CONSUMER ACCEPTABILITY STUDY
PHILIPS HD4012

SMART DEVELOPMENT WORKS
REPORT OVERVIEW

1. Executive Summary
2. Background & Rationale
3. Methodology
4. Baseline Summary
5. Stove Functioning
6. Stove Experience, Preference & Perceptions
7. Renewable Biomass Fuel
8. Stove Costing and Willingness-to-Pay
9. Conclusion
15 (out of 16) respondents used the stove on a daily basis, on average 2 times per day. 12 respondents fully converted, abandoning their traditional stoves.

All respondents acknowledged that the Philips HD4012 uses less fuel than their old primary stove and thereby reduces HH fuel expenditure.

Most respondents observed a noticeable reduction in smoke emissions.

14 respondents found the stove ‘easy to use’. 10 respondents observed increased cooking speed.

The major perceived drawback of the Philips HD4012 in the Cambodian cooking context is the batch feeding character requiring constant tending to refill fuel.

There is considerable willingness to buy the stove, but the high price is perceived as a major obstacle. Instalment plans and stove-fuel bundles lower this barrier.
SNV

BACKGROUND & RATIONALE

ACCS
Advanced Clean Cooking Solutions

SMART DEVELOPMENT WORKS
This report summarises findings from a Consumer Acceptability and Willingness-to-Pay Study for the Philips HD4012 Advanced Biomass Stove in Cambodia.

The purpose of the study was to assess the acceptance of the Philips HD4012 among Cambodian households who use predominately wood and charcoal for cooking on a daily basis. It aimed to gather qualitative information relating to the appreciation of the Philips HD4012 in the Cambodian cooking context.

The study was conducted over a 5-week period by SNV Netherlands Development Organisation in May/June 2014 with 16 selected households in 5 target market segments in urban, peri-urban and rural areas in Cambodia.

The study is part of a series of assessments to evaluate the potential for commercial introduction of Advanced Biomass Stoves in the Cambodian consumer market.
High performance biomass micro-gasifier stove

Designed by Philips Research Laboratories in Eindhoven (NL), manufactured by African Clean Energy in Lesotho

Designed to reduce cooking fuel consumption and household air pollution

Meets Tier III performance benchmarks (emissions, efficiency/fuel savings, indoor air emissions, safety not rated)

Fan-assisted forced-draft stove - fan with electronics to control fan speed

Virtually smokeless

Thermal efficiency up to 42%

Complete combustion of fuel

Biomass fuel agnostic (small diameter wood, rice husk, wood pellets, other dry biomass)

Body and insides stainless steel, combustion chamber lined with refractory material

Estimated retail price in Cambodia: USD $130

Source: Global Alliance for Clean Cookstoves website
CONSUMER ACCEPTABILITY TESTING METHODOLOGY

1. Selection of households from target market segments / Charge and test all stoves before they are deployed
2. Baseline survey
3. Stove (and new fuel) Introduction (Group and Individual training)
4. One week follow-up survey / Placement of SUMS (thermal data loggers)
5. End-line Survey / Collection of SUMS / Willingness-to-pay experiment
6. Data Analysis and Reporting

Consumer Acceptability Research Questions:

- What are the desired attributes of the advanced biomass stove (ABS) and fuel?
- What are the perceived barriers and dislikes of the ABS and fuel? Are there feasible solutions to these barriers?
- Number of times and duration that ABS are used in households.
- Willingness-to-pay and does offering instalment payments influence purchase?
- Validation of expected fuel savings.
· **Week 0**
  - Household Selection, Stove (and fuel) preparation

· **Week 1**
  - Days 1-2: Baseline Questionnaires, Stove Introduction (group and individual)
  - Day 5: One-week Follow-up Survey and placement of SUMS

· **Week 2** [No Visits]

· **Week 3** [No Visits]

· **Week 4**
  - Day 25-26: End-line surveys, SUMs data collection, willingness-to-pay experiment
METHOD FOR SELECTING HOUSEHOLDS

- Households chosen from validated primary and secondary target market segments based on *End-User Market Assessment Report*¹

- Randomized household selection based on End-User Market Assessment survey data set

- Qualifiers = geographic area + income level + type of primary fuel

<table>
<thead>
<tr>
<th>Area</th>
<th>Target Segment</th>
<th>Province / District</th>
<th># of HH's / Stoves</th>
<th>Biomass Fuel Provided</th>
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<td>Firewood users in top 2/3 income &gt;$194 month</td>
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<td>Urban</td>
<td>Charcoal users in top 2/3 income &gt;$251 month</td>
<td>Phnom Penh, Chamkar Mon</td>
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</table>

¹ End-User Market Assessment for Advanced Biomass Stoves – Cambodia. May 2014
1. Self-reported use of stoves [Questionnaires]

2. Stove use monitoring system (SUMS)
   - SUMS record the stove temperature at selected time intervals (e.g. every five minutes); the resulting temperature profiles are analyzed to determine the frequency of “cooking events” (i.e. number of times the stoves were lit) per day.

Placement
Of SUMS iButtons on the Philips stove
SURVEY INSTRUMENTS AND DATA COLLECTION TOOLS

- Baseline Questionnaire
- One-week Follow-up Questionnaire
- End-line Questionnaire
- Willingness-to-pay method and script
- Stove introduction material (stove operation and maintenance manual translated to Khmer)
- Thermal data logger (SUMs) and data sheet
Preparation included ensuring that all stoves are in good operating order and fully charged before being deployed in households.
HOUSEHOLD PROFILE

- Sample of 16 HHs from 3 geographic areas; 5 market segments
- 100% Respondents Female
- Average age of respondent is 45 (range 24-68 years)
- 94% of all respondents attended school
- Average highest grade attended is 6th grade
- Average household size of sample is 7
GENERAL LOCATIONS OF HOUSEHOLDS

Kandal province (rural)
All respondents are middle- to high-income earners

Average monthly income is $502 (ranging from $250 to $1,000)

On average, 3.3 family members contribute to HH income

Respondents’ HHs own on average 1.6 motorbikes, 3.5 mobile phones, 1.4 television sets

All respondents are connected to grid electricity
Main Source of HH Income

- Government: 12%
- Small business: 38%
- Factory (non-garment): 19%
- Farming: 6%
- Other: 25%

Person in Charge of Spending

- Respondent: 63%
- Spouse: 10%
- Both respondent and spouse equally: 5%
- Parents: 2%

All survey households generate income from business or employment.

63% of respondents are in charge of spending income (on average $43, ranging from $5 to $100).

All respondents save some money (mainly for medical treatment and children’s education).
STOVES TYPES

Primary Stove Type

- Traditional Wood: 31%
- LPG Large: 6%
- New Lao Stove / Charcoal: 6%
- Traditional Charcoal: 38%
- Fixed Stove: 6%

Secondary Stove Type

- None: 19%
- Traditional Wood: 6%
- LPG Large: 6%
- LPG 200ml: 56%
- Traditional Charcoal: 13%

Average # of stoves per HH = 2.5
Average # of stoves used per meal = 1.5
Main primary stove: Traditional Charcoal and Wood stoves
Main secondary stove: LPG 200ml single burner
Most frequently stated benefits of primary stove: ‘ease of use’, ‘strong fire’, ‘supports many cooking methods’
Most frequently stated benefits of secondary stove all relate to convenience: ‘fast cooking’, ‘saving time’, ‘easy to ignite’
FUELS TYPES

Primary Fuel Type
- Charcoal: 44%
- Wood: 38%
- LPG: 6%
- LPG 200 ml: 12%

Secondary Fuel Type
- Charcoal: 13%
- Wood: 6%
- None: 19%
- LPG: 6%
- LPG 200 ml: 56%

- Main primary fuel: charcoal (44%) & wood (38%)
- Main secondary fuel: 200ml LPG canister (56%)
- Average monthly fuel expenditure (all fuels): $13.10 (ranging from $0 to $22.90)
- Average monthly fuel expenditure (by type):
  - Charcoal: $14.46
  - Wood: $7.5
  - LPG: $13.14
• Most common ignition fuel in the sample group for wood and charcoal stoves is rubber (38%)
COOKING HABITS

- Stove location = 6 inside the house, 6 outside/open courtyard, 3 in a separate building, 1 under the house.

- Average meals per day = 2.38
- Average dishes per day = 6
- Average # of stove meals per day = 3.69
- Most common cooking methods = boiling; frying on both sides
- Average time spent cooking = 50 mins (ranging from 30 mins to 90 mins)
Traditional Kitchen
In a separate room in the main dwelling, with one window and one door.
Most respondents are aware of the health consequences of smoky stoves.

100% of respondents think that smoke from their stove is a problem.

When asked how exactly they think smoke is a problem, almost all respondents name: stinging eyes, headaches, coughing, difficulty breathing.
Stove

Introduction

The Philips stove is introduced in a small group setting in the study participants’ homes.
STOVE OPERATION

- None of the respondents physically modified their stove to accommodate for their cooking style.

- Respondents mostly followed the procedure for lighting and operating the stove as instructed. However, some respondents used variations of the instructed procedure. Most common variations were:
  - Respondents used kerosene in addition to the biomass starters provided
  - Respondents reduced fan usage in order to save electricity.

  This particularly applied both during initial lighting of the stove (respondents chose to use fan mid-speed instead of max-speed as instructed) and after cooking was completed (respondents chose to let the stove cool down naturally rather than using the fan to assist cooling down)
TECHNICAL ISSUES

- Two technical issues were reported:
  - One stove’s fan did not work from the beginning. The stove was replaced.
  - The air fan malfunctioned in 1 stove after approximately 3.5 weeks of use. The stove was replaced.
STOVE FEATURES

Stove features

- 2/3 of respondents stated that the Philips stove is the perfect size to cook most meals. 1/3 found that it is too small.

- The stability of the stove was questioned for use of large or heavy pots.

- Respondents confirmed that the stove was not suitable for grilling (without additional appliances)

- Some respondents suggested incorporating an opening to remove ash; to enlarge the opening for fuel feeding; to make the base of the stove more stable & fireproof (metal instead of plastic base)

Maintenance & Spare parts

- Several study participants raised questions regarding the availability and costs of replacement parts; and regarding the lifetime of the stove and its components.
CASE ANALYSIS: ‘DRIVING A STICK-SHIFT IN 1ST GEAR ONLY’

In spite of detailed instruction regarding the correct lighting and operation of the fan-assisted Philips stove, one study participant routinely overfilled the stove’s fuel chamber. To avoid frequent refilling, she stated in a follow-up interview, she used the Philips micro-gasifier much like her traditional bucket stove, going about other household chores while a large amount of fuel was simmering away unattended. Consequently, none of the benefits of the stoves’ modern combustion principles were realised – her stove consumed unreasonable amounts of fuel, emitted considerable amounts of smoke, and cooking time was not reduced. This case goes to illustrate that clean cooking practices are not equally easily adopted by everyone, and merely providing a new technology is not sufficient. Cookstove interventions must sufficiently accommodate for ‘end-users’ need to fully embrace a new way of doing a routine task and learn to adapt their behavior.
STOVE EXPERIENCE, PREFERENCE & PERCEPTION
STOVE USAGE

Adoption Rate & Usage Patterns

- All respondents (except one) used the stove on a daily basis, on average 2 times per day. Self-reported use was confirmed by data collected via thermal data loggers (SUMS).

- 75% (12 respondents) fully converted to the new stove and abandoned their old stove.

- 4 respondents indicated they still used their traditional stoves daily to supplement use of the Philips stove.

- 1 respondent discontinued participation in the study due to illness.
STOVE USE MONITORING SYSTEM (SUMS)

- SUMS consist of thermal data loggers, and other equipment and software used to monitor stove usage¹.

- Thermal data loggers were placed on all stoves one week after the stoves were first introduced, and recorded data over a period of 20 days.²

- The thermal data loggers were placed on the outside surface of the stove, on the backside middle of the stove.

- The thermal data loggers recorded temperature readings every three minutes.

- Cooking event algorithm: all temperatures more than 20°C above minimum are cooking times.

¹ http://berkeleyair.com/services/stove-use-monitoring-system-sums/
² from 5/19 to 5/29 and from 5/31 to 6/8.
### SUMS DATA (5/19 TO 5/29)

5/19/2014 12:00 AM to 5/29/2014 11:59 PM (5280 Samples, Sample Frequency 3 minutes)

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EASE OF USE

- 87% of respondents found the Philips stove ‘easy to use’.
- However, some respondents did not like the batch feeding character of the stove requiring constant tending to refill fuel. 87% of respondents stated that the Philips stove requires more tending than their baseline stove.
- The majority of respondents observed increased speed of cooking with the Philips stove.
- However, some respondents stated that the continuous fuel feeding was time consuming.
- Some respondents found it difficult to remove ash. Particularly when cooking for longer periods, users had to remove ash frequently.
- Some respondents suggested a larger opening for fuel feeding.
Most respondents used the Philips stove for making most dishes they would have otherwise prepared on their old stoves.

75% of respondents agreed on the same ranking of cooking methods the Philips stove is best suited for:

1. Boiling water
2. Cooking rice
3. Frying
4. Making soup

All respondents agreed that the stove is not suited for grilling.

All respondents agreed that the food prepared on the Philips stove tastes the same as when cooked on their own stoves.
Most respondents (13 out of 16) observed a noticeable reduction in smoke in their home or kitchen. This observation slightly decreased over the study period among charcoal users who felt that their baseline stove emits less smoke once it reaches smouldering state.
Most respondents agreed that the stove made them look modern and gave them a better standing in their community.

All respondents had talked to someone about their stove, mainly their neighbors and relatives.
After 1 week of use, 75% of respondents indicated they prefer the Philips stove over their own stove.

This number dropped to 50% preference of the Philips stove after 4 weeks of use.

The key reason for this was that respondents did not like the batch feeding / continuous tending character of the stove which prevents them from doing other housework simultaneously.

87% of respondents stated that the Philips stove requires more tending than their own stove.
Participants’ most stated reasons for preferring the Philips Stove over their baseline stove were:

- 93%: less fuel
- 73%: faster cooking
- 40%: less smoke
- 40%: portable
- 33%: less soot, cleaner kitchen
- 27%: looks nice
- 27%: easy to light
- 13%: brings pride

Other reasons stated: ‘safer than LPG’, ‘easy to use’, ‘cooks food well’.

Most common reasons stated for preferring their baseline stove: ‘can be used for grilling’, ‘less time required to refill fuel’/‘can do housework simultaneously’.
EXPECTED IMPACT

When asked how they think the Philips stove would change their every-day life, respondents most frequently stated:

- Save money on fuel (mentioned by 10 respondents)
- Shorten cooking time (mentioned by 6 respondents)
- Less smoke (mentioned by 5 respondents)
- No change (mentioned by 3 respondents)
- Less time collecting fuel (mentioned by 2 respondents)
Taking all factors into account, respondents rated their overall satisfaction with the Philips HD4012 as follows:

Overall Satisfaction with the PHILIPS HD4012
Participant of the Philips stove trial. She lives with her family of 7 in Cher Teal Village in Kandal Province.
Fuel Introduction

Renewable biomass fuels introduced in combination with Philips stove (Cambodia)
For future commercialisation of advanced biomass stoves in Cambodia, the availability of suitable fuels plays a key role in possible cost savings, overall stove performance and consumer acceptance.

To assess the acceptability of renewable biomass fuels suitable for use in micro-gasification stoves, study participants were provided with a supply of 3 fuel types: rice husk pellets, dried corn cobs, and crushed coconut shells.
RENEWABLE BIOMASS FUELS

93% of respondents agreed that the Philips HD4012 uses less fuel than their old primary stove.¹

This observation increased over the 4-week study period.

Most respondents acknowledged that reduction in fuel consumption would reduce HH fuel expenditure.

¹ Response is based on user perception. Kitchen Performance Tests (KPTs) are required to quantify fuel savings.
The majority of study respondents prefers Rice Husk Pellets. Major reasons for pellet preference were: ‘easy to light’, ‘emits less smoke’, ‘cooks quickly’. Other reasons stated were: ‘high power’, ‘good hot flame’, ‘it’s clean’. Several respondents appreciated the Philips HD4012’s ability to use a variety of different fuels – and the flexibility this brings for the user.
STOVE COST

- When assessed individually, respondents expected to pay an average retail price of USD $25 for the Philips stove (ranging from USD $12.50 to USD $50).

- Half of the respondents were willing to pay $30, none of the respondents was willing to pay more than $50.

- There was considerable willingness among the study respondents to buy the stove (due to its observed benefits), but the high price was perceived as a major obstacle.
All of the respondents stated that if they were to buy the stove, they would either use their existing savings or save specifically for the stove.

When offered an instalment payment option, 80% of respondents indicated they would be interested in buying a stove.

The average monthly instalment respondents stated they were able to pay was $3.80 (ranging from $1.25 to $5).
Willingness-to-Pay Experiments

- All rural respondents were given the choice to keep the provided sample stove (owning it free of charge as reward for their participation in the study) or to sell the stove back to SNV for USD $50 cash on the spot.

  All 4 rural respondents opted to forgo the cash reward and instead kept the stove.

- All urban and peri-urban respondents were offered the sample stove at a discounted price of USD $75 (since it was now in used condition) and were offered various payment plans to pay off the amount over time.

  3* out of 12 respondents opted for a payment plan, another respondent plans to sign up for a payment plan in 2 months time.

* From market segments: High income firewood peri-urban (1x); High income charcoal peri-urban (2x)
To address the price barrier, study participants were offered various payment plans.

### Payment Plan

1. **Philips Stove (Stove Only)**
   - **$ 75** one time payment (used condition)
   - ($135 = full value of stove)

2. **Philips Stove Payment Plan (Stove Only)**
   - | Duration | USD/Month | KHR/Month |
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<tr>
<td>18 months</td>
<td>$4.18</td>
<td>16,700</td>
</tr>
</tbody>
</table>

3. **Philips Stove and Rice Husk Pellet Combination (One Year Contract)**
   - | Weight (kg) | USD/Month | KHR/Month |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>$15.75</td>
<td>63,000</td>
</tr>
<tr>
<td>25</td>
<td>$14.25</td>
<td>57,000</td>
</tr>
<tr>
<td>20</td>
<td>$13.00</td>
<td>52,000</td>
</tr>
<tr>
<td>15</td>
<td>$11.50</td>
<td>46,000</td>
</tr>
<tr>
<td>10</td>
<td>$9.75</td>
<td>39,000</td>
</tr>
<tr>
<td>5</td>
<td>$8.15</td>
<td>32,600</td>
</tr>
</tbody>
</table>

4. **Rice Husk Pellets (Monthly Delivery)**
   - | Weight (kg) | USD/Month | KHR/Month |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>$9.50</td>
<td>38,000</td>
</tr>
<tr>
<td>25</td>
<td>$8.00</td>
<td>32,000</td>
</tr>
<tr>
<td>20</td>
<td>$6.75</td>
<td>27,000</td>
</tr>
<tr>
<td>15</td>
<td>$5.25</td>
<td>21,000</td>
</tr>
<tr>
<td>10</td>
<td>$3.50</td>
<td>14,000</td>
</tr>
<tr>
<td>5</td>
<td>$1.90</td>
<td>7,600</td>
</tr>
</tbody>
</table>
CASE ANALYSIS: ‘LET’S DO THE MATH’

When we arrived at this respondents house for the final interview, she had already neatly packed the Philips stove in the original box it came in, and was certain she would return it to the SNV team. Not because she didn’t like the stove – she appreciated having been able to try it – but she was ready to go back to ‘how she has always done things’. Glancing over the data we had captured from her, the team quickly noticed that her household stood out for exceptionally high monthly fuel expenditure. While the respondent was aware that her daily expenditure for charcoal and LPG was approximately $0.65, she did not realise that this amounted to almost USD $20 per month, or $240 per year. The team offered her to sign up for Payment Plan #3 – for $15.75 per month (less than her current monthly fuel expenditure) for a duration of 12 months she now receives a supply of rice husk pellets sufficient for 1 month worth of cooking (30kg) AND pays off installments for her Philips stove at the same time. She agreed that the deal was unbeatable and thanked the team wholeheartedly for helping to improve her household economics. As with other SNV base-of-pyramid marketing projects, this case illustrates that simplified return-on-investment (ROI) calculation is a key tool to help households to think about their economic situation and identify savings opportunities. Sales agents coming in as trustworthy ‘household finance advisers’ fare particularly well in selling innovative devices that really make a difference in people’s lives.
Doing the Math
Return-on-investment calculation proves to be an effective tool in interpersonal sales events.
CONCLUSION
CONCLUSION

- On the basis of the data collected, it can be concluded that the Philips HD4012 was well accepted and appreciated among study households.

- Study participants acknowledged fuel savings, smoke reductions, ease of use and speed of cooking as main benefits of the stove.

- The major perceived drawback of the stove is that it requires a modification of cooking style – users have to stay near the stove to refill fuel. This is perceived as more time consuming.

- There was considerable willingness to buy the stove, but the high price was perceived as a major obstacle. Instalment plans and stove-fuel bundles can lower this barrier.

- There was noticeable readiness and curiosity among households to ‘try out’ a new cooking device and to consider investment in cooking equipment upgrades.
CONSUMER ACCEPTABILITY TESTING SERVICES

- SNV Cambodia offers Consumer Acceptability Testing services to stove suppliers wishing to enter the Cambodian market.
- SNV Cambodia offers a Standard Package at no cost to the stove supplier and a Premium Package that includes costs.
- SNV Cambodia can introduce and assess the acceptance of just stoves or stoves in combination with new fuels.
- All research staff (local and international) have been trained and have applied these research methods on multiple occasions in Cambodia.

Contact us to request further information
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