Project Summary for Research, Development & Commercialisation Team

Date	**25/07/2018**	Country:	**Cambodia**
Team Leader:	**Thomas de Heus/ Mitch Lew**	Group Leader:	**Jessica Riley**
Project:	**Fuel Sustainability**		

Executive Summary

Following the success of the Fuel Sustainability project in Fiji, an evaluation was made that there was sufficient potential for the Buka Stove model to be applied to the Cambodian market. Our Fuel Sustainability team has conducted the first month of operations in Cambodia. Our major goal was to evaluate the viability of implementing the Buka Stove in Cambodia. Our other goals included mapping out a potential supply chain, researching competitors, manufacturing a prototype and presenting it to 25 customers.

The PEV Fuel Cambodia team empathised throughout Cambodia and conducted secondary research. We identified three main problems that were inefficient fuel use, environmental degradation and negative health impacts. The pain points we have identified include difficulties lighting, excessive smoke, cooking time, heat sustainability and contributing to the cutting down of trees.

The most promising solution ideated is biowaste charcoal briquettes. There is a saturation of cookstoves throughout Siem Reap that already use wood charcoal as a fuel source. Hence, there is potential for our briquettes to be a superior and more sustainable fuel source. The prototyping process was reasonably simple and achievable. The briquettes were tested with villagers and received consistently positive feedback, further reinforcing the viability of our solution.

Our main competitors in Siem Reap are wood and charcoal. Wood is free, although requires collection, continual maintenance while cooking and produces significant smoke. Charcoal is preferred although has a cost associated and can be difficult to light. Secondly, SGFE (Sustainable Green Fuel Enterprise), a French NGO, who operates primarily in Phnom Penh have a large established supply chain and strong manufacturing capabilities.

The future actions required of this project are firstly, to improve on the current prototype using feedback gathered through offer testing, whilst ensuring the scalability of the product. This may involve new designs for briquette compositions and new methods of manufacturing the briquettes, such as pressing and drying machinery. In addition to this, researching and creating an effective supply chain should be conducted for effective delivery of briquettes, as well as building 8 different customer archetypes that represent customer segments and the problems that they identify with.

The most significant commercial, safety, reputational and financial risks to be aware of are reliable suppliers and SGFE as a competitor; sharp objects, fire and smoke inhalation; breaching direct or indirect expectations with suppliers or customers; and high initial costs and low proof of demand respectively.

Table of Contents

Background

Preliminary Work / Business Opportunity

Fuel sustainability has been running as a project in Fiji for 8 months where there has been significant success in the development of the Buka Stove venture. With information indirectly gathered by previous projects in Cambodia, it was evaluated that there is sufficient potential for a project aimed at evaluating the buka stove model in Cambodia.

As this is the first fuel team to begin work in Siem Reap, a lot of background research had to be done. The team was able to access vital information about how the Buka stove model in Fiji came to be at the state it is currently in and the directions and potential for development that it has. The team did preliminary research into rocket stoves, regarding how they can be built, what their function is and their value proposition. The team was also able to research existing projects in Cambodia in order to gain a preliminary understanding of the Cambodian market and culture.

The Problem

	Inefficient Fuel Use	**Environmental Degradation**	**Negative Health Impacts**

Why is it a problem?	- Long cooking time
	- High amount fuel required.
	- Excessive smoke
		- Deforestation
		  - Legal
		  - Illegal
		- Increased emissions
			- Woodsmoke inhaled is bad for respiratory health

Who suffers from the problem? **Who benefits from the solution?**	- All users of the NLS and other stoves (74% of Cambodia) - Restaurants	- Local villages where trees are cut down - Entire planet	- Low affluent families that use wood. - To a lesser extent, users of charcoal. - Those who cook - Children
How widespread is the problem?	- Majority of the Cambodian Population (81%) with an exception of people only using gas (19%).	- Throughout Cambodia - Reports have shown illegal deforestation for wood charcoal is common	- Majority of Cambodia utilise wood or charcoal as their main fuel source (81%)

Proposed Solution

Current solution

The major solutions observed in Cambodia at the moment are fuel efficient cookstoves and a range of fuel sources.

The current cook stove solution is the New Lao Stove, manufactured by Groupe Energies Renouvelables, environnement et solidarités (GERES), a French NGO. This stove and it's traditional alternative have 74% market share of Cambodia, with several value propositions including a low price point, long life and efficient combustion.

The current solution in Siem Reap, as far as fuels, can be split into four market segments. (i) Wood only, (ii) Charcoal Only, (iii) Charcoal and Gas, (iv) Gas Only. These segments reflect different levels of affluence. This ranges from the lowest affluence level choosing to find and collect wood for free and/or purchasing wood charcoal for 1500R to the highest level of affluence able to afford a portable gas stove for $15 and ongoing costs of 1000R per gas cylinder (lasts for 2-3 days).

The current solution countrywide is very similar to the solution in Siem Reap, with one exception which is in Phnom Penh. In this city, there is a major competitor in the area of agricultural waste charcoal briquettes. Sustainable Green Fuel Enterprise (SGFE) is a social enterprise established by GERES and PSE that has established manufacturing and supply chain capabilities within Phnom Penh. They have the capacity to produce tonnes of agricultural waste charcoal briquettes.

Possible Solutions Considered

The first possible solution that was considered was the viability of the Fijian Buka Stove model or a similarly designed business model tailored for Cambodia. This model was effectively evaluated partway through July as not viable. The major reasoning for this is the strength of the major competitor, The New Lao Stove. More information on this decision can be found here.

Alternative possible solutions were ideated through a 5 doors and a window ideation activity. These included ideas such as 3D printed stoves from recycled plastic, solar powered electric stoves, drone delivered pre-cooked food, a friction based spinning cook stove and genetically engineered Cambodians that no longer need food. We eventually settled on an alternative fuel solution utilising recycled agricultural waste, as we could tailor our product to the New Lao Stove.

Most Promising Solution

Agricultural Waste Biochar briquettes.

The appeal of this solution was threefold;

1. There is a large prevalence of stoves for which the fuel could be specifically designed for and used within.
2. There is a high use of charcoal throughout the country and it is a proven business model in Phnom Penh.
3. The existing illegal wood charcoal market is causing significant damage to protected forests, and this is recognised by Cambodians.

Project Everest Ventures is well positioned in Siem Reap as;
- there are no major competitors currently in the region
- the existing FarmEd project data is a valuable resource for sourcing agricultural waste
- PEV trekkers have a great capacity for forming key relationships and networks and ideating and testing briquette prototypes.

Blocks

At this point in time, key issues that may prevent the solution being practically implemented are:
- Inconsistent supply of agricultural waste
- The ability to penetrate the charcoal distribution service with biochar briquettes
- The risk of competitor, SGFE, entering the Siem Reap market
- Costs in manufacturing that are currently unknown and may inhibit the ability to offer biochar briquettes at a lower price than charcoal

Implementation

The implementation of this model is significantly influenced by the future relationship with the competitor in Phnom Penh; SGFE. This company could be a major threat to our operation, and also could be a powerful key partner.

The key steps involved in implementing this idea are:
- Build a prototype, test and measure the product functionality and test for customer validity in the market, learn from feedback and build another prototype.
- Development of a strong distribution and manufacturing capability, this will include;
  - supply depots for agricultural waste
  - a storage location
  - carbonisation equipment, drying equipment, pressing equipment.
  - relationships with the existing charcoal distribution network.
- Fleshing out our business model; specifically determining all of our assumptions and testing them.

These blocks could exist and need to be determined through detailed research into the supply chain and manufacturing. Preliminary research and empathising has shown that these should be possible by building strong stakeholder relationships with farmers and distributors.

Justification

This solution is justified by producing the briquettes and offer testing them with over 25 households. Reception has been positive and every single person has said if our product is cheaper than charcoal and works just as well or better, people will buy it. The offer testing results for three separate locations are available for Chreav village, Phnom Krom and Puok district. The product is environmentally sustainable and has the ability to reduce the cost of living for rural households and businesses. An impact assessment has shown the impact of the solution is net positive. The justification of pivoting to alternative fuels over rocket stoves is clearly outlined in the pivot document.

Alternative Solution/Competitive Analysis

Buka Stove

The alternative solution that was seriously considered was a Rocket Stove similar to the Buka stove implemented by the PEV Fuel Team in Fiji. During the first two weeks of project, the viability of this stove was assessed. It was determined that this solution is not viable because the main competitor, The New Lao Stove and Traditional Lao Stoves, hold the majority of the market. This stove is efficient, relative to the Buka Stove and portable gas stoves, is very cheap (2-3USD) and very durable. It would be incredibly risky for PEV to attempt to compete with them and the possible gain in social development would not be large enough for this to be viable.

The New Lao Stove

The New Lao Stove is a product of Groupe Energies Renouvelables, environnement et solidarités (GERES), a French NGO who were funded by the European Union during startup. GERES has used VERs (Verified Emissions Reductions) to finance its operations as well as use micro-financing solutions for producers and distributors. Their other partners range from the Cambodian Ministry of the Environment and World Bank to the Global Alliance for Cookstoves. The New Lao Stove has been established since 2003 and have sold 2 million units with 31 production centres and a production capacity of 30 000 stoves per month. The stoves are established to last 18 months and reduces fuel consumption by 22% compared to the Traditional Lao Stove.

Biowaste Briquettes

By comparison, the proposed solution (biowaste briquettes) demonstrates a lot of potential for a strong business model. Additionally, the coconut husk briquettes have more significant positive environmental impacts when compared to the current fuel sources such as wood and charcoal, whereas the Buka Stove would have minimal positive environmental impact when compared to the current stoves used in Cambodia (NLS and TLS).

Sustainable Green Fuel Enterprise

There is an organisation known to be prominent in the alternative fuel space using biomass waste, such as coconut husk and sugarcane to make charcoal briquettes. Sustainable Green Fuel Enterprise (SGFE) another French NGO initiated by GERES that have been operating since 2010 and have an established supply chain. SGFE operate only in Phnom Penh. Their product claims to save 6.6kg of wood for every 1 kg of char briquette consumed. Unlike traditional wood charcoal, SGFE's product has a fixed shape for every briquette; a hexagonal shape with a hole in the middle to improve burning efficiency. The product comes in two forms: premium briquettes and diamond briquettes. Premium briquettes burn for 2 hours and cost 1700+ riel/kg and diamond briquettes burn for 5 hours with higher calorific value but cost 2700 riel/kg. SGFE are also looking at using rice pellets in their future products.

Charcoal & Wood

Cambodia Fuel Team's time empathising, in Siem Reap rural areas, has suggested that no biomass waste briquettes are being sold here. All households/ businesses were observed to use either wood or charcoal, with the majority fuel being charcoal. This presents an opportunity for PEV to establish a business model able to service this gap in the market, with potential to improve the design of the briquettes as well as use a wider range of biomass waste as fuel. PEV also has the capability to travel to villages and talk to potential customers in person, obtaining information in more depth than another organisation.

Backing Data

Empathising data

The empathising data summary can be found here and documents all findings for the separate villages. This data shows that all villages have New Lao Stoves (NLS) and all households in the villages are able to obtain the NLS via truck or tuk tuk that come to the village. This data supports the fact that the NLS already has a well established market and logistical setup, since all villages receive the NLS in the same way (via truck or tuk tuk). Also the fuel that the NLS requires to work (charcoal or wood) has an established logistical system with trucks or tuk tuks delivering bags of charcoal and wood. The charcoal bags weigh around 15-25kg and roughly cost around $3USD and the wood can vary in price from being free (pick up from the ground) to a few USD (delivered). Both these fuel sources can also be bought from the market and local shops if needed on demand, albeit at a slightly higher price (generally around 50c higher per 15kg bag).

Portable gas stoves are the only other competitor to the NLS in these villages and are used due to their faster cooking time and convenience. However the portable gas stoves are considerably more expensive at 10-15 USD initially and then an additional >0.25 USD for each gas canister replacement. The less affluent villages have no portable gas cooking stoves at all. The data from the villages confirms that the NLS is preferred when there is free time to cook with charcoal rather than with gas. This is because the villagers prefer the charcoal taste from the NLS and the cost and efficiency of the stove too, particularly when cooking fish.

Collected data

Researched data for the NLS and other alternative cook stoves can be seen here and here. Experimental data gathered on a NLS used back at GHQ for various experiments can be viewed here. The data shows that despite some weaknesses the NLS stove may have, such as ash build up and smoke emission, the costs is the bottom line. The advantages the NLS has is the large supply chain currently setup in Cambodia. With 31 manufacturing facilities and the capacity to produce 30,000 stoves/month, there is always a steady supply of NLS being produced and there is a demand to match as the links can show. Further, the experimental data shows the NLS has very effective cooking times for rice which is the main staple of Cambodia giving the NLS a huge competitive advantage. The experimental data however needs to be verified by repetition of the experiment to confirm these results.

The method of how the NLS can be manufactured and sold cheaply can be read about here. The NLS uses micro financing and competitive rates for loans to keep costs down. This is something PEV Fuel Cambodia did not investigate fully as we pivoted in week 2 from stoves to bio-fuel briquettes.

Finscope Survey (2015)

The data from the finscope survey for cookstoves can be found here. The NLS and its traditional design consists of 74% of the market share with the rest being made up of portable gas stoves and other. This final evidence gathered for alternative fuel sources (NLS, portable gas stoves and other cook stove types) led the conclusion that trying to implement a stove from PEV in Cambodia would simply not be feasible.

Coconut husk briquette production data

The solution the PEV Fuel Cambodia chose was to make charcoal briquettes out of dry coconut husks. The method, including the process to burn, manufacture and press the briquettes can be found in the folder here. This was chosen as an idea to cater to the already established NLS market and take advantage of the monopoly that the NLS currently holds. This was seen as a sustainable business due to the fact that the villages may only use one type of stove, however they use many types fuels and charcoals and hold no loyalty to their current fuel sources. The coconut charcoal briquettes are designed to be cheap, sustainable and reduce coconut and other biowaste in and around Siem Reap. The supply chain for the collection of coconut husk waste still needs to be established as does the logistics, however a general idea is provided

here.. The current PEV Fuel Cambodia team has only done preliminary testing of a prototype and empathised with villagers to see if they would be willing to use the briquette, which received positive reception.

Coconut husk briquette offer testing data

The data collected in Chreav village can be found here for the availability and use of coconut husks. At the moment most villages here use coconut husks as a form of kindling and buy charcoal via tuk tuk as has been seen before. When presented with the charcoal coconut briquettes, there was a positive response. The general response was that if the briquettes were delivered at a lower cost than the charcoal, and were of high quality, the villagers would buy them.

Table for quick links to data

Data Type	**Link**
NLS Experimental Data	Here
Briquette Experimental Data	Here
NLS Empathising Data	Here
Briquette Offer Testing Data	Here

Critical Future Actions

Logical steps

- Further develop the supply chain to confirm possible mid and long term agricultural waste and other suppliers.
- Evaluating the viability of utilising the existing charcoal distribution system.
- Prioritise meeting with SGFE and potentially work with them as a partner to provide practical advice on how PEV can start their business.
    - SGFE is well established and has significant experience in the alternative fuels space, thus making them a valuable contact.
    - Keep in mind that SGFE are a social enterprise with social benefit being their priority and continued operations despite making losses so they are willing to speak to us due to having similar goals
    - They also expressed quick willingness for meeting when first contact was made.
- Upgrading or redesigning the current briquette pressing machine to enable larger scale and more effective production.
- More research and development is required on a viable design of biowaste briquettes.

    - Learn from past and successful models of charcoal briquettes.
- Produce briquettes of different compositions and test them against one another based on this criteria:
    - density
    - time taken to light
    - sustainability (mins of burning)
    - release of smoke
    - time taken to boil water
- Test the product with a range of customers
    - Search for and decide on early adopters.
    - Build customer archetypes
- Develop an understanding of all of the customer segments that exist and the associated problems that they have.
- Develop an understanding of what value propositions would best target each segment.

Intermediate analysis

- Problem identifying a reliable supply chain considering many people throw out coconut husks.
- Cost effective and scalable briquette pressing machine designs
- Competitor analysis/research.
    - Online or through meeting with NGOs/ other organisations that may be knowledgeable in the fuel space.
- Evaluate the information found regarding the correct ratio of mixtures of ingredients to make the briquette.
- Test other fuel sources (i.e. bagasse (sugarcane), rice husks or corn husks) to determine alternative sources.
    - A full list of potential fuel sources is listed in Fuel Source Analysis

Australia vs. in country

- Research on a design for the briquette can be done in Australia including asking university professors etc.
- Most of the work regarding briquettes and supply chain can only be done while in country. This is because the materials and equipment needs to be sourced in-country so that a reliable and sustainable system can be created. There is no use creating a briquette press from material that is unsourceable in Cambodia.
- Research on possible briquette design and briquette press solution would however be beneficial to the project and does not need to be done in-country.

Key skills, resources/people involved in next steps

People required moving forward: (contacts spreadsheet):

- The Project Manager of SGFE (Francesco Carocci) who was interested in a meeting with the fuel assessment team, however was not available until after end of project month.
- Trekkers with engineering experience would be required as well as trekkers with business experience.
    - Engineering experience would be useful when it comes to designing and perfecting the briquette design.
    - Business experience would be of great assistance when considering the business model, upscaling, marketing the product and understanding the market and financial viability of the product.
- University of South East Asia Director of English - Mr Sovan. He can provide the team with at least two students to work as translators for free whilst the students get a reference from Project Everest Ventures and general work experience.
- Coconut husk & bagasse suppliers
- Households whose contacts were acquired
- Tuk tuk drivers who sell charcoal and firewood (would form part of the supply chain).
- Business owners who sell charcoal (distributors).

Key skills

- Pyrolysis experience.
- DIY skills - able to use a drill etc.
- English-Khmer speakers - translators to help us communicate (and potentially be involved in marketing)

Timeframe and resources

- These steps should be achieved within the next month of project (December).
- Utilise key contacts
- Resources required to perform the next steps would be a constant supply of materials such as coconut husks, bagasse, starch and sawdust, most of which can be easily accessed from the team's findings and mapping.

Milestones hoped to be achieved

- Perfecting the briquette design i.e. producing more than one briquette at a time.
- Testing high demand of product
- Repeated tests to evaluate the most effective and cost efficient briquette composition
- Making sales

Summary table of all key activities

Key Achievements	Proposed methods to achieve this
Improve the current briquette pressing machine	Improve the strength of the press by welding pieces together for added strength. Could also create a screw cap to add to the end of a metal cylinder (better seal/ easier to get briquette out). The tube could be made out of steel, with holes into it to allow water to escape. Also looking into a way of making a hole through the briquette to increase its lighting/burning capabilities, whether that is by alternating the design or coming up with a way of manually making holes without affecting the structural integrity of the briquette.
Perfect the briquette design focusing on their main interests (ie cheap or increased cooking time)	The following team should take advantage of the opportunity to iterate and test many composition of the briquettes. E.g. - to alter the shape - the types of agricultural waste - the potential additives (such as filler, binder, accelerant) - the process of carbonising - the process of pressing - the process of drying.
Test for early adopters that are passionate about the product.	Bring the prototyped briquettes to previously visited customers and test the briquettes. Investigate what price they would be willing to pay for such a product.

Risks

Commercial

- When sourcing suppliers for the supply chain, there is a risk that suppliers are unreliable to meet demand of the business, especially when PEV is not in country.
- Resistance to change, cultural influences, changing preferences or people growing to dislike alternative fuel briquettes.
- There is a risk that competitors (SGFE) expand to PEV's areas of operation and there is no longer a need for PEV to operate. PEV has no market in the operational area.

Safety

- Smoke inhalation and burn injuries from the briquette prototyping or testing.
- Handling the drum with drilled holes is a safety risk due to the sharp metal protrusions in the drum, and it is hot.
- Burning the remaining chemicals that are in oil drums releases toxic fumes.
- Crushing risk with briquette pressing machine.

Reputational

- PEV cancels or suspends the project. This deteriorates trust with PEV from contacts made in the country
- Set and breaching expectations that are beyond our capabilities, such as offering employment, really cheap or free products, 12 months operation, constant and faultless supply, 100% perfect briquettes.
- PEV begins its business but cannot meet demand. This will lead to customers seeing PEV as being incompetent and unreliable. Contacts are less likely to help us or trust us, customers less likely to buy our products.

Financial

- There is no need in the market for the briquettes and teams end up investing money in possible supply chains and more expensive briquette pressing equipment which ultimately lead to zero sales and great financial loss.
- If demand changes or shifts to competitors after a supply chain is established, the business may begin making a loss and money invested would become a sunk cost. This could lead to a shutdown of operations due to loss of money.
- Infrastructure, manufacturing costs, materials, distribution and transport costs could be higher than projected (or is unknown) and it could be impossible to keep costs lower than the price of standard charcoal, at which then, the risk is making a loss with the business hence rendering it unviable.

Next Teams Goals (December)

Refer to the linked Crowdicity post for the full experiment.

- Iterate on the prototype to implement current customer feedback and ensure possibility for scale in relation to manufacturing (Solution)
- Research and draft supply chain for effective delivery of briquettes (Key Resources, Key Activities, Key Partners)
- Build 8 different customer archetypes (Customer Segment, Problems)

Appendix

Project specific and technical theory/processes

Fuel usage statistics:
https://drive.google.com/open?id=18l3z5qNSiirql2anExfCQieEcvdfyjXM

SGFE Research Info:
https://docs.google.com/document/d/1gbLw_4NTD4Kctm7ncxX4PypwTkTfdmj4l8JweRY-13g/edit

Fuel competitor analysis:
https://docs.google.com/document/d/19lqH1a2RdcasA5Llu3CTjz6FmDsLH7J4vP9po8Km2Yg/edit

Fuel source matrix:
https://docs.google.com/spreadsheets/d/1CNREd6H7Xvt3J_nNuqujzdrG9rpBVlPOpL8MNMzGyel/edit#gid=0

Charcoal testing against coconut charcoal briquettes:
https://docs.google.com/document/d/1FA0DIx-75hCep8qD8mYBgA8oYxXX2FiyaaUPcBsE_nU/edit

Briquette Making Method:
https://docs.google.com/document/d/15C3A9kSsUYAMKm-JeDBbu04ZOKvDAV-Gvyw9KWKKyGo/edit?usp=drive_web&ouid=112729714577985205718

Briquette Process Report:
https://docs.google.com/document/d/1LbSkboiiTXmPdFlsC9rl4ViY7UZ8cbb6m00Mpafludc/edit

News article on charcoal market:
https://www.khmertimeskh.com/news/5751/green-charcoal-maker-moves-into-the-black/

Villages visited map:
https://www.google.com/maps/d/u/0/edit?mid=1lSih0OQrya_HrQBhZhRGP8mKklSWo5GX&ll=13.639674104346398%2C104.10501648437503&z=8
https://docs.google.com/document/d/1lTeyqr310QY12AJAYJd8j5czADWvphVcyIL2pyHYrwQ/edit

Contacts:
Table of Fuel Contacts