The cookstove market in Cambodia is relatively large in comparison to the number of households in the country, with an estimated 2.9 million households (~90% of total households) relying on traditional biomass fuels (firewood and charcoal) as their main cooking fuel, and households on average own and use 2.5 cookstoves. There are an estimated 7.5 million cookstoves in use nationwide with a total market value of approximately USD 45 million. Although the use of LPG is slightly increasing among higher income households in urban areas, the prospect for the many peri-urban dwellers and rural households in moving to modern cooking fuels is still a long way off because of the limited access to and higher prices of LPG and electricity and the abundance of fuelwood. The use of solid biomass fuels places a heavy burden on the country's natural resources. According to FAO data, Cambodia is experiencing on average a loss of 1.3 million hectares of forest per year, which is the largest deforestation rate in the region. Unsustainable fuelwood production is one key driver of deforestation in Cambodia.

Costs for traditional biomass fuels are also on the rise. Charcoal prices have increased fivefold over the last 8 years. The rural poor spend about 10% of their consumption expenditure on energy needs with cooking energy needs representing 70% of the total energy spending. This high energy expenditure among Cambodian households poses a significant obstacle for socio-economic development of the country.

Addressing the above described situation, cookstove interventions were initiated a decade ago. Today, Cambodia is recognised as one of the most developed improved cookstove (ICS) markets in the world and sales of ICS continue to increase exponentially every year. However, currently all improved cookstove technologies available in Cambodia are based on traditional designs with incrementally improved durability and fuel savings but do not address health issues related to smoke and safety.

Cooking with solid fuels with traditional stoves has particular effects on the health of end-users as the smoke from cooking contributes to high levels of household air pollution. The Global Burden of Disease 2010 report estimated that household air pollution from cooking with solid fuels is the second leading risk factor contributing to disease and premature death in Cambodia. The WHO estimates that this results in 6,600 premature deaths per year, equal to 18 deaths per day. Even when cooking outdoors, smoke finds its ways indoors, harming health, especially of women and children.

Cookstove production in Cambodia is a traditional industry, with the supply side of ICS currently consisting exclusively of artisanal manufacturers producing the New Lao Stove (NLS) and the Neang Kongrey stove (NKS), both clay bucket stove models (NLS with metal cladding) introduced by French NGO GERES. Artisanal producers use traditional sales channels, such as mobile ox-carts.
and district markets to distribute stoves to end-users.

The industry suffers from a lack of national standards that could provide policymakers, donors, investors and stove experts with a credible basis to further advance stove performance beyond what is currently available. As a consequence, innovation has been notably absent from the Cambodian cookstove market since introduction of the NLS model 10 years ago.

To date, clean biomass cookstove options are not available to Cambodian consumers. While these new generation stoves are relatively expensive compared to current offerings in the market in Cambodia, they significantly cut cooking costs and time use compared to traditional stoves and have been found to be more convenient to use, cleaner and healthier.

SNV Cambodia and partners believed that the time has come for the large-scale introduction of clean biomass stoves that improve peoples’ health and that are safe to use and fuel efficient. Therefore the SNV team designed the Advanced Clean Cooking Solutions (ACCS) project with the main objective to broaden the existing stove supply to the Cambodian market, giving consumers an opportunity to purchase a range of high quality, high performance and cleaner biomass cookstove appliances at different price points. If this is done, the benefits that these cookstoves provide to the households and to the local and global environment are numerous.

In order to broaden the supply chain the ACCS project would need to stimulate the interest of stove manufacturers of advanced biomass stoves and local distributors and retailers to engage in this market. Therefore, the SNV team set out to design and implement a comprehensive suite of market-making activities that would reduce market entry risk for the private sector. This set of activities includes:

1. Market Intelligence
2. Inclusive Business / MSME Capacity Development
3. Distribution Model Development and Piloting
4. Consumer Awareness and Marketing Approaches
5. Stove Testing and Research
6. Knowledge Sharing

1. Market intelligence

In the beginning of the project we set out to understand the market opportunities for advanced biomass stoves and cleaner and renewable fuels. We commissioned Emerging Markets Consulting (EMC) to conduct a large household survey and a number of focus groups to gather data and feedback including willingness to pay for these appliances to determine the scope of the market.

The research indicated the following market potential within the selected market segments in the table below:

- Economic Potential: 1,066,635 households (ability to pay)
- About 568,000 households have the desire to adopt an advanced biomass stoves
- Achievable Potential: 143,000 households (ability to pay, willingness to pay USD 100) valued at USD 14.3 million or 32% of the overall market value.

Market potential is expected to increase once advanced biomass stoves move from early adopters to a mass market product.
These findings are also supported by market research studies conducted by the Global Alliance for Clean Cookstoves, which clearly show market potential but lack of clean cookstove options beyond those stoves with incrementally improved efficiency. This research also indicates consumer willingness to utilise financing schemes to lower the investment barrier.

Moreover, Consumer Acceptability and Willingness-to-Pay Studies conducted by the ACCS project on several stove models indicate there is considerable appetite among households for cooking equipment upgrades beyond what is currently available to them, and a general readiness to embrace new, more modern technologies. The team used a number of data collection techniques during these studies including Stove Use Monitors (SUMs) to quantitatively collect data on the frequency of stove use.

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. The study provided valuable baseline data on household cooking behaviour. Some key data points are:

- The average cooking firewood consumption among firewood users: 4.87 Kg/household/day.
- The average charcoal consumption throughout the study: 2.023 Kg/household/day
- Percentage of wood users that purchase firewood: 29%
- Percentage of firewood users that collect firewood: 85.6%
- Charcoal and wood users spend 105-108 minutes cooking per day
- Traditional Lao Stove (TLS) remains the most prominent stove for both wood users (58.2%) and charcoal users (60.2%).
2. Inclusive Business / MSME Capacity Development

For local distributors that wanted to engage, the SNV team supported them to pilot the distribution of stoves including providing them sales agent training and support to create consumer awareness.

In collaboration with the ADB funded project “Harnessing Climate Change Initiatives to Benefit Women” that SNV is also implementing, we supported distributors in the identification, training, and coaching of female sales agents in order to mainstream gender into their supply chain of advanced biomass stoves. This coaching included how to conduct effective village level stove demonstrations.

3. Distribution Model Development and Piloting

“The proof is in the pudding”. Survey and focus group data only has so much value. Conducting a pilot to confirm all assumptions made about the market is a key milestone in reducing the risk for the private sector to engage. SNV conducted a couple different pilot activities. One was in collaboration with stove manufacturer, African Clean Energy (ACE), and local distribution company, Lighting Engineering Solutions (LES). The distribution pilot was implemented on a limited geographical scale, a few districts (rural) in Kampong Chhnang province, in the latter part of 2015 to test fundamentals of a sustainable business model for an advanced biomass stove supply chain, including distribution chain arrangements, consumer financing models, and marketing messages. LES and their commissioned sales agents sold over 100 ACE-1s for USD 100 each. LES provided in-house financing, allowing consumers to pay instalments over a one year period. The majority of households took this payment option. Purchases were made based on a combination of the following drivers:

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel savings</td>
<td>More efficient than traditional biomass stoves</td>
</tr>
<tr>
<td>Convenience</td>
<td>Easy to light, easy to use and control, and faster cooking</td>
</tr>
<tr>
<td>Less agitation caused by smoke</td>
<td>Less smoke generated from gasifier stoves compared to traditional biomass stoves</td>
</tr>
<tr>
<td>Modern (primarily from a male buyer perspective)</td>
<td>Aspirational: looks modern, associated with high social status</td>
</tr>
</tbody>
</table>

The barriers to not buying the stove were the following:

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Disposable Income and High Price</td>
<td>Different models with different price points will be available. Local production/assembly to bring costs down</td>
</tr>
<tr>
<td>Distributors should arrange a payment plan for the consumer through MFIs, in-house financing, or community savings models.</td>
<td></td>
</tr>
<tr>
<td>Lack of spare parts and repairing services / Fear of being deceived on quality and service</td>
<td>Addressed through a one year warranty and after-sales services provided by the manufacturer’s representative located in Cambodia (local phone number to call)</td>
</tr>
<tr>
<td>Stove distributors should get the buy-in and endorsement from local authorities prior to conducting village demonstrations, small-group meetings, and door-to-door marketing</td>
<td></td>
</tr>
<tr>
<td>Not enough knowledge about the product / nervous about new technology</td>
<td>This will increase with more promotion of the products at the village level, and more demonstrations. First adopters will spread knowledge about the products to their neighbors, friends and family, which is the most effective promotional tool.</td>
</tr>
</tbody>
</table>

The consumer profile of ACE1 buyers is:

- Firewood / Charcoal / and LPG 200ml users (small cannisters)
- Female
- Age range (30 to 50 years old)
- Multiple income sources (i.e. different incomes coming from different family members living in
the same household and/or different types of jobs (e.g. farming, small shop, factory)

- Type of house (as Socio-economic identifier)
  - Wood with corrugated iron roof
  - Wood with tiles
  - Half concrete half wood with tiles
  - Concrete with open kitchen (in peri-urban areas)

In one farming village in Kampong Chhnang province, 15% of households purchased the ACE1 stove. The number of households in the village are 199 and 30 stoves were purchased for USD 100 each. The village is relatively poor with 50% of the village households officially classified by the government poor. The households in the village collect firewood for free, for which it is available in abundance, so there was no direct economic savings to drive their purchase decision. Their reasons for purchasing are consistent with the purchase drivers listed in the above table. The households who purchased the stoves were a mix of poor and nonpoor households. The village sales agent, Ms. Un Lim, was a driving force behind the large sales numbers. She purchased two stoves herself and conducted several demonstrations, either for groups or for individual households at their homes, showing them how to use the stove. She also let households borrow her stove for a couple days to test it out. Her efforts combined with a good product and the one year payment plan provided by LES, made her the top seller compared to LES’s other commissioned sales agents.

Another pilot was in collaboration with Differ Group (Norway) and Prime Cookstoves (Indonesia) with local company Sustainable Green Fuel Enterprise (SGFE). The pilot tested out SGFE as the wholesaler in the supply chain, with one container of Prime stoves (~1,000 units) nearly selling out within 4 months to local distribution companies and organisations.

4. Consumer Awareness and Marketing Approaches

What are the messages that hit home and make someone want to buy an advanced biomass stove? SNV and partners tested out a number of messages, and with support from 17Triggers and TNS Cambodia, conducted an action research to understand whether health messaging was effective in driving sales. The results were that health messaging combined with other product benefits is effective, versus focusing messaging solely on the health impacts. The action research resulted in several lessons learned in how to market products in villages, building trust with local authorities, and the essential need to recruit confident and proactive sales agents that believe in the product.

5. Stove Testing and Research

For all new advanced biomass stoves that we investigated, it was important to understand how they perform compared to traditional Cambodian stoves. This data is important to share with market players and consumers, so expectations and value added benefits are accurately portrayed in the local context. In order to understand fuel savings over the most prominent baseline stove, the SNV team with help from stove testing experts conducted a number of controlled cooking tests with Cambodian cooks and common Cambodian cuisine. All tests were conducted with firewood. Results, as compared to the most prominent baseline stove (Traditional Lao Stove) are the following:

<table>
<thead>
<tr>
<th>Stove Model</th>
<th>Stove Type</th>
<th>Fuel Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mimi Moto</td>
<td>Forced Air TLUD Gasifier</td>
<td>31%</td>
</tr>
<tr>
<td>ACE1</td>
<td>Forced Air TLUD Gasifier</td>
<td>20%</td>
</tr>
<tr>
<td>Philips HD4012</td>
<td>Forced Air TLUD Gasifier</td>
<td>22%</td>
</tr>
<tr>
<td>Prime Fuelwood</td>
<td>Natural Draft TLUD Gasifier</td>
<td>12%</td>
</tr>
<tr>
<td>BioLite Homestove</td>
<td>Forced Air Rocket Gasifier</td>
<td>7%</td>
</tr>
<tr>
<td>RocketWorks ZaMa Zama</td>
<td>Natural Draft Rocket Gasifier</td>
<td>21%</td>
</tr>
<tr>
<td>Traditional Lao Stove (Baseline)</td>
<td>Ceramic with thin metal cladding</td>
<td>0%</td>
</tr>
</tbody>
</table>
It was also important for SNV to build the evidence base on household air pollution in Cambodian households related to cooking smoke and the positive health impacts of advanced biomass stoves and household biodigesters. This would support claims that advanced biomass stoves are indeed a healthier option than cooking on traditional biomass stoves. To do this, SNV commissioned Berkeley Air Monitoring Group and a local field team to conduct kitchen air pollution and personal exposure monitoring on a number of households from July to September 2015. The ACE-1 sub-study was conducted in 24 peri-urban and 24 rural, wood-burning households and involved measurements of personal exposure (PE), kitchen air pollution (KAP), and stove use before and after the introduction of the ACE-1 stove (before-after study design). The biogas sub-study was conducted in 24 rural biogas households and 24 rural control households (cross-sectional study design) and also involved measurements of personal exposure, kitchen air pollution, and stove use.

ACE-1 and biogas use resulted in statistically significant decreases in kitchen air pollution (KAP) and personal exposure (PE) resulting in positive health outcomes (measured in averted disability adjusted life years, ADALYs) for the populations using these cleaner technologies, as modelled in the Household Air Pollution Intervention Tool (HAPIT) version 3, a web-based application developed by University of California, Berkeley. A summary of the results is shown below:

<table>
<thead>
<tr>
<th>Technology</th>
<th>Kitchen Air Pollution (PM2.5 µg/m³)</th>
<th>Personal Exposure (PM2.5 µg/m³)</th>
<th>ADALYs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Reductions</td>
</tr>
<tr>
<td>ACE-1</td>
<td>183</td>
<td>111</td>
<td>72</td>
</tr>
<tr>
<td>Biogas</td>
<td>172 (control)</td>
<td>35</td>
<td>137</td>
</tr>
</tbody>
</table>

SNV also commissioned Sustainable Green Fuel Enterprise (SGFE) to determine the optimal fuel source for fan powered gasifier stoves, more specifically in this case for the Philips stove (model HD4012) (“Philips stove”), for cooks in Cambodia, and compare performances against baseline stove models. The stove was tested with over 13 types of fuel, first qualitatively and then quantitatively through water boiling tests and controlled cooking tests. Fuels that came out on top were rice husk pellets, wood, corn cobs, and coconut shells. A follow up assignment, also conducted by SGFE, was a feasibility study and preliminary business plan for rice husk pellet production and distribution in Cambodia, resulting in a financially viable decentralized business model for rice millers to produce rice husk pellets and for enterprises to distribute them. To test some business plan assumptions and the marketability of rice husk pellets, SNV procured a mini-pellet mill, for which SGFE operates to produce rice husk pellets and sell them in combination with gasifier stoves. This work is still ongoing.

6. Knowledge Sharing

We shared all the market intelligence and testing and research reports with interested private sector actors to spur their interest in entering the market – this spans from international stove producers to local distributors. All knowledge products are posted on www.advancedcleancooking.org and www.thestoveauction.org.
Through the ACCS project intervention we have successfully engaged international stove producers and local distributors to get them interested in the Cambodia market. Our high quality knowledge products, such as our market intelligence and consumer acceptability reports, our research on health impacts, our action research on most effective marketing messages, etc, all provided highly valuable information to the private sector about the market. This resulted in their investment in Cambodia, through sending in containers of stoves at their own costs, making several visits to learn more about the landscape and meet potential distributors, and hiring local representation (Differ and Prime) or starting up offices in Cambodia and making steps toward local production (ACE).

We also built enough evidence to demonstrate market potential and opportunity for scaling-up, and secured funding for a four year results-based financing program funded by Energising Development to further stimulate the private sector to accelerate the market for advanced biomass stoves.

Through this intervention, SNV prides itself in having catalysed the growth of an emerging market, bringing proven advanced biomass cookstove technologies to Cambodia for the first time ever.

"When I was firstly contacted by Mr. Chanty-LES’s staff in July 2015, I was hesitant to engage in distributing the stove as I never had any experience and I do not trust the product’s quality. When I attended the first meeting, followed by the training, I became confident. Unexpectedly, I sold 24 stoves in two months, generating around 192 USD. My husband appreciates my work and sometime helps me to do household chores when I am not around to promote the stove". Ms. Un Lim, Top Sales Agent, Kampong Chhnang province

"In my village, we do not have option besides using traditional cookstove. I feel proud that I can provide better options to my villagers. Through distributing the ACE1, I feel I contribute to development of my villagers through helping them to have better health, save money and time”. Mr. Koy Vannak, Sales Agent, Kampong Chhnang province

Start and end date of contract: January 2014 to December 2015

Team: 2 SNV Staff and 2 LCBs

Financial resources invested: EUR 750,000

Funded by: Ministry of Foreign Affairs of the Netherlands