



# Biodigestion, Sanitation, and Public Health in Rural Cambodia

Jonathan S. Alldridge, David N. Baden, Sarah G. Katz<sup>1</sup>,  
Edward W. Garcia, Sagar Kumar, Taylor S. Norrell and Dr. Ann C. Wilkie<sup>2</sup>

<sup>1</sup>EWB-UF Cambodia Project Team Leader

<sup>2</sup>Mentor, Soil and Water Science Department



## Background & History of Engineers Without Borders

Engineers Without Borders is a non-profit organization that “helps create a more stable and prosperous world by addressing people’s basic human needs by providing necessities such as clean water, power, sanitation and education. (<http://www.ewb-usa.org/>)”. It does so through a strong relationship with universities across the U.S., fostering engineering students through the meaningful application of their skills. International projects begin for a chapter with a need from an outside organization or individual. Sustainable Cambodia (SC), a Cambodia-based non-profit organization, approached EWB-UF four years ago to help rural villages in the Pursat Province of Cambodia with irrigation. A small subgroup of EWB-UF consisting of students and a mentor was formed. Soon SC found a commercial solution to the irrigation problems. The group decided to switch their focus on reducing the use of firewood in the villages. Deforestation and respiratory illnesses are major problems in Cambodia. Currently, the EWB group is focused on the use of biogas digesters to tackle these problems with the help of Dr. Wilkie of the Soil and Water Science Department.

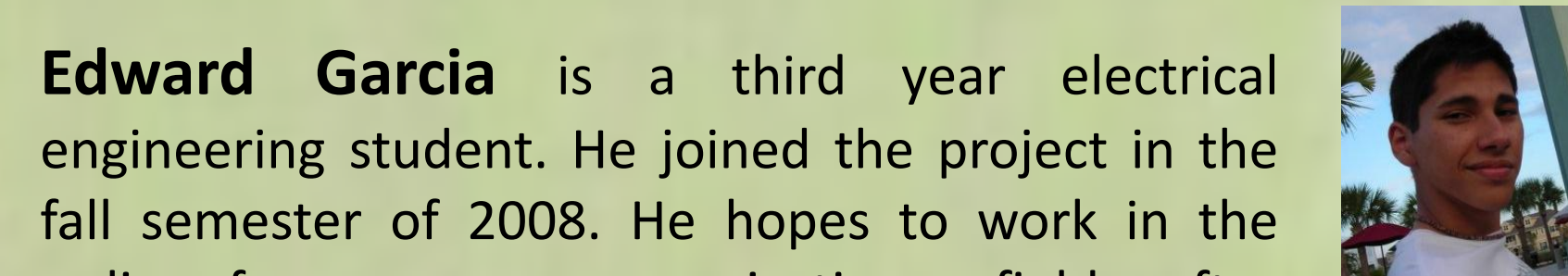
As an answer to deforestation and respiratory issues stemming from the burning of firewood, anaerobic digestion became the project’s main focus with the intent to utilize readily available organic waste to create a clean-burning fuel. The team developed their own cost-effective anaerobic digester made from polyethylene bags used primarily for food storage. Initially, these digesters were to be implemented in villages surrounding Pursat, Cambodia. Once enough funds were gathered, two project members and the project mentor went to these villages on an assessment trip.

## Team Biography

**David Baden** is a sophomore Mechanical Engineering student. He is working towards a career in alternative energy.



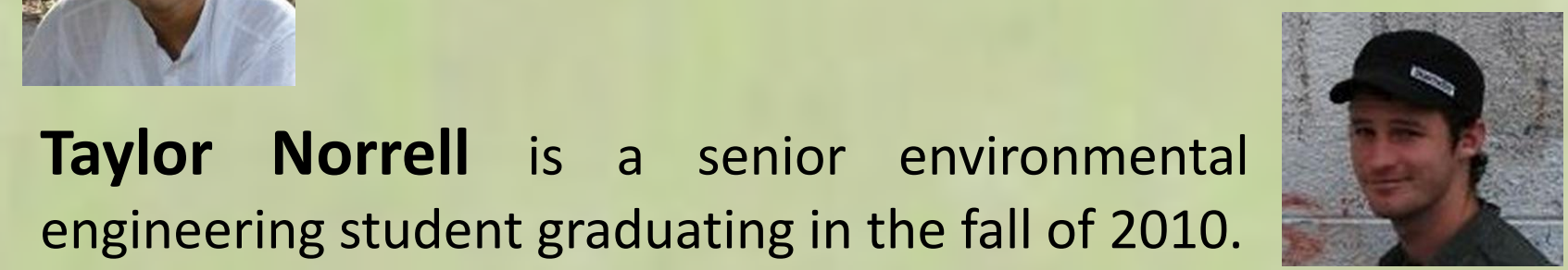
**Sarah Katz** is the project lead of the EWB-Cambodia group. She is a junior in chemical engineering and hopes to have a career in research.



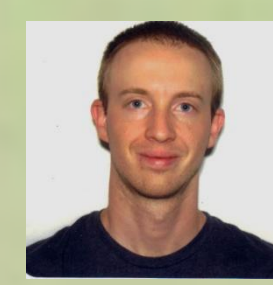
**Edward Garcia** is a third year electrical engineering student. He joined the project in the fall semester of 2008. He hopes to work in the radio frequency communications field after graduating from UF.



**Sagar Kumar** is a junior computer science engineering student.



**Taylor Norrell** is a senior environmental engineering student graduating in the fall of 2010.



**Jonathan Alldridge** is a second-year masters student in Agricultural and Biological Engineering studying the application of climate forecasts. He is interested in sustainable development & natural resource management.

**Dr. Ann Wilkie**, an Associate Professor in Soil and Water Science, is the project mentor, experienced in biodigestion applications in developing countries and in U.S. agricultural operations. Her research is focused on Bioenergy and Sustainable Technology.



## Project Motivation

The Kingdom of Cambodia is a country in southeast Asia that was torn apart by civil war and U.S. bombing in the 1960’s and 1970’s. The notorious Khmer Rouge, led by Pol Pot, took power in 1975 and plunged the country into 4 years of terror, where 1 to 3 million of the 8 million people living in Cambodia were murdered. While ethnic groups were targeted heavily, doctors, lawyers, teachers, previous military members, and anyone showing signs of intellectualism or mistrust of the Khmer Rouge were killed along with their families. This exacerbated the poverty and starvation problems the country was already facing. It also led to the complete destruction of the country’s knowledge base, painfully slowing rebuilding and economic development.

\*30% of Cambodians are living below the poverty line and those living in rural and agricultural areas face a lack of clean drinking water sources and water shortages during the dry season

\*Diarrhoeal diseases are the number 3 killer in Cambodia behind AIDS and tuberculosis, accounting for 11% of all deaths and 17% of deaths under age 5.

\*Rainforests covered 70% of Cambodia in 1970 and in 2007 that had dropped to 3.1% according to the FAO -- since the end of the 1990’s 75% of that loss

\*The WHO estimates that indoor air quality is responsible for 2.7% of the world’s disease burden. For these reasons an alternative fuel to firewood, such as biogas, would be highly beneficial to rural Cambodians.



Traditional rice planting (left) and a typical rural home, with cooking/relaxing room underneath & sleeping quarters above – note the level of smoke (right)

## Anaerobic Digestion

Anaerobic digestion is the process in which bacteria growing in an anaerobic environment metabolize organic matter with a gaseous byproduct commonly called biogas. Biogas is mainly comprised of methane (>50% by mass) and carbon dioxide (remainder) gases. This gas can be collected and combusted for heat or light in a wide variety of applications. The exhausted material leaving the digester has nutrients in a more plant-available form and has been highly reduced in pathogen content. Manure is traditionally the organic feedstock for anaerobic digestion, but almost any other organic waste can be utilized.

The National Biogas Programme digester design is a variant of the Deenbandhu model from India and designed by the Dutch Non-Governmental Organization, SNV. The smallest unit (and most appropriate for a family with only a few animals) is 4m<sup>3</sup>. For these, the suggested loading rate is 20 kg of fresh manure per day, with a hydraulic retention time of approximately 50 days. The units are installed by masons who are trained in building these units via a 12 day course taught by the NBP and cost approximately \$450 USD with a subsidy of \$150, with the families responsible for a \$300 share.



From top down: Artistic rendition of family home with digester, side view of NBP digester illustrating underground portion, stove running on biogas, lantern running on biogas.

## Assessment Trip Findings

In order to ensure a successful project, Engineers Without Borders requires each team to first take an assessment trip to their target area before implementation. The goals of an assessment trip are to become familiar with the needs of the local population, determine possible obstacles preventing implementation, and assess the feasibility of the project in the area of interest. Following the trip, the team is able to formulate the best course of action to implementation. While travelling, the team discovered the National Biodigester Programme (NBP), a joint venture between the national government and SNV, a Dutch NGO. NBP has been working in Cambodia to promote anaerobic digestion among rural villages since 2006. NBP has made considerable progress in Cambodia and had just entered the team’s project area two months prior to assessment with a sturdy, sustainable unit for villagers to invest in. The team met with several families who had invested in the digester within a period of 2 to 24 months. The families were satisfied with their investment and felt that it made for a better standard of living.

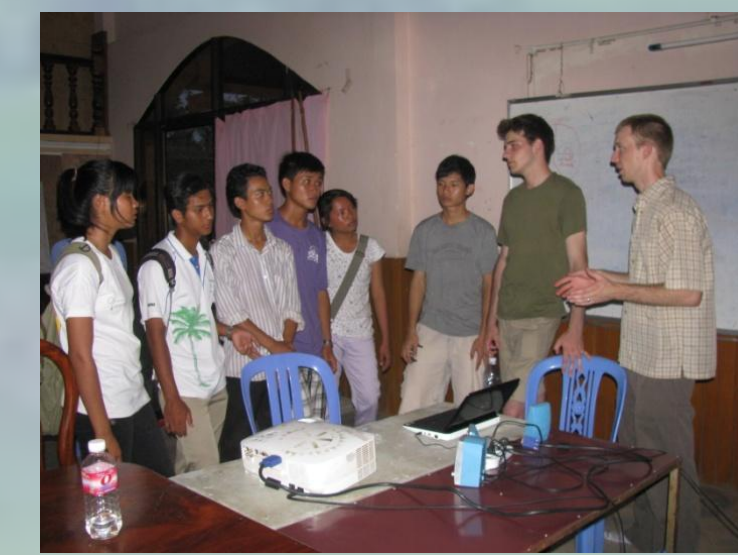
These findings confirmed that a proven initiative for implementing anaerobic digestion was already in place in Pursat, Cambodia. The team discontinued the initial plan to implement their own digester design, as it was not in the best interest for both the team and the villages surrounding Pursat. The focus of the team has shifted to areas with room for improvement such as waste disposal, sanitation, and water collection. These issues were confirmed as problem areas based on data collected from the villages that the team interacted with. While unexpected circumstances caused a change of plans, the team is excited with their new direction and now has the knowledge of the target area required to implement successful projects.



Testing biogas composition in a Cambodian kitchen



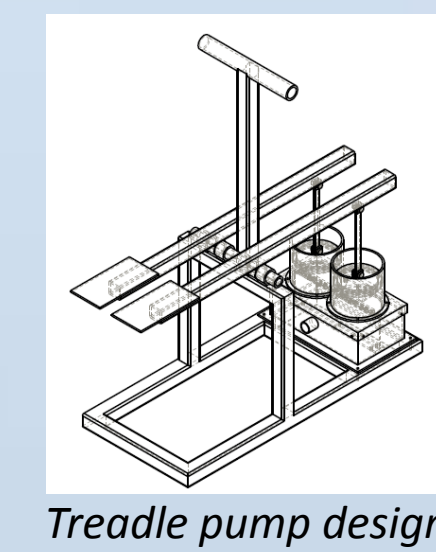
Soknay Sorn, National Coordinator for Sustainable Cambodia, speaking to a digester open house hosted by EWB-UF



Speaking with students about biogas and gaining insight into Cambodian culture & values



Speaking with a digester-owning family



Treadle pump design



Construction of and filling the bag anaerobic digester with pig manure slurry. Featured: Kelly Jones, past project lead, and Rachel Donahue, previous team member



From left to right: working bag digester model, model gas collector, and biogas flame at night



Map of assessment trip route



Improved latrine design with potential to be integrated with anaerobic digestion



Sustainable Cambodia's designs for (from left to right) bioand filters, safe wells, and rainwater collection tanks



## Project Timeline & Implementation

**Fall 2006-** Sustainable Cambodia contacts EWB-UF with a request to develop small scale irrigation pumps. An initial team is formed and begin to brainstorm solutions to the problem.

**Spring 2007-** Sustainable Cambodia decides to implement a commercial solution to the irrigation problem. The team’s focus changes to finding a solution to the rising cost of firewood faced by the villagers.

**Fall 2007-** The team starts to consider anaerobic digestion as an alternative to firewood consumption. Not only does this solution eliminate the problems associated with firewood use (smoke inhalation and unsustainably) but it also addresses sanitation issues associated with human and animal wastes. Dr. Wilkie is named as the team mentor.

**Spring 2008-** The team begins work on a prototype poly-ethylene bag anaerobic digester. The digester is built in the University of Florida’s Energy Research and Education park. Manure is taken from UF’s swine unit and fed into the digester. The team is able to determine the feasibility of the design and use the digester as an example of alternative energy to the local community.

**Fall 2008-** The team looks into making briquettes made of manure, rice husks and sawdust as another possible substitute to firewood use.

**Spring 2009-** The team begins to make preparations for an assessment trip to the Pursat province.

**January 2010-** The team applies for the Davis Foundation’s 100 Project for Peace grant in order to implement digesters in the villages surrounding Pursat.

**February 2010-** The team applies for a Boeing Biofuel grant through the EWB-USA foundation.

**March 2010-** The team is awarded \$10,000 from the Davis Foundation for implementing digester in Cambodia.

**April 2010-** The team is awarded \$5,500 through the Boeing Biofuel grant for use on an assessment trip.

**July 2010-** Dr. Wilkie and a group of 2 students travel to Cambodia on an assessment trip of the surrounding villages of Pursat in an effort to determine the feasibility of implementing digesters in the region. The team meets with Sustainable Cambodia and is able to talk to the local population. The team also establishes ties with the National Biodigester Programme which had recently expanded its projects to the Pursat region.

**August 2010-** Based on the information gathered from the assessment trip, EWB-UF decides to promote the already proven NBP digester model instead of the polyethylene bag model developed in-house. EWB-UF and SC decide to work in conjunction with the NBP and start a subsidy program to bring 60 digesters to the families surrounding Pursat. The project garners the attention of the local population and 20 families immediately sign up. The team hopes to complete the 60 digester by August of 2011.

**Fall 2010-** The team convenes to brainstorm solutions to the water collection problem and draw out designs for a latrine system that can be integrated with the digesters already built.

## Acknowledgements

Generous funding that will help bring 60 digesters to needy families who will serve as community biogas advocates was provided by a Davis Projects for Peace grant.

The EWB-USA Bio-Fuel Grant, funded by The Boeing Company, provided funds for the assessment trip.

Dr. Ann Wilkie has provided lab space, materials, and expertise on this project for four years.