Guatemala City Landfill Gas Burning Stove

Jason Chang




The smoke from a cooking fire was illuminated by a single naked light bulb and filled the top quarter of an open room inside a Cakchiquel home in the mountains of Guatemala. At six-foot-four, I found it difficult to breathe with my entire head enveloped in the haze. In the corner was the bed where the family would sleep, and it was easy to see why respiratory problems were so prevalent in these villages.

- Josh Jackson, Luke Society

Introduction

The traditional method of cooking among the vast rural and poor population exacerbates two of Guatemala's problems, namely deforestation and air pollution. The main methods are either open fires, which are nothing more than uncovered fires on the floor in the kitchen, or poorly functioning stoves; both of these burn wood for fuel. Two-thirds of all families in Guatemala rely on firewood for cooking, and 60% of energy use in general comes from firewood. Air quality greatly suffers due to the carbon monoxide and dioxins from burning wood and even plastic. The World Health Organization identified air pollution attributed to smoke as one of the main causes of death in Third World countries. In Guatemala City, the problem is magnified due to its southeast location in the middle of a valley, which causes the pollution to stay concentrated in the city.

Carlos shares about the health hazards of the traditional open fires. The toxic wood smoke that is a byproduct of these fires have been linked to serious health problems, including eye infections, tuberculosis and pneumonia. "There is a 10 to 15 per cent reduction in life expectancy (from the open fires) for anyone in the house but particularly the women because they are in the house more." Carlos himself suffers from eye problems as a result of being exposed to this smoke during the first 12 years of his life. As a result, he has difficulty reading. His mother also has problems with her eyes and lungs from all of her years working in front of an open fire. "The smoke gets into the

Carlos' mother suffers from eye and lung problems from many years of exposure to an open fire in her home.

eyes," Carlos says. "As you are exposed to smoke for many years, your vision is impaired."

- Dianne Pinder-Moss, The Smith Falls

In addition, another problem that contributes to air pollution is landfill fires. Guatemala City has one of the world's largest dumpsites, where decomposing organic waste creates a buildup of methane gas. The accumulation of methane gas underneath the garbage at times becomes unstable and explosions occur, causing frequent fires.

Alternatively, a possible solution to the first two problems is found in the third problem. Burning methane would reduce the likelihood of an over-accumulation of explosive gas buildup and prevents greenhouse effects. Similarly, why only burn the landfill gas? Why not use it as a fuel for cooking?

Proposed Solution

Just think, each morning a thousand families firing up their stoves, a thousand women not risking blindness each day while cooking for their families; six thousand not filling their lungs with toxic smoke every day. Perhaps ninety thousand years of life expectancy (when you multiply 10 to 15 years per person).

- Ali Ross, coordinator of the Guatemala Stove Project
-

A potential solution to the issues of deforestation and air pollution (and the poverty (which exacerbates them) is to develop a stove that runs on a landfill gas system. Not only is the landfill gas an untapped resource, it also has cost advantages over current fuels used for cooking. Propane gas was introduced in the 1980^s as an alternative fuel for cooking, but was never adopted by the rural and poor demographics because of the high cost involved, both for the fuel and the equipment. In terms of $/BTU, propane costs $9, natural gas $3 and methane (LFG) $2. The advantages over burning wood are that LFG burns cleanly, with carbon dioxide being the only byproduct, as opposed to noxious smoke and poisonous carbon monoxide from fuel wood, and cooking times could

potentially be reduced. This leads to the potential for higher productivity and poverty reduction. However, before examining the stove, it is necessary to discuss the system.

The method of processing landfill gas to the medium or high BTU levels necessary for clean combustion is a mature technology. The methane is first extracted from the landfill via a vacuum collection system utilizing perforated horizontal pipes made of high density polyethylene (higher corrosion resistance to toxic substances). It is then passed through a series of filters removing potentially harmful or unpleasant elements before being compressed for storage and use (see schematic below).

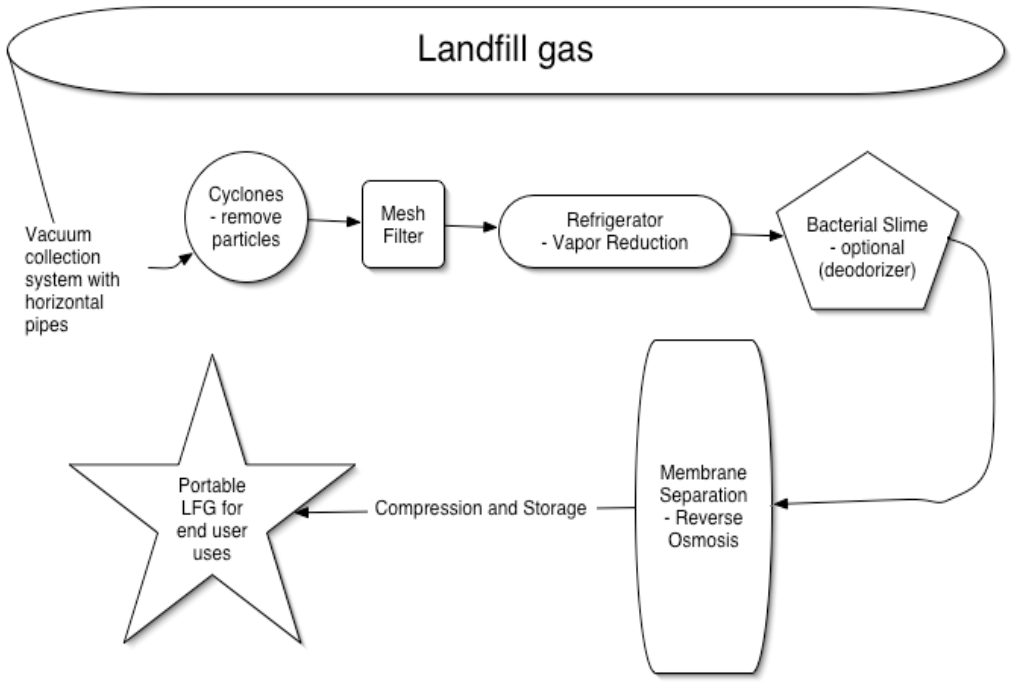
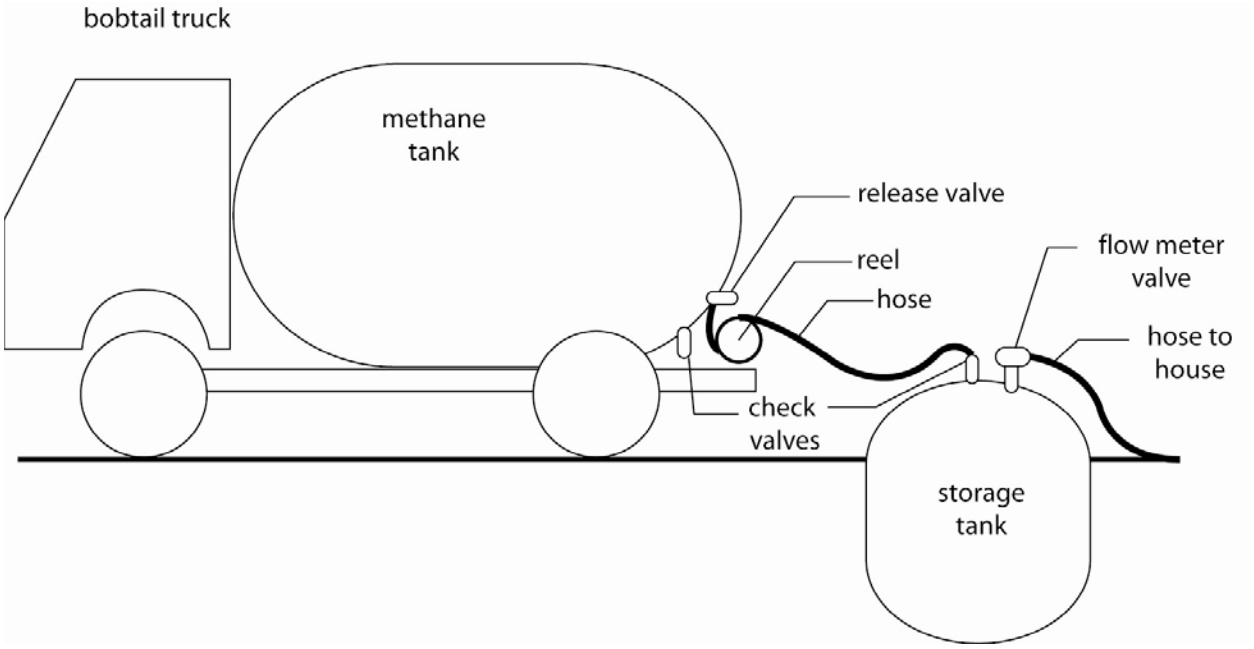


Figure S.2 Schematic of the proposed filtration procedure

The bulk of the cost of filtration goes towards the removal of carbon dioxide from the landfill gas. However, combustion of carbon dioxide at stove flame temperatures does not introduce harmful by-products, so that step in the filtration process may be omitted to reduce cost.

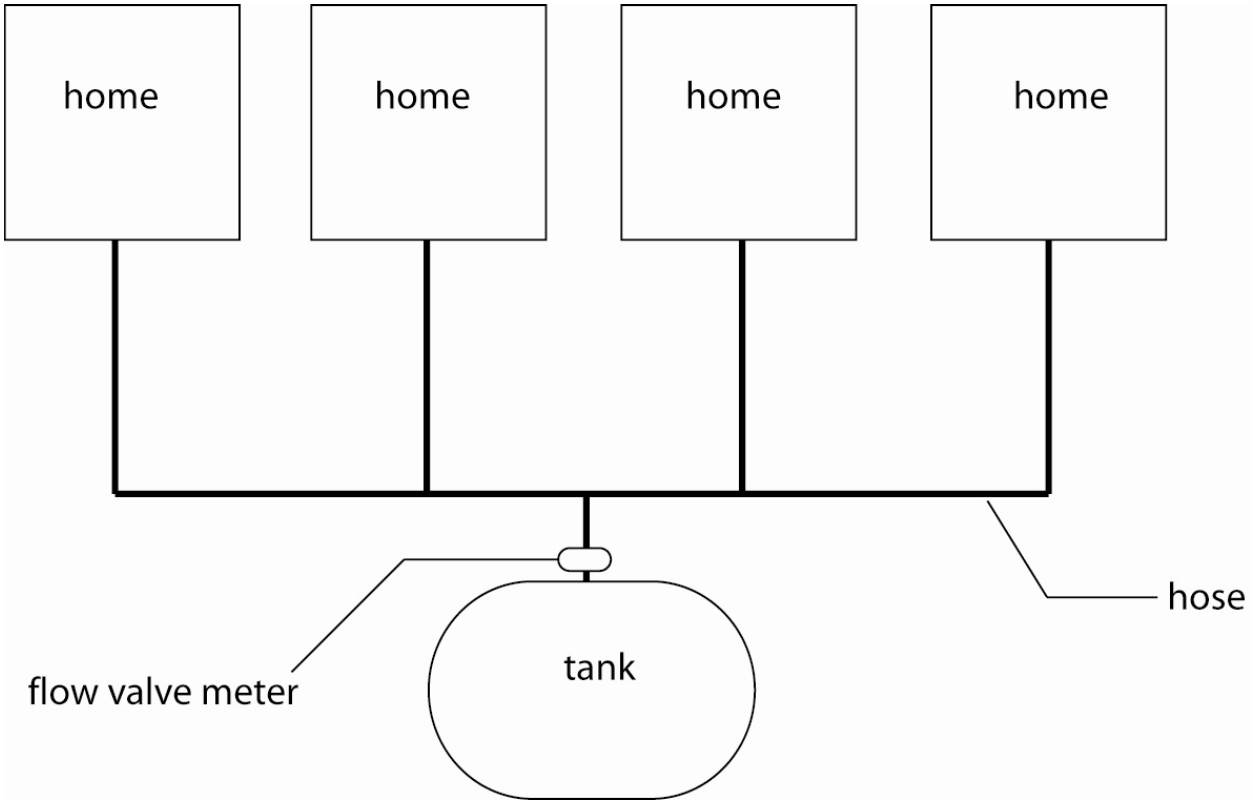
In addition to cost, another challenge to distributing landfill gas to the poorer population is integrating the system into the garbage dump culture without upsetting its established economy. For example, it may seem easier to pipe the gas from the dump straight into people's homes, but it is impractical due to the temporary nature of the makeshift shelters in which the slum dwellers live. Also, using pipes to distribute gas is only economical within a two-mile radius of the source, which may limit potential markets outside that immediate area.

Thus the system is best served by a transportable system using bobtail trucks, a common method of transporting propane gas, to deliver landfill gas to local storage tanks which could provide up to a two week's supply of gas to four households.



This model of landfill gas distribution could apply to slums and lower- to middle-class houses. In both cases, hoses connected to volume meters on the tank would supply gas to

each household. The hoses would be made of HDPE, which is resistant to the effects of corrosion from landfill gas and could either be buried or placed above ground. The use of plastic hoses also makes the system more mobile and adjustable.



Once the landfill gas is supplied to the households, what does the end product look like for the end user? For lower to middle class homes, it's simpler: a stove, similar to ones that burn propane and are used extensively in the city. The only difference would be a larger valve stem to compensate for the lower combustion energy of methane gas. However, at cooking temperatures, the performance is pretty much the same.

Marketing a stove to the people who live around the dump is another matter. A commercially viable methane-burning stove would be similar in cost to a propane-burning stove, which costs at least $50 and up. The cost far exceeds what people in the

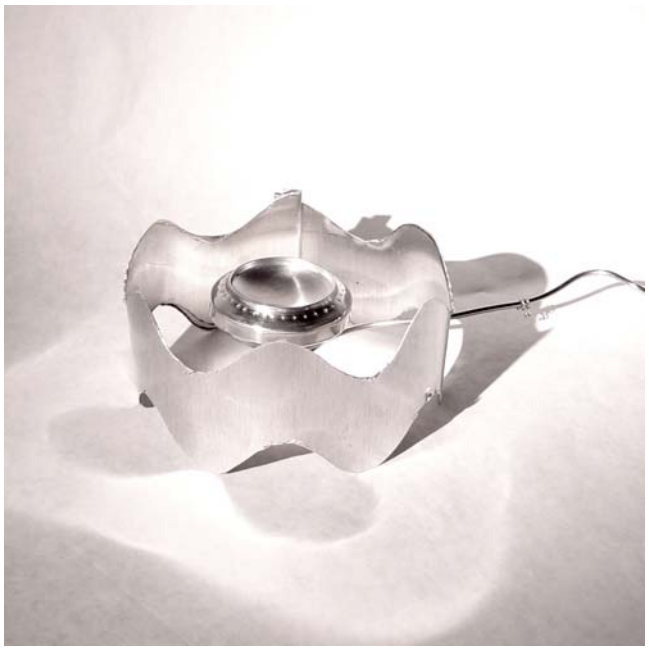
slums can afford, with their average salary of $150 a year just enough to cover sustenance.

Take Advantage of the Garbage Dump

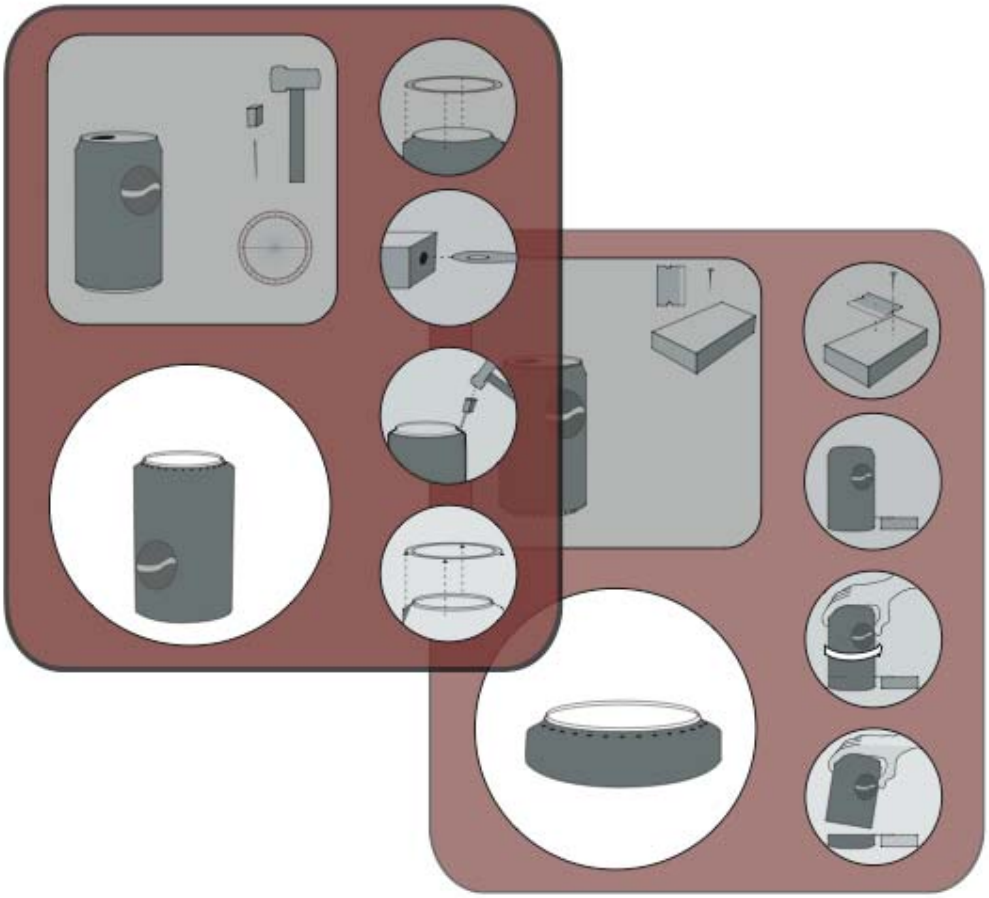
Sometimes I find treasures in the trash.
I like the toys, the dolls and the balls,
but toys are for six-year-olds and now I'm eleven.
I'd like something new.
Now I'd like to find a purple silk skirt,
flat, black shoes,
the kind that shine like a mirror,
a pink silk blouse with long sleeves,
with lace.
I'd like to find a gold necklace,
and a golden bracelet too,
and a ring with a diamond
that gives light like a star,
and dressed this way I would walk around
as happy as a princess.

-*"Like a Princess",* Rosario Lopez

One approach would be to take advantage of the dump as a resource and use found objects to build a stove. As shown below, disposed soda cans, food tins, dryer vent sleeves or scrap metal could all be used to construct a working stove and stand. As a wholly sustainable entity, the dump serves as a complete cooking solution, from supplying the landfill gas as fuel and the materials for the stove.



The product, however, need not necessarily be the stove. An alternative idea would be to teach people how to build their own, perhaps supplying a kit complete with simple tools and assembly instructions using graphical, communicative instruction cards. Considering the high illiteracy rate among the rural and poor demographic, the instructions need to move beyond text directions and clearly communicate the process in a visual manner.



The Market

The people living in the slums around the dump have been identified as the users of these stoves, but does marketing a kit to every household make sense? Although inexpensive, kits still incur cost, mostly for the tools included in it. Some of the tools, such as sewing needles and razor blades, are pretty insignificant in terms of cost, but other tools such as hammers are somewhat costly. The kit could assume that people supply their own hammer, but it could potentially be an erroneous assumption that every person be able to find their own hammer, and the idea of selling thousands of them at a loss doesn't make the most business sense either. If that's the case, to whom is the kit marketed?

Take Advantage of the Garbage Dump Economy

Don Celso looks for bags
To wash, to sell, to buy clothes
For his four kids.

Bags of every size,
Bags and bags,
Plastic bags,
And sheets of plastic too.

If he could only find something electric.
What luck!
A lamp or an iron,
Would be a treasure
To him.

"The Bag Man" by Rember Ramirez

The garbage dump is full of people like Don Celso, scavengers who specialize in all different trades. One person buys and sells scrap metal. Another person scavenges for broken toys, which he sells to another person who fixes broken toys, who then sells them to a man who peddles toys. Within the Guatemala City dump exists a unique, complex economy, suggesting that it would be most beneficial to market the kit to a local scavenger hungry for a new entrepreneurial opportunity.

The Micro Enterprise Model

Telma Inec Santos Alvarado, 49, lives in Guatemala City in one of the run-down neighborhoods surrounding the city dump. Before obtaining a loan through Potter's House Association, Enterprise Development's partner organization, Telma spent most of her time scavenging through the dump for items she could clean up and resell to support her family. She also had a small business making donuts, but was never able to buy enough ingredients to make a profit. Her family had very little food and no money to pay bills. Telma used her first loan to buy ingredients to make more donuts. Soon, her donut business grew by 50 percent. With her profits, she has been able to purchase soap in bulk and resell it. Telma recently enrolled her 17-year-old son in mechanics school, and is able to pay her bills and keep food on the table. "My whole life is changed!" reports a smiling Telma.

-Enterprise Development International

Marketing the kit to a local aspiring entrepreneur or offering a micro loan to purchase the kit to build and sell stoves would be far more advantageous than trying to sell every person a kit or stove. A local person knows the people and can communicate with them. Helping them start their own business provides an opportunity for them to provide good customer service and potential to create more market demand. As the business matures, the stoves become higher quality products, and customizable to a household's specific needs. An increase in demand for the stoves could potentially create a demand for supplies, such as cans or other pieces of metal, generating more businesses that create opportunities for people to achieve sustainability.

Conclusion

By the time the sun is a glimpse on the Guatemalan horizon, an army of workers has already begun their descent into the garbage from their homes built alongside the dump, atop the compacted trash.
Looming to the west, the towering volcano, Agua, rests like a sleeping sentry.

The mountainous terrain and the majesty of Agua is a panorama tourists pay handsomely to view.
Those in the dump don't take the time to savor the view. It is beyond what they can imagine and they seem overpowered by the immediacy of their surroundings and their struggle to survive.
The ground inside the dump smokes from invisible fires that swallow homes and workers without warning.
Hunched over in the backbreaking repetition of digging for garbage, the workers seem oblivious to the vista just beyond the cement barricades that shroud the view of the dump from outsiders.
This is the bottom rung of civilization.

- *"The Servant's Heart"*, www. stplmunster.com/Dump.htm

The Guatemala City garbage dump is in its own way a sensitive ecosystem: although any reasonably humane person would agree it's a horrible reality that people live and work in the garbage, without the dump there is no way for the people who exist there to continue. There are many programs in the works aimed at moving people out of the dump and on to better lives, but these take time and until they can fully be realized, the main worry is whether or not the people in the dump will be able to sustain themselves long enough for the programs to reach a critical mass. The proposal of a landfill gas system would allay fears of the city's movement to incinerate the trash, improve air quality by reducing the amount of greenhouse gases emitted from the dump, and provide the government a resource for further technological development (such as methane fuel cells).

The use of methane burning stoves has three significant benefits. The first is a reduced need for firewood, which directly relates to a reduction in deforestation rate and household expenditure costs (if people have to purchase wood). The second is a decrease of smoke from cooking, meaning better air quality and improved long-term health conditions. Thirdly, according to Ross, "Before a family gets a stove, it would be common practice for a woman to wake up at 4 am to prepare the meals her family would need for the day. The reduction in cooking time allows for increased productivity, leading to a potential increase in welfare.

The micro enterprise kit strategy creates opportunities for people to develop sustainable and potentially successful businesses that are scaleable and spawn new businesses in horizontal markets.

In summary, the kit/stove/landfill gas system proposes to be an environmentally and culturally sensitive solution that adds a touch of humanity in the lives of those who exist in the “bottom rung of civilization”.

References

http://www.stplmunster.com/Dump.htm
http://www.iadb.org/idbamerica/index.cfm?thisid=2941
http://www.lukesociety.org/profiles/guatemala.html
http://www.guatemalastoveproject.org/intro.html
http://www.jrwhipple.com/sr/fuel_info.html
http://www.pcthiker.com/pages/gear/pepsiGstoveinstruct.shtml
http://www.endpoverty.org/RecentN/RN9-Guatexped.html

"Childhood Asthma and Indoor Woodsmoke From Cooking in Guatemala"
Morten A. Schei, Jens O. Hessen, Kirk R. Smith, Nigel Bruce, John McCracken, Victorina Lopez
Journal of Exposure Analysis and Environmental Epidemiology (2004)

"The Evolution of Improved Stoves in Guatemala: Lessons from Three Programs"

"Out of the Dump", Nancy McGirr
Lothrop, Lee & Shepard Books, New York 1996