-implement activities with Village Industrial Power (VIP)—a firm that specializes in the development of innovative biomass fueled co-generation plants.

In rural areas of sub-Saharan Africa, access to modern energy services is extremely limited. Without electricity, farming communities are slow in their adoption of modern agriculture practices—resulting in sparse irrigation, lagging food production, and few opportunities for value-added processing and refrigerated storage. Though some communities depend on fossil fuel-based technologies to meet their energy needs, perpetually escalating fuel costs—coupled with adverse environmental impacts—necessitate the exploration of more affordable and sustainable options.

Village Industrial Power (VIP) steam plants are powered through the combustion of biomass waste produced at local agricultural processing facilities. The VIP Plants generate mechanical/electrical/
thermal energy for use in a diverse range of agricultural activities—processing fruit, palm, rice, and cocoa; dairy pasteurization; purifying water; and powering irrigation pumps.

Impact
The project will result in the establishment of 25 agro-processing centers and village mini-grids capable of producing 10kW of electricity and 60kW of thermal energy for homes, social services, and businesses. It is anticipated that the VIP Plants will service more than 2,500 agrarian families. This clean energy solution will contribute agricultural development and low-carbon economic growth that improves food security, financial stability, environmental sustainability, and women's empowerment through new entrepreneurship opportunities.

Progress Update
To demonstrate the benefits of the VIP system, Camco and VIP have installed five 10-kW VIP units in three different applications. In the Village of Uchindile, Tanzania, Victoria Hongole has been chosen to be the operator of the VIP mini-grid. Three palm oil processing businesses in South Eastern Benin are using the VIP to displace diesel and wood consumption in the processing of oil palm. In this application all three forms of energy are used; mechanical energy is used in running the expeller press, electrical energy is used to power a submersible pump and electric motors, and thermal energy is used to supply hot water to the palm fruit cooking vats. A rural clinic near Kigoma, Tanzania, is using hot water from the VIP in their laundry and will be powering their submersible pump and other equipment with the electricity. Training in VIP operation and maintenance has been provided at all sites. Feedback from the early adopters of the VIP have been incorporated into the next generation units. These same improvements will be installed on the first five units in Benin and Tanzania.
Smart Grid on Main Street: Electricity and Value-added Processing for Agricultural Goods

Organization
EarthSpark International is a U.S.-based, nonprofit organization with over six years’ experience working with communities, businesses, and government to bring energy access to Haiti’s unelectrified population. Through its local brand Enèji Pwòp, EarthSpark is an established and recognized brand in Haiti with the track record and infrastructure to scale up its clean energy and micro-grid activities. For this project, EarthSpark has partnered with the Haitian agro-processing company Entreprises La Foi. EarthSpark also spun-off the smart meter technology SparkMeter, Inc., which is now providing solutions to grid operators in other countries.

Problem/Opportunity
Seventy-five percent of Haiti’s population lacks access to electricity, and farmers frequently lose value of their crops for want of infrastructure and processing equipment. Where processing facilities do exist, they are typically diesel-powered and expensive to operate. This imposes a severe limitation on farmers’ ability to process agricultural goods, maximize the value of their products, and improve their livelihoods.

Clean Energy Solution
EarthSpark has developed a solar-diesel hybrid micro-grid system that will increase access to affordable, reliable electricity for value-added agricultural processing. By providing technical guidance and facilitating
access to financing for local partners, EarthSpark is assisting agribusinesses in upgrading to efficient electric mills so the processing of rice, sorghum, coffee, and corn can be modernized. The project first focuses on breadfruit crops that typically rot due to lack of processing. Converting the fruit to flour or chips extends the shelf life by months and significantly increases its value and marketability.

Impact
By reducing food losses and enabling value-added processing, the project will boost agribusiness incomes as well as provide surrounding residents with access to electricity, through a pre-paid smart metering system. The project will demonstrate a sustainable business model for operating a local micro-grid, for agribusiness’ upgrading to efficient electric mills for breadfruit processing and electric de-kernelling for corn.

Progress Update
In May 2015, EarthSpark energized the grid, expanding service to 430 households and businesses in downtown Les Anglais; connecting these customers to grid electricity for the first time. The newly installed grid is powered by a state-of-the-art hybrid generation system including 90 kW of PV capacity, 400 kWh of battery capacity and a small diesel backup generator. EarthSpark has developed a town-scale distribution system which includes a medium-voltage line, standard electrical installation, and use of next-generation smart meters. In late September, an efficient, electric mill was installed in Les Anglais and started operation. In August, EarthSpark also helped a women-run cooperative in the area start a corn de-kernelling business that uses clean, microgrid electricity to de-kernel corn cobs in a region with ample corn production. EarthSpark recently began testing breadfruit chip production and recipes and is in discussions with local partners on expanding production.
Organization
KickStart was established in Kenya in 1991 with the mission to lift millions of people in Africa out of poverty quickly, cost-effectively and sustainably. KickStart designs, promotes, and mass-markets simple irrigation pumps that smallholder farmers buy and use to start highly profitable family enterprises. KickStart has partnered with Encap Technologies to provide motors for affordable, solar-powered irrigation pumps and with Angaza Designs to incorporate a ‘pay as you go’ (PAYG) mechanism.

Problem/Opportunity
In Kenya, solar-powered irrigation technology remains prohibitively expensive, far beyond the means of poor smallholder farmers. There is also limited demand due to lack of awareness of clean energy technology and the aforementioned prohibitive cost. KickStart’s clean energy solution will not only greatly reduce the cost of the irrigation hardware, but, through the introduction of a PAYG mechanism, will provide farmers with flexible financing options that will further promote affordability and, therefore, demand.
Clean Energy Solution
KickStart and its partners will focus on designing a clean energy solution with the farmer in mind—a high-performance yet easy to assemble, highly mobile, robust and durable unit that requires minimal maintenance. KickStart will design a foldable, flat pack solar irrigation pump that is easy for farmers to install. As Encap’s pumps are both low cost and highly efficient, they only require small solar panels. The addition of an innovative, flexible and reliable PAYG system will provide the farmer with affordable, alternative modes of payment and, by substantially de-risking the provision of credit, will attract investment from traditional lenders such as banks and microfinance institutions.

Impact
KickStart aims to transform the food and income security of smallholder farmers by enabling them to transition from rain-fed subsistence farming to year-round commercial irrigated agriculture. Over the next six years, KickStart plans to sell approximately 270,000 pumps across 16 countries in Sub Saharan Africa and estimates that 30 percent of these could be solar powered.
Organization
Claro Energy provides off-grid solar power pumping solutions to power-deficient regions in India. The company was established in 2011, with the objective of harnessing solar power to pump ground water. Claro’s solar water pump solutions can have broad application across irrigation, agriculture, drinking water, and urban settings.

Problem/Opportunity
In India, the availability of irrigation water is dependent on monsoon patterns or the availability of power to operate ground water pumps. Many villages lack access to electricity. Given this lack of electricity, diesel pumps are often the most reliable means to pump the water that is used for irrigation. The use of diesel fuel has many drawbacks, including environmental pollution, as well as ever-increasing costs which have a negative impact on farmers’ economic prosperity.

INNOVATION STAGE: 2. Research & Development
CLEAN ENERGY SOURCE: Solar Photovoltaic
AGRICULTURAL FOCUS: Irrigation
PRODUCT SEGMENT: Horticulture, Staple Crops
WEBSITE: www.claroenergy.in
Clean Energy Solution
Claro Energy intends to offer a pay-per-use irrigation service that uses a portable solar pump. The portable design will provide affordable, convenient, and on-demand irrigation. The service will meet the needs of a wide range of farmers who do not own pumps, with no upfront capital costs incurred. The farmer will call a toll-free line, pre-pay, and schedule irrigation service at his field.

Impact
The project will enable farmers to irrigate larger amounts of farmland, increase production during the summer season, and invest funds saved on the purchase of diesel in more efficient technologies. All of these results will increase farmers’ productivity and income, while decreasing GHG emissions. The proposed project will create employment in rural, agricultural communities, as villagers have the opportunity to become local irrigation service providers.
Organization
The Institute for University Cooperation (ICU) was established in 1966, and is recognized as an NGO for development cooperation by the European Commission and the Italian Ministry of Foreign Affairs. ICU has extensive experience in agriculture, water management, and the environmental sector. ICU has partnered with Nur Solar Systems in Jordan, and Mena Solar in Lebanon. Nur Solar Systems is a leading Jordanian solar systems manufacturing company; Mena Solar specializes in solar energy systems, with a particular expertise in photovoltaics.

Problem/Opportunity
Water is scarce in the Middle East and North Africa (MENA) region and Jordan is one of the world’s driest countries. In Jordan and Lebanon, the widespread use of inefficient irrigation methods results in the waste of large amounts of water. This wasted water could be used for wider and better irrigation of crops. The diffused use of fertilizers and agrochemicals increases soil salinity and contaminates soil and groundwater. Farmers are also in remote areas with no, or unreliable, access to the electrical grid. Financing can be difficult to obtain and farmers may be reluctant to use innovative methods.

INNOVATOR:
Institute for University Cooperation (ICU) (Italy)

COLLABORATORS:
Nur Solar Systems (Jordan)
Mena Solar (Lebanon)

LOCATION APPLIED:
Jordan; Lebanon

INNOVATION STAGE:
3. Initial Piloting

CLEAN ENERGY SOURCE:
Solar Photovoltaic

AGRICULTURAL FOCUS:
Irrigation

PRODUCT SEGMENT:
Horticulture, Staple Crops

WEBSITE:
www.icu.it
www.nursolarsys.com
Clean Energy Solution
ICU will install a drip irrigation system powered by PV solar energy at pilot farms. The system supports fertigation, which provides the possibility of fertilizer distribution through the irrigation system. Farmers will be supported in accessing to financing for the installation of the system. The CES will provide a complete package for purchase and installation, including training and access to knowledgeable extension agents and companies’ staff.

Impact
The project will provide energy savings, as farmers will rely on photovoltaic systems for their irrigation energy needs, taking advantage of the 300+ sunny days in their areas. The limited water resources will be saved and used in a more efficient manner. More precise application of fertilizers will make their use more effective, and reduce the amount introduced into the environment. Farmers will benefit from increased and higher quality crop production and the associated increase in revenue.
Scaling the Distribution of Tailored Agro-Solar Irrigation Kits to Smallholder Farmers

Organization
SunCulture, based in Nairobi, Kenya, sells the AgroSolar Irrigation Kit (ASIK), an entirely solar-powered drip irrigation system that makes it easier and cheaper for farmers to grow a wide variety of crops. The kit combines solar water pumping technology with high-efficiency drip irrigation and includes everything a farmer needs to grow more while spending less, in a sustainable and energy-efficient way. REEEP, as a project partner, will provide information and knowledge management support.

Problem/Opportunity
The majority of farmland in Africa is unsuited to rain-fed agriculture, yet only 6 percent is under irrigation and crop yields are low. The African market lacks aggregation of the presently disconnected and inefficient agriculture value chain. Farmers rely on expensive diesel pumps which contribute to greenhouse gas emissions, or hand carried water, typically collected by women and girls.

INNOVATOR:
SunCulture (Kenya)

COLLABORATORS:
REEEP (Austria)

LOCATION APPLIED:
Kenya; Tanzania; Uganda; Zambia

INNOVATION STAGE:
4. Early Adoption/Distribution

CLEAN ENERGY SOURCE:
Solar Photovoltaic

AGRICULTURAL FOCUS:
Irrigation

PRODUCT SEGMENT:
Horticulture

WEBSITE:
sunculture.com
www.reeep.org
Clean Energy Solution
The SunCulture AgroSolar Irrigation Kit combines cost-effective solar pumping technology with a high-efficiency drip irrigation system to make it cheaper and easier for farmers to grow. The kit pulls water from any water source (lake, river, stream, well, borehole, water harvester, etc.) using solar power. The solar panels provide the pump's electricity directly without the need for expensive batteries or inverters. Water is pumped into a raised water storage tank during the day. When irrigation takes place during the evening, a valve on the water tank is opened and water flows down through a filtration system and onto crop root zones via drip irrigation tape.

Impact
As a result of switching to solar irrigation, smallholder farmers will realize significant benefits. These benefits include increased production of higher value produce, cost savings, and more efficient use of time. Time saved on farming and water gathering can be directed to other more productive activities.
Sunflower Pump: Asset-Financed Solar Irrigation Pumps for Smallholder Farmers

Organization
Futurepump represents the commercial arm of a partnership that has spent the past ten years developing and perfecting the Sunflower solar irrigation pump. Futurepump is partnering with Kenya’s Equity Bank to make the Sunflower product available to customers through consumer financing that will lower the barrier to entry.

Problem/Opportunity
The growing capacity of many smallholder farmers is limited by their ability to irrigate. The limitation may be labor, in the case of manual irrigation, or the costs of purchasing and paying for fuel to run engine pumps. Women and children take on much of the work required to pump or carry water for irrigation. Restricted access to finance is a key constraint for smallholder farmers, particularly for female farmers. Women make up 50 percent of Kenya’s agricultural workforce.

Clean Energy Solution
The Sunflower pump is an easy-to-maintain solar irrigation pump, built around a simple piston pump arrangement. Futurepump has made the product cheaper and will offer it on finance, in order to lower the upfront barriers to solar technology.
Impact

Productivity can be doubled through the use of irrigation water that doesn't rely on engine pumps. The growing season can be extended through the dry season, during which produce brings a high market prices. Small vegetable farm profits can be increased as much as 45 percent through the use of a solar pump, while reducing their reliance on fossil fuel. All of these benefits will have a major impact on women, particularly because of the reduction in labor burden that mechanization will bring.
Organization
SimGas is a design and production company with facilities in the Netherlands and East Africa that focuses on clean, affordable, and high quality energy and sanitation solutions. Their teams work together to design, manufacture, and install high quality, modular, domestic biogas systems that can be installed in a day. By doing so, SimGas creates healthy and safe environments for millions of rural households while contributing to the reduction of indoor air pollution, deforestation, and carbon emissions. Together with partner SNV—world leader in promoting domestic biogas in developing countries with 25 years of experience in the sector—SimGas is developing and will demonstrate off-grid, small-scale, biogas-powered milk chillers for smallholder farmers in Kenya, Tanzania and Rwanda.

Problem/Opportunity
The emerging dairy industry in East Africa affects the livelihoods of more than 2 million smallholder farmers. While demand is expected to more than double in coming years, only 15 percent of milk produced reaches the formal market and 30–50 percent is not delivered to milk collection centers. The reason being that raw milk is not cooled at farm level because 85 percent of rural East Africa lacks access to a (reliable) power grid. There are no solutions available on the market to provide milk chilling at micro-scale, for farmers with up to 10 dairy cows, that run independently from the power grid, and that comply with the International milk cooling standard. This creates a huge opportunity to close the supply-demand gap.

INNOVATOR:
SimGas Tanzania, Ltd. (Tanzania)

COLLABORATORS:
SimGas BV (Netherlands)
SNV (Netherlands)

LOCATION APPLIED:
Kenya; Rwanda; and Tanzania

INNOVATION STAGE:
2. Research & Development

CLEAN ENERGY SOURCE:
Biogas

AGRICULTURAL FOCUS:
Cold Storage

PRODUCT SEGMENT:
Dairy

WEBSITE:
simgas.org
www.snvworld.org
Clean Energy Solution
SimGas is developing the first off-grid, biogas-powered milk chiller at farm level to help milk supply meet demand: the SimGas Biogas Milk Chiller (BMC). The BMC sparks a revolution in the dairy industry; it is the first link towards a reliable milk cool chain from cow to dairy. It helps small dairy farmers to reduce milk losses and meet quality standards required to access the formal sector. The BMC runs on biogas, produced with an on-farm biogas digester. The amount of manure produced by a cow creates enough biogas to refrigerate her own milk, while leaving enough biogas to cook a meal for the household.

Impact
The SimGas Biogas Milk Chiller will empower small dairy farmers to guide their own development; the BMC can greatly improve the income of small dairy farmers, help supply to meet demand, help farmers to access the formal dairy market, and contribute to improved nutrition. The quantity and quality of milk will improve, which will enable dairies to better meet the increasing demand for milk and milk products. Savings at the farm level will lead to additional investments and more satisfied members. In addition, the use of clean energy (biogas) for cooling and other purposes, such as cooking, will help reduce deforestation and carbon emissions.
Organization
The Horn of Africa Regional Environment Center and Network (HoA-REC&N) is an autonomous institution under Addis Ababa University. HoA-REC&N focuses on environmental concerns and sustainable development options within the Horn of Africa. Partner institutions include University of Hohenheim; University of Massachusetts—Boston; and the Oromia Coffee Farmers Cooperative Union.

Problem/Opportunity
Coffee accounts for 60 percent of the export earnings in Ethiopia, and is processed by dry and wet processing. Wet processed is preferred in the global market. Unfortunately, farmers do not see the full benefit of their coffee production. A significant portion of coffee harvested is of inferior quality due to the traditional sun drying process. This process can take up to twelve days and increases exposure of coffee to fungi and other undesirable elements. Thermal drying is energy intensive and takes up a large amount of space.

Clean Energy Solution
The proposed solution uses state of the art infrared technology to reduce coffee pulp drying time from several days to hours. Reduced drying time minimizes the post-harvest loss that occurs when using the conventional sun drying process. Biogas generated from coffee pulp and coffee husk will be used to power the bioreactors used for infrared drying.
Impact
The project will significantly reduce the time farmers spend processing their coffee crop. This time saved can be used for other more productive activities. Converting waste products from coffee production into useful energy reduces greenhouse gas emissions. The project will also improve work conditions for women and children, who are primarily responsible for the sun drying process which requires all-day exposure to the sun. In addition, the project will provide alternative livelihoods for the woman by engaging them in mushroom production from coffee husk.
Organization
The University of Toronto will oversee a small team conducting research focused on design, and analysis of the new aquaculture aeration technology. The University of Toronto has partnered with Curiositate to provide industry feedback and consultation throughout the development of the technology. A partnership has also been formed with BRAC for field trials and planning for technology scale-up.

Problem/Opportunity
Aquaculture is a large industry in many low income countries (LICs); fish farms account for about 5 percent of the GDP of Bangladesh. Improving the quality of aquaculture pond water has the potential to increase fish yields, raise incomes, and improve food security. In large aquaculture facilities, aeration has been shown to improve water quality and increase yields. However, aeration equipment is costly and requires electrical power inputs which can limit its use in LICs. Dissolved oxygen (DO) that is used by the fish is provided by photosynthesis, which is related to sunlight and takes place during daylight hours. The oxygen is produced at the pond surface and much oxygen is lost to the atmosphere. By circulating the water, more oxygen can be introduced.
Clean Energy Solution
The proposed solution is a new aeration method that does not require electricity, has few maintenance requirements with no moving parts, and is inexpensive to fabricate and deploy in LICs. The system uses heat that is captured through a solar thermal absorber plate and transferred to the bottom of the pond to heat the bottom water. The heated water will rise and mix the pond, spreading oxygen-rich water from the top through the entire depth of the pond. This increases the DO reservoir and can result in improved water quality and higher pond yields.

Impact
The system will allow for increased density of fish stock, higher yields of fish, as well as larger fish that have a higher market value and demand. Fish feed is also used more efficiently, which reduces feed and operation costs. The solution is an alternative to power-hungry aeration systems that consume a significant amount of energy and capital. For farmers not using aeration, the technology will provide all of the benefits described above. For farmers using aeration, replacing or supplementing existing devices can greatly decrease energy consumption for aquaculture.
Solar Agro-Processing Power Stations

Organization
Village Infrastructure Angels (VIA) was incorporated in 2012 with the mission to make poverty-alleviating infrastructure affordable to everyone through long-term loans.

Problem/Opportunity
Many small, rural villages and towns are off grid, with limited or no access to reliable sources of electricity. Agro-processing is a productive end use of electricity for which a large gap currently exists. These small villages typically do not have access to a diesel mill for crop processing, and must rely on manual processing, or travel long distances to use a mill.

Clean Energy Solution
VIA plans to install solar mills in villages in Indonesia, Papua New Guinea, Philippines, and Vanuatu. These mills will deliver services to up to 10,000 households. Small mills will be installed, with an appropriate capacity for the village, through a microfinancing program. The mills will be used to process staple crops, such as rice, corn, and cassava, that require processing before eating, and make up the majority of the diet of rural villagers.
Impact

Use of solar mills will increase productivity for rural farmers, while decreasing the amount of manual processing required. The time saved in manual labor can be redirected to other efforts that will increase income, particularly for women who are the primary source of labor for agro-processing. Cost savings will be realized in the reduced consumption of diesel fuel, and reduced time spent traveling to mills in remote villages.
Organization
The Universidad del Valle de Guatemala (University of the Valley of Guatemala (UVG)) is a private, not-for-profit, secular university located in Guatemala City, Guatemala. Founded in 1966 by a private foundation, it was the first private university in Guatemala to give a strong emphasis to technology. UVG has partnered with Development Ventures and Greenergyze, S.A. Development Ventures will serve as the technical lead on financial infrastructure activities. Greenergyze will lead the physical infrastructure activities.

Problem/Opportunity
Small-scale producers from low-income agricultural communities in Guatemala are among the most vulnerable actors in agricultural value-chains across the country. Suitable technologies, including irrigation systems and cold storage facilities, are readily available in Guatemala, however, there are three main constraints preventing producers from accessing them: lack of affordable clean energy to power facilities; lack of affordable finance for investment in clean energy power generation; and lack of skilled service providers who can sustainably operate services at a price-point affordable to producers.
Clean Energy Solution
UVG uses an innovative approach to developing low-cost community utility companies in ‘off-grid’ agricultural communities called Community Accelerators. Each Accelerator will consist of a localized photovoltaic (PV) mini-grid and will be operated by a local for-profit service provider company that also provides agribusiness service. This “utility in a box” approach is designed so that private sector financing can be used to fund the establishment of Accelerators, making this clean energy solution scalable without additional donor funding.

Impact
The project will provide access to clean energy to operate irrigation systems and cold storage facilities. Micro-financing will allow operators to provide services at an affordable price, while generating enough revenue to remain profitable year-round. Increasing the availability of clean energy in communities will reduce reliance on carbon-based fuels currently used to power generators, kerosene lamps, etc. Deforestation may also be reduced as the CES provides an alternative to wood-fueled fires used to dry cardamom.
Organization
International Development Enterprises (iDE) has over 30 years’ experience in designing and delivering market based anti-poverty programs. The project is implemented in partnership with Renewable World—a UK-based charity tackling poverty using renewable energy. In addition, the following private sector partners will provide technical expertise: United Finance Company—a non-bank financial institution specializing in lease financing; Rahimafrooz Renewable Energy Ltd.—a pioneering solar company in Bangladesh; and Electro Solar Power Ltd.—the first solar PV manufacturer in Bangladesh.

Problem/Opportunity
Off-grid fish hatcheries in Bangladesh, and their surrounding communities, rely extensively on diesel and kerosene to provide electricity needed to pump water and provide light. Use of kerosene and diesel, in addition to being costly, pollutes the environment and threatens the food chain and human health. The households around hatcheries typically rear fish in small ponds, using fingerlings from the hatchery for part of the year. A cost-effective, clean energy solution is expected to reduce energy costs and increase productivity for hatcheries and household fish-raisers while also providing domestic energy access.
Clean Energy Solution
The proposed solution will replace diesel generation with a micro-grid powered by economically viable renewable sources. The system will power hatchery water pumping activities and provide household-level renewable power through an innovative metering technology. The mobile metering and billing system will allow users to pay for their electricity using mobile money, either pre- or post-usage. The innovative joint venture business model will ensure that hatcheries and surrounding households can afford the technical solution by bringing private sector investment that would otherwise not be attracted to renewable grid development. The use of fish hatcheries as a hub for clean power generation provides a guaranteed, niche market with a higher level of sustainable and economic success.

Impact
The project will provide many economic benefits to the hatcheries using the system, as well as the surrounding communities. These benefits include reduced diesel costs due to the use of clean energy, increased profits and sales for the hatchery, increased sales of fingerlings to local farmers, increased employment, and increased sustainability of aquaculture practices. The availability of evening lighting will enable social and educational benefits, such as studying after dark and additional time for operation of homestead-based businesses. The project will also benefit technology value chains by investing in key research and development which can encourage investment from financial service providers and technology investors, making clean energy solutions more affordable for poor rural consumers.
Organization
Ariya Capital Group (Ariya) is an experienced fund manager that develops, structures, invests, and manages clean energy and infrastructure projects throughout sub-Saharan Africa. Ariya has partnered with African Solar Designs (ASD), a Kenya-based renewable and rural energy company, and Windfire, a UK-based renewable energy company that provides medium-scale Vertical Axis Wind Turbine solutions for the Distributed Renewable Energy (DRE) sector.

Problem/Opportunity
Agriculture is a cornerstone of Kenya’s economy, with horticulture and the export of flowers serving as a major employer. Energy is an important part of modern Kenyan agriculture, accounting for 15 percent of input costs. A lack of stable and available energy sources is an issue, which leads farmers to rely on expensive, polluting diesel generators as a backup source.

Clean Energy Solution
Ariya’s project will provide end to end cost-effective, low-risk renewable energy generation and energy efficiency services to local flower and horticulture farms in Kenya, Uganda, and Tanzania. These services will be structured to minimize the up-front investment required by farmers. A mixed technology approach, using various DRE and energy efficiency solutions, will allow flexibility in designing energy systems tailored for each user.
Impact

The project will provide flower farms and horticulture groups with dependable, cost effective, green energy solutions, which ultimately impact their bottom line. Increased reliability of power will allow farmers to use more sophisticated techniques, such as hydroponics and aeroponics, which lead to improved productivity and reduced water usage. Beneficial impacts will include reduced carbon emissions thus allowing East African horticulture exporters to retain their competitive edge by neutralizing the carbon cost of flying their produce to European markets, on-demand power production, potential return of surplus power to the grid, and job creation.
Organization
Husk Power Systems (HPS) designs, installs, and operates biomass and solar photovoltaic (PV)-based power plants. HPS has partnered with Diamond Development Initiatives (DDI) in Nigeria, and Technology Management Group (TMG) in Ghana. DDI is a not-for-profit development service provider. TMG is an electrical contracting company that provides solutions for rural and urban electrification challenges.

Problem/Opportunity
Rural, off-grid communities in Ghana and Nigeria that rely on solar PV systems are limited in their hours of agricultural operations and access to electricity. Diesel generators and battery back-ups are expensive to operate, so operations are limited to a single shift.

Clean Energy Solution
Husk Power will install a hybrid solution that combines a biomass gasification system with a solar PV system. The biomass plant uses a proprietary downdraft gasification technology that converts abundant agricultural residue into electricity. The system will power a mini-grid that produces electricity for residential, as well as agricultural, needs. The electricity is distributed to rural households and micro-enterprises through a mini-grid system—providing a better quality, cheaper way to...
meet their need for energy. Agricultural uses that will be powered include irrigation pumps, agro-processing mills, and drying and heating processes. The biomass plant converts abundant agricultural residue, such as maize cobs, rice husks, coffee husks, and cotton stalks, into electricity.

**Impact**

The hybrid plant uses a combination of solar and biomass—both abundant resources in the communities selected for installation. Agricultural operations will be able to continue processing during nighttime hours, as the biomass plant will provide power when the solar PV system is not operating.