POWERING AGRICULTURE:

AN ENERGY GRAND CHALLENGE FOR DEVELOPMENT

ANNUAL REPORT
FINANCIAL YEAR 2016

ABOUT POWERING AGRICULTURE

In 2012, The United States Agency for International Development (USAID), the Government of Sweden (Sida), the Government of Germany (BMZ), Duke Energy Corporation, and the United States Overseas Private Investment Corporation (OPIC) (collectively, the "Founding Partners") combined resources to create the Powering Agriculture: An Energy Grand Challenge for Development (PAEGC) initiative. The objective of Powering Agriculture is to support the development and deployment of clean energy innovations that increase agriculture productivity and stimulate low carbon economic growth in the agriculture sector of developing countries to help end extreme poverty and extreme hunger.

Powering Agriculture utilizes the financial and technical resources of its Founding Partners to support its Innovator cohort's implementation of clean energy technologies and business models for households, farms, villages, cooperatives, and industrial facilities in order to: (i) Enhance agricultural yields/productivity; (ii) Decrease post-harvest loss; (iii) Improve farmer and agribusiness income generating opportunities and revenues; and/or (iv) Increase energy efficiency and associated savings within the operations of farms and agribusinesses.

For more information, visit PoweringAg.org

FOREWORD

As Program Manager, I am excited to share the latest fiscal year annual report for the Powering Agriculture: An Energy Grand Challenge for Development (PAEGC) initiative. Since its inception, Powering Agriculture's Theory of Change has been that the usage of an energy/agriculture nexus approach will allow the initiative to source new innovations from a diverse group of entrepreneurs while providing data & evidence on the clean energy technologies and policy reforms that support climate- and energy-smart economic development in some of the most food insecure and poverty stricken areas around the world.

The development impacts and successes that Powering Agriculture has achieved are not solely due to one person or USAID alone. Powering Agriculture's partnership with the private sector and other donors has allowed us to harness our collective intelligence, strengthens, and resources to achieve outcomes that no single Powering Agriculture partner could have reached on their own.

As I prepare to depart Powering Agriculture for a new overseas assignment next year and reflect back on my last three years with the initiative, I am awestruck at the evolution of Powering Agriculture into its current iteration. Powering Agriculture has taken the lessons learned from the management of its first innovator cohort and expanded our gender and acceleration support while also intensifying our knowledge management and mainstreaming activities to better share our results. Moreover, I am humbled by the immense amount of work that will still need to be undertaken within the clean energy/ agriculture nexus to address extreme hunger and extreme poverty around the world.

While it is unclear what the full ramifications of climate change will be on global energy and food production, the endeavors of and lessons learned from Powering Agriculture will provide policy makers, farmers, agribusinesses, and other stakeholders with much needed global solutions to make informed decisions on the most viable and cost effective options to increase our resilience to possible climate change impacts and to meet our ever growing need for energy and food.

Sincerely,

Dr. Ryan Shelby

Foreign Service Engineering Officer
Program Manager, Powering Agriculture: An Energy Grand Challenge for Development
United States Agency for International Development (USAID)

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EXECUTIVE SUMMARY

This annual report describes the key activities of Powering Agriculture: An Energy Grand Challenge for Development (PAEGC) implemented over the financial year period of October 2015 to September 2016. Powering Agriculture: An Energy Grand Challenge for Development represents a partnership of the United States Agency for International Development with the Government of Sweden, the Government of Germany, Duke Energy Corporation, and the Overseas Private Investment Corporation. It was launched in 2012 to support the development and deployment of clean energy innovations that stimulate low-carbon economic growth within the agriculture sector of developing countries to help end extreme poverty and extreme hunger. Powering Agriculture will:

- Support clean energy technology and business model innovations for agriculture.
- Ensure that financial intermediaries have the capital they need to help organizations scale their clean energy innovations and reach the farmers and agri-businesses that need these technologies.
- Develop partnerships with public and private sector organizations that want to support the goals of the Powering Agriculture initiative.
- Serve as a clean energy and agricultural information resource hub for people around the world.

Some of the main activities that were implemented during the reporting year period include:

- Establishment of a regional Powering Agriculture hub based in Kenya to integrate clean energy solutions, and support Powering Agriculture within regional/national agriculture production and food security programs in East Africa.
- Development of a gender integration framework and hiring of a gender specialist to expand gender support to all Innovators to better address gender equity, gender as a social construct, and ensure that Powering Agriculture does not reinforce negative gender norms.
- Conducted an in-depth assessment of both Innovator cohorts about their plans for gender integration and activities to date and prepared a summary report based on the results of this assessment.
- Held a week-long Powering Agriculture Xcelerator (PAX) acceleration training program for Powering Agriculture Innovators in November 2015. The week concluded with the Powering Agriculture Innovator Showcase (PAIS), during which the 2015 Innovator cohort was formally introduced.
- Publication of the "Opportunities for Agri-food Chains to become Energy-Smart" study in October 2015, prepared in conjunction with the Food and Agriculture Organization of the United Nations (FAO). The report focused on the energy needs, at all stages, along selected agri-food value chains and includes recommendations on how these value chains may become more energy smart by employing clean energy solutions.
- Preparation of a report in conjunction with the Food and Agriculture Organization of the

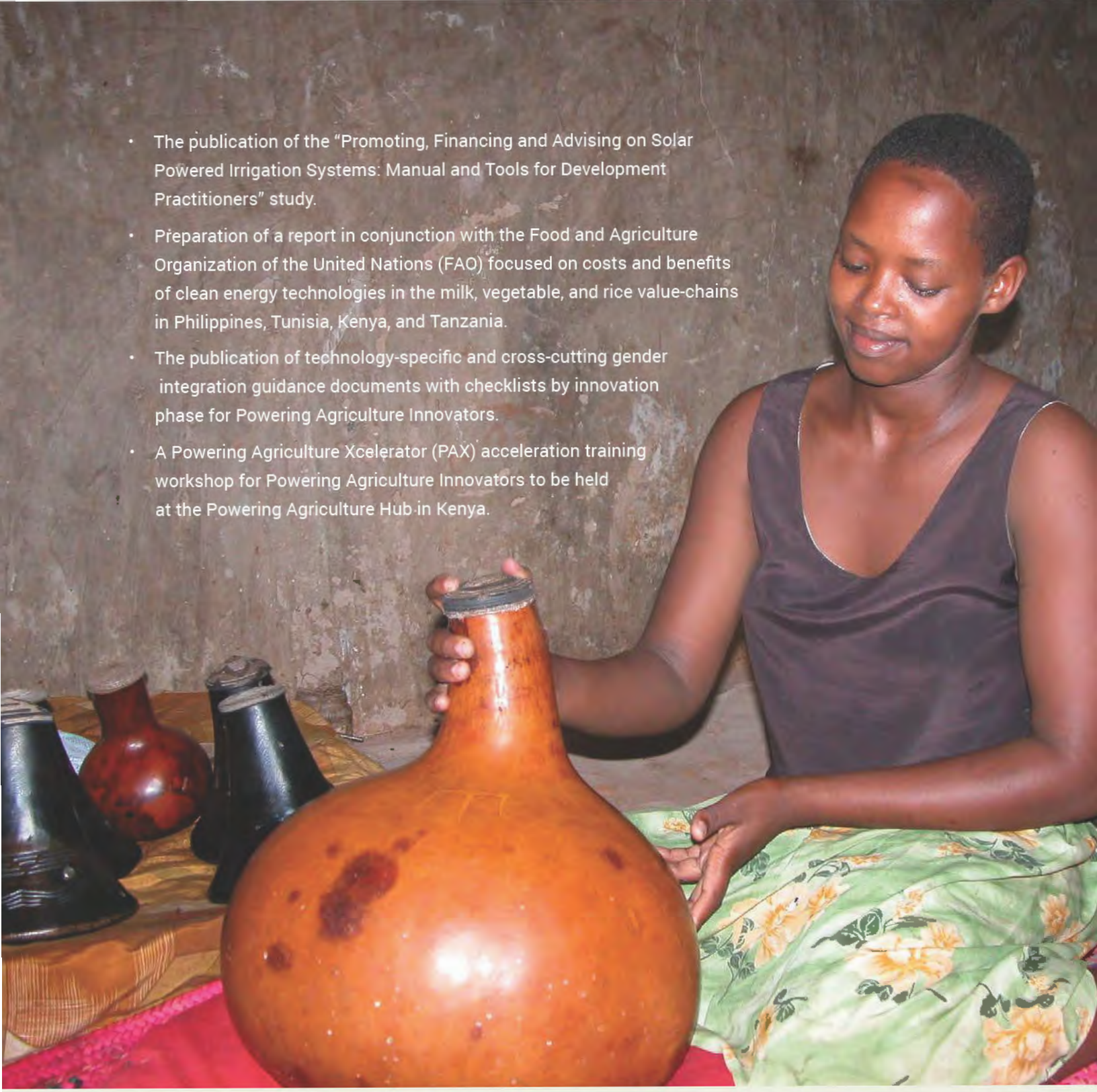
United Nations (FAO) focused on costs and benefits of clean energy technologies in the milk, vegetable, and rice value-chains.

- Preparation of a solar powered irrigation systems manual and toolkit for development practitioners.
- The successful launch and execution of the 8-week, free Massive Open Online Course, Powering Agriculture-Sustainable Energy for Food. Nearly 1,700 participants from around the globe took part in the course.
- Completion of a program and Innovator level midterm evaluation that provided findings and recommendations that will be used to make mid-course adjustments to improve the effectiveness of the program and to inform future decision-making by the Powering Agriculture Founding Partners.
- The launch of the PAX webinar series, which has included the following sessions: *Benefits of Becoming a Kiva Field Partner; Angel Investor Insights; and Gender in Ag Tech: Examples, Issues, and Strategies for Technology Access and Adoption*, to further support gender integration within Powering Agriculture.
- Participation in various conferences, including the National Council for Science and the Environment's 2016 Food-Energy-Water Nexus conference, SE4All Technical Workshop Water-Energy-Food Nexus, Intersolar, Biogas Africa Forum 2016, and International Off-grid Renewable Energy Conference – IOREC.
- Hosted the first-ever Agriculture Innovation Investment Summit (AIIS) in collaboration with the USAID administered Securing Water for Food grand challenge and the USAID Feed the Future Partnering for Innovation program. The two-day summit included an Innovator Marketplace, a pitch competition, and TED-style talks from Innovators, including 14 from Powering Agriculture.
- Site visits to 10 of the 11 Innovators from the 2013 cohort were conducted, during which progress was verified and beneficiaries were interviewed.

In the next financial year (October 2016 to September 2017), Powering Agriculture expects to implement the following major items:

- Establishment of a public-private partnership investment fund to support the commercialization and scale-up of clean energy technologies and innovative business models for farmers and agribusinesses.
- Expansion of regional support from the Powering Agriculture Hub to Innovators via workshops and training programs such as *"Increasing Efficiency in Industries in the Agricultural Value Chain"* to be held on October 26th, 2016.
- Gender workshop at SIDA's headquarters on October 26th, 2016, to review the lessons learned and findings on gender integration support to Innovators within the Powering Agriculture and Securing Water for Food Grand Challenges for Development initiatives.
- The publication of "Costs and benefits of clean energy technologies in the milk, vegetable and rice value-chains" study, prepared in conjunction with the Food and Agriculture Organization of the United Nations (FAO). This follow-up study utilizes the same agrifood value-chains in the October 2015 study, each linked with two or three clean energy technologies selected by their potential for adding value and/or for saving fossil fuel demands.

- The publication of the "Promoting, Financing and Advising on Solar Powered Irrigation Systems: Manual and Tools for Development Practitioners" study.
- Preparation of a report in conjunction with the Food and Agriculture Organization of the United Nations (FAO) focused on costs and benefits of clean energy technologies in the milk, vegetable, and rice value-chains in Philippines, Tunisia, Kenya, and Tanzania.
- The publication of technology-specific and cross-cutting gender integration guidance documents with checklists by innovation phase for Powering Agriculture Innovators.
- A Powering Agriculture Xcelerator (PAX) acceleration training workshop for Powering Agriculture Innovators to be held at the Powering Agriculture Hub in Kenya.



ACKNOWLEDGEMENTS

The Powering Agriculture Founding Partners would like to thank the team from the Powering Agriculture Support Task Order, implemented by Tetra Tech ES, Inc., for their assistance in preparing this report, specifically Jeannelle Blanchard, Jacqueline Boltz, Daria Mashnik, Jessica Menon, and Greg Berger.

ACRONYMS AND ABBREVIATIONS

AC	alternating current
AIIS	Agriculture Innovation Investment Summit
BMC	Biogas Milk Chiller
BMZ	German Federal Ministry for Economic Cooperation and Development
CES	clean energy solution
DC	direct current
DDI	Diamond Development Initiative
DO	dissolved oxygen
FY	fiscal or financial year; in the case of this report refers to October 1, 2015 through September 30, 2016
FAO	Food and Agriculture Organization of the United Nations
GCD	Grand Challenge for Development
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HIO	high impact opportunity
HoA-REC&N	Horn of Africa Regional Environment Center and Network
HPS	Husk Power Systems
ICU	Istituto per la Cooperazione Universitaria Onlus
iDE	International Development Enterprises
IOREC	International Off-Grid Renewable Energy Conference
IR	infrared
LIC	low-income countries
M&E	monitoring and evaluation
MENA	Middle East and North Africa
MOOC	massive open online course
MOU	Memorandum of Understanding
NCSE	National Council on Science and the Environment
OPIC	Overseas Private Investment Corporation
PAEGC	Powering Agriculture: An Energy Grand Challenge for Development
PAIS	Powering Agriculture Innovator Showcase
PARRB	Powering Agriculture Requests and Reminders Bulletin
PASTO	Powering Agriculture Support Task Order
PAX	Powering Agriculture Xcelerator
PAYG	Pay-As-You-Go
PV	photovoltaic
SDG	Sustainable Development Goal
Sida	Swedish International Development Cooperation Agency
SPIS	solar-powered irrigation system
TMG	Technology Management Group
UGARF	University of Georgia Research Foundation
USAID	United States Agency for International Development
UVG	Universidad del Valle de Guatemala
VIA	Village Infrastructure Angels
VIP	Village Industrial Power
WCA	West and Central Africa

I INTRODUCTION

This annual report describes the key activities of Powering Agriculture: An Energy Grand Challenge for Development (PAEGC) implemented over the period of October 2015 to September 2016.

The Powering Agriculture: An Energy Grand Challenge for Development initiative represents a partnership of the United States Agency for International Development (USAID) with the Government of Sweden, the Government of Germany, Duke Energy Corporation, and the Overseas Private Investment Corporation (OPIC); collectively known as the 'Founding Partners'. The goal of Powering Agriculture is to support new and sustainable approaches to accelerate the development and deployment of clean energy solutions for increasing agriculture productivity and/or value in developing countries to help end extreme poverty and extreme hunger.

Powering Agriculture contributes to the 2030 Agenda for Sustainable Development by supporting the following goals: SDG 1 (No Poverty), SDG 2 (Zero Hunger/Sustainable Agriculture), SDG 5 (Gender Equality), SDG 7 (Affordable and Clean Energy), SDG 8 (Economic Growth), SDG 9 (Innovation), SDG 13 (Climate Action), and SDG 17 (Partnerships for the Goals).

Powering Agriculture follows the Grand Challenges for Development (GCD) model which focuses on defining problems, identifying constraints, and providing evidence-based analysis for a variety of development issues. The Grand Challenges for Development initiative is rooted in two fundamental beliefs about international development:

- Science and technology, when applied appropriately, can have transformational effects; and
- Engaging the world in the quest for solutions is critical to instigating breakthrough progress.

1.1 **The Problem**

Throughout developing countries, agriculture remains the most prominent source of livelihood for most households. As our population expands, farms and agribusiness will need to produce, process, and transport an increasing amount of food. The Food and Agriculture Organization of the United Nations (FAO) estimates that at least 70% more food will need to be produced on the same amount of agricultural land. Identifying means by which clean energy technology can be used to intensify agricultural production will be crucial in meeting this demand.

Increasing the agricultural sector's access to clean energy and efficiency technologies will enable farmers to mechanize their operations, add value to commodities through processing, and store fresh produce in refrigerated containers to extend its shelf life.

These advancements will lead to more food in the market, increased incomes for farmers and traders, and decreased dependency of the agriculture sector on fossil fuels.

Unfortunately, significant barriers exist that hinder the integration of clean energy technology in agriculture development:

- Farmers are not aware of the variety of new technologies that may be appropriate for them.
- Clean energy technologies are relatively new, therefore farmers have limited access to distributors for installation, parts, and service.
- Farmers often do not have the means to cover high capital costs associated with clean energy upgrades - and financing is seldom available.

Likewise, clean energy enterprises seeking to serve these farmers face a number of barriers:

- Limited access to debt and equity to support business development and growth.
- Farmers are not aware of the economic and environmental benefits of the technology, and therefore demand for clean energy technology is low.
- The client base of agricultural communities is remote, scattered, and often very poor.
- There are few examples of successful business models that have been effective in delivering clean energy solutions to the agriculture sector in developing countries.

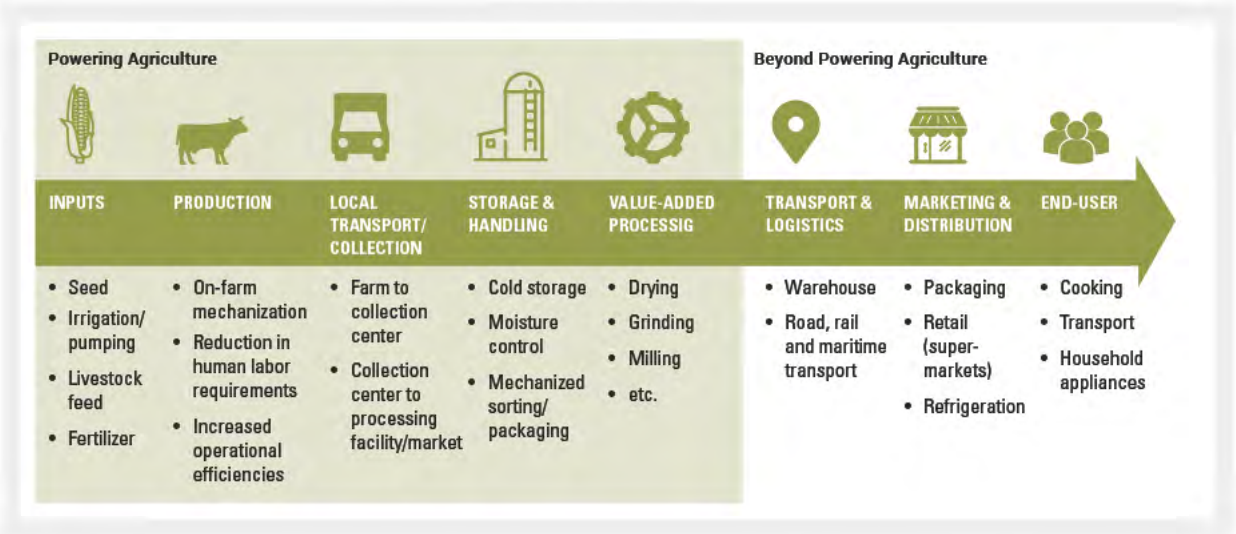
These issues create an unproductive cycle in which suppliers and buyers are not connected, and farmers and agribusinesses are unable to leverage more cost-effective clean energy technologies. Strengthening the links between modern energy service providers and the agriculture sector will create positive feedback loops to increase productivity along major components of the agricultural supply chain: (1) on-farm productivity; (2) cold storage; (3) transport; (4) post-harvest agriculture processing; and (5) agriculture waste for energy applications.

1.2 The Solution

Energy is critical to almost every aspect of the agricultural value chain, as shown in Figure 1.1. Globally, the food sector consumes 30 percent of total energy supply and generates 20 percent of global emissions.

The activities of Powering Agriculture are scheduled to run through 2019.

Figure 1.1 Energy Inputs throughout the Agricultural Value Chain



In order to solve the challenges described in section 1.1, Powering Agriculture was launched in 2012 to:

- support clean energy technology and business model innovations for agriculture;
- ensure that financial intermediaries have the capital they need to help organizations scale their innovations and reach the farmers and farm-related businesses that need these technologies;
- develop partnerships with public and private sector organizations that want to support the goals of the Powering Agriculture program; and
- serve as a clean energy and agricultural information resource for people around the world.

1.3 The Work of Powering Agriculture

Powering Agriculture utilizes a cross sectoral nexus approach to concurrently focus on the energy and agricultural sectors while providing technical, business acceleration, financing and policy support to its innovators and other stakeholders.

TECHNOLOGY & BUSINESS MODEL INNOVATION

Powering Agriculture provides innovation grants ($500,000–$2,000,000) to design, pilot and deploy clean energy solutions to different points along the agricultural production cycle.

Powering Agriculture provides on demand, tailored technical assistance using the Powering Agriculture Support Task Order (PASTO) implemented by Tetra Tech.

FINANCING FACILITY

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

KNOWLEDGE MANAGEMENT

Powering Agriculture serves as a clean energy and agricultural information resource hub for people around the world by providing knowledge products that contain detailed data on the policy, economic, gender and energy requirements to end extreme poverty and extreme hunger in developing countries.

MAINSTREAMING

Powering Agriculture utilizes the regional Powering Agriculture Hub in East Africa and collaborates with U.S. presidential initiatives such as Power Africa and Feed the Future to integrate clean energy solutions within regional/ national agriculture production and food security programs.

1.4 Powering Agriculture and the Sustainable Development Goals

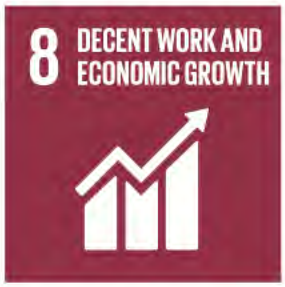
At the United Nations Sustainable Development Summit on Sep. 25, 2015, world leaders adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030. The Powering Agriculture Founding Partners and Innovators support the SDGs in a variety of ways, with a specific focus on the following SDGs:

Goal 1: End Poverty in All Its Forms Everywhere: Powering Agriculture supports the development and deployment of clean energy innovations that stimulates low carbon economic growth within the agriculture sector of developing countries to help end extreme poverty.

Goal 2: End Hunger, Achieve Food Security and Improved Nutrition and Promote Sustainable Agriculture: Powering Agriculture supports the adoption of climate-smart agricultural innovations and techniques to increase crop yields, improve the energy and water efficiency of farm operations, and reduce food insecurity in vulnerable regions to help end hunger

Goal 5: Achieve Gender Equality and Empower All Women and Girls: Powering Agriculture supports clean energy innovations that contribute to reducing gender disparities in access to, control over, and benefit from clean energy resources, wealth, opportunities and services.

Goal 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All: Powering Agriculture provides funding and support to commercialize clean energy technologies and innovative business models to expand access to reliable, affordable and clean energy services to farmers and agribusinesses.



Goal 8: Promote Inclusive and Sustainable Economic Growth, Employment and Decent Work for All: Powering Agriculture supports solutions that integrate clean energy technologies and innovative business models to: (i) Enhance agricultural yields/productivity; (ii) Decrease post-harvest loss; (iii) Improve farmer and agribusiness income generating opportunities and revenues; and (iv) Increase energy efficiency and associated savings within the operations of farms and agribusinesses, while stimulating low carbon economic growth within the agriculture sector of developing countries. This combined clean energy/ agriculture approach helps introduce inclusive and pro-poor income-generating opportunities in developing countries.

Goal 9: Build Resilient Infrastructure, Promote Sustainable Industrialization and Foster Innovation: Powering Agriculture seeks to address the concerns of water usage, food production/processing and energy consumption in the agriculture sector by supporting innovation within the energy/ agriculture nexus. Specifically, innovation is supported in emerging markets and developing countries where many farmers and agribusinesses lack access to reliable, affordable and clean energy services.

Goal 13: Take Urgent Action to Combat Climate Change and Its Impacts: Powering Agriculture supports a combined clean energy/ agriculture approach that maximizes the impact of finite energy resources in order to mitigate adverse climate change effects that stem from the agriculture sector. Powering Agriculture uses the following indicators to monitor the results of global climate change mitigation/ adaptation efforts: GHG emission reduction, increased investment in climate change mitigation/adaptation activities, clean energy generation and/or energy efficiency.

Goal 17: Revitalize the Global Partnership for Sustainable Development:

The Powering Agriculture Founding Partners have collectively combined resources to fund Powering Agriculture. Through this Partnership, Powering Agriculture uses a clean energy/agriculture approach to address farmers' and agribusinesses' lack of access to reliable, affordable and clean energy services for food production.

1.5 The Founding Partners

The Founding Partners have made financial and in-kind contributions to finance the activities of Powering Agriculture. In-kind contributions are technical assistance resources that individual Partners have committed to support the goal of Powering Agriculture but are managed by the individual Partners themselves. USAID serves as the administrator of Powering Agriculture managing the disbursements of the finances. Table 1.1 provides a description of each Founding Partner.

Table 1.1. Powering Agriculture Founding Partners

ORGANIZATION	DESCRIPTION
United States Agency for International Development	The American people, through the USAID, have provided economic and humanitarian assistance worldwide for nearly 50 years. www.usaid.gov USAID's support and implementation of Powering Agriculture is coordinated by USAID's Bureau for Economic Growth, Education and Environment (E3).
Government of Sweden	The Swedish International Development Cooperation Agency (Sida), an authority under the jurisdiction of the Swedish Ministry for Foreign Affairs, focuses on improving living conditions for developing nations around the world. http://www.sida.se/English/ Sweden's support for Powering Agriculture is coordinated by Sida's Unit for Global Economy and Environment.
Government of Germany	The BMZ, Federal Ministry for Economic Cooperation and Development, develops the guidelines and the fundamental concepts on which German development policy is based. It devises long-term strategies for cooperation with the various players concerned and defines the rules for implementing that cooperation. These are the foundations for developing shared projects with partner countries and international development organizations. All efforts are informed by the United Nations' Sustainable Development Goals. http://www.bmz.de/en Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) supports BMZ in implementing the German contribution to the Powering Agriculture Energy Grand Challenge. Germany's support for Powering Agriculture is coordinated by BMZ's Special Initiative "One World – No Hunger."
Duke Energy	Duke Energy, one of the largest electric power companies in the United States, supplies services in a sustainable manner - affordable, reliable, and clean. http://www.duke-energy.com/ Duke Energy's support for Powering Agriculture is coordinated by Duke's Federal Government Affairs unit.
The Overseas Private Investment Corporation	OPIC is the U.S. Government's development finance institution. It mobilizes private capital to help solve critical development challenges and in doing so, advances U.S. foreign policy. Because OPIC works with the U.S. private sector, it helps U.S. businesses gain footholds in emerging markets, catalyzing revenues, jobs and growth opportunities both at home and abroad. OPIC achieves its mission by providing investors with financing, guarantees, political risk insurance, and support for private equity investment funds. http://www.opic.gov/. OPIC's support for Powering Agriculture is coordinated by OPIC's Agriculture and Project Finance unit.

1.6 The Innovators

Powering Agriculture held two global innovation calls in 2012 and 2014 to source solutions within the clean energy/agricultural nexus that

1. Enhance agricultural yields/productivity;
2. Decrease post-harvest loss;
3. Improve farmer and agribusiness income generating opportunities and revenues; or
4. Increase energy efficiency and associated savings within the operations of farms and agribusinesses – while stimulating low carbon economic growth within the agriculture sector of developing countries.

Table 1.2 presents an overview of the entities referred to as "Innovators" that were selected to receive funding. See Chapter 3 for a fuller description of each Innovator.

Table 1.2 2013 and 2015 Innovator Cohort Information

2013 COHORT	INNOVATOR	PROJECT NAME	COUNTRY OF IMPLEMENTATION	START DATE	END DATE	AWARD VALUE
1	**African Bamboo**	Thermal treatment of agricultural goods based on a demand driven and energy-efficient biomass combustion unit	Ethiopia	10/1/2013	9/30/2017	$1,041,145
2	**Camco Advisory Services**	Biomass Mini-Grids for Palm Oil Producing Communities in Benin and Tanzania	Benin, Tanzania	10/1/2013	6/30/2017	$999,805
3	**The Earth Institute at Columbia University (COMPLETE)**	Micro-Solar Utilities for Small-Scale Irrigation in Senegal	Senegal	10/1/2013	3/31/2016	$1,082,161.67
4	**EarthSpark International**	Smart Grid on Main Street: Powering Agricultural Processing with Sustainable Energy Services	Haiti	10/1/2013	3/31/2017	$1,091,315
5	**ECO Consult**	Hydroponic Green Farming Initiative	Jordan	10/1/2013	6/30/2017	$1,149,707
6	**iDE**	Clean Irrigation Solution (CIS) for Increased Agricultural Productivity	Honduras, Nepal, Zambia	10/1/2013	6/30/2017	$1,499,831
7	**Motivo Engineering, LLC**	Hybrid Agriculture/Road Vehicle with Electricity Storage and Transformation (HARVEST)	India	10/1/2013	5/12/2017	$861,158
8	**Promethean Power Systems**	Solar-powered Milk Chilling in Rural India	India	10/1/2013	6/30/2017	$992,980.00

9	Rebound Technologies (COMPLETE)	Solar Cooling for Horticultural Preservation	Mozambique	10/1/2013	9/30/2018	$500,000
10	**SunDanzer Refrigeration**	Sustainable Milk for Africa through Refrigeration Technology	Kenya	10/1/2013	9/30/2017	$1,041,145
11	**University of Georgia Research Foundation**	Renewable Energy-Powered Evaporative Cooling for Small-Holder Farmers	Uganda	1/3/2014	7/31/2017	$1,000,000
12	**Experience International (CANCELLED)**	Solar Powered Cold Storage and Ice Making Facilities for Fishing Communities in Eastern Indonesia	Indonesia	10/1/2013	04/20/2014	$1,000,000

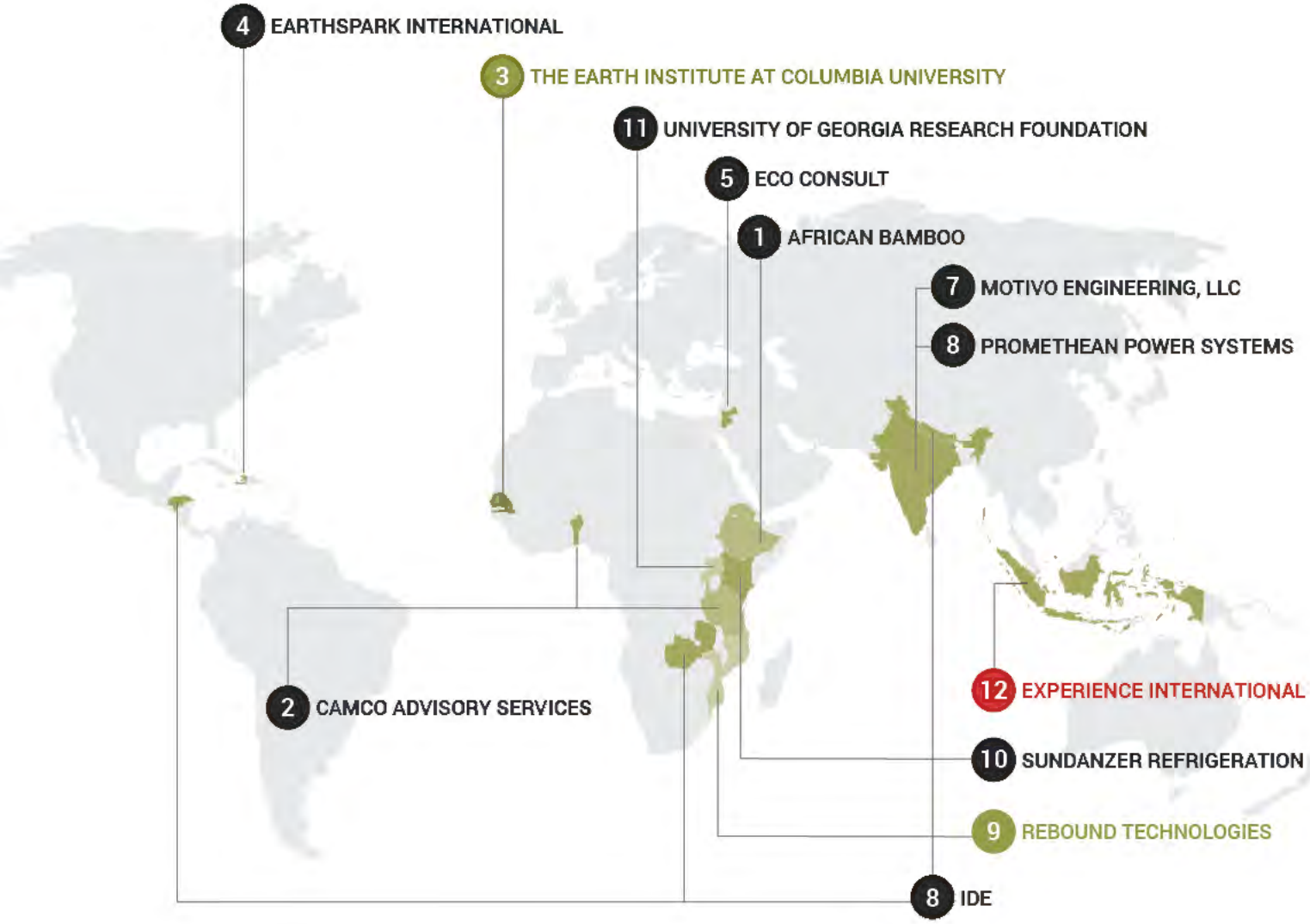
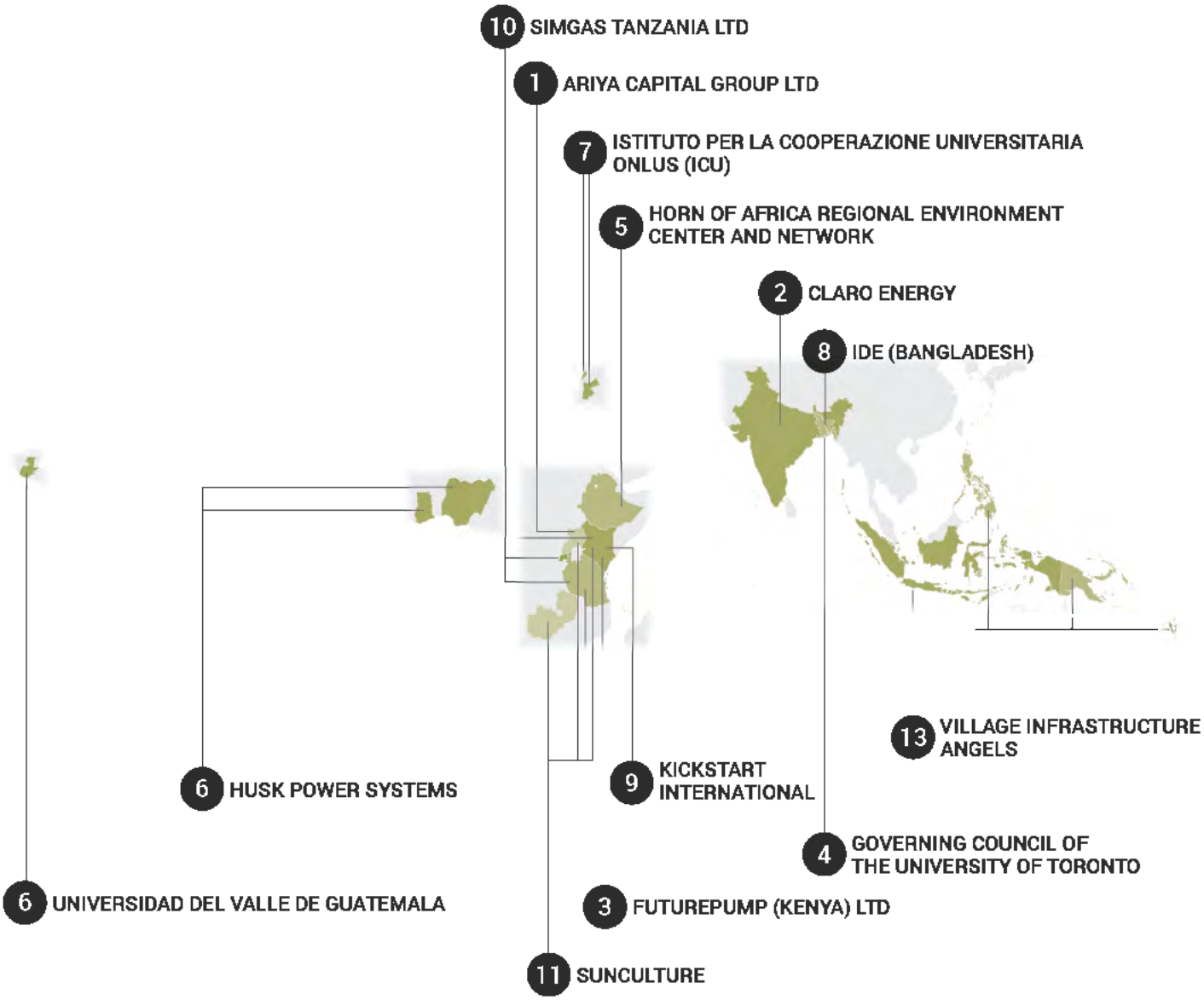


Table 1.2 2013 and 2015 Innovator Cohort Information (Continued)

2015 COHORT	INNOVATOR	PROJECT NAME	COUNTRY OF IMPLEMENTATION	START DATE	END DATE	AWARD VALUE
1	Ariya Capital Group Ltd	Powering Agriculture with Renewable Energy	Kenya; Tanzania; Uganda	2/3/2016	12/31/2018	$1,905,700
2	Claro Energy	Launch low-cost on-demand pay-as-you-go irrigation service using solar trolley systems to cut irrigation costs in half	India	12/10/2015	9/30/2018	$500,000
3	Futurepump (Kenya) Ltd	Sunflower Pump - A working capital facility & after sales investments to support a growing solar irrigation business in Kenya	Kenya	12/29/2015	9/30/2018	$1,999,563
4	Governing Council of the University of Toronto	Field Evaluation of Passive Aeration System for Aquaculture	Bangladesh	1/18/2016	1/17/2019	$500,000
5	Horn of Africa Regional Environment Center and Network	Improving coffee production and quality using Infra-red technology	Ethiopia	2/2/2016	2/1/2019	$434,780
6	Husk Power Systems	Hybrid Solution- Biomass and Solar PV: Clean Energy Intervention in the food belts of Nigeria and Ghana	Ghana; Nigeria	1/21/2016	9/30/2018	$1,282,418
7	Istituto per la Cooperazione Universitaria Onlus (ICU)	PV integrated irrigation systems in Jordan and Lebanon	Jordan; Lebanon	12/14/2015	3/31/2018	$499,688
8	iDE (Bangladesh)	Renewable micro-grids for off-grid fish hatcheries and surrounding communities in Bangladesh	Bangladesh	12/14/2015	6/30/2018	$499,748
9	KickStart International	To increase access to affordable, high-performance solar-powered irrigation technology amongst poor smallholder farmers in rural Kenya	Kenya	12/10/2015	9/30/2018	$500,000
10	SimGas Tanzania Ltd	Biogas Milk Chilling to increase productivity and double the income of East African dairy farmers	Kenya; Rwanda; Tanzania	12/11/2015	10/30/2018	$499,998

11	SunCulture	SunCulture: Scaling up distribution of smallholder tailored agro-solar irrigation kits across Africa	Kenya; Tanzania; Uganda; Zambia	2/11/2016	9/30/2018	$2,000,000
12	Universidad del Valle de Guatemala	Private-Sector Financed Community Solar Power Grids (ComGrids) and Agricultural Accelerators in Off-Grid Communities in Guatemala	Guatemala	12/14/2015	12/13/2018	$499,008
13	Village Infra-structure Angels	Solar Agro-processing Power Stations for 5000 Households	Indonesia; Papua New Guinea; Philippines; Vanuatu	12/11/2015	9/30/2018	$1,762,400



Tables 1.3 through 1.8 provide a more detailed breakdown of the clean energy solutions being funded by Powering Agriculture, their areas of focus, and where they are being implemented.

Table 1.3 Innovation Focus

TYPE OF CES FUNDED	# OF INNOVATORS	INNOVATORS
Clean Energy Technology Focus	10	African Bamboo, iDE, Motivo, Promethean, Rebound, UGA, Horn of Africa, SimGas, U. of Toronto, VIA
Business Model Focus	3	FuturePump, Husk Power, SunCulture
Both	11	Earth Institute, EarthSpark, Ariya, iDE Bangladesh, KickStart, UVG, SunDanzer, Camco, Claro Energy, ECO Consult

Table 1.4 Innovation Stages Achieved in Fiscal Year 2016

INNOVATION STAGE IN FY 2016	# OF INNOVATORS	INNOVATORS
Concept Development	0	-
R&D	5	KickStart, SimGas, Horn of Africa, iDE Bangladesh, Husk Power
Initial Piloting	8	U. of Toronto, ICU, UVG, Claro Energy, Motivo, Rebound, U. of Georgia, Camco,
Early Adoption/Distribution	10	FuturePump, VIA, Ariya, SunCulture, African Bamboo, Earth Institute, EarthSpark, iDE, SunDanzer, ECO Consult
Market Growth	1	Promethean
Wide-scale Adoption	0	-

Table 1.5 Clean Energy Source Used for Powering Agriculture Innovations

CLEAN ENERGY SOURCE	# OF INNOVATORS	INNOVATORS
Biogas	3	SimGas, U. of Georgia, Horn of Africa
Biomass	3	Husk Power, African Bamboo, Camco
Solar PV	16	ECO Consult, KickStart, Husk Power, Claro Energy, Earth Institute, Ariya, UVG, ICU, Promethean, iDE Bangladesh, SunCulture, EarthSpark, VIA, iDE, SunDanzer, Futurepump
Solar Thermal	2	U. of Toronto, Rebound
Wind	2	Ariya, iDE Bangladesh
Hybrid	1	Motivo
Energy Efficiency	1	Promethean

Table 1.6 Agricultural Focus of Powering Agriculture Innovations

AGRICULTURAL FOCUS	# OF INNOVATORS	INNOVATORS
Irrigation	9	ECO Consult, KickStart, Motivo, Claro Energy, Earth Institute, ICU, SunCulture, iDE, Futurepump
Cold Storage	6	SimGas, U. of Georgia, Motivo, Promethean, SunDanzer, Rebound
Decentralized Power	7	Husk Power, Camco, Motivo, Ariya, UVG, iDE, EarthSpark
Aeration	1	U. of Toronto
Processing	4	African Bamboo, Motivo, Horn of Africa, VIA

Table 1.7 Product Segments Focused on by Powering Agriculture Innovators

PRODUCT SEGMENT	# OF INNOVATORS	INNOVATORS
Agro-Forestry Products	2	African Bamboo, Camco
Aquaculture	3	U. of Toronto, Motivo, iDE Bangladesh
Dairy	5	SimGas, U. of Georgia, Motivo, Promethean, SunDanzer
Fruit	1	Horn of Africa
Horticulture	12	ECO Consult, KickStart, Motivo, Claro Energy, Earth Institute, Ariya, UVG, ICU, SunCulture, iDE, Rebound, Futurepump
Staple Crops	6	HuskPower, Motivo, Claro Energy, ICU, EarthSpark, VIA

Table 1.8 Regions in which Powering Agriculture Innovators are Working

PRODUCT SEGMENT	# OF INNOVATORS	INNOVATORS
Africa	14	KickStart, SimGas, U. of Georgia, Husk Power, African Bamboo, Camco, Horn of Africa, Earth Institute, Ariya, SunCulture, iDE, SunDanzer, Rebound, Futurepump
Asia/Pacific	7	U. of Toronto, Motivo, Claro Energy, Promethean, iDE Bangladesh, VIA, iDE
Latin America and the Caribbean	3	UVG, EarthSpark, iDE
Middle East	2	ECO Consult, ICU

2 HIGHLIGHTS

The following are highlights of the main activities that were implemented during the reporting period.

2.1 Partners Meeting

The Partners held their annual Partners Meeting at the USAID headquarters in United States over June 1 to 3, 2016. Representatives from USAID, GIZ, and Sida were in attendance. The key decisions coming out of the meeting were as follows:

- On Day 1, the Partners attended the Agriculture Innovation Investment Showcase (AIIS) at USAID's headquarters.
- On Day 2, the Partners in attendance reviewed the findings and recommendations from the midterm program and Innovator level reviews.
- The Partners in attendance on Day 2 agreed to the following action items:
  - to utilize the newly hired gender specialist to further expand gender integration support for all Innovators with a focus on gender equity, gender as a social construct, and ensuring that Powering Agriculture does not reinforce negative gender norms
  - to utilize an external consultant to conduct an Innovator level impact study in the 2018/2019 timeframe on a subset of ' high impact' Innovators from the 2013 and 2015 cohorts to measure development impact
  - to utilize an external consultant to conduct an overall program level impact study on Powering Agriculture in 2018/2019 timeframe

- to explore options to leverage private sector capital to scale late stage, high impact innovations in current and future Powering Agriculture cohorts
- to focus on mainstreaming Powering Agriculture with our Missions/other in-country programs where alignment is possible and interest is expressed

- On Day 3, the Partners in attendance discussed plans for expanding acceleration and gender services to Innovators and plans for 'Powering Agriculture 3.0' which would involve a financing facility/PPP.
- The Partners in attendance on Day 3 agreed to the following action items:
  - to actively pursue the release of a solicitation or to review unsolicited proposals for a financing facility/PPP to accelerate the scaling of Powering Agriculture and aid in the mainstreaming of the Innovators and the overall initiative
  - to adopt the proposed gender integration framework
  - to review the budget implications of expanding PAX-like acceleration and scaling support for 'high impact' Innovators for up to three years after their awards have ended if funds are available
  - to hold the next PAX workshop in Kenya to better leverage the resources of the newly established GIZ hub for Powering Agriculture
  - to hold the next Partners meeting in Bonn, Germany, with BMZ and GIZ as the host.
  - to discuss options for expanded partnership and collaboration amongst the donors at the next Partners meeting

2.2 **Mid-Term Review**

Two midterm evaluations of the overall Powering Agriculture program and its 2013 Innovator cohort were completed during the reporting period.

2.2.1 **Program-Level Mid-Term Evaluation**

Powering Agriculture commissioned Syspons GmBH, an external evaluation team, to evaluate the program-level structures, processes and impacts of the initiative. The evaluation team conducted an in-depth analysis of relevant documents and data, in-depth interviews as well as an analysis of the results from the 2013 Innovators Assessment. The report includes key findings, conclusions and recommendations, and is intended to inform future decision-making by the Founding Partners. The full report can be accessed at http://poweringag.org/resources.

The evaluation indicated that Powering Agriculture is a unique challenge fund that addresses highly relevant global developmental challenges such as food insecurity and climate change with an integrated approach. A comparative study of 50 challenge funds conducted by the evaluation team confirmed the relevance of Powering Agriculture on the international level. It showed that Powering Agriculture currently is the only global challenge fund which takes an integrated approach to fund and support the scale-up of innovative solutions at the interface of the energy and agriculture sector. The setup of the grand challenge allows it to reach new and innovative actors from the private sectors in developing countries and emerging markets, thereby bringing new perspectives into the field of international cooperation. Another strength is the initiative's effective and efficient cooperation and steering structure, which is characterized by a mode of

co-production and the usage of comparative advantages of the partners' competences.

The evaluation also critiqued certain aspects of the Powering Agriculture initiative. For instance, the initiative has not yet accomplished its objective of establishing a financing mechanism via a public-private partnership to support the scale-up of later stage commercial efforts within the energy/ag nexus. The evaluation team noted that the lack of such a mechanism hinders Powering Agriculture's capacity to further partner with and leverage private-sector resources to scale innovations that could address energy poverty, economic growth and food insecurity goals. Another weakness observed by the evaluation team is that Powering Agriculture had not conducted an impact evaluation of its innovators. Given that the initiative's 2013 innovator cohort was composed of rather early stage innovators that required most of their award period to design and test their solution before field implementation, the evaluation team recommended that impact assessment be conducted after the 2013 and 2015 innovators cohort have deployed their technologies with end users and other beneficiaries.

In addition, it was also noted that Powering Agriculture's innovations and lessons learned are not currently systematically integrated into and fully adopted by the bilateral structures and programs of the partners. Despite the weaknesses, the evaluation concluded that Powering Agriculture has the opportunity to strengthen its position as a unique challenge fund in the energy-agriculture nexus and provided eight recommendations at the strategic and operational levels.

2.2.2 **Mid-Term Innovators' Assessment**

Tetra Tech ES, Inc., through the USAID-funded PASTO, conducted the Mid-Term Innovators Assessment to determine the progress to date of the 2013 Innovators. This assessment included the following:

- a survey addressing the four main assessment questions
- data collection through virtual check-in meetings with the 2013 Innovators
- document review of award documentation, milestones, deliverables and progress reports
- data verification and stakeholder interviews during project site visits; and
- an analysis of reported performance indicator data.

The assessment presents findings, conclusions, and recommendations that will be used to make mid-course adjustments to improve the effectiveness of the program and to accelerate the development and deployment of Powering Agriculture Innovators' clean energy solutions. The full report can be accessed at: http://poweringag.org/resources.

The main finding was that the progress and likely outcomes for the 2013 cohort are consistent with other grand challenges or open competitions that source and develop high potential solutions to overcome critical barriers to development through the application of scientific, technological, and engineering methods. The innovations selected by Powering Agriculture could be considered high risk/high gain due to their potential to be transformative; therefore, the Partners should expect a success rate of 10% to 25%. Given that, the Assessment detailed the support that the Innovators require

to be successful which includes monitoring and evaluation, business acceleration, gender integration and partnerships. The Assessment also recommended that for some Innovators, business acceleration support should be intensified; for others, the support should be focused on the documentation of field testing results; and for a few, support should cease.

2.3 Raising the Public's Awareness

Powering Agriculture utilized multiple approaches and tools to communicate the program objectives and activities; build awareness of the clean energy/ag nexus and to disseminate results and knowledge from the initiative. These tools included the online platforms and communication tools detailed in Table 2.1 below, stories published in various print and online media outlets, and participation in conferences and workshops.

Table 2.1 Powering Agriculture Communication Platforms

PLATFORM		PURPOSE	CONTENTS
Powering Agriculture website www.poweringag.org		Powering Agriculture's primary public website; Communications and Outreach for Information Dissemination about the program	Official documents Calls for Proposals Outreach information (press releases, news articles, videos, event information) Resources
Powering Agriculture Portal on energypedia.info www.energypedia.info/wiki/Portal:Powering_Agriculture		Networking with experts; Research; mutual knowledge exchange	Thematic pages Articles and reports Studies Event announcements
Powering Agriculture E-Newsletter		To raise awareness of Powering Agriculture, its activities, and the successes of its Innovators	News Success Stories Event announcements
@Poweringag Twitter Account		To raise awareness of Powering Agriculture, its activities and the successes of its Innovators	News Event announcements
Powering Agriculture Facebook Account		To raise awareness of Powering Agriculture, its activities and the successes of its Innovators	News Event announcements Innovator Promotion
Powering Agriculture Dashboard		To inform senior management of the Founding Partners of programmatic and Innovator updates	News Event Announcements Resources

2.3.1 Powering Agriculture Website

Powering Agriculture continued to use the website as its primary tool to store and disseminate information and news on the program and drive traffic to the website through social media posts. Figure 2.1 shows the website traffic during the reporting year.

Figure 2.1 Powering Agriculture Website Analytics

2.3.2 Powering Agriculture newsletter

Powering Agriculture disseminated 3 editions of its newsletter during the reporting period, as shown in Table 2.2.

Table 2.2 Powering Agriculture Newsletter Data FY2016

DATE OF NEWSLETTER PUBLICATION	# OF CONTACTS	OPEN RATE (21% – INDUSTRY STANDARD*)	CLICK RATE (9% – INDUSTRY STANDARD*)
January 14, 2016	4,706	34%	24%
April 19, 2016	4,343	31%	15%
July 25, 2016	4,574	32%	11%

* Based on industry standards developed by Constant Contact.

2.3.3 Social Media activities

Powering Agriculture continued to use social media as a means of promoting the program and our Innovators. The Facebook and Twitter accounts were used to post Innovator and program news, along with relevant energy/agriculture nexus stories. Social media also was an important tool in promoting the Powering Agriculture MOOC (described in Section 2.4.2). Each course module was promoted for a week at a time. Powering Agriculture conducted a *"Meet the 2015*

Table 2.3 Powering Agriculture Social Media Activity FY2016

	FOLLOWERS	NUMBER OF POSTS IN FY2016	HIGHEST CLICKS/ PROFILE VISITS	LARGEST REACH/ TOP TWEET
	2,688	64	82: Join Powering Agriculture's Free Open Online Course, Dec 17 2015	2,036: #DidYouKnow: Agriculture is a powerful tool for reducing poverty. Aug 31, 2016
	2,547	264	1,492 November 2015	6,693 Impressions: Check out how.@poweringag supports. @USAID #cleanenergy efforts to address Global Climate Change #ActOnClimate bit.ly/1KJuMUZ, Oct 22, 2015

Innovator" campaign highlighting one of the 2015 Innovator cohort per week with Tweets and Facebook posts, as well as a "Did You Know Campaign", highlighting facts about agriculture and clean energy with weekly posts on Twitter and Facebook. Table 2.3 presents highlights of this year's social media efforts.

2.3.4 **Conferences**

Powering Agriculture organized two major events this year during which the grand challenge and the work of its Innovators were promoted.

Powering Agriculture Innovator Showcase (PAIS): This half-day event was held on November 20, 2015, and attended by 130 people. During the event, the 13 finalists comprising the 2015 Innovator cohort were announced, followed by pitches and exhibits by 23 Innovators, as well as speeches by Powering Agriculture Partners, and a keynote speech from Jehiel Oliver, CEO of Hello Tractor.

The showcase also served as the official launch of "Opportunities for Agri-food Chains to Become Energy-Smart", a report co-authored by Powering Agriculture and the Food and Agriculture Organization of the United Nations (FAO). Dr. Alessandro Flammini, Natural Resources Officer for the FAO, and one of the report's primary authors, presented remarks about the report during PAIS. Printed copies of the report were available for attendees at the event. A speaker highlight video can be viewed at the Powering Agriculture website.

Agriculture Innovation Investment Summit (AIIS): On June 1 and 2, 2016, Powering Agriculture, along with Securing Water for Food Grand Challenge and the USAID Feed the Future Partnering for Innovation, hosted the first-ever Agriculture Innovation Investment Summit (AIIS). The Summit, held in Washington, D.C., brought together nearly 60 Innovators—including 14 representing Powering Agriculture, along with representatives from the investment community and development organizations. The two-day program included an Innovator Marketplace, a pitch competition, and TED-style talks from Innovators, along with remarks from USAID Administrator Gayle Smith, BMZ's One World, No Hunger Initiative Dr. Stefan Schmitz, One Acre Fund's Tony Kalm and the White House Office of Science and Technology's Tom Kalil. Innovators who participated in the TED-style talks and pitch competition received support and feedback in the development of their presentations.

African Bamboo meets with Powering Agriculture Partner representatives

2013 and 2015 Innovators

Powering Agriculture also hosted sessions and exhibited at several conferences as follows:

- The 16th National Conference of the National Council for Science and the Environment (NCSE) "The Food-Energy-Water Nexus" in January 19-21, 2016, in Arlington, Virginia. Powering Agriculture was promoted at a booth and represented on the Opportunities and Challenges in Integrated Food-Energy Systems panel. Approximately 150 individuals visited the booth; 100 copies of the FAO landscape study were distributed; and other materials were distributed including the Powering Agriculture fact sheet, MOOC flyer and Innovator Profile books.
- SE4All Technical Workshop Water-Energy-Food Nexus, February 22, 2016, Vienna, Austria. The members of the Nexus HIO (High Impact Opportunity) explored opportunities to operationalize the water-energy-food nexus in the context of the SDGs. Powering Agriculture contributed its implementation experiences within the energy/ agriculture nexus.
- Intersolar, June 22-26, 2016, Munich, Germany. The world's leading exhibition for the solar industry attracted more than 1,077 expositors and about 43,000 visitors. Powering Agriculture Partner GIZ/BMZ presented the solar-powered irrigation system (SPIS) stocktaking study, manual, and toolkit, while 2015 Powering Agriculture Innovator Village Infrastructure Angels (VIA) presented their clean energy solution (CES).
- Biogas Africa Forum 2016, July 11-13, 2016, Nairobi, Kenya. Platform for the key stakeholders in the biogas value chain to discuss and exchange on 'industrial size' biogas activities of private developers, policy makers and development partners in Sub-Saharan Africa. Powering Agriculture Partner GIZ / BMZ gave a brief presentation of the Powering Agriculture initiative and Powering Agriculture Innovator SimGas presented their CES and activities in East Africa.
- International Off-grid Renewable Energy Conference – IOREC, September 30-October 1, 2016, Nairobi, Kenya. Global platform for sharing experience and best practices about renewables. Powering Agriculture Partner GIZ / BMZ co-organized two side events together with the International Renewable Energy Agency. The Powering Agriculture studies "Opportunities for Agri-Food Chains to become Energy-smart" and "Solar Powered Irrigation Systems – Manual and Tools" (forthcoming) were received with great interest by the audience. The Powering Agriculture Innovators SunCulture and Futurepump contributed to a panel discussion, discussing eco-system requirements.

2.3.5 **Media Outreach**

During the reporting year, 984 media outlets/reporters were contacted; 156 pitches were made to media outlets to introduce the Powering Agriculture initiative and its Innovators; 16 interviews were conducted with Powering Agriculture representatives or Innovators; 60 stories were published highlighting the Powering Agriculture program or Innovators. Table 2.4 presents the stories published during FY2016.

Table 2.4 FY 2016 Powering Agriculture Media Coverage

MEDIA OUTLET	TITLE
Farmers Review Africa	Solar Powered Pumps Reduce Irrigation Costs
Microgrid Knowledge	First Microgrid in Haiti: The Road to Feminist Electrification
RMI Outlet	Changing Lives With Solar Microgrids
PRI	An MIT Lesson in Failure Helps Deliver Fresh Milk to Millions in India
Redshift (formerly line/shape/space)	How KickStart International Is Pumping up Entrepreneurial Spirit in Africa
Forbes	A Conversation With Praveen Penmetsa, CEO/Founder of Motivo Engineering
Financial Times	Kenyan Farmers Use SunCulture Solar Power to Help Water Dry Land
Humanosphere	Solar-powered Irrigation Promises Relief to Southern Africa, but Is It Sustainable?
Devex Impact	The Art of the Pitch: How Startup Social Enterprises Pitch Impact Investors
ClimateWire	From Bamboo to Solar Irrigation, Entrepreneurs Eye New Markets
Green Prophet	U.S. Supports Hydroponics to Revitalize Mideast Food, Water and Security
She Shapes the City	Caroline Makenzi Shapes Nairobi with Solar Engineering
Farmbiz Africa	Biogas Chiller Extends Milk Shelf-life for 14 Hours
VentureWell	The Challenge of Hardware Startups
Global Ag Investing	Innovative Solar Poised to Drive Down Costs for Small Farms
Hindu Business Line BL ink	The Rot Stops Here
DEM+ND	Reinventing the Steam Engine
DEM+ND	The Scaled-Down Solar Pump
Your Story	The Story of Delhi-based Claro Energy, the Pioneers of Solar Pumping Solutions
The Daily Star	iDE Launches Clean Energy Project for Hatcheries
Power for All	Insight: The Rise of Solar-Powered Irrigation
ISTG	One-on-One with Samir Ibrahim of SunCulture
Pioneers Post	What The World Needs to Know About African Enterprise
Trust – Thomson Reuters Foundation	2015: Year Zero of Sustainable Development?

Table 2.4 FY 2016 Powering Agriculture Media Coverage (Continued)

MEDIA OUTLET	TITLE
How We Get to Next	Solar-Powered Farming, Built in Kenya
Carbon Pulse	Four Years on, World Bank CDM Fund Signs up First PoA
Business Daily Africa	Four Kenyan Firms Picked for Sh1.3bn Green Energy Fund
AgFunder News	6 Questions with Kenyan Irrigation Tech Provider SunCulture on Startup Funding Challenge
NPR – Goats and Soda	A SkyMall For Farmers Would Have Fish Bubblers And Poop-Powered Coolers
Sustainable Brands	$13M in Clean Energy Investment to Power Agriculture Innovation in Emerging Markets
AgFunder News	Government-led Coalition Invests $12.9m into Clean Energy Agtech Innovations for Emerging Markets
Grist	Hold on to your straw hats. Farming is about to go low-carbon
Onultalia.com	ICU premiata a Washington da USAID per progetto irrigazione Libano e Giordania
News Today	Domestic Firm Makes It Big in International Agri Contest
Fast Company Co.Exist	A New Kind Of Irrigation Could Boost African Farming—And It's Powered By The Sun
AllAfrica	Africa: USAID and Partners Announce Winners of Agriculture Innovation Competition
The Economic Times	Indian Firm Among Agriculture Innovation Competition Finalists
TechCabal	FuturePump, SunCulture And 11 Other Clean Energy Innovators To Receive $13 Million In Funding
The Guardian	The Top 10 Sustainability Innovations of 2015
EcoWatch	10 Groundbreaking Solutions for a Sustainable Planet
Trust – Thomson Reuters Foundation	From Hearing Aids to Farming, Solar Energy Powers Climate Innovation
CNBC	Transforming the way milk is stored
USAID Global Waters	Improving Water Services for a More Water Secure Middle East
Stanford | Engineering	Dr. Martin Fisher of KickStart International Named Stanford Engineering Hero

Powering Agriculture also prepared a collection of videos featuring the 2015 Innovators and members of the Partner organizations (see below), as well as a speaker highlight video from the PAIS event.

SPEAKER VIDEOS FROM PAIS
Jehiel Oliver of Hello Tractor on Innovation and Market Development
John Morton of OPIC on Multi-Agency Solutions
Philipp Ackermann on Market-Based Renewable Energy Ideas
Ann Mei Chang on the Transformative Nature of Unexpected Ideas
Björn Lyrvall on Addressing Global Challenges
Alessandro Flammini of the U.N. FAO on Energy—Agriculture Linkages
Powering Agriculture MOOC—Sustainable Energy for Food

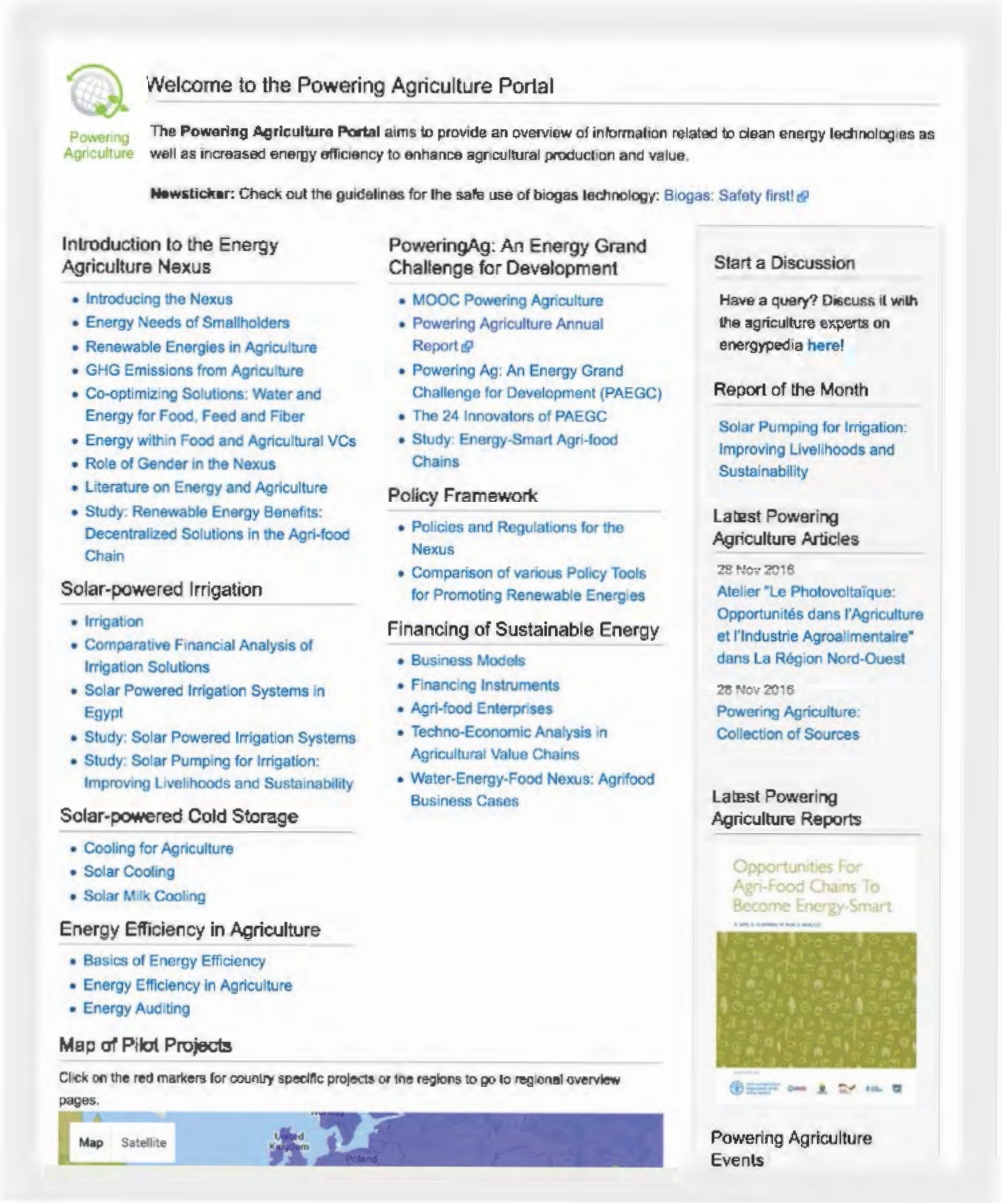
A number of the Innovators were also featured in other videos, including:.

OUTLET	TITLE
Hub Culture	COP21 Hub Culture Paris 2015 Interview with Samir Ibrahim & Charlie Nichols - SunCulture
The Economist	Solar Frontiers
National Geographic	How a Town-Size Solar Grid is Changing Lives in Haiti
TV2Africa	Bamboo Farming Market Expands in Ethiopia
Sida	African Bamboo: Innovating for Change
Smart Villages	Webinar: Off the Beaten Path: Rural Energy and Remoteness
Smart Villages	Webinar: The Big Chill: Off-grid Cooling for Water, Refrigeration, Spaces, and More...

2.3.6 Publication activities

The Energypedia Wiki Portal "Powering Agriculture" published a multitude of articles in order to create awareness and provide an overview of information related to clean energy technologies. Strong emphasis was given to promoting the value of energy efficiency to enhance agricultural production. There were an average of about 12,000 page views per month and 127 articles on the clean energy/ag nexus, 70 of which were prepared by Powering Agriculture.

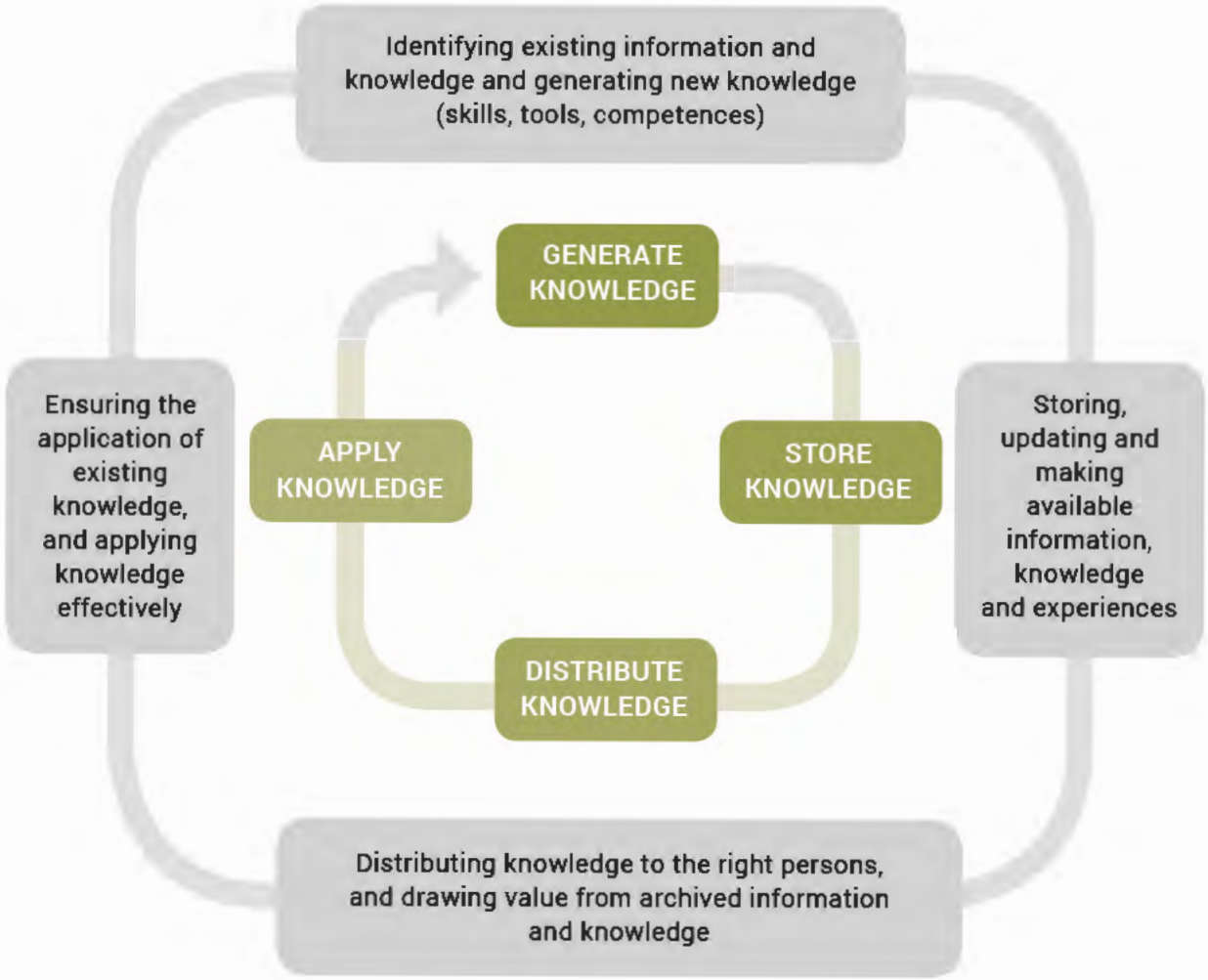
Figure 2.2 Screenshot of https://energypedia.info/wiki/Portal:Powering_Agriculture



2.4 **Knowledge Management and Mainstreaming**

Analyzing and disseminating experiences and knowledge complements Powering Agriculture's overall goal of supporting new and sustainable approaches to accelerate the development and deployment of CES for increasing agriculture productivity. Knowledge management – including generating, analyzing, disseminating and supporting the application of knowledge – leverages Powering Agriculture's support to the Innovators to further integrate clean energy solutions within agricultural supply chains in developing and emerging countries and adapt CES to local context. Figure 2.4 illustrates Powering Agriculture's approach to knowledge management. Powering Agriculture utilizes the regional Powering Agriculture Hub in East Africa and collaborates with U.S. presidential initiatives such as Power Africa and Feed the Future to mainstream the results, knowledge gained and lessons learned from the implementation of Powering Agriculture and to catalyze the integration of clean energy within regional/national agriculture production and food security programs.

Figure 2.3 Knowledge Management Cycle



2.4.1 **Research and Studies**

As part of Powering Agriculture's work to generate new knowledge in the clean energy/ag nexus, three publications were prepared.

The first joint FAO/Powering Agriculture study "Opportunities for Agri-food Chains to Become Energy Smart", was published in November 2015. The study emphasized the importance of assessing value chains from a nexus perspective to identify clean energy solutions for reducing GHG emissions. It was presented at conferences, disseminated to the media, and its facts were used for Powering Agriculture's "Did you know" campaign and for the MOOC. Five hundred copies were disseminated and the full study was also made available electronically. It was received with great interest by experts from the agricultural and energy sector and cited in many follow-on papers.

The 2nd joint FAO/Powering Agriculture study tentatively entitled "Costs and benefits of clean energy technologies in the milk, vegetable and rice value-chains" was drafted as a follow up to the November 2015 study and focuses on the costs and benefits of clean energy technologies in the milk, vegetable and rice value-chains in specific countries. The report will be made public in early 2017.

Powering Agriculture has developed a manual which introduces solar powered irrigation systems (SPIS) as one technology option to sustain and increase agricultural production in developing countries. The manual, entitled ***Promoting, Financing and Advising on Solar Powered Irrigation Systems Manual and Tools for Development Practitioners***:

- targets agricultural extension advisors, providing them with information on technical, agronomic, economic and environmental risks and benefits of SPIS use on farm level;
- can be used to train financial service providers to assess the financial risks and benefits of SPIS use at the farm level; and
- provides advice that farmers can use to make investment decisions.

The Manual and Tools will be made public in early 2017.

Powering Agriculture prepared two papers for submission in early FY2017 to the *Special Issue on Energy and Food Security in a Humanitarian Context, Journal of Sustainable Energy Technologies and Assessments*. One paper is entitled "Increasing Productivity through Irrigation: Problems and Solutions Implemented in Africa and Asia" and presents three major problems inhibiting the spread of irrigation in areas where agricultural productivity heavily depends on rainfall: lack of access to water, lack of access to energy, and lack of access to finance. It discusses how these problems are interconnected, complicating the use of technological solutions addressing them, and analyzes several solar irrigation approaches tackling these problems in Asia and Africa supported under Powering Agriculture.

The other paper is entitled "Milk Chilling through Use of Clean Energy and Energy Efficient Methods in Developing Countries" and discusses the in-country performance and applicability of various solar and biogas powered innovative milk cooling technologies in East Africa and India supported under the Powering Agriculture. The paper examines the technical and market barriers faced by the milk cooling technology Innovators and system implementers funded by Powering Agriculture,

specific to each country's dairy supply chain and method of milk collection. It also analyses the proposed business models and the innovations' applicability to the various stages of milk production value chains and steps needed to achieve their targeted impacts. If the papers are accepted, they will be published in mid-2017.

2.4.2 **Training – MOOC**

Powering Agriculture concluded its first, very successful, massive open online course (MOOC) "Powering Agriculture – Sustainable Energy for Food" in spring 2016. The contents were developed together with the TH Köln – University of Applied Sciences, the FAO, the World Bank, the Center for Development Research of the University of Bonn and Tetra Tech through PASTO.

Nearly 1,700 participants from around the globe took part in the course and learned about the sustainable use of energy throughout agricultural value chains. With the large participant turnout, lively discussions, and thousands of comments, the MOOC achieved its main goals: creating awareness and providing knowledge on the energy/agriculture nexus. The MOOC platform, including all materials and links, remains available online.

2.4.3 **GIZ Powering Agriculture Hub**

In January 2016, Powering Agriculture Partner BMZ/GIZ established a regional project hub for East Africa based in Nairobi, Kenya, to take advantage of the vast potential for the energy/ag nexus and to capitalize on the fact that most of the Innovators are implementing their projects in East Africa. With staff on the ground and close proximity to the American, Swedish, and German embassies and Missions in East Africa, the hub provides the Powering Agriculture Innovators with exchange and networking opportunities through which the Innovators can present their work, discuss it with likeminded experts, and create business opportunities. The Innovators can also benefit from research undertaken by the hub on topics such as solar-powered irrigation systems, milk cooling, and location-specific business models that will help them to become more competitive in their respective market environment.

3 INNOVATORS

3.1 Innovator progress

The Innovators' projects are focused on new clean energy technologies and business models that demonstrate potential to achieve the objectives of Powering Agriculture.

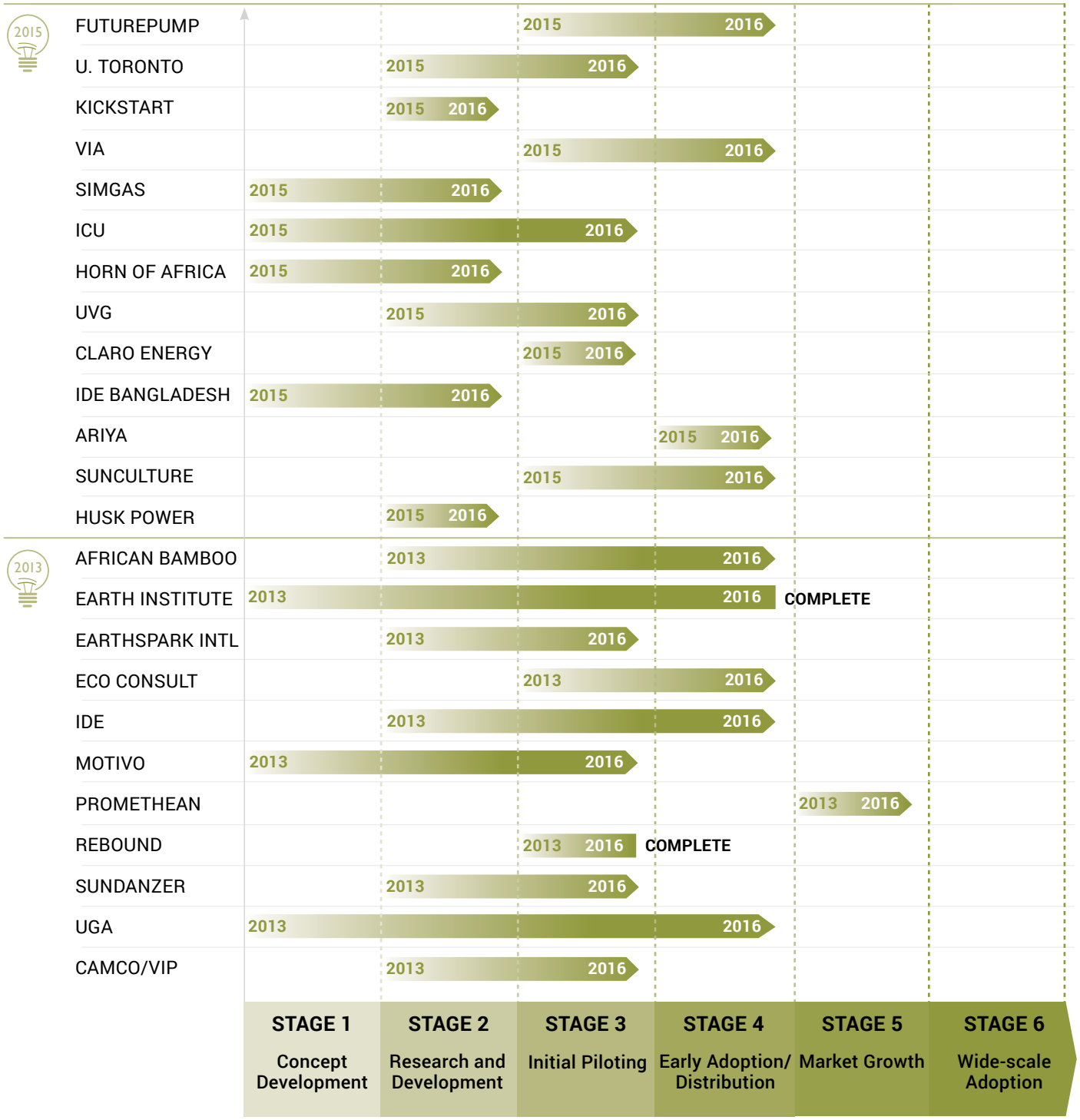
Many of the 2013 Innovators are in the final stage of implementation of their awards and continued testing their solutions in the field and making refinements as necessary. The awards of two Innovators ended in the spring of 2016: Earth Institute at Columbia University and Rebound Technologies.

The 2015 Innovator cohort have been in start-up mode, with Innovators who are lab-based working on the refinement of their technologies, while others who are in more advanced stages focused on the planning of their pilot demonstrations and field testing.

Figure 3.1 shows the 2013 and 2015 Innovators and their progress along the stages of innovation as of September 2016, as determined by the Innovators.

The current status of each Innovator funded in 2013 and 2015 is presented in the section below.

Figure 3.1 2013 and 2015 Innovators and Their Stages of Innovation at October 2016



2013 Innovators

The following profiles provide a snapshot of each Innovator's clean energy solution, their expected impacts, and their progress to date, as of September 2016. Visit www.poweringag.org/innovators for the most up to date information about the Innovators' work.

AFRICAN BAMBOO

PROJECT
Biomass-Powered Thermal Processing of Ethiopian Bamboo

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Biomass

AGRICULTURAL FOCUS
Processing

PRODUCT SEGMENT
Agro-Forestry Products

COLLABORATOR(S)
Heartland Global (USA)

LOCATION APPLIED
Southern Nations, Nationalities, and Peoples' Region (SNNPR), Ethiopia

WEBSITE
www.african-bamboo.com

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 and the improvement of the livelihood of the local community through job creation by forming new micro and small enterprises for bamboo forest harvesting and transportation, bamboo forest thinning, and micro charcoal production from low quality bamboo culms. Once production starts, the farmers will receive a fair and stable income for the supply of bamboo and at scale, African Bamboo will employ 6,000 smallholder farmers. 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

The construction of the bamboo processing factory has been completed and it was inaugurated on July 11, 2016, within the world class Hawassa Industrial Park. African Bamboo has received three factory sheds of 5,500 square meters each. African Bamboo has signed agreements with a variety of suppliers to equip the factory and pre-order agreements with companies for the purchase of the products.

African Bamboo has already organized 2,239 smallholder farmers into 31 cooperatives for the sourcing of the bamboo raw material in Ethiopia's administrative zones of Sidama and West Arsi and the farmers have received their first training in sustainable bamboo harvesting. On September 14, 2016, African Bamboo signed a frame public-private partnership memorandum of understanding with Oromia Forest and Wildlife Enterprise for joint forest development and utilization.

CAMCO

2013

PROJECT
Building Markets for Efficient Biomass Power Provision in Africa

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Biomass

AGRICULTURAL FOCUS
Decentralized Power

PRODUCT SEGMENT
Agro-Forestry Products

COLLABORATOR(S)
Village Industrial Power (VIP) (USA)

LOCATION APPLIED
Oueme region in Benin, and the Kigoma and Mufindi regions in Tanzania

WEBSITE
www.camcocleanenergy.com/africa
www.villageindustrialpower.com

ORGANIZATION

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.

PROBLEM/OPPORTUNITY

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.

CLEAN ENERGY SOLUTION

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 resulted in the field testing of five beta prototype steam-driven micro combined heat and power units capable of producing 7.5-kW of electricity and 40-kW of thermal energy for agro-processing facilities and residential and commercial end-users. The unit powering the village mini-grid in Tanzania contributes to the community's financial stability and entrepreneurship opportunities. The three units tested with the palm oil processors in Benin showed the potential of the clean energy solution to increase palm oil yield, and reduce or completely eliminate the consumption of diesel and wood used to power their milling machinery. They hope to use the electrical energy and the thermal energy generated by the units to power other motors, dry their crops, or produce hot water for the milling process which would reduce their wood consumption in the future. A number of issues have prevented the achievement of the original installation targets of the award. However, with support from a new funding source facilitated through Powering Agriculture and the feedback gained from the end-users during the field testing, VIP has designed the 4th generation of the VIP technology to be installed in Kenya, Benin, Tanzania and now India.

PROGRESS UPDATE

Camco and VIP have to date installed five units in three locations. Three palm oil processing businesses in South Eastern Benin have tested the VIP unit in order to displace diesel consumption that is used in running the expeller press and the kernel and fiber separator. The VIP mini-grid in the village of Uchindile, Tanzania, has electrified over 15 shops, homes, and a hospital, and is looking to test the system for an agricultural application, such as an irrigation pump or a small mill. A rural clinic near Kigoma, Tanzania, tested the VIP unit to power a submersible pump and other equipment with the electricity produced by the unit. Training to operate and maintain the units has been provided at all sites.

THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

PROJECT
Micro-Solar Utilities for Small-Scale Irrigation in Senegal

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture

COLLABORATOR(S)
The MDG Center West and Central Africa (Senegal)

LOCATION APPLIED
Potou, Senegal

WEBSITE
www.earth.columbia.edu

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 allows farmers, even with small land holdings and/or little access to capital, to benefit from irrigation. Access to Pay-as-you-go irrigation in this part of coastal Senegal has shown farmers how they could potentially grow two crops in a year and generate an annual revenue of as much as $5000/ha.

PROGRESS UPDATE

By the end of the Powering Agriculture Award in March 2016, Earth Institute had installed three shared battery-less solar PV pumping systems in Potou, Senegal. The three shared systems serve 21 farms, including a farm run by a women's cooperative, and are now seeing maximum utilization. Farmers have experienced a 29% average increase in agricultural production, and resulted in 24 tons of CO_2 equivalent emissions avoided from not having to use diesel pumps.
Eight persons have been trained on how to service the pumping systems. The project is now seeking partnerships for scaling up, adoption and local maintenance contracts.

EARTHSPARK INTERNATIONAL

PROJECT
Smart Grid on Main Street: Electricity and Value-added Processing for Agricultural Goods in Rural Haiti

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Decentralized Power

PRODUCT SEGMENT
Staple Crops

COLLABORATOR(S)
Entreprises La Foi (Haiti)

LOCATION APPLIED
Les Anglais, Haiti

WEBSITE
www.earthsparkinternational.org

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

EarthSpark has built a 'town-sized, solar-powered, smart grid' now serving 450 households and businesses in downtown Les Anglais. The grid's arrival in 2015 brought grid electricity to these customers for the first time. Directly serving over 2000 people with 24-hour electricity powered primarily by solar energy and battery storage, the grid is cutting customers' energy costs by up to 80% over previous energy sources like kerosene, candles, and privately-owned diesel generators. The community-scale grid is large enough to power small industry while progressive enough to offer accessible service to every single resident living within the infrastructure's footprint.

EarthSpark has also been working with local agricultural entrepreneurs to both replace diesel run machines with electric ones and introduce new technologies. The local miller now has the ability to use clean energy to mill corn. A local women's cooperative is trying to mechanize corn de-kernelling with an electric thresher that will save countless hours of manual labor. This same cooperative is also experimenting with breadfruit processing and the ability to extend the shelf life of an extremely perishable product, helping food security. Beyond the targeted agricultural processing businesses and organizations, the grid has enabled residents to start or expand other businesses. EarthSpark has profiled one such entrepreneurial resident, Ms. Antonia Maurice, on the EarthSpark blog.

ECO CONSULT

PROJECT
A Hydroponic Green Farming Initiative

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture

COLLABORATOR(S)
El Wir Farm in Zarqa River and one large farm in the Highlands. The community households cluster will be identified during the feasibility study

LOCATION APPLIED
Jordan; Middle East and North Africa region

WEBSITE
www.ecoconsult.jo

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.

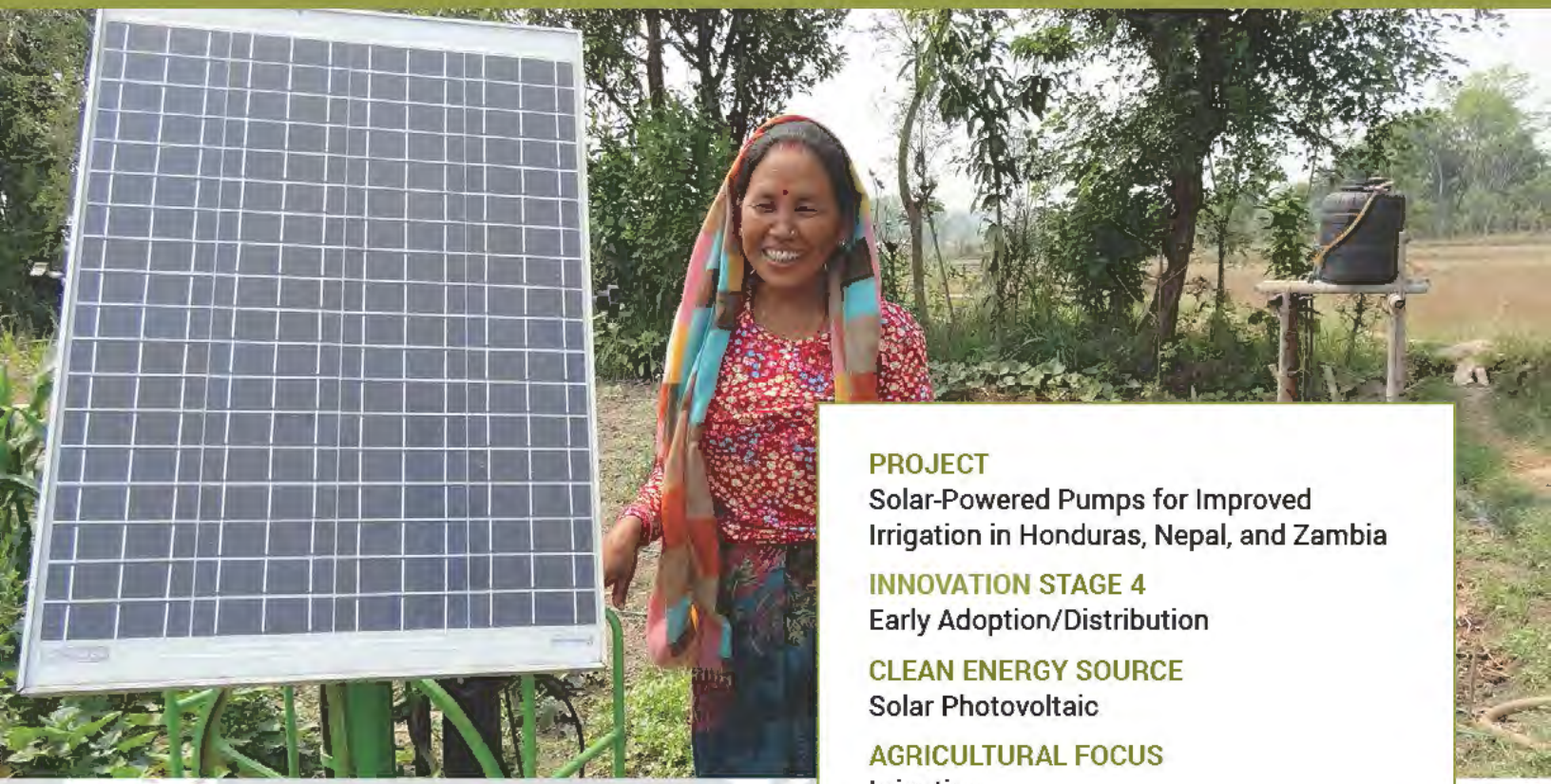
IMPACT

ECO Consult works with small household farms, as well as large commercial farms, to educate them and help them adopt basic hydroponic systems to allow them to produce high quality vegetables and maximize their economic return per cubic meter of water, while saving large volumes of water. Through the establishment of 10 demonstration sites, ECO Consult shows farmers how to start and manage these farming systems. As more farms adopt these new technologies at a small scale, rural households will realize additional sources of income and new employment opportunities, including women and youth.

PROGRESS UPDATE

ECO Consult focused heavily on expanding the knowledge and use of hydroponics by Jordanian farmers, private companies and suppliers. Four additional demonstration sites were established; two were commercial sites; one in the Jordan Valley and another in Yadoudeh, the third site in Bani Kananeh, and the last site in Mafraq. Over 399 people attended field demonstration days or visited the project sites to learn how to start their own hydroponics. ECO Consult held an extensive five day training course in the Netherlands at Wageningen University (WUR) Research Station where Jordanian representatives from government, private sector, farmers and the project team were trained on hydroponic farming systems and took part in field visits and lectures to learn about the Dutch experience in the domain of horticulture and hydroponics.

iDE



PROJECT
Solar-Powered Pumps for Improved Irrigation in Honduras, Nepal, and Zambia

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture

COLLABORATOR(S)
PRACTICA Foundation (Netherlands), Futurepump Ltd (UK)

LOCATION APPLIED
Honduras; Nepal; and Zambia

WEBSITE
www.ideorg.org

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 allows farmers to increase their farm productivity, and thus their income. It allows farmers to mechanize their farming with zero carbon emissions. When paired with a drip irrigation system, use of the Sunflower pump can also significantly reduce labor requirements. Use of the Sunflower pump instead of a fossil fuel engine can reduce annual carbon emissions by 0.5 a ton. With a 10-year lifespan, each pump reduces CO_2 emissions by 5 tons.

PROGRESS UPDATE

iDE has pioneered a new product category of solar pump. iDE has worked with its partners, Futurepump and the PRACTICA Foundation, on the development of the Sunflower pump, a highly efficient piston pump powered by an 80 watt PV panel. iDE currently has installed 84 pumps for testing at 48 active field sites; 80 in Honduras, Zambia, Nepal. An additional 4 pumps have been installed in the USA, Bangladesh, Burkina Faso, and Cambodia, which shows iDE's progress towards global distribution. As a result of these field tests, iDE and its partners have gone through five design iterations of the pump. In addition, 80 pumps have been sold to iDE's private sector partners for sales to end users in Zambia and Nepal.

MOTIVO ENGINEERING, LLC

2013

PROJECT
Hybrid Vehicles with Exportable Power for Community-Based Agriculture Mechanization

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Hybrid

AGRICULTURAL FOCUS
Cold Storage, Decentralized Power, Irrigation, Processing

PRODUCT SEGMENT
Aquaculture, Dairy, Horticulture, Staple Crops

COLLABORATOR(S)
The KVK Foundation (India), Feuerlabs (USA)

LOCATION APPLIED
Rangareddy, Telangana, India

WEBSITE
www.motivoengineering.com

ORGANIZATION
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.

PROBLEM/ OPPORTUNITY

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 cold 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.

CLEAN ENERGY SOLUTION

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.

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

The partially assembled HARVEST prototype is now in India and is close to being field tested by Indian farmers. It was previously tested in California in small fields and nurseries and the results were used to make the tractor more functional.

PROMETHEAN POWER SYSTEMS

PROJECT
Reducing Milk Spoilage through Solar Powered Milk Chilling in Rural India

INNOVATION STAGE 5
Market Growth

CLEAN ENERGY SOURCE
Energy Efficiency, Solar Photovoltaic

AGRICULTURAL FOCUS
Cold Storage

PRODUCT SEGMENT
Dairy

COLLABORATOR(S)
Hatsun Agro (India), Orb Energy (India)

LOCATION APPLIED
India

WEBSITE
www.coolectrica.com/impact

ORGANIZATION
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. Promethean's clean energy solution improves access to forward markets, higher income for the dairy farmers, and wealth creation through increase in herd size. Specifically, Promethean has observed the following positive impacts:

- Promethean's solution makes it viable for the dairy processors to set up more village level collection centers in the rural parts of India. The chilling infrastructure increases the overall income for the village by bringing more farmers into the organized collection of milk.
- Rather than transporting the warm milk to a distant central chilling center, processors can eliminate middle-men and pay more money, with more transparency, directly to farmers.
- The solution preserves the quality and eliminates spoilage. This reduces the financial risk to the farmers, as farmers only receive money for milk that makes it to the market, and improves the quality of milk that reaches the dairy processor.
- When milk chilling technology is installed in a village, the whole ecosystem rises because farmers see permanent infrastructure that gives assurance that they will have an off-taker for their milk in the future. They therefore end up investing in more cows and grow their income over time. Data has confirmed that milk collection increases by up to 60-90% and farmers make about 10% more money per liter of milk once collection starts in their village.
- The assured daily income also enables the smallholder farmer, many of whom are women, to invest in education, health and housing for their families.
- Women benefit greatly from having a milk chiller in their village. They have a more flexible schedule for getting the milk to the milk collection area; the existing method has a strict timetable so that raw milk can be rushed to a distant center for chilling. The village-level milk chiller reduces this time constraint, allowing women to better balance their childrearing and farming

responsibilities. The reliable income from getting their milk safely to market enables women to develop a financial cushion which they can utilize to invest in more cows to further grow their income or to spend on school fees for their children to enhance their future economic prospects.

PROGRESS UPDATE

Promethean has now sold over 400 units, of which they have deployed and commissioned over 250 milk chillers coupled to its patented Thermal Battery. The remaining units are pending installation or are in production today.

To date, none of the 250 Promethean chillers in the field 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, leading to higher costs and increased carbon emissions, or milk chillers would not have been installed at all, leading to greater spoilage and decreased quality of milk. As deployment of the chillers continues, Promethean has been able to adapt the solar component design to address specific logistical needs of dairy partners and have seen increased adoption of the chilling solution as a result.

REBOUND TECHNOLOGIES

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.

PROJECT
SunChill: Solar Cooling for Horticultural Preservation in Mozambique

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Solar Thermal

AGRICULTURAL FOCUS
Cold Storage

PRODUCT SEGMENT
Horticulture

COLLABORATOR(S)
Colorado State University, TechnoServe, Mozambique Organicos

LOCATION APPLIED
Inhambane Province, Mozambique

WEBSITE
www.rebound-tech.com

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. Rebound has utilized some of the data and lessons learned from field testing SunChill™ have been incorporated into its latest IcePoint™ technology for the US market.

PROGRESS UPDATE

Rebound completed the Powering Agriculture project in March 2016 by validating a SunChill™ field demonstration unit in Mozambique which cooled 43 kg of tomatoes during the pilot. The total project effort resulted in the completion of the engineering work that forms the technology foundation. Remaining is the industrial design work necessary to move SunChill™ to a commercialized product available for deployment. Rebound plans to Open Source all SunChill™ engineering documents by the end of 2016, opening the doors for students and entrepreneurs to leverage Rebound's learnings and transition them into a successful, marketable product.

SUNDANZER REFRIGERATION

PROJECT
Solar-Powered Refrigeration for Kenyan Dairy Farms

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Cold Storage

PRODUCT SEGMENT
Dairy

COLLABORATOR(S)
Winrock International (USA)

LOCATION APPLIED
Nakuru Region, Kenya

WEBSITE
www.sundanzer.com www.winrock.com

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.

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. Users have stated that the solution has provided benefits that include adding financial security to the household, cell phone charging which saved time and added income to the household, as well as food preservation.

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; one was installed at Egerton University; and one was installed at the Mogotio milk cooperative. 40 more units are on their way to Kenya to be installed at farms in rural Kenya counties, two additional units will be installed on farms in Rwanda as a separate project. SunDanzer has added Chloride Exide as their distributor/ installer in Kenya.

The farm owner with a few cows was full of praise on how the cooler has changed her life for the better. She noted that there are days when she is late in milking or times when the cooperative truck fails to come for collection of milk. On such occasions, she now has the cooler to preserve the milk for later delivery/collection. Previously, this milk would have gone to waste without the cooler. She also mentioned how the cooler has changed her life, as she stores other perishable household groceries in the fridge.

UNIVERSITY OF GEORGIA RESEARCH FOUNDATION

PROJECT
Biogas-Powered Evaporative Cooling for Uganda's Dairy Industry

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Biogas

AGRICULTURAL FOCUS
Cold Storage

PRODUCT SEGMENT
Dairy

COLLABORATOR(S)
Smallholder Fortunes (Uganda)

LOCATION APPLIED
Wakiso District, Uganda

WEBSITE
www.ovpr.uga.edu/ugarf

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 EvaKuula is benefiting smallholder dairy farmers by decreasing milk spoilage and increasing production and profits. A fraction of the captured biogas is being 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 is being mitigated.for cooking. Also, by extracting biogas from cow manure, greenhouse gas emissions from fermenting cow manure is mitigated.

PROGRESS UPDATE

UGARF deployed the first two units with two female dairy farmers last March. Income for both these farmers has increased as a result of EvaKuula adoption. When asked about impact, one of the farmers said "*I have been sending my granddaughter to sell our evening milk, door-to-door, after she comes back from school. Most of the time she would manage to sell one to two liters per day, out of the 10 or so liters we harvest in the evening. We consume some of the unsold milk and the rest given freely to the neighbors and/or workers on the farm. Sometimes all the milk just gets spoilt when my granddaughter gets home late and I can't send her out in the dark. Where has this technology been all these years!!!?*" Seven contracts are in hand to supply EvaKuula units in October 2016. UGARF has participated in a trade show in Kampala and a training of over 70 farmers. Based on demand generated by these activities, UGARF anticipates deploying approximately 10 units per month.
[See EvaKuula Facebook page.]

ARIYA CAPITAL GROUP LTD

2015

PROJECT
Powering Agriculture with Renewable Energy

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic, Wind

AGRICULTURAL FOCUS
Decentralized Power

PRODUCT SEGMENT
Horticulture

COLLABORATOR(S)
African Solar Designs (Kenya)
Windfire Group (United Kingdom

LOCATION APPLIED
Kenya, Tanzania, Uganda

WEBSITE
http://www.ariyacapital.com/

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 decentralized renewable energy (DRE) and energy efficiency solutions, will allow flexibility in designing energy systems tailored for each user.

IMPACT

The on-site power supply and management services provided by the project will enable flower farms and horticulture groups to displace grid power with renewable sources of power, leading to reduced energy costs and a reliable power supply not subject to load shedding or instability. By helping East African horticulture exporters to increase their bottom line, employees on their farms—ranging from 1,000 to 25,000 per farm and 50% women—and the associated local communities can benefit from greater job security and improved living standards. Other impacts include reduced carbon emissions, improved productivity, and reduced water usage resulting from farms using more sophisticated agriculture and horticulture techniques, and where legislation permits, the export of excess power to the grid or through micro-grid designs that permit supply to other local businesses and communities. Ariya will leverage Powering Agriculture's investment to catalyze additional financing of 2.6 times the original award to install 20 systems totaling a minimum of 2.4MW over the life of the award period.

PROGRESS UPDATE

Ariya and its partner, ASD, have conducted a significant outreach effort to sensitize and educate farm directors, general managers, and others on the benefits of renewable energy, and to introduce the Ariya/ASD finance, installation, and operations and maintenance model. As part of the effort, three workshops were held in areas where there are clusters of floriculture and horticulture - Naivasha, Nanyuki and Athi River. Ariya has conducted feasibility studies of 30 of the 70 farms that it has shortlisted for consideration as potential recipients of the systems. Of the 30 farms, 19 are viable for systems and agreements have been signed for four systems. A qualified and local engineering, procurement, construction (EPC) contractor has been selected and local engineering companies have also been identified to provide the necessary monitoring systems and other ad hoc mechanical and engineering works.

CLARO ENERGY

2015

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

PROJECT
Low-Cost Pay-Per-Use Irrigation Using Solar Trolley Systems

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture, Staple Crops

LOCATION APPLIED
India

WEBSITE
http://www.claroenergy.in/

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.

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.

PROGRESS UPDATE

Claro Energy is finalizing the engineering and design of its prototype and developing the associated technologies for remote monitoring and pay-per-use.

FUTUREPUMP

2015

PROJECT
Sunflower Pump: Asset-Financed Solar Irrigation Pumps for Smallholder Farmers

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture

COLLABORATORS
Equity Bank (Kenya)

LOCATION APPLIED
Kenya

WEBSITE
http://www.futurepump.com/

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 does not rely on engine pumps. In addition, the growing season can be extended through the dry season, during which produce brings higher market prices. Our customer, Bob Ouma, explains how he can now sell green maize in the dry season, fetching four times the income than that of the dried maize he used to sell. [See YouTube video]

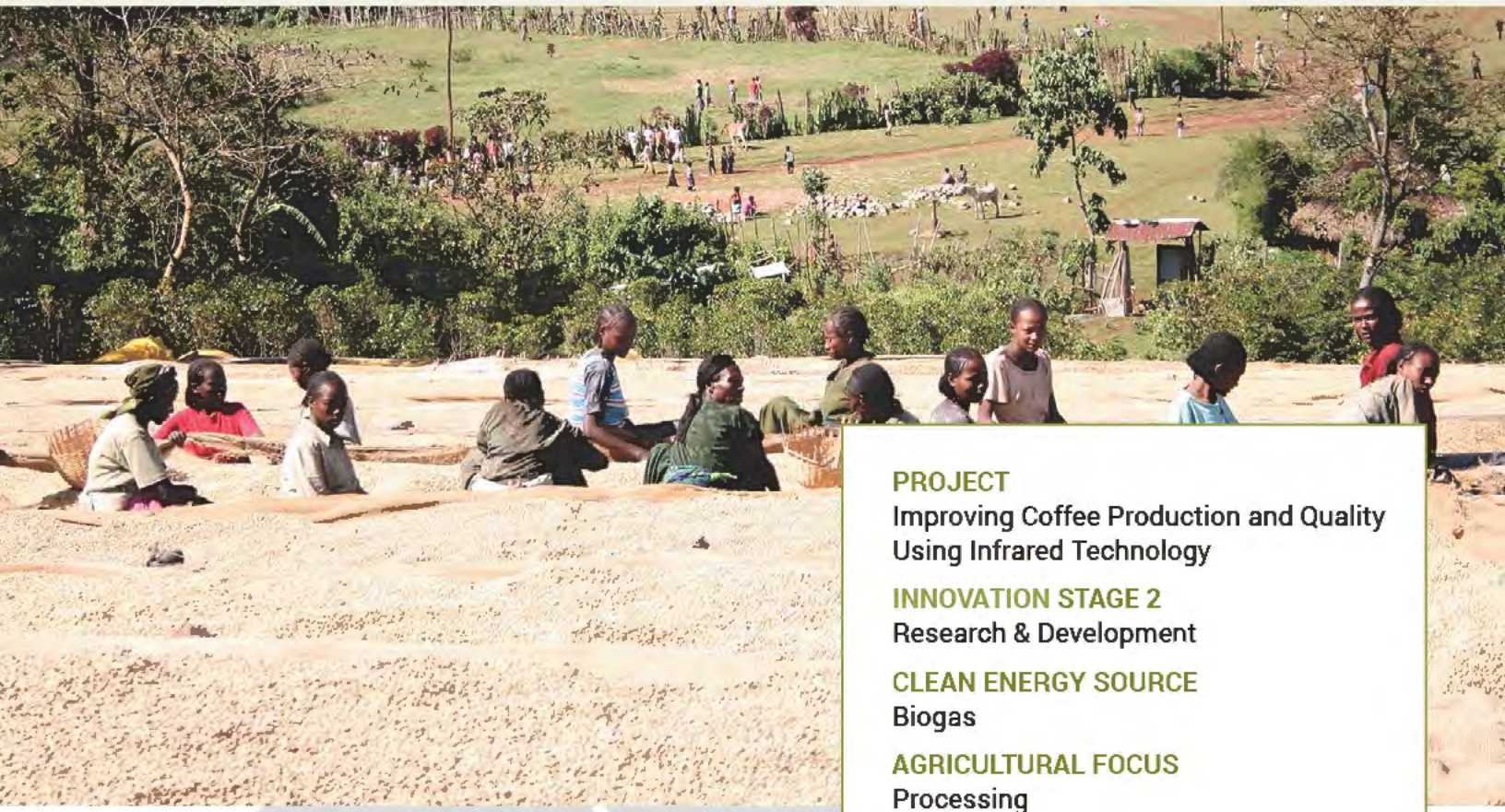
Small vegetable farm profits can be increased as much as 45 percent through the use of a solar pump, while reducing their reliance on fossil fuel. All of these benefits will have a major impact on small- scale farmers; for female farmers in particular the reduction in the labor burden of manual irrigation or carrying fuel pumps is a significant benefit.

PROGRESS UPDATE

Futurepump has shipped over 400 SF1 solar pumps from their factory in India to Kenya to date, and increased direct sales to customers utilizing innovative financing plans. They have utilized more detailed monitoring and evaluation techniques to identify that customers of the SF1 solar pump are expected to save $100-$200 a year from reduced fuel and labor costs. In addition to labor savings and reliable energy, many customers use the additional income or monetary savings to pay school fees for their children or grandchildren. One of Futurepump's lead farmers, Joshua Okundi, explained that these fees can be around $1,500 (150,000 KES) a year and having a reliable income is essential to being able to meet this cost.

HORN OF AFRICA REGIONAL ENVIRONMENT CENTER AND NETWORK

2015



PROJECT
Improving Coffee Production and Quality Using Infrared Technology

INNOVATION STAGE 2
Research & Development

CLEAN ENERGY SOURCE
Biogas

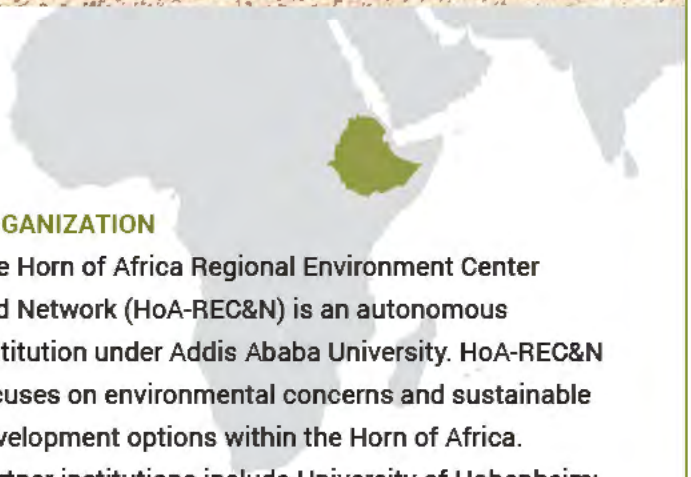
AGRICULTURAL FOCUS
Processing

PRODUCT SEGMENT
Fruit

COLLABORATORS
University of Hohenheim (Germany)
University of Massachusetts–Boston (United States)
Oromia Coffee Farmers Cooperative Union (Ethiopia)

LOCATION APPLIED
Ethiopia

WEBSITE
http://www.hoarec.org/index.php/en/



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 success of this project will lead to new opportunities that can transform the current traditional coffee production system while improving the quality and quantity of coffee. By reducing the time farmers spend in coffee processing, the time saved can be used for other productive uses which will help them generate additional income. 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.

PROGRESS UPDATE

HoA-REC&N has been working on developing a biogas digester and an Infrared (IR) Dryer to dry coffee beans. Over the past few months HoA-REC&N constructed and commissioned four bio digesters which were tested with two different coffee feedstocks–husk and pulp. The tests showed that the coffee pulp resulted in higher yields of bio-methane. Additional experiments were conducted to analyze the effectiveness of coffee drying at different temperatures and power. In collaboration with one of their partners, University of Massachusetts-Boston, HoA-REC&N has finished putting together technical specifications for the IR Dryer. Finally, HoA-REC&N has selected the Kenterie coffee cooperative, comprised of 1520 members, as the site to pilot their technology.

HUSK POWER SYSTEMS

2015

PROJECT
Biomass and Solar PV Hybrid Minigrids for Off-Grid Farming Communities

INNOVATION STAGE 2
Research and Development

CLEAN ENERGY SOURCE
Biomass, Solar Photovoltaic

AGRICULTURAL FOCUS
Decentralized Power

PRODUCT SEGMENT
Staple Crops

COLLABORATORS
Diamond Development Initiatives (Nigeria)
Technology Management Group (Ghana)

LOCATION APPLIED
Ghana, Nigeria

WEBSITE
http://www.huskpowersystems.com/

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 Tanzania 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. Husk Power is serving approximately 100 households and small businesses with their biomass gasification system. Customers have switched from kerosene- and diesel-powered systems to the Husk mini-grid. However, these customers demand access to reliable and 24/7 power, which is driving the efforts to convert these two sites to the hybrid mini-grid to meet customers' aspirations. These hybrid sites will enable Husk Power Systems to provide cost effective power to customers during daytime with solar PV and night time with Biomass gasification system.

PROGRESS UPDATE

Husk Power has installed a new biomass gasification system in the Bagamoyo area of Tanzania, with a target customer base of 200 households, small businesses, and a couple of agro processing units. An order has been placed for 170kW of Solar Panels sufficient for 5 sites installation and grid tied inverters and physical structure for two sites. Husk Power's goal is to convert this new biomass gasification site and another site at Kongwa, Tanzania, to a Hybrid mini-grid site (Solar PV + Biomass).

iDE BANGLADESH

2015

PROJECT
Renewable Microgrids for Off-Grid Fish Hatcheries and Surrounding Communities

INNOVATION STAGE 2
Research and Development

CLEAN ENERGY SOURCE
Wind, Solar Photovoltaic

AGRICULTURAL FOCUS
Decentralized Power

PRODUCT SEGMENT
Aquaculture

COLLABORATORS
Renewable World (United Kingdom)
Electro Solar Power Ltd. (Bangladesh)
United Finance Company (Bangladesh
Rahimafrooz Renewable Energy Ltd. (Bangladesh)

LOCATION APPLIED
Bangladesh

WEBSITE
http://www.ideorg.org/

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.

PROGRESS UPDATE

As part of the initial piloting phase, iDE Bangladesh has completed several week-long research deep dives aimed at unpacking end-consumer and market insights for the adoption of its clean energy solution in fish hatcheries and surrounding communities in Bhola, Barisal, and Patuakhali districts of coastal Bangladesh. The project completed technical pre-feasibility in 10 hatcheries and feasibility in 5 hatcheries, with ongoing negotiations in two selected hatcheries for CES micro-grid and business model testing. The proposed solution aims to replace 2,300 liters/year of diesel per hatchery and for 15 small fish farmers for water pumping, and 2,400 liters/year of kerosene to electrify 40% of households without Solar Homes Systems (SHS), and provide 6 extra hours of lighting and 4 hours of fan for 60% of households with SHS through 2017.

INSTITUTE FOR UNIVERSITY COOPERATION (ICU)

2015

PROJECT
PV-Integrated Drip Irrigation and Fertigation Systems

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture, Staple Crops

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

LOCATION APPLIED
Jordan, Lebanon

WEBSITE
http://www.icu.it/en/

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 agro-chemicals 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.

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 a comprehensive technology package for PV-Drip Irrigation and fertigation which will encourage the switch from diesel powered to solar powered pumps, resulting in reduced CO_2 emissions and energy costs. In addition, the drip and fertigation system will reduce water and fertilizer use up to 30% compared to traditional systems due to efficient and localized application. In order to make the CES technology accessible to farmers the project will facilitate access to credit and widen the presence of trained technical staff able to provide technical and maintenance assistance.

PROGRESS UPDATE

The project has installed 3 PV-Integrated Irrigation Systems in Lebanon for a total capacity of 30kW. Out of the 3 first farmers, 2 are women, Nada and Roula, who produce seasonal vegetables and Mustafa, instead, produces dwarf varieties of peaches. 20 professionals from private companies have been trained in preparing a technical-financial study to present along with credit request for energy loans. The project also participated in the International Beirut Energy Forum 2016 to present the CES.

KICKSTART INTERNATIONAL

2015

PROJECT
Affordable, High-Performance Solar Irrigation for Smallholder Farmers

INNOVATION STAGE 2
Research and Development

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture

COLLABORATORS
Angaza Design (United States)
Encap Technologies (United States)

LOCATION APPLIED
Kenya

WEBSITE
http://www.kickstart.org/

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 transforms the food and income security of smallholder farmers and broader rural communities by enabling the transition from rain-fed subsistence farming to year-round commercial irrigated agriculture with individually-owned technologies. On average, farmers who adopt one of KickStart's best-selling human-powered irrigation pumps increase their household income by 400% and over 1,000,000 people have taken a major step out of poverty as a direct result of using these innovative tools. In 2015, KickStart launched a new strategic plan to double this impact across 16 countries in sub-Saharan Africa by 2021, empowering an additional 1,000,000 people to lift themselves out of poverty while significantly expanding smallholders' role in water management.

KickStart has sold close to 300,000 MoneyMaker brand pumps to date and the introduction of the affordable solar-powered pump and flexible financing being developed through this project will be essential to both the organization's goal and the continent's broader need for sustainable irrigation: Currently, about 96% of farmland in sub-Saharan Africa is entirely dependent on rain.

PROGRESS UPDATE

KickStart and its partners are conducting two parallel R&D processes on the first generation prototypes of both a low-cost solar PV irrigation pump and an optional pay-as-you-go (PAYG) financing platform.

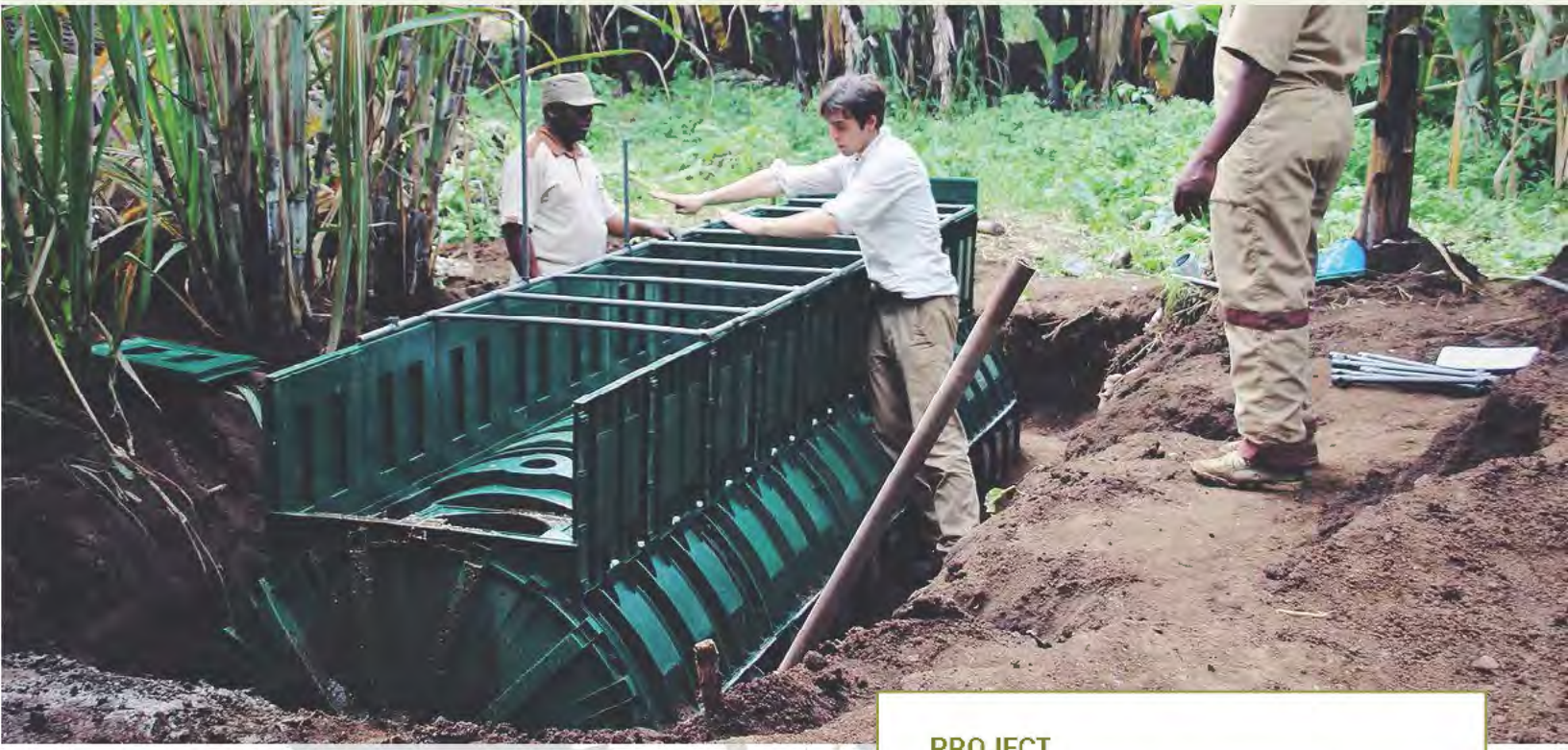
A highly specialized and experienced design team is currently developing the first prototype of an individual solar-powered irrigation pump that will be more efficient and affordable than any product currently available in the Kenyan market. The assembled group of expert engineers combine deep knowledge on the needs of smallholders, typical characteristics of their farms and water sources, and experience building state-of-the-art motors and impellers with broad industrial applications. Their targeted design parameters for a "pack and play" pump are firmly rooted in farmers' reality.

Based on feedback from KickStart's customers and Nairobi-based product design team, the prototype under R&D must reach a minimum suction depth where groundwater is known to be available, irrigate half an acre assuming four peak sunlight hours per day, have a total diameter that can fit down a standard 2" borehole, and sell for an affordable retail price of under $200.

To further reduce the upfront cost of solar-powered irrigation, R&D for a PAYG system to couple with KickStart's pumps is also underway. Angaza has completed the initial hardware for the first PAYG prototype, which includes a power switch, cell phone charger offtake (USB) and keyboard that can enable farmers to pay for time used, time passed, or a combination of both. The first generation hardware is complete, including a durable enclosure that houses the electronics, is resistant to sun, water, and dust that is fitted for easy mounting directly on the back of solar panels, and input/output connections.

SIMGAS TANZANIA LTD

2015



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.

PROJECT
Biogas Milk Chilling to Increase Productivity and Incomes of Dairy Farmers

INNOVATION STAGE 2
Research & Development

CLEAN ENERGY SOURCE
Biogas

AGRICULTURAL FOCUS
Cold Storage

PRODUCT SEGMENT
Dairy

COLLABORATORS
SimGas BV (Netherlands)
SNV (Netherlands)

LOCATION APPLIED
Kenya, Rwanda, Tanzania

WEBSITE
http://simgas.org/

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.

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

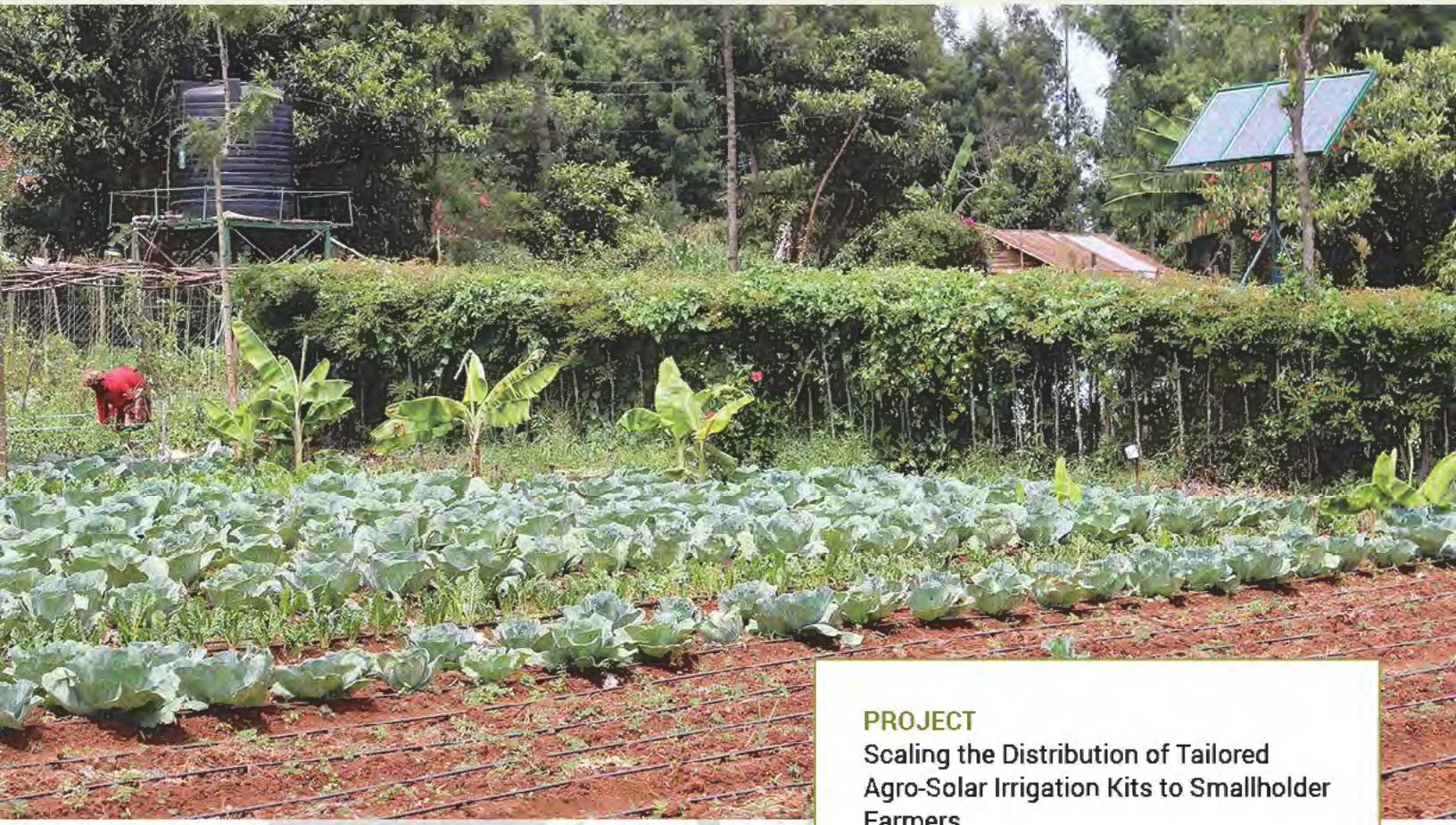
The SimGas Biogas Milk Chiller will empower small dairy farmers to guide their own development; the BMC can greatly improve the income of small dairy farmers, help supply to meet demand, help farmers to access the formal dairy market, and contribute to improved nutrition. The quantity and quality of 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.

PROGRESS UPDATE

SimGas' partner SNV has completed market assessments for the Biogas Milk Chiller in Kenya and Tanzania, and is currently performing market research In Rwanda. SimGas' R&D team tested 4 prototypes at 4 dairy farmers in Tanzania which demonstrated that the BMC complies with the international milk cooling standard: cooling raw milk down from 35 degrees Celsius to 4 degrees Celsius within 3 hours' time.

SUNCULTURE

2015



PROJECT
Scaling the Distribution of Tailored Agro-Solar Irrigation Kits to Smallholder Farmers

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Irrigation

PRODUCT SEGMENT
Horticulture

COLLABORATORS
REEEP

LOCATION APPLIED
Kenya, Tanzania, Uganda, Zambia

WEBSITE
http://www.sunculture.com/

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.

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. In addition, SunCulture's system has environmental benefits - in the next year, current SunCulture farmers will save 1.4 billion liters of water and generate over 84,000 kilowatt hours of power annually - all this while growing over 9.4 million kilograms of fresh fruit and vegetables.

PROGRESS UPDATE

Since the beginning of the Powering Agriculture award, SunCulture has sold 40 AgroSolar Irrigation Kits (ASIKs) in Kenya which allowed 187 farmers to provide better nutrition, higher quality education and healthcare for themselves and their families. They have also trained 25 technicians that provide agronomy support from planning through harvest, as well as installation and after-sales support to the beneficiary farmers. SunCulture has also developed a distribution partnership in Tanzania and are targeting expansion into two additional countries in 2017.

UNIVERSIDAD DEL VALLE DE GUATEMALA (UVG)

2015

PROJECT
Private Sector Financed Community Solar Microgrids and Agricultural Accelerators

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Decentralized Power

PRODUCT SEGMENT
Horticulture

COLLABORATORS
Development Ventures (United States)
Greenergyze S.A. (Guatemala)

LOCATION APPLIED
Guatemala

WEBSITE
http://www.uvg.edu.gt/

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 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

By linking them with impact investors, the project will facilitate investment by two agricultural communities in Guatemala in affordable clean energy generation systems, This investment will enable them to power agricultural production/processing equipment (such as irrigation systems and/or cold storage facilities) that is specifically tailored to the needs of each community. In addition, the communities will receive training in new agricultural production techniques allowing them to increase their productivity.

PROGRESS UPDATE

The project team has analyzed over 100 potential pilot sites and is now in the final stages of the defined engagement process with four selected potential pilot sites. The team is aiming to complete agreements with two communities to finalize the investments. The project has also succeeded in sourcing two Guatemala-based impact investors and is in the process of completing the legal requirements for the investments to proceed.

UNIVERSITY OF TORONTO

2015

PROJECT
Field Evaluation of a Passive Aeration System for Aquaculture

INNOVATION STAGE 3
Initial Piloting

CLEAN ENERGY SOURCE
Solar Thermal

AGRICULTURAL FOCUS
Aeration

PRODUCT SEGMENT
Aquaculture

COLLABORATORS
BRAC Enterprises (Bangladesh)
Curiositate

LOCATION APPLIED
Bangladesh

WEBSITE
http://www.mie.utoronto.ca/labs/werl/

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 passive aeration 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.

PROGRESS UPDATE

Using the Powering Agriculture funding, the device design has been further optimized to use the solar thermal energy more efficiently in the aeration process The University of Toronto has built and installed two trial solar aeration devices at a fish farm in Bangladesh. These initial devices were installed at two trial ponds at a hatchery operated by BRAC to evaluate the technology. An intake survey has also been conducted with 120 fish farmers to gauge their interest in the device and select the participants for the randomized control trial which will evaluate the efficacy of the device.

VILLAGE INFRASTRUCTURE ANGELS (VIA)

2015

PROJECT
Solar Agro-Processing Power Stations

INNOVATION STAGE 4
Early Adoption/Distribution

CLEAN ENERGY SOURCE
Solar Photovoltaic

AGRICULTURAL FOCUS
Processing

PRODUCT SEGMENT
Staple Crops

LOCATION APPLIED
Indonesia, Papua New Guinea, Philippines, Vanuatu

WEBSITE
http://www.villageinfrastructure.org/

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 decrease the amount of manual processing required and may also reduce reliance on diesel-fueled mills. 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.

PROGRESS UPDATE

From a target of 200-500 solar mills, VIA and its main partner, Project Support Services, have delivered over 100 solar mills to market to date, and have more shipping to various countries. From a target of $3 million of investment to be mobilized over the award period, VIA has secured over $500,000 and has over $1 million more in the final stages of negotiation, which will enable fast progress in 2017. The solar mills were launched at Intersolar in Munich in June, which has raised interest from more potential partners beyond the original Asia-Pacific focus geography, and the first solar mills have now reached Africa.

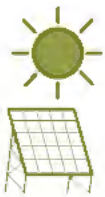
3.2. Powering Agriculture Impact

Powering Agriculture has continued to have a positive impact as the Innovators continue the field testing of their clean energy solutions and some of them scale up and start selling commercially.

The following are the results reported in FY 2016 by 23 Innovators implementing in 15 countries[1].

1 This data has been se f-reported by the Innovatbrs and reviewed by Powering Agriculture, w th the exception of African Bamboo and ECO Consu t who did not report any data.

During Fiscal Year 2016:



- **14** clean energy solutions have been developed (clean energy technology and/or business models)
- **65 kW** of clean energy generation capacity was installed
- **385** clean energy systems have been deployed (in Africa, Asia/Pacific, Latin America and Middle East)

- **190** tons of CO_2 equivalent has been reduced as a result of Powering Agriculture field activities
- **6,889** farmers and households have benefitted from Powering Agriculture funded clean energy solutions, **1,968 of which are women**

- **336** local professionals, **35 of which were women**, became accessible to the end-users of the clean energy technologies
- **594** people have been trained on operation and/or maintenance of clean energy systems, **94 of which were women**
- Nearly **22,000** people attended demonstrations on clean energy systems funded under Powering Agriculture

- **Approximately 7,500 women** have increased their knowledge of clean energy by attending demonstrations on clean energy systems funded under Powering Agriculture
- Approximately **USD $1.4 million** of additional net income had been raised by the farmers using the Powering Agriculture funded clean energy solutions
- **USD $4 million** in additional funding was mobilized from public and private investments as a result of Powering Agriculture

3.2.1. Impact on Beneficiaries

The following stories show how farmers' lives have improved due to the innovations being implemented in their countries.

BIOGAS-POWERED EVAPORATIVE COOLING FOR THE DAIRY INDUSTRY

UGANDA

SUCCESS STORY

INNOVATOR: UNIVERSITY OF GEORGIA RESEARCH FOUNDATION

Mrs. Jemba, a smallholder farmer, and her UGARF milk chiller.

Mrs. Lidia Jemba is a smallholder famer in the Namayumba region of Uganda that received one of the UGA milk chillers as part of the pilot program in February. She uses the chiller to chill both her milk and milk from nearby neighbors for a small fee. Mrs. Jemba's husband recently suffered a serious health issue and he has frequent doctors' appointments and associated medical bills. The additional income from the sale of the evening milk has helped the family afford to go to all of the appointments. Prior to the additional income from evening milk sales, he had to skip some appointments due to the family's limited finances.

MICRO-SOLAR UTILITIES FOR SMALL-SCALE IRRIGATION

SENEGAL

SUCCESS STORY

INNOVATOR: EARTH INSTITUTE AT COLUMBIA UNIVERSITY

Ousmane Diop surrounded by the crops irrigated by pump powered by the solar array seen in the background.

Ousmane Diop resides in the farming community of Gabar, Senegal where he is the president of the Gabar Irrigation Co-op. The area has been experiencing droughts and decline in aquifer levels, forcing the farmers to invest in drilling deeper boreholes to reach the groundwater. Ousmane cultivates 0.2 hectares of land on which he grows peppers, cabbage, carrots, onions and corn. Prior to using a solar powered pump installed by Earth Institute, Ousmane used a diesel powered pump which cost him 1,200 CFA/day ($1.97) in fuel. Before that, he spent 8 hours a day irrigating his crops with the help of his family by transporting water from a well by hand using rope and a bucket.

He now runs the solar pump for 3 hours a day with minimal supervision. The free time he has gained from using the solar pump has allowed him to go to the village for business-related activities and see his parents more often. His wife now cultivates her own small plot since she no longer needs to spend as much time assisting him in the field. By switching from a diesel fueled pump to a solar pump that he pays for on an hourly basis Ousmane has been saving about 4,500 CFA/month ($7.39) during the months when it does not rain. His vegetables have improved in quality due to the avoided pollution previously produced by the diesel generator and due to his crops being irrigated more uniformly. At present, all vegetables are priced the same on the market, regardless of their quality, but Ousmane hopes that in the future he will gain more income from selling higher quality produce.

SOLAR-POWERED PUMPS FOR IMPROVED IRRIGATION

HONDURAS

SUCCESS STORY

INNOVATOR: INTERNATIONAL DEVELOPMENT ENTERPRISES (IDE)

"iDE no solo está en la parcela, si no que en il uvazon de cada uno de nosotros"

"iDE is not only present on our land, but also in our hearts"

—**Dona Linda Pérez-Manvelez**

Dona Linda Pérez-Manvelez and her son Mario Pérez on their organic farm with their solar pump.

Dona Linda Pérez-Manvelez and her family live in the middle of a coffee-producing area of Marcala, Honduras. They run an off-grid, organic farm growing coffee, vegetables and raising animals and provide training to nearby farmers on how to grow coffee organically. Before using iDE's solar pump, the farm used a human-powered treadle pump to bring water up from a nearby river and relied on a body of water lying above their land that dried up 2 years ago. Due to the solar pump's portability, Dona's family uses the solar pump for two applications - to transport water from the river and to pump that water into two large water tanks.

The solar pump has enabled Dona to double the size of her cultivated land from 175m2 to 350m2 and buy 20% more domestic animals, which rely on the drinking water pumped from the river. It has also eliminated 3 to 4 hours of daily manual labor, primarily done by Dona's son Mario, who has since been trained on operation and maintenance of the solar pump by iDE's in-country staff and has become employed as a regional technician attending to the nearby end-users of the solar pumps. The solar pump has also brought in an additional 9,000HNL ($402) of annual income from the farm growing the high value tomato crop.

"If we have solar, the we don't have to use human force. I am very excited. We can have time to do other things... I think it will lead to more money and a better life"

—**Herminia Gutierrez,** coffee farmer benefiting from **iDE** solar pumps and slow-drip irrigation in Honduras

SOLAR-POWERED REFRIGERATION FOR DAIRY FARMS

KENYA

SUCCESS STORY

INNOVATOR: SUNDANZER

Suzanna Nyaywia has benefitted from SunDanzer's solar milk refrigerator.

Suzanna Nyaywia is one of few female dairy farm operators in Nyandarua County, Kenya. She runs a medium sized farm which produces 90 to 140 liters of milk a day, depending on the season of the year. The farm is located 2 kilometers from the national grid and does not have access to a diesel generator, so the milk that is produced in the afternoons is cooled with the water from a nearby river. This method was often not sufficient, resulting in 80 to 120 liters of milk being rejected by the dairy cooperative due to bacterial growth every week. The rejected milk was then given away to the farm workers for free.

The solar refrigerator piloted by SunDanzer has allowed farms to chill 30 to 40 liters of evening milk every night and sell it to the dairy cooperative the following morning. As a result, the number of milk rejections have gone down, which, in return, has motived the farm to invest in more cows. Since the solar refrigerator installation they have doubled their herd and with the additional income have been able to purchase supplementary cow feed, which has increased individual cow production by 3 liters of milk a day. Subsequently, Suzanna has benefited from a salary increase, which she used to pay for her children's school fees.

REDUCING MILK SPOILAGE THROUGH SOLAR-POWERED CHILLING

INDIA

SUCCESS STORY

INNOVATOR: PROMETHEAN POWER SYSTEMS

Dairy Collection Center Operator S. Ambika (left) weighs milk brought in by a dairy farmer (right).

S. Ambika has been a dairy collection center operator for 7 years. She is the main operator in her wife-and-husband team operating one of Hatson Dairy collection centers in Manjemadu, India. Prior to Promethean having installed a grid powered milk chiller, the operators had to transport the collected milk to the nearest chilling center which was 8 kilometers away two times daily. By the time they would reach the facility one 40 liter can would be rejected due to bacterial growth.

Since the installation of the new milk chiller, the collection center expanded their opening hours from one hour in the morning and in the evening to 2 hours in the morning and 4 hours in the evening. As a result, more farmers can reach the collection center in time to sell their milk. The number of visiting farmers had doubled and the daily quantity of chilled milk collected by the center grew from 610 to 1,530 liters. Two farmers encountered at the center said they have purchased 2 additional cows each because the chiller guarantees them access to the organized dairy value chain into which they can sell their milk. One of the farmers brings double the quantity of milk as before, earning additional $72 a month. Another farmer sells 50% more milk than before, which has increased his monthly income by $67.

SOLAR-POWERED PUMPS FOR IMPROVED IRRIGATION

NEPAL

SUCCESS STORY

INNOVATOR: INTERNATIONAL DEVELOPMENT ENTERPRISES (IDE)

Members of Janachetana Farmer Cooperative in Kailali District in Nepal react positively to the solar pump installed by IDE to irrigate their plots.

Janachetana Farmer Cooperative in Kailali District of Nepal consists of 25 members who are primarily women. The cooperative leases small sections of its 0.17 hectare plot to group members, who mainly grow cabbage, tomatoes, cauliflower and cucumbers. The cooperative allows women to take loans on various agricultural inputs and gives an additional source of income from the crops grown on these plots, on top of the profits gained from their larger, family-owned land.

The group received iDE's pilot solar pump to field test in the spring of 2016. Previously, the members used a hand pump and buckets to water the crops. Since the installation the cooperative members report a 10-15% yield increase and no water shortages, which they used to encounter with a hand pump. They like that they no longer have to spend time on manual labor and find the pump's design to be beautiful.

SOLAR-POWERED PUMPS FOR IMPROVED IRRIGATION

ZAMBIA

SUCCESS STORY

INNOVATOR: INTERNATIONAL DEVELOPMENT ENTERPRISES (iDE)

Miriam and Edward Lwabila have benefited greatly from iDE's solar pump. Their children are no longer hungry, have 3 meals a day as opposed to one, and perform better in school due to their improved concentration.

Miriam and Edward Lwabila live on a farm in Chibombo, Zambia with 4 of their children, where they grow onions, cabbage corn and peppers. In July 2015 they received a portable solar pump from iDE which has changed their lives dramatically. Prior to the installation of the solar pump, the family used a treadle pump to irrigate their land and irrigated with buckets using the water from their well before that. The laborious watering methods took 6 hours a day, with their children contributing additional 2 to 3 hours of their time each. The family was able to cultivate only 10 basins and all yielded produce was consumed on-farm.

The arrival of the solar pump has enabled the family to expand their cultivated land to 40 basins and sell 90% of their crops to a nearby market through traders that come to them. Not only has their yield increased from 1-2 bags to 3-10 bags a week, the improved quality of the produced has prompted a 50% increase in unit price asked on the market. With the increased income, the family has invested in their own business shop, school fees for their 4 children, and was able to purchase a car this year. The diet of the family has improved as well to include higher value vegetables, fish, more meat and soft drinks and the children eat 3 meals a day, as opposed to one. Miriam proudly shared that her children's school results have shown improvement because they are able to concentrate better due to no longer feeling hungry.

3.3 Innovator support

Powering Agriculture continued to provide various types of support to both Innovator cohorts in order to enhance the chances of the successful deployment of their clean energy solutions.

During the reporting period, Powering Agriculture expanded usage of the following tools to streamline communication and reporting:

- The **Powering Agriculture Requests and Reminders Bulletin** (PARRB) is disseminated via email monthly and updates Innovators on Powering Agriculture developments, informs them of upcoming deadlines, events, funding opportunities and requests any required information.
- **WebMo** is the Powering Agriculture online project monitoring platform where Innovators can upload required milestones, reports and data which can be then be accessed by all Powering Agriculture Partners and their contractors. The WebMo platform has credentialed access (user code/password) which ensures that the individual Innovators can only access their data.

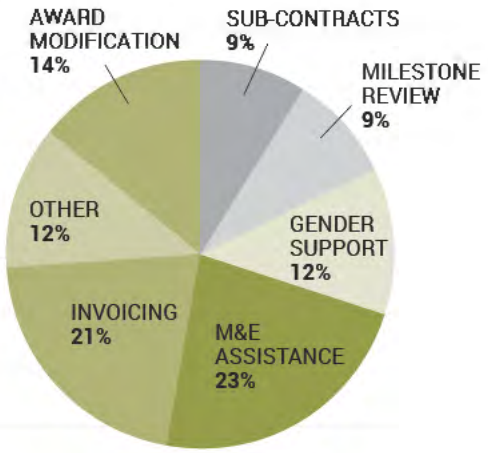
3.3.1 Implementation Support

Powering Agriculture continued to use the Powering Agriculture Support Task Order (PASTO), which is implemented by USAID contractor, Tetra Tech, to provide a variety of support, including:

- 21 instances of implementation assistance such as feedback on milestones, guidance on M&E
- 23 instance of assistance with compliance with USAID policies and procedures including award modification
- development of 9 templates/manuals/guides for Innovators' use
- site visits to 9 Innovators in 12 countries to verify progress and document impacts on beneficiaries
- Promotion of Innovator progress on the website, on social media (Facebook and Twitter), at conferences, and to the media

Figure 3.1 illustrates the breakdown by type of assistance provided by PASTO to the Innovators.

Figure 3.1 Innovator Assistance by Type



3.3.2 Business Acceleration Support

Powering Agriculture expanded acceleration support to its Innovators by retaining VentureWell, in association with Investors' Circle through the PASTO contract in September 2015, to provide Powering Agriculture Innovators with biz-tech development services, investment, and market partnership facilitation in a structured program called the Powering Agriculture Xcelerator - PAX. The program provides:

- Needs assessment, involving intake survey, scorecard, in-person strategy workshop and facilitator feedback

- Portfolio managers who work through customized work plans and monthly calls on business model validation and market-partnership facilitation and draw on the PAX advisory board
- Peer mentoring through cohort groupings
- Investment facilitation focused on investor-readiness assessment, investor preparedness coaching, and investor linkages

Powering Agriculture Xcelerator was formally launched during a four-day workshop in Arlington, VA, November 16-19, 2015 during which representatives of 21 Powering Agriculture Innovators participated in sessions on topics ranging from how to comply with their USAID award to strategy development and risk management. The workshop was facilitated by VentureWell and Investor's Circle, the contractors for the PAX Program.

The Xcelerator in-person workshop was primarily focused on several aspects of an Innovator's strategy to market while one day was focused on how to comply with the terms of their Powering Agriculture funding issued as an USAID grant or cooperative agreement. First, the content modules helped the Innovators focus on the most critical components of their strategy. Second, Innovators valued the dedicated team planning time to align their approach. Lastly, the workshop created valuable networking and community building opportunities that may also lead to furfure partnerships among the Innovators.

- **Day 1 – Monday, November 16, 2015**, was focused on introductions and understanding how to comply with the terms of the award issued to the Innovators by USAID. The Powering Agriculture Founding Partners each made remarks following by presentations on PASTO, communications, gender integration, compliance with USAID regulations, invoicing and accruals, environmental compliance, monitoring and evaluation, reporting, and the Powering Agriculture WebMo platform. The first day ended with a meet and greet event where the Innovators, the Powering Agriculture Partners and PASTO staff could mingle informally.
- **Day 2 – Tuesday, November 17, 2015**, was focused on understanding (for the 2013 Innovators) and / or confirming (for the 2015 Innovators) the product – market fit. For both groups, the morning content modules included product/service utility map and the value proposition canvas. In the afternoon the Product - Market Fit group worked on their strategy maps and a round of peer review of their maps. The Business Model Validation group was introduced to the business model canvas and had discussions about each of the components of the map. This group also built their strategies in to life-sized business model canvases that hung on the wall.
- **Day 3 – Wednesday, November 18, 2015**, the two Innovator groups spent much of the day working intensely on their strategies. Group 1 focused on identifying partnership needs along the value chain, further mapping their strategy to validate their market, understanding target audience's perspective and barriers to change, teams work on interview questions to ask potential partners. Group 2 further developed hypotheses around their key components and relationships, starting with their Value Proposition and customer segments. They

then moved in to mapping the customer or end user experience, the impact on their value proposition and customer segments and how to prioritize the multitude of competing needs. Finally, there were small group discussions on channels and revenue streams. Both groups ended the day working on their storytelling & pitching their innovation in preparation for the day 5 showcase.

- **Day 4 – Thursday, November 19, 2015,** opened with a rich discussion on financial sustainability and a focus on sources of revenue. This segued in to a discussion about risk, and risk mitigation strategies in small groups. The teams were able to share valuable lessons from previous ventures as well as their current work. There were several mini-labs in the afternoon, including a small- group presentation for the solar irrigation Innovators by GIZ, office hours with Investors' circle, pitch prep for the Innovator showcase, filming for the Innovator videos, and office hours with the PASTO team.

Through PAX, Innovators have received 95 instances of assistance on business issues and 49 referrals/linkages/partnerships/connections over the reporting period. See Figures 3.2 and 3.3 for the breakdowns of the type.

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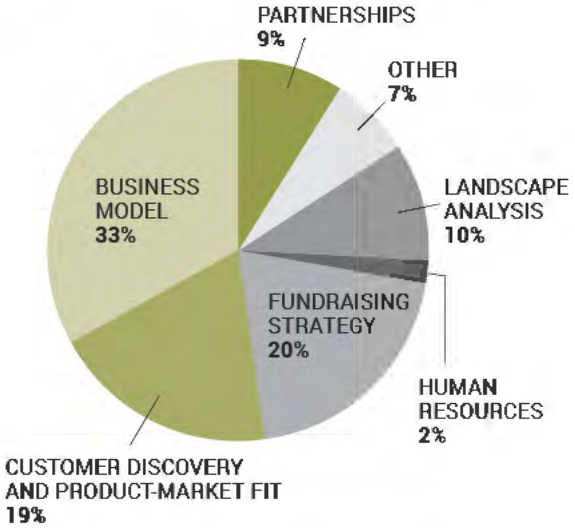
Figure 3.2: Types of Assistance Provided by PAX



Business Model – Advice on revenue, costs, channels, activities, resources, partners, customer segments, and value proposition, how they all work together, and how to communicate the business model (and elements of it) to third parties.

Customer Discovery and Product-Market Fit – Support on analyzing findings and feedback from engaging with potential customers and understanding how that impacts product-market fit, such as adjusting the product or the market accordingly.

Human Resources – Advice and resources on hiring, defining roles, organizational structure, and professional development.

Landscape Analysis – Discussions and resources on understanding and analyzing the value chain in which the Innovators are operating and what other stakeholders are doing.

Fundraising Strategy – Discussions and resources on funding types, needs, uses, potential sources, and implications.

Partnerships – Supporting and navigating partnership development, providing feedback on potential partners.

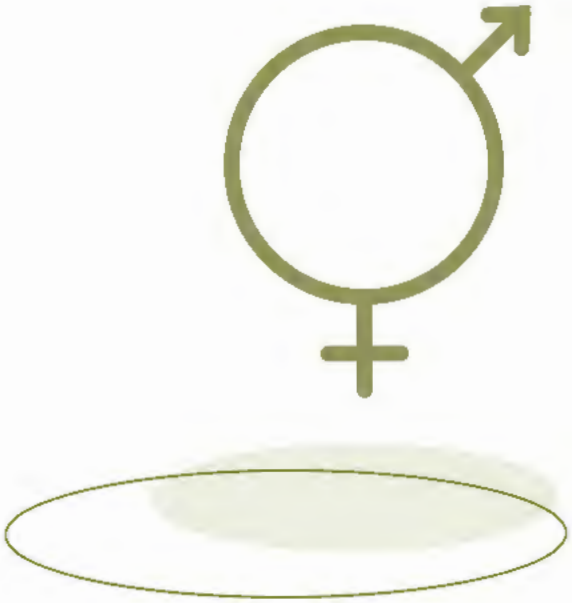
Figure 3.4 Referrals and Partnerships Facilitated by PAX

3.3.3 **Gender Integration Support**

Powering Agriculture Partner Sida, engaged International Law and Policy Institute (ILPI) to conduct a gender analysis of the 2015 Innovators. ILPI used the analysis to develop individualized recommendations for each Innovator on how to address gender equality and potential performance indicators to measure how technology is reducing inequality gaps between the genders.

In June 2016, Powering Agriculture expanded its support to provide tailored gender support by adding a gender integration specialist to provide targeted technical assistance and support to the Powering Agriculture Innovators at the project level. To date, individualized demand-driven technical assistance has been provided to five Innovators to provide resources, strengthen gender in data collection tools, and review marketing materials. Topics covered included integrating gender into surveys and M&E plans, marketing to female customers, working with women's agricultural cooperatives, and supporting female entrepreneurs.

4 GENDER



4.1 Gender Integration Overview

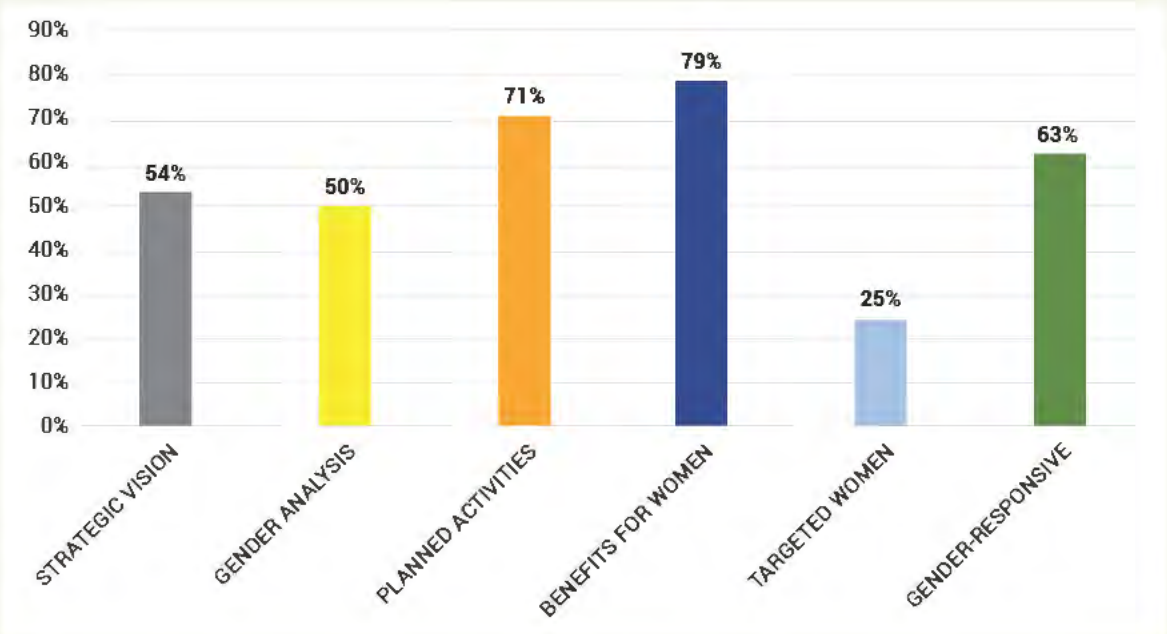
Powering Agriculture has intensified its efforts to ensure that gender issues are considered by the Innovators in the design, development, and deployment of their clean energy solutions. During the reporting period, Powering Agriculture conducted an in-depth assessment of Innovator project plans and reporting documents, complimented by a brief survey and phone calls with its Innovator cohorts about their plans for gender integration. Although many of the Innovators are still in preliminary phases of implementing activities, there are a number of findings and lessons learned about how project planning and design integrates gender and engages women. The following sections detail those results. An expanded, companion report on Powering Agriculture's gender work which contains further details on our findings will be released in early FY2017.

4.2 Gender Integration in Project Planning Phase

Out of 24 Innovators, 15 (54%) articulated a specific goal or purpose of the CES to promote gender equality. The degree of vision varied from women's economic empowerment as a central project objective to projects including a secondary objective or intended benefit to promote gender equality or empower women.

The majority of Innovators (79%) articulated some benefit for women within their planning documents, as shown in Figure 4.1., 71% included at least one specific actionable activity to integrate gender, 63% percent described a technology with benefits that could be (pending

Figure 4.1 Gender Integration in Innovator Work Plans



evaluation) anticipated to be gender-responsive, 50% included in upfront work plans some type of gender analysis to inform strategy and activities, and 25% explicitly targeted women. The common trait shared by Innovators that had a strategic vision on gender was that almost all (94%) targeted smallholder farmers/producers.

The majority of Innovators (19 out of 24) during planning were able to identify some benefits for women anticipated from the adoption of the CES technology. Out of those Innovators that cited any intended gender-related benefits, the most commonly cited benefits were: time savings (60%), with several other benefits identified at varying levels. These benefits are shown in Figure 4.2.

Sixty three percent of Innovators were found to have technologies that have potential to be categorized as gender-responsive technologies.

"Gender" — responsive technologies are:

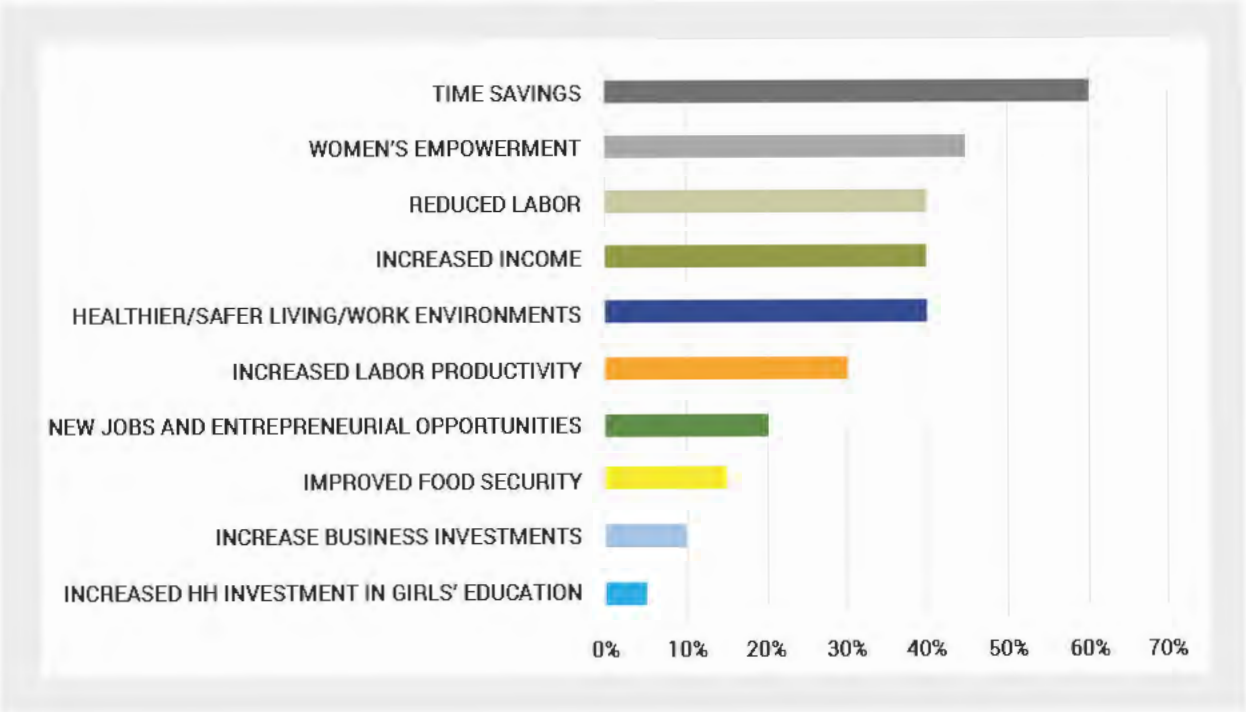
- Based on needs and interests of both female and male farmers.
- Those that reduce time/ labor for female farmers.
- Accessible and affordable to both menand women."

Global Alliance for Climate Smart Agriculture

This designation is based on criteria such as: the CES is based on needs and interests of both female and male farmers; the technology is accessible and affordable to both men and women, and based on research and Innovator identification of potential benefits, particularly in time savings and reduced labor.

Similar trends are found in work planning documents across Innovators for those

Figure 4.2 Anticipated Benefits of Focus Technologies



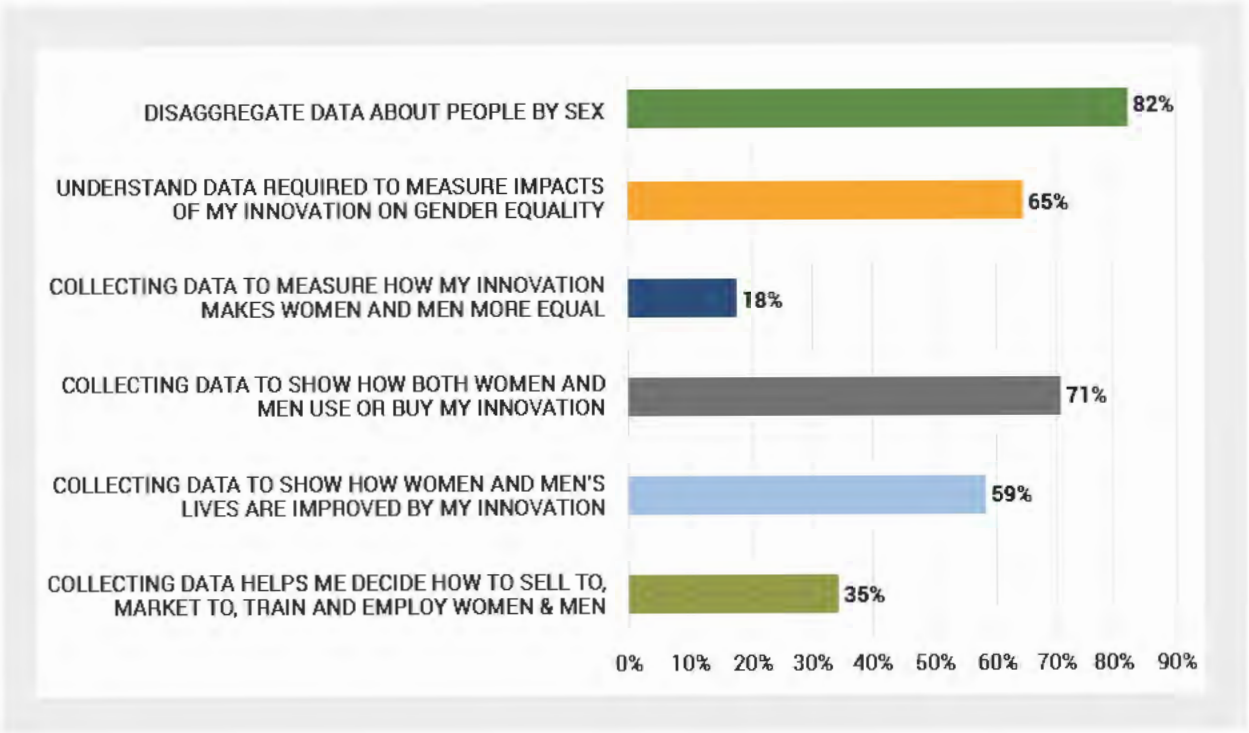
that outline actionable activities for gender integration. The majority (71%) of Innovators identified at least one actionable gender integration activity in their work plans, across technology types and agricultural sector. Innovators who explicitly target smallholder farmers are more likely to include specific gender integration activities in their work plans than Innovators targeting medium- to large-scale farmers or operations. Some examples of actionable activities for gender integration from Powering Agriculture work plans include: enable and encourage sales contracts to be signed by both male and female in the household, to ensure that the woman of the household also holds ownership; and give preference to partnerships and contracts with businesses that promote female involvement in management and operations.

4.3 Gender-Responsive Monitoring and Evaluation Plans and Data Collection

Across all 24 Innovators, 20 (82%) explicitly indicated within their M&E plan that they intended to disaggregate by sex at least one indicator and/or chose to add a custom indicator that included a gender-specific measure or was sex-disaggregated. Many of Innovators seem to be either unaware or unclear that four out of the 10 required Powering Agriculture annual performance indicators mandates that Innovators disaggregate the data by sex. This could be an indication that more training on M&E should be provided to the Innovators to address any knowledge gaps on the data reporting requirements in connection with gender.

Eight Innovator M&E plans (33%) introduced custom indicators in baseline data collection

Figure 4.3 Data Collection for PAEGC

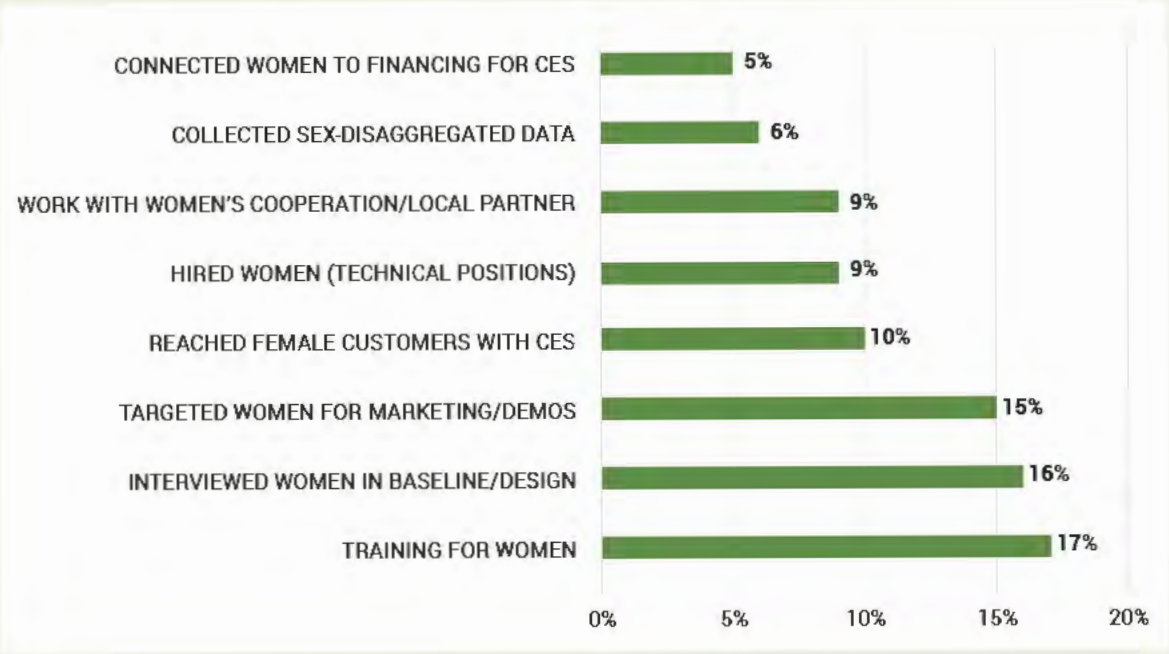


or routine monitoring that collect information on women's use, access or benefit from CES technologies. In addition, three Innovators included planning for qualitative collection of data related to gender equality impacts; three included specific planning for gender integration in the baseline assessment; and three included plans for quantifying results or benefits to women or gender equality at the outcome or impact level. Figure 4.3 describes the types of data being collected by Innovators. One example of plans to do this is conducting a needs assessment that "will take into account social-economic and educational needs and demands from male and female smallholder farmers within the areas of implementation as well as look examine the differentiated aspects of access to water and impacts of climate change".

4.4 Activities Completed to Integrate Gender

As noted earlier, at the time of this report the majority of projects were currently in the start-up (44%) or early adoption/distribution stage (33%) for their CES technology. Training is the most frequent activity that Innovators engage in for a total of 17 activities across Innovators, followed by interviewing women during baseline assessments or design as part of gender analyses, baseline assessments, market assessments, or research (16 activities). Several other types of activities have been undertaken by Innovators, as shown in Figure 4.4.

Figure 4.4 Gender Integration in Activities Completed

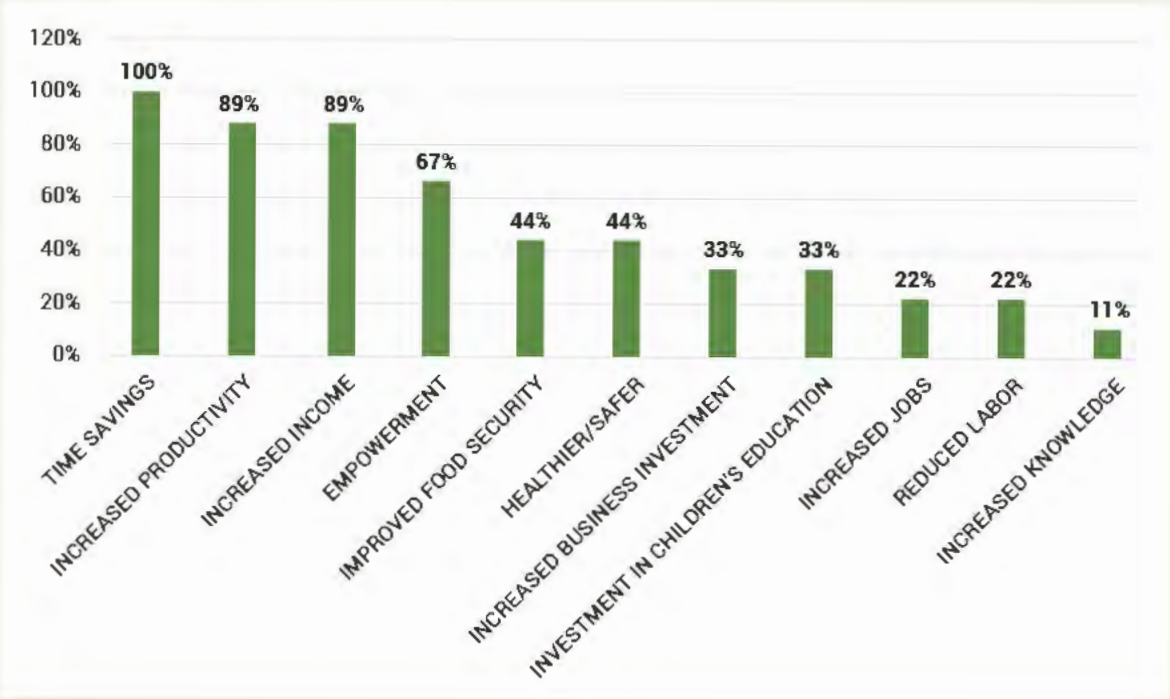


4.5 Observed Changes, Benefits, or Impacts Related to Gender (to date)

Across all 24 Innovators, from award to date, 15 are either not yet at a stage where they are able to demonstrate any tangible impacts, benefits, or change related to gender equality and women's empowerment. However, the rest (9) of the Innovators identified some tangible benefits or changes as a result of use or adoption of their CES qualitatively with anecdotal information based on client reports of benefits, vignettes, or case studies. Out of the nine Innovators that reported some gender-related change or impact as the result of CES use, 100% reported time savings of women, followed by increased productivity and incomes (89%), women's empowerment through financial independence (67%). Additional benefits or changes were identified at lower levels, as shown in Figure 4.5.

At the Bani Kananeh household site where **ECO Consult** worked with a women's CBO to train women in hydroponics, 56 women are using the system to cultivate thyme on individual plots in eight villages. ECO Consult reports that increased profits from introduction of the new technology equal "approximately 100JD (US$141) per family per month" and could "potentially generate over 390JD (US$548) per year for each family". At the plot of one thyme grower, Umm Ali, Eco Consult found that production had increased five-fold and that Umm Ali was additionally able to grow and harvest vegetables, for which she employed local Jordanian and Syrian women.

Figure 4.5 Innovator Self-Reported Changes



4.6 Challenges Encountered in Implementing Planned Gender-Related Activities

The Innovators identified a number of challenges that inhibit their ability to better integrate gender considerations into their projects and to ensure that women benefit from their technologies. The most commonly cited challenges were women's limited access to land and financial capital (5 projects), male dominance in decision-making roles in agricultural industries and in the household (4 projects), and a lack of women in agricultural technical fields (3 projects).

Two Innovators which cited lack of women in technical fields (mainly engineering) as a challenge to hiring more female staff, made concerted efforts to identify female technical staff for their projects. The successful approach was instituted by Husk Power Systems in Tanzania which liaised with Tanzania's Board of Engineers and the Institute of Engineers of Tanzania to find suitable candidates.

Three main gender integration challenges identified by the innovators:

- Women's access to land and capital
- Male dominance in decision-making
- Lack of women in agricultural technical fields

Several Innovators also cited women's competing responsibilities in the home as inhibiting their participation in community-project meetings and technical trainings. These projects found this challenge easily mitigated by: 1) consulting with women about the best timing of meetings/trainings; 2) holding women-only meetings, as needed; and 3) requiring a quorum of women before a meeting or training could begin.

4.7 **Lessons Learned From the Innovators**

1. **Integrating gender into CES technology projects makes sound investment and business sense that positively impacts Innovators' bottom line.**

Husk Power Systems (HPS) views gender equality not only as a valuable pursuit but also witnesses how it makes business sense because of their customer base. HPS finds that Tanzanian villages "*are dominated by women*," while men are fully engaged in other activities, and as a result women demonstrate higher levels of interest than their male counterparts in what HPS is doing. Additionally, HPS is aware that major investors will only invest in HPS if they are demonstrating real inclusion of women—not just mentioning it in plans but actually seeing tangible activities on the ground. HPS estimates that approximately 40-50% of their investors want to see, or require, that their investment is making a positive impact on gender equality and inclusion of women within activities.

As well, **KickStart** highly values gender equality as a critical desired outcome to its work. This has also served KickStart well in securing social impact investment funding to continue its work. KickStart depends on philanthropic support for about 70% of its costs across all its programs in all countries. KickStart notes that funders are prioritizing their investments in meaningful work that promotes gender equality. As such, gender integration is a necessary fundraising tool. KickStart sees the inherent value in gender equality, but also knows they need to excel in this realm to attract and keep major investors.

> ***"Our top four funders providing support with multi-year, multi-million commitments expect that we're talking about gender equality. Our investors who account for the lion's share for philanthropic investment, including Exxon, Ikea, and others have high expectations for work on gender equality. We have to speak to gender before they even consider investment…it's a deal breaker."***
>
> —Kickstart International, October 2016

Social impact investors and philanthropic organizations are a key resource for investments in technology, and are increasingly interested in ensuring that their investments are supporting gender equality and empowerment of women.

2. **Integrating gender analysis into marketing assessments and strategies helps reach the targeted market and an expanded customer base.**

SimGas views gender integration not as something additional, but as basic to sound business planning and marketing. SimGas' partner, SNV, integrated a number of questions regarding gender into their market survey for Rwanda, after noting that the absence of such questions in their Kenya and Tanzania market assessments limited their ability to develop

business plans that took into account the significant role of women in the dairy v alue chain.

Improved Market Assessment through Strengthened Gender Analysis in Rwanda

After completing market assessments in Tanzania and Kenya, SimGas realized they were missing information. As a result, they ensured the next market assessment in Rwanda integrated more gender-specific questions related to roles and responsibilities across the dairy value chain from feeding and milking to sales, collection, and decision-making over milk.

Assessment responses revealed that women dominate most areas of the value chains; thus, the integration of gender analysis into their market assessment assisted SimGas to better tailor their marketing strategy to women. SimGas expects that they can now better determine how to incorporate gender equality into the entire customer journey, starting with awareness creation and marketing targeted at women, enabling women to access their proposed milk payback schemes, customer trainings targeted at women, forming groups of female ambassadors to promote the product in their communities, etc. SimGas created a female persona and customer journey map that is incorporated into the business plan.

Futurepump also recognizes that women are a key market to tap. There are many places in rural Kenya where women and men farm jointly, and many instances of men migrating to larger cities or out of Kenya for work, while women remain on farms. As such, Futurepump recognizes the importance of female sales team(s) and is currently exploring the possibility of a "Sisterhood of Sales" approach, tapping into existing social capital and networks among female community members. Futurepump is actively seeking to recruit women in sales and marketing positions for this purpose once staff positions open up.

3. **Upfront gender analysis and detailed work planning to integrate gender at the earliest stage possible can identify ways to facilitate success and avoid costly or time-consuming mistakes, while also laying the groundwork for documenting gender-specific impacts.**

After many years of experience globally, **iDE** has found that women are as likely as men to benefit from CES technologies, and vice versa, if women are involved in the consultation and design stage. As a result, iDE actively encourages and facilitates women's participation by identifying and addressing their specific needs and aspirations, and by monitoring and evaluating the impacts on both women and men. iDE has further concluded that the most successful way to reach women is through existing organized women's groups which serve as a platform for women to engage with local product and service providers.

University of Toronto read studies about gender equality in Bangladesh, including women's and men's roles in fish farming and included some of this analysis of constraints and opportunities

in their original work plan. However, they did not have discussions with their local implementing partner, BRAC, early on to discuss how this would affect their work. University of Toronto noted that this impacted their first field visit and selection processes for farmers that they met with, who happened to be all male. Looking back, University of Toronto has learned that it would have been advantageous to have had discussions with BRAC earlier on in the process, and to request sex balance in initial meetings with farmers, so that there could have been better distribution of men and women in the first field trip in order to identify more about male/female dynamics, challenges, expectations, and realistic activities to mitigate challenges earlier on to inform the rest of the process.

VIA has found that women in off-grid villages spend up to one hour per day processing crops by hand to feed their families. VIA estimates that saving one hour per day for 250 million women globally would result in an additional 100 billion hours/year of productivity – the equivalent of an 8-hour day for the entire workforce of the UK or France. Saved time can translate into more time spent in fields and gardens increasing food security and engaging in non-agricultural income-generating activities. VIA estimates that women can earn 5-10 times more per hour if they switch from processing crops by hand for 0.5-1 hour per day to some other income-generating activity.

4. **Early engagement with community organizations, local partners, and women's groups can improve entry of the technology into the community with potential benefits in the success of technology adoption and marketing.**

UVG, in identifying communities for its micro-grid project, took its time to make sure that partnerships with organizations with a strong gender component were present in the communities with which they worked. The project was slow starting up because they re-evaluated the community selection criteria and processes to make sure the selections were sound. Selection criteria included the existence of community networks with partners that already have a strong gender component and female empowerment at the household level. They consider these communities to be more "mature" and viable for success. A key lesson learned for UVG is that, looking back, they realized that their first step into community engagement should have been, and should be moving forward, identifying and contacting all of the NGOs and INGOs that already operate within the communities to request existing community maps and gender analyses in order to help inform their community engagement and outreach for each individual community. UVG found that work was already done by many organizations and that in some places there was existing extensive information on community mapping and contact details for female community leaders and active women.

During **ECO Consult's** first year of implementation in Jordan, its Hydroponic Green Farming Initiative (HGFI) was successful in laying the foundation for achieving the program's objectives. ECO Consult noted that CBOs such as Bani Kananeh, a women's cooperative, had great success managing and marketing their hydroponic produce, indicating a possibility for replication and expansion in other communities throughout Jordan. ECO Consult drew on lessons learned

in year one to note that it is most important to continue documented success by "Focusing on vulnerable demographic groups, namely women and youth, when designing key outreach and dissemination activities". Indeed, ECO Consult's documented benefits in terms of increased job opportunities, incomes, and observed women's empowerment is noteworthy as a case study for lessons learned for others.

5. **Although finding women with appropriate skills in science, technology, engineering, and math (STEM) is challenging, targeted approaches to recruiting and training women pays off.**

In their work on various projects in STEM, **UVG** has realized that there are not as many girls/ women going into the field of science and engineering, so when they set targets to reach 50% females, it can be quite challenging. However, UVG recognizes that this does not mean that it cannot be done, but it rather means they need to be aware of the challenges and identify how to reach more women/ girls and reach their 50% target. UVG also sees an inherent benefit in hiring more women—they view them as desirable technical operators on their micro-grid projects because men tend to migrate out of the communities, especially once the men have learned skills or received technical training. UVG invests time and resources into training operators, and they find women are less likely to leave the communities because women have young children and strong connections to their communities. Thus, UVG employs specific strategies to meet their 50% target, including strong upfront community engagement and linkages to women's organizations, as well as targeting of trainings (location, timing) in order to accommodate women's schedules and household responsibilities.

Husk Power Solutions worked doggedly in Tanzania to find qualified female engineers. In Tanzania, similar to other places, there are fewer female engineers, so it would be easy to simply continue to employ and train male engineers. However, they have worked with the Board of Engineers, and the Institute of Engineers of Tanzania to provide them with the Terms of Reference (TOR) and job descriptions/ solicitations to circulate among engineers. In addition, they tell these organizations that they have a 50/50 male/female requirement, and specifically request unemployed female engineers to send CVs. This has been successful—they are still receiving applications for an upcoming solar power training, and, so far they are receiving applications from enough qualified female engineers that they expect it will be easy to achieve their requirement of 50/50 male/ female trainees out of the total of 25 targeted engineers.

6. **Adapting flexible work conditions harmonized with women's roles at home can successfully open-up more income-generating and job opportunities for women.**

In India, **Husk Power Systems** innovated a way to convert rice husk char to incense sticks. In order to manufacture these incense sticks, HPS recruited and trained approximately 150 women from communities from which HPS supplies power. To employ women, HPS mandated a production-based payment system and not a regular 8 am to 5 pm schedule. This flexibility in work was necessary for women in these villages as they are typically responsible for household chores and sending children to school. Given the success of this model, HPS plans to replicate a similar process in Africa by converting rice husk char to briquettes and employ women for manufacturing. HPS plans to provide similar

time flexibility to these women in Africa so that they can send their children to school as well as earn a living by manufacturing these briquettes.

Overall, the Innovators recognized the importance of considering both men and women in the deployment of their clean energy solutions. Whereas the 2013 Innovator cohort have integrated gender on a more ad hoc basis, the 2015 Innovator cohort have been informed of the importance of gender from the start of the award and have been better able to plan for its systematic integration.

5 FINANCIAL INFORMATION

The following financial information on Powering Agriculture's budget, contributions, and disbursements is confidential and limited for distribution only to the Powering Agriculture Partners.

6 LOOKING AHEAD

Powering Agriculture plans to implement the following major activities over the next financial year of October 2016 to September 2017

- Establishment of a public-private partnership investment fund to support the commercialization and scale-up of clean energy technologies and innovative business models for farmers and agribusinesses.
- **Milk cooling in Kenya:** Powering Agriculture Partner GIZ / BMZ has joined forces with the University of Hohenheim and the Green Innovation Center in order to explore solutions for improving the dairy value chain in Kenya by introducing solar-powered milk cooling systems. In the beginning of 2017 a research paper on specific value chain settings and economic analyses of milk cooling solutions will be available.
- The identified knowledge gaps within the energy/ag nexus will be further investigated in the follow-up FAO/Powering Agriculture study **"An enabling environment to foster investments in sustainable energy interventions in the agrifood sector"** (forthcoming). The final report is planned for October 2017. It will assess the specific financial and economic implications of the identified energy technologies in the agri-food sector, the technology suitability for a specific development context, the actual return on investment expected, as well as the enabling conditions and policies needed to trigger the much sought pro-poor investments in the sector with regard to clean energy solutions. The study will also feed into a stakeholder dialogue in countries that provide case study materials.

- The development of technology specific gender guides and technology specific environmental compliance guides for the use by the Innovators
- Holding a Powering Agriculture Xcelerator (PAX) acceleration training program for Powering Agriculture Innovators at the Powering Agriculture Hub in Kenya

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