

Appendix 2 Documentation of Work Completed to Date

GlobalResolve received \$49,500 in funding in beginning in February 2008 to aid in the development of the ethanol gelfuel project in Domeabra. At this time, we have largely accomplished the goals set forth in the 2007 grant proposal. The goal of the project were:

1. Design and test a gel fuel generator and companion smokeless stove that accommodate the needs of Domeabra in terms of cost, available resources, fabrication capabilities, and business value (October 2007 – March 2008).
2. Deliver a working prototype to Domeabra and partner with residents in setting up fabrication and distribution of the products (May 2008).
3. Assist Domeabra residents in the start-up of a business that will continue to develop the gel fuel and smokeless stoves, with the goal of operating at break-even point by December 2008 and earning a profit in 2009.

These goals have largely been met as of October 2008, as explained below.

Objective 1: Design and test a gel fuel generator and companion smokeless stove that accommodate the needs of Domeabra in terms of cost, available resources, fabrication capabilities, and business value

The design of the gelfuel production system, was initiated in the Fall of 2007 by 13 students in the Mechanical and Manufacturing Engineering Technology Department, under the supervision of Dr. Rogers. The basic requirements were that the system be built to produce gelled ethanol fuel using corn as the feedstock, the system was to be designed for operation in a remote African village in which electricity was not available, and that the system be modular so that it could be shipped to Africa and set up in the village. (Corn was chosen as the feedstock based on conversations with Nana Afaokwa.) Based on these requirements, four sub-teams were formed, responsible for the subsystems of corn treatment, fermentation, distillation, and the gelling. The basic systems were designed in the Fall of 2007, then built and integrated when NCIIA funds became available in February of 2008. The individual systems were integrated together in March of 2008, and the entire system was operational in April of 2008.

The stove design is proceeding on schedule. A team of six senior students in both Mechanical and Manufacturing Engineering Technology and General Engineering have teamed to work on this project to meet the requirements of their two-semester senior capstone sequence. The first prototype stove will be produced by the end of November 2008, and the design will be transferred to Nana Afaokwa.

Pictures of the construction and operation of the system and the disassembly and shipping to Ghana are shown below in figures A2-1 and A2-2.



Figure A2-1. Construction of the reflux column still in March,2008.

- Upper left: Construction of the cooling coil.
- Upper center: Steam-side coil being craded in the column.
- Upper right: construction of the steam/ethanol vapor inlet.
- Lower left: Installation of the Rashid rings.
- Lower center: The completed still.
- Lower right: The still mounted on the support tower, with the cooling water tank mounted on top of the tower



Figure A2-2. The gelfuel production system in Arizona.

- Upper left: The gelfuel system installed and being tested in Arizona in April 2008
- Upper right and lower left: The system being loaded in to the shipping container.
- Lower right: The system departing ASU bound for Ghana on June 6, 2008.

In April 2008, Nana Frimpong Afaakwa visited ASU to inspect and critique the system in April 2008, and his visit was featured on the PBS show Horizon. The figure below shows Nana being interviewed for the feature. The link to this program is: www.azpbs.org/horizon/transcript06.asp?ID=886. (The program is called “Ghana Cooking Stove.”)



Figure A2-3. Nana Frimpong Afaakwa in Arizona

Objective 2: Deliver a working prototype to Domeabra and partner with residents in setting up fabrication and distribution of the products.

The system was reassembled in Domeabra in September 2008. The following figure shows the ASU team along with Nana Afaokwa and villagers from Domeabra unpacking the gelfuel system in Domeabra.



Figure A2-4. Unpacking and installing the gelfuel system in the Domeabra facility.

- Upper pictures: Assembly of the main structural frame.
- Lower pictures: Unpacking and removing the reflux column still.



Figure A2-5. Testing the Gelfuel Production System in Domeabra.

- Upper left: The initial test of the firebox, in this case using wood. (The system is configured to use either direct combustion or LPG.)
- Top center: ASU student Chanson Shells with Nana Afaokwa, explaining the gelling process.
- Upper right: Domeabra residents taking the first ethanol sample
- Lower left: Product test - 93% ethanol (186 proof)
- Lower center: Water boiling on a South African version of a gelfuel stove
- Lower right: ASU student Brian Smith inspecting a small water leak in the cooling system
- Center: The ASU team and our Ghanaian partners in front of the gelfuel unit.

Objective 3: Assist Domeabra residents in the start-up of a business that will continue to develop the gel fuel and smokeless stoves, with the goal of operating at break-even point by December 2008 and earning a profit in 2009.

In the September testing the cost of production of ethanol, in terms of consumables, was found to be approximately 60 cents (US) per liter of fuel. This is very promising because the market cost of similar products in Ghana is found to be roughly six times this price, indicating that this product can be offered to consumers at a very reasonable price. Because of this low cost, it is likely that the system will be profitable.

At the present time, we are working with Nana Afaokwa to develop a business plan for the gelfuel project, including establishing a supply chain and distribution network. ASU and GlobalResolve are directly supporting this effort. Specifically, with the assistance of Professors Rogers and Henderson, Professor Jim Hershauer in the Carey School of Business at the Tempe campus has assigned this project to his senior honors thesis class. GlobalResolve continues to monitor this progress through bi-weekly communications with the Chief in Domeabra.