ANAEROBIC SOLID WASTE DIGESTERS

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Nepal is a South Asian country located between India and China; it is a developing economy with a population of 29 million in-habitants. Most of the Nepalese population resides in a rural area and makes a living off of a subsistence or production farming lifestyle, the amount of land suitable for agriculture is near the 30% mark, which is a significant amount (Canada has 6.8% Agricultural suitable land). Nepal's main natural resources are quartz, water, timber, and hydropower (World factbook, 2016). Nepal has many social and economical issues that can be researched, further but the emphasis of this export proposal will focus on the following issues:

a.) Water Pollution caused by agricultural and human bio-waste

b.) Lack of access to electricity

c.) Sole reliance on hydro-electric power production

Water pollution in Nepal is caused by both the agricultural sector, and the urban areas. Waterborne illness caused by harmful bacteria and pathogens found in water are responsible for 44 000 deaths/year of children under the age of 5 (MIT, 2001). The major diseases caused by this factor are: bacterial diarrhea, hepatitis A and E, and typhoid fever. (World factbook 2016)

Although an improvement has been seen in the years between 2002 and 2012 the amount of residents of Nepal who have access to electricity remains low at 76% (World factbook 2016). On the world spectrum this is relatively low and leaves room for growth.

Nepal has an immense capability of producing hydroelectric power, unfortunately that is also it's sole production method for it's population, if another method was available the hydroelectric power could be exported and could create stimulation on the stagnant economy.

The export idea in question is the Biodigestor. The following is a simple explanation of an Anaerobic Biodigestor: Biodigestors are becoming a common occurrence in townships and farms globally. The machines collect our animal and human waste, use an anaerobic bacterial breakdown process to extract bio-gas, then harness the

methane produced. This methane is the key output; it is used to heat houses, cook, and we can also take this biogas and further refine it to create bio-diesel and more products. This form of obtaining fuel is a sustainable process that can be an alternative to fossil fuels. The main components of a biodigestor are a mixing chamber, a methane exhaust, a solid waste output pipeline and a manure input pipe. The outputs of this type of mechanism are

a.) Biogas

b.) Solid fertilizer

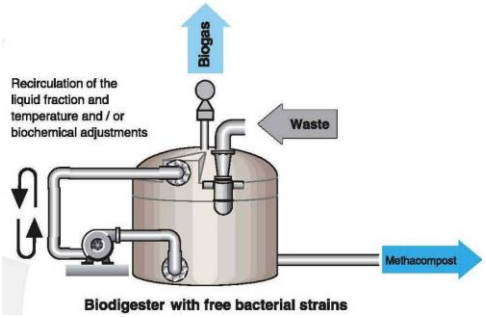


Figure 1.) Example of a simple biodigestor showing inputs and outputs.

Solid waste management (2009)

This is a small-scale biodigestor operation which can be established in a rural setting for one or multiple farmers, as long as the manure or other organic materials are stored and introduced into the system the device can create the desired outputs which will A.) Provide a clean burning energy source for cooking and heating and B.) Produce a better quality solid fertilizer for field crops resulting in higher yield and more money in the farmer's pocket.

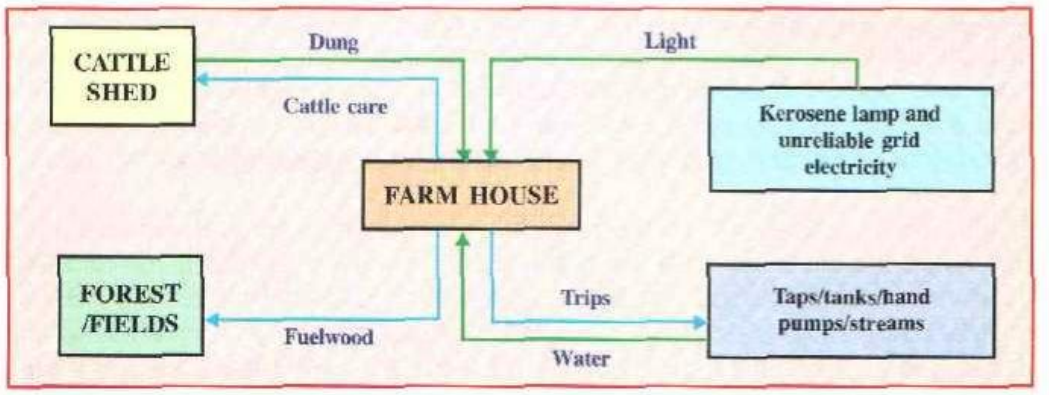


Figure 2.) Traditional sources of household utilities in rural Nepal (Bajgain & Mendis, 2005)

Anaerobic digesters are not new to Nepal, the country has a branch of government that handles biogas and focuses on production of said gas through anaerobic digesters (Biogas Sector Partnership Nepal). In several circumstances biodigestors initiatives have been introduced. Notably the Nepal prison biodigestor system was introduced in the 2000`s after a surge in prison population following a time of conflict in the country. Prisons with a minimum population of 15 prisoners partnered with the International Red Cross (IRC) and installed five anaerobic digesters that fed off of prison sewage and kitchen waste. The systems cost $2000USD- $8000 USD, in 2008 a study was performed to asses their impact. The systems paid for themselves in 1.5 to 5.4 years while providing a better overall environment for prisoners as well ad causing less environmental damage to the ecosystem (Vögeli, Riu, Gallardo, Diener, & Zurbrügg, 2014). A more recent case of biodigestor implementation in Nepal was a program created by the government and international GMOs called the Nepal Biogas Initiative, where farmers who qualified could build their own small-scale biodigestors for a very small fee (biogas support 2015). The farmers were offered subsidized prices on the installation of 4, 6, 8, and 10 m^3 Biodigestors (Bajgain & Mendis, 2005). The program was extremely successful, it is responsible for the installation of over 2 million units.

The results form these small-scale initiatives along with the direct impacts carries a list of indirect impacts such as the creation of jobs in the biogas sector in the form of technicians, consultants and producers.

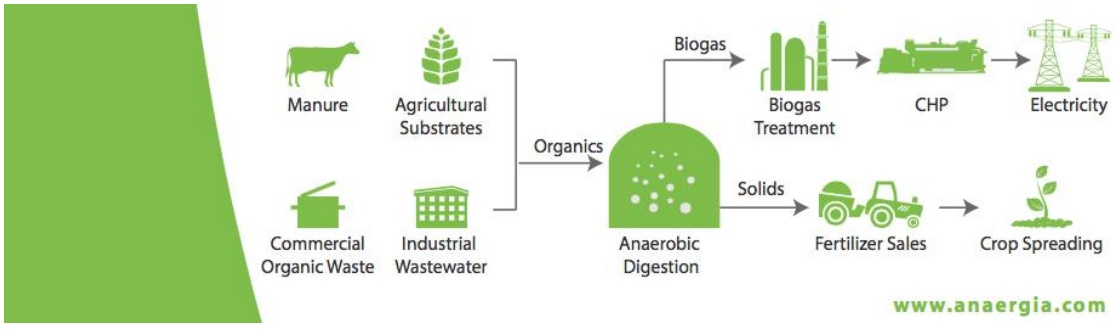
These initiatives for small-scale anaerobic biodigestors are also the reason that a Canadian exportation of individual farm biodigestors will not be viable. A Canadian company could not compete with the prices of government subsidized biogas plants for individuals. Though the quality of Canadian products will be superior to the subsidized product, Nepal being a developing country would prefer the favorable price point over quality.

Although Nepal is capable of producing the small-type anaerobic digesters it has insufficient materials and knowledge on large-scale bio-gas waste conversion plants

which are capable of harnessing the agricultural or human waste of a large population for storage of biogas and further refinement for electricity or biofuel.

My target export would focus on the large scale sector which is untapped in Nepal, The developing world is a prime target for this type of technology because usually it has a fast growing population with no infrastructure to support it, in countries such as Nepal and other developing nations this growth in population means a surplus of waste with no possibility of disposal. OMAFRA classifies this system as a centralized system, where material from multiple sources is hauled to the plant (Anaerobic, 2007). The anaerobic waste facilities would be a perfect fit for this emerging problem.

Large scale plants have been created before and have been highly successful because of their sustainable attributes, the Canadian company for which I propose the contract for these plants be awarded to is Anaergia inc. with headquarters in Hamilton, ON. The company's founder Dr. Andrew Benedek has been in the sustainable energy business for over 30 years and has created several multi million dollar companies. Anaergia is beginning to catch steam in the worldwide spectrum, it is responsible for several large scale bio waste conversion plants throughout the world including the largest anaerobic digester power plant in eastern Europe located in Szarvas, Hungary, the plant produces 4.2 MW of electricity, 4.1 MW of Heat and 90 800 tons of solid fertilizer per year. The inputs necessary for this are 45 000 Tons/year of commercial substrates (sewage) and 75 000 Tons/year of agricultural substrates.(Europe, n.d.) Szarvas is a town of 16 000 people which is the target size town for this project in Nepal.



(Europe, n.d.)

Why Is Nepal a prime country for this technology? Nepal has such a high rural population that the collection of animal and agricultural substrates would be viable,

Nepal has over 3 million head of cattle and buffalo combined (Bajgain & Mendis, 2005). Nepal's terrain region has the highest percentage of agricultural production along with beneficial climatic temperatures for this type of plant. Winter months in other regions could cause a decrease in gas production of plants because of colder temperatures(Bajgain & Mendis, 2005).

For large-scale anaerobic digesters everything depends on the size of the facility, realistically in Nepal the aim would be in small to mid size towns with population size reaching a maximum of 5000 inhabitants. The transportation limitations would make the inflow and outflow of products very difficult with larger towns, as the production would exceed potential consumption locally.

Ideally the export company would form relationships with large biogas companies in Nepal as well as with government agencies, which deal in biogas and renewable energy. These entities have existing relationships with potential suppliers of inputs and clients for outputs.

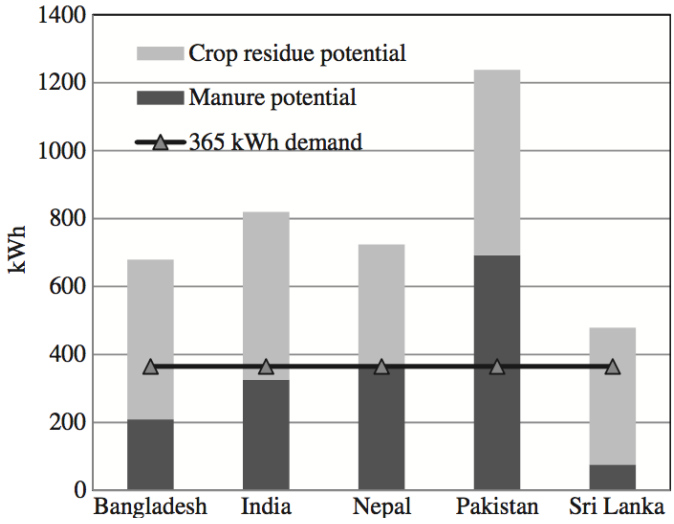


Figure 4.) The potential energy potential that may be created by agricultural substrates in Nepal (Rahman & Paatero, 2012).

Anaergia operates in two ways, either a private contractor or investor will do the number crunching for a potential project and come to Anaergia with the findings and hire them to manufacture the desired plant .the 3rd party will then maintain and service the

plant. The second option is for Anaergia to be the sole owner and operator of a project, they will evaluate the potential markets and custom design plants to fit their needs and capacities, they manufacture a large portion of the components in their operations so they can guarantee the quality of the process. The aim is for these components to be manufactured as locally as possible whether abroad or in Canada, it will depend on the locale of the project. The company has offices all over the world including their Asian office located in nearby Singapore. Anaergia is present in the whole process from raw waste to electricity production by combining the string of all it's products together depending on the need of the locale (Steve Watzeck, personal communication).

The most important and difficult areas to secure before a project of this scale may be initiated are securing local contracts for inputs (feedstock: i.e. Slaughterhouse waste, agricultural waste, human waste), and contracts for sale/management of outputs. Steve Watzeck indicated in a personal communication that the most integral part is to secure these contracts over the long-term (e.g. 10 years) instead of having yearly contracts; this is specially true in developing countries where a large investment may be made in a project but it deteriorates because lack of management in the succeeding years.

Anaerobic digesters are an expensive piece of technology which have been implemented in mainly 1st world countries, the export is idealistic logistically in developing nations but is entirely possible. "Is large scale Biodigestor technology viable in Nepal, or is it a technology reserved for developed countries with the capital?" was a question posed to the Chief commercial officer of Anaergia Inc. by the writer of this report. Mr.Watzeck indicated that anaerobic technology is entirely viable in developing nations and is becoming widespread throughout that market. Although there are many things that must be in place such as sufficient knowledge and dedication on management and maintenance of these systems, experts must be available to aid in the day to day handling of waste power plants. In developing countries much effort must be made to monitor the use and misuse of the outputs of the plants (Steve Watzeck, personal communication)

Funding for projects by Anaergia come solely from private funding at interest rates of 7-10% on large loans and up to 13% on small loans (under $1 million)(Steve Watzeck, personal communication). In developing nations many other

options are possible. With the Nepal national subsidized biodigestor initiative the funding was provided in part by the federal government as well as a contribution from participating farmers but the project received an influx of funding from the world bank in the name of the Nepal Biogas program in the sum of $5 million USD. For larger projects such as the Anaergia the company can seek these external funding options in the form of grants, loans and investments. Anaergia being a Canadian company may also seek the financial aid of the Canadian government (Export development Canada) for funding and loans in international ventures

Although exportation regulations are one of the relatively less complicated areas of logistics pertaining to export, they will pose some resistance as there is a long process. Exportations to Nepal from are of small scale but common because the country imports most resources and products. Canadian merchandise exports to Nepal are equivalent to 22 million a year (EDC, 2016). EDC (Export Development Canada) describes its expertise on the Nepalese exporting environment as having "Limited knowledge and experience in the market. We could consider providing support to Canadian companies planning on or currently doing business in the market". The lack of knowledge can cause many barriers to exporting to the country but may also provide an opportunistic environment. The EDC has aided 13 Canadian companies to set up trade agreements with Nepal; they are also willing to help more companies such as Anaergia to succeed.

Benefits of creating an AD (Anaerobic Digester) locally	Challenges of creating an AD (Anaerobic Digester) locally

-Production of direct by-products (biogas, usable effluent etc...) -Reduction of weed seeds in conversion form input to output -Odor and pathogen reduction in input -Reduction of volume of pollutants in environment	-Obtaining insurance for the plant -Obtaining permission to receive and purchase off-site waste -Obtaining permission to sell and use created energy -Sourcing technical knowledge to manage and service the plant

Table 1.) Challenges vs. Benefits of a basic AD (Anaerobic Digester) source: (Anaerobic 2007)

Anaerobic fermentation power generation is simple when looked at broadly, but most of the challenges occur before and after the physical process. The largest challenge is the control of output from the production process; the solid effluent must be monitored to be safe for spread on land, and the inputs monitored closely for toxicity. This issue is a bigger factor in developing countries because at times policy on these matters is weak or non-existent.

Competition in manufacturing of the material product may exist in China and neighboring India, the allure of cheaper physical components of the Anaerobic digester process may influence in marketing of the Canadian product in Nepal Alibaba.com offers many components of the product and it can deliver to Nepal. Although cheaper alternatives exist the physical product the planning and design of anaerobic waste management plants offered by Canadian companies are unparalleled.

The marketing strategy would need to be very focused on selling the service of design and knowledge along with certified components of the export service.

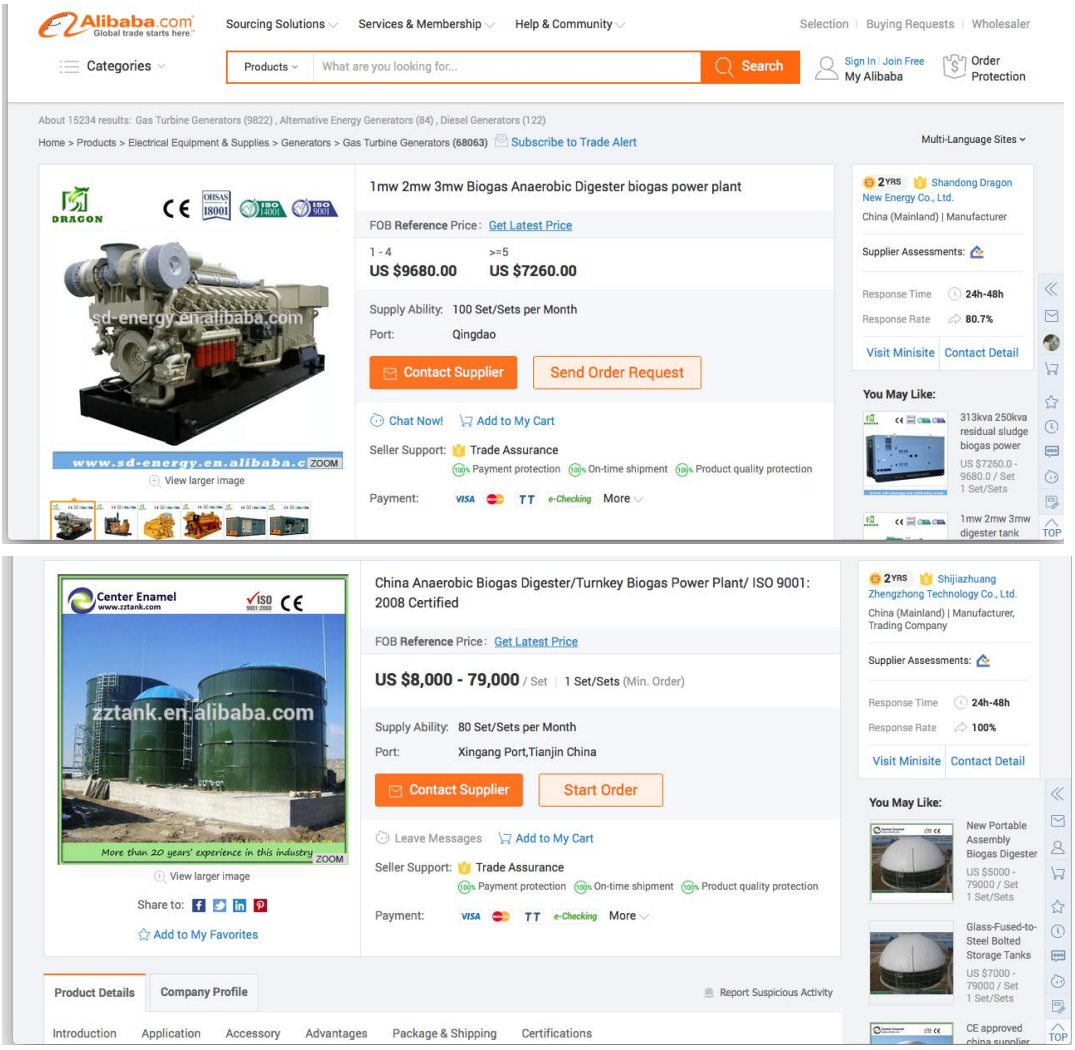


Figure 5.) Competitor biodigestor component products available on alibaba.com, upper: Machine that converts biogas into usable energy, lower: Anaerobic chamber

Benefits form sustainable energy plants such as anaerobic digesters are felt on a worldwide spectrum as well as on a national one. In Nepal we would see decrease in pollution of waterways and cleaner drinking water. The de-contamination would make the large resource of fresh water another booster for the Nepalese economy. Air quality and health would also improve as rates of other fuel sources (e.g. wood, coal) decline because of the cheaper alternative of biogas. Nepalese and Canadian jobs would be

created on account of this initiative both directly, and indirectly through the manufacturing, construction, maintenance, and management of anaerobic digester sites. The relationship between Nepalese and Canadians may strengthen through such export projects leading to an increasing amount of foreign investment in the nation of Nepal. The country is prime for foreign investment as the economy is comparatively simple and stable, the country is inexpensive and the government is easily accessible. The export market for large scale anaerobic digesters is ripe because Nepal remains a largely agricultural country with a large amount of livestock and livestock waste (Rahman & Paatero, 2012). Major flaws in the Nepalese business spectrum for this category of export include but are not limited to it's a lack of transport infrastructure and interconnectivity within the country as well as lack of qualified individuals to staff plants in rural areas versus urban areas.

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