PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2017

Solar Powered Irrigation Pump

Agricultural & Biological ENGINEERING

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Problem Statement

Water resource distribution is a vital challenge to improve crop production. Small scale farmers are in need of an inexpensive and reliable system to irrigate crops and increase production. A solar powered pump could be the solution for many farmers across the globe.

Objectives

1. Pump prototype
2. Build a system prototype
3. Field test prototype
4. Evaluate pumping rate

Timeline

Fall	Spring
• Research	• Construct Second Prototype
• Calculations	• Field Tests
• Order Materials	• Data Collection
• Construct Prototype	• Analysis

Constraints

- Budget
- Low Maintenance
- Simplicity
- Water Quality
- Sun Intensity
- Elevation Change
- Energy Storage
- Pressure Capability
- Acreage

Size Requirements

- 250 Gal/Ac/Day
- 2.1 GPM
- 60 PSI
- 1/2” Input Hose
- 3/8” Output Hose
- 100 W Panel
- 34 AH Battery

Cost Analysis

Component	Farmer's Cost	Project's Cost
Pump	$79.99	$79.99
Solar Panel	$99.95	$99.95
Battery	$158.95	$158.95
MC4 Solar Cable	$30.68	$30.68
Hose/Hose Clamps*	TBD	$140.24
Wire/Alligator Clamps*	TBD	$73.97
Misc. Measuring Tools	-	$74.43
Second Prototype Costs	-	$420
Total	$370	$1,078
Budget	$500	$1,500

***Determined by length and size based on farmer’s specifications**

Alternative Solutions

- Submersible Pump
  - -More expensive
  - -More energy
  - -More versatility
- Hose Size
  - -Less friction loss
  - -Greater distance and elevation change
- Water Storage
  - -Less simplistic
  - -More maintenance
  - -Less versatility
  - -More expensive
- Wind Power
  - -More expensive

Background

The project’s goal was to create a system that would help farmer’s, primarily in Uganda. The focus is to irrigate one acre of land at a time, so that modifications can easily be made with growth of acreage. Simplicity and low maintenance are key components to ensure these farmers can use the system efficiently. Diesel powered pumps can be expensive and difficult for farmers to use, so the team was asked to design a solar powered option at a low cost.

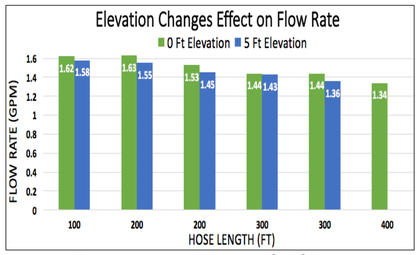
Field Tests/Data Analysis

1/2" Hose (Ft)	3/8" Hose (Ft)	Total Length (Ft)	Elevation Change (Ft) 0	5	10	15	20
50	50	100	1.62	1.58	1.50	1.37	1.21
100	100	200	1.53	1.45	1.45	-	-
150	50	200	1.63	1.55	1.54	1.53	-
150	150	300	1.44	1.36	-	-	-
200	100	300	1.44	1.43	1.41	-	-
200	200	400	1.34	-	-	-	-

Flow Rate (GPM)

Pump Capability

Fixed Parameters	
Maximum Water Pressure	60 PSI
Friction Loss for Elevation	2.31 Ft/PSI
Friction Loss 1/2" Hose	6 PSI/100 Ft
Friction Loss 3/8" Hose	25 PSI/100 Ft
Maximum Theoretical Flow Rate	2.1 GPM
Battery Strength	10 AMP
Straight Hose	- Ft



Phone Charger Capability

Battery	34 Amp Hours
Phone Charger Average Amp Draw	0.5 Amps
Actual Time Avaliable	68 Hours

Battery Capability

Hose Length	20	100	200	300	Ft
Elevation	0	0	0	0	Ft
Total Time	14	11	9	7	Hrs

Panel Capability

Solar Panel		
Optimum Panel Efficiency	14	%
Calculated Battery Charge Time	6	Hours
02/23/17		
Angle of Max Intensity (February)	42	Degrees
Weather (Cloud Cover & Temperature)	Sunny, Clear, 45	°F
Sun Intensity	286.4	W/m2
Total Hose Length	100	Ft
Elevation Change	0	Ft
Maximum Theoretical Flow Rate	2.1	GPM
Average Flow Rate	1.47	GPM

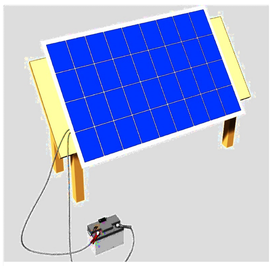
The images to the left show testing battery capability to run the pump with a fixed hose length including the battery meter with charge percentage.

Solar panel mounted at an angle for optimum sun intensity

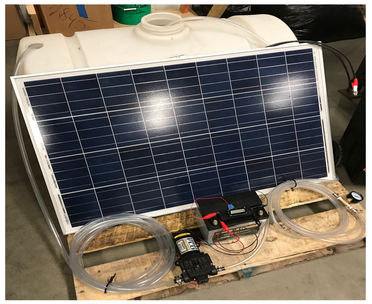
Impact/Sustainability

This project was able to fulfil its goal, but it also allows for many future opportunities to grow and develop some design for every farmer and help to irrigate the world as cost effectively and practically as possible. Several different opportunities for innovative ideas and other uses of the system are possible. For example, a phone charger connected to the battery was tested and successful. This allows the battery to be transported anywhere to power several different devices, which will change how people are able to use technology in underdeveloped areas.

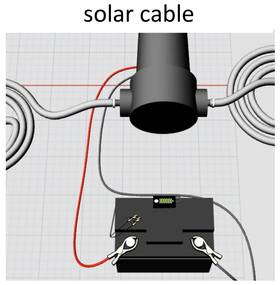
Final Design



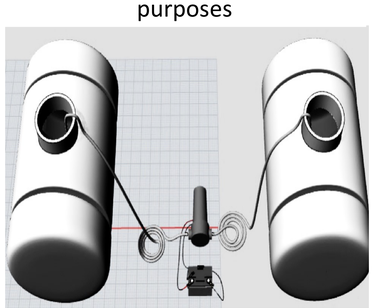
Solar panel charging the battery with the MC4 solar cable



System set up for demonstration purposes



Pump running from battery power



System pumping water from one tank to another with battery power

Sponsor:
Dr. Noble Banadda

Technical Advisor:
Dr. Engel

Instructors:
Dr. Stwalley
Dr. Engel

Acknowledgements:
Purdue University
ABE Department
Scott Brand
Dr. Lumkes
Dr. Heber

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