



Demonstration of an improved top-down  
ignition method in the Emfuleni municipality

Phase 1

Baseline report

Nova Institute

August 4, 2009

## **Executive summary**

### **Objective of the project**

The overall objective of the project is to achieve a sustained reduction in ambient air pollution through the expansion of the Basa njengo Magogo (BnM) programme into the Vaal Triangle.

The key quality indicator for BnM implementation is the sustained reduction in ambient air pollution.

Immediate project performance indicators include the percentage of coal using households in a given area that attend demonstrations, the percentage of demonstration attendants that use the Basa njengo Magogo method correctly, the percentage of initial users that continue to use Basa njengo Magogo method correctly as well as the number of households that did not attend demonstrations, but have taken over the method in other ways.

### **Implementation area**

The baseline survey was conducted in the towns of Sharpeville, Boipatong, Bophelong, Tshepiso, Eatonsyde and Ironsyde in the Emfuleni Municipality. The combined number of households in the implementation area is given by the 2001 census as 34950 households. Based on information about the number of residential stands and the number of households per stand that was derived from the data collected in the baseline survey it is estimated that there are 33397 households in the implementation area.

### **Past campaigns**

In 2007 the Clean Fires Campaign, a media campaign launched by the DEAT, was implemented in the area. Radio, newspaper and billboards advertisements were used to promote the use of the improved top-down ignition method. From the survey results it appears that less than 1% of coal users were converted to the improved method in this way.

## Research method

Data was collected by way of structured interviews with 1634 respondents based on a multi-phase sample from the implementation area. A questionnaire was developed based on version 4.1 of Nova's *Basa Magogo User Verification Survey*. Data capture was done *in situ* by trained fieldworkers using a mobile phone based questionnaire. The first level of quality control was already programmed onto the mobile phone. Extensive quality control, re-interviews per telephone and revisits were done afterwards to ensure accurate data.

## Results

Respondents were asked a range of questions related to their perception about air pollution, housing and domestic energy use. It is clear from the responses that almost all respondents (94%) are concerned about air pollution, but that most (67%) think that factories are the most important source. Recent modeling suggests however that from a health impact point of view, domestic sources are by far the most detrimental.

Slightly less than a third of households (32%) live in formal brick houses while about 37% live in subsidy houses. One fifth (20%) of the households in the area live in shacks. Although the majority of coal users live in formal houses, shacks have a higher proportion of coal users.

Just over a third of respondents (35%) indicated that they use coal in their homes. This proportion is as high as 69% in Ironsyde and as low as 19% in Eatonsyde. There has been a decline in coal use over the past three decades and this trend is continuing. This decline is also not evenly distributed between towns. About half of respondents in Bophelong who do not use coal have stopped using coal in the past two years while there was barely a decline in coal use in Tshepiso over the past two years. Coal is mainly used in winter with only 6% of coal users using coal in summer. Cast iron stoves are by far the most popular coal burning device. Braziers represent 19% of coal burning devices and are strongly associated with respondents who live in shacks.

The person who is responsible for making the fire is mostly an adult woman (median age: 45). Children very rarely have the responsibility of making fire.

Less than 1% of the coal users currently use the improved top-down ignition method.

About 12% of respondents use wood but not coal. This means that wood users will also represent a significant domestic source of air pollution that will not be addressed by the demonstration of the improved top-down ignition method for coal (although the method also works for wood). Only 17% of respondents do not use electricity. Respondents who do not use electricity are more likely to use coal although the majority of coal users also use electricity.

## Findings

The most important findings from the baseline results are:

1. There is general concern about air pollution although respondents generally do not believe that domestic coal use and especially domestic wood use, are the most important contributors.
2. Most respondents and most coal users live in formal housing.
3. Respondents who live in informal houses are more likely to use coal.
4. The area is densely populated with a mean of 1.27 households per stand.
5. Coal use varies significantly between towns.
6. Nowhere do coal users represent more than half of the population of a town.
7. Coal use have declined significantly in the past two years in some areas.
8. There is no significant level of use of the improved top-down ignition method in the area despite the activities of the *Clean Fires Campaign*.
9. The majority of coal users use cast iron stoves. The use of these stoves are likely to lend a high degree of inertia to coal use patterns.
10. Brazier use is associated with shack dwellers.
11. The person responsible for making fire is likely to be a female and is very seldom a child.

12. One tenth of the population uses wood but not coal. This is likely to be a significant source of air pollution.
13. The vast majority of respondents and also of coal users use electricity.
14. Households that do not use electricity are more likely to use coal.
15. Shack dwellers are less likely to have electricity.

## Conclusions

The main conclusions can be derived from the findings are:

1. The house-to-house demonstration of the improved top-down ignition method should continue as there is a significant number of coal users in the area and practically no uptake of the method from other sources.
2. It is likely that pollution from domestic wood use makes a significant contribution to the health impact of air pollution in the area and that the incidence of domestic wood use may increase due to very high coal prices.
3. The methodology of the *Clean Fire Campaign* was not effective and should be reconsidered.

## Planned implementation

Based on the information from the baseline survey, the following targets have been set for each area. The targets are based on the number of coal users in each town and the target uptake rate (73%) which is the product of the target contact efficiency<sup>1</sup> (90%), the target invitation efficiency<sup>2</sup> (90%) and the target demonstration efficiency<sup>3</sup> (90%). The target efficiencies are significantly higher than what most implementers have achieved thus far. The number of stands, number of households, number of coal users derived from the results of this survey and targeted conversions per town are given in the table below.

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<sup>1</sup>The proportion of the coal using population contacted

<sup>2</sup>The proportion of the invited coal users who attend a demonstration

<sup>3</sup>The proportion of the coal users who convert after attending a demonstration

<b>Township</b>	<b>Stands</b>	<b>Coal use %</b>	<b>Coal users</b>	<b>Conversions at 73% uptake</b>
Sharpeville	6263	43%	3493	2546
Tshepiso	6116	34%	2670	1946
Boipatong	3401	41%	1830	1334
Bophelong	10517	27%	3633	2640
Eatonsyde	1575	19%	295	215
Ironsyde	631	69%	436	318
Boiketlong	±2000	38%	764	557
<b>Total</b>	<b>30 503</b>		<b>13 121</b>	<b>9556</b>

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# Chapter 1

## Background

### 1.1 Purpose of this document

The purpose of this document is to determine the extent of coal use and use of the improved top-down ignition method before the start of demonstrations of the technique within the project area. This will facilitate a transparent assessment of the impact of the project.

The results presented here will furthermore be used as key input into detailed implementation planning to ensure realistic targets which could be measured in an accurate and transparent manner.

### 1.2 Project objective

The overall objective of the project is to achieve a sustained reduction in ambient air pollution through the expansion of the Basa njengo Magogo (BnM) programme into the Vaal Triangle. The key quality indicator for the BnM implementation is the sustained reduction in ambient air pollution. Nova's benchmark is that this should be in the order of 40% but will depend on the relative contribution of other sources.

The following intermediate efficiencies are monitored to ensure that the project objective is achieved:

**Contact efficiency** The percentage of coal using households contacted within the project area.

**Invitation efficiency** The percentage of households in a given area that attend common or household demonstrations.

**Demonstration efficiency** The percentage of the households that attend demonstrations, that use the Basa njengo Magogo method correctly.

**Retention** The percentage of households that continue to use Basa njengo Magogo method correctly after a given period of time.

**Spillage** The number of households that did not attend demonstrations, but have taken over the method in other ways.

The specific target for each indicator is given in 5.1.3.

## 1.3 Implementation area

The project is executed within the boundaries of the Emfuleni Municipality which is part of the Sedibeng District Municipality and is situated in Gauteng, South Africa. Since the Emfuleni Municipality has engaged in a similar project in Sebokeng and Evaton, the project is limited to the remaining coal using areas of Emfuleni namely Sharpeville, Boipatong, Bophelong, Tshepiso and Ironsyde/Eatonsyde. Basic background on these areas is provided below.

### 1.3.1 Sharpeville

#### 1.3.1.1 History

Sharpeville was established in 1942 where 5466 dwellings were erected. Sharpeville has played an important part in the political history of South Africa. The Sharpeville shootings occurred on 21 March 1960, when South African police began shooting on a crowd of black protesters, killing 69 people. Humans Rights day has been commemorated in South Africa on this day since 21 March 1994. Former president Nelson Mandela selected Sharpeville as venue for signing the law of the Constitution of South Africa on 10 December 1996.

### 1.3.1.2 Population

The 2001 census estimated the population of Sharpeville at 11 434 households. The census results for the main sources of heating energy is given in Table 1.1 on page 3. This only indicates 1 242 coal using households. One should bear in mind that the census only asked what the *primary* source of heating energy was and did not have space for more than one heating energy source. The survey results presented in Chapter 3 will give a more accurate and current estimate of the number of coal users in the area. It is interesting to note that paraffin is only slightly less popular than coal as source of heating energy.

Table 1.1: Census 2001 results for primary energy source for heating: Sharpeville

	<b>Electricity</b>	<b>Gas</b>	<b>Paraffin</b>	<b>Coal</b>	<b>Other</b>	<b>Total</b>
Sharpeville Ext 17	239	3	24	42	3	310
Sharpeville	3	0	128	183	109	424
Sharpeville SP	8562	48	740	1017	109	10700
<b>TOTAL</b>	<b>8804</b>	<b>51</b>	<b>892</b>	<b>1242</b>	<b>221</b>	<b>11434</b>
%	77.00%	0.45%	7.80%	10.86%	2.07%	100.00%

### 1.3.2 Boipatong

Boipatong, Tshepiso and Bophelong were established in 1955 to house black residents who worked in Vanderbijlpark (mainly Iscor) and Vereeniging (mainly Usco).

#### 1.3.2.1 Population

The 2001 census counted 4 487 households in Boipatong of which 36.71% used coal as primary source of heating energy. Summarised results of the 2001 census are given in Table 1.2 on page 4.

Table 1.2: Census 2001 results for primary energy source for heating: Boipatong

Sub_Place	Electricity	Paraffin	Coal	Other	Total
Boipatong	4	339	724	139	1206
Boipatong SP	1923	309	923	125	3281
<b>TOTAL</b>	1927	648	1647	244	4487
%	42.95%	14.44%	36.71%	5.88%	100.00%

### 1.3.3 Tshepiso

#### 1.3.3.1 Population

The number of households in Tshepiso is given in the 2001 census as 6706 of whom 21.34% (1431) used coal as primary source of heating energy.

Table 1.3: Census 2001 results for primary energy source for heating: Tshepiso

Sub_Place	Electricity	Paraffin	Coal	Other	Total
Tshepiso	76	490	199	195	960
Tshepiso SP	3650	492	1232	371	5746
<b>TOTAL</b>	3726	982	1431	566	6706
%	55.56%	14.64%	21.34%	8.46%	100.00%

### 1.3.4 Bophelong

#### 1.3.4.1 Population

The 2001 census results indicate that Bophelong had 12 323 households of which 12.26% (1511) used coal as primary heating source.

### 1.3.5 Housing and population

The Emfuleni Municipality gathered information about the number of people in each area as well as the types of houses in which each household lived. A summary is given in Table 1.5.

Table 1.4: Census 2001 results for energy source for heating: Bophelong

Sub_Place	Electricity	Paraffin	Coal	Other	Total
Bophelong	0	4	254	0	258
Bophelong SP	8 177	1 140	1 257	1 491	12 065
<b>TOTAL</b>	8 177	1 144	1 511	1 491	12 323
%	66.36%	9.28%	12.26%	12.10%	100.00%

Table 1.5: Population and house type per town

Township	Brick houses	RDP Houses	Informal houses	Population
Sharpeville	5 466	190	607	25 052
Tshepiso	1 419	2 918	1 779	24 464
Boipatong	2 289	1 095	17	13 604
Bophelong	1 209	9 217	91	42 068
Total	10 383	13 420	2 494	105 188

## 1.4 Past BnM campaigns in the area

In July 2008 the deputy minister of Environmental Affairs and Tourism launched the *Clean Fires Campaign* in Sebokeng, also in Emfuleni. In the business plan of the Campaign, the purpose was described as follows:

... what is required is a campaign that will:

- Make at least 1 million affected people aware of the impacts of pollution from “dirty” fires.
- Make the people aware of the Basa Njengo Magogo fire-making methodology as a “win-win”, no-cost alternative to dirty fires.
- Motivate people, through political commitment, social responsibility or pure self-interest, to change to BnM.
- Clearly demonstrate how to implement the methodology in their own homes.

The strategy was to involve marketing professionals to design a high-profile, high-impact campaign. (CFC 2007:19). Billboards, radio and newspaper advertisements as well as public events were used.

# Chapter 2

## Research method

### 2.1 Sample design

A multi-stage sample was used. The following process was followed for each town included in the study:

1. All suburbs where coal is used and where demonstrations are to take place were selected.
2. In each suburb the street blocks were uniquely numbered.
3. A number of street blocks were randomly selected.
4. In the selected street block a random starting point was selected. The starting point would be a random corner (north-east, north-west, south-east, or south-west).
5. A random starting house was selected choosing one of the first three houses with the aid of a list of random numbers between one and three.
6. From the first house, each third house was selected. When respondents refused to participate or were not present, the next house in the sequence was selected.
7. The fieldworker continued to interview respondents in houses that fall within the sequence until she/he reached the starting point again.

8. If more interviews had to be done to complete the quota for each town, another block was selected in the same manner.

A total of 1634 structured interviews were conducted, electronically coded, captured, subjected to quality control and analysed.

## 2.2 Recruitment and training of fieldwork staff

After a steering committee was established to include all community stakeholders in the implementation process, an invitation was given to the various ward councilors to identify suitable fieldworkers from each area. From this pool a total of 12 were selected to be trained as Nova fieldworkers. The training was done with three groups of fieldworkers: six from Sharpeville, Boipatong and Tshepiso at the end of February 2009, a further three from Bophelong at the end of March 2009 and three from Ironsyde, Eatonsyde en Boiketlong in April 2009. Training sessions stretched over two days, and included:

- Background on the Nova Institute and the development of the BnM method.
- Demonstration of the improved top-down ignition method in stoves and braziers.
- The role of local steering committees.
- The function of the Baseline and Verification Survey.
- Feedback from the two field-tests conducted with the improved mobile phone-based survey methodology.
- A complete description of each question and the possible answers.
- The employment of cell phones to conduct surveys, including question structure, different types of questions, maintenance of phones and problem solving.
- Virtual interviews for practice during training.

- A full description of the importance of the quality control process and all steps taken by Nova to ensure accurate information.
- Contracting, payment, obtaining bank details and issuing of uniforms and cell phones.
- Detailed explanation of the output based remuneration system.

## 2.3 Fieldwork

The fieldwork was carried out by a team of nine fieldworkers who had undergone fieldwork training. The work started the first week of February in Sharpeville and continued until 2009-06-03 when the work in Eatonsyde was completed. A total of 1634 structured interviews were conducted.

The initial phase of the baseline study was conducted in Sharpeville, Tshepiso, Bophelong and Boipatong. Analysis of the preliminary results lead to the decision to extend the project area to Eatonsyde, Ironsyde and Boiketlong. The national elections made it difficult to operate during the first half of April 2009 as councilors were not available. For that reason the fieldwork for the second phase of the baseline report only took part after the elections on 22 April 2009.

## 2.4 Quality control

**Levels of quality control** The quality control process was implemented at different stages of the process. These stages were:

1. Execution of the sample plan
2. Data collection by structured interviews
3. Coding and data capture
4. Analysis

On each level of implementation certain errors may occur. The steps that were taken to ensure that an accurate and reliable result would be obtained at the end of the process are described below. This is summarised in Table 2.1 on page 11 and discussed further in the paragraphs that follow.

Table 2.1: Quality controls (part 1)

Stage of survey	Possible errors	Possible impact of error	Controls implemented	Scale of control	Corrective action	Result
<b>Selection of numbers</b>	Omission of sections from sample plan	Sample will not represent the total project boundary	1. Sample compared with maps of area	All sections	None needed	The sample represents the whole of the geographical project boundary
<b>Adherence to sample plan</b>	Fieldworker (FW) deviation from sample plan	Depends on scale and if deviation was random or systematic	Fieldwork manager (FM) checks questionnaires against sample plan	All realised interviews	A number of records was deleted because they fell outside the sample	Deviations from sample plan are small and non-systematic
<b>Structured interviews</b>	Fieldworker interview errors	Inaccurate data	1. FM revisits or phones a selection of houses 2. Electronic checks	1. >10% 2. All data was electronically checked through pre-programmed checks	1. Phone or revisit household to repeat and clarify questions 2. Errors were sent back to FW for revisit and correction	1. Ambiguous interviews avoided through by programmed functions on mobile phone 2. Questionnaires containing inconsistencies were identified and corrected

Table 2.2: Quality controls (part 2)

Stage of survey	Possible errors	Possible impact of error	Controls implemented	Scale of control	Corrective action	Result
<b>Structured interviews</b>	Fieldworker fraud	Completely false information	FM phoned or revisited a selection of households from each fieldworker	10% phoned / revisited	Disqualify suspect interview records and repeat	None needed
<b>Data coding and capture</b>	Fieldworker typing error	Final data set is an inaccurate version of fieldwork	Pre-programmed checks, required questions and skip patterns on mobile phone	All records	Implemented in real time	The final database is to a high degree free from typing errors

**Execution of the sample design** It is also possible that a fieldworker may deviate from the numbers allocated to her/him either deliberately or not. If the deviation is small and random, it would not jeopardise the representivity of the sample. If the deviation was systematic it could bias the sample. To control for this the area leader allocated the house numbers to field workers and checked responses against the sample design to ascertain if any deviations occurred and what the extent of the deviations was. The few deviations that did occur will have no impact on the representivity of the sample.

**Data collection by structured interviews** Conducting the structured interviews is the most crucial stage of the work because this is where the information from the respondents is obtained. Different kinds of errors occur at this stage. When responses are documented by hand, the most common errors are related to incomplete or ambiguous questionnaires or mistakes by fieldworkers in asking the questions and documenting the answers from respondents. For this reason, the mobile-phone based system can be programmed to make questions compulsory (in order to avoid incomplete data). Pre-programmed skip patterns and prerequisites ensure consistency in each questionnaire.

Daily spot checks were performed by the fieldwork manager (either by phone or revisit) to ensure that the fieldworkers actually visited the respondents.

During quality control, three issues relating to this phase were identified and addressed:

1. One fieldworker multiplied the monthly coal usage of households with four to obtain a total winter usage. This was contrary to the training given. This practice was immediately identified, and the worker instructed to return to each household and obtain the correct information. The records were amended and it was ensured that she understood the right method for further surveying.
2. Another case was found where the fieldworker did not properly explain the question on coal usage, resulting in respondents not indicating that they used coal during winter. Instead, they replied 'no' when asked if they used coal, meaning that they did not use coal at the time of the interview. Again, the practice was identified soon in the surveying process, and revisits were conducted to amend records. The formulation

of the question was also changed to clearly state that coal use at any time of the year was relevant.

3. A third case was found where a large number of respondents who were re-interviewed telephonically claimed that there was no visit by the Nova fieldworker at their houses. The fieldwork manager was supplied with the records of all these respondents, and personally visited each household. He found that each household had indeed been visited, and that the data submitted by the fieldworker was indeed correct. The cause of the incorrect results appeared to be one of two factors. Firstly, the fieldworker pressured respondents to supply phone numbers, and when they did not have a phone, to supply a household member's number. When the number that didn't belong to the original respondent was dialed, the owner of the phone was mostly unaware of the fieldworker's visit. Secondly, some respondents reacted to a general atmosphere of nervousness caused by the upcoming national elections (22 April 2009). These respondents became very defensive when asked about their personal details, and as a first reaction did not want to engage with an evaluator. The revisit by the area leader however soothed their concerns, and an open atmosphere resulted in honest communication. The fieldworker's data was thus deemed to be reliable. Again, the formulation of the question asking a contact number was changed to stress the importance of a personal number if it is available, and to refrain from giving someone else's number.

**Coding and data capture** The responses are captured directly by the fieldworker on the mobile phone and transmitted to a central database. Some questions are programatically recoded on the database to make them more readable.

Apart from the quality deviations mentioned above, the only amendments made to original records were in regard to suburb names. There are discrepancies between the naming of suburbs on the maps provided by the municipalities and the names by which residents know these areas. For example, an area named 'Tshepiso Extension 1' on the map might be known by another name. Occasionally, fieldworkers will indicate the common name of a suburb rather than the name that was provided on the sampling plan. This caused a problem with the data analysis. The names were thus amended to reflect

the identification in the sampling plan. This was done by ensuring that the stand number provided in the fieldworkers record correspond to the number provided in the sampling plan and that the number is unique in the entire plan. Furthermore, it was also cross-checked with date and time recordings that the worker was in fact active in that specific area. Secondly, the spelling of a suburb name also caused difficulty when electronically analysing the data. For Tshepiso Extension 1 there might be multiple spellings (e.g. Tshepiso Extension 1, Tsep Ext 1, tsep ext1, TSH EXT.1 etc.), resulting in a multitude of identifications for a particular area. In correlation with the method described above, these records were amended to reflect a uniform suburb name (for the above example ‘Tshepiso Ext 1’). The original records were however kept for record purposes.

**Analysis** After the data had been coded and captured, computerised tests were performed to ascertain the consistency of the data and uncover any further mistakes that may be present in the data. The tests performed include the following:

1. Checking minimum and maximum values to see if values fall within the expected range
2. Checking for known correlations

## 2.5 Conclusion

The method employed for sampling, data collection and capture provided data of sufficient quality to be used as baseline for the project and to be used as a basis for estimating the impact of the project together with a similar post-implementation survey. The baseline method will also form part of scope of the methodology review by an external auditor, which is part of the improved methodology that is a deliverable of the project.

# Chapter 3

## Results

This chapter gives the detailed results of the structured interviews. The interviews contained questions about aspects including personal details of the respondents, the houses they inhabit, the stands that they live on, coal use and coal use trends, coal burning devices, fire making practices, wood use and electricity use. The questionnaire is attached as Addendum A.

### 3.1 Respondents

A total of 1634 responses was obtained from 10 distinct areas. The areas with the number of responses obtained for each are given in Table 3.1<sup>1</sup>.

### 3.2 Concern about air pollution

Two questions in the questionnaire were included to determine if the population in the research area are concerned about air pollution and what they think the major source of that pollution is. The results are presented in Table 3.2.

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<sup>1</sup>On the last line of each table, information about the sample size and number of missing values are given. Not all questions were answered by all respondents as some only apply, for example, to coal users. Two respondents were under aged and did not complete the whole interview. For this reason there are two missing values for a number of variables.

Table 3.1: Table of town

	Frequency	Percent
Boiketlong	90	5.51
Boipatong	203	12.42
Boipatong Informal	29	1.77
Bophelong	336	20.56
Eatonsyde	160	9.79
Ironsyde	55	3.37
Sharpeville	300	18.36
Sharpeville Informal	53	3.24
Tshepiso	301	18.42
Tshepiso Informal	107	6.55
Sample.info	: n=1634	Missing=0

Table 3.2: Table of Concerned about air pollution

	Frequency	Percent
YES	1533	93.93
NO	61	3.74
Don't know	38	2.33
Sample.info	: n=1632	Missing=2

The question “Do you think that air pollution is a problem in this community” was answered overwhelmingly affirmative with 1533 respondents (93.93%) agreeing with the statement. It is clear that the people of the Vaal Triangle believe that they are exposed to dangerous levels of air pollution. The responses to the question about the main source of air pollution reveal that factories are seen as the main source of pollution. This is given in the table below.

### 3.3 House types

The types of houses occupied by the respondents are shown in Table 3.4. A total of 528 (32.35% of the sample) respondents live in formal brick houses.

Table 3.3: Table of Most important pollution source

	Frequency	Percent
Factories	1030	67.19
Power stations	29	1.89
Traffic	76	4.96
Coal	270	17.61
Wood	18	1.17
Veld fires	74	4.83
Something else	36	2.35
Sample.info	: n=1533	Missing=101

RDP houses account for 605 or 37.07% of the responses while shacks account for 334 or 20.47% of houses. A smaller percentage (4.96% and 4.66%) live in extended RDP houses<sup>2</sup> or leanto shacks<sup>3</sup>.

Table 3.4: Table of House Type

	Frequency	Percent
RDP	605	37.07
Ext.RDP	81	4.96
Leanto	76	4.66
Shack	334	20.47
Brick	528	32.35
Other	8	0.49
Sample.info	: n=1632	Missing=2

The question whether there is a relationship between coal use and house type is important for a project that aims to reach a very high proportion of coal users because if a strong correlation exists, field teams could be instructed to place special emphasis on reaching inhabitants of specific house types. A cross-tabulation of the results of the question on house type and the question on coal use is given on the next page. When interpreted correctly, a cross-tabulation of categorical data alone, reflects a lot of useful information. When

<sup>2</sup>A RDP house extended by a shack

<sup>3</sup>A shack build against the wall of a formal house

summarised in a cross-tabulation, a chi-square test can be used to test for a dependency between *house type* and *coal use*. For the purpose of this test, house types *RDP* and *Extended RDP* were considered one category and house types *shack* and *leanto shack* were sorted together in a third category. The category *other* was not used in the analysis.

Crosstabulation of hh.type.r by hh.coal.use.r

hh.type.r	hh.coal.use.r		
	YES	NO	
Brick	229	299	528
	43.37	56.63	32.51
	40.18	28.37	
RDP	153	533	686
	22.3	77.7	42.24
	26.84	50.57	
Shack	188	222	410
	45.85	54.15	25.25
	32.98	21.06	
	570	1054	1624
	35.1	64.9	

X2[2] = 86, p = 2.1e-19

observed

expected

	YES	NO	Total
Brick	229	299	528
	185.32	342.68	
RDP	153	533	686
	240.78	445.22	
Shack	188	222	410
	143.90	266.10	
Total	570	1054	1624

Cell Contributions

YES NO

Brick 10.30 + 5.57 +  
 RDP 32.00 + 17.30 +  
 Shack 13.51 + 7.31 = 85.99

df = 2 P-value = 0

The first table above is read in the following way: The first number in each cell indicates the raw frequency. The second value in each cell gives the row percentage while the third gives the column percentage. Consider for example the first cell. There were 229 respondents in the sample who live in brick houses who use coal. These 229 respondents represent 43.37% of the 528 respondents who live in brick houses and 40.18% of the 570 coal users in the sample.

The p-value of the chi-square test is given below this first table. The very small p-value of practically zero indicates a strong dependency between house type and coal use. Inspection of the contributions of the individual cells to the total chi-square value revealed the following: The much lower than expected coal use by residents in RDP houses (153 observed versus 240.78 expected) and the higher than expected non-coal using inhabitants of RDP houses (533 observed versus 445.22 expected) were the two cells with the largest contribution to the high chi-square value and thus the most significant.

### 3.4 Number of houses per stand

The average number of households per stand in the study is 1.27. This means that the population density of the area is high compared to other townships and very high compared to suburban areas.

### 3.5 Coal use

This section will report the findings on the extent and nature of domestic coal use in the study area, which was also the main purpose of the baseline study.

### 3.5.1 Extent of coal use

Of all the respondents, 575 or 35.23% indicated that they use coal in their homes. However, because of differences in the coal using profiles for the different towns, it may be better to analyse the coal use per town individually. For this reason a table of the percentage of coal users per town is presented in Table 3.5.

Table 3.5: Table of Coal using percentage per town

Town	Coal using percentage
Boiketlong	38.20
Boipatong	42.36
Boipatong Informal	34.48
Bophelong	26.49
Eatonsyde	18.75
Ironsyde	69.09
Sharpeville	39.80
Sharpeville Informal	60.38
Tshepiso	23.59
Tshepiso Informal	61.68

As can be seen in the table above, the proportion of coal using household per town varies from a minimum of 18.75% in Eatonsyde to a maximum of 69.09% in Ironsyde. In no instance do coal users form a majority of households.

The projected number of coal users per town is given in Table 5.2.

### 3.5.2 Decline in coal use

There has been a decline in domestic coal use in South Africa since the 80s. The current survey again revealed evidence of such a decline. A question was included for households who do not use coal whether they have used coal in the past two years. Responses showed that 17.41% of households who do not use coal at the moment were using coal in the past and have stopped between 2007 and 2009.

Once again there are differences between towns regarding their historical levels of coal use as well as the rate of decline over the past two years.

Table 3.6: Stopped using coal since 2007 per town

Town	Used coal in past:		Still use coal	% of non-coal users who stopped using coal since 2007
	Yes	No		
Boiketlong	8	47	35	14.55
Boipatong	0	117	86	0.00
Boipatong Informal	0	19	10	0.00
Bophelong	126	121	89	50.01
Eatonsyde	8	122	30	6.15
Ironsyde	2	15	38	1.76
Sharpeville	34	146	120	18.88
Sharpeville Informal	1	20	32	4.76
Tshepiso	5	225	71	2.17
Tshepiso Informal	0	41	66	0.00

The very high number of people who have recently stopped using coal in Bophelong (51.01%) is striking. Similarly striking is the fact that there was barely a decline in coal use (only 2.17%) amongst the respondents in Tshepiso. There is a need to further investigate the reasons for these differences.

A question was included to ascertain if any of the households who have stopped using coal over the past two years were users of the improved top-down ignition method. Of the 184 respondents who stopped using coal in the last two years, 0 were *Basa njengo Magogo* users.

### 3.5.3 Coal burning devices

The households who indicated that they use coal were asked what coal burning device they use. Their answers are summarised in Table 3.7.

Most coal users (69.04%) use cast iron stoves while 9.22% of coal users use a welded stove and 18.78% use braziers (*izimbaula*).

Cast iron stoves are extremely durable and lend a high level of inertia to coal use patterns since they also represent a substantial investment for a low income family. Braziers on the other hand are not durable at all and seldom last longer than a year. One can expect that brazier users will be more flexible in their use of energy carriers. It has been suggested that the fact that metal containers from which braziers are traditionally made is no

Table 3.7: Table of Coal burning device

	Frequency	Percent
Welded Stove	53	9.22
Cast iron stove	397	69.04
Mbaula	108	18.78
Other	17	2.96
Sample.info	: n=575	Missing=1059

longer readily available (amongst other things because paint is sold in plastic containers lately) contributes to the decline of brazier use.

Crosstabulation of hh.coal.device.r by hh.type.r

hh.coal.device.r	hh.type.r			
	Brick	RDP	Shack	
Cast iron stove	201	98	94	393
	51.15	24.94	23.92	71.07
	90.54	68.06	50.27	
Mbaula	5	25	78	108
	4.63	23.15	72.22	19.53
	2.252	17.36	41.71	
Welded Stove	16	21	15	52
	30.77	40.38	28.85	9.403
	7.207	14.58	8.021	
	222	144	187	553
	40.14	26.04	33.82	

$X^2[4] = 110, p = 5.9e-23$

Crosstabulation of hh.coal.device.r by hh.type.r

hh.coal.device.r	hh.type.r			
	Brick	RDP	Shack	
Cast iron stove	201	98	94	393
	51.15	24.94	23.92	71.07

	90.54	68.06	50.27	
Mbaulta	5	25	78	108
	4.63	23.15	72.22	19.53
	2.252	17.36	41.71	
Welded Stove	16	21	15	52
	30.77	40.38	28.85	9.403
	7.207	14.58	8.021	
	222	144	187	553
	40.14	26.04	33.82	

observed  
expected

	Brick	RDP	Shack	Total
Cast iron stove	201	98	94	393
	157.77	102.34	132.90	
Mbaulta	5	25	78	108
	43.36	28.12	36.52	
Welded Stove	16	21	15	52
	20.88	13.54	17.58	
Total	222	144	187	553

Cell Contributions

	Brick	RDP	Shack	
Cast iron stove	11.85 +	0.18 +	11.38 +	
Mbaulta	33.93 +	0.35 +	47.11 +	
Welded Stove	1.14 +	4.11 +	0.38 =	110.43

df = 4 P-value = 0

An analysis has been done to ascertain if coal burning devices are more

strongly associated with certain house types. The table above cross-tabulates coal burning device and house type<sup>4</sup>.

The table is read in the same way as described previously for the cross-tabulation between house type and coal use in subsection 3.3. Consider as an example the first cell: There were 201 respondents who live in brick houses who use cast iron stoves in the sample. These 201 users are 51.15% of the 393 respondents who use cast iron stoves while 90.54% of coal using respondents who live in brick houses use cast iron stoves.

A chi-square test for independence was conducted on the table above. The test resulted in a very small p-value of practically zero (3.26e-20) thus indicating a strong dependency between household type and coal burning device. Inspection of the contribution of the individual cells towards the total chi-square value revealed that the very high percentage brazier use by shack dwellers and the very low brazier use by inhabitants of brick houses were the two cells with largest contribution to the high chi-square value and thus the most significant.

### 3.5.4 Winter and summer use

Coal users were asked if they also use coal in summer. Of the 575 (35.23%) respondents who are coal users, 35 (6.09% of coal users) reported also using coal in summer. This finding supports published data which suggests that coal use in the Vaal triangle is mainly a winter activity. This again emphasised the important role that the need for thermal comfort plays as driver of coal use.

### 3.5.5 Coal purchase

Coal is sold by coal merchants who operate coal yards where large quantities (usually 15 ton loads) from the mines are delivered. From there it is sold by bag or by tin or sold from tractors or even horse-carts in the streets. This means that coal can be delivered to the households at their doorstep

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<sup>4</sup>The category “Other” has been left out for each variable as there were very few responses. The category “Leanto shack” has been merged with “Shack” and “Extended RDP” has been merged with “RDP”.

on almost every day of the week. The comfort of acquiring coal and the well established network of distribution are reasons why one can expect coal use to continue for some time.

### 3.5.5.1 Format

Coal users were asked in what format they buy coal. Results are presented in Table 3.8<sup>5</sup>.

Table 3.8: Table of Format

	Frequency	Percent
Big Bag	375	65.22
Small Bag	110	19.13
Tin	79	13.74
Other	11	1.91
Sample.info	: n=575	Missing=1059

It is clear that coal is purchased mainly in bags with a unexpectedly high number of users (13.74% of coal users) who buy coal per tin.

### 3.5.5.2 Frequency

Coal users were also asked at what frequency they buy coal. The responses is presented in the Table 3.9.

Most coal users (21.18%) buy coal as needed.

## 3.5.6 Person responsible for fire

It is important to determine the profile of the population who ignites the fire as this will give an indication which ways of communication should be employed to reach them in the most effective way. It is important to determine in the first place how many of the household members ignite the fire. The

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<sup>5</sup>The large number of missing values is due to the fact that respondents who do not use coal did not answer the question. This does not indicate a poor response to the question.

Table 3.9: Table of Frequency

	Frequency	Percent
As needed	346	60.17
Monthly	129	22.43
Every Fortnight	42	7.30
Weekly	49	8.52
Other	9	1.57
Sample.info	: n=575	Missing=1059

questionnaire allowed for the details of multiple fire makers to be captured. The age and sex of the person or persons who make fire were also determined for each household.

### 3.5.6.1 Number of coal users per household

Out of the 575 respondents who use coal, 515 (89.72%) have only one person who makes fire in the household while 45 (7.83%) households have two persons and 14 (2.43%) have three or more. Research in other areas has shown that it is possible that some members of the households use BnM while others do not.

### 3.5.6.2 Sex

The majority of persons responsible for igniting the fire are female. Of the total of 648 firemakers, 491 (75.77%) are female. Of the 516 households where only one person makes fire, 77.71% are female.

### 3.5.6.3 Age

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
1	18.00	32.00	45.00	46.10	58.00	98.00	2.00

Table 3.10: Summary of age of firemaker

The average age of the persons who make fire in households where only one person makes fire is 46.1 . The median age is 45. The small difference between the mean and the median is indicative of a rather symmetric distribution for age. The minimum age was 18 and the maximum was 98. Half of all firemakers are aged between 32 and 58.

This shows that the people responsible for making fire are adults and that a focus on children younger than 18 is misplaced as they are not responsible for making fire.

### **3.5.7 Improved top-down ignition**

The purpose of the project is to promote the adoption of the improved top-down ignition method by the highest possible proportion of coal users in the project area. For this reason the current levels of use of the improved top-down ignition method is of the utmost importance. The question related to the use of ignition method was phrased in such a way as to avoid biasing the respondent toward a particular answer. The question was phrased: "Describe how you ignite your coal fire". The field workers were trained in the improved top-down ignition method so that they were able to identify the improved method from the description of the respondent.

#### **3.5.7.1 Distribution**

The responses to the question on ignition method were recorded separately for each fire maker. Of all 648 firemakers only 5 use the improved top-down ignition method. This represents 4 out of the 575 (i.e. 0.7%) households who use coal.

#### **3.5.7.2 Source of information**

The users of the improved top-down ignition method were asked where they had learned the method. Three respondents learned about it on the radio while the other two (who live in one household) have attended a demonstration in 2008.

### 3.5.7.3 Coal savings

The users of the improved top-down ignition method were asked if the use of the improved method had helped them to save coal. Since there were so few responses, the results cannot be analysed statistically. They are however reported here for the sake of completeness.

Of the 4 households who use the improved method, 4 reported coal savings of an average of 56.25% of their initial use before starting to use the improved ignition method.

## 3.6 Wood use

Wood use causes more pollution per unit of energy produced than coal use. It is therefore important to understand wood use patterns as well. Respondents were asked in what format they buy wood. The results are represented below.

Table 3.11: Table of Format of wood use

	Frequency	Percent
I don't use wood	908	55.64
Bundles	108	6.62
Pallets	413	25.31
Collect in bushes	167	10.23
Bags	13	0.80
Other	23	1.41
Sample.info	: n=1632	Missing=2

A comparison of wood and coal users reveals that there are 200 wood users who do not use coal. This is a significant proportion of the population (12.24%) and given the very high emission factors for wood use, would make a significant contribution to air pollution in the area.

Further analysis was performed to try to establish if these wood users were associated with a certain town or house type.

Crosstabulation of town by wood.only  
wood.only

town	FALSE	TRUE	
Boiketlong	55	34	89
	61.8	38.2	5.453
	3.77	19.65	
Boipatong	199	4	203
	98.03	1.97	12.44
	13.64	2.312	
Boipatong Informal	24	5	29
	82.76	17.24	1.777
	1.645	2.89	
Bophelong	281	55	336
	83.63	16.37	20.59
	19.26	31.79	
Eatonsyde	148	12	160
	92.5	7.5	9.804
	10.14	6.936	
Ironsyde	53	2	55
	96.36	3.636	3.37
	3.633	1.156	
Sharpeville	263	36	299
	87.96	12.04	18.32
	18.03	20.81	
Sharpeville Informal	49	4	53
	92.45	7.547	3.248
	3.358	2.312	
Tshepiso	292	9	301
	97.01	2.99	18.44
	20.01	5.202	
Tshepiso Informal	95	12	107

88.79	11.21	6.556
6.511	6.936	
1459	173	1632
89.4	10.6	

$X^2[9] = 125, p = 1.5e-22$

observed  
expected

	FALSE	TRUE	Total
Boiketlong	55 79.57	34 9.43	89
Boipatong	199 181.48	4 21.52	203
Boipatong Informal	24 25.93	5 3.07	29
Bophelong	281 300.38	55 35.62	336
Eatonsyde	148 143.04	12 16.96	160
Ironsyde	53 49.17	2 5.83	55
Sharpeville	263 267.30	36 31.70	299
Sharpeville Informal	49 47.38	4 5.62	53
Tshepiso	292 269.09	9 31.91	301

Tshepiso Informal	95	12	107
	95.66	11.34	
Total	1459	173	1632

## Cell Contributions

	FALSE	TRUE	
Boiketlong	7.58 +	63.96 +	
Boipatong	1.69 +	14.26 +	
Boipatong Informal	0.14 +	1.21 +	
Bophelong	1.25 +	10.55 +	
Eatonsyde	0.17 +	1.45 +	
Ironsyde	0.30 +	2.52 +	
Sharpeville	0.07 +	0.58 +	
Sharpeville Informal	0.06 +	0.47 +	
Tshepiso	1.95 +	16.45 +	
Tshepiso Informal	0.00 +	0.04 =	124.7

df = 9 P-value = 0

## Crosstabulation of hh.type.r by wood.only

hh.type.r	wood.only		
	FALSE	TRUE	
RDP	543	62	605
	89.75	10.25	37.07
	37.22	35.84	
Ext.RDP	77	4	81
	95.06	4.938	4.963
	5.278	2.312	
Leanto	70	6	76
	92.11	7.895	4.657
	4.798	3.468	
Shack	280	54	334

	83.83	16.17	20.47
	19.19	31.21	
Brick	482	46	528
	91.29	8.712	32.35
	33.04	26.59	
Other	7	1	8
	87.5	12.5	0.4902
	0.4798	0.578	
	1459	173	1632
	89.4	10.6	

$\chi^2[5] = 16, p = 0.0059$

Both the chi-square tests for independence between town and wood use only and house type and wood use only resulted in very small p-values, thus indicating dependency in both cases. Primary wood use is more strongly associated with the town of Boiketlong and with households living in shacks.

### 3.7 Electricity use

Respondents were asked if they used electricity in their homes. The results are given below.

Table 3.12: Table of Electricity use

	Frequency	Percent
YES	1354	82.97
NO	278	17.03
Sample.info	: n=1632	Missing=2

Out of the 1632 respondents who answered the question, a total of 1354 (82.97%) use electricity. The question arises if the 17.03% of respondents who do not use electricity are more likely to use coal. It would also be

interesting to determine if these respondents do not use electricity due to the unavailability of electricity in the area where they live, or due to economic reasons.

A crosstabulation of responses for the questions on coal use and electricity use is given below. The application of a chi-square test can be used to determine whether coal use and electricity use are dependent.

Crosstabulation of hh.coal.use.r by electricity.r

hh.coal.use.r	electricity.r		
	YES	NO	
YES	436	139	575
	75.83	24.17	35.23
	32.2	50	
NO	918	139	1057
	86.85	13.15	64.77
	67.8	50	
	1354	278	1632
	82.97	17.03	

X2[1] = 31, p = 2.3e-08

observed

expected

	YES	NO	Total
YES	436	139	575
	477.05	97.95	
NO	918	139	1057
	876.95	180.05	
Total	1354	278	1632

Cell Contributions

```

      YES      NO
YES  3.53 + 17.21 +
NO   1.92 +  9.36 = 32.02

```

```
df = 1  P-value = 0
```

There is a clear dependency between these two factors, evident from the very small p-value. This dependency is especially clear from the higher than expected frequency respondents who use coal but not electricity (139 observed versus 97.95 expected) and also from the lower than expected frequency (139 versus 180.05) of respondents who use neither coal nor electricity.

In the same way the existence of a dependency between electricity use and house type was investigated.

Crosstabulation of hh.type.r by electricity.r

```

      electricity.r
hh.type.r  YES      NO
Brick      220      2      222
           99.1    0.9009  40.14
           52.76   1.471
RDP        143      1      144
           99.31   0.6944  26.04
           34.29   0.7353
Shack      54      133     187
           28.88   71.12   33.82
           12.95   97.79
           417     136     553
           75.41   24.59

```

```
X2[2] = 330, p = 2.4e-72
```

```

observed
expected

```

	YES	NO	Total
Brick	220	2	222
	167.40	54.60	
RDP	143	1	144
	108.59	35.41	
Shack	54	133	187
	141.01	45.99	
Total	417	136	553

## Cell Contributions

	YES	NO
Brick	16.53 +	50.67 +
RDP	10.91 +	33.44 +
Shack	53.69 +	164.62 = 329.86

df = 2 P-value = 0

From the small p-value, there is a clear dependency between house type and electricity use. Respondents living in shacks are much less likely to use electricity while almost all those who live in RDP houses or brick houses use electricity. Only 54 out of 187 (28.88%) respondents who live in shacks use electricity while 220 out of 222 (99.1%) respondents who live in BRICK houses and 143 out of 144 (99.31%) respondents who live in rdp use electricity.

# Chapter 4

## Conclusions

### 4.1 Findings

From the results of the survey, the following findings are relevant.

1. There is general concern about air pollution although respondents generally do not believe that domestic coal use and especially domestic wood use is the most important contributor.
2. Most respondents and most coal users live in formal housing.
3. Respondents who live in informal houses are more likely to use coal.
4. The area is densely populated with a mean of 1.27 households per stand.
5. Coal use varies significantly between towns.
6. Nowhere do coal users represent more than half of the population of a large town.
7. Coal use has declined significantly in the past two years in Bophelong and Boipatong but not in Sharpeville and Tshepiso.
8. There is no significant level of use of the improved top-down ignition method in the area despite the activities of the *Clean Fires Campaign*.
9. The majority of coal users uses cast iron stoves.

10. Brazier use is associated with shack dwellers.
11. The person responsible for making fire is likely to be a female and very unlikely to be a child.
12. One tenth of the population uses wood but not coal.
13. The vast majority of respondents and also of coal users use electricity.
14. Households that do not use electricity are more likely to use coal.
15. Shack dwellers are less likely to use electricity.

## 4.2 Conclusions

1. Coal use is declining over the long term. The factors contributing to the decline include formalisation of housing, electrification and probably also economic development. There is however a degree of inertia to coal use patterns and it is likely that domestic coal use will continue in the medium term.
2. Replacement of informal houses with subsidy houses will lead to a reduction in the coal using population. Coal use will however not be totally eliminated by formalisation of houses only as is shown by the still large numbers of coal users who live in formal housing.
3. In the same way electrification will lead to a reduction in the coal using population. Coal use will however not be totally eliminated by electrification only as is clear from the fact that the vast majority of coal users use electricity.
4. The use of cast iron stoves is likely to lead to a high degree of inertia in coal use patterns since these stoves are expensive and very durable. It may also result in a flare-up of coal use after a period of decline if coal prices drop suddenly.
5. Domestic wood use is likely to be a significant source of air pollution. There is a possibility that given the high price of coal, a number of coal users may fall back to using wood as heating source. This will

increase the health impact of air pollution significantly. because of the high levels of harmful emissions associated with wood.

6. There is no significant increase in use of the improved top-down ignition method in the area despite the activities of the *Clean Fires Campaign*.
7. Targeting school children with an information campaign on the improved top-down ignition method is unlikely to be successful because the person responsible for making fire is almost always an adult.

### 4.3 Recommendations

1. The house-to-house demonstration of the improved top-down ignition method should continue as there is a significant number of coal users in the area and practically no uptake of the method from other sources.
2. More research needs to be conducted into domestic wood use in the area since it is likely that pollution from domestic wood use makes a significant contribution to the health impact of air pollution in the area. The likelihood exists that the incidence of domestic wood use may increase due to the escalation in coal prices.
3. The media-based method of the *Clean Fire Campaign* was not effective and should be reconsidered

# Chapter 5

## Detailed implementation plan

This chapter uses results from the baseline survey to set performance targets for project implementation in each distinct area. Decisions that are made include the choice of area, the number of teams and daily performance targets. Having made these choices, the duration of the project in each area can be calculated.

### 5.1 Variables to be monitored during implementation

During implementation, data from households and fieldwork teams is collected and processed continuously in order to inform the management of the implementation performances.

#### 5.1.1 Data collected daily by fieldworkers

The fieldworkers collect data for every invitation and demonstration. This includes

- Number of households approached including stand number.
- Number of respondents contacted including contact details and address for each respondent.

- Number of coal-using respondents.
- Number of demonstration attendants including contact details and address of each respondent.

From this data a number of other indicators is calculated. These include:

- Number of households per stand.
- Proportion of households at home.
- Proportion of households who uses coal.
- Proportion of invited coal users who attends a demonstration.

### 5.1.2 Data collected by evaluator

An evaluator will be appointed to evaluate the work of the field workers and help determine the effects of the demonstrations. This is done by visiting a sample of demonstration attendants a week after the demonstration to ascertain if they use the method correctly. The following is ascertained

- Quality control on fieldworker data
- Demonstration efficiency

### 5.1.3 Efficiency targets

From the baseline data collected, specific target efficiencies are set for the implementation phase. These targets function as performance indicators to monitor the quality of implementation.

#### 5.1.3.1 Contact efficiency

Contact efficiency is the proportion of coal using households in a given area that has been invited to a demonstration expressed as a percentage.

$$Contact\ eff = \frac{\#Coal\ users\ invited}{Coal\ using\ population} \times 100$$

### 5.1.3.2 Invitation efficiency

Invitation efficiency is calculated as the proportion of coal using households who attends a demonstration after being invited expressed as a percentage.

$$Invitation\ eff = \frac{\#Coal\ users\ attending\ demo}{\#Coal\ users\ invited} \times 100$$

### 5.1.3.3 Demonstration efficiency

Demonstration efficiency is the percentage of the households that attends the demonstrations that use the Basa njengo Magogo method correctly. This is calculated from data collected by the evaluator after demonstrations from a sample of demonstration attendants.

$$Demo\ eff = \frac{\#Initial\ users\ of\ BnM}{\#Coal\ users\ attending\ demo} \times 100$$

### 5.1.3.4 Uptake

Uptake is the net result of the process of invitation and demonstration. Thus:

$$Uptake = \frac{\#Initial\ users\ of\ BM}{Coal\ using\ population}$$

### 5.1.3.5 Retention

Retention can only be calculated after a year has passed since retention is the percentage of households that continues to use Basa njengo Magogo method correctly after a given period of time.

$$Retention = \frac{\#Initial\ users\ of\ BM}{\#Remaining\ users\ of\ BM\ (after\ 12\ months)}$$

### 5.1.3.6 Spillage

Spillage is the proportion of BnM users who use the method correctly but who have not attended a demonstration but have heard about BnM through word of mouth or example. From the baseline results spillage in the area is currently less than 1%.

## 5.2 Planning per area

### 5.2.1 Estimation of coal users per town

The proportion of coal users was estimated from the sample for each town. These proportions are given in Table 5.1. *Sample* is the number of respondents interviewed per town and *Coal users* gives the number of respondents who indicated that they use coal. In this table, a point estimate as well as the 95% confidence interval are given. The point estimate gives a single estimate for the proportion of coal using households per town. The lower and upper limit gives a 95% confidence interval for the estimation of the proportion of coal using households, e.g. the point estimate for Boiketlong is 0.38 and the approximate 95% confidence interval is (0.28; 0.48)

The point estimate as well as the 95% confidence interval of the number of coal users in each town is given in Table 5.2. The values are derived from the information in Table 5.1. Once again Boiketlong can serve as example: the estimated number of coal users in Boiketlong is  $0.382 \times 2000 = 764$ . The 95% confidence interval (562; 962) is derived by multiplying the lower- and upper limits in Table 5.1 by the number of households, in this case 2000.

Table 5.1: Estimation of coal using proportion

	Town	Sample	Coal users	PointEst	Lower	Upper
1	Boiketlong	89	34	0.38	0.28	0.48
2	Boipatong	232	96	0.41	0.35	0.48
3	Bophelong	336	89	0.26	0.22	0.31
4	Eatonsyde	160	30	0.19	0.13	0.25
5	Ironsyde	55	38	0.69	0.57	0.81
6	Sharpeville	352	151	0.43	0.38	0.48
7	Tshepiso	408	137	0.34	0.29	0.38

### 5.2.2 Number of teams required

The number of teams appointed per geographically distinct area should strike a balance between manageability and cost. Cost implies less teams while

Table 5.2: Estimation of coal using households per town

	Town	Households	Low coal	High coal	Point coal
1	Boiketlong	2000	562	966	764
2	Boipatong	4421	1549	2110	1829
3	Bophelong	13672	2976	4267	3621
4	Eatonsyde	1575	200	391	295
5	Ironsyde	631	359	513	436
6	Sharpeville	8142	3072	3914	3493
7	Tshepiso	7951	2305	3034	2670

speed of implementation implies more. Based on these consideration one team per town has been chosen except for Bophelong which requires two teams because of its large population and low coal use density. Boiketlong, Eatonsyde and Ironsyde share a team of three members. The number of teams is given in Table 5.3. The point estimates and confidence intervals of the number of coal users targeted for conversion for each town are given in Table 5.4.

Table 5.3: Teams per town

	Town	Low coal	High coal	Point coal	teams
1	Boiketlong	562	966	764	0.25
2	Boipatong	1549	2110	1829	1.00
3	Bophelong	2976	4267	3621	2.00
4	Eatonsyde	200	391	295	0.25
5	Ironsyde	359	513	436	0.25
6	Sharpeville	3072	3914	3493	1.00
7	Tshepiso	2305	3034	2670	1.00

### 5.2.3 Daily targets

A daily target of 40 conversions per team has been set.

Table 5.4: Targeted conversion per town

	Town	Conversions: Low coal	Conversions: High coal	Conversions: Point coal
1	Boiketlong	410	704	557
2	Boipatong	1129	1538	1334
3	Bophelong	2170	3110	2640
4	Eatonsyde	146	285	215
5	Ironsyde	262	374	318
6	Sharpeville	2239	2853	2546
7	Tshepiso	1681	2212	1946

The efficiency targets are as follows:

**Contact efficiency** 90%

**Target invitation efficiency** 90%

**Target demonstration efficiency** 90%

**Uptake** From the above it follows that the target uptake is 73%

From these targets and the number of coal users per town and the number of households that has to be approached per day can be calculated.

The total number of households that has to be approached per day is calculated by first calculating the number of coal users that has to be approached in order to reach the daily conversion target of 40 conversions per team. This is calculated by the following formula:

$$\text{Daily coal users target} = \frac{\text{Daily conversion target}}{\text{at home} \times \text{Invitation efficiency} \times \text{Demo efficiency}}$$

Where:

*at home* =The proportion of households where the fieldworkers will be able to find someone at home. Assumed at 0.7 from previous implementation data

*Daily conversion target* = The number of conversions expected from a team of four. Set at 40

If a team has to convert 40 coal using households per day at the given efficiencies and 70% of households can be found at home, then it needs to target<sup>1</sup> approximately<sup>2</sup> 71 coal users per day:

$$\text{Daily coal users target} = \frac{40}{0.7 \times 0.9 \times 0.9} \approx 71$$

The initial daily coal user target is therefore approximately 71 for all seven towns. This means that every team has to approach 71 coal users per day in order to convert 40. To establish the number of total households to approach, this number is divided by the proportion of coal users in each area (given in Table 5.1).

$$\text{Daily door knocks} = \text{Daily coal users target} \div \frac{\# \text{Coal users}}{\text{Population}}$$

For example for Boiketlong the number of households to approach per day is approximately 185:

$$\begin{aligned} \text{Daily door knocks} &\approx 71 \div 0.38 \\ &\approx 185 \end{aligned}$$

Table 5.5 gives the number of households to approach, i.e. the number of doors to knock on per day if the target of 40 conversions per team is to be achieved at the given efficiencies. An estimation based on the point estimate and confidence intervals for coal use (see Table 5.1) is given. *Door knocks PointEst* is the estimation of households to approach based on the point estimate for coal use. *Door knocks Lower* is based on the lower limit of the 95% confidence interval and *Door knocks Upper* on the upper limit. In the tables that follow this naming convention is also used.

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<sup>1</sup> *Target* means to approach a household and knock on the door. *Invite* means to speak to residents and invite them to a demonstration if they use coal. *Demonstrate* means to physically show a person how to ignite a fire using the improved ignition method.

<sup>2</sup> Numbers in the example are rounded and may differ slightly from the corresponding number in the tables where rounding takes place at the end

Table 5.5: Daily targets per team

	Town	Door knocks PointEst	Door knocks Lower	Door knocks Upper
1	Boiketlong	185	251	146
2	Boipatong	170	201	148
3	Bophelong	266	324	226
4	Eatonsyde	376	555	284
5	Ironsyde	102	124	87
6	Sharpeville	164	187	147
7	Tshepiso	210	243	185

### 5.2.4 Revisits

The target of 90% contact efficiency with the assumption of 70% households at home will mean that some households will have to be visited more than once. The number of households that cannot be successfully contacted and therefore needs to be revisited at a later date is estimated as follows:

$$\#Revisit = (1 - at\ home) \times Daily\ door\ knocks$$

If one assumes that coal users and people who do not use coal do not differ in their habits and movements as far as the time that they spend at home is concerned, the expected number of coal users included in a first round of revisits is given by:

$$\#Coal\ revisits = coal\ use \times \#Revisit$$

Where:

*coal use* = The proportion of the population that uses coal

*#Revisit* = The number of revisits that have to take place for each day worked

The number of houses to revisit and the number of coal users that will be included in that revisit for Boiketlong are given as an example:

The number of houses to revisit for each day worked is:

$$\begin{aligned}\#Revisit &= (1 - 0.70) \times 185 \\ &= 56\end{aligned}$$

The number of coal users included in the group that has been missed during the first round of invitations and will thus have to be revisited is thus:

$$\begin{aligned}\#Coal\ revisits &= 0.38 \times 56 \\ &= 21\end{aligned}$$

It follows that the estimated number of coal users that has been missed on any specific day would be the same proportion of the difference between the contacted households and the targeted households. Because the target of 40 conversions per team is the same for each town, the number missed will also be the same for each town. If the invitation efficiency is 90% and the demo efficiency is 90%, 50 households have to be invited for 45 to attend a demo for 40 to convert to the improved ignition method.

### 5.2.5 Duration of implementation

When the number of coal users per town is estimated, the number of teams decided and the targets set, the duration of the project in each town can be estimated. The duration of the first round of invitations is calculated as:

$$round\ 1\ workdays = \frac{Population}{Daily\ door\ knocks \times \#teams}$$

For Boiketlong the duration first round of invitations<sup>3</sup> would be:

$$\begin{aligned}round\ 1\ workdays &= \frac{2000}{185 \times 0.25} \\ &\approx 43\end{aligned}$$

Table 5.6: Duration of first round of invitations

	Town	1st round days PointEst	1st round days Lower	1st round days Upper
1	Boiketlong	43	32	55
2	Boipatong	26	22	30
3	Bophelong	26	21	30
4	Eatonsyde	17	11	22
5	Ironsyde	25	20	29
6	Sharpeville	50	44	55
7	Tshepiso	38	33	43

Table 5.6 gives the estimated workdays for the first round of invitations per town.

During the first round of invitations an estimated 10% of coal users who have been contacted will not attend a demonstration. The total number of coal users who have been contacted but who have not attended a demonstration is calculated as follows:

$$\begin{aligned} \textit{invited never attended} &= \textit{at home} \times \textit{Daily coal users target} \times \textit{\#teams} \\ &\quad \times (1 - \textit{Invitation eff}) \times \textit{round 1 workdays} \end{aligned}$$

For Boiketlong the number of coal users who have been invited during the first round of invitation but who will not attend (assuming 90% invitation efficiency) is thus:

$$\begin{aligned} \textit{invited never attended} &= 0.7 \times 71 \times 0.25 \times (1 - 0.9) \times 43 \\ &\approx 55 \end{aligned}$$

After the initial invitations, all those who has not been at home and the known coal users who have not attended demonstrations have to be visited

<sup>3</sup>With only one fieldworker, thus 0.25 teams

again. The number of working days needed to revisit those who have been missed plus known coal users who never attended a demonstration are calculated as:

$$\text{round 2 workdays} = \frac{(1 - \text{at home}) \times \text{Population} + \text{invited never attended}}{\text{Daily door knocks} \times \#\text{teams}}$$

For Boiketlong the duration of the second round of invitations would be:

$$\begin{aligned} \text{round 2 workdays} &= \frac{(1 - 0.7) \times 2000 + 53}{185 \times 0.25} \\ &\approx 18 \end{aligned}$$

Table 5.7 gives the estimated workdays for the second round of invitations per town.

Table 5.7: Duration of second round of invitations

	Town	2nd round days PointEst	2nd round days Lower	2nd round days Upper
1	Boiketlong	14.2	10.2	18.3
2	Boipatong	8.5	7.1	10.0
3	Bophelong	8.2	6.6	9.7
4	Eatonsyde	5.2	3.5	7.0
5	Ironsyde	8.6	6.9	10.4
6	Sharpeville	16.3	14.2	18.5
7	Tshepiso	12.2	10.5	14.1

The total workdays for two rounds of invitations is given in Table 5.8.

### 5.2.6 Continued refinement of implementation plan

This planning is based on information from the baseline survey and provides sufficient information for an initial work plan as has been presented below. This work-plan will be further refined as daily data is gathered during the process of implementation.

Table 5.8: Total duration: 2 rounds of invitations

	Town	Total days PointEst	Total days Lower	Total days Upper
1	Boiketlong	57	42	73
2	Boipatong	34	29	40
3	Bophelong	34	28	40
4	Eatonsyde	22	15	29
5	Ironsyde	33	27	39
6	Sharpeville	66	58	74
7	Tshepiso	50	43	57