



GRASP/METER preliminary report

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# Abstract

# Introduction

# Background

## Fundamental problem

### Carbon emissions

### Cooking heat in low-income countries

## Carbon markets, an opportunity for funding sustainable energy for low-income households

Gold Standard [1], [2], [3]

## Scope of work

# Existing solutions

## Smart Biogas (commercially available) [4]

A green box with wires and a circuit board

Description automatically generatedA drawing of a machine

Description automatically generated

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Max Pressure readings (kPa) | Min Flow | Max Flow | Pipe fitting  (in) | Specified accuracy (%) |
| 10 | 0.07 | 4.20 | ¾ - ½ |  |

## Geocene (commercially available)

[5]

## iButton DS1921H-F5#

[6]

# Current projects at GHE

## Project tables

**High-level evaluation**

|  |  |
| --- | --- |
| Title | Status |
| Life Cycle Analysis of biogas digesters | In-progress |
| Estimating uncertainty in past biogas offsett projects and methodologies | In-progress |

**Testing**

|  |  |  |
| --- | --- | --- |
| Title | Status | Citation |
| Testing the accuracy of the smart biogas measurement device | Done | [7] |
| Comparing accuracy of Smart Biogas |  |  |
| Impact of Hydrogen Sulfide on Biogas Burning and Removal Evaluation | In-progress |  |
| HDPE and PET property testing with physical, chemical, and biological contamination | In-progress |  |

**Product development**

|  |  |
| --- | --- |
| Title | Status |
| Casing design, manufacturing and testing for in-situ biogas monitoring | Done |
| Monitoring of improved cookstoves: from prototyping to small batch manufacturing | Done |
| Logging and transmitting remote data from cookstove and biogas sensors in Malawi | Done |
| Volumetric flow meter development for household scale biogas reactors | Done |
| Developing a Methane Sensor for Biogas reactors in Malawi | Done |
| Development of a Monitoring Device for Improved Cookstoves | Done |
| Biogas sensor development: from prototyping to production | In progress |

## Project results/intermediary results

### Testing the accuracy of the smart biogas measurement device [7]

The Smart Biogas product developed by Inclusive Energy [4] was tested in a lab setting using calibrated mass flow meters using air-methane mixtures (Figure 1).

A green box with wires and pipes

Description automatically generated with medium confidenceA machine with wires and a red box

Description automatically generated

Figure 1 Lab setup with Smart Biogas connection (left) and mass flow controllers for CO2 and CH4 (right)

Initial results indicated errors above 20% for all flows and concentrations (Figure 2)

A graph of different colored lines

Description automatically generated

Figure 2 Initial tests with varying methane concentration and flow

Further tests showed frequent errors above 100% (Figure 3). The large errors in measurements are attributed to the sensor assembly itself. The use of a venturi restriction with absolute and differential pressure sensors does not seem appropriate in this case. The pressure sensors are only qualified for use with air and may degrade under CH4 and other corrosive gases present in biogas (such as H2S).



Figure 3 Smart Biogas tests under different flows, concentration and relative humidities.

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