# 1 Executive summary

The writer was hired to establish the validity of the claimed reduction in carbon emissions, as summarised in the PIN. The agreed process for conducting this check was a desk study of the documentation, a site visit and interviews with key informants. The report that follows contains the considered findings and conclusion – which are briefly highlighted in this executive summary under the four agreed criteria, as follows:

## 1.1 Are the projects real, on going and free of obvious design or structural flaws (including unintended social or environmental damage)?

The project is certainly real and on going. It does not present any obvious structural or design flaws or unintended damage.

## 1.2 Are the technologies listed in place and functional?

The project is very clearly in place and the gel fuel purchasing and distribution is operational. Record keeping is sufficient but could be improved. There is an issue with the functionality of the stoves and their longevity. It is apparent that after 3 years a number of stoves are not functioning optimally. The vent mechanism (and in some instances the whole lid) has rusted, making the stove considerably less efficient – and the project increasingly unlikely to achieve its off-set targets into year 4. The replacement of fuel-buckets and lids after 2-3 years is critical and is a first priority for any earnings from carbon sales.

## 1.3 Are the estimated CO2 savings plausible and unbiased?

The calculation of the CO2 savings as reflected in the PIN is, in the writer's opinion, unnecessarily complicated. The data and assumptions are not properly referenced and the calculations are not entirely apparent from the results. The finding from this check is that the CO2 savings are indeed plausible and unbiased, albeit on a different basis of calculation from that set out in the PIN.

The checked estimate of CO2 savings is set out in the table below:

| Technology | Year | Total emission savings (tCO2) |
|---|---|---|
| Avoided CO2 through gel fuel cook stoves | 2008 | 512 |
| Avoided CO2 through gel fuel cook stoves | 2009 | 1,814 |
| Avoided CO2 through gel fuel cook stoves | 2010 | 3,208 |
| **Total Avoided CO2 from project to date** | **2008 - 2010** | **5,535** |

## 1.4 Is the impact on poverty easily discernible?

Yes, the project has an obvious and easily identifiable impact on relieving poverty in the target area.

# 2 Project Summary

The project involves the distribution of over 4000 bio-fuel stoves to rural and some peri-urban households and the monthly distribution of 7 litres of bioethanol gel fuel, for free to each of these households. The project has been ongoing since at least 2008 and although some of the houses initially benefiting from the scheme have subsequently been supplied with electricity, additional houses have been added to maintain a distribution total of over 4000 beneficiaries.

# 3 Baseline

The baseline as defined in the PIN is the use of coal, paraffin, wood and dung for cooking and water heating purposes.

# 4 Sustainable social, environmental and developmental benefits

The poverty alleviation impact of the project flows from the cost savings to individual households where paraffin is displaced; and the time/effort where wood/dung is displaced. The distribution of a two-plate cook stove, free of charge provides a useful longer-term asset. The cash savings are in the range of R50 to 70 per month per household if paraffin is being displaced. Improved indoor air quality with the possible easing of related respiratory stress is also likely although some literature suggests that gel fuel is not harmless on this score. Gel fuel also reduced the fire/health risk associated – particularly with paraffin. There are new gel fuel stoves on the market which dramatically improve efficiency and these are worth considering in future roll out.

Although the contribution to poverty alleviation is modest by some standards, the levels of poverty in the target group are such that a small saving is significant at household level. The project also addresses an important political imperative – ensuring that municipal efforts focus beyond the formal sector and that the rural poor are not ignored when it comes to distributing 'free basic energy' which is often provided only to homes on the grid.

# 5 Volume assessment

The Municipality keeps a record of stove and gel fuel distribution, through a team of temporary staff who accompany the municipal truck to various sites within the Municipal area on different days. From a review of the sheets for 2010, it appears that 4,428 stoves are in play. It appears further that approximately 10% of the beneficiaries do not collect fuel, or do so erratically.

The easiest volume assessment method, however involves the purchase orders of gel fuel and the paid invoices kept by the municipality. It is apparent that gel fuel is not being stored for long periods and that there is no excess hoarding by the target beneficiaries. Gel fuel is in demand and the beneficiaries come to the distribution points to collect it. The gel fuel orders fluctuate from month

to month based on the stock left over from the previous month. From this information – and given the validation provided by the distribution lists – it is evident that we can more accurately rely on gel fuel purchases as the bases for assessing distributed volume. Estimated volumes distributed, working on an average sample of 4,000 homes, would be 7(litres) x 12 (weeks) x 4000 (homes). We would thus expect at best a total of 336,000 litres distributed in a year. If we look at the actual purchases for one year, it is evident that these ranged between 152,400 in 2009 and 269,500 in 2010. Working on the gel fuel payments within the municipal accounting records is therefore a more appropriate (and conservative) reflection of distribution. [1]

Gel fuel purchases (according to municipal accounting records) appear from the table below:

| Month | Year | 5L | 2L | Total Litres |
|---|---|---|---|---|
| August | 2,008 | 2,000 | | 10,000 |
| September | 2,008 | 1,100 | | 5,500 |
| October | 2,008 | 1,500 | | 7,500 |
| November | 2,008 | 2,000 | | 10,000 |
| December | 2,008 | 2,000 | | 10,000 |
| **2,008** | | **8,600** | **-** | **43,000** |
| February | 2,009 | 3,500 | | 17,500 |
| April | 2,009 | 5,000 | | 25,000 |
| May | 2,009 | 2,500 | | 12,500 |
| June & July | 2,009 | 6,000 | | 30,000 |
| August | 2,009 | 2,500 | 7,700 | 27,900 |
| September | 2,009 | 1,700 | 2,500 | 13,500 |
| November | 2,009 | 4,000 | 3,000 | 26,000 |
| **2,009** | | **25,200** | **13,200** | **152,400** |
| January | 2,010 | 6,000 | 6,000 | 42,000 |
| February | 2,010 | 3,000 | 3,000 | 21,000 |
| March | 2,010 | 3,000 | 3,000 | 21,000 |
| April | 2,010 | 3,000 | 3,000 | 21,000 |
| June | 2,010 | 6,000 | 6,000 | 42,000 |
| August | 2,010 | 3,000 | 3,000 | 21,000 |
| September | 2,010 | 1,500 | 1,500 | 10,500 |
| October | 2,010 | 5,000 | 5,000 | 35,000 |
| November | 2,010 | 3,000 | 3,000 | 21,000 |
| December | 2,010 | 5,000 | 5,000 | 35,000 |
| **2,010** | | **38,500** | **38,500** | **269,500** |

# 6 Methodology check

The methodology referred to in the PIN is AMS IIE, "Energy efficiency and fuel switching for buildings". This methodology is applicable to fuel switching in residential buildings. The aggregate energy savings may not exceed the equivalent of 60 GWh per year, the expected energy savings from this project is estimated (as per the PIN) at 4.24 GWh.

[1] It is recommended that the Municipality do a reconciliation of the distribution records and purchase records to ensure that these are accurately recorded.

Findings on the Methodology to calculate $CO_2$ equivalent emissions savings:

- The choice of AMS IIE is applicable to the replacement of paraffin with ethanol gel fuel for cooking and water heating purposes at a household level.

# 7 Emissions reduction calculation check

The CO2 savings identified in the PIN, are based on an assumed heating of approximately 88 litres of water per day, of which the quantity of gel fuel supplied will displace approximately one quarter (so, 22 litres). It is unclear to the writer why it was considered necessary to reduce the energy displaced at a homestead for cooking and water heating to a *factor* of '22 litres of boiled water' and to estimate the displaced fuel from a fairly complicated energy-balance calculation.

It is clear from the PIN and corroborated in the literature that the average rural household spends on average two to four hours cooking and heating water per day. The PIN estimates emissions of 4 tCO2 per year from this activity.

### 7.3.1 A pragmatic 'sense' test

As part of this checking exercise, a simple 'sense' test was conducted, using a bio-fuel stove and gel fuel available on the local market. It was evident that 250ml of gel would bring 1.1L of water to the boil (in about 15 minutes) with open vents and enable approximately 3 L of water to be brought to the boil successively before the gel fuel ran out. That is approximately 12L of water boiled per litre of gel fuel. In a repeat of the test, the water, once boiling was allowed to simmer at boiling temperature (with vents partially closed) for a total elapsed time of 2 hours, before the 250ml of gel ran out. Used conservatively, one litre of gel fuel could therefore bring 4 litres of water to the boil and keep it simmering for 8 hours.

**Table 1: Results of gel and gel stove "sense test"**

| | **Vents** | **Time to boil 1 litre of water** | **Time to use up 250 ml of gel** | **Extrapolated to 1 litre** |
|---|---|---|---|---|
| Green gel | Open | 15 mins | 40 mins | 2.6 hrs |
| | Closed | | 2 hrs | 8 hrs |

When the vents were left wide open, the 250ml of green gel fuel lasted a total of 40 minutes. One litre of gel fuel would do four times that; totalling 2hours and 40 minutes. Based on an average estimated 2 hours of daily cooking time, we could then certainly expect 7 litres of gel fuel to last at least 7 days and up to three times that if used conservatively. This matches the evidence from the field where households report that their gel fuel displaces approximately one week's worth of energy requirements, where they are often cooking two pots simultaneously (on the double burner). The field interviews also found

that it was unlikely that all users turned down (closed) the vents to allow a pot to simmer and the rusted state of many of the lids would in event have made this difficult.

It is clear, therefore (both from the controlled 'sense' test and from the stated experience of the beneficiaries) that the Gel fuel is (conservatively) displacing about one quarter of household energy use and if the estimate of 4 tons of emissions (from cooking and water heating) per annum per household is accurate, then the displacement of 1 tCO2 per household per year through the use of gel fuel is plausible and unbiased, given the relative emissions of gel fuel, compared to paraffin.

### 7.3.2 Rural household emissions

The question then is how reasonable the estimate is of 4 tCO2 emissions per year per household. Energy efficient cook stoves – on which there is a great deal of research literature – provide a useful comparative analysis. Emission savings from these stoves (which are estimated to reduce biomass use by about 35% across rural Africa) are calculated at 1tCO2/hh/y. The basis for this calculation must be an average total emission of about 3 tCO2/hh/y. Given the relative affluence of rural KwaZulu Natal, compared to most of rural Africa and the inclusion of significant paraffin use within the project area, 4 tCO2/hh/y is not an unrealistic estimate.

### 7.3.3 Carbon off-set calculation

The checked estimate of CO2 savings is set out in the table below:

| Technology | Year | Volume of gel fuel (in litres) | Factor of gel fuel to displace one quarter of fuel (7 Litres x 12 months) | Total emission savings (tCO2) |
|---|---|---|---|---|
| Avoided CO2 through gel fuel cook stoves | 2008 | 43,000 | 84 | 512 |
| Avoided CO2 through gel fuel cook stoves | 2009 | 152,400 | 84 | 1,814 |
| Avoided CO2 through gel fuel cook stoves | 2010 | 269,500 | 84 | 3,208 |
| **Total Avoided CO2 from project to date** | **2008 - 2010** | **464,900** | **84** | **5,535** |

## 7.2 Project monitoring

The emissions reductions are dependent on the quality of the gel. As was shown by the "sense test" different gel types perform differently, and this is highlighted in a study by Lloyd and Visagie[2]. It is proposed that the gel quality be kept constant and that the gel supplier (Green Gel) supply the

[2] Lloyd PJD and E F Visagie (2008), "The testing of gel fuels, and their comparison to alternative cooking fuels", Energy Research Centre, University of Cape Town.

municipality with an indication of the gel quality each time the supply is tendered, to ensure that an effective comparison is made between different suppliers. Either the efficiency or the calorific value should suffice but it may also be useful to conduct a quick field test.

The manner in which the stove is used also impacts dramatically on the efficiency, providing variable household cost savings and emission reductions. On going education of the users on how to use the gel stoves efficiently and effectively is important. As is the distribution of spare gel buckets and lids after every 3 years.