PROJECT PLAN: PRODUCTION OF BIODIESEL BY WASTE VEGETABLE OIL

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ABSTRACT

In the present project Technological and Economical aspects of biodiesel was studied, in first part of project bio diesel was synthesized from Waste vegetable Oil (WVO) by three-step method and regressive analyzes of the process was done. The raw oil was collected from local restaurant of Barcelona city in Spain. In the three-step method, the first step is saponification of the oil followed by acidification to produce FFA and finally esterification of FFA to produce biodiesel. In the saponification reaction, various reaction parameters such as oil to sodium hydroxide molar ratio and reaction time were optimized and the oil to NaOH molar ratio was 1:2, In the esterification reaction, the reaction parameters such as methanol to FFA molar ratio, catalyst concentration and reaction temperature were optimized Finally HHV of biodiesel was measured and compared with biodiesel and petro-diesel standard. It was found almost equal to petro diesel produced by National Refinery of Pakistan i.e. 40000 KJ/Kg. In second part detailed market survey was done in restaurants in order to check the supply of raw material and need of the targeted market and then detailed economical analysis was also done in order to check the feasibility of the project in the target market in Pakistan. The market is not saturated and there is a need of the product but initial capital investment found is higher and investors will have to wait for the revenues.
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EXECUTIVE SUMMARY

Restaurants in Dhaka and Karachi are facing difficulties due to the long Blackouts during their peak business hours. And they have to use alternate means to overcome the effect of blackout, by survey we found out that they are using diesel generators to generate their own electricity. We considered this as an opportunity to make bio diesel by using their waste vegetable oil and to sell this bio diesel back to them at low market price than petro diesel.

We conducted an experiment to make the bio diesel by this waste vegetable oil, The results of Bio diesel was satisfactory and is almost as comparable to the petro diesel produced by National Refinery of Pakistan, Karachi.

The market analysis was done through survey using different means like through questionnaire, electronic survey and personnel interview. Mr Ali Khubaib in Islamabad, Pakistan helped us in conducting the survey through questionnaire and personnel interviews from Restaurants owners/managers.

It was concluded from the survey that there is a potential market demand of bio diesel and restaurants are willing to sale their waste vegetable oil to us and they also show interest to purchase our product to use in diesel generators.

In the last phase of the business project Economic analysis was done. We did the analysis for only one year but our project looks feasible even after the end of 1st year.

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this Business Plan is to make approximate 500 L / week of Bio Diesel from Waste Vegetable Oil (WVO) collected from Restaurants in Dhaka, Bangladesh and Karachi, Pakistan and to sale the Bio diesel back to Restaurants again to use this fuel in energy back outs.

Biodiesel created from our systems will provide the same performance as that of conventional petro diesel, but at a very competitive price and ecologically safe alternatives to regular diesel. Market is still at initial stage but expected to expand rapidly in south Asia due to growing concerns about levels of environmental pollution and limited supply of energy sources.

Our initial target customers are basically Suppliers i.e. Restaurant owners but with time we have plant to offer our product to transport companies, farming and delivery companies all of which are hit very hard by the rising fuel costs of diesel fuels.

It is important to note here that we are not seeking to re-invent the Biodiesel process, rather focus on consistent production. We are not seeking to patent our process but we very possibly will be able to patent our blending matrix of chemicals and computer controls for our systems.

In addition, we strongly feel that our approach of collecting the WVO and then sale product to potential customers will make for an easier sale.
1.2 OBJECTIVE

Our product will be a true viable and sustainable alternative for petro diesel fuels while demonstrating cost effectiveness, and at the same time addressing the mounting economical concerns of our market-space customers. Main objectives for our business are:

- Feasibility study about production and utilization of Bio fuels for small-medium business own electrification;
- Start production of Biodiesel within a year with one working Biodiesel Mini-plant in operation.
- Maintain Net Profit Margin 30% with selling price no higher than that of conventional fuels.
- International partnership with companies and organizations working on bio fuels

1.3 SCOPE

Because Biodiesel is produced from domestically produced plant oils or waste fats, switching from Petroleum-based diesel to Biodiesel decreases dependence on foreign petroleum, reduces net greenhouse gas emissions, and provides tangible benefits for the domestic economy.

The potential benefits associated with Biodiesel have driven national, state, and local governments to adopt policies that mandate or make it financially beneficial to produce and use Biodiesel. The limited supply of fossil fuels and the increasing level of global environmental consciousness suggest that additional incentives and mandates are likely in the future.

Biodiesel incentive programs can be delineated into two main categories—production and consumption. Both types of incentives lower the cost of Biodiesel, eroding the price differential that currently prevents its widespread adoption. It appears that there may be significant public policy momentum for Biodiesel in the near future that combines local, state, and federal mandates and incentives into a sustainable business opportunity.

When we look deeper into the inherent advantages for Biodiesel over petroleum-based diesel fuel, we see that Biodiesel has the potential to provide a more stable, regionally specific diesel source because of the wide variety of feedstock options available for producing Biodiesel.

The key issues for a start-up Biodiesel business opportunity in an urban market are: abundant feedstock at an attractive price, minimized transportation cost, few delivery points, and a high customer value for Biodiesel attributes.
In urban areas, WVO and yellow grease currently provides the lowest cost sourcing option, but a cost comparison reveals that even Biodiesel derived from yellow grease is still more expensive than Bio diesel from WVO and petroleum-based diesel.

2.0 PROBLEM FORMULATION

2.1 BACKGROUND

Pakistan’s population is 180 million (2012 estimated) and it is growing at the rate of 1.99% per year (CIA-World Fact Book). Karachi represents the largest city with 18 million inhabitants (National Public Radio, 2008).

Karachi is the biggest industrial city of Pakistan and the only port city which is known as the backbone of Pakistan’s economy. This produces almost 45% of the total GDP of Pakistan economy. Nowadays, industry in Karachi is dying due to huge shortage of the electricity and desperately looking forward to the foreign investment in the energy sector.

The Karachi imports 100% of its fossil fuels from abroad (mainly through Middle East countries). Most imported fuel is used in the transportation sector and electricity generation. Due to this only a small proportion of fossil fuel is used for electricity generation and country is facing the shortage of electricity.

2.2 PROBLEM IDENTIFICATION

Pakistan is having Energy crisis and this energy crisis is affecting the life of common people and small/medium business owner more than others. In Pakistan there is almost 8-10 hours of blackout now a days.

Due to overcome the effect of these energy blackouts the business owners are using the Diesel Generators.

2.3 OPPORTUNITY

An experiment has been conducted by using Waste vegetable Oil collected from restaurant and then made the Biodiesel from WVO the results obtained are satisfactory.

We also conducted the survey through different means in two big cities of Bangladesh and Pakistan and found out that we can collect the Waste Vegetable Oil from them and make Biodiesel and then sale the Bio diesel back to those Restaurant owners on considerable fewer prices.
3.0 STATE OF THE ART

Biodiesel is a fuel made from vegetable oils and alcohols (Methanol / Ethanol / ISO-Propane) utilizing a chemical process called Trans esterification. The resulting Mono-Alkyl Esters have an acceptable viscosity and can be used interchangeably with petroleum diesel.

Cetane number is a measure of the ignition quality of a diesel fuel, i.e. the fuel’s readiness to ignite. Fuels with a high Cetane number will have short ignition delays which correspond to greater efficiency; contrarily engines started with a low Cetane number fuel may suffer from engine knock and blow white clouds of smoke during engine ignition in severely cold weather. Biodiesel have higher cetane number then diesel.

Kinematic viscosity and density are important characteristics to consider because they affect the fuel spray characteristics through flow resistance inside the injection system and in the nozzle holes [34] High viscosity causes poor fuel atomization during the spraying process, which in turn
increases the engine coke deposits, demands more energy in order to pump the fuel and wears fuel pump elements and injectors. Biodiesel have more viscosity and density than diesel. For reducing this we need to blend it in diesel.

**Flash point temperature** is the lowest temperature at which the vapor of a combustible liquid can be ignited in air. The flash point of biodiesel is much higher than that of diesel. This makes its ignition relatively difficult, but its transportation and handling is much safer.

**The carbon residue** value correlates with the carbonaceous deposits inside the combustion chamber and injector systems. Its formation is due to the way the fuel is injected and ignited in the diesel engine: when the fuel is injected, in the compression cycle, it is ignited spontaneously due to compression pressure and the air and fuel do not have a chance to mix thoroughly before ignition. The presence of fuel dense pockets, in the mixture, results in incomplete combustion of the fuel and the production of carbon soot or BC particulate matter.

**Chemical process involved in making biodiesel**

The major components of vegetable oils and animal fats are Triglycerides. In the transesterification process a glyceride reacts with an alcohol in the presence of a catalyst, forming a mixture of fatty acids esters and an alcohol. Using triglycerides results in the production of glycerol. Transesterification is a reversible reaction and is carried out by mixing the reactants. A strong base or a strong acid can be used as a catalyst. At the industrial scale, sodium or potassium methanolate is mostly used. The following reaction occurs:

\[
\text{CH}_2 - \text{O} - \text{C} - \text{R}_1 + \text{CH}_3 - \text{O} - \text{C} - \text{R}_1 + 3 \text{CH}_3\text{OH} \rightarrow \text{CH}_3 - \text{O} - \text{C} - \text{R}_1 + \text{CH}_3 - \text{OH} + \text{CH}_2 - \text{OH}
\]

![Chemical process involved in making biodiesel](image)

The production of biodiesel is relatively simple from a technical standpoint, also allowing the construction of small decentralized production units without excessive extra costs. This limits the need to transport raw materials long distances and permits operations to start with modest-sized installations. Rapeseed, sunflower, soybean, palm oils, UCO and animal fat are the most common raw materials being used for the production of biodiesel. Using methanol in the transesterification process has the advantage that the resulting glycerol can be separated simultaneously during the transesterification process. When using ethanol during the process the ethanol needs to be free of water and the oil needs to have a low water content as well to achieve an easy glycerol separation. The end products of the transesterification process are raw biodiesel and raw glycerol. After a cleaning step biodiesel is produced. The purified glycerol can be used in the food and cosmetic industries, as well as in the chemical industry. The glycerol can also be used as a substrate for anaerobic digestion.
Biodiesel Materials / Biodiesel Feedstock:

- Vegetable Oils
  - Soybean
  - Cotton seed
  - Palm
  - Peanut
  - Rape Seed / Canola
  - Sunflower
  - Safflower
  - Coconut
- Animal Fats
  - Tallow
- Waste Oils
  - Used Frying oils
Biodiesel making process and Toolkit:

Step by step process:
1. Put your pre-treated oil in a processor
2. Heat the oil up to about 130-135 deg F (make sure your processor can handle the heat!)
3. Figure out how much catalyst (lye or caustic potash) you’ll need (Titration)
4. Add the strong base (lye or caustic potash) to the methanol to make meth oxide
5. Add the meth oxide to the oil & mix it all up
6. Let it separate & pull off the glycerine
7-8. Wash it & dry it
8. Add it to the tank & drive on down the road.

Example:
1. Add 100 litres of oil to processor & turn on the heat
2. Measure out 20 litres of Methanol
3. Titrate oil using KOH as strong base
4. Assume a Titration of 3.
5. 3 + 7 = 10 grams per litre. 10 X 100 = 1,000 grams
6. Add 1,000 grams of KOH to the methanol
7. Allow the KOH to fully dissolve
8. Once the oil hits 130 deg F, kill the heat
9. Slowly add the KOH/Methanol mixture to the processor
10. Mix everything in the processor for at least 2 hours
11. After 2 hours, allow it to sit for 18-24 hours
12. After it’s sat, drain off the glycerine
13. Transfer it to a wash tank
14. Wash and dry the Biodiesel
15. Once dry, add it to the fuel tank

Figure 3-4: Step by step making process of biodiesel.
Now-a-days different kind toolkit is used to make commercially. Commercial plant can be made by two ways-

1. Purchase plan to make own toolkit.
2. Purchase total toolkit and transport it to the required place. On one hand making own toolkit is cost effective but as we do not have much experience, it will be more feasible to use ready toolkit for starting the business. We choose for our business 2 Tank System; Model 6016-1 biodiesel toolkit.
Figure 3-6 : 2 Tank System; Model 6016-1 biodiesel toolkit

It can produce 135 gal/day. With additional modification suggested innovation aspect part it would be possible to make double output then this in a day.

**Biodiesel Blends:**

Normally you can use pure biodiesel or a mixture of biodiesel and petroleum diesel as a fuel in any unmodified diesel engine. There are two situations in which you definitely should mix biodiesel with petroleum-based diesel.

- If you are going to be running the engine at a temperature lower than 55° F (13° C), you should mix biodiesel with petroleum diesel. A 50:50 mixture will work for cold weather. Pure biodiesel will thicken and cloud at 55° F, which could clog your fuel line and stop your engine. Pure petroleum diesel, in contrast, has a cloud point of -10° F (-24° C). The colder your conditions, the higher percentage of petroleum diesel you will want to use. Above 55° F you can use pure biodiesel without any problem. Both types of diesel return to normal as soon as the temperature warms above their cloud point.
- You will want to use a mixture of 20% biodiesel with 80% petroleum diesel (called B20) if your engine has natural rubber seals or hoses. Pure biodiesel can degrade natural rubber, though B20 tends not to cause problems. If you have an older engine (which is where natural rubber parts are found), you could replace the rubber with polymer parts and run pure biodiesel.

<table>
<thead>
<tr>
<th>Blend</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>B2</td>
<td>2% Biodiesel and 98% Diesel</td>
</tr>
<tr>
<td>B5</td>
<td>5% Biodiesel and 95% Diesel</td>
</tr>
<tr>
<td>B20</td>
<td>20% Biodiesel and 80% Diesel</td>
</tr>
</tbody>
</table>

Note: These blends with Petro diesel are not Biodiesel.

**Advantages of Biodiesel:**

- Biodiesel is the only alternative fuel that runs in any conventional, unmodified diesel engine. Biodiesel can be stored exactly like petroleum diesel.
- Biodiesel can be used alone or mixed in any ratio with petroleum diesel.
The use of Biodiesel can extend the life of diesel engines because it is more lubricating than petroleum diesel fuel, while fuel consumption, auto ignition, power output, and engine torque are relatively unaffected.

Biodiesel is safe to handle and transport because it is as biodegradable as sugar (pure Biodiesel degrades 85% to 88% in water within 28 days), 10 times less toxic than table salt (lethal dose is greater than 17.4 g/kg body weight, while for salt (NaCl) it is 1.8 g/Kg), and has a high flashpoint of about 200°C compared to petroleum diesel fuel, which has a flash point of 70°C.

Biodiesel is a proven fuel with over 20 years of use in Europe and 30 million successful US road miles.

Combustion of Biodiesel provides over a 75-90% reduction in environmental pollution and a 90% reduction in cancer risks.

Biodiesel is the only alternative fuel to meet all environmental and human health requirements for energy sources and has much higher oxygen content than standard diesel fuels.

Disadvantages of Biodiesel:

- Inherent higher price
- High expensive Feedstock’s
- Increased NOx exhaust emissions due to reduced excise taxes

### 4.0 PROPOSED SOLUTION

Two products are planned to be produced and sold (in consequent order): Biodiesel, Through waste vegetable oils, and the blend of biodiesel with petro diesel for lubrication. This is our only focus to allow for rapid market penetration through the performance and rapid deployment of our systems.

Bio Diesel production depends upon a reliable supply of feedstock. To date, such a supply chain has not yet been established in the target markets. Although the raw material is there and environment is suitable for production. At present, the local production of bio fuel even from dedicated energy plantations is believed to be negligible. Indeed, the product of existing “energy plantations” is for human consumption, animal feed or export.

### 4.1 PRODUCT DESCRIPTION

Biodiesel is the name for the methanol-ester-based bio fuel made from vegetable oils or animal fats. In this business plan Biodiesel will be produced from Waste Vegetable Oils (WVO’s), but our equipment could be utilized also for processing other vegetable or waste cooking fats.

Biodiesel is a clear liquid, without unpleasant odor or handling characteristics, of virtually the same viscosity as mineral fossil diesel oil. For this reason, it may be used in a standard diesel engine without additional modifications. It may also be blended with petro diesel to improve quality of latter.

Product Performance
Biodiesel shows similar fuel consumption, horsepower, torque, and other properties as conventional diesel fuel and provides significant lubricity improvement over petroleum diesel fuel. Lubricity results of Biodiesel and petroleum diesel using industry test methods indicate that there is a marked improvement in lubricity when Biodiesel is added to conventional diesel fuel. Even Biodiesel levels below 1 percent can provide up to a 30 percent increase in lubricity.

**Sourcing**

The major planned source of raw material is WVO. To ensure stability of supply, we are planning to put the burden of feedstock supply direct to the customer as they are the ones seeking to lower costs and therefore have a stakeholder interest in ensuring their control over their costs. Our focus is value-add in consulting, supply and development of custom and highly automated equipment to achieve the customer’s goals of fuel cost controls. Total outsourcing capabilities will be well within our ability to assist our customers.

**Future Products and Services**

Glycerol is a by-product of our technological process, but it needs further cleaning. We are not planning to install glycerol processing equipment in the first 3 years, because this equipment requires additional 40% investment and we want to ensure quality and uninterrupted production of Biodiesel, as a flagship product. However, after successful implementation of this Biodiesel project, we are also planning to sell cleaned glycerol, which could generate an additional 10% turnover.

### 4.2 TECHNICAL FEASIBILITY

Producing home brewed biodiesel probes in lab

**Resources required per 1 batch:**

1. Wasted cooking oil (sunflower oil) 400 ml
2. Methanol 80ml
3. NaOH 3g as catalyst
4. Isopropyl alcohol 30 ml per titration
5. Indicator 2-3 drops
6. Distilled water
7. Heating plate

*Figure 4.2-1: Required tools for Bio diesel production*
STEPS:

Fig 4.2-2: Step 1. Determination of amount of catalyst required by titration

Fig 4.2-3: Step 2. Heating of oil up to 55 °C

Figure 4.2-4: Step 3. Mixing of WVO, methanol and Catalyst
Figure 4.2-5: Step 4. Leaving the mixture to settle for 12 h in sealed container

Separation of oil and glycerol after 12 h of settling

Figure 4.2-6, 4.2-7, 4.2-8 Step 5. Separation steps of oil and glycerol

Figure 4.2-9, 4.2-10: Step 6. Washing of oil 3-4 times (1. batch 3; 2. 4 times) with distilled water till water gets clear when it settled 30 min

Testing of quality

1. Washing test – successful batch if water and oil are totally separated (3. batch failed)
Figure 4.2-11, 4.2-12: Washing test of bio diesel

2. Methanol test (225 ml methanol, 25 ml of oil)– successful when oil it totally soluble with added methanol

Figure 4.2-13: Methanol Test
Results:

From 400 ml of oil with 1. batch 80 ml of biodiesel was brewed; 2. batch 200 ml. Losses came from separation (old technique and lack of tools, ca 150 ml lost) and also from washing 50-100 ml. It is also assumed that greater amount of biodiesel would be produced if longer settling time would have been applied as showed the difference of 1. and 2. Batch outcome, 80 ml and 200 ml, respectively. Failed batch, the 3rd one, was experimental having different ratio of methanol and oil, extra methanol of 120 ml was added. As biodiesel is soluble with methanol, in the 3. probe the produced mixture had too high share of methanol and therefore reaction of forming biodiesel was incomplete, giving outcome looking like an emulsion.

Table 4-1 Results of Bio Diesel

<table>
<thead>
<tr>
<th>Sample #</th>
<th>HHV KJ/Kg</th>
<th>HHV of Diesel (NRL Karachi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39453</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>38840</td>
<td>40000 KJ/Kg</td>
</tr>
</tbody>
</table>
4.3 INNOVATION ASPECTS

The production of biodiesel from waste vegetable oil offers a triple-facet solution: economic, environmental and waste management. The new process technologies developed during the last years made it possible to produce biodiesel from recycled frying oils comparable in quality to that of virgin vegetable oil biodiesel with an added attractive advantage of being lower in price. Thus, biodiesel produced from recycled frying oils has the same possibilities to be utilized. While transesterification is well-established and becoming increasingly important, there remains considerable inefficiencies in existing transesterification processes. There is an imperative need to improve the existing biodiesel production methods from both economic and environmental viewpoints and to investigate alternative and innovative production processes. Some improvements are giving below which are going to be used in production process.

Dry Washing

There are two generally accepted methods to filter and purify biodiesel: wet and dry washing. The more traditional wet washing method is widely used to remove excess contaminants and leftover production chemicals from biodiesel. In this process a fine water mist is sprayed over the fuel. The fuel's impurities are removed as the water settles to the bottom of the tank. However, the inclusion of additional water to the process offers many disadvantages, including increased cost and production time.

- First, the dry wash process decreases production time. Dry washed biodiesel can be ready for use in a few hours and is significantly quicker to produce than wet-washed fuel.
- The dry wash process can also lower costs. In addition to the ever-increasing cost of water and the significant expense of water removal equipment, disposal of effluent water is often the single largest cost during production.
- Less space is required to conduct the dry wash process.
- The dry wash process creates high-quality fuel. Since water isn't added in the dry wash process, it's possible to achieve less than 500 parts per million (ppm) water content in accordance with ASTM D 6751. In wet washing, the fuel's water content is usually more than 1,000 ppm, making it expensive, difficult and time-consuming to effectively remove.
- Another advantage to the dry wash process is resin can be reused. (Biodiesel magazine)

Figure 4-1: Dry wash tower.

DW-R10 Dry Wash Resin-Ion Exchange Resin:

Resins are used to do the dry wash of biodiesel. Now-a-days people use many resins such
as Amberlite, Purolite, DW-R10, or other dry wash resins. DW-R10 is a special commercial grade dry wash ion exchange resin that can be used to remove impurities from Biodiesel after the glycerin has settled and been removed. It works extremely well at removing soaps, catalyst, glycerin, and even water. When used as recommended and in tandem with a demethylation system, it can allow you to remove the contaminant levels in Biodiesel down to ASTM specifications. Highest capacity for salts, soap, catalyst. (Turner Biodiesel)

**Saw dust:**
There should be no more than 2000 PPM (Parts per Million) of total impurities (glycerin, soap, unused catalyst and other trace impurities) in the Biodiesel to be dry washed but less than 1000 ppm is highly recommended. Otherwise, the resulting Biodiesel can become too acidic. If soap levels are higher than 1500 PPM, it is recommended to pre-treating the Biodiesel with a cellulose media product, such as saw dust to running it through DW-R10 Dry Wash Resin. As a saw dust it requires kiln dried, contains only hard woods, and has been mixed to the perfect ratio of wood chips to saw dust.

**5.0 WORK PLAN AND SCHEDULE**

Work plan is divided into five main following phases.

- Market Identification
- Market survey
- Testing the prototype of Alternative fuel (Bio Diesel)
- Financial Forecasting
- Finalising the Project
Figure 5-1: Work Plan and Schedule
6.0 NEEDS ANALYSIS

6.1 MARKET ANALYSIS

The most important thing in developing and starting this business is the availability of raw materials and demand of product in the market. For this purpose we used the survey method to analyze the market the following methods are used:

- Written Surveys
- Electronic (email, face book, twitter) Survey
- Survey through Interview

Questions asked through survey are:

- How much waste vegetable Oil they are wasting per week?
- Will they sale this waste oil to us
- Average Blackout (number of hours)
- Which kind of backup they are using for Blackout?
- Cost for using the backup (diesel for generators)?
- Will they use the Biodiesel

The answers collected through surveys are compiled in the following two tables’ one for Karachi and other for Dhaka.
### Table 6-1 Market Survey in PAKISTAN

<table>
<thead>
<tr>
<th><strong>BIG LOCAL CHAINS</strong></th>
<th><strong>Ltrs per week</strong></th>
<th><strong>Willingness to sale</strong></th>
<th><strong>Load shedding</strong></th>
<th><strong>backup</strong></th>
<th><strong>cost</strong></th>
<th><strong>they want to use our fuels</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar B Q Tonite (04 big restaurants)</td>
<td>21-25</td>
<td>Yes</td>
<td>own Generators</td>
<td>didn’t told</td>
<td>yes after demo</td>
<td></td>
</tr>
<tr>
<td>Food court in Park tower Shopping mall (approx 10 food chains)</td>
<td>&gt;30</td>
<td>Yes</td>
<td>Generators of shopping mall</td>
<td>paying fixed money to mall owners</td>
<td>yes after demo</td>
<td></td>
</tr>
<tr>
<td>Food court in Dolmen Shopping mall (approx 15 food shops)</td>
<td>40-45</td>
<td>Yes</td>
<td>Generators of shopping mall</td>
<td>paying fixed money to mall owners</td>
<td>yes after demo</td>
<td></td>
</tr>
<tr>
<td><strong>International Food chains</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*KFC (more than 25 restaurants)</td>
<td>20 approx</td>
<td>Yes</td>
<td>own Generators</td>
<td>10-15 gals/day depend on week days</td>
<td>yes after demo</td>
<td></td>
</tr>
<tr>
<td>*Pizza Hut (approx 20 restaurants)</td>
<td>15 approx</td>
<td>Yes</td>
<td>own Generators</td>
<td>10-15 gals/day depend on week days</td>
<td>yes after demo</td>
<td></td>
</tr>
<tr>
<td>*McDonalds (more than 20 restaurants)</td>
<td>20 approx</td>
<td>Yes</td>
<td>own Generators</td>
<td>&gt;15 gals/day</td>
<td>yes after demo</td>
<td></td>
</tr>
<tr>
<td><strong>Local food chains</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bovichick</td>
<td>Not clear</td>
<td>Yes</td>
<td>own Generators</td>
<td>5 gals/day</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Food Street in Sea View (10-15 food chains)</td>
<td>Not clear</td>
<td>Yes</td>
<td>own Generators</td>
<td>didn’t told</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Javed Nihari House</td>
<td>Not clear</td>
<td>Yes</td>
<td>Generator</td>
<td>don’t know</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

*Survey conducted in only one shop
From the above survey we can say that there is a potential market for manufacturing of Bio diesel and there is enough raw material available.
Market Trends

Government of both targeted countries is taking imitative to overcome the energy crisis in the country and they are also planning to give subsidies on tax legislations on renewable energy productions. But these are long term plans and target market still needs some alternatives energy whether in the form of fuel of electricity.

The most important trend in the fuel market is the growing prices. Although with some limitations, this was true for years and seems to be accelerating due to political and economic reasons. Biodiesel prices may grow even faster, because of its “ecological friendliness” and concerns in all industrialized countries about the level of environmental pollution.

It is necessary to assume, however that because of a future increase in the Biodiesel production over the Country and possible inventions of other alternative fuels (methanol, etc).

Our main competitors in the target area simply do not exist at that time. But after entering in the market and increase of needs of these alternative energy sources the market will increase with time. The biggest problem may appear if a country imposes the taxes for Biodiesel, which however, is highly unlikely, because of the strategic importance of alternative fuels for the country.

6.2 COMPETITOR ANALYSIS

In the following table we did a competitor analysis with the manufacturers of the similar products.

- Biodiesel from WVO
- Biodiesel from Pure Vegetable oil
- Diesel from Crude Oil

<table>
<thead>
<tr>
<th>Factor</th>
<th>Biodiesel from WVO</th>
<th>Strength/Weakness</th>
<th>Biodiesel from Pure Vegetable oil</th>
<th>Diesel from Crude Oil</th>
<th>Importance to Customer 1=Low, 5=High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products</td>
<td>Bio diesel</td>
<td></td>
<td>Bio diesel</td>
<td>Diesel</td>
<td>3</td>
</tr>
<tr>
<td>Price</td>
<td>Less</td>
<td>Strength</td>
<td>Higher than Crude Oil</td>
<td>Medium-High (Unstable)</td>
<td>5</td>
</tr>
<tr>
<td>Quality</td>
<td>Depend on raw material quality</td>
<td>Weakness</td>
<td>High</td>
<td>Very high</td>
<td>4</td>
</tr>
<tr>
<td>Reliability</td>
<td>High</td>
<td>Strength</td>
<td>High</td>
<td>High</td>
<td>1</td>
</tr>
<tr>
<td>Stability</td>
<td>High</td>
<td>Strength</td>
<td>High</td>
<td>Medium</td>
<td>1</td>
</tr>
<tr>
<td>Expertise</td>
<td>Medium</td>
<td>Weakness</td>
<td>Medium</td>
<td>High</td>
<td>2</td>
</tr>
<tr>
<td>Company Reputation</td>
<td>Medium ( will increase with time )</td>
<td>Weakness</td>
<td>High</td>
<td>High</td>
<td>1</td>
</tr>
</tbody>
</table>
It can be concluded that despite some weaknesses Bio diesel from WVO has a potential future aspects and with time it will give significant challenge to conventional petro diesel due to its relatively low price and high quantity. Our most important competitive edge is entering the bio diesel market and gaining rapid experience and market share before the intrusion of new competitors in this mini-plant approach.

### 6.3 ENVIRONMENTAL ANALYSIS (PEST ANALYSIS)

Political, Economical, Social, and Technological analysis are done and presented in the following table.

**Table 6-4 PEST analysis**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Trend</th>
<th>Evaluation</th>
<th>Impact (1 = low; 5 = High)</th>
<th>RANK in terms of Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POLITICAL</strong></td>
<td>Government is appreciating clean energy</td>
<td>Opportunity</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Increased subsidy in diesel prices (Bangladesh only)</td>
<td>Threat</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Difficult to start the business without using some political power (e.g., Bribe for registration)</td>
<td>Threat</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>ECONOMIC</strong></td>
<td>Rapid increase in Crude Oil Prices</td>
<td>Opportunity</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rise in raw material costs</td>
<td>Threat</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rapid growth in emerging markets</td>
<td>Opportunity</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>By-product is reusable</td>
<td>Opportunity</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>SOCIAL</strong></td>
<td>Clean Energy</td>
<td>Opportunity</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Consumers want constant Electricity</td>
<td>Threat</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>TECHNOLOGICAL</strong></td>
<td>Easily available technology</td>
<td>Opportunity</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Relatively large operating cost</td>
<td>Threat</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

From the above PEST analysis it can be conclude that there are more opportunities than threats, technology is easily available, social impact is more positive, by product i.e. glycerol is also reused, raw material is easily available, Government is supporting the clean energy.

**MARKETING STRATEGY**

Market strategy is made by considering these points.

- Emphasize inherent qualities of Biodiesel and focus on target markets. We must differentiate Biodiesel from other fuels. We need to establish our business offering as a clear and viable alternative for our target markets.
- Produce high quality fuel with highly automated deployment and development.
- Offer competitive price at the level of the conventional diesel fuel with higher quality.
• Create strong distribution channels to ensure stability of production.
• Emphasize key advantages of our product both our system and end-product.
• Build a relationship business: long-term relationships, not single-transaction deals with customers.
• Become their fuel supply department, not just a vendor. Make them understand the value of our relationship for the whole society and economy.
• Focus on fuel distributors and big consumers as key target markets.

6.4 OUTPUT ANALYSIS (SWOT ANALYSIS)

Table 6-5 SWOT analysis

<table>
<thead>
<tr>
<th>Helpful to achieving the objective</th>
<th>Harmful to achieving the objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td><strong>Weaknesses</strong></td>
</tr>
<tr>
<td>• Able to run on unmodified Engines</td>
<td>• Relatively High Capital Investment and operating cost</td>
</tr>
<tr>
<td>• Simple Chemistry</td>
<td>• Relatively High Energy Input/Costs</td>
</tr>
<tr>
<td>• Variable Production is possible</td>
<td>• Not full Green (Methanol used is derived from Fossil Fuel)</td>
</tr>
<tr>
<td>• Higher yield (almost 100%)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internal origin (attributes of the system)</th>
<th>Opportunities</th>
<th>External origin (attributes of the environment)</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opportunities</strong></td>
<td>• High consumption and low production in the market</td>
<td>• Waste Vegetable Oil supply is dependant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ever Increasing Crude Oil Price</td>
<td>• Relatively costly and unstable prices of Raw materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Funding is available for research and production.</td>
<td>• Large Companies will Start in near future</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Glycerol is reusable and methanol is recoverable</td>
<td>• No standards exists</td>
<td></td>
</tr>
</tbody>
</table>

This SWOT analysis presented the main advantages and disadvantages, the drivers and barriers of various technologies in the biofuel sector.

In South Asia most experiences exist for bioethanol since these two fuels have the highest market share. In contrast, far less experience exist for biofuels which are in their initial phase of market introduction, such as from waste vegetable oil and yellow grease. For example, the use of pure oil still is a niche application for the agricultural transport sector, supported by the decentralized pressing process of rape seeds.
Since a SWOT analysis is always qualitative, it has the great opportunity to objectively demonstrate advantages and disadvantages of fuels. In conclusion, the present SWOT analysis shows pros and cons of biodiesel without judging them. It represents an objective base for discussing the best options for future alternative fuels. Such discussions shall be complemented by using results of additional quantitative studies, for example on costs, greenhouse gas emissions and energy balances.

7.0 BUSINESS MODEL

VALUE PROPOSITION, CHANNELS AND REVENUES

We think our value proposition is quite clear, and can be quite easily distinguished from most of the others in the market. We offer a suitable solution to restaurants for running their business without any significant effect during energy blackouts, ecology-friendly and renewable type of fuel at a reasonable market price. Our project brings also new jobs and high-technology will rapidly create market share.

We depend on direct contacts as our main way to reach new buyers. As we grow, however, we need to change the way we promote ourselves:

We depend on our alliance with local producers of waste vegetable oils to generate a continuous supply of raw material (feedstock) now and into the future. Our strategies are to assist our end users on the securing of their own feedstock sources while we provide the means to add value to this feedstock supply.

➤ The detailed BUSINESS MODEL is shown in the below table
### Table 7-1 Business Model Canvas

#### BUSINESS MODEL CANVAS

<table>
<thead>
<tr>
<th>KEY PARTNERS</th>
<th>KEY ACTIVITIES</th>
<th>VALUE PROPOSITIONS</th>
<th>CUSTOMER RELATIONSHIPS</th>
<th>CUSTOMER SEGMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small and medium Restaurants (as supplier)</td>
<td>Purchasing of Raw material</td>
<td>Providing needed product</td>
<td>In-person</td>
<td>Small and medium Restaurants (as customer)</td>
</tr>
<tr>
<td>Domestic Suppliers</td>
<td>Collection of WVO</td>
<td>Offering suitable solution by providing Quality product at very less price</td>
<td>Trust based relations</td>
<td></td>
</tr>
<tr>
<td>Chemical Industries (Raw material Suppliers)</td>
<td>Manufacturing of Bio Diesel</td>
<td></td>
<td>Long term focused relations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sale and distribution</td>
<td></td>
<td></td>
<td>Local Transport users</td>
</tr>
<tr>
<td></td>
<td>Maintenance of Tool Kit</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### KEY RESOURCES

- Technological Infrastructure
- Waste Vegetable Oil (WVO) from Restaurants

#### COST STRUCTURE

- Cost driven model for producing quality product at low price
- Sales and Marketing
- Maintenance Cost

#### REVENUE STREAMS

- PRODUCT SALES
8.0 ECONOMIC FEASIBILITY

Calculations for biofuel production are done for one year for both country’s biggest cities, Bangladesh capital Dhaka and Pakistan biggest city Karachi. Prices of both countries are taken in account as much as possible, including taxes. The amount of production was derived from a survey. Survey was conducted in the targeted cities biggest with larger restaurants in order to find approximate resource sources for wasted cooking oil and to know their willingness either to give it for free or for a symbolic price.

There is around 100 restaurants in both cities which could be used as source for wasted cooking oil. Bangladesh restaurants could provide around 15 litres and in Pakistan 30 litres per restaurants. For Pakistan available resources would allow even to produce more than the toolkit could provide, 12 000 litres monthly, although 10 000 monthly is the limit of the equipment.

The investment cost includes cost of equipment for production. It is imported from United States and includes shipping cost, in total it is 6,695. The chemical resources needed for production are either bought from target countries or imported from neighbour countries, mostly from China. All imports include value added tax (VAT) that is 15 % for both countries (United States Council for International Business, 2013; VAT act 2012 Bangladesh, 2012). Operational expenditures include direct and direct cost. Operational expenditures are shown in tables below. Capital expenditure is same for both countries, 6,695.15 USD in total. The toolkit for producing biodiesel has 15 year guaranteed lifetime given by the seller (Biodiesel Kits Online, 2013). Indirect costs are either targeted countries market prices or Chinese market price. Electricity and water rate are taken from local providers (Dhaka Power Distribution Company Limited, 2013)(Dhaka Water Supply and Sewerage Authorisation, 2013)(Karachi Electric Supply Company, 2013)(Karachi Water and Sewerage Board, 2013). Accountant and lawyer prices were asked directly from local company of Bangladesh and used also for Pakistan as there were no prices found online, neither the there was no response from any of them(Harun Legal Associates, 2013). There is no marketing cost as webpage and media related things are already done with no expenditures on our own. Rent prices for production unit are taken average of local market with taking into account that it can be only industrial areas due to safety regulations.

Table 8-1. Direct operational expenditure for biodiesel production in Pakistan (Alibaba Group, 2013)(Methanex, 2013)

<table>
<thead>
<tr>
<th>Resources for production of 1 L biodiesel</th>
<th>total cost/1 l biodiesel</th>
<th>total cost/month</th>
<th>total cost/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wasted cooking oil (sunflower oil) 400 ml USD/mt *</td>
<td>0.4</td>
<td>4000</td>
<td>48000</td>
</tr>
<tr>
<td>Methanol 80ml price USD/ mt**</td>
<td>0.1035</td>
<td>1035</td>
<td>12420</td>
</tr>
<tr>
<td>Naoh3g as catalyst (alcaline lye) g (5-7.5 g)***</td>
<td>0.0029325</td>
<td>29.325</td>
<td>351.9</td>
</tr>
<tr>
<td>Isopropyl alcohol 30 ml per titration</td>
<td>0.08625</td>
<td>862.5</td>
<td>10350</td>
</tr>
<tr>
<td>Titration Indicator 2-3 drops ((5-7.5 ml/ 1 ml/g lye)*****</td>
<td>0.00805</td>
<td>80.5</td>
<td>966</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>6007.325</td>
<td>72087.9</td>
</tr>
</tbody>
</table>
Three different scenarios were done for feasibility study.  
**First one** is with producing bio fuel from the amount of resources assumed from the outcome of survey – 15 l for Dhaka per restaurant, resulting 6000 litres and 30 litres per restaurant in Karachi, resulting 12 000 litres. Cash flow statement is conducted with three versions of different price for the bio fuel.  
First scenario includes three different price Range for biodiesel starting with lowest price – circa 60 % for Bangladesh and 80 % for Pakistan of the diesel price of the countries, second one with selling half year with a bit increased price and rest half year with same price as the diesel has in the Bangladesh and Pakistan, 0.8 USD/l (Bangladesh Petroleum Corporation, 2013) and 1.2 USD/l respectively (Pakistan State Oil, 2013). The lower price of diesel in Bangladesh is due to governmental subsidy (Bangladesh Petroleum Corporation, 2013).  
**Second scenario** is calculated with maximum production level – 500 litres per day and three different price ranges similar to precisely mentioned, only none of it is same level as diesel price in countries.  
**Last scenario** includes maximum production level with 3 different price options, including selling with same price as diesel has. All scenarios calculations are shown in tables below, for both countries. All scenarios include cash-flow, gross margin, and earnings before interest, taxes, depreciation and amortization. A corporate tax, which is 13 % on both countries are also included to find final net profit. All calculations for different scenarios with three bio fuel price variants for Bangladesh and Pakistan are shown in tables below.

### Table 8-2. Indirect operational expenditure for biodiesel production in Pakistan

<table>
<thead>
<tr>
<th>Other resources</th>
<th>price USD</th>
<th>total cost monthly</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office rent</td>
<td>500</td>
<td>6000</td>
<td></td>
</tr>
<tr>
<td>Production labour (2 persons)</td>
<td>200</td>
<td>400</td>
<td>4800</td>
</tr>
<tr>
<td>Mgmt labour (1 person)</td>
<td>150</td>
<td>150</td>
<td>1800</td>
</tr>
<tr>
<td>Lawyer (1 time per year)</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accountant (1 time per year)</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water (l)</td>
<td>3600</td>
<td>4USD /1000l</td>
<td>12</td>
</tr>
<tr>
<td>Electricity for production (kwh)</td>
<td>650</td>
<td>0.0775 USD/kWh</td>
<td>50.375</td>
</tr>
<tr>
<td>Mobile + landline</td>
<td>50</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>50</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Lighting + ventilation</td>
<td>60</td>
<td>720</td>
<td></td>
</tr>
<tr>
<td>Container 30 l</td>
<td>400</td>
<td>3.5</td>
<td>1167</td>
</tr>
<tr>
<td>Insurance</td>
<td>50</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>50</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Marketing (web page)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1272</strong></td>
<td><strong>16269</strong></td>
<td></td>
</tr>
</tbody>
</table>
### Table 8-3 Profit and losses for Pakistan

<table>
<thead>
<tr>
<th>Pakistan</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues from biodiesel sale A</td>
<td>120000</td>
<td>110000</td>
<td>120000</td>
</tr>
<tr>
<td>Revenues from biodiesel sale B</td>
<td>132000</td>
<td>120000</td>
<td>132000</td>
</tr>
<tr>
<td>Revenues from biodiesel sale C</td>
<td>144000</td>
<td>132000</td>
<td>144000</td>
</tr>
<tr>
<td>Production cost (direct cost; resources)</td>
<td>72088</td>
<td>72087.9</td>
<td>72087.9</td>
</tr>
<tr>
<td>Gross margin A</td>
<td>47912</td>
<td>37912.1</td>
<td>47912</td>
</tr>
<tr>
<td>Gross margin B</td>
<td>59912</td>
<td>47912.1</td>
<td>59912</td>
</tr>
<tr>
<td>Gross margin C</td>
<td>71912</td>
<td>59912.1</td>
<td>71912</td>
</tr>
<tr>
<td>Gross margin A %</td>
<td>40</td>
<td>34.46554545</td>
<td>40</td>
</tr>
<tr>
<td>Gross margin B %</td>
<td>45</td>
<td>39.92675</td>
<td>45</td>
</tr>
<tr>
<td>Gross margin C %</td>
<td>50</td>
<td>45.38795455</td>
<td>50</td>
</tr>
<tr>
<td>Production cost (indirect cost)</td>
<td>16269</td>
<td>16268.5</td>
<td>16268.5</td>
</tr>
<tr>
<td>EBITDA A</td>
<td>31644</td>
<td>21643.6</td>
<td>31644</td>
</tr>
<tr>
<td>EBITDA B</td>
<td>43644</td>
<td>31643.6</td>
<td>43644</td>
</tr>
<tr>
<td>EBITDA C</td>
<td>55644</td>
<td>43643.6</td>
<td>55644</td>
</tr>
<tr>
<td>Cost of capital</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>DA (Investment)</td>
<td>6,695</td>
<td>6,695.15</td>
<td>6,695</td>
</tr>
<tr>
<td>EBT A</td>
<td>24,948</td>
<td>14,948.45</td>
<td>24,948</td>
</tr>
<tr>
<td>EBT B</td>
<td>36,948</td>
<td>24,948.45</td>
<td>36,948</td>
</tr>
<tr>
<td>EBT C</td>
<td>48,948</td>
<td>36,948.45</td>
<td>48,948</td>
</tr>
<tr>
<td>corporate taxes A</td>
<td>3243</td>
<td>1943.2985</td>
<td>3243</td>
</tr>
<tr>
<td>corporate taxes B</td>
<td>4803</td>
<td>3243.2985</td>
<td>4803</td>
</tr>
<tr>
<td>corporate taxes C</td>
<td>6363</td>
<td>4803.2985</td>
<td>6363</td>
</tr>
<tr>
<td>NET A</td>
<td>21,705</td>
<td>13,005.15</td>
<td>21,705</td>
</tr>
<tr>
<td>NET B</td>
<td>32,145</td>
<td>21,705.15</td>
<td>32,145</td>
</tr>
<tr>
<td>NET C</td>
<td><strong>42,585</strong></td>
<td><strong>32,145.15</strong></td>
<td><strong>42,585</strong></td>
</tr>
</tbody>
</table>
Conclusion

Calculations show that For Pakistan the highest net profit is for scenario one and three, as available resource could cover as much to produce maximum allowed amount by toolkit. Producing 10 000 litres per month and selling it with same price as the diesel has is most profitable. The lowest profit is for scenario two, producing maximum amounts, 10 000 litres monthly and selling with lowest price, 1 USD/l.

Bibliography