Quarter 2 Report

January 1, 2014 – March 31, 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 second quarter of this project, activities focused primarily on component production, designing the PV-powered CIS, drip kit testing, creation of the water management tool, and some preliminary field work in Nepal.

Futurepump has been conducting field tests in Kenya. Based on these reports, PRACTICA has been pursuing a more compact design for all three CIS configurations. This has resulted in further cost reduction of the pump. Additionally, the compact design leads to a lighter and more mobile pump.

1.0 Component Production

iDE and Futurepump have been developing a network of vendors in India, primarily concentrated around Pune, with capabilities for low-cost manufacturing. The engine frame design was modified so that it could be cast. 12 frames have been cast. All 30 engine frames are expected to be cast by the end of April.

Injection molds for the stem guide and inlet and outlet valves have been designed and sample parts have been produced using these molds. These pieces can be seen in the picture to the left.

2.0 PV-Powered System

The PRACTICA Foundation has designed and tested the PV-powered CIS pump. The pump was lab tested with a water depth of 4 meters and had a panel to water pumping efficiency of nearly 40%. This efficiency is nearly double the pumping efficiency of other small solar pumps that iDE has tested at similar depths.

The PV pump is driven by a DC motor, which was sourced from India for approximately $35. It has also been designed with a three-step friction wheel transmission and a lever for hand pumping.

The team has also procured quotes for photovoltaic panels in India. Many of the quotes priced solar panels at about 75 cent a watt. With PV panels at 75 cents a watt and a DC motor costing $35, the team now believes the most economical solar powered option will be the PV powered CIS and not the solar steam power CIS. The next steps will be field trials, a durability assessment, and performance test of the lower cost PV CIS.

3.0 Nepal Preliminary Field Work

iDE's Irrigation Engineer visited Nepal in February to lay the groundwork for the project's implementation in Nepal. During this trip, he began to develop the field staff team in Nepal that will be responsible for the introduction of the pump in-country.

The team also conducted a site selection analysis for the CIS introduction in Nepal. The Terai region appears to have the most potential for success. The majority of the Teri region sits on top of shallow aquifers. Coupling the CIS technology with low cost manual well drilling will allow for an affordable and scalable solution to hundreds of thousands of farmers living in the Tari Adoption of the CIS in the mountain regions of Nepal will be more difficult, as the region has deep water tables and stony soil. This makes well-drilling expensive and difficult, limiting water access in this region.

A key lesson from the preliminary work in Nepal reiterated the importance of product cost. In order for the CIS to be viable in Nepal, it needs to be cost competitive with small engine pump rental. Small engine pumps can be rented for $3.00 an hour. These engine pumps are capable of pumping the same volume of water in hour as the CIS is designed to pump in day. An updated cost analysis can be found in Appendix A. To design for affordability, financing and leasing models will be a critical component. For rapid uptake, iDE believe the pump will need to cost less on daily rate then it would for farmer to rent engine pump set.

4.0 Water Management Tool

iDE has developed a water management tool that helps farmers and field staff determine the appropriate amount of water that needs to be applied based on crop, crop stage, and climate. iDE is building a data bank so that the tool can be customized for different regions and crops. A sample of the tool can be found in Appendix B.

5.0 Drip Kit

iDE has run tests on three different commercial drip tapes through low-pressure scenarios. All three tapes had good performance. Their inclusion in the CIS drip kit will be contingent upon cost and performance under local water conditions.

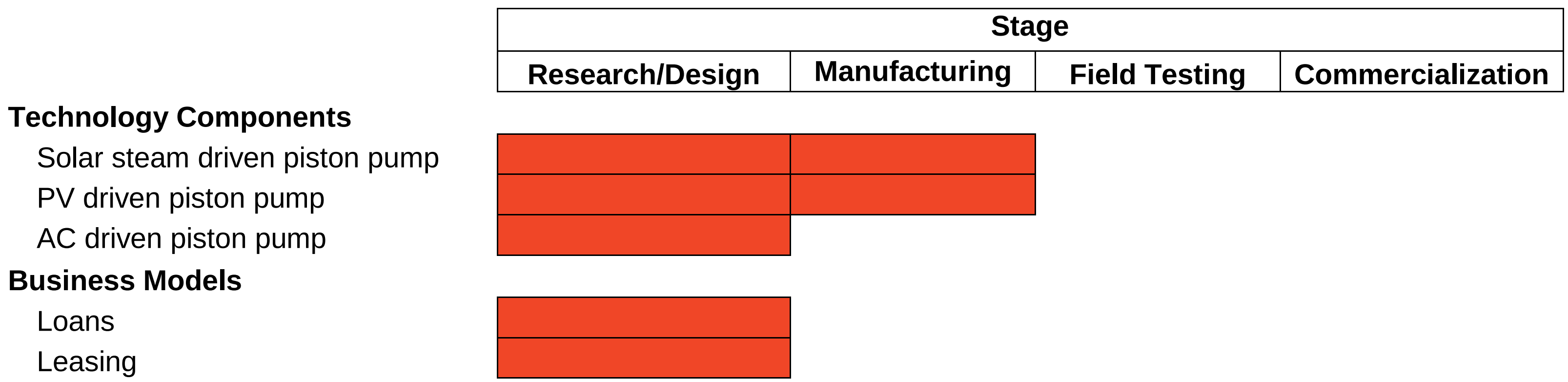
III. Progress Toward Milestones

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 50% Completed Completed Completed 80% Completed

IV. Monitoring and Evaluation

Progress toward the indicators outlined in the Monitoring and Evaluation plan are reported below. Many of the indicators are designed to measure in-field progress, and therefore no progress towards these indicators has been made during the first stage of the project. The components of the technology and business models are in the following stages:



(e) PERFORMANCE INDICATOR	(f) UNITS	(g) DATA SOURCE	(h) BASELINE DATA		(i) CUMULATIVE TARGETS								(j) COMMENTS /ASSUMPTIONS
					FY 2014		FY 2015		FY2016		END OF PROJECT		
			Year	Value	Target	Actual	Target	Actual	Target	Actual	Target	Actual	
IR 1: Increase in farmers and agribusinesses' access to and/or use of clean energy solutions													
IR 1 Required Indicators													
1.1 Type and number of clean energy solutions developed	Number (of CES type developed, state of development)	Project records, testing reports	2013	3 technologies; 2 business models	3 technologies; 2 business models	3 technologies; 2 business models	3 technologies; 2 business models		3 technologies; 2 business models		3 technologies; 2 business models		3 technologies and 2 business models can be paired interchangeably to create a CES
1.2 Type and number of farms/agribusinesses using PAEGC Awardees' clean energy solutions	Number (of farm/agribusiness)	Customer surveys	2013	0	0	0	30		129		129		

(e) PERFORMANCE INDICATOR	(f) UNITS	(g) DATA SOURCE	(h) BASELINE DATA		(i) CUMULATIVE TARGETS								(j) COMMENTS /ASSUMPTIONS
					FY 2014		FY 2015		FY2016		END OF PROJECT		
			Year	Value	Target	Actual	Target	Actual	Target	Actual	Target	Actual	
1.3 Type and number of wholesalers/ retailers/ maintenance professional accessible to beneficiaries for selling/servicing clean energy solutions	Number (of wholesalers/retailers/ maintenance professionals)	Project records	2013	0	1 wholesaler; 3 retailers; 3 maintenance professionals	0	1 wholesaler; 3 retailers; 9 maintenance professionals		1 wholesaler; 6 retailers; 18 maintenance professionals		1 wholesaler; 6 retailers; 18 maintenance professionals		
IR 1 Custom Indicators													
1.4 Total value of sales of CES	$	Sales data from manufacturer	2013	0	0	0	$200,000		$350,000		$350,000		In Year 2, cost per system estimated at $400 (selling 500 units); cost reduction throughout the project should result in a $300 price point in Year 3 (selling 500 units)
1.5 Area under CES irrigation	m^2	Customer surveys, sales data, system testing reports	2013	0	0	0	45,000		193,500		193,500		Assumes each CES in use is irrigating 1,500 sqm
IR 2: Increase in agricultural production and/or value among farmers and agribusinesses													
IR 2 Required Indicators													

(e) PERFORMANCE INDICATOR	(f) UNITS	(g) DATA SOURCE	(h) BASELINE DATA		(i) CUMULATIVE TARGETS								(j) COMMENTS /ASSUMPTIONS
					FY 2014		FY 2015		FY2016		END OF PROJECT		
			Year	Value	Target	Actual	Target	Actual	Target	Actual	Target	Actual	
2.1 Change in agriculture production attributed to use of PAEGC Awardees' clean energy solution	Metric tons/hectare	Customer surveys	2012	26	0	0	0		117		117		Baseline data is based off of tomato cultivation in Zambia in 2012. We anticipate the first 30 pump installations to be with farmers who are already using a mechanized pump to cultivate high-value vegetables. Therefore, instead of an increase in production, we will see a decrease in the cost of production and an increase in efficiency. In Year 3, we expect bucket farmers, currently irrigating 100-200sqm of land switching to a CES, which is capable of irrigating 1,500 sqm. These farmers will experience an increase in yield. Based on this, we have made an estimate of agricultural production. This is only an estimate, and we anticipate our targets changing as we continue with the project.

(e) PERFORMANCE INDICATOR	(f) UNITS	(g) DATA SOURCE	(h) BASELINE DATA		(i) CUMULATIVE TARGETS								(j) COMMENTS /ASSUMPTIONS
					FY 2014		FY 2015		FY2016		END OF PROJECT		
			Year	Value	Target	Actual	Target	Actual	Target	Actual	Target	Actual	
2.2 Change in income attributed to use of PAEGC Awardees' clean energy solution	$/client		2013	0	0	0	$450		$380		$380		Assuming that farmers using the CES in Year 2 are shifting from fossil-fuel pump use. Change in income for Year 2 is attributed to savings in recurring energy costs from fossil-fuel pumps (estimated $22 for fuel per 1,000 sqm of land irrigated). Additionally, we assume farmers earn an additional $0.25 of income per square meter irrigated. Farmers in Year 3 will not be experiencing fuel savings, as they will be converting from bucket to pumping.
IR 2 Custom Indicators													
2.3 Cost per unit of area irrigated	$\$/m^2$	Project records, system testing reports	2013	$0.60	$0.35	N/A	$0.26		$0.20		$0.20		Baseline – $600 system can irrigate 1,000 sqm; we hope to increase the irrigable area to 1,500 and reduce the price point.
2.4 Clients "satisfied" with product	%	Customer surveys	2013	0	70%	0	80%		90%		90%		
IR 3: Increase in support for low-carbon economic growth within the agriculture sector													

(e) PERFORMANCE INDICATOR	(f) UNITS	(g) DATA SOURCE	(h) BASELINE DATA		(i) CUMULATIVE TARGETS								(j) COMMENTS /ASSUMPTIONS
					FY 2014		FY 2015		FY2016		END OF PROJECT		
			Year	Value	Target	Actual	Target	Actual	Target	Actual	Target	Actual	
IR 3 Required Indicators													
3.1 US Dollar amount of supplemental funds leveraged to support investments in the clean energy/agriculture space.	US Dollars ($)	Project records, agreements	2013	$250,000	$375,000	$100,000	$500,000		$700,000		$700,000		
3.2 Greenhouse Gas (GHG) emissions, estimated in metric tons of CO2e, reduced, sequestered, and/or avoided as a result of PAEGC assistance	Metric tons CO_2 equivalent (annual)	Project records; system testing reports	2103	0	0	0	11		48		48		Assuming use of a CES instead of a 5 horsepower diesel engine reduces annual CO2 emissions by 250 kg per 1,000 sqm irrigated
IR 3 Custom Indicators													
3.3 Pump and power driver efficiency improvement	%	System testing reports	2013		Piston pump: 10%; reflective dish: 10%; boiler: 5%	N/A	Piston pump: 10%; reflective dish: 10%; boiler: 5%		Piston pump: 10%; reflective dish: 10%; boiler: 5%		Piston pump: 10%; reflective dish: 10%; boiler: 5%		

(e) PERFORMANCE INDICATOR	(f) UNITS	(g) DATA SOURCE	(h) BASELINE DATA		(i) CUMULATIVE TARGETS								(j) COMMENTS /ASSUMPTIONS
					FY 2014		FY 2015		FY2016		END OF PROJECT		
			Year	Value	Target	Actual	Target	Actual	Target	Actual	Target	Actual	
3.4 Unit sales outside of direct project areas	# Units	Sales data from the manufacturer	2013	0	0	0	400		800		800		

Appendix A: CIS Cost Analysis

Comparing Fossil Fuel Pump Ownership to CIS Options

					Over 1 Year	Over 2 Years	Over 4 years
Pump Set Costs	**Estimated Pump Production Cost**	**Estimated Infield System Cost[1*]**	**Reoccuriong Fuel Costs Per Year[2]**	**Yearly Gross Income Potential[3]**	**Percent Income expensesed towards pumping**	**Percent Income expensesed towards pumping**	**Percent Income expensesed towards pumping**
Existing Alternatives							
Fossil Fuel-Powered Pump Set[1]	$150.00	$250.00	$150.00	$750.00	53%	37%	28%
iDE's Clean Irrigatio Solution(s)							
Solar Steam Powered Piston Pump	$205.00	$705.00	$0.00	$1,050.00	67%	34%	17%
PV Powered Piston Pump (80 Watts)	$300.00	$800.00	$0.00	$1,050.00	76%	38%	19%
AC Powered Piston Pump	$165.00	$665.00	$0.00	$1,050.00	63%	32%	16%

[1] Includes wholesale cost of the pump, wholesale cost of iDE low pressure drip kits, $200 distribution mark-up, $50 installation fee.

[1] Engine Pump system cost include wholesale price of the pump, $50 markup cost, and a $50 installation fee*

[2] Fuel is based on fuel used by typical 5hp pump to pump water 5 meter at fuel cost of $1.00 a liter with an irrigation efficiency of 40%

[3] Yearly gross Income potential is based on farmers who makes 25 cents per square meter on 1500 sq meter plot twice a year, and 35 centers per square meter when using drip irrigation.

Comparing Fossil Fuel Pump Rental to CIS Options

					Over 1 Year	Over 2 Years	Over 4 years
Pump Set Costs	**Estimated Pump Production Cost**	**Estimated Infield System Cost[1*]**	**Reoccuriong Rental and Fuel Costs Per Year[2]**	**Yearly Gross Income Potential[3]**	**Percent Income expensesed towards pumping**	**Percent Income expensesed towards pumping**	**Percent Income expensesed towards pumping**
Existing Alternatives							
Fossil Fuel-Powered Pump Set[1]	$0.00	$0.00	$300.00	$750.00	40%	40%	40%
iDE's Clean Irrigatio Solution(s)							
Solar Steam Powered Piston Pump	$205.00	$705.00	$0.00	$1,050.00	67%	34%	17%
PV Powered Piston Pump (80 Watts)	$300.00	$800.00	$0.00	$1,050.00	76%	38%	19%
AC Powered Piston Pump	$165.00	$665.00	$0.00	$1,050.00	63%	32%	16%

[1] Includes wholesale cost of the pump, wholesale cost of iDE low pressure drip kits, $200 distribution mark-up, $50 installation fee.

[1] Engine Pump system cost include wholesale price of the pump, $50 markup cost, and a $50 installation fee*

[2] Rental costs are based market price of $3 hour found in Nepal for a small engine. A small engine pump will pump in one hour about the same amount of water the CIS will pump in one day.

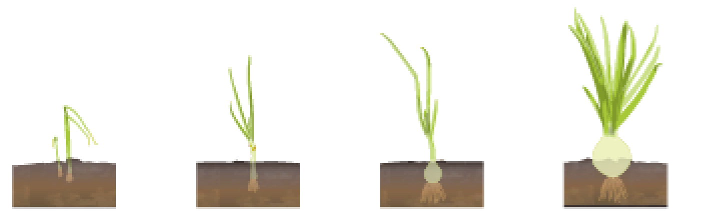
[3] Yearly gross Income potential is based on farmers who makes 25 cents per square meter on 1500 sq meter plot twice a year, and 35 centers per square meter when using drip irrigation.

Appendix B: Water Management Tool

IRRIGATION PLANNING TOOL

ONIONS
Bhairawa, Nepal

STEP 1: Determine Growth Stage



Inital (30 days) Mid-Season (85 days) Late Season (30 days)

STEP 2: Determine Relative Temperature

cool — If the temperature feels cooler than normal for this time of year use the **"cool"** column.

typical — If it feels like a normal day for this time of year, use the **"typical"** column.

hot — If it feel especially hot or sunny for this time of year, use the **"hot"** column.

STEP 3: Determine Water Requirement from Chart

	WATER REQUIREMENT (MM/DAY)								
	Initial			Mid-season			Late		
Month	cool	typical	hot	cool	typical	hot	cool	typical	hot
Jan	3 1/2	4	4 1/2	6 1/2	7 1/2	8 1/2	5	5 1/2	6 1/2
Feb	3 1/2	4	4 1/2	6 1/2	7 1/2	8 1/2	4 1/2	5 1/2	6 1/2
Mar	3	3 1/2	4	5 1/2	6 1/2	7 1/2	4	5	5 1/2
Apr	2 1/2	3	3 1/2	4 1/2	5 1/2	6	3 1/2	4	4 1/2
May	2	2 1/2	3	4	4 1/2	5	3	3 1/2	4
Jun	2	2	2 1/2	3 1/2	4	4 1/2	2 1/2	3	3 1/2
Jul	2	2	2 1/2	3 1/2	4	4 1/2	2 1/2	3	3 1/2
Aug	2 1/2	2 1/2	3	4	5	5 1/2	3	3 1/2	4
Sep	2 1/2	3	3 1/2	5	5 1/2	6 1/2	3 1/2	4 1/2	5
Oct	3	3 1/2	4	5 1/2	6 1/2	7 1/2	4	5	5 1/2
Nov	3	4	4 1/2	6	7	8	4 1/2	5	6
Dec	3 1/2	4	5	6 1/2	8	9	5	6	6 1/2

STEP 4: Use water requirement from chart on 1 to determine the number of bags to use.

Water Requirement for 200 Liter Bag

Water Req (MM/DAY)	FIELD SIZE (m^2) 100	150	200	250	300	350	400	450	500	550	600
1/2	1/4	1/2	1/2	3/4	3/4	1	1	1 1/4	1 1/4	1 1/2	1 1/2
1	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3
1 1/2	3/4	1 1/4	1 1/2	2	2 1/4	2 3/4	3	3 1/2	3 3/4	4 1/4	4 1/2
2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
2 1/2	1 1/4	2	2 1/2	3 1/4	3 3/4	4 1/2	5	5 3/4	6 1/4	7	7 1/2
3	1 1/2	2 1/4	3	3 3/4	4 1/2	5 1/4	6	6 3/4	7 1/2	8 1/4	9
3 1/2	1 3/4	2 3/4	3 1/2	4 1/2	5 1/4	6 1/4	7	8	8 3/4	9 3/4	
4	2	3	4	5	6	7	8	9	10		
4 1/2	2 1/4	3 1/2	4 1/2	5 3/4	6 3/4	8	9				
5	2 1/2	3 3/4	5	6 1/4	7 1/2	8 3/4	10				
5 1/2	2 3/4	4 1/4	5 1/2	7	8 1/4	9 3/4					
6	3	4 1/2	6	7 1/2	9						
6 1/2	3 1/4	5	6 1/2	8 1/4	9 3/4						
7	3 1/2	5 1/4	7	8 3/4							
7 1/2	3 3/4	5 3/4	7 1/2	9 1/2							
8	4	6	8	10							
8 1/2	4 1/4	6 1/2	8 1/2								
9	4 1/2	6 3/4	9								
9 1/2	4 3/4	7 1/4	9 1/2								
10	5	7 1/2	10								
10 1/2	5 1/4	8									
11	5 1/2	8 1/4									

Water Requirement for 1000 Liter Bag

Water Req (MM/DAY)	500	550	600	650	700	750	800	850	900	950	1000
1/2	1/4	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
1	1/2	3/4	3/4	3/4	3/4	3/4	1	1	1	1	1
1 1/2	3/4	1	1	1	1 1/4	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 1/2
2	1	1 1/4	1 1/4	1 1/2	1 1/2	1 1/2	1 3/4	1 3/4	2	2	2
2 1/2	1 1/4	1 1/2	1 1/2	1 3/4	1 3/4	2	2	2 1/4	2 1/4	2 1/2	2 1/2
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3 1/2	1 3/4	2	2 1/4	2 1/2	2 1/2	2 3/4	3	3	3 1/4	3 1/2	3 1/2
4	2	2 1/4	2 1/2	2 3/4	3	3	3 1/4	3 1/2	3 3/4	4	4
4 1/2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 1/2
5	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5
5 1/2	2 3/4	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5	5 1/4	5 1/2
6	3	3 1/2	3 3/4	4	4 1/4	4 1/2	5	5 1/4	5 1/2	5 3/4	6
6 1/2	3 1/4	3 3/4	4	4 1/4	4 3/4	5	5 1/4	5 3/4	6	6 1/4	6 1/2
7	3 1/2	4	4 1/4	4 3/4	5	5 1/4	5 3/4	6	6 1/2	6 3/4	7
7 1/2	3 3/4	4 1/4	4 1/2	5	5 1/4	5 3/4	6	6 1/2	6 3/4	7 1/4	7 1/2
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9 1/2	4 3/4	5 1/4	5 3/4	6 1/4	6 3/4	7 1/4	7 3/4	8 1/4	8 3/4	9 1/4	9 1/2
10	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10
10 1/2	5 1/4	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	
11	5 1/2	6 1/4	6 3/4	7 1/4	7 3/4	8 1/4	9	9 1/2	10		