

The image shows two fishing boats on a body of water during sunset. The boat in the foreground is white with a cabin and a mast with several flags. The boat behind it is red. The water is dark blue with small waves, and the sky is a mix of orange and grey. In the background, there are some structures and a rocky shore.

THE PROJECT BIOFUELS FOR THE FISHING INDUSTRY

# Energy efficient fishing

A manual about biodiesel usage at sea

**Sanna-Sofia Skog**

Translation: Monika Fröjdö, Niklas Frände

## Biofuels for the fishing industry

The EU funded Project, Biofuels for professional Fisheries, investigated the possibility of using biofuels in Ostrobothnia fishing industry. By using biodiesel as an alternative fuel in the fishing boat, the fishermen improve fisheries sustainability, and possibly even improve the external perspective on commercial fishing industry which could be leading to increased interest in domestic fish.

The project was implemented in cooperation with Ostrobothnia Fisheries Association, Feora Oy, Larsmo municipality and two fishermen. In the engine laboratory in Technobothnia Research Centre fuel testing has been carried out on both biodiesel and petroleum diesel, in collaboration with the University of Vaasa. The use of biodiesel has in practice been tested in two fishing boats, and Larsmo municipality taxi boat MS Wilma.

To find more about the project please visit our website where you find the full project report: <http://www.novia.fi/assets/filer/Publikationer/Serie-R-rapporter--2013/Biobrnslen-fiskenringen-7.2013.pdf>

### The project biofuels for the fishing industry / Energy efficient fishing

Researcher/editor: Sanna-Sofia Skog

Publisher: Novia University of Applied Sciences, Wolffintie 33, Vaasa, Finland

© Sanna-Sofia Skog & Novia University of Applied Sciences

Novia publikation och produktion, serie L: Läromedel 4/2015

ISBN 978-952-7048-15-3 (online)

ISBN 978-952-7048-16-0 (print)

ISSN 1799-4195

Printing: Fram, Vaasa, 2015

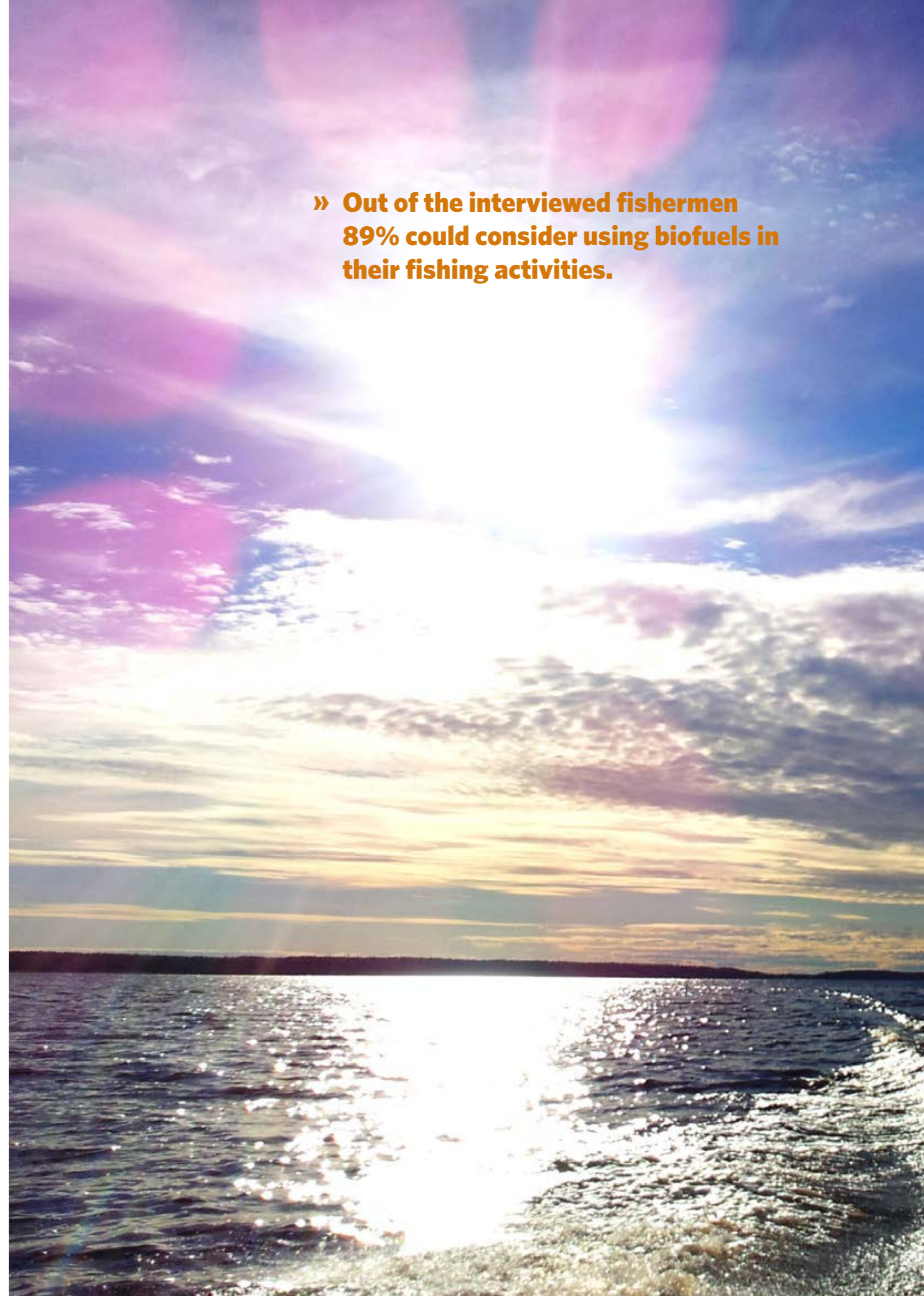
Layout: Mikael Paananen

In cooperation with: Österbottens fiskarförbund r.f., municipality of Luoto, Ab Feora Oy

Funding organisations: European fisheries fund, Coastal Action Group of Ostrobothnia



» Out of the interviewed fishermen  
89% could consider using biofuels in  
their fishing activities.



## What is biofuel?

Biofuels are fuels produced directly or indirectly from organic materials. Biofuels that are most suitable for vehicles are ethanol, biogas and biofuel. The main focus in this study has been on using biofuel, as the biofuel can be used in existing diesel engines, just with some small modifications.

## What is biodiesel?

Biodiesel is a fuel made out of vegetable oils or animal fat. There are different ways to produce biodiesel. The most common manufacturing method is transesterification. During the transesterification process the pure vegetable oil or the animal fats undergoes a chemical reaction. The presence of a catalyst (mostly a base) allows a reaction of the oil and the fats together with some alcohol (in most production methanol). The products of the reaction are the biodiesel itself and glycerol. After that the glycerin and biodiesel phases are to be separated and the biodiesel is purified by washing with warm water to remove residual catalyst or soaps, and is ready to be used.

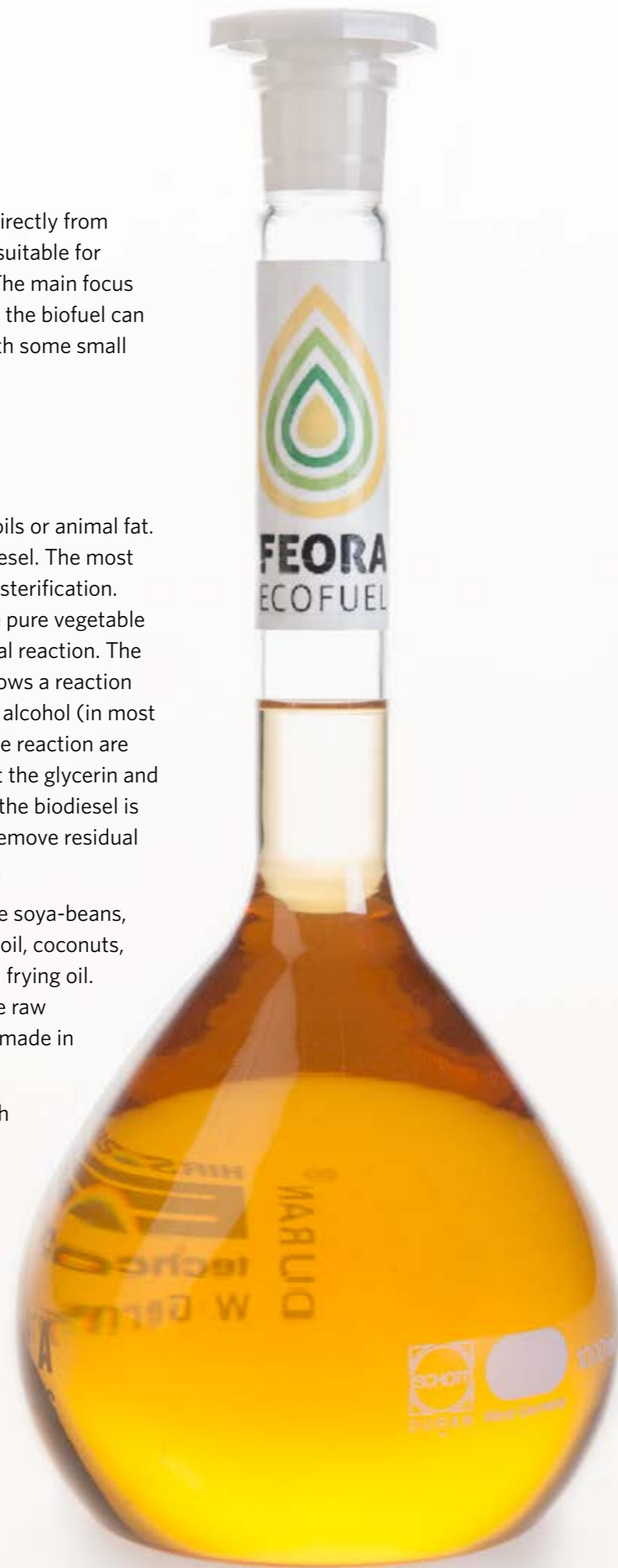
Biodiesel raw materials vary. Examples are soya-beans, cotton-seeds, palm-trees, nuts, rapeseed oil, coconuts, sunflower-seeds, lard, grease, fish oil, and frying oil. Depending on the origin and quality of the raw material, some changes maybe has to be made in the production process.

Biodiesel can be blended, in any ratio, with petroleum diesel. Diesel blended with biodiesel is usually termed Bx, which means that the diesel contents of x % biodiesel, e.g. B10 contents of 10 % biodiesel and 90 % petroleum diesel.

**Transesterification** = the most common process to produce biodiesel

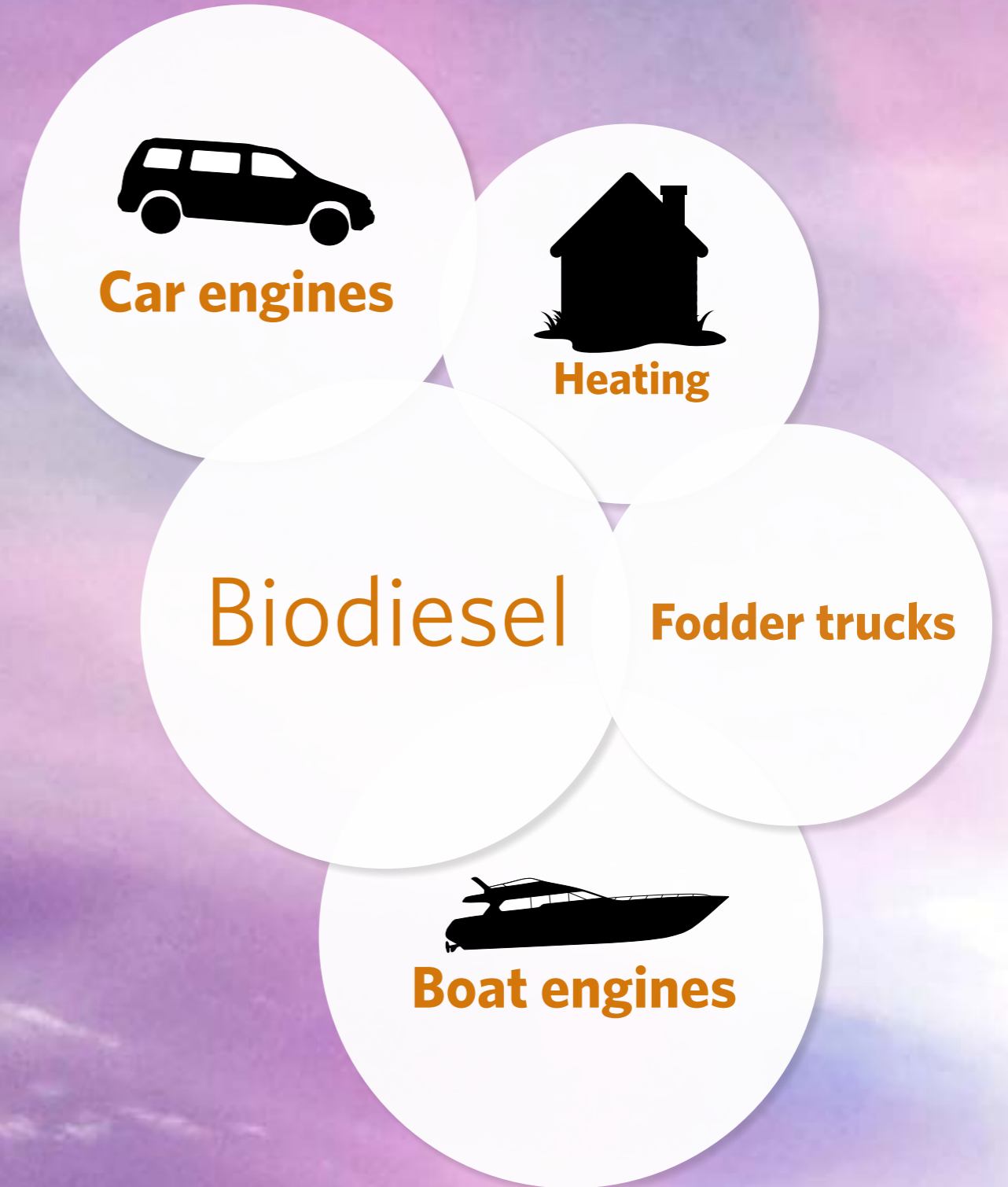
**A base** = a substance, that in aqueous solution has a pH over 7, e.g. potassium hydroxide (KOH)

**Glycerol** = by-product of biodiesel production



## Applications

Where is biodiesel meant to be used?



## Biodiesel fuel advantages and disadvantages



### Advantages

- renewable
- biodegradable
- high flash point
- reduces the emissions of hydrocarbons (HC), polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>) and sulfur oxides (SO<sub>x</sub>)
- non-toxic
- requires little or no engine modifications
- good lubrication properties



### Disadvantages

- more viscous
- lower energy content
- poor cold properties
- higher emissions of nitrogen oxides (NO<sub>x</sub>)
- incompatibility with some engines
- poor storage properties
- biodiesel has a cleaning effect on the engine and the tank, which could loosen accumulated dirt and clog the fuel filter

**CO = Carbon monoxide:** Is a harmful air pollutant that even at low concentrations is lethal to aquatic organisms such as fish. At high concentrations carbon causes hypoxia in humans.

**NO<sub>x</sub> = Nitrogen oxides:** They are produced from the reaction of nitrogen and oxygen at high temperatures and high pressures. Nitrogen oxides cause acidification of water bodies.

**HC = Hydrocarbons:** Chemical compound consisting only of carbon and hydrogen. Hydrocarbons are harmful to both humans and the environment.

**PM = Particles:** A complex mixture of extremely small particles and liquid droplets. The particles are dangerous if inhaled. Depending on the size, the particles can be carried deep into the man's breathing organs. PM<sub>10</sub> refers to particles with a diameter less than 10 microns.

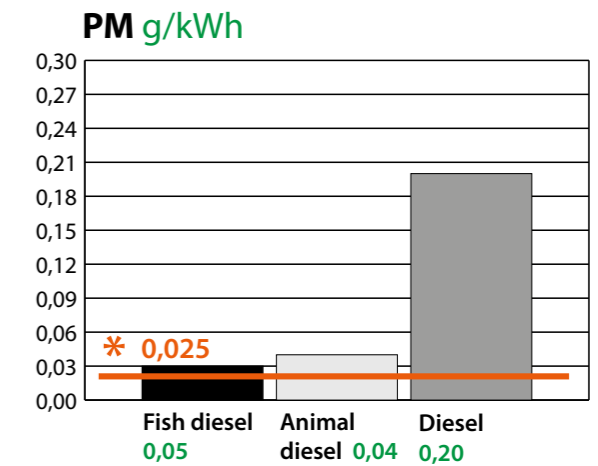
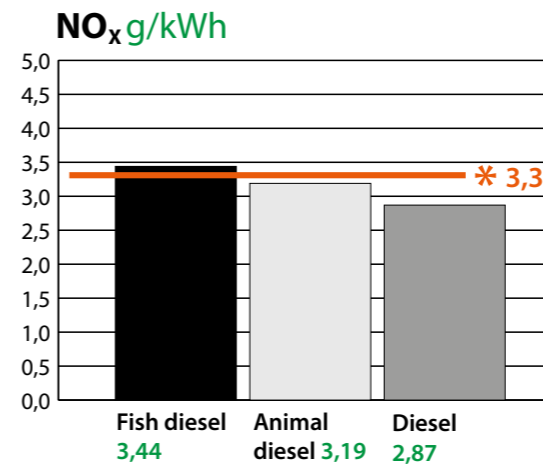
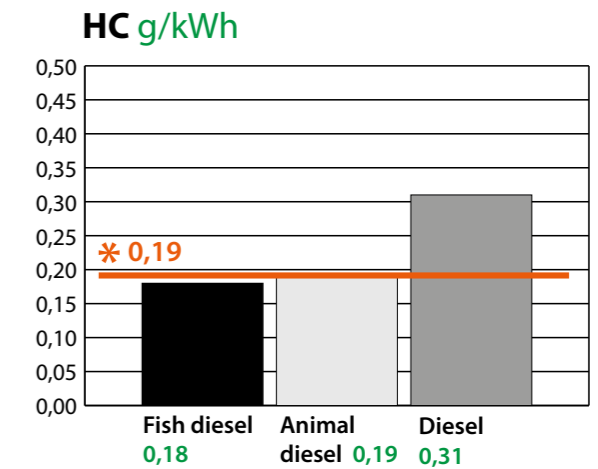
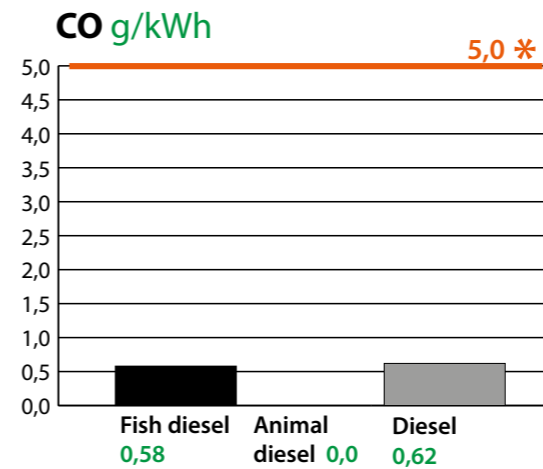
**PAH = Polycyclic aromatic hydrocarbons:** Occurs in e.g. coal and petroleum, carcinogens.

**SO<sub>x</sub> = Sulfur oxides:** Resulting from the burning of sulfur-containing substances. Sulfur oxides cause acidification of water bodies.

**CO<sub>2</sub> = Carbon dioxide:** A greenhouse gas.

**Cetane Number** = A measure of diesel fuel ignition delay. The higher the cetane number the quicker the spontaneous combustion of the fuel.

**Energy content** = Fuel heating value



\* Emission limits for Non-road engines with a rated power of 75-130 kW (2012) [g/kWh], source <http://www.dieselnet.com/>

## Emissions

Diesel and two other biofuels were tested in the engine laboratory in Techno-bothnia. Biodiesel produced from fish guts from rainbow trout and biodiesel made from animal fat was used in the tests.

Compared to diesel, the biofuels are cleaner on all emission points, beside the nitrogen oxides. Higher nitrogen oxides emissions are partly due to the fact that the viscosity of biodiesel is higher, i.e. has a high density and partly due to a lower cetane number. A high cetane number means a quick self-ignition of the fuel, which lowers the combustion temperature. Particle requirements could be achieved e.g. by adding a particulate filter.



The fuels were tested in a AGCO Sisu Power 44CWA Non-road diesel engine in the engine laboratory in Techno-bothnia.

## Biodiesel for marine use

Biodiesel can, with little modifications be used in boats with diesel engines. As the biodiesel has excellent cleaning properties, they can dissolve accumulated dirt in the fuel system. Therefore it is recommended to clean the fuel system and the tank before using biodiesel. Biodiesel dissolve old petroleum deposits in the tank and the fuel system, which cause clogged filters. The filter should be changed before starting using biodiesel. It is recommended always having an extra filter in the boat, in case the filter gets clogged during the journey. The filter might have to be changed more often than usual.

Gaskets, hoses, adhesives, plastics and seals made of polyvinyl, polypropylene, and Tygon nitrile may leak and degrade on contact with biodiesel. These should be replaced with synthetic material such as nylon, Teflon, Viton and fluorinated plastics. Find out what materials the engine consists of before starting to use biodiesel.

Biodiesel is oxidation-sensitive in contact with oxygen. It also has a tendency to break down with exposure with water. Heat, sunlight, and oxygen will also cause biodiesel to degrade more rapidly, so storage should minimize exposure to these conditions. Biodiesel should not be stored any longer than one year.

The performance of biodiesel in cold conditions is markedly worse than that of petroleum diesel. At temperatures below +5 degrees it has to be blended with petroleum diesel. B20 can be used at temperature up to about -15 degrees. Always check your engine manufacturer's recommendations before transition to Biodiesel.

Out of the 37 interviewed fishermen in Ostrobothnia 89% could consider using biofuels in their fishing activities, in case it's available and cheaper than what they are using today.

### Facts about the suppliers

#### Ab Feora Oy

Jakobstadvägen 38,  
66900 Nykarleby  
www.feora.fi

#### Sybimar Oy

Energiatie 2,  
23500 Nystad  
www.sybimar.fi

#### Storfjärdens Fisk Ab

Sixten Sjöblom  
Torpvägen 114  
22270 Eckerö

» **89% could consider using biofuels** in their fishing activities, in case it's available and cheaper than what they are using today.

» **The fuel filter** should be changed more frequently than usual.



## Interviews with fishermen that has tested biodiesel

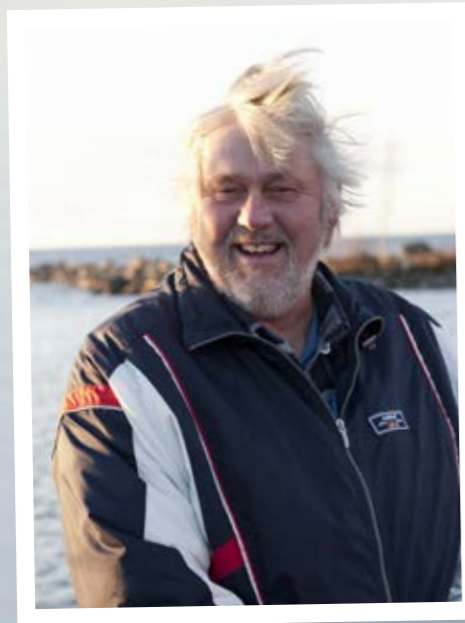
**Paul Holm**  
Fisherman

**Engine running on biodiesel:**  
**Valmet (6 cyl. 410 HP)**

**Fishing port:** Vexala fishing port

Had to change the fuel filter a couple of times and clean the fuel tank. It is hard to compare the fuel consumption as it differs during the summer and winter season.

Has been using only biodiesel during the summer seasons 2011 and 2012.



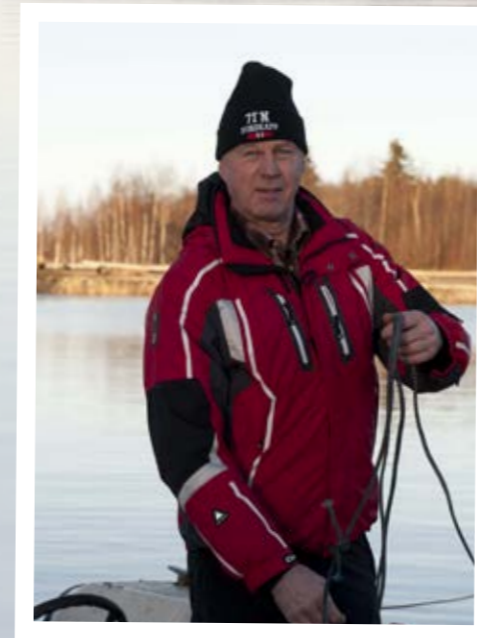
**Karl-Johan Elvström**  
Fisherman

**Engine running on biodiesel:**  
**Perkins (6 cyl. 185 HK)**

**Fishing port:** Vexala fishing port

Has not noticed any difference, feels like the engine has been running at full efficiency on the biodiesel. I changed the fuel filter in the boat before I started running on biodiesel and I have not had any problems whatsoever.

Has been using only biodiesel for 9 weeks during late summer 2012.



**Boris Bäck**  
Municipality of Larsmo

**Property caretaker at Municipality of Larsmo**

**Engine running on biodiesel:**  
**Volvo Penta (4 cyl. 48HK)**

Did not notice any difference between the use of biodiesel and diesel. Have nothing to remark on, but it would be interesting with long-term testing.

Drove the taxi boat MS Wilma which is commuting between Köpmanholmen island in Larsmo and the mainland. MS Wilma used 200 liters of 100 % biodiesel during the summer season 2012. The fuel filter was changed once.

» **The fishermen in Ostrobothnia** estimate that they operate their fishing boat around 300 hours per year which consumes around 2100 liters of petroleum.

## Different ways to lower the fuel costs

By fishing in an energy efficient way, fuel consumption could be lowered by up to 30 %.

### General

- Use navigational technology and echo sounding to shorten the transport distances
- Reduce the resistance of the nets, by using lighter materials and yarn with a smaller diameter
- Be observant

### Increase the efficiency of the propeller

- Increase the diameter of the propeller
- Remove dirt
- Repair damages and material fatigue

### Driving style

- Planing boats should be driven below or a bit above the planing threshold, and then the boat should be driven at a cruise speed suitable for the boat
- The bow wave should be visible around the middle of the boat
- When approaching waves, take a small detour instead of slowing down and later accelerate
- Load the boat evenly
- Reduce the cruise speed

### Tools and machinery

- Keep an eye on the fuel consumption for better monitoring of the performance
- Clean and tend to tools and machinery
- Tend to cooling cables
- Clean the air filter and the ventilation system in the engine room
- See to that the cooling fans are clean
- Inspect the engines filters, hoses and connections every season and replace the spark plug
- Make sure you use the correct size of tools, machinery and ship for the required task

### Reduce the friction

- Tend to the hull
- Remove vegetation from the hull
- Add corrosion-preventing paint

The fuel consumption for a fishing boat varies, depending on the fishing equipment and the fishing methods. In a survey to 37 fishermen the average engine use was estimated to be about 300 hours per year. During that time the fishermen used an average of 2100 liters of fuel.

Mr. Fisher uses approximately 7 liters petroleum per hour.

**Yearly consumption:** 2100 liter/year  
**Engine use:** 300 hours/year  
**= 7 liter per hour**

We assume he runs the engine most of the time during summer when it is warm and less time during late autumn and early spring. During summer Mr. Fisher replaces the petroleum to biopetroleum (biodiesel), which at Feora is 15 cent/liter cheaper than ordinary petroleum.

**Summer consumption:** 200 hours/1 400 liter  
**Winter consumption:** 100 hours/700 liter  
**Cheaper fuel price:** 0,15 €/liter

**Savings:** 210 €/year

By regular maintenance of the hull and propeller, and by keeping the surface of the propeller blades in good shape and by thinking about his driving habits Mr. Fisher can reduce his fuel consumption by up to 30 %.

**Saving by maintenance and driving habits:** 630 liter/year (30 %)

If the price of the petroleum is 1,05 €/liter, it means that Mr. Fisher saves 660 € yearly by regular maintenance and eco-friendly driving, if we assume a maximum fuel saving.

**Driving on biofuel:** -210 €/year  
**Maintenance and driving habits:** -660 €/year

**Total:** -870 €/year



## Engine manufacturer's recommendations

Biodiesel can be used in most diesel engines without or with small engine modifications. Engine manufacturers do have their own regulations and recommendations about the usage of biodiesel in their engines. Generally all manufacturers demand that the biodiesel to be used should fulfill the standards EN 14214 or ASTM D6751.

Most engine manufacturers approve the use of B5 biodiesel mixtures in all their diesel engines. B5 fuel can be used with normal maintenance. If the level of biodiesel in the fuel increases, the engine manufacturers apply additional maintenance demands on the engine. The oil filter, engine oil and fuel filter shall be replaced more frequently, especially in the beginning after switching to biodiesel. Many manufacturers make demands on the quality of the engine oil and only selected engine oils should be used during operation on biodiesel. In addition to this, one should make sure that the filters is compatible with biodiesel. Hoses, gaskets and other plastic and rubber components in the fuel system should be inspected more often, since some materials are not compatible with biodiesel and leakage can occur.

If the engine is to be left unused for a longer time, many engine manufacturers recommends rinsing the engine and the fuel system with regular diesel before storage. The recommended storage time for biodiesel is 4-6 months and the storage tanks should be kept away from water and direct sunlight to prevent the growth of microbes. Storage tanks and fuel tanks should be thoroughly rinsed before they are filled with biodiesel.

Different engine manufacturers treat the use of biodiesel differently with respect to warranties. Some manufacturers do not provide warranty for engines using more than 5 % biodiesel, while other manufacturers provide warranty for 100 % biodiesel usage as long as you follow the manufacturer's instructions on biodiesel usage.

More information about specific engine manufacturers and their recommendations on biodiesel can be found under the internet links to the right. To assure that the information is up to date and applies to your engine specifically, contact the engine retailer to get clear instructions on biodiesel usage.

### AGCO Power SISU diesel engines

<http://www.agcocorp.com>

<http://investors.agcocorp.com/phoenix.zhtml?c=108419&p=irol-newsArticle&ID=936736&highlight=>

### Caterpillar

<https://marine.cat.com/>

<http://parts.cat.com/cda/files/3244668/7/SEBU6251-16.pdf>

### Cummins

<http://cumminsengines.com/>

<http://cumminsengines.com/biodiesel-faq>

[http://www.sbmar.com/Maintenance/PDF/Cummins-Fuel\\_ServiceBulletin\\_Nov-07.pdf](http://www.sbmar.com/Maintenance/PDF/Cummins-Fuel_ServiceBulletin_Nov-07.pdf)

### Perkins Sabre

<http://www.perkins.com/marine>

### Scania

<http://www.scania.com/products-services/engines/marine-engines/>

<http://www.scania.com/products-services/buses-coaches/environment/alternative-fuels/biofuels.aspx>

### Volvo Penta

<http://www.volvopenta.com/volvopenta/se/sv-se/pages/pentahome.aspx>

[http://www.volvopenta.com/volvopenta/finland/fi-fi/marine\\_leisure\\_engines/clean\\_safe\\_at\\_sea/alternative\\_fuels/biodiesel/pages/biodiesel.aspx](http://www.volvopenta.com/volvopenta/finland/fi-fi/marine_leisure_engines/clean_safe_at_sea/alternative_fuels/biodiesel/pages/biodiesel.aspx)

### Yanmar

<http://www.yanmarmarine.eu/>

[http://www.yanmarmarine.com/index.cfm/go/News/c/main/news\\_id/8](http://www.yanmarmarine.com/index.cfm/go/News/c/main/news_id/8)



