Summary Statistics: Cooking Fuel Consumption Baseline Survey

INTRODUCTION

SNV commissioned Fast-Track Carbon to undertake a study on baseline consumption of cooking charcoal and wood in Cambodia. Charcoal measurements were performed in 33 cities and wood consumption in 63 villages. The study implemented surveys in 2,072 Cambodian households. The surveys were implemented between June and August 2014 by the local firm Angkor Research Consulting.

It is important to note that the study was applied only in households where the primary cooking fuels are charcoal and wood. Thus, households cooking primarily with other fuels like LPG or electricity are excluded from the study. Nonetheless, it was found that many study households use LPG and electricity as secondary fuels as will be shown below.

This document presents some of the most relevant metrics obtained in the survey. For comparison purposes, the data is divided between wood users and charcoal users. These populations vary significantly not only in terms of fuel usage, but also in socio-economic characteristics. However, some aspects such as the types and frequency of meals cooked are similar, highlighting socio-economic aspects and urban-rural location are important cooking fuel choice determinants.

SUMMARY STATISTICS:

The below section presents relevant summary statistics obtained in the study:

Average cooking firewood consumption among firewood users: **4.87 Kg/household/day**

Province with highest average: **Kampong Thom** (6.75 Kg/household/day)
Province with lowest average: **Battambang** (3.57 Kg/household/day)

Average charcoal consumption throughout the study: **2.023 Kg/household/day**

Locality with highest average: **Takeo** (2.85 Kg/household/day)
Locality with lowest average: **Pursat** (1.59 Kg/household/day)

Average age of cooks who responded the wood survey: **44.5 years**

Median age of cooks who responded the charcoal survey: **46 years**

Note the median age in Cambodia is 24.1 years,[1] reflecting a young population and the fact that cooks are usually older than household averages.

Household size in the survey: **5.3** for charcoal users and **4.89** for wood users. Household size according to the General Population Census of Cambodia 2008 is **4.7**.

Fuel collection and purchase:

Wood users:

Percentage of wood users that purchase firewood: **29%**

Percentage of firewood users that collect firewood: **85.6%**

Annual increase in firewood price (2013 to 2014): **15%**

Annual increase in the time travelled to collect firewood: **5%**

Charcoal users:

Annual charcoal price increase (2013 to 2014): **22.1%**

Charcoal and wood users spend **105-108 minutes cooking per day**

Assets owned by households

Asset owned	Wood users	Charcoal users
Bicycles	70.6%	64.7%
Radios	40.8%	36.7%
TV	66.21%	93.7%
Cars/koyun	17%	15.4%
Tuk-tuks	0.5%	1.2%
Refrigerator	1.5%	17%
Motorcycle	62%	82.2%
Phone	85.2%	95.8%

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[1] Source: CIA World Fact Book. Cambodia Fact Sheet. Accessed through https://www.cia.gov/library/publications/the-world-factbook/fields/2177.html on November 18, 2014

Although some assets have similar penetration across groups, ownership of equipment using electricity and motorcycles is more prevalent among charcoal users, reflecting the urban nature of the charcoal study and possibly also higher levels of wealth.

Main sources of income for household

Source of income	Wood users	Charcoal users
Farming/Fishing	51.5%	16.6%
Factory worker	22.8%	11.7%
Government worker	3.8%	15.9%
NGO/Company worker	0.9%	6.3%
Own business	18.2%	46.8%
Other	2.8%	2.7%
Households with more than one source of income	57.8%	55%
Years of education of head of household	4.21	5.59

The sources of income vary across groups. Wood users tend to be in rural areas where farming and fishing are more important than office jobs (e.g. Government, NGOs, Companies). It is also worth noting that education levels are lower among wood users than charcoal users. Despite the differences, both populations rely heavily on additional sources of income.

Types of stoves used

Name of stove	Wood users	Charcoal users
Traditional Lao Stove	58.2%	60.2%
200 mL LPG stove	12.4%	50.4%
New Lao Stove	16%	39.4%
Rice cooker	6%	20.4%
> 4 Kg LPG stove	2.6%	13.2%
Neang Kongrey Stove	10.6%	6.8%
Other traditional stove	13.2%	2.3%
Siam stove	10.2%	1.5%
Electric stove	0.2%	1%
Three-stone fire	8.1%	0.8%

Name of stove	Wood users	Charcoal users
Other stove	3.6%	2.3%
Percentage of households owning at least one improved cooking device[2]	29.5%	78.3%
Average number of cooking devices per household	1.87	2.44

From this table it is notorious that cleaner cookstove models, like LPG stoves and the New Lao Stove, have much higher penetration among charcoal users. 78.3% of charcoal users already use some kind of clean cooking device.

Stove usage

Parameter	Wood users	Charcoal users
Number of meals cooked per day	2.7	2.6
Average number of dishes cooked per meal	1.8	2.0
Average number of stoves used per meal	1.43	1.51
Average number of stoves used at the same time for preparing meals	1.36	1.51

Frequency of meals cooked

Meal	Wood users (times cooked per week)	Charcoal users (times cooked per week)
Rice	16.6	16.1
Soup	9.7	10.7
Fried food	5	6.1
Heat or boil water	10.2	10.2
Barbecue	3.5	3.9
Dessert	1.6	1.5

The main dishes are prepared almost as often between the two groups. This indicates that cooking habits are very similar across the population, despite differences in cooking devices and fuels.

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[2] Includes LPG, New Lao Stove, Electric Stoves and Rice Cooker

Other uses of biomass fuels:

Use of biomass fuel	Wood users	Charcoal users
Repel insects from household	15.7%	4.9%
Repel insects from animals	27.8%	3.5%
Heat water for bathing	23.6%	23.5%
Dry clothes	0.9%	2.6%

Firewood users often tend to burn fuel to drive insects away with smoke. This practice can produce indoor air pollution and increase the susceptibility to disease.

Cooking locations

Type of kitchen location	Wood users	Charcoal users
Room inside house	33.9%	48%
Under roof with one or no walls	14.8%	16.1%
Room outside house	32.2%	14.2%
Outdoors	5.2%	11.2%
Under roof with two or three walls	13.9%	10.9%

Burning charcoal and wood in inefficient cooking devices is an important cause of disease throughout the world. This table shows that Cambodians often cook indoors (e.g. rooms inside or outside the house) which can lead to high exposure to air pollutants.

Health issues related to indoor air pollution and cooking

Disease or symptom	Wood users	Charcoal users
Chronic cough	73%	41.9%
Respiratory illness	25.2%	13.2%
Eyes water when cooking	56.5%	42.9%
Frequent headaches	5.5%	4%

The surveyed population presents a high frequency of disease symptoms that can be attributed to indoor air pollution resulting from the use of inefficient charcoal and wood stoves. It is worth noting that the prevalence of every symptom is higher among wood users. Although the combustion of both fuels results in air pollution, burning wood for cooking can produce more noxious pollutants than burning charcoal.

ANNEX I. BASELINE STUDY DESIGN

SAMPLING DESIGN

OBJECTIVE AND RELIABILITY REQUIREMENTS

The sampling objective was to obtain accurate and reliable estimates of firewood and charcoal consumption among Cambodian households whose main fuel is either firewood or charcoal. The data captured served to estimate a measure of firewood and charcoal consumption per stove per year in Cambodia (baseline value). This parameter can be used to estimate baseline and project emissions under Clean Development Mechanisms carbon credit programs. The target reliability levels were 90% confidence and 10% precision.

TARGET POPULATION

The target population of the study is all households in Cambodia whose primary fuel is either firewood or charcoal. All urban and rural villages of Cambodia were included in the sampling frame.

POPULATION STRATIFICATION

Firewood Households. The two main sources of geographic variation in firewood consumption could be: a) the types of stoves used (some traditional models seem to be more efficient than others); b) the fuel mix; and c) Proximity to forest resources. This analysis revealed little variation across different types of stoves and fuel mixes. However, the proximity to forest resources cannot be eliminated as a source of variation in firewood consumption. The scope of this study does not incorporate forest proximity as a variable; however, given the large number of villages included in the sample, it may be possible to establish a correlation between forest proximity and firewood usage if information on the former variable becomes available.

Charcoal Households: Before this study, little information existed ex-ante on the variability of charcoal consumption across Cambodian urban areas, and their differences with respect to Phnom Penh. Data indicates that Cambodia's population is highly homogeneous in terms of social characteristics and cooking habits. For instance, the majority of Cambodians (90% or more) pertain to the Khmer ethnic group[3] and around 96.9% of the population's religion is Buddhism.[4] Moreover, the climate is somewhat homogeneous throughout Cambodia and the country is relatively small.

However, a distinction could be made between Phnom Penh and other cities in Cambodia. Phnom Penh has a population of 2.2 million, many times higher than the next largest city in Cambodia, Siem Reap, with a population of 169,000. The large population difference could make Phnom Penh a distinct biomass fuel consumption stratum. For instance, the high population size and density could entail different biomass fuel supply chain characteristics and economics, forcing households to adapt to them.

Therefore, sampling considered two strata: Provincial Cities and Phnom Penh. Differences in charcoal consumption between Phnom Penh and Provincial Cities are not statistically significant and are minimal (0.16%) when adjusted to simultaneous stove use. The nationwide urban metric adjusted to simultaneous stove use is 3.16 tonnes of woody biomass/stove/year.

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[3] The CIA World Factbook. Accessed through: https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html, Accessed on August 21, 2014
[4] General Population Census of Cambodia 2008 data.

Firewood Households. The sampling method used for this study was multi-stage sampling. This method is effective when travel times and costs between one locality and another can be substantial. Such is the case of firewood-using populations in Cambodia, which are spread throughout the country. Multi-stage sampling reduces the travel effort by only sampling a selection of localities and then sampling a fraction of the population in those localities. Because of its convenience, this method was used to sample to select localities.

Multi-stage sampling consisted in two sampling stages. In a first stage, villages were randomly selected following a probability proportional to size approach.[5] The second stage consisted in randomly selecting households within those villages.

Because individual household data is not available for Cambodian villages, a systematic random sampling approach was used. A sampling interval was calculated using the village's population data and target number of surveys per village (sampling interval=number of households in village/target number of surveys per village). The target number of surveys was 20 based on the researchers' experience to optimize survey effort. Four to six intersections in each village were identified. Sampling began with a household closest to a randomly selected intersection. From there, enumerators turned right and sampled every n^{th} household (n is the sampling interval)[6]. At every intersection, enumerators turned right. This way, the entire village is covered and all household have an equal chance of being included in the sample.

Samples sizes were estimated conservatively based on Fast-Track Carbon expert knowledge and based on published information for similar studies.

Charcoal Households. The sampling approaches differed by strata and were selected based on the practicality to obtain the information while preventing any type of bias. The two sampling methods considered for this study were simple random sampling and multi-stage sampling. Simple random sampling is appropriate when the population is relatively homogeneous and concentrated in a small area. Such is the case of Phnom Penh, where all samples are confined to the city. However, provincial cities are spread throughout Cambodia, and travel times and costs between one locality and another can be substantial. Multi-stage sampling reduces the travel effort by only sampling a selection of localities and then sampling a fraction of the population in those localities. Therefore, this method was used to sample provincial cities.

Multi-stage sampling consisted in two sampling stages. In a first stage, cities were randomly selected. The selection followed a probability proportional to size approach, meaning that cities with more primary charcoal-using households had higher probabilities of being selected. The number of primary charcoal users was obtained from the General Population Census of Cambodia 2008. The second stage consisted in randomly selecting households within those cities.

Because individual household data is not available for Cambodian cities, a systematic random sampling approach was used. A sampling interval was calculated using the city's population data and target number

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[5] The number of primary firewood users was obtained from the General Population Census of Cambodia 2008

[6] The sampling interval is the frequency at which data is collected. Its value is estimated by dividing the village population size by the number of samples to be taken in the village. Since the number of samples to be taken is constant across villages (20), but the village population is not, the sampling interval varies in each village.

of surveys per city (sampling interval=number of households in city/target number of surveys per city). The target number of surveys was 20 based on the researchers' experience to optimize survey effort. Four to six intersections in each provincial city were identified. Sampling began with a household closest to a randomly selected intersection. From there, enumerators turned right and sampled every n^{th} household (n is the sampling interval[7]). At every intersection, enumerators turned right. This way, the entire city is covered and all households have an equal chance of being included in the sample.

Areas within Phnom Penh were randomly selected and from these areas the field implementer established random transects where every n^{th} household was selected. Enumerators established a random transect in each area to further randomize the sample. In this manner, completely random samples were ensured among the Phnom Penh population.

Samples sizes were estimated conservatively based on Fast-Track Carbon expert knowledge.

DATA COLLECTION

Data was collected using structured surveys. The survey questionnaire was designed to capture factors that could affect baseline fuel consumption as well as other parameters of interest to SNV Cambodia. The questionnaire had 166 questions divided into the following 11 sections:

1. Basic information [on the household]
2. Household structure and meals
3. Stoves
4. Fuel use
5. Meal preparation
6. Other uses of fuel
7. Seasonal fluctuations
8. Health indicators
9. Income information
10. Fuel measurement
11. Notes and observations

To measure fuel consumption, respondents were asked to make a pile of either firewood or charcoal representing their consumption in an average day in the dry and in the wet season (2 piles in total). These piles were then measured using digital hanging scales with a precision of +-10 grams.

All questionnaires were implemented by Angkor Research and Consulting (ARC), a Cambodian firm specialized in survey implementation. Four teams, each consisting of one supervisor, one field editor, four enumerators, and a driver were deployed to the field to conduct the surveys between June 17th and July 5th, 2014. Fieldwork was overseen by the Fieldwork Director, who also acted as a supervisor for one team, and was in contact with the other field teams and the Research Director every day.

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[7] The sampling interval is the frequency at which data is collected. Its value is estimated by dividing the village population size by the number of samples to be taken in the village. Since the number of samples to be taken is constant across villages (20), but the village population is not, the sampling interval varies in each village.

QUALITY CONTROL AND ASSURANCE

QUESTIONNAIRE REFINEMENT, PRE-TESTING AND TRAINING

ARC provided feedback to adapt to the local context on the initial questionnaire proposed by Fast-Track Carbon. The questionnaire was then translated into Khmer, the local language, and thoroughly pre-tested in a sequence of two small-scale field tests to improve flow and to ensure questions were well understood by enumerators and respondents. The questionnaire was then back-translated into English to ensure consistency with the intended meaning.

The instrument was first pre-tested by field supervisors and editors among 35 households in Kampong Speu province on May 29th, 2014. The second pre-test was conducted by all enumerators among 79 households on June 13th, 2014 in four villages of Kampong Speu province.

Enumerators were thoroughly trained in proper questionnaire implementation and scale use. Training lasted 5 days in June 2014 right before enumerators were deployed to the field. Enumerators and data entry personnel conducted the second pre-testing at the end of the training. Staff was also trained in appropriate interview techniques, household sampling procedures, data collection methods, and ethical issues.

QA/QC MEASURES WHILE IN THE FIELD

Scales were calibrated daily to ensure the quality of the weight data. To calibrate the scales, enumerators took to the field a liter bottle of intravenous solution. This volume presented two important advantages. First, it is widely available in pharmacies throughout Cambodia, so if one of these bottles is lost, it can easily be replaced. Second, the bottles present a very accurate volume which measured by a calibrated scale[8] is one kilogram. After each day of work, enumerators would compare the weight of the bottle against the weight indicated by their scales and calibrated accordingly.

Supervisors and Field Editors used field reporting forms to manage data collection. In the field, Supervisors conducted spot checks, re-interviews and/or direct observations of 20 percent of all interviews to ensure data quality. The Field Editors in each team checked all questionnaires before leaving each village. Each team reported in from the field at the end of each day with totals of completed interviews and non-responses.

RANDOMIZATION OF SAMPLES

Selected villages, cities and localities to sample were strictly drawn at random using the online service provided by random.org. To ensure random sampling within each village, city or locality, enumerators followed the procedures described in the Sampling Method section of this report.

QA/QC MEASURES ON COLLECTED DATA

After fieldwork, data was entered into a specially designed data entry tool using CSPro (Census and Survey Processing System) software by ARC trained data encoders. All questionnaires were entered twice by different data encoders (double data entry). The two databases were then reconciled, and all entries checked for inconsistencies. ARC verified and corrected all inconsistencies by comparing data with the completed questionnaires. Checks and error messages for legal values, validation rules and queries for internal

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[8] The calibrated scale model is Chatillon CCR-44-N Digital Hanging Scale 44 lb x 0.02 lb

consistency checks were also performed. Simple cross tabulations allowed ARC to check and either explain, correct, disregard or delete incorrect values.

Fast-Track Carbon performed further checks on the data. A first check verified that randomly selected localities were consistent with the localities presented in the database. The database was also checked for completeness and congruency among similar or related questions and the presence of firewood or charcoal consumption outliers

The sampling check confirmed that all randomly selected localities were sampled in the field. The completeness and congruency check revealed a minimal rate of errors on the data.[9] Therefore, the data collection procedures were deemed appropriate to estimate baseline firewood and charcoal consumption values.

SELECTED CITIES AND VILLAGES

The population was divided into 3 strata: firewood users, charcoal users in provincial cities and charcoal users in Phnom Penh.

Firewood stratum selected villages:

Province	Village name
Banteay Meanchey	Kambaor
Battambang	Spean
Battambang	Bak Amraek
Battambang	Kbal Thnal
Battambang	Thnal Bat
Kampong Cham	Cheung Prey
Kampong Cham	Hanchey
Kampong Cham	Tuol Bei
Kampong Cham	Thma Totueng Cheung
Kampong Cham	Phum Lekh Muoy
Kampong Cham	Khnar Sar
Kampong Cham	Ou Pralaoh
Kampong Cham	Vihear Kraom
Kampong Chhnang	Kaoh Lot
Kampong Chhnang	Kampong Boeng
Kampong Chhnang	Chrak Romiet
Kampong Speu	Snao Ti Muoy
Kampong Speu	Roka Thum
Kampong Speu	Romeang Slab
Kampong Speu	Ruessei Muoy Kum

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[9] The only exception is the length of seasons. See seasonal fluctuations section below for further explanation on the analysis.

Province	Village name
Kampong Speu	Sab Nga
Kampong Speu	Trapeang Leaph
Kampong Speu	Kraviek
Kampong Thom	Thnal
Kampong Thom	Tuol Neang Sav
Kampong Thom	Trapeang Trom
Kampong Thom	Ta Triel
Kampot	Dan Koum Khang Cheung
Kampot	Chheu Teal
Kampot	Chrak Sdau
Kampot	Krasang Mean Chey
Kampot	Damnak Trayueng
Kampot	Khpos
Kampot	Trapeang Reang
Kampot	Boeng Thum Khang Lech
Kampot	Kampong Nong
Kandal	Samraong K'aer
Kandal	Lvea
Kandal	Kaoh Dach
Kandal	Khchau
Kandal	Traeung
Kratie	Roha
Kratie	Kantuot
Phnom Penh	Phum La Kamboar
Prey Veng	Trapeang Danghet
Prey Veng	Chour Ti Muoy
Prey Veng	Set Kramuon
Prey Veng	Kampong Popil
Prey Veng	Pak Pri
Prey Veng	Kaong Srae
Prey Veng	Char
Pursat	Choar Mkean
Siem Reap	Doun Reach
Siem Reap	Thea Sna
Siem Reap	Prayut
Siem Reap	Voat Svay
Siem Reap	Rohal
Preah Sihanouk	Ong
Svay Rieng	Trapeang Ph'av

Province	Village name
Svay Rieng	Tbaeng
Takeo	Thlok Damnak Luong
Takeo	Tom
Takeo	Trapeang Skear

Selected provincial cities:

City	Province
Baek Chan	Kandal
Banlung	Ratanak Kiri
Battambang	Battambang
Kampong Cham	Kampong Cham
Kampong Chhnang	Kampong Chhnang
Kampong Pranak	Preah Vihear
Kampong Speu	Kampong Speu
Kampong Thom	Kampong Thom
Kampot	Kampot
Koh Kong	Koh Kong
Kratie	Kratie
Malai	Banteay Meanchey
Mongkol Borey	Banteay Meanchey
Pailin	Pailin
Poipet	Banteay Meanchey
Pramoey	Pursat
Preaek Khsay Ka	Prey Veng
Preaek Pnov	Kandal
Prey Veng	Prey Veng
Pursat	Pursat
Samraong	Otdar Meanchey
Siem Reap	Siem Reap
Sihanoukville	Preah Sihanouk
Sisophon	Banteay Meanchey
Srae Ambel	Koh Kong
Stueng Traeng	Stung Treng
Suong	Kampong Cham
Ta Khmau	Kandal
Takeo	Takeo
Udong	Kampong Speu