IPRO 323:
Design of a Reliable, Cost Effective Water Pumping System
Problem Formulation

• Water related diseases kill a child every eight seconds and are responsible for 80% of all illness and deaths in developing countries.

• Rural communities all over the world do not have a reliable source for clean, potable water.
IPRO 323

• **Overarching Principle**
  To design an affordable, sustainable, and reliable system to access potable ground water for communities in developing countries.

Monterrey, Mexico
Objectives

• Evaluate water sources and water demands of the target community
• Design and construct a small-scale test system to approximate the performance of a full-scale system
• Design a full-scale solar powered water pumping system—Kankakee
• Research available components and perform cost-benefit analysis
• Work toward Mexico proposal
System Selection Process

Technical Considerations
Power Options

- Utility Grid
- Gas Generator
- Wind Turbine
- Solar Generator
- Ram Pump
- Hand Pump
Storage & Distribution

• Storage
  – Gravity Fed
  – Pressurized lines
  – Ground tank

• Pump
  – Low cost vs. low maintenance
Conditions to Consider

- Geographic variables
- Weather consistency
- Gov. Utility infrastructure
- Water Demand
Kankakee/Mexico

- No Utility infrastructure
- Consistent sunlight
- Low water demand <1000 G/day
- Poor wind conditions
- Flat terrain
The Team

- Team break-down
  - Two sub-groups
    - Test model – Farr Hall
    - Kankakee Design
Methodology

Objective

Research

Piping

Solar Pumps

Storage Tank

Solar Panels

Test Model
Conceptual Design
Pipes and Pumps
Storage Tank and Panels
Test Model Results

- Gained experience with components
- Experimented with the technology
- Observed correlation to manufacturer data
Test Model Results

• Measurements
  – Flow Rate
  – Electrical Output

• Lessons
  – Learned about the Circuitry
  – Correlated power to flow rate
  – Pressure Calculations
  – Insolation Values
Methodology Continued

- Test Model
- Full Scale Model
- General Application
Large-Scale Proposal
Design, Construction and Performance Analysis of a Solar Water Pump For Kankakee, IL
Kankakee Site

• Rural community
• Flat landscape
• 4 full seasons
• Minimal shade
• Small community
• 3 cabins
Initial Design

Internal Storage

- 260 gallon storage tanks within attic of each cabin
- Single solar powered pump
- Gravity fed system
Advantages vs. Disadvantages

Advantages
- Simple Design
  ➢ Single pump
  ➢ Simple electrical setup
- Storage removed from environmental conditions
- Reliable system

Disadvantages
- Limited water supply
- Low amounts of pressure
- Stress factor
- Buckling loads

Figure: stress analysis of pine cross beam under distributive loading.
Final Design

• Elevated Water Storage
• Single Pump Design
• 2-Phase Construction
  ➢ Well Construction
  ➢ 15 ft. Elevated Storage
• Easily Expandable System
• Reliable System
Final Design

Storage Tank:
• External Tank
• 1500 gallon high density polyethylene tank
• Gravity fed system
• Raised 15 ft. above foundation
• Insulation for year-round use

Pump:
• Submersible pump
• Lorentz PS200 HR-14
  ➢ Max. flow rate: 11.8 gpm
  ➢ Max. head height: 65 ft

Solar Panels:
• 48 V solar panel array
• 4 BP 350J panels
  ➢ Power: 50 watts
  ➢ Nominal Voltage: 12 Volts
Future Tasks

• Break ground in Kankakee
  – Start with phase 1
    • Drill well
    • Install Pump
    • Pour cement for tower base
    • Install storage tank

• Mexico
  – Begun legal process of government approval in Mexico to install the system
Conclusion

• Problem
  – Need for potable water in rural communities

• Methodology
  – Broke up group
    • Farr Hall
    • Kankakee

• Future Tasks
  – Kankakee
  – Mexico
    • Future IPRO semesters
• Special thanks to

  – Kankakee Farm owners
    • Dr. Jifunza Wright and Mr. Fred Carter
  – Monterrey Institute of Technology
    • Katty Davila
  – Architect for Kankakee
    • Daniel Hatch
  – Our advisor
    • Dr. Nasrin Khalili