

## IPRO 325 Final Report:

### 0.1 INTRODUCTION

IPRO 325's reason of being has been to create a program at IIT, which looks to make an impact in the most immediate problems dealing with the world's rural poor. This will be a long term IPRO that will last for hopefully years. During the initial phase of this program, our responsibility was on researching and becoming familiar with the current trends and events throughout the world which address these poverty issues. We examined the organizations and universities which are working towards annihilating the world's grossly impoverished areas; we have also examined 10 factors which we selected as being those which impact the world poor the greatest. After careful analysis, we narrowed down the list to three main problems that we consider as the most important: access to energy, access to pure drinkable water, and appropriate shelter conditions. This semester we investigated energy and water in specific, and our goals were to create a working prototype to address a specific energy and water problem, as well as raise awareness of global poverty on the IIT campus.

### 0.2 WATER SUB-GROUP BACKGROUND

**Water is fundamental to life**, without it we cannot survive. Seventy-five percent of the world is covered with this precious resource, yet for much the world's poor water issues continue to plague their lives. Of the some 2 billion poor people living on less than \$3 a day, approximately **1.1 billion** of them **lack access to clean water; millions more lack enough to water their crops.**

Through research from the previous semester, such water issues have been categorized into three major components: **access, sanitation, and irrigation.**

The problem of **access** refers not merely to a complete physical lack of water in a given region, i.e. the Sahara Desert, but rather to adequate access of clean water sources. Piped water into households averages about 85% for the wealthiest 20% of the population, compared with a slight 25% for the poorest 20% of the population. For many of these poor, their only access to water is from riverbeds and lakes, much of which have become increasingly polluted from industrialization or have dried up from misuse by these industries, making the nearest water source many miles away from their homes.

Issues of **sanitation** and **irrigation** problems are many times a direct cause of the lack of access to clean water for much of the rural poor population. More than 5 million people die annually from water-born, water-based, water-related diseases every year. These illnesses many times a result of **cultural** practices or lack of advanced sanitary knowledge. In addition, farmland in rural areas is many times so over used through poor farming practices that deforestation, desertification, and soil erosion has occurred. Such damage to the environment strips the earth of its natural defenses against bacteria causing diseases.

Organizations throughout the world, such as International Development Enterprises (IDE), have been working to educate and empower poor communities to help address and solve these issues, yet there are simply too many people affected for them to reach each and every one. Thus, as students, we are compelled by **moral** and **ethical** obligation to join these organizations in working to improve the quality of water consumed by poor rural communities.

## 0.2 ENERGY SUB-GROUP BACKGROUND

Two billion people across the world do not have access to affordable energy. This leads to lack of communication, lack of proper lighting at night, inadequate food processing and storage, inadequate storage of vaccines and other medications, and other basic needs that people in developed countries take for granted. Work, which could otherwise be performed by machines, has to be done manually. Often times this work is heavy and hazardous, and takes up a lot of time that could be better spent on practical tasks.

Traditional energy sources are environmentally harmful and become more and more expensive, because they are not sustainable. The use of firewood for cooking and heating has led to deforestation in many areas of the world. For example, just in Africa an estimated 1000lb of wood per person are used annually for cooking. Using firewood for cooking is also hazardous, since it can cause unwanted or destructive fires (especially in regions with dry climate) and smoke inhalations can lead to serious health problems. This also poses a very gaping ethical issue for us: in a rapidly globalizing planet, do we, as a citizens of the world, chose to stand on the side and watch or chose to do something to help.

Many organizations are dedicated to fighting problems like this by developing and introducing affordable products that can be easily maintained by local people.

The IPRO 325 Energy group is committed to join their effort by conducting research on affordable energy sources like the sun and the wind, and developing at least one prototype that addresses a specific problem of energy use of the world's poor.

## 0.3 PURPOSE

The **objective** of the Water sub-team was to create a program at IIT which looks to make an impact in the most immediate water problems dealing with the world's rural poor; **access, sanitation, and irrigation**. We sought to do this via the following objectives:

- Extend our current research
- Create a working prototype
- Raise awareness on campus about the problems facing the world's poor

The Water sub-team, after extensive research into specific rural regions with severe water problems, has focused its efforts toward a village in **Nicaragua**. It has been identified that our greatest area of impact within the village is a solution that **sanitizes the local water**, making it safer to drink. We sought to do this via the following objectives:

- Produce a working **water sanitation** prototype

- Produce manuals to **educate** the local population

Our **goal** was to help alleviate biological contaminants that negatively affect the people of this region through the consumption of water.

Our **goal for future IPRO 325** water sub-groups is to further the research through field studies and testing of the prototype within a poor rural community. From such studies, the team will be able to better understand and acknowledge their needs; customizing the prototype to more effectively address those needs.

The first objective the energy group set was to narrow the scope of the research done last semester, and propose a prototype to address a specific energy related problem of the world's poor. After detailed investigation on the use of the four most available renewable energy sources: wind, water, the sun, and biogas; the energy subgroup decided to create and test an affordable prototype of a solar cooker, and by utilizing locally available tools and materials limit its cost to \$5 USD. The group found that such a product has the potential to cause great impact on the lives of people living in impoverished communities by eliminating the hazards and expenses associated with cooking with firewood and charcoal. For prototype destination we selected the Peruvian Andes, where we can work in collaboration with Dr. John Duffy, from University of Massachusetts at Lowell. In working towards our objective, a full-scale prototype was designed, built and tested against one of the most efficient, but very costly, commercially available solar cookers – the SunOven (\$260). Also, a second prototype was designed and a half-scale model was created. As part of our objective, we have created detailed instruction manuals on how to build and use the solar cookers we designed.

#### 0.4 RESEARCH METHODOLOGY

In order to create such a program for the water sub-group we:

1. Illuminated the seriousness of the water issues all around the world, showing the credible quantitative data from research through class presentation.
2. Identified organizations currently working to alleviate water issues amongst the rural poor of the world and establish contacts within these organizations.
  - a. Dr. John Duffy PhD, University of Massachusetts-Lowell
  - b. International Development Enterprises (IDE)
  - c. Peace Corps
  - d. Amigos de Nicaragua
3. Given the broad research from the previous semester, we narrowed down the scope of the project to a single global region in which to focus our efforts. We did this using a set criteria of:
  - a. Pervasiveness of problem

- b. Stability of country
  - c. Time zone (relative distance to IIT)
  - d. Degree of language barrier
  - e. Climate
4. Identified the most serious water issue plaguing the region (**access, sanitation, irrigation**)
- a. Developed criteria for evaluating methods that address said problem
  - b. Researched existing methods/technology used in region (if any)
  - c. Evaluated methods/technology used in region
    - i. Greatest positive effect
    - ii. Greatest negative effect
    - iii. Affordability
    - iv. Profitability
  - d. Investigated alternative methods/ technology used in other regions that could be applied to our region
    - i. Greatest positive effect
    - ii. Greatest negative effect
    - iii. Affordability
    - iv. Profitability
5. Selected one solution on which to develop and introduce into the said region, based on the following criteria:
- a. Greatest positive effect
  - b. Greatest negative effect
  - c. Affordability
  - d. Ease of local production
  - e. Ease of maintenance
  - f. Ease of local material usage
  - g. Profitability opportunities for locals
  - h. Ability to be implemented by student group
6. Developed a plan in which to introduce/ implement the solution to the said region
- a. Learn how to surpass/adapt to cultural barriers
  - b. Create educational aids for the local populace
7. Staged events on the IIT campus to gain awareness of water issues affecting the poor by providing a series of speakers to the IIT community to talk about their experiences and work in areas of the rural poor throughout the world.

Lecture Series, included:

- a. Dr. John Duffy PhD, University of Massachusetts-Lowell
- b. International Development Enterprises (IDE)

8. Completed final deliverables
  - a. Final report
  - b. Final presentation
  - c. Final Prototype Design
9. Determined the “next steps” for future IPRO group

As originally proposed for the energy sub-group, the project was carried out in three distinct phases: Research, Design, and Testing phase. Although conceptually these phases remained the same, there were some structural changes made as we progressed with the project.

### **Research Phase:**

The first step of the development of the project was to familiarize ourselves with the research done during the preceding semester. Based on their recommendations, we narrowed down the research to four possible sources of energy generation: wind, water, solar, and biogas. Each member of the sub-team was assigned a specific topic and was given the task to propose a prototype that was geared towards a specific problem. After each member presented his research findings and proposed at least one prototype, a group decision was made to begin work on developing an affordable prototype of a solar cooker. To do that, we had to thoroughly study the concept of solar cooking. We began by dividing it into four different aspects. Each member was assigned one aspect of solar cooking and he had to familiarize the rest of the team with his research on a weekly scheduled subgroup meetings.

- **Advantages and disadvantages of solar cooking** – among many things, solar cooking is a clean, safe, and absolutely free way of processing all kinds of food. There is no risk of fire, no smoke inhalations, and no risk of burning the food inside the solar cooker. The downside of it is that it takes longer time to prepare a meal, and it cannot be used in poor weather conditions such as rain or cloudy days.
- **Existing designs** – almost all of the existing designs can be conceptually categorized in three groups: single-box cookers, double-box cookers, and parabolic cookers. Every solar cooker consists of a reflective panel(s), well-insulated interior, and a transparent surface to let the solar radiation in.
- **Past and present projects involving solar cookers** – we analyzed different approaches to implementing solar cookers in developing countries, examining the factors that contributed to the success (SunOvens International and Solar Cookers International projects in Haiti and Ghana) or failure (Zimbabwe, Mexico) of these projects.
- **Geographical and Social Requirements** – because solar cooking requires a lot of sunshine, it is not applicable to certain climates and geographic regions. There are also certain cultural barriers to solar cooking like eating habits and traditional cuisine. For example, in some countries, like Mexico, the traditional meals are fried, which is one thing

solar cookers can't do.

As a culmination for the first phase, we organized a fieldtrip to a company that has great experience in manufacturing and distributing solar cookers around the world – SunOvens International. The information and knowledge they provided greatly helped us to proceed to the next stage of the project.

The research phase was the only phase that didn't have any significant deviations from the proposed plan.

### **Design Phase:**

Originally, the design phase was proposed to be carried out by two design teams, working simultaneously. However, due to the shift of resources inside the IPRO team, the two designs had to be performed sequentially. Brief description of the two conceptual designs follows:

- **The Earth Cooker:** It is essentially a single-box solar cooker, where “the box” is actually a circular hole in the ground. Excellent insulation is provided from the earth and the hole is covered with a glass top. It uses one reflector, which is made of a flat piece of cardboard, wood, or sheet of metal, covered with aluminum foil or the reflective inside of several bags of potato chips. It is supported by two rods, so that its position can be adjusted relative to the sun.
- **The Adobe Cooker:** Another variation of the single-box cooker, but it is made out of adobe bricks, which is the main structural material in many impoverished villages including those in the Peruvian Andes. It uses the same type of reflectors as the Earth Cooker, but it can utilize two or even four reflectors for better performance.

Although work on both designs started at the same time, design sketches and materials list for the Earth Cooker were created first with the Adobe Cooker designs created shortly after. With this, the Design phase was concluded. The creation of the prototypes was pushed in the third phase of the project.

### **Testing Phase**

Once our designs were completed we needed to test them to ensure that they would work and achieve the desired temperature or 250 degrees Fahrenheit. We decided to proceed with the construction of the adobe cooker. Initially, we intended to create it out of adobe bricks, but because of the issues listed in further detail in the obstacles section, we opted to use regular construction bricks. These bricks should exhibit many of the same properties of a well constructed adobe brick.

We created our Adobe Cooker using standard bricks. The inner dimensions for the cooker are 14” x 14” with an 8” depth. After constructing the box we purchased a glass piece to serve as a cover. The cost for this was roughly \$7 which should be the only cost involved when building this cooker. The reflector panel was made out of a piece of cardboard which was then covered using the reflective insides of potato chip bags, which anecdotal evidence suggests is readily available in the Peruvian Andes, where we hope to implement this design.

Once the Adobe Cooker was completed, we scheduled the tests around the Chicago weather so that they could be done in close to optimal conditions. We placed our Adobe Cooker and the store bought SunOven next to each other in a spot where they were likely to receive as much sunlight as possible. The SunOven was to be used as a test control so that we had an idea of what an already successful design could accomplish. Temperature readings were taken using an oven thermometer in the Adobe Cooker, and the integrated thermometer for the SunOven. The Adobe cooker was outfitted with one reflective panel, and the positioning and angle for both of the solar cookers was adjusted periodically to ensure that they received the most possible sunlight.

To conclude the last phase and the project, two instruction manuals were created, showing how to build and use the solar cookers.

## 0.5 ASSIGNMENTS

Team Member	Tasks
L. Justin Harris	<ul style="list-style-type: none"> <li>▪ Lead the IIT awareness lecture series</li> <li>▪ Researched Africa; Ethiopia's water problems</li> <li>▪ Researched material properties and previous testing</li> </ul>
Jaime McClain	<ul style="list-style-type: none"> <li>▪ Sub-group Leader</li> <li>▪ Organized workload and individual tasks, organized team meetings.</li> <li>▪ Prepared progress reports and presentations</li> <li>▪ Research S.E. Asia; India's water problems</li> <li>▪ Researched and prepared educational materials for Water Farm</li> </ul>
Tony Osborn	<ul style="list-style-type: none"> <li>▪ Originally a member of the Shelter sub-group</li> <li>▪ Researched local material availability</li> <li>▪ Created Water Farm images and renderings</li> <li>▪ Established Water Farm operations</li> </ul>
Brian Schiller	<ul style="list-style-type: none"> <li>▪ Researched Central America; Nicaragua's water problems</li> <li>▪ Established and maintained contact with Amigos de Nicaragua</li> <li>▪ Designed and carried out experiments</li> <li>▪ Established Water Farm de-contamination process</li> </ul>

The table below gives a detailed summary of the particular tasks and roles performed by energy team members during the semester.

<b>Team Member</b>	<b>Tasks</b>
Nikola Baltadjiev	<ul style="list-style-type: none"> <li>▪ Subteam Leader</li> <li>▪ Organized the workload into individual tasks, organized team meetings.</li> <li>▪ Researched Wind energy alternatives</li> <li>▪ Prepared progress reports and presentations</li> <li>▪ Established and maintained contacts with SunOvens International</li> <li>▪ Led the construction of the adobe prototype</li> <li>▪ Designed experiments</li> </ul>
Danny Kim	<ul style="list-style-type: none"> <li>▪ Researched Water energy alternatives</li> <li>▪ Designed the Earth Cooker, prepared materials list</li> <li>▪ Created AutoCAD sketches for both prototypes</li> <li>▪ Participated in the building and testing of the Adobe Cooker</li> <li>▪ Created instruction manuals for both prototypes</li> </ul>
Jeremy Locquiao	<ul style="list-style-type: none"> <li>▪ Researched Biogas alternatives</li> <li>▪ Designed the Adobe Cooker, prepared materials list</li> <li>▪ Participated in the building and testing of the Adobe Cooker</li> <li>▪ Documented the building and testing processes</li> </ul>
Ricardo Gonzalez	<ul style="list-style-type: none"> <li>▪ Researched Adobe structures</li> <li>▪ Performed adobe brick experiments</li> <li>▪ Led the construction of the Earth Cooker model</li> <li>▪ Participated in writing the final report</li> </ul>

The following table provides a brief account of the budget for the energy subgroup. All receipts were presented to the IPRO Office.

<b>Item</b>	<b>Proposed Budget</b>	<b>Actual Budget</b>
SunOven®	\$200	\$175.74
Materials	\$100	\$77.29
Equipment	\$50	\$72.27
<b>Total</b>	<b>\$350</b>	<b>\$325.30</b>

## 0.6 OBSTACLES

The Water sub-team initially had a hard time deciding which sanitation method would be most appropriate for our region in Nicaragua. Although we had done extensive research into the area, none of the team members had been to the region or had first-hand experience with problems that the rural poor face. In addition, many of the organizations we contacted were slow to follow up, so we experienced a period of slow progress. However, through patience and persistence, we were able to get the feedback needed from volunteers in the region; and, as a team, decided, enthusiastically, on a solution.

Through our second phase of exploration and testing of our solution, our sub-team encountered more barriers and obstacles, including:

- Difficulty finding specific information about the life-cycle of PETA plastic bottles to determine a maintenance/replacement schedule for our prototype.
- Obtaining necessary testing materials, specifically bacteria.
- Replicating the conditions of our target area to produce truer results.
- Obtaining lab space to carry out the necessary experiments.

To address the obstacles pertaining to the experiment and material collection, we continued looking for additional resources. We were unable to obtain some of the bacteria, so we had to change our experiment to accommodate. We contacted experts in biology, chemistry, and polymers to answer our questions and give us recommendations for future tests.

Some barriers and obstacles our sub-team expects future teams to encounter:

- Developing an effective means of communication with our intended user group.

The energy subgroup has experienced few problems within the subgroup and in the research and implementation of the project. Internal problems involved lack of communication between team members, resulting in delayed work submission. To cope with such problems the subgroup has organized mandatory meetings outside of class, where each member of the team is presenting his progress so far and his plans for the upcoming week. Problems, encountered in the research or design process, are also addressed at these meetings, where the best possible course of action is being decided by all team members.

Some technical obstacles that we encountered involved the creation of Adobe bricks for the construction of the Adobe Cooker prototype. Because of the amount of time required to properly dry an adobe brick, a process that requires several weeks of dry, sunny conditions, we attempted to cure these bricks in a conventional stove. However our results were less fruitful than we had hoped for and we decided that because of the time constraints of the project, we would use regular construction bricks as an alternative for testing our solar cooker. For the earth cooker, we had to develop a conceptual model, as our design requires digging a rather large hole, and we did not believe that this would be possible to do in an accessible on-campus location.

## 0.7 RESULTS

The Water sub-team, this semester, has successfully:

- Identified a specific target area in Nicaragua for the final prototype to be implemented.
- Established a line of communication with organizations already working in and around our target area; as well as, organizations conducting similar work with the issues of water access, sanitation and irrigation.
- Determined the most severe water problem in our target area to be sanitation.

- Designed an experimental outline to combat the sanitation problem in our target area.
- Developed an appropriate solution, in the form of an extremely affordable prototype design, which utilizes local and salvageable materials, to begin experimentation.
- Created a plan to turn our single prototype into an efficient “Water Farm”.
- Begun exploring means and avenues of introducing the IDE Micro-Enterprise model.

Given the initial problem that 1.1 billion people lack access to clean water, the team quickly determined that the scope of the problem was too great to affectively tackle. To narrow the scope, each team member researched a country plagued by extreme water problems and rural poverty. After conducting the research, we weighed our options through our pre-determined criteria to select one of the countries to further investigate.

	Safety concerns	Difficulty of travel	Communication gap	Population affected	Access severity	Irrigation severity	Sanitation severity
Nicaragua	Low	Low	Low	Mod	High	Mod	Mod
Ethiopia	Mod	High	High	High	Mod	High	High
India	Mod	High	Mod	High	Mod	High	High

Low    
  Mod    
  High

Through research, the sub-group determined that while Nicaragua has abundant sources of freshwater, 72% of them are severely contaminated with biological and industrial waste. Of which, is directly affecting the health (sanitation) and agriculture (irrigation) of the local population. Thus, the problem of access to clean water was the most serious water issue plaguing the country.

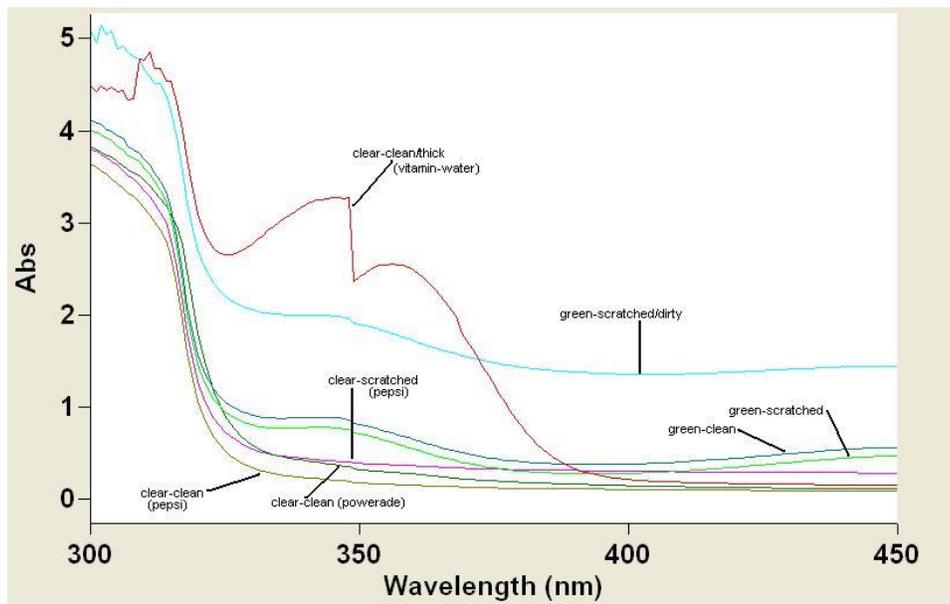
Existing solutions to the problem included the building of local wells throughout rural villages by various world organizations. However, the maintenance required for upkeep and repair is many times too great a task for the locals, either from lack of communication, skill-level, or access to proper materials. In addition, many field studies found that even when wells were functioning properly, the water was being re-contaminated from transferring and handling of the water once outside the well. The cost, as well, is far above the target of \$2, making the system virtually out-of-reach without outside donations or funding.

The Solar Water Disinfection Process (SODIS), which has been used in other rural areas of the world, offers a solution that is highly effective, scaleable, and requires little cost. The method uses plastic “PET” bottles (which allow the greatest UV penetration) and sunlight to get rid of 99% of biological contaminates. The process is also known as UV Irradiation.

This system was determined to be the most satisfying to the needs of our user group, poor rural farmers near Lake Managua, and to the needs/abilities of our IPRO sub-group team.

The Water sub-team produced the plans for the “Water Farm” prototype. The farm will sanitize water through the process of UV Irradiation, with the use of 16-20oz. plastic beverage bottles. From our research, we have determined an impoverished rural region in Nicaragua as our target area for the implementation of our design. From the knowledge we have obtained about this area, we have conducted testing on the major components of the prototype; PET plastic bottles ranging in opacity/color, wall thickness, and condition.

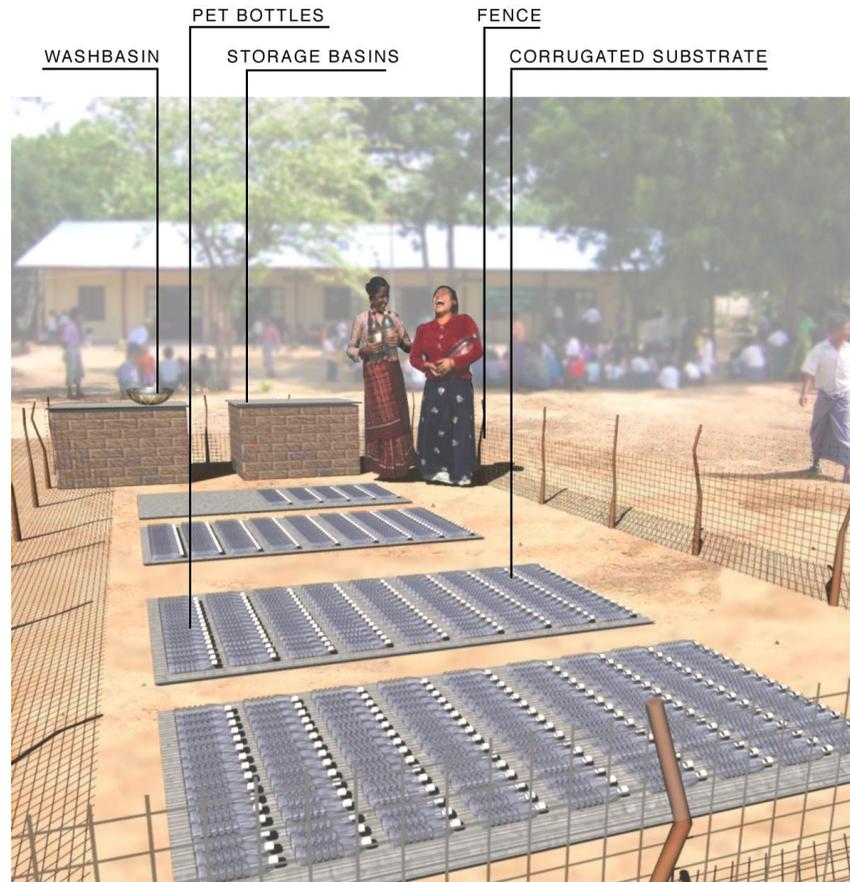
**Test Results**



<b>PET Bottle Properties</b>	<b>Thickness</b>	<b>Opacity/ Color</b>	<b>Condition</b>
<b>Acceptable</b>	<b>Thin-</b> Coke, Pepsi, Aquafina, etc	<b>Clear/ Light blue tint</b>	<b>Scratched/ scuffed</b>
<b>Unacceptable</b>	<b>Thick-</b> Sobe, Vitamin Water, etc	<b>Colored</b>	<b>Dirty-</b> must clean or use new

From our test results and those found through research, we were able to determine that the

SODIS was viable given the context of the region and Water Farm proposal. In addition, our team began to introduce the IDE Micro-Enterprise model into the Water Farm concept.



The Micro-Enterprise model, which has been shown to be extremely effective in other poor rural regions, offers benefits of:

- Providing a villager with income
- Providing operating capital
- Ensures proper disposal of bottles (when rendered ineffective)

In conjunction with the micro-enterprise, a micro-loan investment system could provide the funding for purchasing clean, unused PET bottles and caps on a regular basis and for soap; for the farm manager to regularly clean his hands, the bottles, and the caps to combat contamination of the Water Farm system.

The following table provides a brief account of the budget for the water subgroup for the testing and simulation of the Water Farm and SODIS concepts.

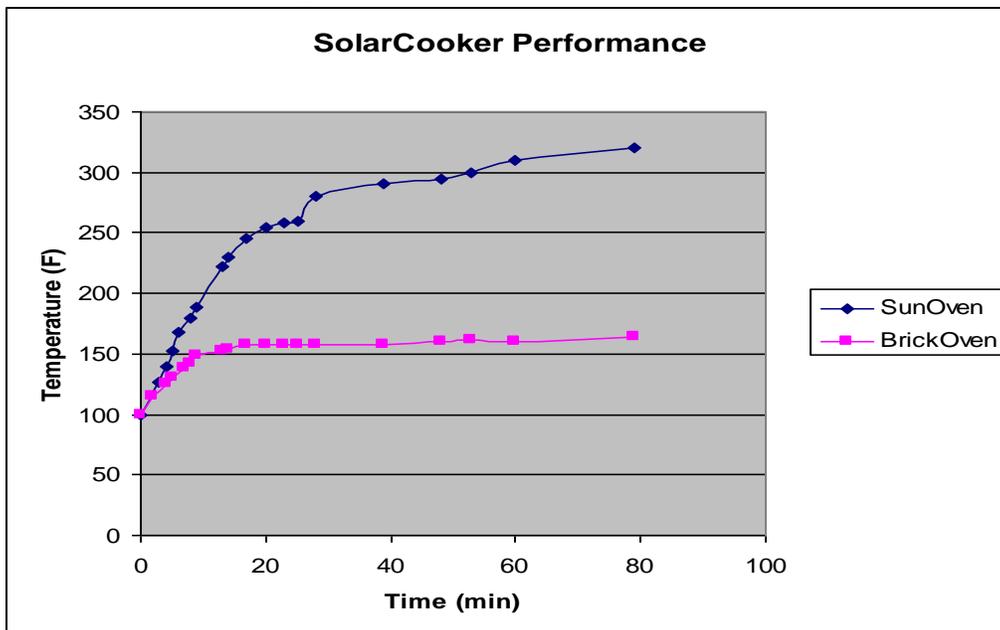
Item	Proposed Budget	Actual Budget
Corrugated Metal Sheet	\$35.00	\$ [still to be purchased]
Chicken Wire Fencing	\$21.98	\$ [still to be purchased]
PET Bottles		\$0.00 (bottles donated and recycled)
<b>Total</b>		<b>\$</b>

During the course of the semester the Energy subteam successfully

- Conducted research in renewable energy sources and the possible benefits for impoverished communities
- Established line of communication with companies and organizations, working in the field of solar engineering
- Produced two preliminary designs of affordable solar cookers
- Built a full-scale functional model for the Adobe cooker, and half-scale conceptual model for the Earth Cooker
- Performed tests with the Earth cooker and compared results with the best commercial solar cooker

Detailed description of the test results and our conclusion follows.

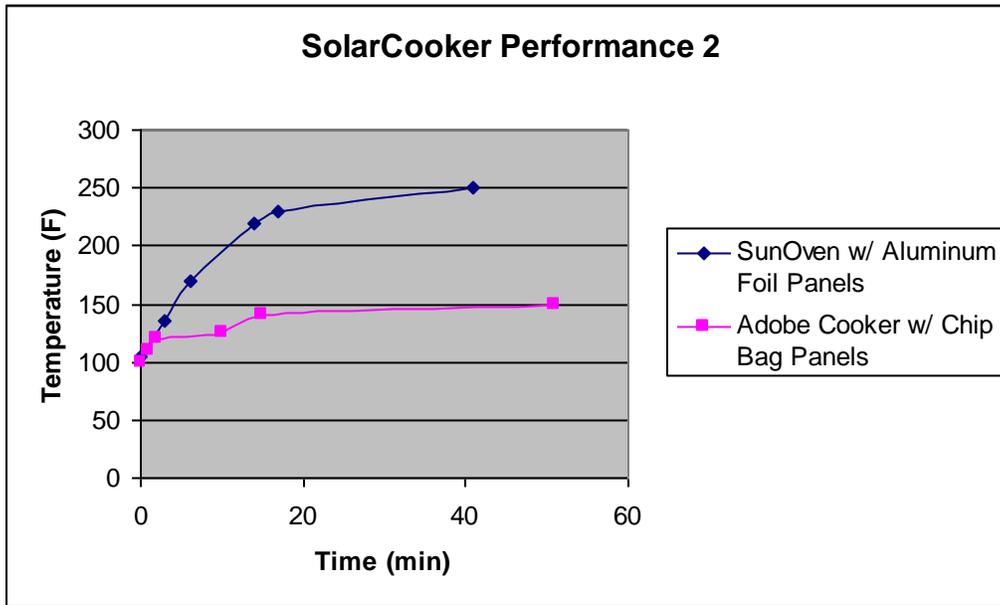
Our first test yielded the following results:



The sun oven outperformed our solar cooker, as we expected it would. The maximum achieved temperature for the SunOven was 320F, which far exceeded our goal of 250F degrees. The Adobe Cooker, however fell a bit short. While the temperature increased pretty significantly from the 51F ambient temperature, it maxed out at 160F.

This test led us to make a couple of changes to the Adobe Cooker in an effort to bring it to our desired temperature. This list of changes included making the inside of the cooker black, so as to absorb more heat, create a better seal between the glass top and the brick box, and add additional reflectors. We hoped that these changes would be sufficient to further heat our cooking chamber.

For the second test, we added a second panel to our cooker. We sealed the glass to the brick using duct tape, and we used black cardboard to line the inside chamber. Once again we made a side by side comparison, but this time, we covered the reflective panels of the SunOven with aluminum foil to ensure that this was not the cause of the temperature differential.



In this test, under relatively the same environmental conditions as the first test, the SunOven maxed out at 250F, where the Adobe Cooker reached a maximum temperature of 150F. For the SunOven, this seems to be a pretty significant change in temperature with the use of the aluminum reflective panels when compared to the integrated panels used in test 1. For the solar cooker, however, the addition of more panels, as well as the changes made to the seal and darkened inside, there was not any marked improvement, and in fact we saw a minor decrease in temperature.

Some conclusions that we can draw from this is that, while aluminum foil is sufficient to reach 250F in the sun oven, there seems to be a different problem inherent in our design. Possible problems hindering the adobe cooker from reaching 250F include the brick itself absorbing too much of the heat, the reflectivity of the panels.

## 0.8 RECOMMENDATIONS

Based off of the research and conclusions, the water sub-group recommends that subsequent teams continue to explore and enhance the micro-enterprise concept of the Water Farm. To do this, we suggest approaching International Development Enterprises (IDE) about becoming an official sponsor for the IPRO.

In addition, we emphasize the importance of field studies within the specified area of focus. Such investigations will provide unmatched knowledge into:

1. Culture of the local population
  - a. customs
  - b. family and community structure
  - c. role designations (gender & age)
  - d. political and social structure
  
2. Realities of the local environment
  - a. Terrain
  - b. Weather
  - c. Accessibility of materials
  
3. Needs of the local population as seen by the local population

It is also recommended that future teams continue to improve the SODIS system. At the present, the system is unable to remove heavy metals from the water. By researching and testing ways to rid the water of these harmful particles, the system would be able to reach a larger user group and, in return, create a bigger impact on fighting global poverty.

Although the energy team's solar cooker could not reach the target temperature of 250F, our experiments showed that a solar cooker that can be built for \$5 or less is within reach. Great expectations are placed on the Earth cooker, since its design solves the insulation problem of the Adobe cooker. Building and testing it will help resolve any possible unpredicted issues and optimize the initial design. The adobe prototype can be improved by adding insulation on the inside and adding more reflective panels.

Another issue that we started addressing is implementation. The instruction manuals that we created have to be adjusted to the final designs. In addition, very detailed manuals on how to cook with a solar cooker have to be developed along with some recipes. Implementation would also require the team to gain considerable knowledge of the way of life of the target population. The best way to achieve that is to actually visit the village and try to live with their problems and experience them first hand.

## 0.9 REFERENCES

Country and regional research:

[www.encarta.com](http://www.encarta.com)

[www.cia.gov/redirects/factbookredirect.html](http://www.cia.gov/redirects/factbookredirect.html)

Amigos de Nicaragua Studies:

[http://www.scielosp.org/scielo.php?script=sci\\_arttext&pid=S1020-49891998000200017&lng=pt&nrm=iso&tlng=en](http://www.scielosp.org/scielo.php?script=sci_arttext&pid=S1020-49891998000200017&lng=pt&nrm=iso&tlng=en)

SODIS:

[www.sodis.ch](http://www.sodis.ch)

[www.rdic.org/sodis.htm](http://www.rdic.org/sodis.htm)

International Development Enterprises:

[www.ide-international.org](http://www.ide-international.org)

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