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Mongolia

Heating in Poor, Peri-urban Ger Areas of Ulaanbaatar

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Appendices A-J

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Appendices to Mongolia Report
Heating in Poor, Peri-urban Ger Areas of Ulaanbaatar

APPENDIX A: SURVEY METHODOLOGY AND DATA

The Baseline Fuel Consumption, Heating Stove, and Household Perception Survey conducted in the ger areas in Ulaanbaatar, which was carried out in December 2007, was one of the first comprehensive household surveys designed to assess household heating fuels consumption, heating stove ownership and usage, and household perceptions toward stoves, heating fuels, and air pollution in the city.

Heating season in Mongolia covers about 8 month staring in September and end around April in the following year. The survey was conducted in December 2007 and January 2008, which is in the middle of 2007/2008 heating season. To collect fuel consumption and expenditure, the survey questionnaire was designed and interviewers were trained to ask respondents on fuels consumption and expenditure from previous heating season, which is September 2006 to April 2007. As a result, the baseline fuel consumption and expenditure reflect household consumption and expenditure for 2006/2007 heating season. However, questionnaire also includes questions aimed to collect the current (at the time of the survey) type of fuels and stove used by the household.

The survey was designed to fulfill the following specific objectives:

(1) Assess and provide baseline information regarding heating fuels consumption and expenditure of households living in the ger areas.
(2) Provide baseline information on the estimated numbers and types of heating stoves used by the households in the ger area.
(3) Analyze the types of heating fuels used by the households as well as their perceptions and preferences toward heating fuel being used and alternative heating fuels.
(4) Analyze the types of heating stoves used by the households as well as their perceptions and preferences toward heating stoves being used and alternative heating stoves, especially improved stoves.
(5) Assess households' knowledge, perceptions, and attitudes toward the air pollution situation and causes the of air pollution problem in the city as well as households' willingness to help solve air pollution problem in the city.

The field survey was conducted in December 2007 by a local market research firm. A pre-designed questionnaire was used to interview heads of household. However, if head of the household was not available, the spouse or responsible adult knowledgeable about heating fuels and stoves was interviewed

Sampling Frame and Sampling Design

Because of the specific hypothesis regarding the relationship between the uses of raw coal for heating among households living in the ger area and air pollution in the city, the sampling method was designed to focus on six ger areas located around the city center. It was determined that the use of raw coal for heating among households that live in the ger areas farther away from the city center have minimal impact on the air pollution problem in the city.

The decision to exclude those ger areas was also based on the time constraint, which required the field survey and analysis to be completed within a very short time span.

Administrative records containing the most up-to-date list of households living in each khoroo was used to develop the sampling frame. Based on the compiled list of households from every khoroo in the six ger areas, there are a total 100,941 households currently living in 74 khoroos covering six districts in the sampling frame. A total of 1,000 households were systematically selected from the sampling frame for interview.

Administratively, Ulaanbaatar municipality consists of nine districts, which are divided into 121 khoroos. In general, the city is divided into two main areas, the city center area and the ger areas. Base on the most recent estimate, there are about 215,727 households currently living in Ulaanbaatar. Based on the administrative records compiled for this project, it is estimated that about 111,533 households are currently living in the ger areas covering six districts and 82 khoroos of the city.

	Bayangol District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	9th	1,583	15
2	10th	1,560	18
3	11th	2,053	32
4	16th	622	6
5	20th	269	4
Total		**6,087**	**75**

	Sukhbaatar District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	12th	1,554	17
2	15th	1,468	14
Total		**3,022**	**31**

	Chingeltei District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	7 th	1,921	19
2	8th	1,850	13
3	9th	1,447	12
4	10th	1,275	12
5	11th	1,094	13
6	12th	1,275	17
7	13th	1,094	15
8	14th	1,180	14
9	15th	1,420	15
10	16th	1,658	16
11	17th	1,404	12
12	18th	1,700	16

13	19th	1,921	19
Total		**19,239**	**193**

	Khan-Uul District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	4th	1,005	10
2	5th	745	7
3	6th	993	13
4	7th	726	6
5	8th	1,831	18
6	9th	1,750	16
7	10th	566	6
8	11th	157	4
Total		**7,682**	**80**

	Bayanzurkh District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	2nd	3,353	32
2	5th	1,418	14
3	6th	1,163	6
4	8th	2,249	16
5	9th	1,834	18
6	12th	1,774	7
7	13th	1,130	12
8	14th	2,023	24
9	16th	2,434	13
10	17th	1,500	14
11	19th	722	7
12	21th	1,025	11
13	22th	1,818	14
14	23th	912	11
15	24th	1,815	25
Total		**24,875**	**224**

	Sukhbaatar District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	1st	1,405	13
2	2tnd	651	5
3	3rd	1,998	19
4	4th	1,976	22
5	5th	1,531	14
6	6th	1,273	12
7	7th	2,128	19
8	8th	1,167	15
9	9th	1,056	14

10	10th	2,153	23
11	11th	1,342	16
12	13th	129	1
13	14th	1,562	15
14	15th	216	2
15	16th	232	2
16	19th	113	0
17	20th	640	4
18	22th	177	1
19	23th	1,529	15
20	24th	995	10
21	25th	1,529	10
Total		**23,802**	**232**

	Sukhbaatar District		
No.	**Khoroo no.**	**Total number of households**	**Number of surveyed households**
1	9th	2,050	22
2	11th	3,071	32
3	12th	1,600	17
4	13th	1,592	13
5	14th	1,558	14
6	15th	1,300	14
7	16th	1,700	18
8	17th	1,540	17
10	18th	1,724	23
Total		16,035	170

Estimate of Sampling Errors

The main errors occurring in the survey can be divided into two types: nonsampling errors and sampling errors. Nonsampling errors usually arise from several situations including interviewing errors, unclear wording in the questionnaire, mistakes made by interviewers and/or respondents, data entry errors, measurement errors, and assumptions used in the data collection process such as average weight and/or size of specific fuels. All attempts were made in all stages of the data collection process and analysis to minimize nonsampling errors. It is not possible to provide any estimate of nonsampling errors. However, it is very important to recognize the problems of nonsampling errors associated with surveys.

Nonsampling Errors

Although it is not possible to measure nonsampling errors, it is important to recognize that some variables collected from the survey are more likely to be subject to higher nonsampling errors than others. These variables include questions that are based on respondents' recollection of heating fuels purchased and used during the last heating seasons. Because the questions are based on recollections, it is not possible for interviewers to weigh fuel usage during the interview. Furthermore, raw coal, firewood, compressed coal, and coal briquettes (except Korean briquettes) bought and sold in the market are based on estimated weight (and estimated size in cubic meters for firewood). Raw coal or

firewood loaded or piled up on the large truck is considered to weigh about five tons (or 5 cubic meters for firewood), and raw coal or firewood loaded or piled up on a smaller truck is considered to weigh about two or three tons (or about two or three cubic meters for firewood). Consumers are usually told about the weight in tons when buying raw coal in large quantities. However, the weight of the coal is not verified, for practical reason. Although raw coal or firewood bought and sold in small bags can be weighed, they are not usually weighed either. Consumers who purchase raw coal or firewood in bags usually rely on traders to tell them the weight. Data collected from field interviews with fuel traders in Ulaanbaatar indicate that to sell raw coal in bags, traders usually divide raw coal into small bags, and one ton of raw coal can be divided into approximately 60 bags. As a result, the survey assumes that one bag of raw coal weights about 16.67 kilograms. Similarly, to sell firewood in bags, fuel traders usually divide one cubic meter of firewood into 20 bags. As a result, the survey assumes that 20 bags of firewood are equal to one cubic meter.

The combination of recall questions and estimated weight and size of fuels bought and sold in the market suggests that the estimated amount of fuels used may be subject to larger nonsampling errors than their corresponding expenditures and other variables in the survey.

One ideal survey technique that can be employed to overcome the recollection and measurement problems is to divide the sample into seven groups. The first group of sample households would be interviewed in September, second and subsequent groups would be interviewed in October, and the subsequent months. In addition, interviewers must use scales to weigh fuels. These survey techniques were discussed but could not be implemented because of a few problems, including the need to complete the study in a few months, and funding for the study was not available until early December 2007.

Sampling Errors

Sampling errors occur in the survey as a result of sampling variation. When sampling is used to estimate a population parameter, the sample estimates will not be exactly the same as the population parameter. The sampling errors are the difference between the sample estimate and true population parameters.

Given the simple random sampling technique with the sample size of 1,000 households, at a 95 percent confidence interval, the sampling error for different proportions for each variable of interest could range from +/- 0.019 to 0.30. For example, if the proportion of households with improved stoves is close about 10 percent, the sampling error is estimated to be +/- 0.019 or about +/- 2 percent sampling error at a 95 percent confidence interval. However, if the proportion of ger dwellings is estimated at about 50 percent—highest variance—the sampling error is estimated to be +/- 0.030 or +/- 3 percent sampling error.

Table A1.1 Estimate Sampling for Selected Variables

	Value	Number of cases	Standard errors (95% confidence interval)	Confidence limits (95% confidence interval) Lower	Upper
Type of dwelling unit: Ger	43.2%	1,000	.0156	40.1%	46.3%
Separate or single family home	55.3%	1,000	.0157	52.2%	58.4%
Ger and single family home	0.7%	1,000	.0023	0.18%	1.2%
Size of home (winter), sq. meters	55.9	562	.9780	44.0	47.9
Size of ger (winter); average # walls	4.8	437	.0326	4.7	4.9
Average household income/month, togrog	242,788	1,000	6046.47	230,923	254,653
Type of stove owned					
Traditional	0.878	1,000	0103549	.8576802	.8983198
Improved	0.020	1,000	.0044294	.011308	.028692
Korean	0.011	1,000	.0033	.0045243	.0174757
Small low-pressure boiler	0.091	1,000	.0090995	.0731436	.1088564
Years household using existing heating stove	5.5	1,000	.1641	5.2	5.8
Total numbers of stove owned and are using to heat home (include 2nd stove and exclude stoves used in home business/kiosk)	103,061	1,000	457.9	102,162	103,959
Household think about performance of his/her heating stove					
Fuel usage:					
Low	15.9%	1,000	.0116	13.6%	18.2%
Medium	49.9%	1,000	.0158	46.8%	53.0%
High	34.0%	1,000	.0014	31.0%	36.9%
Smoke and soot release from stove					
Low	23.2%	1,000	.0133	20.6%	25.8%
Medium	43.6%	1,000	.0158	43.2%	49.4%
High	29.4%	1,000	.0144	26.6%	32.2%
Ability to keep heat for long time					
Low	11.4%	1,000	.0100	9.4%	13.4%
Medium	47.9%	1,000	.0158	44.8%	51.0%
High	40.3%	1,000	.0155	37.2%	43.3%
Freq. to clean soot from chimney					
Low	44.4%	1,000	.0157	41.3%	47.5%
Medium	39.0%	1,000	.0154	35.9%	42.0%
High	15.8%	1,000	.0115	13.5%	18.1%
Difficult to start fire					
Low	61.8%	1,000	.0154	58.8%	64.8%
Medium	33.5%	1,000	.0149	30.5%	36.4%
High	4.2%	1,000	.0034	0.5%	1.9%
Amount of ash					
Low	23.3%	1,000	.0134	20.7%	25.9%
Medium	41.9%	1,000	.0156	38.8%	44.9%
High	33.6%	1,000	.0149	30.7%	36.5%

	Value	Number of cases	Standard errors (95% confidence interval)	Confidence limits (95% confidence interval) Lower	Upper
Household interested in changing stove	51.8%	1,000	.0158	48.7%	54.9%
Not interested in changing stove	46.6%	1,000	.0157	43.5%	49.7%
Household opinion about improved stove					
Improved stove is easier to start fire than traditional stove					
Agree	33.7%	1,000	.0149	30.7%	36.6%
Disagree	10.4%	1,000	.0096	8.5%	12.3%
Do not know	55.9%	1,000	.0157	52.8%	58.9%
Improved stove releases less smoke than traditional stove					
Agree	58.2%	1,000	.0156	55.1%	61.3%
Disagree	5.1%	1,000	.0069	3.7%	6.5%
Do not know	36.7%	1,000	.0152	33.7%	39.7%
Improved stove keeps heat longer than traditional stove					
Agree	38.1%	1,000	.0154	35.1%	41.1%
Disagree	10.1%	1,000	.0095	8.2%	12.0%
Do not know	51.8%	1,000	.0158	48.7%	54.9%
Improved stove uses less fuel than traditional stove					
Agree	44.8%	1,000	.0157	41.7%	47.9%
Disagree	7.3%	1,000	.0082	5.7%	8.9%
Do not know	47.9%	1,000	.0158	44.8%	51.0%
Improved stove is more difficult to use than traditional stove					
Agree	10.6%	1,000	.0097	8.7%	12.5%
Disagree	30.0%	1,000	.0144	27.1%	32.8%
Do not know	59.4%	1,000	.0155	56.3%	62.4%
Improved stove needs to have chimney cleaned more often than traditional stove					
Agree	8.8%	1,000	.0089	7.0%	10.6%
Disagree	24.1%	1,000	.0135	21.4%	26.7%
Do not know	67.1%	1,000	.0148	64.1%	70.0%
Improved stove is too expensive					
Agree	41.1%	1,000	.0155	38.0%	44.1%
Disagree	13.5%	1,000	.0108	11.4%	15.6%
Do not know	45.4%	1,000	.0157	42.3%	48.5%

	Value	Number of cases	Standard errors (95% confidence interval)	Confidence limits (95% confidence interval) Lower	Upper
Household has heard about improved stove from:					
Friends/neighbors/relatives					
Yes	29.3%	1,000	.0144	26.5%	32.1%
No	70.7%	1,000	.0144	67.9%	73.5%
Radio/TV program					
Yes	59.3%	1,000	.0155	56.2%	62.3%
No	40.7%	1,000	.0155	37.6%	43.7%
Newspaper/printed media					
Yes	18.5%	1,000	.0122	16.1%	20.9%
No	81.5%	1,000	.0122	79.1%	83.9%
NGO through project					
Yes	13.4%	1,000	.0108	11.2%	15.5%
No	86.6%	1,000	.0108	84.4%	88.7%
Stove maker					
Yes	4.7%	1,000	.0067	3.4%	6.0%
No	95.3%	1,000	.0067	93.9%	96.7%
Billboard					
Yes	3.7%	1,000	.0059	2.5%	4.9%
No	96.3%	1,000	.0059	95.1%	97.5%
What household thinks if we buy current stove and give back improved and fuel efficient stove at low cost:					
Agree	37.0%	1,000	.0153	34.0%	40.0%
Need to think about it	43.5%	1,000	.0157	40.4%	46.6%
Number of times add fuels during 24-hr period (Sept, Oct 07 and Mar, Apr 08)	2.30	797	.0421	2.23	2.40
Number of times add fuels during 24-hr period (Nov, Dec 07 and Jan, Feb 08)	4.48	797	.0765	4.34	4.64
Average raw coal consumption per household (Sept 07 to Apr 08), tons	4.18	941	.0709	4.04	4.32
Average expenditure on raw coal per household (Sept 07 to Apr 08), togrog	174,357	941	2607.58	169,240	179,474
Average firewood consumption per household (Sept 07 to Apr 08), m^3	4.69	922	.0939	4.50	4.87
Average expenditure on firewood per household (Sept 07 to Apr 08), m^3	84,626	922	1698.22	81,293	87,959
Household thinks air pollution problem in Ulaanbaatar is extremely high	72.4%	1,000	.0141	69.6%	75.2%
Household thinks air pollution problem in Ulaanbaatar is high	27.0%	1,000	.0140	24.2%	29.7%

	Value	Number of cases	Standard errors (95% confidence interval)	Confidence limits (95% confidence interval) Lower	Upper
Household thinks source of air pollution in the city					
Motor vehicle					
Very high	19.7%	1,000	.0125	17.2%	22.2%
High	52.0%	1,000	.0158	48.9%	55.1%
Industry					
Very high	10.3%	1,000	.0096	8.4%	12.2%
High	46.1%	1,000	.0158	43.0%	49.2%
Power plant					
Very high	17.9%	1,000	.0121	15.5%	20.2%
High	50.1%	1,000	.0158	47.0%	53.2%
Heating stoves from ger areas					
Very high	83.9%	1,000	.0116	81.6%	86.2%
High	14.3%	1,000	.0110	12.1%	16.5%
Household thinks best way to reduce air pollution in the city					
Reduce coal consumption					
Most suitable	33.2%	1,000	.0148	30.3%	36.1%
Suitable	52.1%	1,000	.0158	49.0%	55.2%
Consumption of briquette					
Most suitable	11.7%	1,000	.0101	9.7%	13.7%
Suitable	47.5%	1,000	.0158	44.4%	50.6%
Use improved stove					
Most suitable	13.9%	1,000	.0109	11.7%	16.0%
Suitable	52.0%	1,000	.0158	49.0%	55.1%

APPENDIX B: TESTING PROTOCOL

The testing protocol was discussed and approved by all laboratories that have an interest in air pollution control. The purpose of the protocol is to determine emissions factors for a domestic space heating and cooking stove using a particular fuel. This is done by measuring and recording during the whole test the following factors:

a.	Rate of fuel burned	kg/sec
b.	Fuel moisture content beginning of the test)	% wet weight basis (WWB; measured only at the
c.	Dilution factor (excess air)	O_2 % (EA)
d.	Carbon monoxide	CO parts per million (ppm; stack and ambient)
e.	Carbon dioxide	CO_2 % (stack and ambient)
f.	Sulfur dioxide	SO_2 ppm (stack and ambient)
g.	Nitrogen oxides	NO_x ppm (stack and ambient)
h.	Total suspended particulate matter	TSP micrograms per cubic meter ($\mu g/m^3$)
i.	10-micrometer particulates	PM_{10} $\mu g/m^3$
j.	2.5-micrometer particulates	$PM_{2.5}$ $\mu g/m^3$
k.	Volatile organic compounds	VOC $\mu g/m^3$
l.	Polycyclic aromatic hydrocarbons	PAH $\mu g/m^3$
m.	Hydrogen	H_2 ppm
n.	Relative humidity ambient	% RH
o.	Relative humidity in the stack	% RH

Based on the above observations, emissions factors can be calculated for:

q.	CO	grams per megajoule (g/MJ) and g/kg
r.	CO_2	g/MJ and g/kg
s.	SO_2	g/MJ and g/kg
t.	PM_{10}	$\mu g/MJ$ and $\mu g/m^3$ and $\mu g/g$
u.	$PM_{2.5}$	$\mu g/MJ$ and $\mu g/m^3$ and $\mu g/g$
v.	TSP	$\mu g/MJ$ and $\mu g/m^3$ and $\mu g/g$
w.	VOC	$\mu g/MJ$ and $\mu g/m^3$
x.	PAH	$\mu g/MJ$ and $\mu g/m^3$

y. Hydrogen μg/MJ and $\mu g/m^3$

A quality check of the obtained data can be determined by comparing the following results with recorded data:

z. O_2 %, calculated from gases detected in the stack

aa. Carbon balance: $CO_2+CO+HC \times$ stack flow rate = fuel burned

The procedure is based on the SeTAR Center protocol 01-1.04.2009:

Determine the composition of the fuel. Cold start fire in stove with a suitable load of coal (3 kg) and some wood and newspaper; add 1 kg fuel after 2 hours and then do not add any more. Continue to measure at 10-minute intervals until all fuel is spent and there is no flue gas anymore; this may last up to four to five hours. Carry out the procedure three times with each fuel used, whether raw coal, semi-coked coal, briquettes, and the like.

Equipment to be used: an accurate scale capable of holding the whole stove and fuel (150 kg platform scale accurate to 5 grams, or failing that, 10 grams), plus a gas collection and dilution system to quantify the particulate emissions. A facility will have to be constructed with, for example, a concrete scale base and suitable ventilation, a collection hood (to be fabricated locally) to collect emissions, dilute them with dry air, and measure the particulate quantity in real time. The hood can only be installed in a laboratory setting that is permanent.

Except for gas analysis, there is no equipment available for testing stoves. The testing capacity available in Ulaanbaatar is focused on the monitoring of power stations and Heat Only Boilers built according to Mongolian National Standard MNS 5216:2002. That standard deals only with combustion efficiency and durability, not particulate emissions, cooking, and space heating. For CO, CO_2, SO_2, NO_x emissions, a device such as a TESTO 350 or better is needed. A DustTrak or other similar device such as a Beta absorption detector is needed to measure real-time condensed aerosols and very fine dust in small concentrations.

APPENDIX C: STRUCTURED BRAINSTORMING WORKSHOP

A structured brainstorming workshop was organized by the World Bank team jointly with the Ulaanbaatar municipal government (UBMG), Air Quality Division team. About 15 people participated, comprising khoroo governors, stove producers, a stove NGO, the old project implementation unit for the Ministry of Nature and Environment (MNE) stoves program, ministry officials, international NGOs, and households.

Five questions were discussed during the one-day workshop:

(i) What do you think should be the objective of the stove program?

(ii) What do you think went wrong with the previous improved stove program?

(iii) What do you think is more effective in combating ger area air pollution: Improved Stove (IS) or Cleaned Fuels (CF) and why.

(iv) How can a project sell more than 30,000 improved stoves before next winter? How can the future project sell many stoves in a short period?

(v) How should a subsidy for improved stoves be targeted? And why?

The first question, "What do you think should be the objective of the stove program?" gave two main answers: (i) support stove producers to develop better stoves that are cheap, good, efficient, and come with a subsidy; and (ii) air pollution reduction in Ulaanbaatar through stoves that do not pollute air, emit less smoke, reduce fuel consumption, are affordable, are of good quality, compact, can burn anything.

The second question, "What do you think went wrong with the previous improved stove program?" gave eight reasons: (i) project design should have targeted particular khoroos and districts; (ii) policy should have been to prohibit inefficient stoves and should have been better understood and supported by politicians; (iii) stakeholder involvement could have been better: traditional stove producers continued to make traditional stoves and community consultations were weak; (iv) stove awareness and advertisement did not reach the full population; (v) market development was weak, no real marketing strategy, lack of understanding by consumers, and uncertain delivery mechanism, where to buy; (vi) high cost of stoves, particularly at the beginning of the project; a minority of the population can obtain credit to buy a stove; (vii) stove model, design, quality were not appropriate; more models are needed that allow longer refueling periods, emit less smoke, can use different fuels; and (viii) government—poor government management (too broad focus, management should have focused on a smaller area); only one government agency involved; no law, no regulation to support; no dedicated government official looking at air pollution issue, either in national or municipal government; government created a parallel program by providing stoves for free; weak cooperation between the Ministry (MNE) and UBMG; more private organizations should be involved

The project had good results, but the government did not support it. Ministries and khoroos should support more consumers. Stove has a good impact on coal savings and heat efficiency, but could not fully disseminate to the market. In comparison with traditional stove, few improved stoves were produced and a large number of consumers purchased cheap and inefficient traditional stoves.

Responses were discussed and grouped, and then voted on. Participant could give three votes, with weight 1, 2, and 3 for the most important aspect on the board; they could vote for the main topics or for the more detailed subject within the topics. The results are as follows:

Stakeholder Involvement:

16 votes: All stakeholders need a shared vision

2 votes: Lack of community consultation

Project Design:

15 votes: Select the Khoroos to work in

Marketing

14 votes: There was no marketing strategy

9 votes: Lack of understanding of the consumer

5 votes: Poor delivery mechanism (consumers did not know where to buy improved stove)

Stove model, design, quality

11 votes: More and different stove models are needed

4 votes: Improved stoves lack practical usage

4 votes: Improved stove has high emission especially dust and smoke

3 votes: No filter for smoke

Policy:

9 votes: No policy and/or regulation prohibiting the uses of inefficient stoves

2 votes: Very little understanding and support from politicians

Others:

6 votes: Awareness not effective

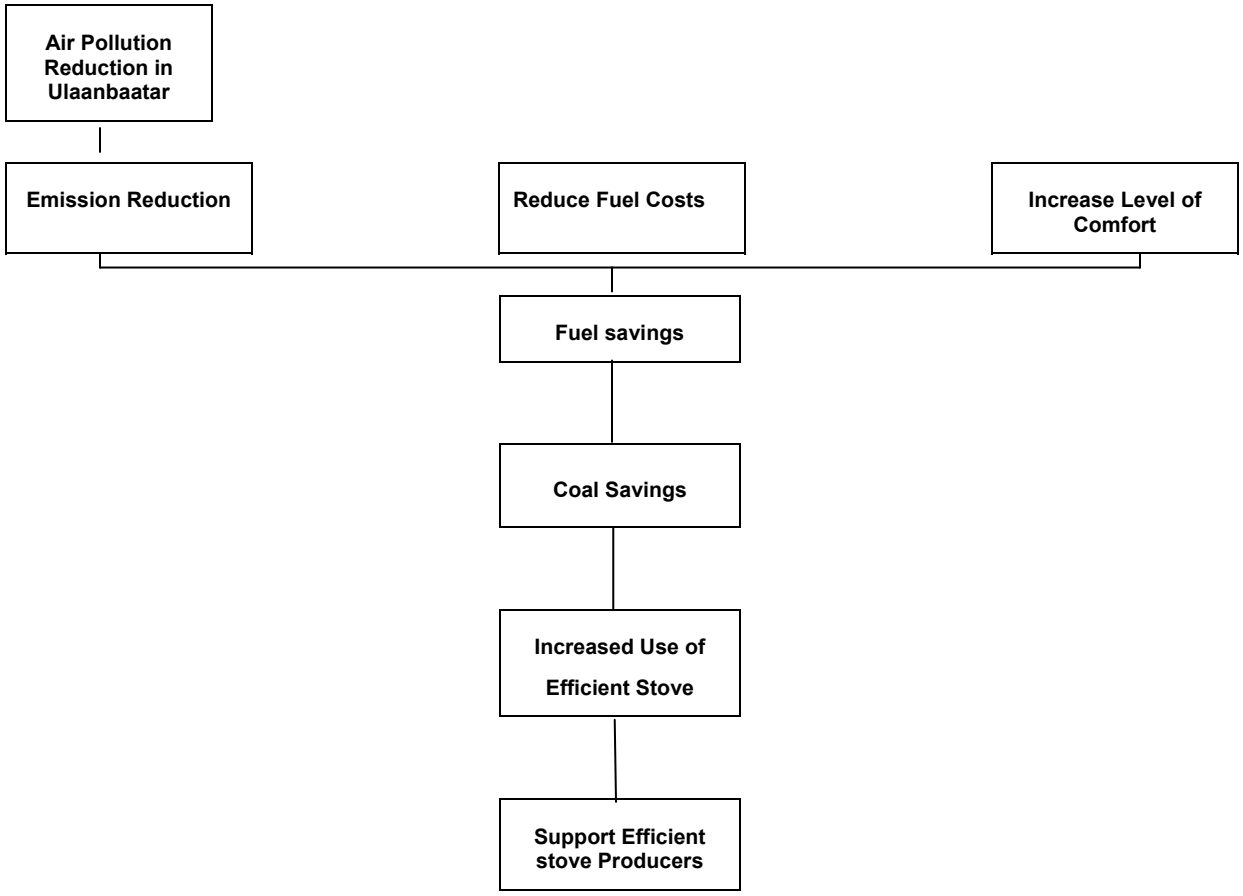
5 votes: More private sector involvement needed

4 votes: Only one government agency was involved in the project

4 votes: Too high costs for stoves

The third question, "What do you think is more effective in combating ger area air pollution: Improved Stove (IS) or Cleaner Fuels (CF) and Why?" gave more importance to improved stoves than to cleaner fuels, although the consensus was that the two are linked:

- IS because at least we have learned some lessons from IS; we have no idea how to introduce clean fuel. Unless draconian measures approach is used to ban raw coal.
- IS, it can only take one type of fuel
- IS, clean fuel is next step
- Have to use IS; there is a case of producing air pollution not depending on fuel heating capacity
- IS, people can buy IS only once; they must buy fuel every day and this is expensive
- IS should become better; it is difficult to control which fuel is used at households
- IS but (i) fuel should be clean; (ii) smoke filter should be used; and (iii) electricity should be used for ger heating



The fourth question "How can a project sell more than 30,000 improved stoves before next winter? How can a future project sell many stoves in a short period?" gave a wide variety of answers, which became much clearer after the voting.

Voting Results:	
Financing:	
20 votes:	Availability of financing, such as providing loan to consumers
11 votes:	Khoroo and local bank involvement in financing activity including credit provision related to voucher system
Creating awareness 19 votes	
Marketing:	
8 votes:	Establish stove sales kiosk in each district
4 votes:	Launch marketing campaign to promote improved stove
Project Design:	
7 votes:	Coordination of all administrative units
7 votes:	Train consumers (short time)
5 votes:	Every household should have access to voucher for improved stove
4 votes:	Every household should have opportunity to replace its old stove with improved stove
Management:	
5 votes:	Ulaanbaatar municipality and government should participate fully to organize awareness, marketing campaign, selling location
4 votes:	Government policy must support dissemination of 30,000 improved stoves
3 votes :	Make good selection of district(s) and/or khoroo(s) and focus on it.

The fifth question, "How should a subsidy for improved stoves be targeted? And why?" gave a split result for consumers and producers. A subsidy to consumers would make the discount most visible, but a subsidy to buy down some costs of the supply chain (manufacturer, distributor, and after-sales service providers) was also seen as productive. Support to producers from the private sector, not through the government, would be win-win for both the producer and the end user, but any subsidy should be based on sales result. Finally, people also said that both consumers and producers should be supported, 50-50.

Disadvantages of the previous stove project as mentioned were:

- Subsidy to producer was provided after the sale, but it would be good instead if some advance were given upfront for raw material purchasing
- All manufacturers should be involved instead of a few and the subsidy should be 50 percent of production costs; number of producers in program too few to get long-lasting effect
- Sales persons needed; subsidy not only for manufacturers: middle man incentives
- Failure to get rid of traditional stove completely
- No choice for households
- Too few stove models
- Iron price went up but subsidy amount did not
- No incentives for manufacturers to reduce the price
- Consumer should also be subsidized through khoroo by 50 percent

APPENDIX D: CASE STUDY FOR ELECTRIC HEATING

This note has been prepared to review the issues dealing with electric heating for ger areas as a measure for reducing air pollution.[1]

Electric Heating in Ger Area, Needs and Issues

Ulaanbaatar city is struggling to accommodate almost 1.2 million people with an infrastructure that was originally designed for not more than half a million people. At this moment, 60 percent of the population, or some 150,000 households, live in ger areas, which are zones made up of informal settlements of gers (nomadic felt tents) and small single-family wooden or brick houses with their own fenced areas, or *hashaas*. In general, ger area dwellers are low-income people compared with apartment dwellers; a significant number of these families recently moved to Ulaanbaatar to escape rural unemployment problems and to obtain better educations for their children.

The recent survey found that in the ger areas of Ulaanbaatar, only 32 percent of the sample population lived on stable incomes such as salaries or pensions; 53 percent of respondents registered themselves as "unemployed" and 80 percent of households reported one or more unemployed adult family members. Poverty incidence in Ulaanbaatar's ger areas was 47 percent, compared with 16 percent among the capital's apartment dwellers. During 2007, of the approximately 17,000 families that moved into Ulaanbaatar from rural areas, only 400 moved to apartments.

Ulaanbaatar is considered one of the coldest capitals in the world—air temperatures range between minus 25 and minus 40 degrees Celsius in the winter. Because of these severe climate conditions, heating is vital for Mongolia and the heating season lasts eight months, from September 15 to May 15. Electricity is considered one of the cleaner heating options but may not be suitable for low-income households in ger areas unless subsidies are provided. The option could be considered if the government and Ulaanbaatar city municipality are willing to commit to the necessary investments and subsidies; this note explains some of the implications. This note reviews the data and analyzes the issues so that a better founded decision can be made.

Electricity Capacity Expansion and Upgrade for Ger Area

There are approximately 150,000 households in the ger area and the average nonheating electricity demand per family is 0.8–1.0 kW. The electric capacity needed to satisfy additional heating needs are estimated as follows:

Heating capacity needed to heat 1 square meter		150 W
Average heating area (small house, 5 × 6 m)		30 m^2
Total heating capacity needed for a detached house	(150 × 30 m^2 = 4,500 W)	4.5 kW
Total heating capacity needed for a ger	(150 × 22 m^2 = 3,300 W)	3.3 kW

If we assume that the average capacity needed for electric heating is 4 kW per family in the ger area, the electric capacity of Ulaanbaatar would need to increase by 600 MW. To compare this with actual capacity, the peak demand in Ulaanbaatar in January 2008 was 335 MW. It is clear that without additional generation capacity, ger area households cannot use electricity for

1. Written by Liu Feng and Tumentsogt Tsevegmid, World Bank staff, based on data in the first half of 2008.

heating. Increased generation capacity requires increased capacity in transmission and distribution networks. In fact, the distribution network in Ulaanbaatar is already 30 years old and needs significant rehabilitation and upgrading. Main feeder transformers of 110 kV at Omnod, Baruun, Umard, Dornod–II, and Tuul substations are already overloaded and cannot accommodate additional loads without the risk of shutting down parts of the system.

Additional investments in the power infrastructure are needed before ger districts can start using electricity for heating on a large scale. Such required investments for increased generation, transmission, and distribution capacity, as well as for the purchase of electric heaters, installation of internal wiring, and special meters, envelope renovation, and so forth can be estimated as follows:

1.	Generation capacity of 600 MW × $1.5 million	$900 million
2.	Transmission system rehabilitation and upgrade	$150 million
3.	Upgrade and rehabilitation of MV and LV	$150 million
4.	Electric heaters, 150,000 × $300	$ 45 million
5.	Internal wiring, special meter, envelope renovation, 150,000 × $1000	$150 million
Total:		$1,395 million

These are very rough estimates based on costs for electric heaters, internal wiring, special meters, and envelope renovations as found in a case study of electric heating in Beijing. It is obvious that neither the government nor Ulaanbaatar city is in a position to finance such investments in near future, even if ger area households provide the heaters and pay for the internal wiring costs.

Housing Plans and the Future of Ger Areas

The government of Mongolia, Ulaanbaatar city municipality, and the Ministry of Construction and Urban Development (MCUD) are in the process of implementing a housing program "40,000 apartments units," including the expansion of heating, electricity, and water and sanitation networks to potential housing area sites. UBMG announced in 2008 the start of a project to relocate khashaa households closest to the city center area into new apartments.

In fact, this is a long-term and relatively expensive option, which has been included in the Master Plan to reduce Air Pollution in Ulaanbaatar. However, many issues need to be clarified, such as evaluation of khashaa land value; expansion of public services infrastructure, such as water supply, sanitation, heating and electricity networks; construction cost of new apartments, and so forth.

Efficiency of Heating Gers with Electric Heaters

From an energy efficiency point of view, electric heating in gers or wooden detached houses is not realistic. The ger itself does not retain heat efficiently because of poor insulation from the materials from which it is constructed, such as felt, wooden framework, and simple fabric. The design of the ger followed the traditional way of life, and was well-suited to the nomadic lifestyle: greater mobility to follow livestock, easy and light to assemble even by one woman, and so forth. But the ger is inefficient in terms of heat insulation compared, for example, with brick houses. Heat losses from infiltration of outside air into the ger is "worse" compared with paneled apartment buildings by 20 times ,and 5 times compared with an ordinary brick house.

Electric Heating Using Nighttime Special Rate for Electricity

There are potential options for using time-differentiated tariffs for electricity during the day and nighttime to make use of spare generating capacity. Estimates were made for the Ulaanbaatar electricity distribution network if electric heaters were used in ger areas, see table D1.1. An average ger area family spends Tog 10,000–15,000 (US$8.30–US$12.50) for electricity in addition to using existing conventional coal heating stoves. Table D1.1 shows how much each family would pay for electricity if heating were to be provided by electric heaters and using the differentiated tariffs during the day and nighttime.

The estimates show that if electric heaters were used for an average of 18 hours a day (9 hours during the night and 9 hours during the day) the cost would be about Tog 110,160 (US$92) per month. Electricity charges would increase by about three times though it is assumed the household will not spend money for fuel (coal, firewood, and briquettes) anymore, which was roughly Tog 2,000 (US$1.67) per day during the coldest days in early 2008.

Table D1.1

#	Items	Unit	Total
1	Average usage of electric heaters per day	hours	18
2	Nighttime usage (9:00 pm – 6:00 am)	hours	9
3	Daytime usage (anytime between 6:00 am and 9:00 pm)	hours	9
4	Electricity used during nighttime	kWh	36
5	Electricity used during daytime	kWh	36
6	Electricity night tariff	Tog/kWh	34
7	Electricity day tariff	Tog/kWh	68
8	Electricity charges during nighttime	togrog	1,224
9	Electricity charges during daytime	togrog	2,448
10	Electricity charges for using electric heater (per day)	togrog	3,672
11	Electricity charges for using electric heater (per month)	togrog	110,160

Thus, the question is whether households can afford to pay for the costs at the current tariff. Even taking into account reduced nighttime tariffs, it appears that electric heating is some 40 percent more expensive than heating with coal. With the current tariff, electric heating would be roughly Tog 110,160 (US$92), not including the electricity used for other purposes, such as lighting, refrigerator, TV, and so on. Compared with heating bills for apartment buildings, these costs appear very high.

Based on the above assumptions, the total subsidy needed for ger area households to use electric heaters at costs similar to those for coal stoves would be roughly US$54 million per heating season.

One of the measures for air pollution reduction in ger areas considered by UBMG and proposed in the "Ulaanbaatar City Master Plan for Air Pollution Reduction" was the use of electric heaters using the nighttime tariffs. At the time of conducting the current study, nighttime tariffs were relatively low at Tog 11.3 per kWh, but beginning July 15, 2008, the Energy Regulatory Authority increased the rates to a daytime tariff of Tog 68.0 per kWh (an increase of 30 percent) and a nighttime tariff of Tog 34.0 per kWh (an increase of 300 percent).

Mongolia covers its peak power deficit by imports from Buryatia of the Siberian Energy System (the Russian Federation). Based on Mongolia's current generation mix, based only on coal-fired combined heat and power (CHP) plants, the National Dispatch Center (NDC) of the Central Energy System (CES) has limited flexibility of dispatch regulation during the peak and off-peak hours. As a result of these limited maneuvering capabilities, the CES does not have another choice but to operate at night to ensure availability and to produce heat for the central heating system (there are no other generation mixes, such as hydro and gas). For many years, Russia did not pay for nighttime electricity and recently it allowed to credit or to write off nighttime electricity flows to Russia from the amount of electricity sold to Mongolia. For that reason, there were public calls to use the nighttime electricity for heating purposes instead of letting it flow to Russia. Currently, the National Dispatch Center has managed to find an optimal generation dispatch regime, which allows only a very small fraction of electricity generated during the nighttime to flow to Russia.

In 2007, CES's total demand was 3,724.13 million kWh. CES imported 130.0 million kWh (3.49 percent) from Russia. The electricity that "flowed" to Russia during the nighttime is only 13.94 million kWh, or 0.37 percent of demand. Out of that amount, about 80 percent was exported during the nighttime, and average capacity was only 15–20 MW. If, in the high scenario, the 100,000 households use electric heaters (100,000 × 4 kW = 400 MW; 400 MW × 9 hours = 3,600 million kWh), the required capacity would exceed the entire demand for CES.

It is very clear that at the moment it is not possible, for technical and economic reasons, at both the state and municipal levels, to introduce electric heaters for heating purposes.

Risks

Heating season coal prices increased from Tog 30,000 (US$25) per ton in 2007 to some Tog 50,000–60,000 (US$42–US$50) per ton in 2008. If coal prices continue to increase and electricity prices remain stable (however unrealistic that is), electric heating becomes cheaper than heating with coal, with the risk that a large number of households may switch to electric heating. The Ulaanbaatar Electricity Distribution Network is not ready for such an increased load and will experience supply problems, with an impact on the whole city.

Case Study: Beijing's Electric Heating Program

As part of Beijing's air pollution control program, the municipal government began studying and demonstrating the use of electric storage heaters to replace coal-fired heating stoves in 2000 in the city's "Historical and Cultural Preservation Zones," where construction of natural gas distribution or district heating networks are prohibited. There are four municipal government agencies involved in the electric heating program, and the principles of the conversion policy were derived from the initial pilots and demonstrations, including the following:

- Sharing the costs (investment and operation) among the municipal and district governments, the electric utility company, and the households; and
- Using distributed electric storage heaters.

More specifically, the municipal and district government and the electric utility (which is owned by the municipal government) cover the costs of upgrading the distribution network and the special meters, as well as the costs of necessary building envelope improvements (wall insulation and double-glazed windows, for example). The government also covers two-thirds of the cost of

the electric storage heaters eligible for the dwelling (in practice, it is basically one heater for one formal living room or bedroom). The households pay for the cost of internal wiring. Households receiving government living expense support receive 100 percent cost subsidy for internal wiring and heaters. In addition, the municipal and district governments also pay for two-thirds of the off-peak electricity cost, which could amount to 130 million yuan (US$18 million) per year for 140,000 households.

The off-peak electricity price for electric heating is 0.30 yuan/kWh, compared with the 0.48 yuan/kWh for regular residential consumption. The special price lasts from 10:00 pm to 6:00 am and is effective from November 1 through March 31. The households prepay the price of 0.30 yuan/kWh and get 0.20 yuan/kWh back from the government after the heating season. Thus, the actual out-of-pocket cost of electricity for off-peak consumption is 0.10 yuan/kWh.

The nominal investment cost (based on officially published figures) of the electric storage heater program is high, at about 38,000 yuan per household (about US$5,290/household), based on 2007 investment figures. About 55 percent of the investment is said to be used for upgrading distribution networks (including meters).

Concluding Remarks

It is clear that the use of electric heaters in Ulaanbaatar will be an extremely expensive option from an economic point of view: the necessary investments are high and there are quite a few technical and financial issues. Even with the established policy for promotion of electric heaters (time-differentiated tariffs, sharing the costs) the government and local authorities need to make a commitment for continuous subsidies.

- Technical issues, such as significant requirements for expansion of generation capacity and upgrades to existing transmission and medium- and-low voltage distribution networks to accommodate possible increases in power demand in ger areas, need to be addressed. Very rough estimates indicate a need to upgrade generation capacity by 600 MW, and to make equivalent upgrades to the capacity of the transmission and distribution networks; and to improve wiring, metering ,and insulation of gers and detached houses to get the full benefits of electric heating. The direct investment costs of such measures may range between US$1.0 billion to US$1.395 billion. These estimates do not include possible tariff subsidies that might be required by the significant number of low-income ger area households, but without a targeted subsidy program this option may not be realized.
- Policy and financial issues need to be clarified. In comparison with the case study in Beijing, it is evident that in Ulaanbaatar no clear policy has been identified yet for electric heating in terms of responsible agencies, financing sources and mechanisms (including tariff subsidy), technical solutions (electric storage heaters or other appliances, automatic remote regulation of consumption during peak and off-peak hours, and the like), investments to upgrade the distribution network, sharing the costs, and so forth. The central and Ulaanbaatar governments have not come up with the thorough and rigorous analysis of how much it would cost to use electrical heating in the ger areas nor the commitment to allocate such resources.
- Future plans for the ger areas need to be clarified. The current Ulaanbaatar city government has plans to exchange the lands of khashaas closer to the city to housing

units. In this case, if electric heating will be used, it should be clarified which ger areas will remain and which areas will be soon transformed into housing areas.

APPENDIX E: LABORATORY TEST EQUIPMENT NEEDED

A suitable permanent laboratory needs to be set up and equipped for stove and fuel testing; total costs for equipping the laboratory are estimated to be less than $100,000, including recorders and computers. Tests to be carried out include fuel consumption tests and emission tests.

The following equipment is required over and above what is already available:

1. A 150 kg platform scale accurate to 5 grams, or failing that, 10 grams. The complete stove and chimney need to be placed on the scale to measure the rate of fuel consumption, from which the power output of the stove can be determined.

2. A source of compressed air (such as a small compressor that can be obtained from any tool shop), fitted with a moisture condenser and then chemical dryer

3. A flow regulator to control the diluted flow of combustion air to the meters.

4. A collection hood (to be fabricated locally) to collect emissions, dilute them, and measure the quantity in real time. The hood can only be installed in a laboratory setting that is permanent.

5. A lab for testing stoves. It appears that the municipality will have to locate and make this space available. The available DustTrak meter can measure the particulates to give an indication of cleanliness of the burn, but the exhaust gases need to be diluted and cooled before they can be measured.

6. Installation of an infrared cell in the Testo 350. At the moment, the Testo 350 only calculates the level of CO_2 from the O_2 level, but should be able to measure CO_2 directly with a nondispersive infrared CO_2 cell.

7. DustTrak DRX Model 8533 or similar for measuring particulate emissions in real time, together with a dilution system to condense particulates prior to measurement. Other suppliers include Ankersmid and Met-One, both of which supply Beta particle absorption mass detection of particulates.[2]

2. The World Bank cites these as examples of the types of equipment that could be purchased but does not endorse the brand or the model in any way.

APPENDIX F: VERIFICATION AND CERTIFICATION SYSTEM

The objective is to quickly lower emissions of pollutants from coal consumption in Ulaanbaatar; this will be realized by replacing, over the next two to three years, the coal-burning heating stoves used by most ger area households to heat their homes. Complementary action will promote the use of cleaner fuels.

The following presents the suggested approach for rapidly disseminating improved heating stoves in ger areas in Ulaanbaatar while also removing inefficient old stoves. It is desirable to create an infrastructure for selling and repairing stoves that is more professional than is now the case. A large information and awareness raising campaign will form the basis for the intervention, targeting all ger area households with messages about the impact of air pollution on their lives and possible solutions.

Calibrated and well-targeted subsidies are needed to facilitate the rapid replacement of inefficient old stoves with new and more-fuel-efficient stoves. It is proposed to provide these subsidies through a voucher system available to all ger area households for the purchase of a new and efficient stove. Households are invited to buy a new stove and can partly pay for it with the voucher—if the stove meets or exceeds the minimum efficiency standards as set forth in the National Stove Standard. Market development will be promoted as much as possible and the goal is to quickly obtain a number of improved stove models from different stove manufacturers in the formal and informal sectors. There should be no regulation of stove prices, which will be set entirely by manufacturers. The focus will be on stoves for use in gers and for use in detached single family houses (with hot water circulation system).

It is proposed to develop and maintain a list of certified stove models and a list of certified producers of stoves that meet the standard; only certified stoves can be paid for with the subsidy voucher, and the payment will be made after verification of the stove and its installation. The list of stoves and manufacturers will be publicized during the awareness campaign. Stove manufacturers will be responsible for providing proof that a stove meets the standards. Laboratories will be used to verify performance of the stoves based on the National Standard.

Previous Experience

The main improved stoves activity was a Global Environment Fund–funded program implemented by the Ministry of Nature and Environment; the Asian Development Bank also provided some funds. Four different stove models were identified through a competitive procedure, of which two were acceptable to households. Initially, orders were given to manufacturers, to pilot test the market. Later an output-based aid approach was used, whereby producers competed for a subsidy that was announced several times. Some 16,000 have been disseminated over the past five to six years. The production process is not sustainable and there is some doubt that currently produced stoves are of the same quality as the ones produced during the project. There is survey and laboratory evidence that the stoves reduce fuel consumption, but political forces prefer to cite the failure of the activity. The main lessons of the project were to involve all stakeholders in the design of the activity, give people choices, and do not disseminate stoves for free. There are or have been some other stove activities, the most significant of which are stoves from the JinSun Energy company and the GTZ program.

Proposed Project

There are four components to the proposed heating stove program:

(i) certification,

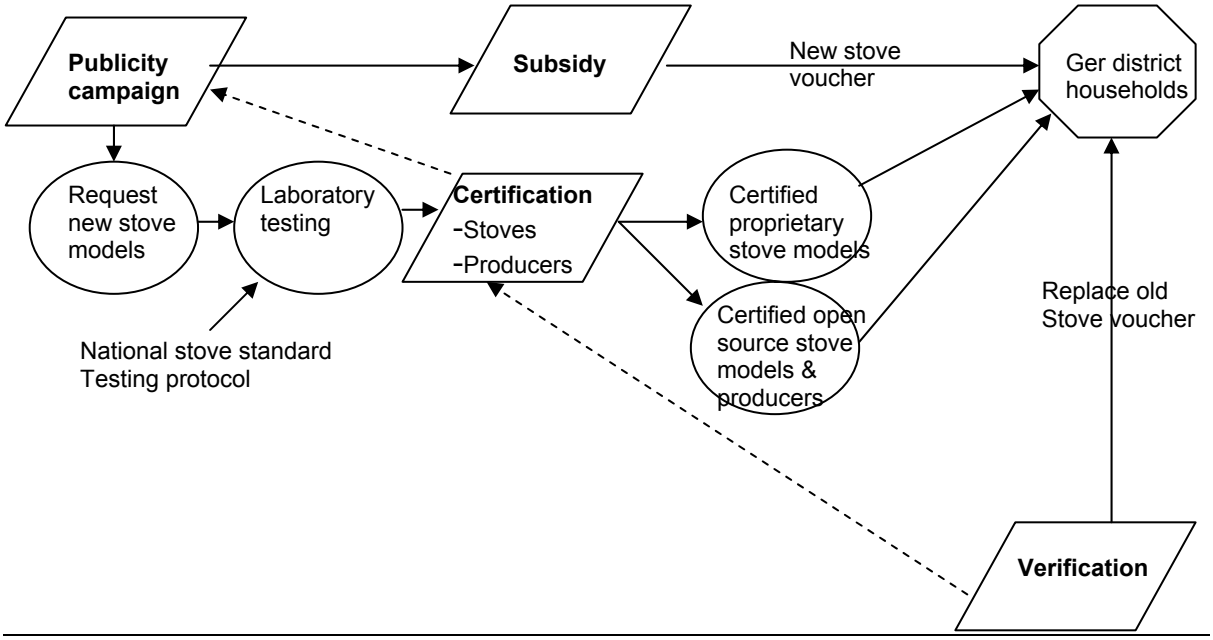
(ii) publicity and promotional campaign,

(iii) subsidy vouchers for new stoves and for returning old stoves, and

(iv) verification of stove quality.

Figure F1.1 shows the project's activities.

Figure F1.1



Component 1: Certification

The program addresses heating stoves for gers and for detached houses in ger areas, and includes both stand-alone stoves and low-pressure boilers. The Ulaanbaatar municipal government will maintain a list of certified stove producers and a list of certified stoves; anyone who satisfies certain criteria (to be developed) can get registered as a certified stove producer and submit stove models for certification. The stove producer will need to get the stove model tested by an agreed laboratory at the producer's own expense; the certification will be done by UBC after verification that it meets or exceeds the national stove standard as tested by the laboratory. UBC will maintain the lists of certified stove models and certified producers.

It is likely that two types of stoves will be submitted for certification: (i) proprietary stoves (which are unknown at the moment) and (ii) public domain stoves (of which two are known, the G2-2000 and the TT-03, the GTZ stove, all of which will still be subject to laboratory tests for certification—with the risk that they cannot be certified because they do not meet emission standards). For the first category, it is likely that one or more stove manufacturers will submit their stove model(s) for certification; they alone will be able to manufacture these stoves unless they allow production under license. For the second category, some stove producers are likely to

request to be registered as certified producers; this will be only for the production of certified public-domain stove types. Each stove on the list of certified models will be accompanied by a registration number or certificate so that its origins can be traced.

The certification procedures will be developed based on the following:

- Evaluation of the national standard for stoves and combustion of fuels
- Standard testing criteria and testing protocol for household heating stoves
- Capacity for testing and certification by laboratories
- An organization that can do the certification of stoves and stove producers, based on data provided by the laboratory and by the producers; this will yield the two lists of certified products and actors. UBMG could also be this organization, or more precisely, the project implementation unit; an alternative would be the Bureau of Standards.

Component 2: Publicity and Promotion

Informing the ger area population about the program to replace traditional heating stoves and making them aware of the certified producers and certified stoves for which a subsidy is available will be a large part of the project's activities. The benefits of such stoves will be made known: cleaner air, fuel savings, longer burning time, and the like. In addition, their old stoves have value and can be turned in against a payment under certain conditions.

The list of stoves and list of manufacturers will be publicized by UBMG; it will be widely circulated and posted at market outlets; it will also be regularly updated to incorporate new stove models and new stove producers. In one way or another, certified products will be distinguishable from noncertified products (a certificate, a sticker, or the like) and certified producers will benefit from the publicity and promotional campaign (to be worked out). For as long as certified producers make stoves that satisfy the criteria, they will be able to benefit from the project's infrastructure and support. As soon as this is no longer the case (that is, they make poor quality stoves and are unable or unwilling to correct the situation), they will be removed from the list.

A subsidy will be available for households to buy certified stoves and also to return old stoves. A voucher system will be used to manage the subsidies. An NGO will verify that certified stoves are actually installed in households and that people know how to use them, and will also collect old stoves.

The publicity and promotional campaign will consist of the following:

- Develop and carry out a promotional campaign to announce that vouchers and subsidies are available for improved stoves and for returning old stoves, using all media to effectively bring this message across;
- Inform ger area households why it is better to use a stove that reduces emissions and what the options are for accomplishing this;
- Publicize the list of certified producers and certified products, and keep this list up to date; the list should be available in various places where people might consult it;
- Assist certified producers with the promotion of their certified products.

Component 3: Subsidy

There are likely to be two types of certified stoves: those meeting the national stove standard, and those exceeding the national stove standard. Stoves in the first category stoves should be almost equal in price to traditional stoves; stoves in the second category are much more efficient and the subsidy level could be higher; details will need to be worked out. A flat subsidy should be used for all certified stove models within each category to reduce production prices and promote competition.

In addition, a second subsidy will be available for any household that (i) purchases a certified stove and (ii) installs it, and (iii) hands in their old stove. A mechanism will need to be developed for the collection of old stoves and for the handing out of vouchers. (See also the verification scheme.)

The subsidy scheme will consist of the following activities:

- Identify the subsidy levels for new stoves, based on actual costs compared with the cost of traditional stoves and on average emissions reduction to be obtained;
- Develop the voucher system to deliver the subsidy; options could be through the khoroo government, one or more NGOs, or even private companies that might be awarded a concession contract for one or more khoroos or districts;
- Identify the subsidy levels for returning old stoves for households that purchase and install new stoves; the level should be determined and a mechanism for collection should be developed, possibly in combination with a certification.

Component 4: Verification

Improved stoves should be of good quality and perform at least according to the national standard. To verify this, a mechanism will be put in place. The mechanism consists of three elements, each with its own characteristics:

- random checks;
- verification of installation; and
- checks based on feedback.

From time to time, randomly selected certified producers will be asked to submit a stove for verification (details to be developed) for retesting, and certified stoves will occasionally be randomly purchased from the market to verify compliance with the quality standards. If a certified producer does not comply with the standards, the producer will need to make corrections or risk being taken off the list of certified producers; this also holds for producers of open-source certified stove models: quality problems must be fixed or they will no longer be allowed on the list of certified producers.

After a producer sells a stove with a subsidy, the beneficiary will be visited to verify the quality of the stove and that the stove is actually installed in the home. Once this is properly verified in the beneficiary's home, the project implementation unit will obtain permission to pay the registered producer the counter value of the voucher. At the time of verification, the household will be asked to hand in the old stove, for which a further subsidy will be given. The exact mechanism is still to be developed. This will allow the project to collect old stoves and recycle

them to the steel mills in Darkhan. This verification system should be set up such that khoroo-based organizations are involved; one way would be that they keep the value of the old stoves.

Consumers are encouraged (through the publicity and promotional campaign) to register complaints if and when justified. If a certified producer or a certified stove model receives a significant number of complaints, a verification check should specifically research this question with a view to finding solutions rapidly.

Risks

Three main risks have been identified: First, is political economy: frequent changes in government posts may lead to alterations or delay in agreed-on work plans. Second, there are not enough certified stove models, or existing stoves are not good enough, for emissions reduction purposes. Specific training and capacity building among national stove producers should take place and a mechanism to import stoves that meet the standards should be created. The potential market for such stoves is sufficiently large that foreign stove producers could be interested. Third, subsidies are not large enough for households to replace their old stoves.

APPENDIX G: SAWDUST BRIQUETTES

This appendix discusses the options for producing a household fuel for heating from natural resources other than coal, and it aims mainly at replacing Ulaanbaatar's coal consumption. Sawdust briquettes are particularly considered here as a generic option. Sawdust briquettes can be made of sufficiently high quality to be transported over long distances (if necessary); they are usually appreciated by households because of the combustion characteristics: smokeless, slow burning, no ash remaining, and 50 percent claimed lower consumption (on a weight basis compared with raw coal). At least two producers exist and one of them carried out limited acceptance tests in Khoroo 50 of Sukhbaatar District: households highly appreciated the briquettes and reportedly even paid Tog 70/kg as compared to Tog 30/kg for wholesale delivery of coal (Tog 40/kg for purchase in bags).

For the supply of biomass briquettes to be sustainable, the supply of raw material to produce the briquettes needs to be stable and assured. Biomass, if managed well, is a renewable energy source and can be used in the long run. In this appendix two cases are considered: (i) wood from natural resources available in Mongolia; and (ii) special cases where a large volume of residues happens to be available.

Resource Base and Theoretical Sustainable Production Capacity

The forest area in Mongolia is about 17.8 million hectares (ha) with a standing stock of about 1.36 billion m^3 of wood of mainly coniferous trees (*Larix*, *Pinus*). The forested area to the north of Ulaanbaatar has an area of about 3 million ha that could annually produce some 3 million m^3 of wood products on a sustainable basis. Total recorded consumption of sawn wood[3] in the country is only 0.6 million m^3 (NSO 2005) and it is likely that much more is harvested but undocumented. Firewood is a major source of energy in the country but there are no statistics on how much wood is harvested for this purpose. Experts who know this northern forest area claim that an additional 1 million m^3 of wood could easily be harvested without impacting the standing stock (that is, no deforestation, and also no disturbance of any ongoing harvesting).

Although it is in no way recommended to start harvesting such large volumes of wood, this option is considered just for the sake of determining the boundaries: is it possible to replace the entire Ulaanbaatar ger area coal consumption[4] with sawdust briquettes for use in traditional stoves? Some 0.5 million tons/year of sawdust briquettes are needed,[5] requiring the annual harvesting of about 0.9 million m^3 of wood. It is not necessary to use top-grade logs but lower quality wood and residues will be good enough. So, at least in theory, the production of wood briquettes to replace the full consumption of coal would certainly be a possible technical option that could be sustainable in the long run, even if improved stoves are not used. Large-scale use of improved stoves will bring down the demand to some 0.3 million tons/year of briquettes.

3. These are taken out in the form of logs; some 25 percent or more of this volume stays in the forest as residue (tops, branches, roots, leaves, and the like).
4. Estimated at 0.7 million tons/year.
5. This is calculated purely on the basis of calorific value of the fuels; 1.3 tons of coal replaces 1 ton of briquettes; the Building Energy Efficiency Center consumption tests showed a replacement factor of 1.10–1.15 plus a large reduction in the use of wood for kindling.

The new Forestry Law allows and promotes long-term management of forests by local communities. Communities active in forest management would greatly benefit if they could produce and sell one or more products, and raw material for the production of high-quality wood briquettes could be one of these products. The communities would harvest and sell the low-grade wood material to transporters. Briquettes would then be made by a locally based company and transported to the market. Several smaller briquetting plants with a production capacity of several dozen kt/year could be set up. The market for briquettes is mainly in Ulaanbaatar, Aimag, and Soum centers, for the heating use of households and low-pressure boilers that now use poor quality brown coal. There are multiple benefits: a high-quality heating fuel available for end users; less air pollution for the community as a whole; employment and income generation for local communities; a profitable operation for the briquetting company; and less CO_2 emissions for the global environment.

Alternative Short-Term Supply Options

An alternative option to harvesting wood from forests is using locally available residues, whether as a one-off or continuous operation. Sawmill residues often tend to accumulate in large mountains that remain intact for many years; at the moment there are no statistics on residue composition and availability, or on the number of operating and closed-down sawmills in the country.

At a sawmill close to Ulaanbaatar (Tunkhul), sawdust has accumulated for many years with a resulting volume of possibly some 0.3 million to 0.5 million m^3.[6] Although the major sawmilling operations ceased a long time ago, small-scale milling continues today and probably a supply of 3,000–5,000 tons of fresh sawdust is generated annually. One company established a pilot plant and already sells 2,000 tons of sawdust briquettes per year to the railway company and intends to scale up to some 16,000 tons/year. The director of the company saw a similar plant while in China and invested in the pilot plant. He has now prepared a business plan to expand to a more fully fledged production facility and is currently looking for financing.

The production of briquettes from sawmill residues—as opposed to from community-managed forests—is a lower-cost option but is normally not sustainable because the residues will be depleted sooner or later. Nevertheless, it would make good business sense to immediately start converting accumulated sawdust into briquettes and simultaneously identify a new supply stream of raw materials to realize a sustainable production level in the medium future.

Potential Supply

The potential supply of briquettes from known sources is large: at least 0.6 million tons of briquettes from the natural forest closest to Ulaanbaatar in theory, and about 0.3million to 0.5 million tons and thereafter a limited quantity of probably 3,000 to 5,000 tons/year from the Tunkhul soum. Data for other sawmills are unknown. These quantities suggest that sawdust briquettes are certainly worth pursuing as long as they can be sold for a price that is acceptable to clients. This means that heating costs do not increase for the average ger area household, although a certain number of them may be willing to pay a premium because of the superior burning characteristics of briquettes. Sawdust briquettes should be considered at least as seriously as semi-coked coal briquettes.

6. This is a very rough estimate and a better evaluation is needed; sawdust may deteriorate over time and become unusable.

Carbon financing could be used to make the production process more viable. Carbon financing at a level of $10/t could reduce the production cost of the briquettes by $19/t.

Market Size

The widespread use of improved stoves would reduce the coal consumption from the current level of some 0.7 million tons/year to about 0.4 million tons/year. Between 0.2 million and 0.3 million tons/year of sawdust briquettes[7] are sufficient to provide the same amount of heat. Smaller quantities of briquettes may be needed even if the results of the limited acceptance tests can be generalized.

Forest Residues–Based Briquette Production: Description of Activities

The sustainable production of sawdust briquettes from forest residues requires the following activities:

(i) forest-based harvesting;

(ii) transformation; and

(iii) commercialization.

The *forest-based* harvesting activities include the extraction of low-quality wood, drying in the sun in a safe place (to prevent forest fires!), and transporting to a collection point. These forest-based activities, including sustainable forest management practices, could be developed either under the proposed World Bank forestry project or under the ongoing GTZ fire prevention activities.[8]

A community group producing 1,000 m^3 of wood per year requires about 15 people to be employed during the harvesting season (100 days/year); they each would earn a reasonable sum of money for work carried out.[9] An area of about 1,000 ha per community is needed for such an operation, which seems not unrealistic. Some 100 community groups would be needed to produce enough wood to produce about 120,000 tons of briquettes in this manner.

The forest-based activities can be avoided if sufficient residues are available; this would lower the production costs, at least temporarily.

Transformation includes chipping at the collection point with a mobile chipper and transporting chips to the briquetting plant, further drying (if needed), hammer milling, and briquetting. A screw press will be used to form briquettes without binder; the high pressure will liquefy lignin in the wood, which will act as a binder. The resulting briquette is of high quality and allows for slow and clean combustion. Some 100–150 people are likely to be involved in this transformation process.

Commercialization involves transport to the end user and retail marketing, and is also likely to require about 100 persons to be involved. Some 10 trucks per day are needed to transport the briquettes to town. In all, the production of 100,000–120,000 tons of briquettes from natural forest feedstock will employ about 2,000 people.

7. If only the heat content is considered, for each ton of sawdust briquettes, 1.3 tons of coal are replaced and 1.9 tons of CO^2 are saved.
8. GTZ confirmed its highly positive interest in this.
9. Here a fee of Tog 4,800/person per day is considered.

Estimation of the Production Costs

Table G1.1 gives a rough estimation of the production costs; included are investment costs and depreciation, operational costs, and margins for all involved.[10] The analysis is based on typical investment costs prevailing in Europe.[11] In addition, a subsidy for avoiding CO_2 emissions from coal and a polluter tax benefit are taken into account. The resulting wholesale price is about Tog 38,600 (US$32) per ton of briquettes, which can be compared to Tog 30,000 (US$25) per ton of coal on an equivalent energy content basis. Or, if the limited acceptance tests can be validated, the equivalent coal price would be 77,200 per ton, in which case a household's costs for heating would be reduced if it switches to briquettes. This also means that without carbon financing and without benefits from a polluter tax, the briquettes can be sold at their current price without an increase in annual heating costs for households.

Table G1.1 ESTIMATED PRODUCTION COSTS OF SAWDUST BRIQUETTES

	Tog/ton	US$/ton
Cost of wood extraction and transport to collection point by community	6,000	5
Sun drying		
Cost of chipping	12,000	10
and transport to the briquetting plant by transporter (50 km)	4,800	4
Drying	12,000	10
Briquetting	18,000	15
Transport to Ulaanbaatar	18,000	15
	70,800	59
Carbon financing	(23,143)	(19.3)
Polluter tax benefit	(9,000)	(7.5)
Total	38,657	32.2

Potential Project Activities

The assistance to develop forestry-based community development activities should be the responsibility of another program and cannot be covered under the Air Pollution Project. However, if a sustainable supply of wood can reasonably be guaranteed, briquetting makes sense, particularly if accumulated resources are used first. An assessment of how many communities there could be, their locations, and their resource availability will need to be carried out as well as an assessment of how many briquetting plants would be optimal for the projected sustainable supply of wood.

The proposed Air Pollution Project could support and enable the transformation and the commercialization of briquettes through a number of private companies. To that end, the market for briquettes could be actively promoted, through acts of publicity and awareness raising, and technical assistance could be provided to potential briquette producers to set up the forest-based

10. A much better analysis will need to be carried out; this is just to give a flavor of the involved costs.
11. Investment costs for a 100kt/yr plant would be $3 million to $4 million, including tractor, forklift, crane, buildings, and the like; the local firm proposed a budget of $0.5 million for a similar plant using Chinese equipment (and not quite adhering to the European labor standards).

chipping capacity and one or more centrally located briquetting plants. In principle, existing transportation companies should be used to transport chips from the forest to the briquetting plant and then briquettes to the consumer. The capacity of the transport sector will need to be assessed. The private firm(s) will need to invest in the briquetting plant(s); the project will neither provide finance for investment nor for the operations; it could possibly provide pre-financing if needed, and mostly technical assistance for starting up the operations. Climate change funds or polluter funds could possibly be available to buy down the production costs of briquettes.

APPENDIX H: SOLID FUEL STOVES IN OTHER COUNTRIES

Modern coal stoves exist, but they may not be easy to find; a few Web sites that offer such stoves are listed at the end of this appendix.[12] In the United States, the United Kingdom, Germany, and some former Eastern European countries, coal is still regularly used by large numbers of customers. Solid fuel stoves appear to be making a comeback in Western countries, mainly because of escalating fuel-oil and gas prices. Wood stoves are the most popular choice, but some interest is gaining in coal stoves. In the United States, emissions are strictly regulated by the Environmental Protection Agency (EPA) and most solid fuel stoves need a catalyzer to meet the air quality requirements. Solid fuel stoves are not cheap; although no prices were collected, one can safely assume that they range between $2,000 and $5,000, including transport and installation.

A quote from a manufacturer: "*If you've been looking, you'll find that coal stoves seem harder to find* [compared with wood burning stoves or stoves using gaseous or liquid fuels]. *It's no illusion. Coal as a fuel source for residential heating has waned, and that's very unfortunate. It's unfortunate because anthracite coal is an excellent fuel, an American resource, and has shown remarkable price stability and value in terms of BTU/$. So why has popularity of coal dropped? Like wood, some people feel it's messy, or too much work. Of course, people had the luxury to feel that way during good economic times and low energy prices when turning up the thermostat was a 'no-brainer'. Another concern was that EPA regulations for emissions from wood stoves impacted sales for those consumers that wanted the flexibility of burning both fuels. This had the effect of forcing many consumers to choose a wood stove or a coal stove and not a combination stove. Most chose wood.*

As more people come to realize that a new energy sensitive era is emerging, coal will probably be recognized for its value and availability, and manufacturers will turn to create more coal stove models."

So, two things can be learned here: First, unlike what most Mongolian households think, a heating stove designed for wood is not always good for burning coal, although a properly designed compromise design (hybrid) is available that can burn wood and/or coal relatively efficiently. Second, it is expected that new models of coal stoves will come on the market in the near future to cater to the market of people who perceive liquid or gaseous fuels as too expensive. It might be an idea to accelerate this movement, to write an open invitation to these (and any other) manufacturers of coal stoves with the message that a market of more than 100,000 coal stoves is present in Mongolia, and inform them about the generic heating requirements, quality of different types of coal being used in Ulaanbaatar, and the generic air quality and fuel consumption characteristics plus the prices that people now pay for their stoves.

A feature of modern solid fuel stoves is their ease of use; they operate almost like a gas stove. Some are designed for pellets and/or come with a hopper, which is an automatic feeder

12. These are commercial manufacturers that were identified through a Google search; the authors do not endorse any of these manufacturers—they are just presented to demonstrate that there is a choice of manufacturers for coal stoves.

mechanism that allows users to feed their stoves only once a day or once every two days. This idea has not been pursued at all in Mongolia, but would make a lot of sense!

Examples of commercial suppliers of coal stoves, mainly in the United States:

http://www.readingstove.com/
http://www.harmanstoves.com/
http://www.leisurelinestoves.com/
http://www.vermontcastings.com/index.cfm
http://hearth.com/econtent/index.php/articles/coal_stoves/
http://www.prestontradingpost.com/coal_stoves.htm
http://coal-stoves.net/

APPENDIX I: THOUSAND HOUSEHOLDS QUESTIONNAIRE

.....
.....
.....
.....
.....

CONTENT OF QUESTIONNAIRE

Questionnaire №.				

Date.	2007	12	
	year	month	date

Starting time				

Name of surveyer:
/...../

Address

№	Address	Code										
1	District name											
2	Khoroo name											
3	Street name											
4	Gate number											
5	Name of household head	/...../										

Please indicate the reason for substitution

1	Do not make fire for heating
2	The household head is aged below 16
3	A household member was absent
4	At the time of visit, noone capable of responding was present
5	Postponed as all members of the household were absent for long time
6	Refused
7	Could not locate the household on the address
8	The address has been changed
9	Could not locate the household's place
10	Other / ----------/

Leader	Reviewed by	Verified by
Name _____	Name _____	Name _____
Date _____	Date _____	Date _____

Survey from the household in the main list	1

Survey from substituted household	2

A. _____

A. INFORMATION OF HOUSEHOLD MEMBERS

A.1. Please write down name of household head /...../

A.2. Please ask for the age of household head /.....yrs old.../

A.3. Sex of household head:

1	Male	2	Female

A.4. Educational level of household head

1	No formal education	4	Complete secondary education
2	Primary education	5	Vocational education
3	. Incomplete secondary education	6	Tertiary education

.

A.5. What is the marital status of head of household?

1	Single	→**GO TO A9**
3	Widower	
2	Separated	
4	Married	
5	Live with partner	

A.6. What is the age of the spouse of household head? /.....yrs old/

A.7. What is the educational level of spouse of household head?

1	No formal education	4	Complete secondary education
2	Primary education	5	Vocational education
3	. Incomplete secondary education	6	Tertiary education

A.8. What is the highest educational level of household member living in this household?

	Member of households	Education level
1	Father	1 Tertiary
2	Mother	2 Vocational
3	Son/daughter	3 Complete secondary
4	Parents in law	4 Incomplete secondary
5	Brothers and sisters in law	5 Primary
6	Nephew in law	6 No formal education
7	Other relatives	
8	Other	

A.9. what is the total number of household members living in this household?
Please enter number of person by age range?
/Do not leave answer blank, enter "0" for no member in that age range/
/Add aup and confirm the total number./

	Age range	Number of persons
1	0-5 years old	
2	6-15 years old	
3	16-20 years old	
4	21-24 years old	
5	25-60 years old	
6	More than 60 yrs old	

Total	

B. RESPONDENT

B.

B.1. How are you retalated to the household head?.

1	Household head →**GO TO B5**
2	Wife of household head
3	Son or daughter
4	Parents of household head or parents in-law
5	Husband or wife sibling
6	Grand son/daughter
7	Other relative
8	Not relative

B.2. Please indicate age of respondent /……./ years old

B.3. Please indicate sex of respondent

1	Male
2	Female

B.4. Please indicate educational attainment of respondent
/select one answer/

1	No formal education
2	Elementaty education
3	Middle school education
4	General education
5	Voccational training education
6	Higher education

B.5. What type of dwelling that your household is currently living in?
/Select one answer below as you observe and ask/

1	Ger
2	Separate house
3	Ger and Separate house
4	Two Ger
5	Other /...../

B.6. Ownership status of home that your household is currently living in.
/Select one answer below/

1	Owned
2	Rented
3	Live for free (assistance)
4	Other/……../

B.7. Have your household privatized your land? /select only one answer/

1	Privatized
2	Not yet privatized
3	Rented
4	Live for free
5	Do not know
6	Other/……../

B.8. Please indicate type of dwelling where your household stay mostly during the cold season

/use technique of observing and asking /

	Type of dwelling	Number of roomse If it is house exclude kitchen & toilet/ If ger how many walls / /	Size of home in Sq meter /exclude kitchen and toilet/	How many storey of this home	NO GO TO
1	Ger	/...../	/XXXXXXXXXX/	/XXXXXX./	
2	Winter home	/...../	/……/	/...../	
3	Summer home	/...../	/……/	/...../	
4	Other/……/	/...../	/……/	/...../	

B.9.1. What are the characteristics of the GER that your household is using as winter ger?

/ answer for each column select one answer/

№	B.9.1.1 Covering of the Wall		B.9.1.2 Covering of the roof		B.9.1.3 Floor		B.9.1.4 Skylight of ger		B.9.1.5 Entrance shed
1	Single	1	Single	1	Wood	1	With cover	1	Yes
2	Double	2	Double	2	Concrete/cement	2	No cover	2	No
3	Other/...../	3	Other/...../	3	Dirt/soil	3	Other/...../		

B.9.2. If you live in ger, are you planning to live in house in near future?

1	Yes
2	No. go to B.10

B.9.3. If you plan to live in house, how long does it take?

1	Within 1 year	4	More than 4
2	1-2 year	5	Other….
3	2-3 year		

B.10. Characteristics of your HOME used as winter home

/ Could answer more than one /

№	B.9.2.1 Wall		B.9.2.2. Roof/ outside panel /		B.9.2.3 Roof insulation
1	Brick	1	Thin metal sheet	1	Ash
2	Cement	2	Asphast roof single	2	Sawdust
3	Solid timber/log/	3	Tile	3	Felt
4	Wood plank/panel	4	Earth and clay with straw	4	Paper
5	Stone	5	Compress asbestos	5	Fibre glass
6	Other/……/	6	Other/……/	6	Dery clay/Soil
				7	No insulation
				8	Other/...../

№	B.9.2.4 Floor		B.9.2.5. Window		B.9.2.6 Door
1	Wood	1	Single window	1	Insulated door
2	Cement	2	Double window	2	Without insulation
3	Paquet	3	Thermal pane window	3	Double wooden door
4	Soil	4	No insulation	4	Other/……/

5	Plastic	5	Other/……/
6	Other/……/		

B.10.2. If you live in house, do you have an interest to solve your heating using a low pressure heat boiler with hot water distribution system in the near future?

1	Yes
2	No. go to C

B.10.3. If you are planning to solve your heating using a low pressure heat boiler with hot water distribution system in the near future, please define the timing.

1	Within 1 year	4	More than 4
2	1-2 year	5	Other….
3	2-3 year		

C. EMPLOYMENT AND INCOME

C.1. Your employment status /Multiple answer allowed/.

	Type of employment	YES	NO
1	Public entity	1	2
2	Business entity	1	2
3	Owns a private company	1	2
4	Self-employed	1	2
5	NGO	1	2
6	International organization	1	2
7	Pension/allowance beneficiary	1	2
9	Unemployed	1	2
10	Student /pupil/	1	2
11	Other /……/	1	2

C.2. Please indicate the total household income per month */salary, pension, business income, allowances etc./*

№	Type of Income and benefits	Total income per month (in TGg /
A	**Type of income**	
1	Salaries and wages	/...../
2	Pension	/...../
3	Disability benefits	/...../
4	Child support	/...../
5	Government honor payment	/...../
6	Support for lost of bread winner	/...../
7	Other benefits /...../	/...../
4	Advance payment	/...../
	Sub Total	**/...../**
B	**2. INCOME FROM BUSINESS ACTIVITY**	
1	Livestock	/...../
2	Agriculture	/...../
3	Trading	/...../
4	Other business activities	/...../
	Sub Total	
C	**Other Income**	
1	Income from rent of property	/...../

2	Stock share	/...../
3	Rent of dwelling and other assets	/...../
4	Income from patent & authors	/...../
5	Repayment loan and saving	/...../
6	Interest from saving & loan	/...../
7	Monetary allowance & gifts	/...../
8	Reward, prize	/...../
9	Remittances specify which: 1. pension, 2. child contribution 3. ….. (there are many!!)	/...../
10	Other	/...../
	Sub Total	/……
	Grand Total	**/...../**

C.3. Who makes your family financial decision?

1	Father
2	Father and Mother
3	All Family members
4	Father consult with his parents
5	Others……

C.4. How does your household make financial decisions
/ select only one answer/

1	Household head only
2	Household head and spouse
3	All household members take part in decision
4	Household head gets advise from parents
5	Other /...../

D. HOUSEHOLD EXPENDITURE

D.1. Right now, I have 25 sticks from a box of matches. Let us assume that these 25 sticks are all money you can spend in a month, i.e. your private money. Please think about how and for what do you spend your money as you go over the expenditure list. After deciding on how to spend your money, please place your sticks accordingly. Per expenditure item, put as many sticks as you think necessary while also omitting some expenditure items.

INTERVIEWER:
Write down the number of sticks in the corresponding cell in the expenditure list below once the respondents finishes to allocate stocks in accordance with his/her spending pattern. Please make sure that the total number of sticks adds exactly up to 25. The respondent must use all 25 sticks.

1. Show a card with the list to the respondents.
2. Indicate the number of sticks per expenditure item.

		Number of sticks

1	Cell phone /service charge/	
2	Private expenditure such as clothing etc.	
3	Education /tuition fee /school payment/	
4	Household utility expenditure such as electricity, water, and maintenance	
5	Leisure and going out with people	
6	Food	
7	Health care and insurance	
8	Loan repayment	
9	Fuel /transport /taxi /bus	
10	Donation to religious and aid organizations	
11	Housing rent, mortgage payment	
12	Savings /investment/	
13	Support for other family members	
14	Heating /coal, firewood etc./	
15	Other /...../	
TOTAL		**25**

E. HEATING STOVE USAGE AND OWNERSHIP

E.1.Which type of stvove is your household using?

/ Use **№2,3,4,5** displays/

	E.1 Type of Stove	Код	E.2 Specific type of stove	E.3 Has heating wall 1. Yes 2. No		E.4. Number Owned (enter "0" for do not own any)	E.4.1. Numbers that are using	E.5. How many years have been using	E.6 Where did you buy it?				E.7 Where do you use it?		
									market	Private person	Through assistance program/gift	Өemade it ourselves	Current home	ӨHousehold business, kios /	Garrage
1	Traditional stove	1	Metal sheet	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		2	Cast iron	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		3	Brick stove	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		4	Sawdust stove	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		5	Other /...../	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
2	Improved stove	6	TT-03	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		7	G2-2000	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		8	EB-1	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		9	BONA-2	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		10	GTZ-Stove	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
		11	Korean stove			/.../	/.../	/.../	1	2	3	4	1	2	3
		12	Other /...../	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3
3	Low pressure boiler with hot water	13	Made locally			/.../	/.../	/.../	1	2	3	4	1	2	3
		14	Imported from ..... /enter name of country/			/.../	/.../	/.../	1	2	3	4	1	2	3
		16	Other /...../			/.../	/.../	/.../	1	2	3	4	1	2	3

	distribution system	17	Other /...../			/.../	/.../	/.../	1	2	3	4	1	2	3
4	**Other**	18	Gas stove			/.../	/.../	/.../	1	2	3	4	1	2	3
		19	Electric stove			/.../	/.../	/.../	1	2	3	4	1	2	3
		20	Other /...../	1	2	/.../	/.../	/.../	1	2	3	4	1	2	3

E.8. What did you do with your previous stove?

/Choose one answer, refer to the most recent one/

1	Sold as scrap metal
2	Throw away
3	Gave to relative or friend for free
4	Sold it to another person/household
5	Still using stove that we have bought
6	Still using it but not for heating
7	Still keeping
8	Other/……./

E.9. What type of stove does your household use in the winter home?

Interviewer: Give an attention to E.7 for identifying stove being used by households	
/...../	/Look back E.7/

E.10. What do you think about the performance of your current heating stove?

/ Ask by every raw and use display No.6 /

№	Performance	Low	Medium	High	Do not know
1	Fuel usage	1	2	3	4
2	Smoke and soot release from stove	1	2	3	4
3	Ability to keeping heat for a long time	1	2	3	4
4	Frequency need to clean soot from chimney	1	2	3	4
5	Difficulty to start fire	1	2	3	4
6	Amount of ash	1	2	3	4
7	Availability of repair and spare parts	1	2	3	4
8	Other /…….....……......./	1	2	3	4

E.11. Are you interested in changing your current stove?

1	Yes
2	No / →**IF NO GO TO E.13**/
3	Have never thought about it

E.12. If you want to change, do you have any type of stove in mind, pease make selection?

/Show display No.7 /

№	Type of stove	Short term	Long term
1	Traditional stovep	1	2
2	Improved stove	1	2
3	Briquette stove /Korean stove /	1	2
4	Sawdust stove	1	2
5	Low pressure HOB stove	1	2
6	Other /…….....……......./	1	2

E.13. Please give reason why you do not want to change the stove?
/Answer all questions below; show display No.8 /

№	Reasons	YES	YNO	Do not Know
1	Our heating stove is still good enough	1	2	3
2	We are used to using our heating stove	1	2	3
3	Difficult to install new stove	1	2	3
4	Stove is special gift to us	1	2	3
5	Other /...../	1	2	3

E.14. When buying heating stove, which characteristics do you consider to be important?
/ Answer for each characteristics listed below /show display No.9/

	Characteristics	Very important	Important	Not so important	Do not Know
1	Price	1	2	3	4
2	Fuel consumption	1	2	3	4
3	Keep heat longer	1	2	3	4
4	Easy to start fire	1	2	3	4
5	Release less smoke & soot	1	2	3	4
6	Easy to use	1	2	3	4
7	Good quality and design	1	2	3	4
8	Shape and appearance	1	2	3	4
9	Other /...../	1	2	3	4

F. KNOWLEDGE ABOUT IMPROVED STOVE

F.1. What is your opinion about improved stove? / Ask every raw / Show display No.10 /

№	Opinion	Agree	Disagree	Do not know
1	Improved stove is easier to start fire than traditional stove	1	2	3
2	Improved stove release less smoke and soot than traditional stove	1	2	3
3	Improved stove keeps heat longer than traditional stove	1	2	3
4	Improved stove uses less fuel than traditional stove	1	2	3
5	Improve stove is more difficult to use than traditional stove	1	2	3
6	Need to clean chimney more often with improved stove	1	2	3
7	Heard improved stove is too expensive	1	2	3
8	Regular fuel cannot be used in the improved stove	1	2	3

F.2. Where did you hear about improved stove ?
/

		YES	NO
1	Never heard of it before /go to F.3/	1	2
2	From friends/neighbors/relatives	1	2
3	Radio/TV program,	1	2
4	Newspaper and /or printed media	1	2
5	From NGO through project	1	2
6	Stove maker	1	2
7	Bill board	1	2
8	Other /...../	1	2

F.3. What difficulty you may encounter when you change your current stove with improved heating stove. / Show display No.11/

№	Шалтгаан	Agree	Disagree	Do not know
1	High price	1	2	3
2	Difficult to install	1	2	3
3	Not suitable for wall stove	1	2	3
4	Do not know where to buy improved stove, it is not popular in the market	1	2	3
5	Improved stove is difficult to operate	1	2	3
6	Fuel expenditure will increase if we use improved stove	1	2	3
7	Improved stove has small firing chamber	1	2	3
8	Fuals does not match with improved stoves	1	2	3
9	Other /……...……/	1	2	3

F.4. What do you think if we buy your current stove and give you back the improved and fuel efficient heating stove at low cost? / Only one answer allowed /

1	Agree
2	Need to think about it
3	Not agree, why…… /Enter the reason why/.
4	Do not know

G. HOUSEHOLD FUEL CONSUMPTION

G.1. Which types of heating fuel does your household use mostly? Show display No.12
/Allow more than one answer**/**

1	**Coal**	1	Nalaikh
		2	Alagtolgoi
		3	Sharyn gol
		4	Baganuur
		5	Other /...../
2	**Wood**	6	Pine
		7	Larch
		8	Rim timber board
		9	Limb, bark
		10	Other /...../
3	**Sawdust**	11	Larch
		12	Pine
		13	Others
4	**Briquette**	14	Korean (yontan)
		15	Compress coal EGG SHAPE
		15	Compress coal (Stick shape)
		16	Sawdust briquette
		17	Other /...../
5	**Other**	19	Cow dung
		20	Paper
6	**Anything that can be burned**	21	Bone
		22	Clothes/boots/Other similar
		23	Tire
		24	Other/...../

G.2. In winter does your household use any other additional heating other than stove?
/ /

	Additional Heating	YES	NO

1	Air condition/Heat pump	1	2
2	Gas space heater	1	2
3	Electric space heater	1	2
4	Other /……/	1	2

G.3. When buying fuels which type of heating fuels listed below, and type of unit do you use?

/ could answer more than one fuel and each fuel could have more than one answer / Use display No. 13/

№	Choice	Bag	Truck	Other
1	Coal	1	2	/...../
2	Wood	1	2	/...../
3	Sawdust	1	2	/...../
4	Briquette	1	2	/...../
5	Other /...../	1	2	/...../

G.4. Which type of fuel does your household use for cooking in summer time (warm season)?

/Answer all /

		YES	NO
1	Use electricity	1	2
2	Wood	1	2
3	Coal	1	2
4	Briquette	1	2
5	Anything that burns	1	2
6	Other /……/	1	2

G.5. What do you use to start fire?

/ Ask by every raw/

		YES	NO
1	Paper	1	2
2	Candle	1	2
3	Tar paper	1	2
4	Plastic material	1	2
5	Kerosene or gasoline	1	2
6	Rubber	1	2
7	Briquette starter	1	2
8	Wood	1	2
9	Other/...../	1	2

H. HOUSEHOLD COAL CONSUMPTION

H.1. Last year during Sept, Oct, Mar, and Apr, how often did you add fuel to your heating stove

between time period listed below?

/ **Use display No.13,14** /

	Time period	**# of times**
1	06^{00}-$16^{:00}$	/...../

2	16^{00}-22^{00}	/...../
3	22^{00}-06^{00}	/...../
4	Do not use coal	**Go to I**
	A day	**/...../**

H.2. Last year in Nov, Dec, and in Jan, Feb this year how often did you add fuel to your heating stove between time period listed below?? / Use display No.13,14 /

	Time period	**# of times**
1	06^{00}-16^{00} цаг	/...../
2	16^{00}-22^{00}	/...../
3	22^{00}-06^{00}	/...../
4	Do not use coal	**Go to I**
	A day	**/...../**

H.3. Last year, how did your household obtain coal supply for use at home?
/ Ask by every raw /

		YES	NO
1	Purchased	1	2
2	Received it free from international organization through assistance program	1	2
3	My employer gave it free	1	2
4	Received it free from Khoroo and District through assistance program	1	2
5	Received it free from friend/relative/siblings	1	2
6	Used left over coal from previous year	1	2
7	Other /...../	1	2

H.4. Please indicate the total amount of coal used and total expenditure for coal by moth between Sept 2006 to June 2007. /Use Display No.16/

Interviewers: /indicate details of every month in table. Write monthly fuel expenditure and way of supplying. Give an attention to the below for filling way of supply:

1. Car or truck type
2. Indicate 0 if you received for free
3. Convert your expenditure into tonn using below table:

No	Type	Measuring unit	Size
1	Porter	Ton	2-3 ton
2	Zil-130	Ton	5 ton
3	Bag	kg	60 bags=1 ton

№	**Month**	**Number of Bag /obtained in Bag/**	**Number of ton /obtained by truck load/**	**Total expenditure /in Tg.)**	**Total number of days cover /days/**	
1	9-10 cap	/……./	/……./	/……./	/……./	
2	10-11 cap	/……./	/……./	/……./	/……./	
3	11-12 cap	/……./	/……./	/……./	/……./	
4	12-1 cap	/……./	/……./	/……./	/……./	
5	1-2 cap	/……./	/……./	/……./	/……./	
6	2-3 cap	/……./	/……./	/……./	/……./	/Calculate total coal used in Ton
7	3-4 cap	/……./	/……./	/……./	/……./	
8	4-5 cap	/……./	/……./	/……./	/……./	
9	5-6 cap	/……./	/……./	/……./	/……./	

Total	/...../	**/……./**	**/……./**	**/……./**				

I. HOUSEHOLD WOOD CONSUMPTION

I.1. Last year, how did your household obtain wood supply for use at home?
/Ask by every raw/

		YES	NO
1	Purchased	1	2
2	Cut from forest for free	1	2
3	Received it for free from international organization through assistance program	1	2
4	My employer gave it for free	1	2
5	Received it for free from Khoroo and District through assistance program	1	2
6	Received it for free from friend/relative/siblings	1	2
7	Used left over coal from previous year	1	2
8	Other /...../	1	2

If you selected 1, 3, 5, 6 please go to I.2

I.2. Please indicate the total amount of wood used and total expenditure for wood per month between Sept 2006 to June 2007. Use display No.17

Interviewers: /indicate details of every month in table. Write monthly fuel expenditure and way of supplying. Give an attention to the below for filling way of supply:

4. Car or truck type
5. Indicate 0 if you received for free
6. Convert your expenditure into cubic meter using below table:

No	Type	Measuring unit	Size
1	Porter	Cubic meter	2-3 cubic meters
2	Zil-130	Cubic meter	5 cubic meters
3	Bag	Cubic meter	20 bags=1 cubic meters

№	Month	Number of Bag /obtained in Bag/	Number of cubic Meter /obtained in truck or M^3/	Total expenditure /in Tg.)	Total number of days cover /days/	
1	9-10 cap	/……./	/……./	/……./	/……./	
2	10-11 cap	/……./	/……./	/……./	/……./	
3	11-12 cap	/……./	/……./	/……./	/……./	
4	12-1 cap	/……./	/……./	/……./	/……./	
5	1-2 cap	/……./	/……./	/……./	/……./	
6	2-3 cap	/……./	/……./	/……./	/……./	/ calculate total wood used in cubic meter/
7	3-4 cap	/……./	/……./	/……./	/……./	
8	4-5 cap	/……./	/……./	/……./	/……./	
9	5-6 cap	/……./	/……./	/……./	/……./	
Total		/...../	**/……./**	**/……./**	**/……./**	

J. HOUSEHOLD BRIQUETTE CONSUMPTION

J.1. Is your household currently using briquette? / Use display No.18 /

№	Frequency of usage	ËCompress coal	Sawdust briquette	Yontan briquette	OTHER /...../
1	Use all the time	1	2	3	4

2	Use some of the time	1	2	3	4
3	Rarely use	1	2	3	4
4	Have not used /go to K/	0	0	0	0

J.2 How did your household supply briquette last year?
Answer to main one. Use display No.19

		Pressed coal	Sawdust briquette	Yongtan briquette
1	Purchased	1	1	1
2	Received it free from international organization through assistance program	2	2	2
3	My employer gave it free	3	3	3
4	Received it free from Khoroo and District through assistance program	4	4	4
5	Received it free from friend/relative/siblings	5	5	5
6	Used left over briquette from previous year	6	6	6
7	Never used /go to K/	7	7	7

J.2.1. Where did you obtain briquettes that your household used?
/ you can choose 1-2 answer in each raw / Use display **№ 20**/

		ËCompress coal	**Sawdust briquette**	**Yontan briquette**	**OTHER** /...../
1	Directly from manufacturer	1	1	1	1
2	Sales person delivered	2	2	2	2
3	Purchased from nearest sales person	3	3	3	3
4	Purchased from the market /……/	4	4	4	4
5	Other /...../	5	5	5	5

J.3 Please indicate the total amount of briquette used and total expenditure for briquette per month between Sept 2006 to June 2007. Use display No.21

Interviewers: /indicate details of every month in table. Write monthly briquette expenditure and way of supplying. Use the code numbers as follows: 1 for pressed coal, 2 for sawdust briquette, 3 for yongtan fuel.

Give an attention to the below for filling way of supply:

7. Car or truck type
8. Indicate 0 if you received for free
9. Convert your expenditure into kg using below table:

No	Type	Measuring unit	Cost	Kg
1	Pressed coal egg shaped	1 bag	900	20 kg
2	Sawdust briquette	1 box	2500	10 kg
3	Yongtan	1 piece	200	13 kg

№	**Month**	**Code for type of briq**	**Number of poeces /if obtain in**	**Number of Bag /obtained in Bag/**	**Number of ton /obtained by truck load/**	**Number of kg /obtained In kg**	**Total expenditure /in Tg.)**	**Total number of days cover /days/**

			piece/						
1	9-10 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
2	10-11 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
3	11-12 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
4	12-1 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
5	1-2 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
6	2-3 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	/ calculate total briquette used in kg/
7	3-4 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
8	4-5 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
9	5-6 cap	/……./	/……../	/……../	/……../	/……../	/……../	/……../	
Total		/……../	/……./	/……../	/……../	/……../	/……../	/……../	/……../

J.4. Please rank briquettes that you use / Ask every raw /Use display№22/

№	Frequency of usage	Compressed coal	Sawdust briquette	Yontan briquette	OTHER /……../
1	Lasts /1-long, 2-medium, 3-fast/	1 2 3	1 2 3	1 2 3	1 2 3
2	Heating value /1-low, 2-medium, 3-good/	1 2 3	1 2 3	1 2 3	1 2 3
3	Emission and particulates /1-small, 2-medium, 3-large/	1 2 3	1 2 3	1 2 3	1 2 3
4	Cost /1-cheap, 2-average, 3-expensive	1 2 3	1 2 3	1 2 3	1 2 3
5	Availability /1-scarce, 2-moderate, 3-plenty	1 2 3	1 2 3	1 2 3	1 2 3
6	Others	1 2 3	1 2 3	1 2 3	1 2 3

K. AIR POLLUTION

K.1. What do you think about air pollution in UB?

1	Extremely high /disaster level
2	High
3	Acceptable
4	Low
5	Do not know
6	Other /……../

K.2. In your opinion which sources contribute to air pollution in the city?

Answer every raw. Use display No:23

№	Source	Very high	High	Medium	Low	None	N/A
1	Motor vehicles	6	5	4	3	2	1
2	Industry	6	5	4	3	2	1
3	Power plant	6	5	4	3	2	1
4	Heating stoves /ger district/	6	5	4	3	2	1
5	Global warming	6	5	4	3	2	1
6	Dust	6	5	4	3	2	1
7	Undisposed solid waste	6	5	4	3	2	1
8	Other /……../	6	5	4	3	2	1

K.3. In your opinion, what will be the best way of reducing air pollution in the city?

Answer every raw and use display No.24

№	Option	Most suitable	Suitable	Not suitable	N/A
1	Reduce coal consumption	1	2	3	4
2	Consumption of briquettes	1	2	3	4
3	Use of improved stoves	1	2	3	4
4	Reduce the number of motor vehicles	1	2	3	4
5	Move ger residents to live in apartment	1	2	3	4
6	Ger residents use electricity for heating	1	2	3	4
7	Provide heat only boiler for groups of ger residents /3-5 households/	1	2	3	4
8	Other /...../	1	2	3	4

L. HOUSEHOLD ATTITUDE

L.1. Would you agree with the following statements?/Answer every raw and use display No.25/

1	Strongly agree
2	Agree
3	No opinion
4	Disagree
5	Strongly disagree

1	Traditional heating stove creates pollution inside home/ger	1	2	3	4	5
2	Air pollution in the city creates health problem for my family.	1	2	3	4	5
3	It is difficult to breath in the morning during the winter	1	2	3	4	5
4	Using improved stove would reduce air pollution problem	1	2	3	4	5
5	Would providing heat to a group of 3 to 5 households with one shared low pressure boiler be of interest to you?	1	2	3	4	5
6	Providing additional felt covers for ger would help ger household save fuel	1	2	3	4	5
7	I would really like to use electricity only to heat our home/ger	1	2	3	4	5
8	Raw coal creates air pollution in the city and its use should be banned	1	2	3	4	5
9	Coal briquette is less polluting than raw coal	1	2	3	4	5
10	It is not a good idea to throw away or sell old stove	1	2	3	4	5
11	Improved stove is cleaner than traditional stove	1	2	3	4	5
12	Improved stove save fuel	1	2	3	4	5
13	I would like to use a heating wall in my house	1	2	3	4	5
14	I prefer to use traditional stove than improved stove	1	2	3	4	5
15	Heating wall is better in providing heat for the household	1	2	3	4	5
16	Electricity is cheaper to heat our home/ger than using coal stove	1	2	3	4	5
17	I will buy a low pressure heat boiler with hot water distribution system in the near future	1	2	3	4	5
18	I will buy an improved stove in the future	1	2	3	4	5
19	I will buy an improved stove in the futue only if it is subsidized	1	2	3	4	5
20	I want to continue using raw coal only	1	2	3	4	5
21	I will buy briquettes in the future because they are less polluting the air					
22	I will buy briquettes in the future only if the costs are similar to raw coal					
23	It is quite expensive to keep my house warm during the cold winter months	1	2	3	4	5
24	Sawdust briquette is expensive that raw coal					
25	Electricity is cheaper to heat our home/ger than using coal stove	1	2	3	4	5
26	I prefer to choose from different fuels which I like					
27	Briquette lasts fast and has low heating value	1	2	3	4	5

Finished at			

Thank you for participating in our survey

APPENDIX J: THOUSAND HOUSEHOLDS SURVEY RESULTS

Household Fuel Consumption and Stove Use Survey
In
Six Ger Districts, Ulaanbaatar

Table 1 Total Number of Households in the Surveyed Districts

District Name	Number of Households	# of Households Sampled
Bayangol	7,369	73
Bayanzurkh	25,235	250
Songinokhairhan	23,317	231
Sukhbaatar	17,463	173
Chingeltei	19,482	193
Khan-Uul	80,75	80
Total	100,941	1,000

Table 2 Characteristics of the Households

Household Income (Tg/mo)	Age of Head of Household	Family Size (persons)
242,788	43.5	4.4

Table 3 Households Income Quintile

Income Quintile (Tg/.per month)	Less than 111,330	111,331 to 172,660	172,661 to 233,990	233,991 to 325,860	More than 325,860	Total
Number of Households	20,390	20,390	19,885	20,087	20,188	100,941

Table 4 Type and Size of Dwelling Unit and Household Income

Type of Dwelling Unit	Number of Households	% of Households	Monthly Income	Size of Dwelling Unit (average)
Ger	43,607	43.2%	206,519	4.8 walls
Separate/Single Family Home	55,820	55.3%	269,698	1.9 rooms/ $46M^2$
Ger and Single Family Home	707	0.7%	406,160	5.8 walls & 1.5 rooms/$37M^2$
Hostel/dormitory	707	0.7%	223,331	1.3 rooms
Other (not specify)	101	0.1%	22,660	1.9 rooms
Total	100,941	100%	242,788	

Table 5 Single/Double Felt Blanket Covering Ger

Felt Blanket Covering Ger				Total
Single Wall & Roof	Double Wall & Roof	Double Wall, Single Roof	Single Wall, Double Roof	
9,085	29,374	2,221	3,331	44,010
20.6%	66.7%	5.0%	7.6%	100.0%

Table 6 Estimated Total Number of Stoves

Specific type of stove	Type of stove			Group Total
	Traditional Stove	Improved Stove	Low Pressure Boiler (HoB)	
Metal/Cast Iron Stove	75,707 85.4%			75,707 75.0%
Brick Stove	8,984 10.1%			8,984 8.9%
Sawdust stove	3,937 4.4%			3,937 3.9%
Stove Model: TT-03		1,110 35.5%		1,110 1.1%
Stove Model: G2-2000		707 22.6%		707 .7%
Stove Model: EB-1		101 3.2%		101 .1%
Stove Model: BONA-2		101 3.2%		101 .1%
Korean Stove		1,110 35.5%		1,110 1.1%
HoB (Made Locally)			7,268 79.1%	7,268 7.2%
HoB (Imported)			1918 20.9%	1918 1.9%
Group Total	8,8626 100%	3,129 100%	9,186 100%	100,941 100%

Table 7 Estimated Total Number of Stoves by Types of Dwelling Unit

Types of Dwelling Types of Stove	Type of Stove			Total
	Traditional Stove	Improved Stove	Low Pressure Boiler (HoB)	
Ger				
Metal/Cast Iron Stove	38,156	-		38,156
	90.9%	0.0%		87.5%
Brick Stove	404	0		404
	1.0%	0.0%		0.9%
Sawdust Stove	3,432	-		3,432
	8.2%	0.0%		7.9%
Model: TT-03	-	303		303
	0.0%	18.8%		0.7%
Model: G2-2000	0	303		303
	0.0%	18.8%		0.7%
Model EB-1	-	101		101
	0.0%	6.3%		0.2%
Korean Stove	-	908		908
	0.0%	56.2%		2.1%
Ger: Total	*41,992*	*1,615*		*43,607*
	100%	*100%*		*100%*
Separate/Single Family Home				
Metal/Cast Iron Stove	36,944	-	-	36,944
	80.6%	0.0%	0.0%	65.4%
Brick Stove	8,378	-	-	8,378
	18.3%	0.0%	0.0%	14.8%
Sawdust Stove	505	-	-	505
	1.1%	0.0%	0.0%	0.9%
Model: TT-03	0	808	0	808
	0.0%	53.3%	0.0%	1.4%
Model: G2-2000	-	404	-	404
	0.0%	26.7%	0.0%	0.7%
Model: Bona-2	-	101	-	101
	0.0%	6.7%	0.0%	0.2%
Korean Stove	-	202	-	202
	0.0%	13.3%	0.0%	0.4%
Made Locally	-	-	7,268	7,268
	0.0%	0.0%	79.1%	12.9%
Imported	-	-	1,918	1,918
	0.0%	0.0%	20.9%	3.4%
Separate Home: Total	*45,827*	*1,515*	*9,186*	*56,528*
	100%	*100%*	*100%*	*100%*
Hostel/Dormitory/Other				
Metal/Cast Iron Stove	606			606
	75%			75%
Brick Stove	202			202
	25%			25%
Hostel/Dorm/Other: Total	*808*			*808*
	100%			*100%*
All Types of Stove&Dwellings	88,626	3,129	9,186	100,941

Table 8 Estimated Total Number of Stoves in the Ger Districts Around City Center

	Number of Stoves Being Used to Hea:t		Home Business/ Kiosk/ Garage	Second Stove Owned by the Household[3/]	Total Number of Stoves in 6 Ger Districts	Percent
	Ger	Home[2/]				
Traditional Stove						
Metal/Cast Iron	38,156	37,550	505	1,615	77,826	74.9%
Brick Stove	404	8,580	101	202	9,287	8.9%
Sawdust Stove	3,432	505	-	-	3,937	3.8%
Sub-Total	*41,992*	*46,635*	*606*	*1,817*	*91,050*	*87.6%*
Improved Stove						
TT-03	303	808	101	-	1,211	1.2%
G2-2000	303	404	-	-	707	0.7%
EB-1	101	-	-	-	101	0.1%
BONA-2		101	-	-	101	0.1%
Sub-Total	*707*	*1,313*	*101*		*2,120*	*2.1%*
Korean Stove	908	202	101	-	1,211	1.2%
Small Heat Only Boiler[1/]						
Made Locally		7,268	-	202	7,470	7.2%
Imported		1,918	101	101	2,120	2.0%
Sub-Total		*9,186*	*101*	*303*	*9,590*	*9.2%*
Total	**43,607**	**57,334**	**909**	**2,120**	**103,971**	**100%**

Source: World Bank and Ulaanbaatar Municipality: Household Fuel Consumption and Heating Stove Survey, December 2007.

Note: [1/] Small Heat Only Boiler (HoB) refers to stove with low pressure boiler and hot water distribution system used to heat home.

[2/] The total figure 606 traditional stoves and 202 brick stoves used in the hostel/dormitory/other type of Dwelling.

[3/] Refers to the stove that is ready to be used to heat ger/home, but it is not currently being used.

Table 9 Number and Percent of Households that Own Two Stoves (Not Using Second Stove)

	Traditional Stove	Improved Stove	Low Pressure Boiler	Total
Households with One Stove	86,809 97.9%	3,129 100.0%	8,883 96.7%	98,821 97.9%
Households with Two Stove	1,817 2.1%		303 3.3%	2,120 2.1%
All Households	88,626	3,129	9,186	100,941

Table 9. Number and Percent of Households that Own Two Stoves & Use Second Stove to Heat Home Business /Kiosk/Garage

	Traditional Stove	Improved Stove	Low Pressure Boiler	Group Total
Households with One Stove	88,020 99.3%	2,927 93.5%%	9,085 98.9%	100,032 99.1%
Households with Two Stove	606 0.7%	202 6.5%	101 1.1%	909 0.9%
All Households	88,626	3,129	9,186	100,941

Table 10 Number of Years Households Have Been Using Current Stove to Heat Home/Ger

	Traditional Stove	Improved Stove	Low Pressure Boiler (HoB)	Total
One Year	12,012 13.6%	2,120 67.7%	1,413 15.4%	15,545 15.4%
Two Year	12,517 14.1%	101 3.2%	1,918 20.9%	14,536 14.4%
Three Year	14,838 16.7%	505 16.1%	1,716 18.7%	17,059 16.9%
Four Year	8,075 9.1%	303 9.7%	1,009 11.0%	9,387 9.3%
Five Year	10,195 11.5%	101 3.2%	1,110 12.1%	11,406 11.3%
Six Year	5,148 5.8%	0 0.0%	303 3.3%	5,451 5.4%
Seven Year	4,139 4.7%	0 0.0%	404 4.4%	4,543 4.5%
Eight Year	3,634 4.1%	0 0.0%	202 2.2%	3,836 3.8%
Nine Year	505 0.6%	0 0.0%	101 1.1%	606 0.6%
Ten Year	7,369 8.3%	0 0.0%	202 2.2%	7,571 7.5%
Over10 Years	10,195 11.5%	0 0.0%	808 8.8%	11,003 10.9%
Total	**88,627**	**3,130**	**9,186**	**100,943**

Table 11 Number of Years Households Have Been Using Current Stove to Heat Ger and Separate/Single Family Home

	GER			Separate/Single Family Home			
	Tradition -al Stove	**Improved Stove**	**Total**	**Tradition -al Stove**	**Improved Stove**	**Low Pressure Boiler (HoB)**	**Total**
One Year	5,047	1,211	6,258	6,662	908	1,413	8,983
	12.0%	75.0%	14.4%	14.5%	60.0%	15.4%	15.9%
Two Year	7,873	-	7,873	4,643	101	1,918	6,662
	18.7%	0.0%	18.1%	10.1%	6.7%	20.9%	11.8%
Three Year	7,772	101	7,873	7,066	404	1,716	9,186
	18.5%	6.3%	18.1%	15.4%	26.7%	18.7%	16.3%
Four Year	4,038	202	4,240	4,038	101	1,009	5,148
	9.6%	12.5%	9.7%	8.8%	6.7%	11.0%	9.1%
Five Year	5,249	101	5,350	4,845	-	1,110	5,955
	12.5%	6.3%	12.3%	10.6%	0.0%	12.1%	10.5%
Six Year	2,524	-	2,524	2,624	-	303	2,927
	6.0%	0.0%	5.8%	5.7%	0.0%	3.3%	5.2%
Seven Year	1,312	-	1,312	2,826	-	404	3,230
	3.1%	0.0%	3.0%	6.2%	0.0%	4.4%	5.7%
Eight Year	1,312	-	1,312	2,322	-	202	2,524
	3.1%	0.0%	3.0%	5.1%	0.0%	2.2%	4.5%
Nine Year	303	-	303	202	-	101	303
	0.7%	0.0%	0.7%	0.4%	0.0%	1.1%	0.5%
Ten Year	2,826	-	2,826	4,340	-	202	4,542
	6.7%	0.0%	6.5%	9.5%	0.0%	2.2%	8.0%
Over10 Years	3,735	-	3,735	6,258	-	808	7,066
	8.9%	0.0%	8.6%	13.7%	0.0%	8.8%	12.5%
Total	41,991	1,615	43,606	45,826	1,514	9,186	56,526
	100%	100%	100%	100%	100%	100%	100%

Table 12 Number of Years Households Have Been Using Current Stove to Heat Hostel/Dormitory/Other Type of Dwelling Unit

	Traditional Stove	Improved Stove	Low Pressure Boiler (HoB)	Total
One Year	303 37.5%			303 37.5%
Five Year	101 12.5%			101 12.5%
Ten Year	202 25.0%			202 25%
Over10 Years	202 25.0%			202 25%
Total	808 100%			808 100%

Table 13 Households Purchase/Obtain Main Stove Used to Heat Home/Ger From

	Household Purchase/Obtain Stove From:				
	Market	**Private Person**	**Assistance Program/ Gift**	**Made Ourselves**	**All Stoves**
Traditional Stove					
Metal/Cast Iron Stove	46,433 61.3%	18,674 24.7%	1,817 2.4%	8,782 11.6%	75,706 100%
Brick Stove	707 7.9%	1,211 13.5%	101 1.1%	6,965 77.5%	8,984 100%
Sawdust Stove	2,019 51.3%	707 17.9%		1,211 30.8%	3,937 100%
Sub Total	*49,158* *55.5%*	*20,592* *23.2%*	*1,918* *2.2%*	*16,958* *19.1%*	*8,8626* *100%*
Improved Stove					
Model: TT-03	707 63.6%	202 18.2%	202 18.2%		1,110 100%
Model: G2-2000	505 71.4%		202 28.6%		707 100%
Model EB-1		101 100.0%			101 100%
Model: Bona-2		101 100.0%			101 100%
Sub Total	*1,212* *60.0%*	*404* *20.0%*	*404* *20%*		*2,019* *100%*
Korean Stove			1,110 100.0%		1,110 100%
Low Pressure Boiler (Hob)					
Made Locally	1,110 15.3%	2,725 37.5%		3,432 47.2%	7,268 100%
Imported	1009 52.6%	707 36.8%	101 5.3%	101 5.3%	1,918 100%
Sub Total	*2,120* *23.1%*	*3,432* *37.4%*	*101* *1.1%*	*3,533* *38.5%*	*9,186* *100%*
All Stoves	52,489 52.0%	24,428 24.2%	3,533 3.5%	20,491 20.3%	100,941 100%

Table 14 Households Purchase/Obtain 2nd Stove Used to Heat Home Business /Kiosk/Garage From

	Household Purchase/Obtain Stove From:				
	Market	**Private Person**	**Assistance Program/ Gift**	**Made Ourselves**	**All Stoves**
Traditional Stove					
Metal/Cast Iron Stove	303 50.0%	101 16.7%		202 33.3%	606 100.0%
Improved Stove Model: TT-03	101 100.0%				101 100.0%
Korean stove			101 100.0%		101 100.0%
Low Pressured Boiler (HoB) Imported		101 100.0%			101 100.0%
All Stoves	404 44.4%	202 22.2%	101 11.1%	202 22.2%	908 100%

Table 15 Type of Stove With or Without Heat Wall Attachment

	With/Without Heat Wall		
	With Heat Wall Attachment	**Without Heat Wall Attachment**	**Total**
Traditional Stove			
Metal/Cast Iron Stove	30,383 40.1%	45,323 59.9%	757,06 100%
Brick Stove	8,378 93.3%	606 6.7%	8,984 100.0%
Sawdust Stove	303 7.7%	3634 92.3%	3937 100.0%
Sub-Total	*39,064* *44.1%*	*49,563* *55.9%*	*88,627* *100%*
Improved Stove	1,212 60.0%	808 40%	2,020 100%
Korean Stove		1110 100.0%	1110 100.0%
Total	40,275 43.9%	51,480 56.1%	91,755 100.0%

Table 16 Total Number of Separate/Single Home Using Stove with/without Heating Wall Attachment

	With/Without Heat Wall		
	Without Heat Wall Attachment	**With Heat Wall Attachment**	**Total**
Traditional Stove			
Metal/Cast Iron Stove	6,965 90.8%	29,979 75.6%	36,944 78.0%
Brick Stove	202 2.6%	8,176 20.6%	8,378 17.7%
Sawdust Stove	202 2.6%	303 0.8%	505 1.1%
Sub Total	*7,369* *96%*	*38,458* *97%*	*45,827* *97%*
Improved Stove	101 1.3%	1,212 3.1%	1,313 2.8%
Korean Stove	202 2.6%	- 0.0%	202 0.4%
Total	7,672 100%	39,670 100%	47,342 100%

Table 17 Number of Households With/Without Heat Wall by Type of Home
(Excluding Household Using HoB)

	Ger	Single/ Separate House	Ger & Single/ Separate House	Hostel/ Dormitory /Other	Total
With Heat Wall	n/a	84.4%	42.9%	75.0%	40,276
Without Heat Wall	100.0%	15.6%	57.1%	25.0%	51,481
Total	43,607	46,635	707	808	91,757

Note: There are 9,186 households living separate/single family homes that use heat only boiler (HoB)

Table 18 Size of Home Using -- Stove With/Without Heat Wall and Heat Only Boiler (HoB)

	Size of Home (M^2)[1/]	% of Households Live in One Room Home
Stove With Heat Wall	43.0	38.2% of Households Use Stove With Heat Wall
Stove Without Heat Wall	38.4	63.0% of Households Use Stove Without Heat Wall
Heat Only Boiler (HoB)	65.0	14.3% of Households Using Heat Only Boiler (HoB)

Table 19 Household Income, Family Size, and Number of Ger/Home With/Without Heat Wall and Home Using Small Heat Only Boiler (HoB)

	Type of Home With/Without Heat Wall and HoB				Total
	Ger	Single Home without Heat Wall	Single Home with Heat Wall	Single Home Using HoB	
Total Household Monthly Income	206,519	240,836	261,005	341,842	242,788
Family Size (in persons)	4.4	4.3	4.4		4.4
Total Number of Ger/Home	43,607	7,672	39,670	9,186	100,941

Table 20 Household Did with Previous Stove

	Number of Stoves
Sold as Scrap metal	4,240 4.2%
Throw Away	15,949 15.8%
Gave to Relative/Friend for Free	12,315 12.2%
Sold it to Another Household/Person	4,441 4.4%
Still Using Stove That We Have Bought	38,963 38.6%
Still Have the Old Stove[1/]	23,822 23.6%
Other	1,211 1.2%

Note: [1/] The majority of these stoves are not being used; and are not in good working condition

Table 21 Household Opinion on the Performance of His/Her Heating Stove

What do you think about the performance of your current heating stove?	Low	Medium	High	Do not know	Total
Fuel usage	16,050	50,370	34,320	202	100,941
	15.9%	49.9%	34.0%	.2%	100.0%
Smoke and soot release from stove.	23,418	46,736	29,677	1,110	100,941
	23.2%	46.3%	29.4%	1.1%	100.0%
Ability to keeping heat for a long time	11,507	48,351	40,679	404	100,941
	11.4%	47.9%	40.3%	.4%	100.0%
Frequency need to clean soot from chimney	44,818	39,367	15,949	808	100,941
	44.4%	39.0%	15.8%	.8%	100.0%
Difficulty to start fire	62,382	33,815	4,240	505	100,941
	61.8%	33.5%	4.2%	.5%	100.0%
Amount of ash	23,519	42,294	33,916	1,211	100,941
	23.3%	41.9%	33.6%	1.2%	100.0%
Availability of repair and spare parts	28,364	31,595	19,179	21,803	100941
	28.1%	31.3%	19.0%	21.6%	100.0%

Table 22 Number of Households Interested In Or Not Interested in Changing Current Stove

Are you interested in changing your current stove?			
Yes	**No**	**Have not thought about it**	**Total**
52,287	47,039	1,615	100,941
51.8%	46.6%%	1.6%%	48.2%

Table 23 Number of Households Interested In Or Not Interested In Changing Current Stove By Types of Stove Owned

	Are you interested in changing your current stove?			
	Yes	**No**	**Have not thought about it**	**Total**
Traditional Stove	485	379	14	878
	55.2%	43.2%	1.6%	100%
Improved Stove	4	16	0	20
	20.0%	80.0%	.0%	100%
Korean Stove	1	10	0	11
	9.1%	90.9%	.0%	100%
Low Pressure Boiler (HoB)	28	61	2	91
	30.8%	67.0%	2.2%	100%
Total	518	466	16	1000
	51.8%	46.6%	1.6%	100%

Table 24 Interested in Changing to Specific Type of Stove in Short/Long Term

If you want to change, do you have any type of stove in mind, please make selection?- Type of stove	**Short term**	**Long term**	**Total**
Traditional stove	1,716 4.6%	1,211 8.0%	2,927 5.6%
Improved stove	20,592 55.4%	8,782 58.0%	29,374 56.2%
Briquette stove /Korean stove/	3,634 9.8%	1,413 9.3%	5,047 9.7%
Sawdust stove	1,918 5.2%	606 4.0%	2,524 4.8%
Low pressure HOB stove	9,287 25.0%	3,129 20.7%	12,416 23.7%
Total	37,146 100%	15,141 100%	52,287 100%

Table 25 Interested in Changing to Specific Type of Stove in Short/Long Term By Type of Dwelling Unit

	Ger			Separate/Single Family Home		
	Short term	**Long term**	**Total**	**Short term**	**Long term**	**Total**
Traditional stove	908 6.2%	505 6.9%	1,413 6.4%	808 3.6%	707 9.2%	1,515 5.1%
Improved stove	9,993 67.8%	5,552 75.3%	15,545 70.3%	10,397 46.8%	3,129 40.8%	13,526 45.3%
Briquette stove /Korean stove/	2,322 15.8%	808 11.0%	3,130 14.2%	1,312 5.9%	606 7.9%	1,918 6.4%
Sawdust stove	1,312 8.9%	505 6.9%	1,817 8.2%	606 2.7%	101 1.3%	707 2.4%
Low pressure boiler (HoB)	202 1.4%	- 0.0%	202 0.9%	9,085 40.9%	3,129 40.8%	12,214 40.9%
Total	14,737 100%	7,370 100%	22,107 100%	22,208 100%	7,672 100%	29,880 100%

Table 26 Reason for not Interested in Changing Current Stove

	Yes	No	Do not know	Total
Our heating stove is still good enough	40,578 83.4%	3,028 6.2%	5,047 10.4%	48654 100.0%
We are used to using our heating stove	45,827 94.2%	2,019 4.1%	808 1.7%	48,654 100.0%
Difficult to install new stove	16,151 33.2%	20,794 42.7%	11,709 24.1%	48,654 100.0%
Stove is special gift to us	3,129 6.4%	43,607 89.6%	1,918 3.9%	48,654 100.0%

Table 27 Reason for not Interested in Changing Current Stove by Type of Dwelling

Reason		Type of dwelling: Ger	Type of dwelling: Separate/ Single Home	Type of dwelling: Hostel/ Dormitory /Other	Total
Our heating stove is still good enough	Yes	17,160 79.8%	23,115 86.7%	303 60.0%	40,578 83.4%
	No	1,716 8.0%	1,211 4.5%	101 20.0%	3,028 6.2%
	Do not know	2,624 12.2%	2,322 8.7%	101 20.0%	5,047 10.4%
	Total	21,500 100%	26,648 100%	505 100%	48,654 100%
We are used to using our heating stove	Yes	20,491 95.3%	24,831 93.2%	505 100.0%	45,827 94.2%
	No	606 2.8%	1413 5.3%		2,019 4.1%
	Do not know	404 1.9%	404 1.5%		808 1.7%
	Total	21,500 100%	26,648 100%	505 100%	48,654 100%
Difficult to install new stove	Yes	5,855 27.2%	10,195 38.3%	101 20.0%	16,151 33.2%
	No	10,498 48.8%	10,195 38.3%	101 20.0%	20,794 42.7%
	Do not know	5,148 23.9%	6,258 23.5%	303 60.0%	11,709 24.1%
	Total	21,500 100%	26,648 100%	505 100%	48,654 100%

Table 28 Reason for not Interested in Changing Current Stove by Type of Dwelling

Reason		Type of dwelling: Ger	Type of dwelling: Separate/ Single Home	Type of dwelling: Hostel/ Dormitory /Other	Total
Stove is special gift to us	Yes	1,716 8.0%	1,413 5.3%		3,129 6.4%
	No	18,775 87.3%	24,327 91.3%	505 100.0%	43,607 89.6%
	Do not know	1,009 4.7%	908 3.4%		1,918 3.9%
	Total	21,500 100%	26,648 100%	505 100%	48,654 100%

Table 29 Characteristics of Stove Considered to be Important by Households

When buying heating stove, which characteristics do you consider to be important?-	Very important	Important	Not so important	Do not know	Total
Price	39,064 38.7%	45,625 45.2%	14,132 14.0%	2,120 2.1%	100,941 100%
Fuel consumption	51,581 51.1%	47,139 46.7%	808 .8%	1,413 1.4%	100,941 100%
Keep heat longer	56,022 55.5%	43,909 43.5%	202 .2%	808 .8%	100,941 100%
Easy to start fire	22,813 22.6%	69,246 68.6%	7,268 7.2%	1,615 1.6%	100,941 100%
Release less smoke and soot	40,881 40.5%	57,133 56.6%	1,009 1.0%	1,918 1.9%	100,941 100%
Easy to use	22,308 22.1%	73,889 73.2%	3,230 3.2%	1,514 1.5%	100,941 100%
Good quality and design	26,648 26.4%	67,328 66.7%	5,350 5.3%	1,615 1.6%	100,941 100%
Shape and appearance	13,728 13.6%	65,208 64.6%	19,885 19.7%	2,120 2.1%	100,941 100%

Table 30 Households' Opinion Toward Improved Stove

What is your opinion about improved stove?-	Agree	Disagree	Do not know	Total
Improved stove is easier to start fire than traditional stove	34,017 33.7%	10,498 10.4%	56,426 55.9%	100,941 100%
Improved stove release less smoke and soot than traditional stove	58,748 58.2%	5,148 5.1%	37,045 36.7%	100,941 100%
Improved stove keeps heat longer than traditional stove	38,459 38.1%	10,195 10.1%	52,287 51.8%	100,941 100%
Improved stove uses less fuel than traditional stove	45,222 44.8%	7,369 7.3%	48,351 47.9%	100,941 100%
Improved stove is more difficult to use than traditional stove	10,700 10.6%	30,282 30.0%	59,959 59.4%	100,941 100%
Need to clean chimney more often with improved stove	8,883 8.8%	24,327 24.1%	67,731 67.1%	100,941 100%
Heard improved stove is too expensive	41,487 41.1%	13,627 13.5%	45,827 45.4%	100,941 100%
Regular fuel cannot be used in the improved stove	21,702 21.5%	19,583 19.4%	59,656 59.1%	100,941 100%

Table 31 Where did you hear about improved stove?

Where did you hear about improved stove?	Yes	No	Total
Never heard of it before	28,465 28.2%	72,476 71.8%	100,941 100%
From friends /neighbors/ relatives	29,576 29.3%	71,365 70.7%	100,941 100%
Radio/TV program	59,858 59.3%	41,083 40.7%	100,941 100%
News paper/printed media	18,674 18.5%	82,267 81.5%	100,941 100%
From NGO through project	13,526 13.4%	87,415 86.6%	100,941 100%
Stove maker	4,744 4.7%	96,197 95.3%	100,941 100%
Bill board	3,735 3.7%	97,206 96.3%	100,941 100%

Table 32 Difficulty Household May Encounter When Change Current Stove With Improved Stove?

What difficulty you may encounter when you change your current stove with improved heating stove?	Agree	Disagree	Do not know	Total
High price	63,492 62.9%	7,571 7.5%	29,879 29.6%	100,941 100%
Difficult to install	24,731 24.5%	25,740 25.5%	50,471 50.0%	100,941 100%
Not suitable for wall stove	14,939 14.8%	26,951 26.7%	59,050 58.5%	100,941 100%
Do not know where to buy improved stove, it is not popular in the market	32,806 32.5%	20,087 19.9%	48,048 47.6%	100,941 100%
Improved stove is difficult to operate	14,031 13.9%	24,932 24.7%	61,978 61.4%	100,941 100%
Fuel expenditure will increase if we use improved stove	12,820 12.7%	32,200 31.9%	55,921 55.4%	100,941 100%
Improved stove has small firing chamber	23,115 22.9%	13,425 13.3%	64,400 63.8%	100,941 100%
Fuel does not match with improved stove	27,153 26.9%	14,838 14.7%	58,950 58.4%	100,941 100%

Table 33

What do you think if we buy current stove and give you back the improved and fuel efficient heating stove at low cost?

Agree	Need to think about it	Not agree	Do not know	Total
37,348 37.0%	43,909 43.5%	10,397 10.3%	9,287 9.2%	100,941 100%

Table 34 Type of Heating Fuels Used by the Household

Coal	Firewood	Sawdust	Briquette	Dung/Paper	Anything that Burn
95,793	95,995	5,249	1,817	4,542	202
94.9%	95.1%	5.2%	1.8%	4.5%	0.2%
100,941	100,941	100,941	100,941	100,941	100,941

Table 35 Sources of Coal Used by the Households

Coal From:	Number of Households
Nalaikh	72,778 76.0%
Alagtolgoi	14,636 15.3%
Sharyn gol	2,725 2.8%
Baganuur	24,226 25.3%
Total	95,793

Note: Households usually use more than one type of coal.

Table 36 Type of Wood Used as Firewood by the Households

Type of Wood for Firewood	Number of Households
Pine	48,956 51.0%
Larch	73,687 76.8%
Rim timber board	4,441 4.6%
Limb, bark	2,322 2.4%
Total	95,995

Table 37 Type of Compress Coal & Briquette Used by the Households

Type of Compress Coal & Briquette	Number of Households
Yontan /Korean/	1,413 77.8%
Compress coal Egg sh	303 16.7%
Sawdust Briquette	101 5.60%
Total	1,817

Table 38 Dung and Paper Used as Fuels by the Households

Dung and Paper	Number of Households
Cow Dung	1,110 24.4%
Paper	3,432 75.6%
Total	4,542
Anything that Burn	Number of Households
Clothes/Boots/ Other	202 100%
Tire	101 50%
Total	202

Table 39 Number of Household Use Supplemental Heating

In winter does your household use any other additional heating other than stove?	Number of Households (%)
Heat pump	505 0.5%
Gas Space heater	1211 1.2%
Electric Space Heater	5148 5.1%
Total Households	100,941

Table 40 Total Number of Household Use Supplemental Heating

Gas Space Heater	Electric Space Heater	Heat Pump & Elec Space Heater	Gas & Eelectric Space Heater	Heat Pump, Gas & Elec Space Heater	Total
808 0.8%%	4,542 4.5%	202 0.2%	101 0.1%	303 0.3%	5,956 5.9%
100,941	100,941	100,941	100,941	100,941	100,941

Table 41 Type of Fuel/Energy Used for Cooking In the Non-Winter Months

Which type of fuel does your household use for cooking in summer time /warm season/?-	Number of Households (%)
Electricity	86,002 85.2%
Wood	30,989 30.7%
Coal	303 .3%
Anything that burns	1,110 1.1%
Total Households	100,941

Table 42 Fuels or Materials Used to Start Fire

What do you use to start fire?-	**Number of Households (%)**
Paper	94,683 93.8%
Candle	7,974 7.9%
Tar Paper	5,451 5.4%
Plastic material	1,918 1.9%
Kerosene or Gasoline	707 .7%
Rubber	6,056 6.0%
Briquette Starter	1,817 1.8%
Wood	77,220 76.5%
Total Households	100,941

Table 43 Average Number of Times Household Add Fuels during 24 Hours

	During Sept, Oct 06, and Mar, Apr 07 how often did you add fuel to your heating stove between time period listed below? (number of times)	During Nov, Dec 06 and Jan, Feb 07. how often did you add fuel to your heating stove between time period listed below? (number of times)
06:00-16:00 O'clock	.97	1.74
16:00-22:00 O'clock	.71	1.60
22:00-06:00 O'clock	.63	1.26
06:00-06:00 O'clock	2.31	4.60
Total Households (Users Only)	80,450	96,096

Table 44 Household Coal Usage and Expenditure by Income Quintile
From Sept 2006 to April 2007

	Total Expenditure For Coal (in Tg/)	**Average Coal Used per Household**	**Total Coal Used by All Households**
<= 111,330 Tg/.	153,275	3.29	61,117
Valid N	18,371	18,573	18,573
111,331 - 172,660 Tg/.	168,993	3.76	71,350
Valid N	18,977	18,977	18,977
172,661 - 233,990 Tg/.	170,912	4.12	76,122
Valid N	18,371	18,472	18,472
233,991 - 325,860 Tg/.	182,726	4.81	95,659
Valid N	19,885	19,885	19,885
> 325,860 Tg/.	196,169	4.92	95,354
Valid N	19,482	19,381	19,381
Total	174,767	4.19	399,601
Valid N	95,086	95,288	95,288

Note: Valid N refers to number of households that reported amount of coal usage and expenditure.

Table 45 Household Raw Coal Usage and Expenditure by Type of Dwelling Unit and Type of Stoves and Heat Only Boiler (From Sept 2006 to April 2007)

Type of Dwelling and Heating System	Average Household Monthly Income	Total Expenditure For Coal (in Tg/)	Average Raw Coal Used per Household	Total Coal Used by All Households
Ger	206,519	162,087	3.49	137,211
Valid N	43,607	39,266	39,367	39,367
Home without Heat Wall	240,836	176,073	3.90	27,939
Valid N	7,672	7,167	7,167	7,167
Home with heat Wall	261,005	176,870	4.49	175,122
Valid N	39,670	38,862	38,963	38,963
Home with Heat Only Boiler (HoB)	341,842	219,385	6.17	55,435
Valid N	9,186	8,984	8,984	8,984
Hostel/Dormitory/Other	198,248	182,125	4.82	3,895
Valid N	808	808	808	808
Total	242,788	174,767	4.19	399,601
Valid N	100,941	95,086	95,288	95,288

Note: Valid N refers to number of households that reported amount of coal usage and expenditure.

Table 46 Household Firewood Usage and Expenditure by Income Quintile
From Sept 2006 to April 2007

	Total Expenditure on Firewood (Tg/.)	Average Firewood Used per Household	Total Firewood Used by All Households
Less than 111,330 Tg/.	88,098.38 18,674	5.05 18,876	95,369 18,876
111,331 - 172,660 Tg/.	90,815.11 18,371	4.96 18,472	91,669.57 18,472
172,661 - 233,990 Tg/.	85,174.44 18,169	4.84 18,371	89,004.73 18,371
233,991 - 325,860 Tg/.	78,761.72 18,775	4.27 19,280	82,362.81 19,280
More than 325,860 Tg/.	81,639.47 19,179	4.31 19,179	82,741.34 19,179
Total	84,852.80 93,169	4.68 94,178	441,147.50 94,178

Table 47 Household Firewood Usage and Expenditure by Type of Dwelling Unit And Type of Stoves and Heat Only Boiler (From Sept 2006 to April 2007)

	Total Expenditure (in Tg/.)	Average Firewood Used per Household (in M^3)	Total Firewood Used by All Households (in M^3)
Ger	85,070.18 38,257	4.82 38,761	186,947.78 38,761
Home without Heat Wall	103,623.66 7,167	5.53 7,268	40,154.33 7,268
Home with Heat Wall	80,842.53 37,853	4.40 38,257	168,465.48 38,257
Home with Heat Only Boiler (HoB)	86,065.56 9,085	4.61 9,085	41,875.37 9,085
Hostel/Dormitory/Other	82,300.00 808	4.59 808	3,704.53 808
Total	84,852.80 93,169	4.68 94,178	441147.5 94,178

Table 48 What do you think about air pollution in UB?

Extremely high /disaster level	High	Acceptable	Low	not know	Total
73081	27254	101	303	202	100941
72.4%	27.0%	.1%	.3%	.2%	100.0%

Table 49 In your opinion which sources contribute to air pollution in the city?-

	Do not know	None	Low	Medium	High	Very high	Total
Motor Vehicles	.3%	.6%	4.9%	22.5%	52.0%	19.7%	100,941
Industry	2.4%	1.1%	10.3%	29.8%	46.1%	10.3%	100,941
Power plant	1.9%	.7%	5.9%	23.5%	50.1%	17.9%	100,941
Heating stoves /ger district/	.3%	.2%	.2%	1.1%	14.3%	83.9%	100,941
Global warming	26.0%	12.2%	21.2%	24.5%	14.1%	2.0%	100,941
Dust	10.2%	5.5%	19.1%	22.4%	31.5%	11.3%	100,941
Un-disposed solid waste	5.7%	4.0%	10.9%	17.5%	38.8%	23.1%	100,941

Table 50 In your opinion, what will be the best way of reducing air pollution in the city?

	Most suitable	Suitable	Not suitable	Do not know	Total
Reduce coal consumption	33.2%	52.1%	11.2%	3.5%	100,941
Consumption of briquettes	11.7%	47.5%	8.2%	32.6%	100,941
Use of improved stoves	13.9%	52.0%	4.1%	30.0%	100,941
Reduce the number of motor vehicles	15.0%	44.1%	32.9%	8.0%	100,941
Move ger residents to live in apartment	63.6%	32.5%	1.6%	2.2%	100,941
Ger resident use electricity for heating	24.2%	46.9%	16.5%	12.4%	100,941
Provide heat only boiler for groups of ger residents /3-5 households/	6.8%	32.9%	22.5%	37.8%	100,941

Table 51 Would you agree with the following statements:

	Strongly agree	Agree	No opinion	Disagree	Strongly disagree	Total
Traditional heating stove creates pollution inside home/ger	62.5%	36.1%	1.0%	.4%		100,941
Air pollution in the city creates health problem for my family	65.9%	33.5%	.5%	.1%		100,941
It is difficult to breath in the morning during the winter	69.6%	28.5%	1.8%	.1%		100,941
Using improved stove would reduce air pollution problem	20.3%	47.6%	30.0%	1.6%	.4%	100,941
Would providing heat to a group of 3 to 5 household with one shared low pressure boiler be of interest to you?	8.2%	33.3%	45.2%	10.9%	2.3%	100,941
Providing additional felt covers for ger would help ger household save fuel	11.1%	48.0%	28.5%	10.4%	1.9%	100,941
I would really like to use electricity only to heat our home/ger	11.0%	48.8%	20.3%	18.7%	1.2%	100,941
Raw coal creates air pollution in the city and its use should be banned	11.6%	47.1%	24.8%	15.0%	1.5%	100,941
Coal briquette is less polluting than raw coal	4.0%	41.7%	49.8%	3.8%	.7%	100,941

Table 51 Would you agree with the following statements: (continue)

	Strongly agree	Agree	No opinion	Disagree	Strongly disagree	Total
It is not a good idea to throw away or sell old stove	8.3%	29.1%	41.2%	18.4%	3.0%	100,941
Improved stove is cleaner than traditional stove	3.4%	42.9%	50.0%	3.1%	.6%	100,941
Improved stove save fuel	5.6%	40.9%	48.2%	4.1%	1.2%	100,941
I would like to use a heating wall inmy house	7.7%	24.0%	30.0%	32.4%	5.7%	100,941
I prefer to use traditional stove than improved stove	3.9%	22.9%	39.5%	30.3%	3.2%	100,941
Heating wall is better in providing heat for the household	9.4%	61.0%	22.5%	6.6%	.5%	100,941
Electricity is cheaper to heat our home/ger than using coal stove	7.0%	39.7%	29.4%	21.3%	2.6%	100,941
I will buy a low pressure heat boiler with hot water distribution system in the near future	6.7%	31.4%	33.2%	25.7%	3.0%	100,941
I will buy an improved stove in the future	4.7%	32.8%	36.0%	24.3%	2.2%	100,941
I will buy an improved stove in the future only if it is subsidized	11.2%	50.3%	27.0%	10.3%	1.2%	100,941
I want to continue using raw coal only	4.4%	25.3%	39.1%	27.7%	3.4%	100,941
I will buy briquettes in the future because they are less polluting the air	4.9%	36.8%	44.7%	12.8%	.8%	100,941
I will buy briquettes in the future only if the costs are similar to raw coal	9.1%	48.9%	29.3%	12.1%	.5%	100,941
It is quite expensive to keep my house warm during the cold winter months	20.6%	62.2%	11.4%	5.5%	.3%	100,941
Sawdust briquette is expensive that raw coal	5.0%	18.4%	71.3%	4.8%	.4%	100,941
Electricity is cheaper to heat our home/ger than using coal stove	5.8%	39.1%	35.2%	18.8%	1.1%	100,941
I prefer to choose from different fuels which I like	9.3%	66.9%	15.2%	8.4%	.2%	100,941
Briquette lasts fast and has low heating value	5.9%	16.5%	68.8%	7.8%	1.0%	100,941