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Executive Summary

Nigeria has a serious energy problem. Grid electricity is unreliable at best in the cities, but in rural areas is often completely non-existent. Small businesses, farms and households in these areas must either go without electricity or use expensive petrol-fuelled generators.

Our company, Trydan Biogas Solutions, will help address this problem by installing small-scale biogas collection plants and generators. These convert cow dung into biogas through anaerobic decomposition, which can then be used directly or to generate electricity. This will lead to economic, health and educational benefits.

Biogas systems are relatively expensive to install, and income levels in rural Nigeria tend to be low. To keep them affordable, our business model will provide these systems at cost price. Costs will also be reduced through the customer providing basic materials and labour. However, we will retain the rights to earn carbon credits from these systems. This will be our primary source of income, along with fees for maintaining the plants. We will start with a pilot scheme of installing 10 systems (which will require only a small capital investment) before expanding sales in later years.

Our company will target the biogas systems at small businesses and farming households in rural Kaduna in northern Nigeria. Government departments will also be targeted as customers who may purchase the systems for any of their development or aid projects. If the pilot is successful we will then move to target similar groups in other regions and even neighbouring countries.
Problem Context

In sub-Saharan Africa, lack of access to reliable energy is one of the most pressing issues to social and economic development. It is a significant contributor to the poor outcomes in health, nutrition, food security, education, security, business competitiveness, and employment. The problem is particularly acute in Nigeria, where 40.7% of the population, equating to 120m people, live without access to electricity (World Bank, 2016).

This problem is also particularly prevalent in rural areas. Many people in rural Nigeria lack electricity altogether, and those that do have it rely on petrol generators. However, this approach uses expensive dirty fuels, and is not efficient, cost effective, sustainable or environmentally sound.

Addressing the access-to-energy challenge in Nigeria requires a combination of both the traditional large-scale power generation and distribution as well as new independent or micro-grid innovations that are smaller scale, lower cost, and quicker to the market.

Our team has come up with a solution to Nigeria’s energy problem that falls under this second approach. We have devised a low capital, profitable plan to install affordable biogas collection plants in rural areas that are fuelled by cow dung. These will come with generators allowing the biogas to be converted into electricity.

Business Overview

Our company will be called Trydan Biogas Solutions (TDS). It will be based in the city of Kaduna, which will allow it to be close to the target market in nearby rural areas.

TDS will be a company that provides biogas energy systems to households and small businesses. It will do this by selling a package that includes the materials required to build the collection plant, someone to oversee the more technical aspects of the installation, and a biogas electricity generator. However, in order to keep costs down, the consumers will provide unskilled labour and more basic materials like sand and gravel.

This package will be sold at cost price. However, the company will retain the rights to sell the carbon credits that the plant earns for its first 5 years. It will then sell these on the international carbon market, which will provide the key source of income for the company.

Our main objectives are:

1. To provide generators at low cost to rural households and small businesses
2. To utilize a valuable resource (cow dung) that is otherwise being wasted
3. To contribute towards the sustainable and renewable development of the country
Product Overview

Design concept

There are several potential designs for biogas collectors. Our company will install plants with a fixed-dome design. This kind of plant is partially underground and constructed of brick masonry and concrete. This makes it cheaper to build, as well as more durable. It is likely to last 20-50 years, significantly longer than the more expensive “floating drum” designs with steel drums that are at risk of rusting (Subedi, 2015).

In order for the plants to remain affordable, they will be relatively small, with a volume of between 6 and 10 m3.

How it works

The biogas-making process starts with the biogas plant receiving organic waste such as cow dung. The dry solid material in cow dung contains carbon compounds. During the process of anaerobic decomposition, this material heats to around 29°C to 35°C to allow microbial fermentation. The carbon compounds are then transformed into methane-rich biogas. The biogas then rises to the top of the digester where it is extracted. This can then be used to directly power stoves, lighting, etc. Alternatively, it can be used as a fuel in a combustion generator to generate electricity (Moharir et al, 2019).

Our biogas collectors can process the total dung from about 6 cows. They will produce approximately 3m3 of biogas per day, which is enough to power gas stoves for 6 hours or generate 4kwh of electricity (Irena, 2016). While this is not enough to run heavy appliances, it will be than sufficient to charge cell phones and operate radios, televisions, and light appliances.
Benefits of Biogas

Biogas technology addresses several of the United Nations Sustainable Development Goals, the most obvious being Goal 7, affordable and clean energy.

Biogas technology generates natural gas, a clean sustainable energy alternative to fossil fuels. By helping people transition to biogas energy, the use of petrol generators and firewood fuel will decrease, resulting in a reduction in carbon emissions. However, unlike other alternative energy sources such as solar or wind, biogas can be generated and stored irrespective of weather conditions or the time of day.

Furthermore, because the biogas is collected from a cow dung, a plentiful waste product, the costs of generating this energy are low.

This method of creating affordable and clean energy also has other positive consequences and addresses other Sustainable Development Goals.

By providing a source of electricity, people in rural Nigeria will have better access to the internet, where they have the opportunity to access educational resources. Electricity will also provide some types of small businesses with the ability to operate in rural areas. Biogas can also be used as an alternative to wood fires for cooking. Burning wood release toxic fumes to the air, which can result in respiratory diseases. Being able to cook with biogas will therefore have positive health effects. Finally, cattle waste will not all just be left to decompose in the open where it can lead to sanitation issues. By recycling animal waste, biogas technology produces a useful natural fertilizer that increases crop yield. (Subedi, 2015).

Economic Analysis

A key challenge with this business is that the construction costs of biogas plants can be quite high, usually around US$500. This can make it difficult to sell the plants at a price that are profitable yet affordable.

Our biogas plants are likely to cost around $350 to install, including the cost of skilled labour. This is slightly lower than standard individual installation costs (Subedi, 2015 & von Blottnitz, 2010). However, we will be able to achieve it through economies of scale and relying on customers to provide some basic materials and labour. Some customers will already have generators that can be easily converted to run on biogas, but others will require new generators, which will bring the total cost to an average of around $500.

Because this is still reasonably expensive for rural Nigeria, we have chosen to sell the plants at cost price. However, we will retain the rights to sell the carbon credits that can be earned.
from creating biogas for the next 5 years. A conservative estimate of the value of these carbon credits is around $100 every year per small plant (Subedi, 2015)(Kumar & Agrawal, 2011). They will provide enough revenue to subsidize the cost of the plants and to make the business profitable. A small amount of income can also be made from biannual maintenance checks.

Table 1: Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6+</th>
</tr>
</thead>
<tbody>
<tr>
<td>New plants under construction</td>
<td>10</td>
<td>20</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total completed plants</td>
<td>10</td>
<td>10</td>
<td>30</td>
<td>70</td>
<td>120</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Predicted maintenance checks*</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>35</td>
<td>60</td>
<td>85</td>
<td></td>
</tr>
</tbody>
</table>

*Based on 1 check per plant every 2 years

The pilot scheme will involve building 10 biogas plants. If the pilot scheme is successful, then the production of another 20 plants would begin in the second year, with production growing at an extra 10 plants a year (see Table 1).

Although the cost of the plants is recovered from the customer, investment capital will still be needed to ensure positive cash flow and to cover other expenses (see Table 3). The primary costs incurred will be administrative expenses such as labour, transaction expenses and a small advertising budget. The pilot will require an investment of $10,000, with a further $30,000 needed to finance the later expansion. This could come from founder equity, crowdfunding, loans or grants.

Table 2: Economic analysis

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6+</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REVENUE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant sales</td>
<td>5000</td>
<td>10000</td>
<td>20000</td>
<td>25000</td>
<td>30000</td>
<td></td>
<td>90000</td>
<td></td>
</tr>
<tr>
<td>Carbon credit earnings</td>
<td>10000</td>
<td>10000</td>
<td>3000</td>
<td>7000</td>
<td>12000</td>
<td></td>
<td>24000</td>
<td></td>
</tr>
<tr>
<td>Maintenance fee income</td>
<td>250</td>
<td>250</td>
<td>750</td>
<td>1750</td>
<td>3000</td>
<td></td>
<td>6000</td>
<td></td>
</tr>
<tr>
<td>Future expected earnings</td>
<td>61000</td>
<td>61000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total revenue</td>
<td>5000</td>
<td>1250</td>
<td>11250</td>
<td>23750</td>
<td>33750</td>
<td>45000</td>
<td>61000</td>
<td>181000</td>
</tr>
<tr>
<td>Discounted revenue</td>
<td>5000</td>
<td>1190</td>
<td>10204</td>
<td>20516</td>
<td>27766</td>
<td>35259</td>
<td>41287</td>
<td>141223</td>
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<tr>
<td>COSTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction materials</td>
<td>5000</td>
<td>10000</td>
<td>20000</td>
<td>25000</td>
<td>30000</td>
<td></td>
<td>90000</td>
<td></td>
</tr>
<tr>
<td>Maintenance service costs</td>
<td>1000</td>
<td>1000</td>
<td>3000</td>
<td>7000</td>
<td>12000</td>
<td></td>
<td>24000</td>
<td></td>
</tr>
<tr>
<td>Admin/office expenses</td>
<td>50000</td>
<td>10000</td>
<td>30000</td>
<td>30000</td>
<td>30000</td>
<td>15000</td>
<td>33000</td>
<td></td>
</tr>
<tr>
<td>Total costs</td>
<td>10000</td>
<td>1100</td>
<td>13100</td>
<td>23300</td>
<td>28700</td>
<td>34200</td>
<td>15000</td>
<td>125400</td>
</tr>
<tr>
<td>Discounted costs</td>
<td>10000</td>
<td>1048</td>
<td>11882</td>
<td>20127</td>
<td>23612</td>
<td>26797</td>
<td>10153</td>
<td>103618</td>
</tr>
<tr>
<td>NPV:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>37605</td>
</tr>
</tbody>
</table>

As the business’ primary income only comes from plants once they are set up and earning carbon credits, revenue will be low initially. A profit will not be made until the third year (Table 3). It will take even longer (5 years) for cash flow to reach a positive level.
Table 3: Cash flow

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual profit</td>
<td>-5000</td>
<td>150</td>
<td>-1850</td>
<td>450</td>
<td>5050</td>
<td>10800</td>
</tr>
<tr>
<td>Net cash flow</td>
<td>-5000</td>
<td>-4850</td>
<td>-6700</td>
<td>-6250</td>
<td>-1200</td>
<td>9600</td>
</tr>
<tr>
<td>Lowest potential balance</td>
<td>-10000</td>
<td>-6100</td>
<td>-17950</td>
<td>-30000</td>
<td>-34950</td>
<td>-35400</td>
</tr>
</tbody>
</table>

However, even if no further plants are built beyond the fifth year, the expected future earnings from the total of 180 plants will be $61,000 (or $41,287 discounted at an average of 8 years). This means that the net present value of the company is $37,605, as is shown in Table 2.

Market Analysis

Target market

Our target market is those living in rural regions of the country. This market is fairly large, as over half of Nigeria’s population lives in rural areas (World Bank, 2017). We are targeting rural areas because they are where power is most inaccessible, and thus where even small improvements to energy provision can generate large benefits.

Our pilot project will be launched in Kaduna. Kaduna is one of the states in Nigeria in dire need of electricity (Nigeria Electricity Hub, 2019). It is located in the north of Nigeria, where cattle farming is common and access to cow dung would be easy.

The city of Kaduna is also reasonably large, with a state government that is actively trying to improve off-grid energy infrastructure around the state. This will mean that the regulatory environment in the area is likely to be reasonably favourable.

Target customers

There are several specific customer groups in this market at whom we will be targeting our product. The first is small business owners in rural villages. Rural businesses are vital in enhancing economic development of rural communities, and a reliable energy source is needed to foster this entrepreneurship. The target demographic of this group will be a male over the age of 18 (since they are more likely to own businesses). This business owner will be a service provider, such as a barber, and thus he will need a power supply. He will have a low income, but higher than others in his area. He will currently be using a generator for his electricity needs, but is tired of the fuel costs associated with it. A biogas system would be new to him but he would be happy to try it, especially because he lives close to a farm from which he can easily obtain the cow dung needed for the plant.

The other key target group will be rural cattle farmers. These will be households with large families who require more energy. They have no access to electricity, and currently cook over a fireplace inside their home. They will be relatively long-term orientated, and will be willing to
invest because they see how valuable access to electricity can be for them. Although they have a low income, they will be willing to split the costs of a biogas system with several other families in their village with whom they can then share the benefits. They will mainly use the biogas as a cooking fuel as well as for generating electricity to charge cell phones.

Finally, we will target aid agencies and the government as customers. These agencies and departments will be concerned with the lack of power in rural areas and will want to provide aid to people such as those in the first two target groups in the form of small-scale energy projects. They will want to improve the lives of others, and believe that this kind of product will create a sustainable change.

**Advertising**

Our initial advertising strategy can be fairly minimal, as the pilot project only looks to install 10 biogas systems. Therefore, our marketing would at first simply be word-of-mouth, posters and other low cost advertising in villages in Kaduna that fit our target market. By providing a good service to our initial customers, we will encourage them to speak well of us to others. We would also partner with the State Government to build trust and convince them to speak for us. The State could also help identify suitable customers due to their on-the-ground presence.

As we gain more ground, we intend to move into some online marketing. Over 92.3 million Nigerians are online and thus easily accessible, including some small businesses in rural areas. With this strategy we intend to target those that have some access to internet/power, but where such access is unreliable or expensive.

**Current competitors**

Biogas is a new concept in Nigeria. Very few companies and individuals are in the industry have much expertise, particularly in small biogas systems. This means that by starting Trydan Biogas Solutions now we would be able to gain a huge share of the market. Furthermore, our unique business model allows us to sell our systems at a very affordable rate compared to any available alternatives.

**Future Outlook**

After the 12 month pilot, we should have provided alternative clean and sustainable energy to 10 small businesses or households in rural Nigeria. We can then expect to expand and increase our supply to others across Nigeria, including outside of the Kaduna state. To ensure that this expansion is successful, we will need to maintain strong relationships with our customers (e.g. through system maintenance checks), so that they continue to speak well of our company to other prospective customers. We will also need to establish good working partnerships with our suppliers to ensure that our supply chain of materials can run smoothly as production increases.

The “herdsmen” in northern Nigeria will also be a major stakeholder going forward. Their nomadic nature means they will not be suitable target customers, but they could be useful providers of cow dung for biogas systems owned by others.

In the long term, we could consider expanding the business to neighbouring countries. Niger, Chad, and the Republic of Benin would all be suitable potential markets. Our business could also expand the scale of the systems we produce. If funding could be obtained, then we could turn our focus to larger sized biogas systems that service entire villages.


