Quarter 3 Report

April 1, 2014 – June 30, 2014

Powering Agriculture: An Energy Grand Challenge for Development

Clean Irrigation Solution (CIS) for Increased Agricultural Productivity

I. Introduction

To increase agricultural productivity, incomes, and livelihoods of smallholder farmers, iDE and its partners have develop a clean energy irrigation pump and delivery system called Clean Irrigation Solution (CIS).

The Clean Irrigation Solution (CIS) centers on an efficient, versatile, and cost-effective piston pump that is powered by a choice of clean energy. It is revolutionary, as it has the potential to cost less than half the price of similar photovoltaic (PV) pumping systems currently on the market and allows for one pumping mechanism to be paired with several clean energy sources, including solar steam, PV, and AC power from both large and micro scale AC grids. To maximize the agricultural output and value of each drop of water pumped, the CIS technology is coupled with iDE's affordable, ultra-low-pressure drip irrigation system.

Through manufacturing cost reduction, performance improvements, a last-mile distribution network, marketing to other organizations, and partnerships with financial institutions, this project will bring the CIS to scale. This will improve the agricultural productivity of millions of smallholder farmers in developing countries while reducing greenhouse gas emissions.

The project is led by iDE's Technology and Innovation Group in the United States. Field installations and pilot sales will take place in three of iDE's country programs –Nepal, Zambia, and Honduras.

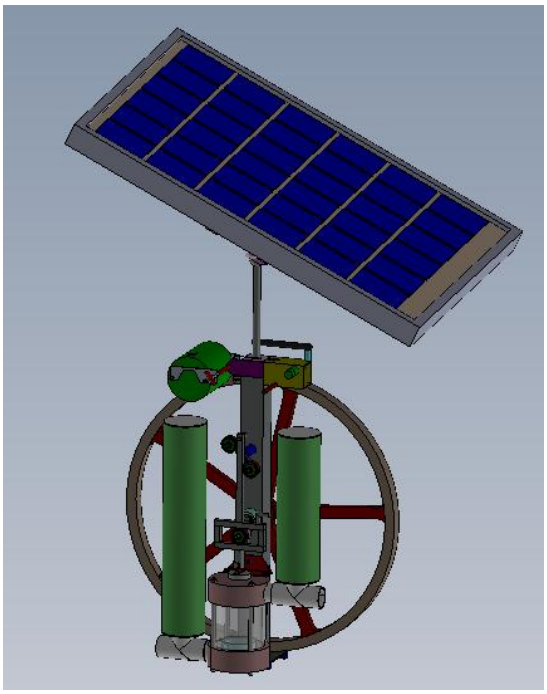
iDE is partnering with the PRACTICA Foundation and Futurepump for this project. The PRACTICA Foundation is responsible for improving the design to increase performance, farmer usability, and manufacturability. Futurepump is working with iDE to establish a manufacturing capacity for the pump, increase the global reach of sales of CIS, and become a provider of the CIS product.

II. Project Activities

The Clean Irrigation Solution for Increased Agricultural Productivity project is currently progressing on schedule. During the third quarter of this project, activities focused on component sourcing and production. Additionally, representatives from the PRACTICA Foundation, Futurepump, and iDE held a meeting at PRACTICA's headquarters in the Netherlands to discuss next steps in moving the project forward.

1.0 Product Design

In Quarter 2, we reported that the PRACTICA Foundation had been pursuing a more compact design of the pump. A SolidWorks drawing and photo of the PV-powered CIS are below:



The PRACTICA Foundation also designed a mount for the AC and DC motor that has three gears that can be manually changed based on the time of day. The three-gear motor and motor mount can be seen in the photo to the right.

2.0 Component Sourcing

AC and DC Motors

AC and DC motors have been sourced from Android System in Pune, India. This manufacturer is also willing to custom-wind motors on future orders to maximize performance.

PV Panels

iDE has several different sources selected for PV panels. In the first round of pump installations, different panels will be paired with the pump to evaluate the best option. iDE has sourced PV panels from Surana in India at $0.75 per watt. Working with personnel from the National Renewable Energy Laboratory (NREL), the panels were tested with a current/volt analyzer which showed the panel performed in range of the manufacturer's specification. Additional temperature measurements were performed to insure quality solder joints. These test showed no indications of poor soldering.

iDE has also met with HighFlex, a company that designs lightweight, flexible, rugged solar panels. While these panels are more expensive than the India panels, they include an internal chip capable of performing maximum power point tracking. Futhermore, the panels are one-tenth the weight of the current panels being sourced in India. The chip would increase panel performance, reducing the necessary watts needed. Reduced weight of the panel could lead significant cost saving in shipping. iDE will continue to monitor this product and conduct a performance and economic review.

iDE has also identified local sources in Nepal for PV panels. These panels are more costly per watt, but can be locally source, eliminating shipping and duty costs. These panels will be tested alongside the Indian panels to compare quality, performance, and overall economics.

Drip Kits

Drip kits for the CIS are being sourced from Harvel Auzd, an Indian company that has provided much of iDE's past drip equipment. Samples of these kits have been sent to manufacturing headquarters in Pune to be adapted to the solar pump.

3.0 Quality Control Protocol and Pump Production

To insure production quality and manufacturing consistency, a set of quality control protocols was created. These protocols outline tolerances and recommended verification methods. They will be implemented at the manufacturing level, and verification will take place at iDE's managed distribution facility. An example of the procedures is shown below:

Sr.No.	Part No.	Part Name	Dimension		Tolerance		GO Size	NO-GO Size	Gauge type	Remarks
1	1.2	Cylinder Head	8 drills at 136PCD to be checked if those match a gauge when checked from either end							
2			Chamfer dia 28 to be centered wrt 20mm bore							
3			Visual check – cross drills opening in the piston cavity – they do not cross larger-dia of the chamfer-ridge (105mm)							
4			A gauge to check valve-housing hole locations, in reference to bores: 46mm wrt 20mm bore, 28mm bore. This gauge to match Stem Guide(1.3.5) – have dia12 pin for Sr.No.13 Valve Cover (1.3.10) - have dia 29 pin for Sr.No.16 & Valve Housing (1.3.17) – use dia 20 section for the checking alignment with the bore for Sr.No.17		46 +0.1 / -0.1					
5			Check depth of the piston chamber Depth		24.5 +0.3 / -0.0					
6			Piston Chamber Bottom Diameter		88mm +0.3 / -0.0					
7			Check – Diaphragm seating with diaphragm as gauge							
8			Thickness of the Cyl.Head		40mm +/- 0.5					
9	1.3.3	Spring								Need input from GJ
10	1.3.4	Pushrod	Dia	12	+0.0	-0.2			Ring	
11			Dia	6	+0.0	-0.3				
12			Step	0.7mm	+0.1	-0.1				
13	1.3.5	Stem Guide – integrate this with Sr.No.4	Dia	12	+0.1	-0.0			Plug	
14	1.3.5	Stem Guide	Dia	31	+0.5	-0.5				
15	1.3.6	Rubber Disc	Dia	id 6 OD 30 x 1 thk	+0.2 +0.5	-0.2 -0.5				
16	1.3.10	Valve Cover– integrate this with Sr.No.4	Dia C-to-C	29 46	+0.5	-0.5				
17	1.3.15	Valve Housing– integrate this with Sr.No.4	Dia C-to-C	20 46	+0.3	-0.3				

4.0 Solar Pumping Summit in the Netherlands

In May, representatives from iDE, Futurepump, and the PRACTICA Foundation met at PRACTICA's headquarters in the Netherlands for a 2-day summit about the solar pumping project. Additionally, representatives from the Solar Pumping Association of Switzerland – another of iDE's partners on a different project – attended to discuss opportunities and challenges in the product development of solar pumping.

The team discussed the process for scaling production in India and proper quality control procedures to accompany this process.

A key outcome of the meeting was that the PV-powered CIS is becoming more cost effective than the solar steam option. The team will monitor this closely in the first round of field trials.

5.0 Project Promotion

iDE worked with a USAID consultant – Anne Usher - writing an article for Headlines about the CIS project and its applicability in Honduras. This article was published at the end of July. The article can be found in Appendix A of this report.

iDE will also have a presence at World Water Week in Stockholm, Sweden. This year's theme of Water and Energy is extremely applicable to iDE's work under the Powering Agriculture project. While iDE will be promoting the project at its booth all week, iDE will also be presenting a poster specifically on the CIS. Materials for this are currently being developed and will be shared with USAID in the next project report.

III. Progress Toward Milestones

iDE has met its two proposed milestones for the second quarter.

Quarter	Milestones	Progress Toward Milestone
Quarter 1	• Baseline performance report created • General promotional material developed	Completed Completed
Quarter 2	• Design for casting process on the CIS pump completed • Molds for injection molding manufactured • Drip kit compatible for the CIS system designed • Water management tool to use with the CIS designed • Installation and training material for the CIS developed	Completed Completed Completed Completed 80% Completed
Quarter 3	• Mount for AC and DC motor configuration designed • DC motor and PV panel for CIS selected • AC motor to use with the CIS selected • Drip kit for CIS sourced • Initial quality control protocol for manufacturing developed • DC motor and PV panels for the CIS sourced • AC motor for the CIS sourced • 10 CIS shipped to Nepal • 30 CIS units ordered and assembled • 30 CIS units quality insured	Completed Completed Completed Completed Completed Completed Completed Incomplete 50% Complete 50% Complete

1.0 Status of Incomplete Milestones and Request for Modification

Installation and Training Manuals

iDE has been working with an illustrator to create a high-quality installation manual for technical field staff. This is an iterative process, as iDE wants to insure that the manual is easy for field staff to follow. A sample of the installation manual to date can be found in Appendix B. When in-country training takes place, iDE's irrigation engineer will gather feedback from field staff on the usefulness of the manual and confusing points.

iDE anticipates having the first complete draft of the manual done by the 4th quarter of this project, but recognizes the manual will change over time.

10 CIS Shipped to Nepal

Due to the delay in the manufacturing of the pumps, iDE has not shipped pumps to Nepal. However, a buffer was built into the original project plan for such delays, so iDE still anticipates meeting future milestones on time. iDE has identified an import agent in Nepal and is currently negotiating processes for duties and customs.

iDE anticipates completing shipping by the end of the 4th quarter of this project.

30 Units Ordered, Assembled, and Quality Controlled

iDE has placed an order for 30 pumps to be assembled. To date, many components have been manufactured and individually quality controlled. However, full CIS units are not complete. iDE anticipated delays in the manufacturing process and built a buffer into the timeline for this milestone.

iDE anticipates completing assembly and quality control of 30 units by the end of the 4th quarter of this project, which will enable iDE to meet future milestones dependent on the production of these units on time.

IV. Monitoring and Evaluation

Progress toward the indicators outlined in the Monitoring and Evaluation plan will be reported on every six months, as written in the contract. This will be included in the next quarterly report.

Appendix A – USAID Frontlines Article

FRONTLINES
ONLINE EDITION

Grand Challenges for Development

July/August 2014

Challenge Grant Winner Betting Solar-Powered Irrigation Gets Green Light from Farmers

By Morning Washburn and Anne Usher

A prototype of International Development Enterprises' Clean Irrigation System in Ethiopia*Photo courtesy of iDE*

A Colorado nonprofit is taking an innovation it first introduced to Hondurans to the next level thanks to a grant from Powering Agriculture: An Energy Grand Challenge for Development—and the enthusiasm of local farmers.

Like most indigenous farmers in the western highlands of Honduras, Herminia Gutierrez's family has cultivated coffee on a 2.5-acre plot for generations. Each day during the growing season, she, her husband and their eight children would make several trips to a river about 40 minutes away and carry back five buckets of water to replenish their plants.

As with most subsistence growers in the Marcala region, they staked their lives on this one crop. As a cooperative member, she was insulated from a common practice here: having to turn over nearly all the proceeds from her harvests to loan sharks, or "coyotes."

Several years ago, a field technician from a Colorado-based nonprofit, International Development Enterprises (iDE), introduced Gutierrez to a more water-efficient drip irrigation system. Since then, 300 farmers in Marcala have adopted it.

iDE encouraged Gutierrez and the other farmers to use the extra water to cultivate vegetables as a way to boost their nutrition and put more cash in their pockets. In addition to coffee, she and other women in the village of La Estanzuela are now growing organic lettuce, beets, cabbage, Mayan herbs and other vegetables.

"Children here are also growing better. There are fewer cases of diarrhea," she said, adding her cooperative is now selling extra produce to markets 28 miles away.

The irrigation system iDE introduced in Honduras uses simple foot-powered treadle pumps to draw water for irrigation from wells. It is a critical improvement over hauling water in buckets, but in today's age of innovation, this upgrade is about to come up against an even newer innovation.

Globally, more than 800 million farmers manually lift and haul water to irrigate their farmland.

In December, iDE was awarded a $1.5 million grant from the **Powering Agriculture: An Energy Grand Challenge for Development**, led by USAID with Germany, Sweden and U.S. power company Duke Energy. iDE beat out nearly 500 competitors with its plan to design and distribute a solar-powered piston pump to replace its foot-powered treadle pump. iDE will link the new solar pump to existing irrigation systems in Honduras, Nepal and Zambia.

Globally, more than 800 million small-scale farmers lift and haul water by hand to irrigate crops on small parcels of 5 acres or less. In the past decade, millions of these farmers have switched to using diesel pumps for irrigation.

iDE is betting its new solar-powered Clean Irrigation Solution can compete or even beat diesel-powered irrigation for small farmers in terms of both cost and productivity benefits—and without introducing a whole new set of health and sustainability risks that come with having to purchase and burn diesel.

According to Bob Nanes, iDE's vice president of technology and innovation, diesel pumps cost about $250 apiece, plus about $150 a year for maintenance and diesel fuel. iDE's system will cost more than a diesel pump upfront—about $400, depending on the model. But with the savings on fuel and maintenance, iDE expects most farmers will break even the first year. It predicts its solar system will beat out all fossil fuel pump systems after two years.

"The solar pump is the best of all possible worlds," said Nanes. "The farmer doesn't have to carry water or buy fuel. There is also much less maintenance than diesel and you don't have those recurring costs." He added it simply turns itself on when the sun rises, so it's easy to use.

The system can be run manually on cloudy days, if necessary. While it would likely be connected to run off a single solar power source—including photovoltaic panels if they are affordable—it will also be able to run off an alternating current in places where there is an electricity grid.

Kit Batten, USAID's global climate change coordinator and a key sponsor of Powering Agriculture, said iDE's clean irrigation system is a **Grand Challenge for Development** winner precisely because it will increase household prosperity and food security and also help deliver clean, reliable energy to developing countries at a time when climate change poses growing risks to agriculture.

Using solar-powered irrigation pumps instead of diesel on small farms would cut carbon dioxide emissions by a small amount, said Nanes, especially if adopted on a wide scale. But the real benefit lies in helping move small farmers to affordable, renewable technologies that are easy to manufacture, use and sell on local markets. This has been a part of iDE's work for more than three decades throughout the developing world.

iDE's ultimate aim is to create self-sustaining markets to sell its clean energy devices, Nanes explained.

"If we were to give products away, we would only give out as many devices as we can finance," Nanes said. "But because we're selling it, the market is only limited by how many people can buy it."

This private sector approach is one that USAID says it hopes to foster through Powering Agriculture.

Powering Beyond Latin America

In addition to Honduras, iDE plans to market its new solar system in Zambia and Nepal. In Zambia, most farmers rely on rainwater and generate energy from manure and other agricultural residue, charcoal and firewood. In Nepal, two-thirds of the population lives in remote hilly or mountainous regions that cannot be easily served by conventional piped water systems. Water is collected in buckets from distant sources, although many farmers have recently bought diesel pumps.

Jeremy Foster, an energy adviser with USAID's **Bureau for Economic Growth, Education and Environment**, noted that population growth means that, globally, agriculture must produce more food from the same amounts of water, land and energy currently used. Technologies like iDE's, he said, "can enable farmers to use energy and water more efficiently in order to grow more food on the same plot of land."

Water-efficient technologies like drip irrigation will become even more critical as rising global temperatures threaten to disrupt local rainfall patterns and water supplies, said Batten, USAID's lead spokesperson on climate change. Combining drip irrigation with a solar-powered pump would introduce a sustainable and affordable irrigation system that does not add to air pollution—locally or globally.

iDE will develop its new clean irrigation system this year with a Dutch partner, the PRACTICA Foundation, and Futurepump Ltd., a British manufacturer. It will also interview farmers in Honduras, Zambia and Nepal to learn what barriers, if any, exist to switching to this solar-powered technology.

After pilot testing, iDE plans to market the solar-powered system through networks of "farm business advisers" in Zambia and rural cooperatives in Nepal and Honduras that it has helped to set up. The goal is to sell 1,000 solar pump systems in three years.

In Honduras, iDE's Country Director Carlos Urmeneta said the Clean Irrigation Solution will be brought initially to farmers in the south. As in most of the country, a lack of water and know-how has kept most farmers there from growing more than one crop.

"Most farmers don't have enough money to feed themselves, let alone their plants," Urmeneta said. "We are bringing technology and developing supply chains for the bottom of the economic pyramid to rural communities where people are abandoned and forgotten."

Many of the farmers iDE is partnering with in Honduras are women. It's not simply an act of empowerment. Women, he said, are willing to try vegetable production, while often their husbands are "fixed on just coffee."

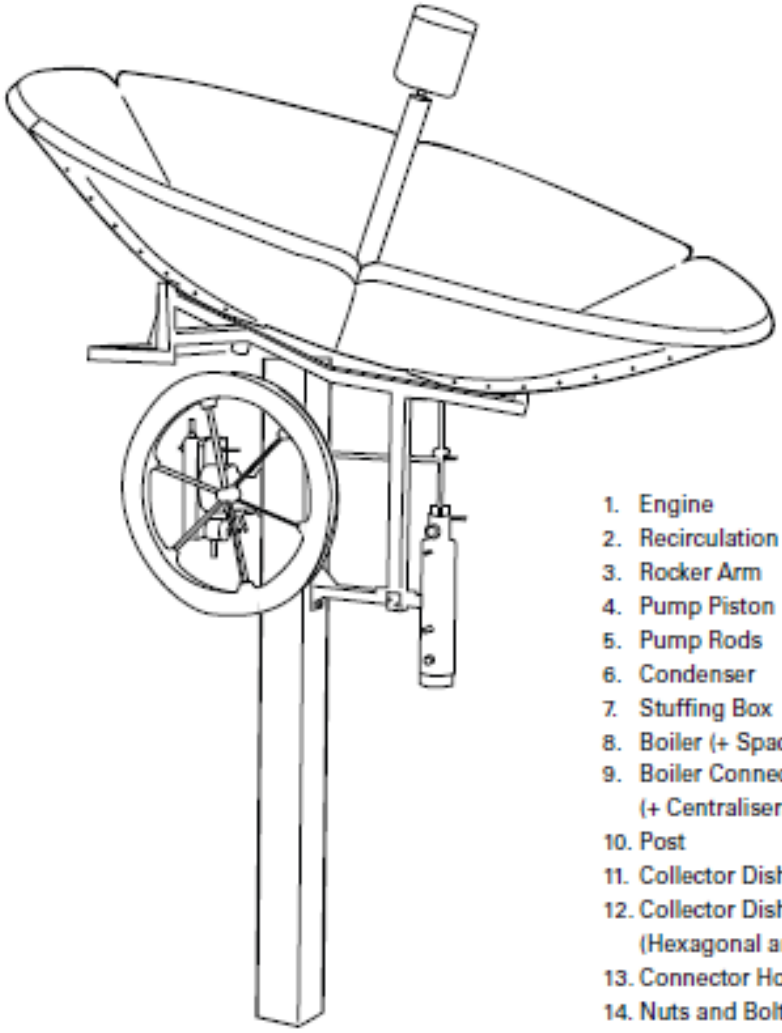
Gutierrez, as head of a womens' entrepreneur group, will be among the first to test the solar pump in Honduras. She credits the new vegetables she's growing for insulating her family when a widespread fungal disease recently decimated half her coffee bushes.

"If we have solar, then we don't have to use human force," she said. "I'm very excited. We can have time do to other things."

She already envisions expanding her plot by a more than a half acre. "I think it will lead to more money and a better life," she said.

Appendix B – CIS Installation Manual

Sunflower Installation Manual v.1.0



1. Engine
2. Recirculation (RC) Pump
3. Rocker Arm
4. Pump Piston
5. Pump Rods
6. Condenser
7. Stuffing Box
8. Boiler (+ Spacer)
9. Boiler Connecting Housing (+ Centralisers)
10. Post
11. Collector Dish Segments
12. Collector Dish Frame (Hexagonal and U-shpaed sections)
13. Connector Hoses (+ tidy clips)
14. Nuts and Bolts Pack

Tools Required

2 ASSEMBLING THE COLLECTOR DISH

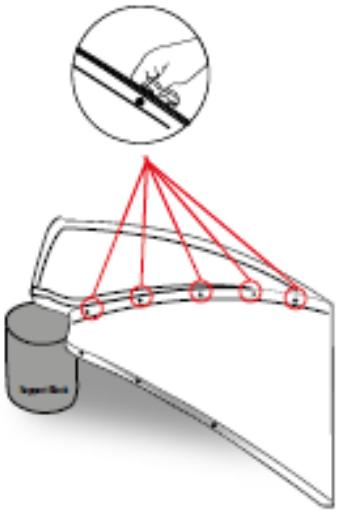
Tools

A B C

Parts Needed

A B C

A PREPARE COLLECTOR DISH



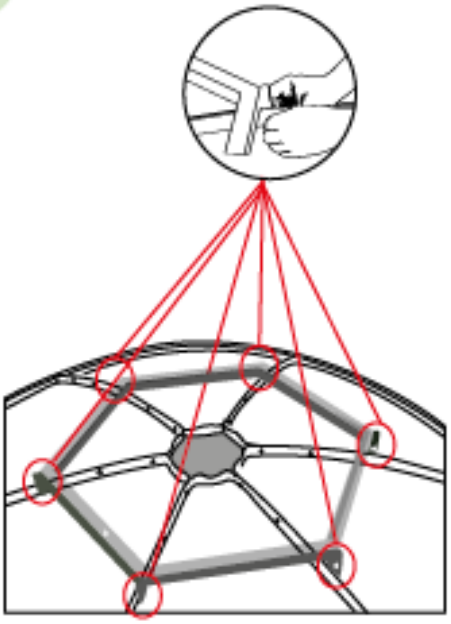
Note:

Clear 2m² of flat ground

Place dish support block in center

- Place the inner edge of 2 segments onto the block and gently bolt together
- Repeat until all segments are connected
- Tighten bolts
- Remove support block

B ATTACH THE FRAME



- Place hexagonal section of dish frame (hex-frame) on dish with "boiler post support" passing through centre of dish. Bolt in place tightly
- Attach each end of the u-shaped section (u-frame) to extensions of the hex-frame. Pass bolts from the u-frame side

- Fix u-frame in position (to prevent movement whilst carrying)