

# Orkney Biofuels Ltd.

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A summary of the biofuels processing project 2003-2012

## Why We Started

In 2003 the Westray Development Trust was looking at ways to generate operating income. The Trust had pulled in considerable amounts in grants for specific projects in Westray but was continually struggling to get its basic operating costs covered.

The Energy sub group of the Trust also had developed a plan to work towards self sufficiency in energy produced from renewable resources.

There was a growing worldwide interest in alternative fuels and lots of information on the web about how people were doing it.

## What we set out to do

The Trust's aims for the biofuel project were to:

- Start with a local waste stream (the used cooking oil)
- Produce diesel fuel from it.
- Make fuel that would go in any ordinary diesel car, truck, tractor etc without any engine modification required.
- Make fuel that was environmentally greener in production.
- Make fuel that would have environmental benefits in use
- Make fuel that would be cheaper at the point of sale to the ordinary retail customer.
- Create local employment
- Contribute to making Westray self sufficient in energy



AGROMOM INSTITUTE  
- For Northern European Crop Research -  
REPORT TO WESTRAY DEVELOPMENT  
TRUST ON BIOFUEL CROPS RESEARCH AT  
ORKNEY COLLEGE BURNING, 2008

FINAL REPORT -  
May 2009



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## What About the Oil?

At that time all the used oil from hotels, restaurants, burger bars etc across Orkney was being collected on behalf of Orkney Islands Council and periodically shipped south to mainland Scotland as waste. This was both costly and wasteful of a potential resource.

The council agreed to work with the Westray Development Trust and supply us with the used cooking oil instead. Much research and a training course in Manchester led to the production of our first useable fuel late in 2003. Initially we had to experiment with ways to clean up the used cooking oil. The oil we receive is a very variable product depending on where it is from, how long it has been used and how much water has got into it since. We ship it and store it in 1000 Litre IBCs (plastic tanks in a cage on a pallet).

Besides the floating chips which are easily filtered out, the used cooking oil;

- May contain up to 30% dirty water (unfortunately we cannot make fuel out of water yet)
- May be very dark burnt oil with very high free fatty acid content (not a good starting point)
- Is usually cloudy with masses of minute particles of food residue.

## Research and Experiments

Highlands and Islands Enterprise gave us grant aid to experiment on the production options for biodiesel from both used cooking oil and oil from rapeseed or other oil crops that could be grown in Orkney. Orkney College grew oil crops for us. We pressed the seed, extracted oil and made fuel from it. This trial was very informative.

Our conclusions on locally grown oil crops for biodiesel were;

- Orkney's climate makes harvesting oil crops very chancy (you need four consecutive, predictably dry days in mid September once it is sufficiently mature). It was then very difficult to dry the oil seeds sufficiently and keep them from absorbing moisture from the air. Absorbed moisture led to mould and mites in the seeds.
- The pressing was quite feasible but slow and labour intensive on a small scale. Only by going to very large equipment could you get the labour cost low enough to produce the raw oil cheap enough for fuel use (needed to be less than 20p per litre). You also need an economic return from the pressed cake.
- We concluded that growing oil crops for fuel could work with a large industrial scale plant in mainland Scotland but not in Orkney.
- We then concentrated on producing biodiesel from used cooking oil
- Highlands and Islands Enterprise gave us grant aid to set up Orkney Bio-fuels Company Ltd as a trading subsidiary of the Westray Development Trust.

## How do we clean it up?

Much experience has taught us that time and gravity work wonders on dirty oil. Most of the problems settle to the bottom over a period of months at no cost and no energy input. We knew a centrifuge would do the same almost instantly but they cost too much and we did not have capital available. We continued using a long slow gravity settle to get most of the good oil separated from the rubbish but are working on refurbishing a large redundant oil cleaning centrifuge from an electricity power station.

## Diesel fuel

We knew that a basic diesel engine will run on almost any clean oil. Rudolf Diesel's original engine was designed for peanut oil. Ordinary forecourt diesel fuel was originally developed by the oil companies to find a sale for part of the residue left when producing petrol from crude oil. Diesel engines have since evolved to use that fuel and as a result are no longer able to use straight vegetable cold. We had ruled out modifications to vehicles so double tanks with switch over, oil preheaters etc were not an option.

## **Our First Fuel**

Research on the web had shown that used cooking oil, if dry and well filtered, could be used in older engines. This was a very green option.

We produced cleaned up oil, mixed it with solvent to lower the viscosity and the test engines and vehicles worked really well on it. However, at that time, Customs and Excise were struggling to define what you could or could not do and stay within their rules which were published on the web. Their rules also changed and it seemed that individual officer's interpretation of them varied around the country. This gave us problems as we had no intention of falling foul of the law. All the time we were making official returns to HMRC and paying the Road Fuel Duty of about 28p per litre of fuel produced. This was later waived for small producers.

## **Our next fuel**

Our solution to the Customs and Excise views on solvents was simple but not ideal. We provided fuel without the solvent – that way the fuel could comply with the official definition. The customer had to mix this with ordinary diesel and then put it in the vehicle. We found 50 – 75% biodiesel a realistic mix with the lower ratio in colder weather. The results were good. The fuel was sold in returnable, recycled 25 litre drums and customers came back for more. Thousands of trouble free miles were covered. Comparison tests we carried out gave fuel consumption figures very similar to regular diesel fuel. The fuel suited diesel vehicles made up to about the year 2000.

## **National Award**

In October 2005 the Westray Development Trust's Bio-fuel project won the Community Waste Initiative Award in the Eventful Scotland Waste Management Awards event at the Glasgow Hilton Hotel.

## **Time to change the system again**

By 2007 it was clear we would need to think again. Common Rail engines had started appearing in production diesel cars about 2000. These engines operate at much higher injection pressures with very fine tolerances on the moving parts of pumps, injectors etc. The fuel has to have low viscosity whatever the temperature and be filtered to a much higher standard. The fuel we were supplying was not suitable for them. The stock of older vehicles that could use our current fuel was disappearing. Sales of biofuel stopped.

## **Transesterification**

Most commercial biodiesel is produced by a process called transesterification. This involves chemically reacting vegetable oil with methanol and caustic soda at a raised temperature and sometimes under pressure.

The process, although essentially simple, has to be carried out carefully and precisely and the quantity of caustic needed depends on the state of the used oil. A titration is carried out on the oil to determine its acidity. Older, more heavily used oil is more acid and requires

more caustic to neutralise it. Both input chemicals are dangerous and commercially available equipment is either too small or big enough but far too expensive for us. We would have to develop a plant to do this and experiment to make quality fuel by the transesterification process.

### **Oil storage regulations**

New regulations for storing any oil came out. The law now required fully bunded storage so that any leak from a container will be contained.

We obtained a £30K grant from the INCREASE scheme (Increase the waste material diverted from landfill) to have a proper concrete bunded store built. Within this grant, we also purchased two 40 foot ex shipping containers, a forklift and significantly a second-hand semi commercial biodiesel processor.

### **A slight anxiety for the future**

Since July 2007 diesel car exhaust systems have incorporated a Diesel Particulate Filter (DPF). This is there because of the problem of PM10s (particles less than 10 microns) in regular diesel exhaust. The electronics of the engine management system now gives a secondary squirt of fuel out of time with the normal injection cycle. This passes into the exhaust pipe and burns off in the DPF to clean it out of these particulates.

Regular diesel fuel requires this but biodiesel fuel does not (40% less PM10s). The problem is that the biodiesel fails to go down the exhaust because it evaporates at a higher temperature than regular fossil diesel. Instead it ends up in the sump and dilutes the engine oil.

In the meantime no small diesel made after July 2007 with a DPF should use biodiesel.

In the future alternative software in the electronics will be developed to enable the use of biofuel.

### **A few facts about biodiesel made from used cooking oil**

- The oil supply is sustainable if production is matched to supply
- The oil came from plants. They took Carbon out of the atmosphere as they grew. Burning the fuel just returns that Carbon back to the atmosphere - so the fuel is approaching carbon neutral
- The used cooking oil cannot by law now be used in animal feed so would be a waste product otherwise
- As such it would have to be shipped south to mainland Scotland for treatment
- No crop growing land is required so no cutting down rainforests or displacing food crops
- Minimal transport of the raw oil if production is localised
- Biodiesel naturally biodegrades quickly if split. In fact it is being used commercially to clean up spills of fossil oils which only degrade very slowly.
- Our experience with minor spills is a slight increase in soil fertility after degradation. Wild orchids flourishing over many years close to out containers

- The exhaust from an engine running on biodiesel contains no sulphur so is far less irritant and unpleasant
- 40% less PM10s (particles less than 10 microns in size which our nose hairs fail to filter out and which get into people's lungs)
- 90% less carcinogenic exhaust
- Biodiesel is a much better lubricant than regular fossil diesel so kinder on the injection pumps etc. Regular fossil diesel now contains a percentage of biodiesel to improve its lubrication qualities and EU law requires this % to increase to reduce fossil oil use
- Biodiesel has a much higher flash point than regular diesel so is inherently more difficult to set fire to. This makes it a very low fire risk
- Biodiesel is apparently less toxic than sugar but we do not recommend drinking it!

### The new plant and process

The second-hand 400 litre stainless steel processor we bought represents about a third of the equipment needed. The rest of the plant is adapted or modified tanks, boilers, pumps, pipes, oil heaters, motor control gear, filtration systems etc all recycled from other uses.

It took months, but eventually it was possible to produce high quality biodiesel fuel that goes in common rail engines. It was tested as the only fuel (i.e at 100%) for more than 20,000 miles in a Fiat Multipla with a 1.9 JTE common rail engine.

### Retail forecourt pump service

This third generation transesterified biodiesel did not need to be mixed with regular fossil diesel. It is filtered to 1 micron and has low viscosity. It can be put straight in the car tank, with or without regular fossil diesel. No drums or premixing needed.

In 2008 we obtained another £5K Increase grant to setup a forecourt pump for customers.

Biodiesel softens some types of rubber seals and requires special design features in a forecourt pump. Previously we had been allowed to use our official, stamped measuring can to fill the drums, but now retail sales from a pump would have to comply with Weights and Measures standards of accuracy.

We eventually tracked down just one suitable forecourt retail pump made by Tokheim that could handle biodiesel and also be certified by Weights and Measures. This has been built into a steel bunded tank unit and is located at WI Rendall's store in Pierowall. The setup is ready but retail sales never started.

### What happened next

Biofuel production was stopped for some time in 2010-2011 because:

- The production plant had to be dismantled and removed when the shed where it was produced was sold
- We do not currently have a suitable site ready for production
- The project had been operated and managed by a single person, and when they had to take up other work temporarily there was no time to make fuel.

- The complexity of the equipment (assembled from a variety of non-standard parts) and the lack of a permanent power supply meant it was impossible for anyone else to step in.

### The final stages

- As one last attempt to make realistically priced and high quality biodiesel, the project manager negotiated with COPE in Shetland to acquire some redundant biodiesel production equipment.
- The project manager/biodiesel maker returned to making biodiesel on the site using generator power and the Shetland kit, but the kit (in two containers) was still considered to need substantial further modification.
- The Westray Development Trust considered a further proposal for a building and power supply on the site to make it easier and safer to produce the biodiesel, and requested a Health and Safety report, as well as a new business plan for the project.
- After a further period of time it became clear to WDT that biofuels could not be produced economically or safely with the current setup. Because the “research and development” phase had continued for so long with no saleable biofuels resulting from it, it was decided to wind up the project.
- In July 2012, negotiations are in progress to pass the equipment on to a non-profit group on Westray so they can continue to process small quantities of biofuels. WDT will no longer be importing the used cooking oil from Orkney Islands Council for processing and it will be up to the new group to obtain supplies of raw materials.