Experiences with Pure Plant Oil (PPO): A Successful Story ?

by Niels Ansø
Dajolka.dk

GREEN MOBILITY conference
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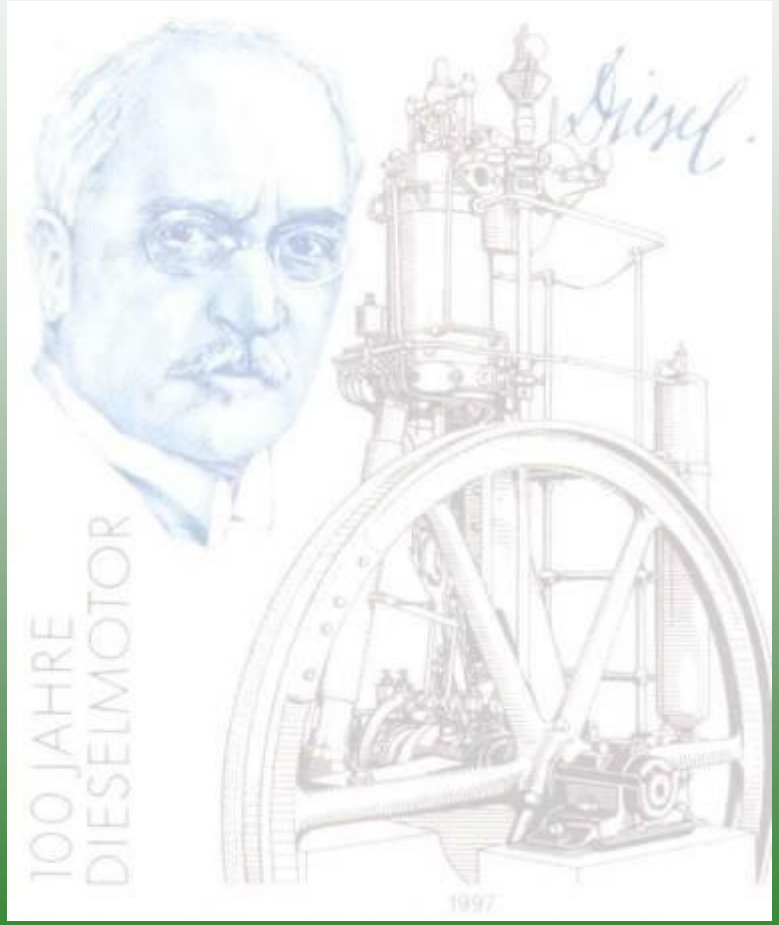
@Folkecenter.dk

Rodulf Diesel used peanut oil in 1912

"The use of plant oil as fuel may seem insignificant today. But such products can in time become just as important as kerosene and these coal-tar-products of today."



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PPO - just one of the several solutions

In the future it will be necessary to use
a broad range of fuel solutions for transportation:

- Ethanol
- Methanol
- Electrical cars
- Hydrogen cars
- **Pure Plant Oil (PPO)**
- Biodiesel

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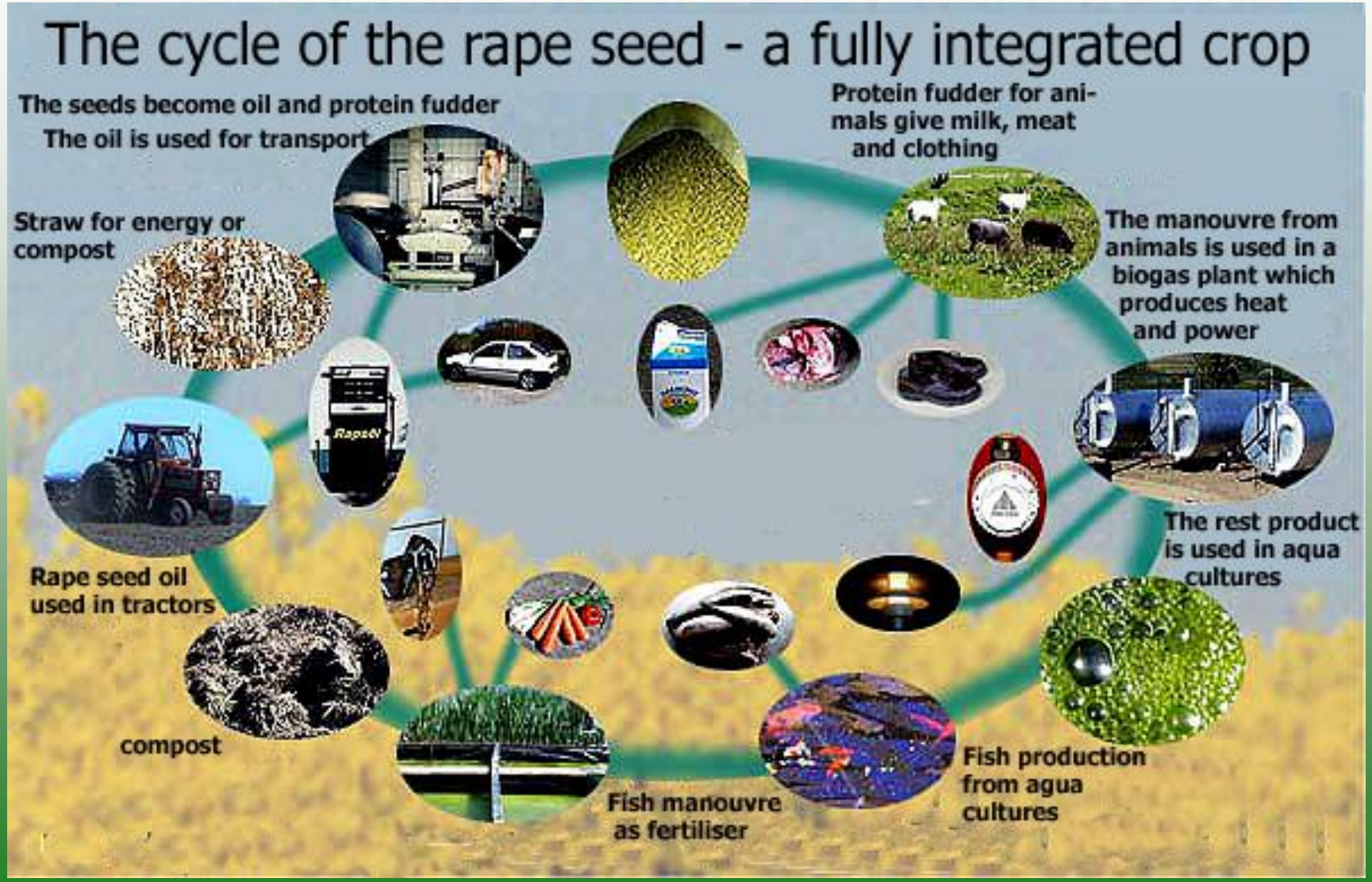
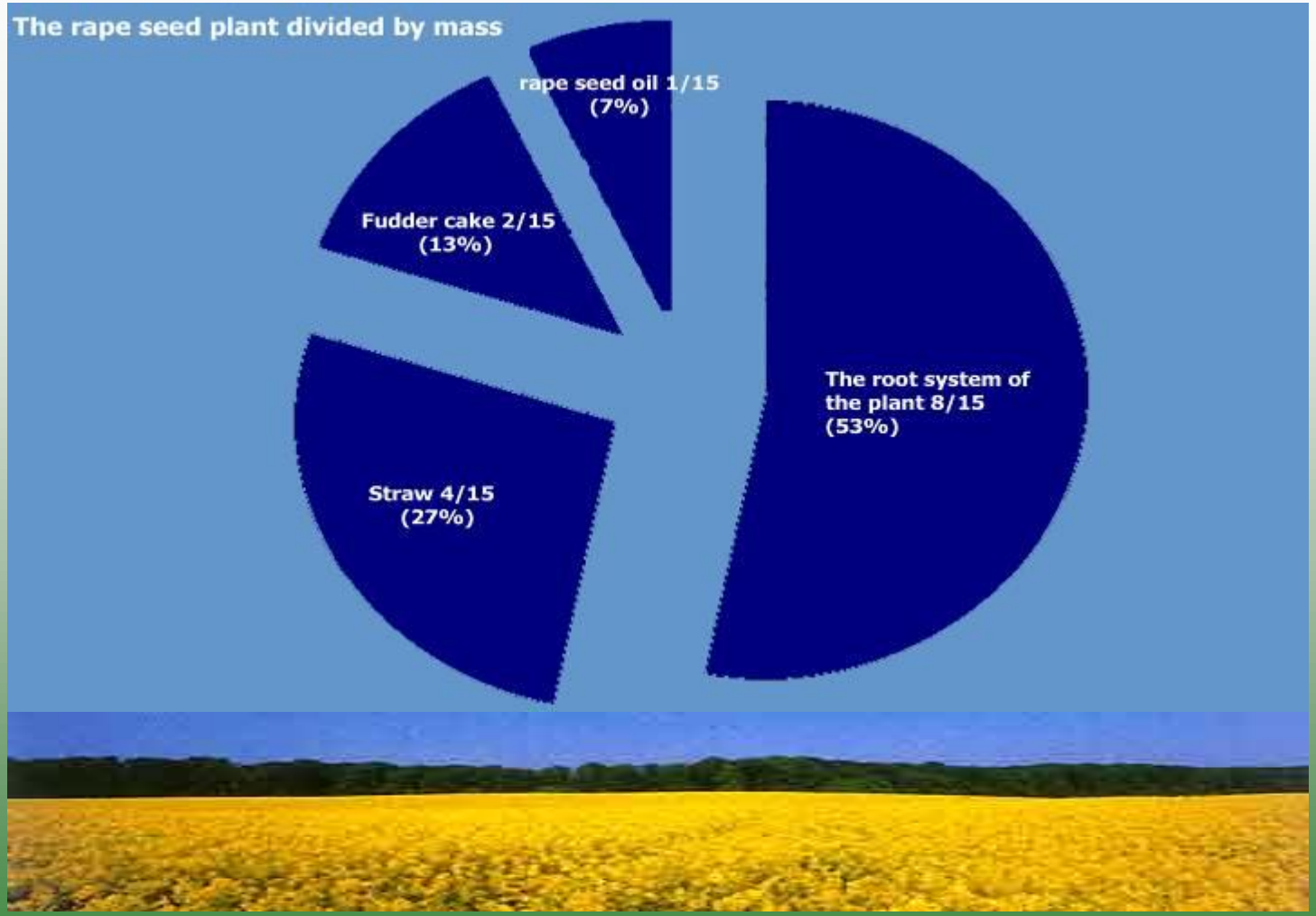
Integrated solution



Harvesting biomass, example Rape seed plant: produce oil, protein fodder, straw & roots



The rape seed oil is only 7% of the total grown biomass. 13% press cake, 27% straw and 53% root system.

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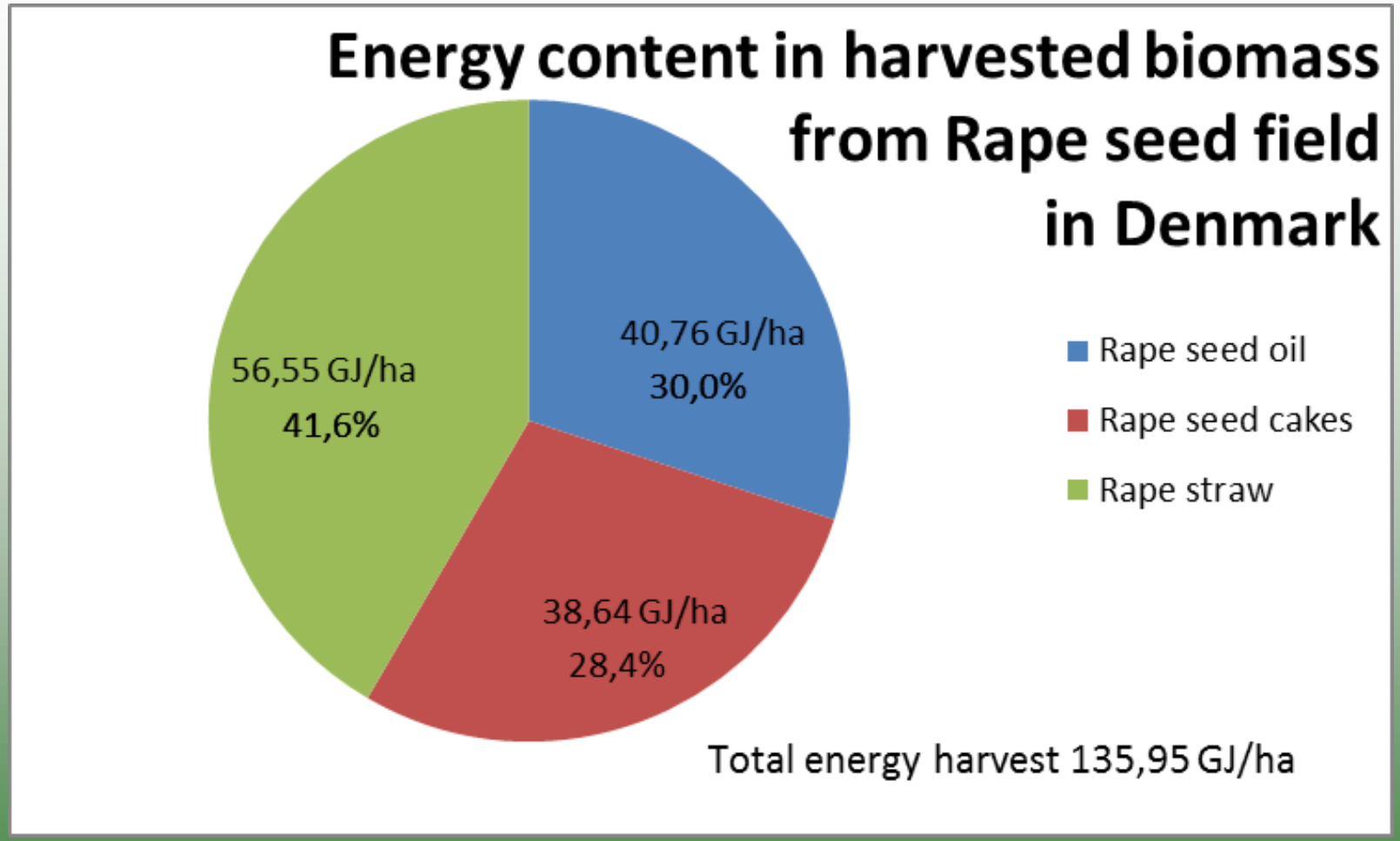
Harvesting Energy, example Rape seed oil - just a small part of the harvest



The rape seed oil contain only 30% of the harvested energy, but often the oil has to ”pay” for the production of press cake and straw in energy- and CO_2 balances.

PPO development in Denmark, BACKGROUND: Grass root activities

- Grass root activities created successful bottom up development in Denmark, led by Nordic Folkecenter for Renewable Energy.

- The PPO technology appealed to the people, but constantly met resistance from the Danish government, agencies and institutions.

- The practical experiences gained by the activities in Denmark are important for our current activities in Developing countries.

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PPO technology demonstrated at Folkecenter since 1992

Oil pressing test lab at Folkecenter

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Example small Oil press

”Täby” Oil expeller from Swedish pioneer, Skeppsta Maskin

Pure Plant Oil or Biodiesel?
Example cold pressed rape seed oil <> RME

Rape seed

Press

Filter

PURE PLANT OIL

Fuel for modified Diesel Engines

13% process energy

Incl. cultivation

26% process energy

Incl. cultivation

Methanol + Catalyst

Esterification

RME

Glycerin

Purification

Destilation

Conditioning

BIODIESEL

Fuel for ordinary Diesel Engines

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Production Plant of Pure Plant Oil

Photo´s from farm scale oil mill in Germany

Storage and distribution PPO, Examples:

In emergency case ..

.. oil from the Supermarket works

Why PPO when comparing with other `green´ solutions

- PPO is CO_2 neutral.
- PPO has the best Energy- & CO2 balance comparred to all other biofuels
- Is a well developed, tested technology.
- Available on the market today, e.g for tractors
- No danger of fire, can be stored in carports, on the ground, everywhere.
- Will not pollute ground water in case of leakages.
- Can be stored for more than a year; will not deteriorate.

Why PPO when comparing with other `green´ solutions

- It is a dual fuel system and the vehicle can still be fueled by diesel with normal efficiency.
- Is economical and can be installed in existing cars and tractors etc.
- High efficiency can be achieved in modern diesel engines; up to 37% (efficiency for gasoline cars is less than 24%).
- You can use it in the salad or on the frying pan.
- Production: locally, with modest investments. Specialized skills not required.

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What can be fueled by Pure Plant Oil

Many vehicles, which today are diesel driven:

- Diesel cars.
- Trucks and busses.
- Tractors.
- Ships.
- Trains.
- Combined heat power systems

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Examples of Plant oil operation

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3 main criterias for success with PPO fuel

- 1) Suitable diesel engine and proper conversion.
- 2) Good PPO quality with low content of FFA and low content of natural ash building components (S, P, Ca, Mg) as defined in the DIN PPO fuel standard
- 3) Suitable load pattern and good maintanance.

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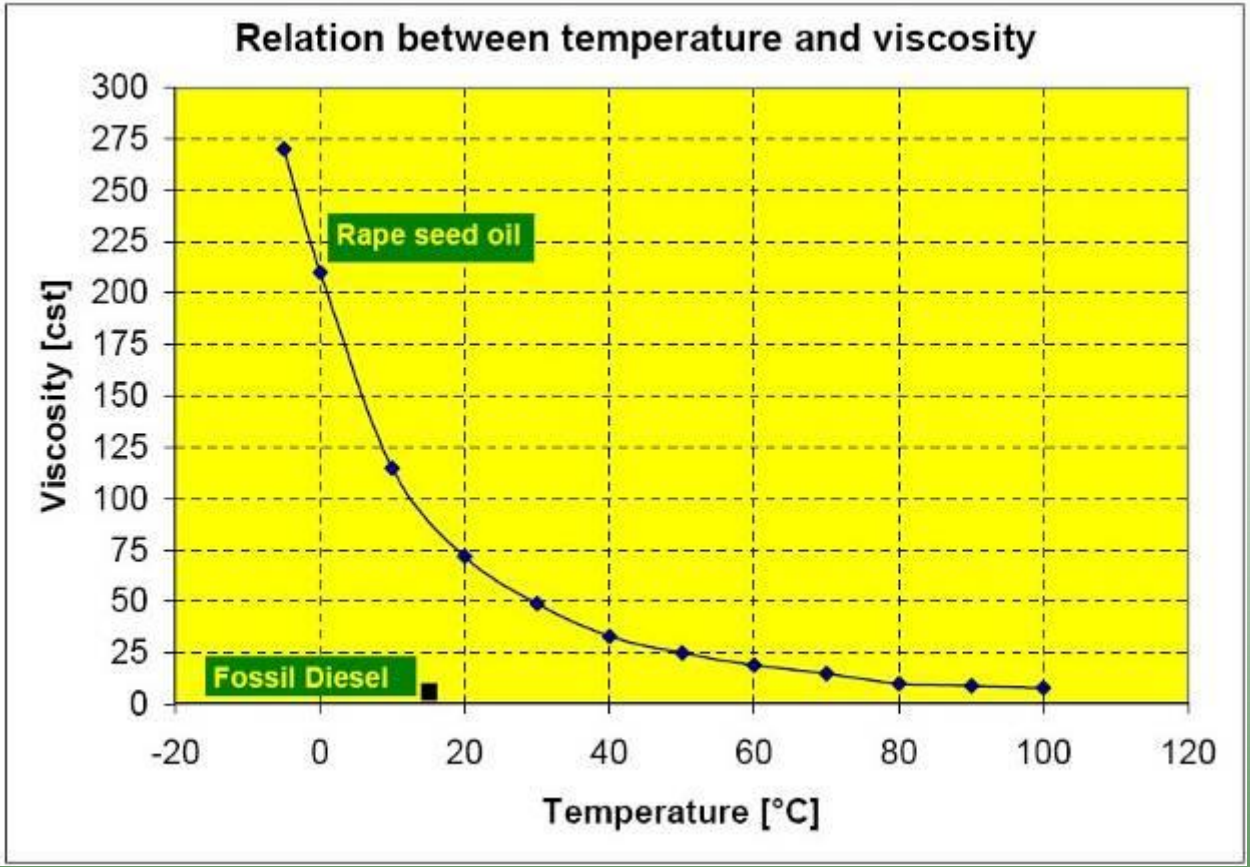
Fuel properties PPO <> Diesel
Viscosity of rape seed oil



When heated with engine cooling water to 60-70°C the viscosity is reduced consideerable.

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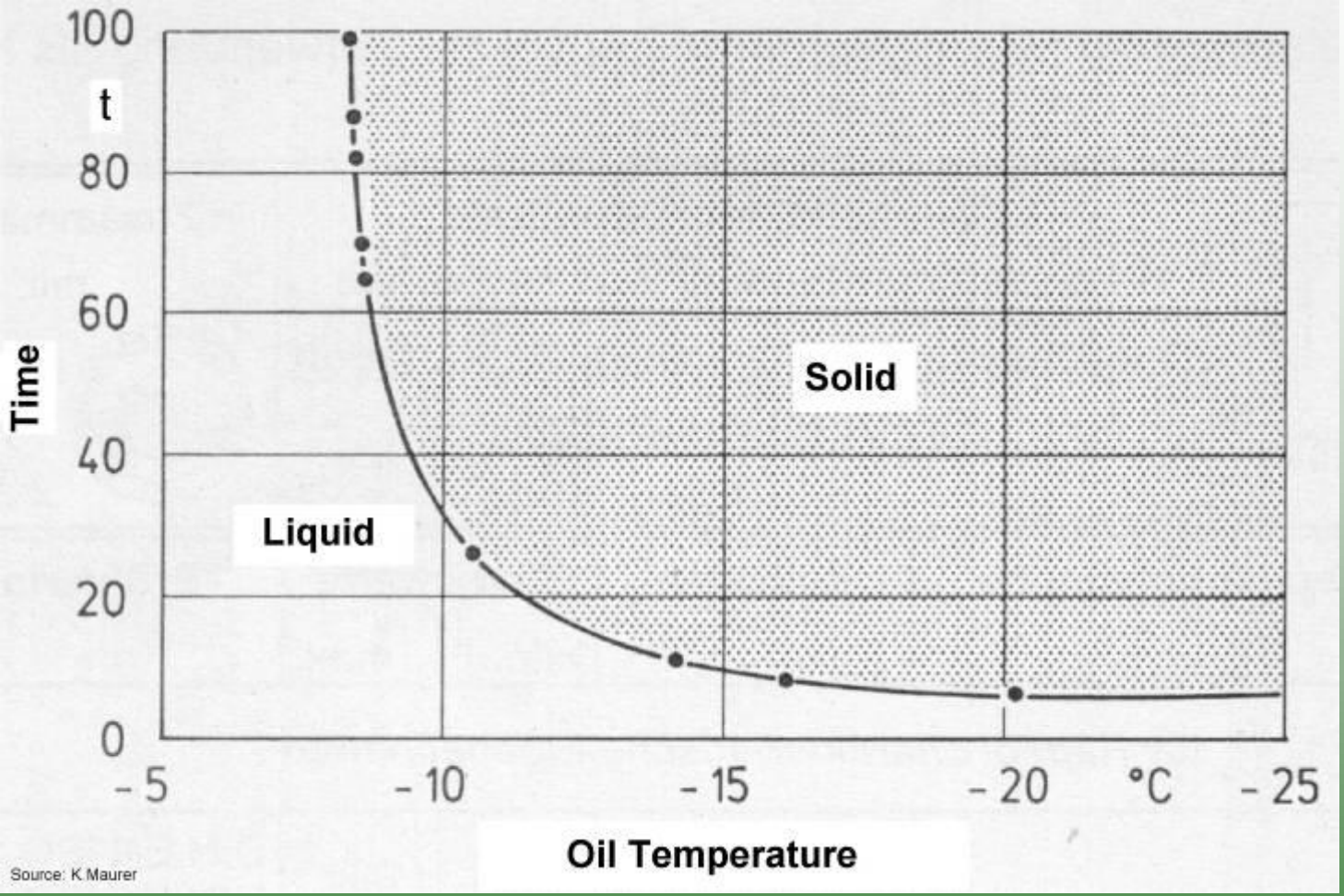
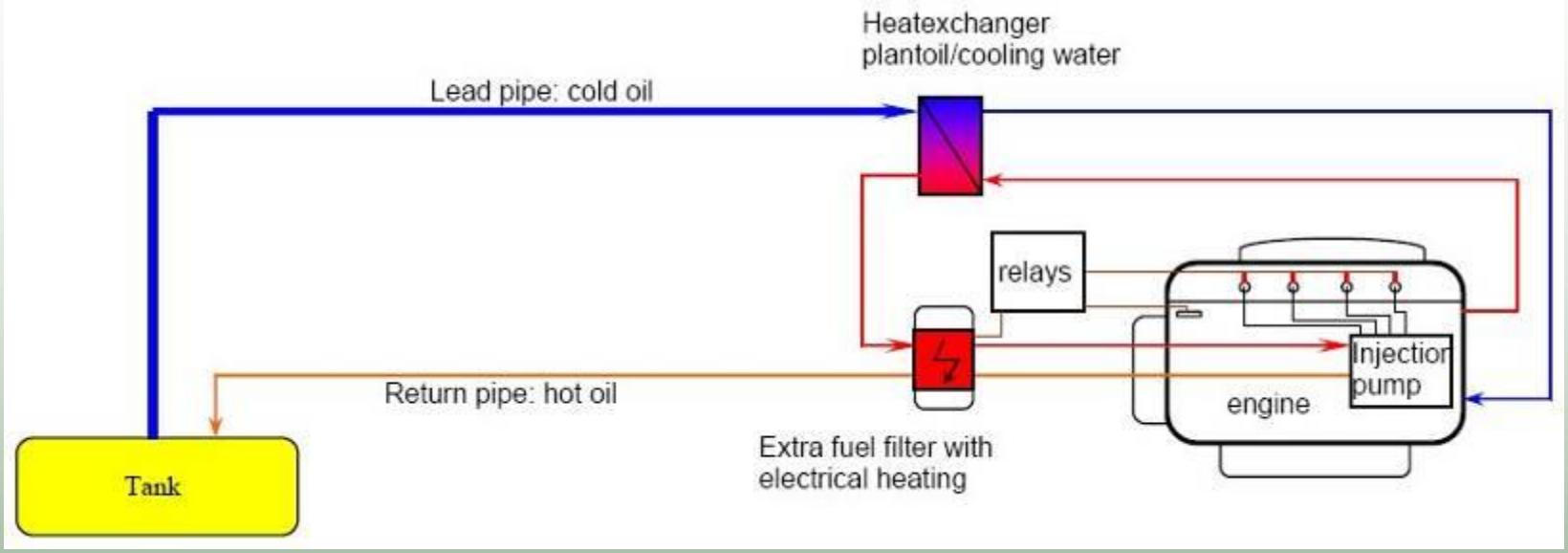
Fuel properties PPO <> Diesel
Rape seed oil at cold condisions



Freezing depends on time and temperature.
Other plant oils have similar solidification characteristic, but at different temperatures

Modification of Standard diesel engines



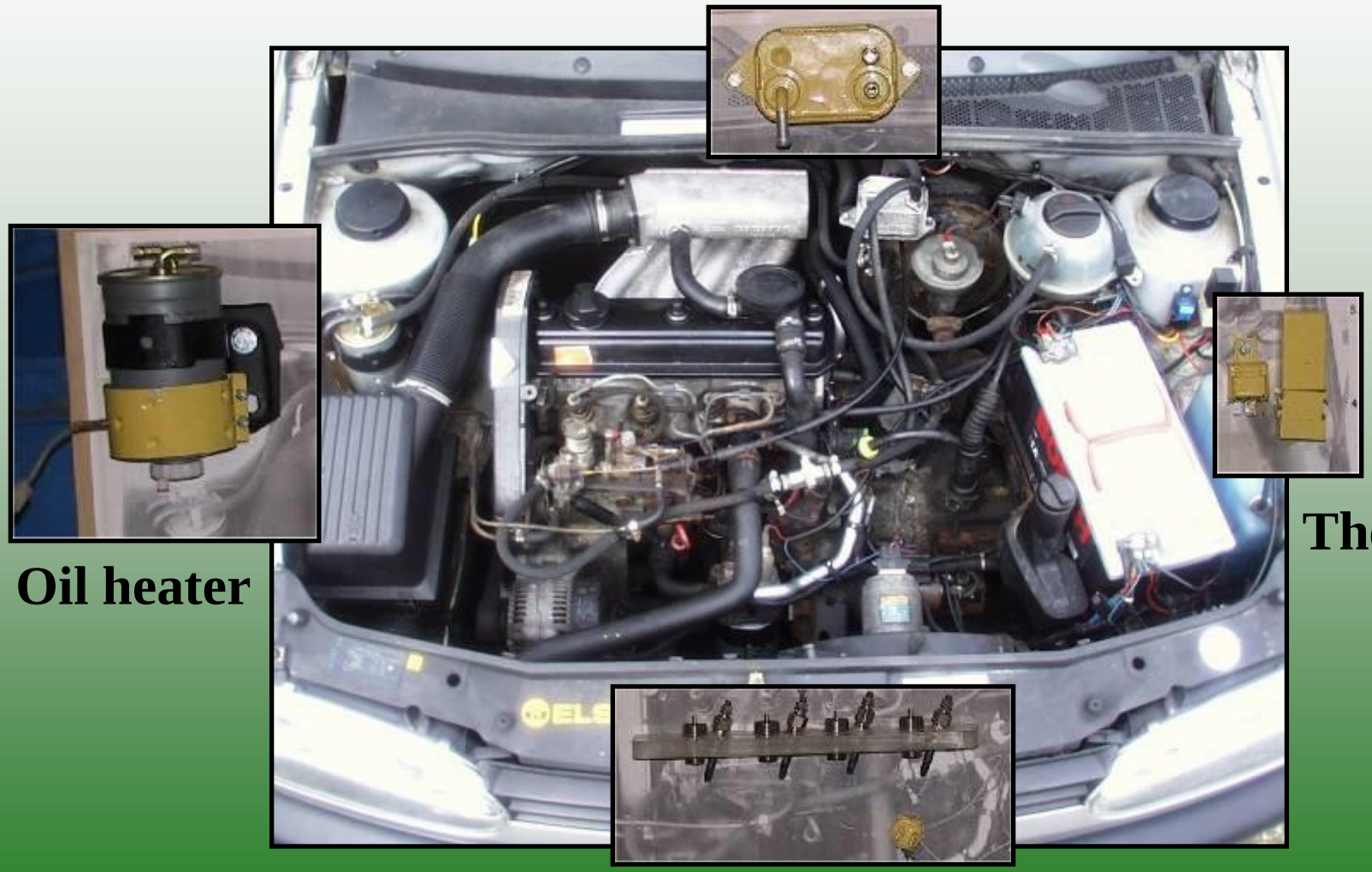
- Injection system should be Bosch or similar, but NOT distributor-types manufactured by DELPHI, LUCAS, CAV, Stanadyne and Roto-Diesel
- The engine should be in good condition
- A heat exchanger is installed to heat up the plant oil with hot cooling water
- A larger fuel pipe from tank to engine is installed
- An electrical heater is installed on the fuel filter which heats the first minutes of operation. The old fuel filter remains as extra filter.
- New injectors and adjusted injection pressure.
- New glow plugs which works the first minutes of operation 6: Relays for controlling glow plug, filter heater etc.

ELSBETT Parts for Modification of Standard diesel engines

From top left: glow plugs, hand pump, heat exchanger, fuel filter with electric heating, stop valve, injector nozzles, wires and relays

Conversion of standard diesel engine
How does it look in the vehicle

Heat exchanger



Oil heater

Thermostat

Glow plugs and nozzles

Self-builder workshop at Folkecenter

Car conversion by car workshops or self builders. Here DIY workshop at Folkecenter in April 2002. About 120 cars was been converted this way at 9 workshops (until nov. 2005)

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Self-builder workshop at Folkecenter

Crouwded and good atmosphere

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Self-builder workshop, hosted by Technical School for car mechanics

More space in professional surroundings, good atmosphere

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Local authorities trust & believe

New VW T4 modified for Vejle Amt, environmental department.

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Every self-builder-workshop a musician

An enthusiastic musician & his practical car mechanic.

Modification package – safety in the supply

New plantoil drivers usually buys complete package including modification, quality plantoil, and filling equipment.

Large engagement – fuel for local development

Enthusiastic self-builder(DIY) develop small oil press – The Hybren Oil expeller was born

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Local development creates new products and jobs

Enthusiastic self-builder becomes professional – Hybren Oil Expeller integrated in pellet boiler

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Local development creates new products and jobs

Another Danish developed oil expeller from SWEA

Local development creates new products and jobs

Another Danish developed oil expeller from BT Maskinfabrik

Reliable technology – personal experiences

VW Touran TDI
Particulate filter
7 years & 240.000km
on PPO (til now)

VW Golf with >10 years on 100% plant-oil. On the photo in the Austrian Alps and about -13°C

We drove > 960.000km on PPO with 4 cars during 18 years

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How do the vehicles drive

- The noise is slightly reduced. Plant oil is a “softer” fuel than diesel and the engine runs more smoothly.
- The consumption is comparable to diesel.
- Performance and torque are unchanged

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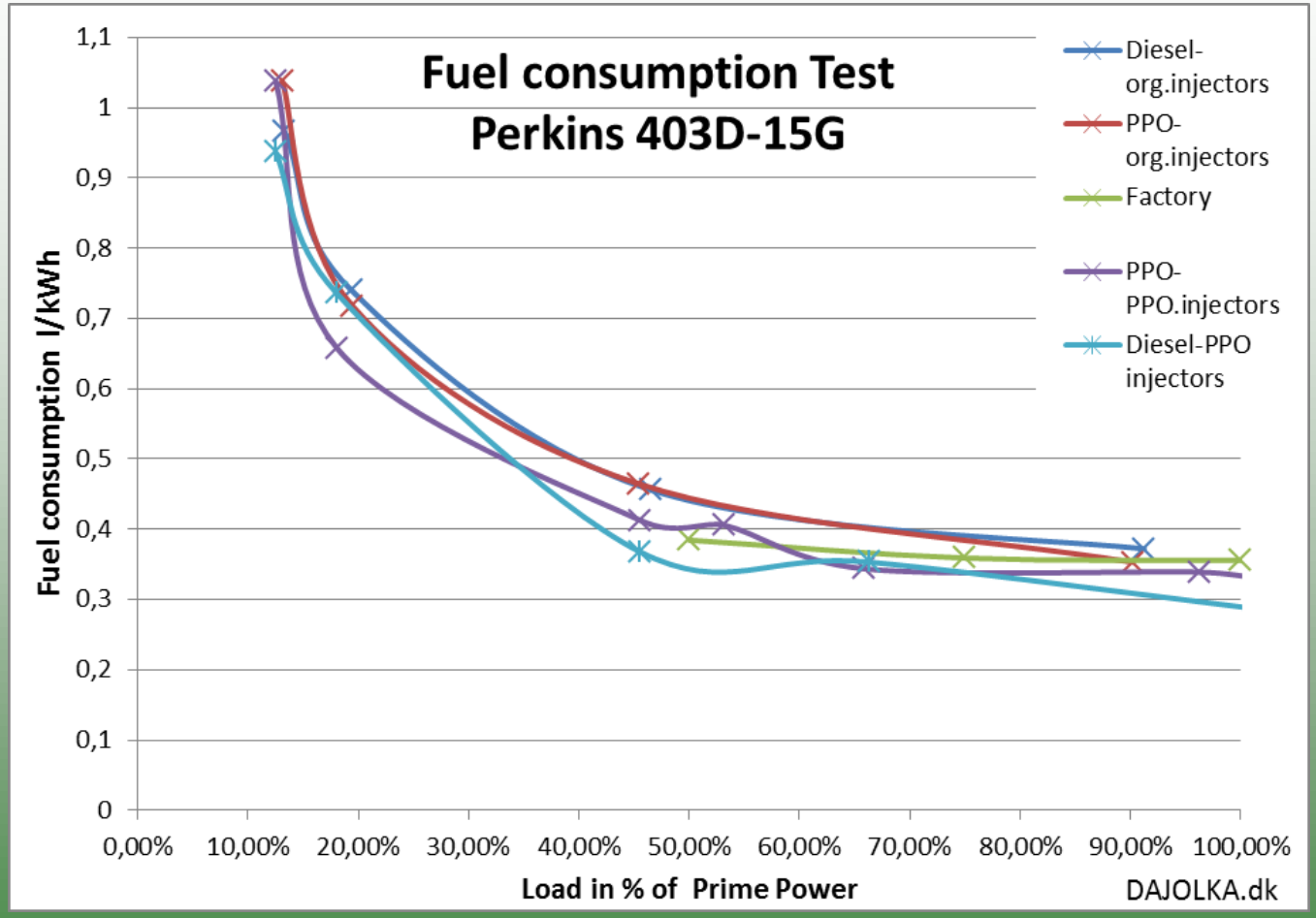
Energy content

Energy content in rape seed oil And fossil diesel	Rape seed oil	Diesel
Energy content [MJ/kg]	36,5	42,7
Density [kg/l]	0,92	0,84
Energy content [MJ/l]	33,6	35,9
Comparison energy / litre in %	93,6	100
Difference in %	-6,4	0

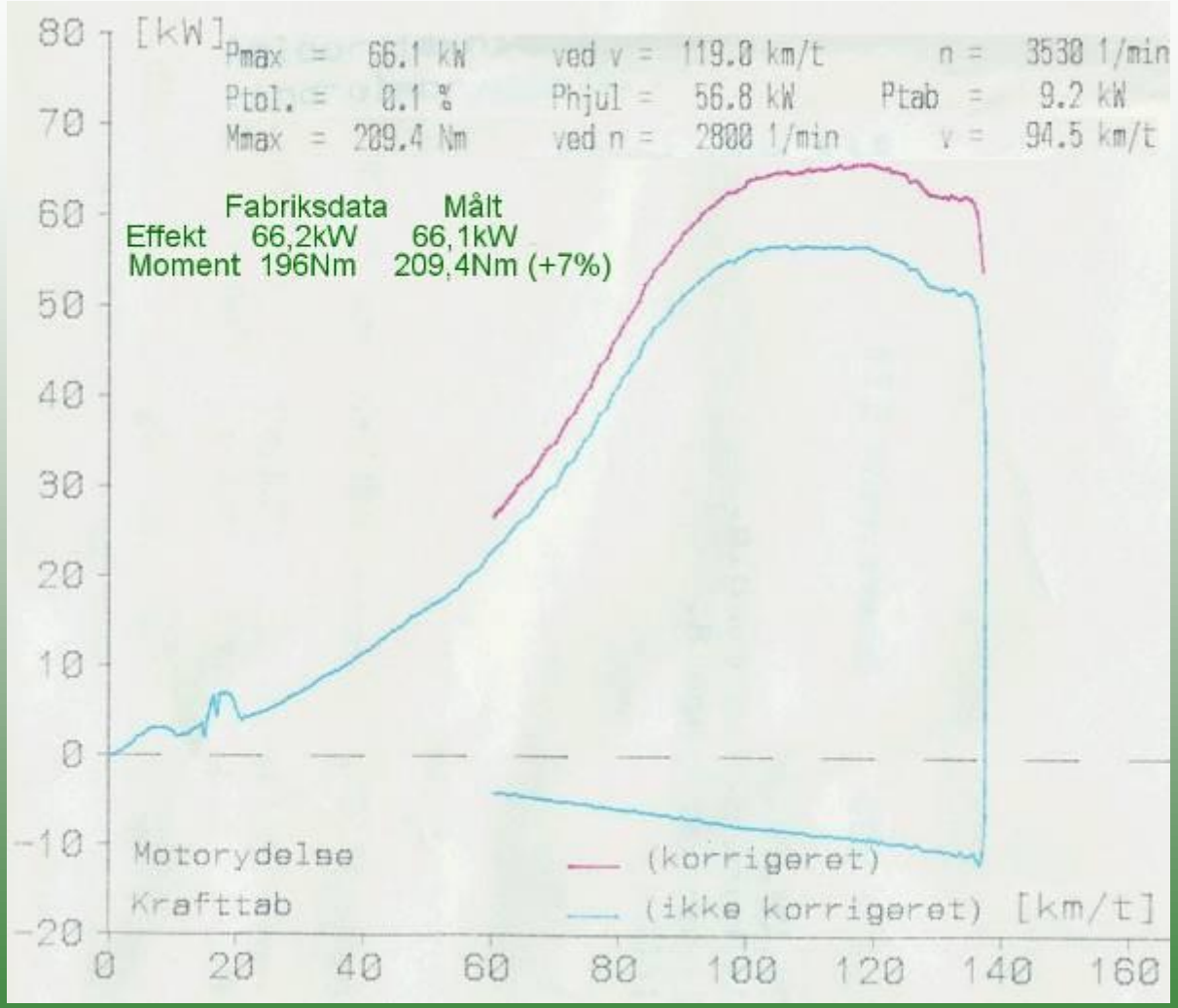
Energy content of PPO is a little less than for diesel, but same power and consumption for an engine due to higher efficiency caused by a natural content of ~11-12% O_2 in PPO

Energy content in PPO less – but fuel consumption the same as with diesel



Test of fuel consumption PPO<=>Diesel on gensets we delivered to developing countries.

Power and Torque PPO <> Diesel unchanged



Measurements on DAJOLKA´s Citroen Xantia 1,9TD

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World Wide PPO activities benefits from German research

DIN V 51605(2011)[3] – Quality Standard for Rape Seed Oil as engine fuel

Parameter	Limit	Unit
Characteristic/natural properties [1]		
Density at 15 °C	900 - 930	kg/m³
Flashpoint Pensky- Martens	min. 101	°C
Kinematic viscosity at 40 °C	max. 36,0	mm²/s
Calorific value (incl. H_2O –Correction)	min. 36.000	kJ/kg
Cetane number	min. 40	-
Carbon residue CCR (from Original)	max. 0,40	% (m/m)
Iodine number	95 - 125	g Jod/100 g
Sulfur content	max. 10	mg/kg
Variable properties [2]		
Total contamination	max. 24	mg/kg
Acid number	max. 2,0	mg KOH/g
Oxidation stability	min. 6,0	h
Phosphorus content	max. 12	mg/kg
Earth alkali content (Ca + Mg)	max. 20	mg/kg
Ash content	max. 0,01	% (m/m)
Water content	max. 0,075	% (m/m)

1) The natural properties which are independent from the process, handling and storing.
2) The variable properties which are influenced by the process, handling and storing
3) A final version of DIN 51605, with reduced limits for ash building components, were introduced by January 1.st 2012, especially to meet requirements for the newest type diesel engines with particulate filter installed, meeting the newest emission standard on the European market. The limits in the table above are from the DIN norm before January 1st, and are suitable for diesel engines without particulate filter, which applies to most engines in developing countries as well.

There´s a new DIN 51605 from 1/1 2012 for engines with DPF

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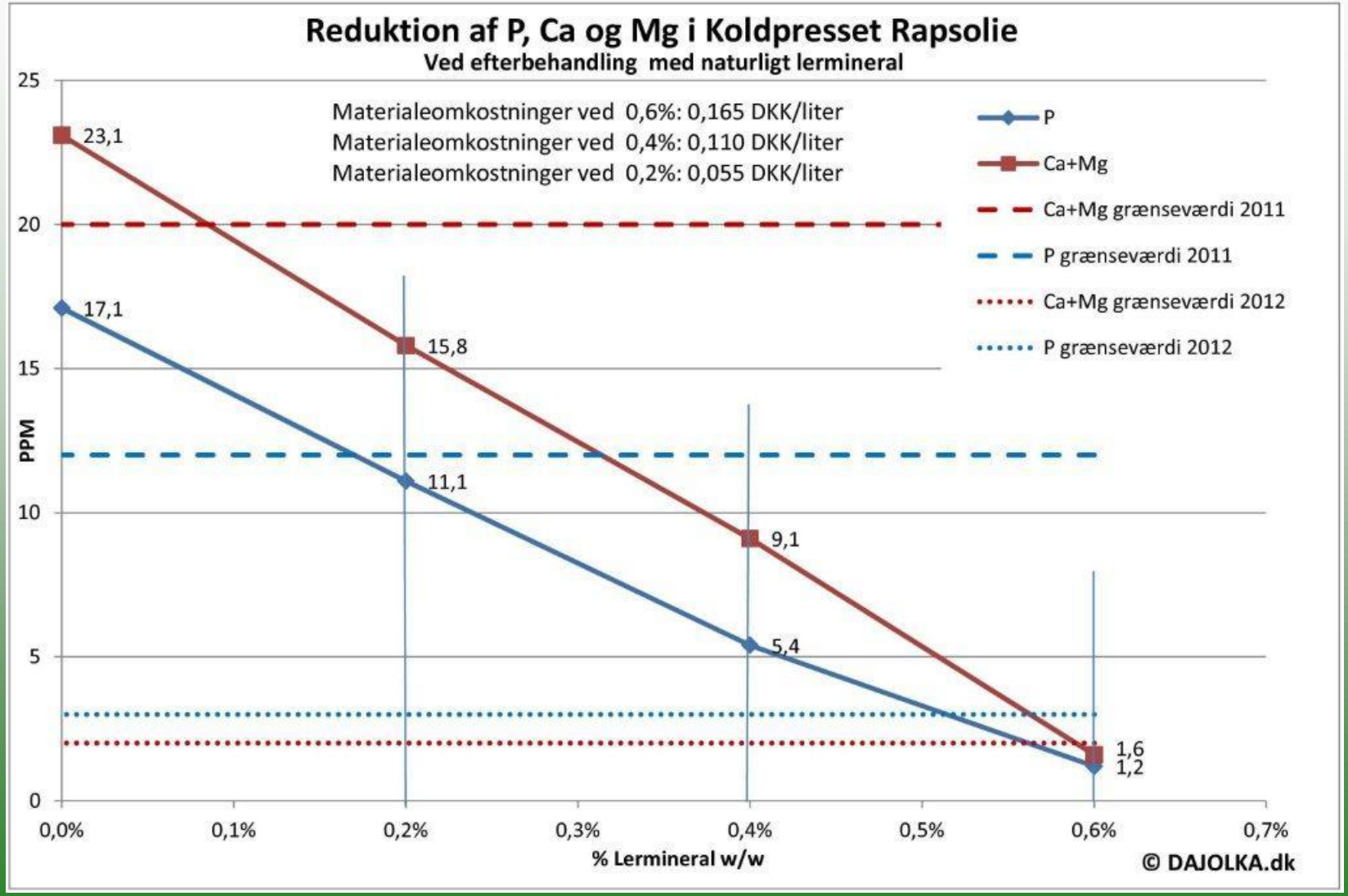
Improve quality by semi-refining
Easy and at low cost



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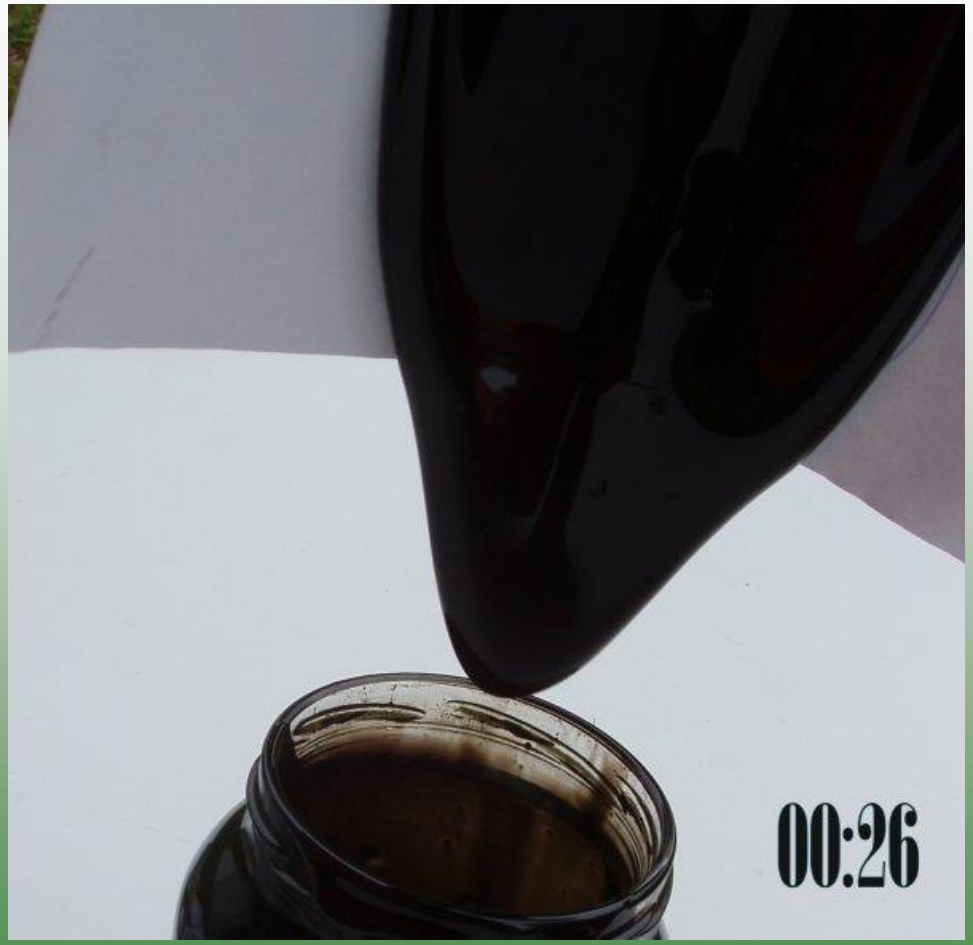
Quality of the Plantoil

Take care for bad quality (waste)plantoil on the heating oil market.

PPO technology is NOT idiot proof: Damages caused by bad fuel / maintenance



Polymerisation of lubrication oil due to dilution with un burned PPO fuel, bad fuel and/or bad maintenance. Typically leads to damage of turbo charger or whole engine

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Damages coursed by waste oils

WORTH CASE: Piston from broken injection pump after only 20 litres use of waste oil from biodiesel factory.

(The oil was intended and sold for heating purpose – not as engine fuel)

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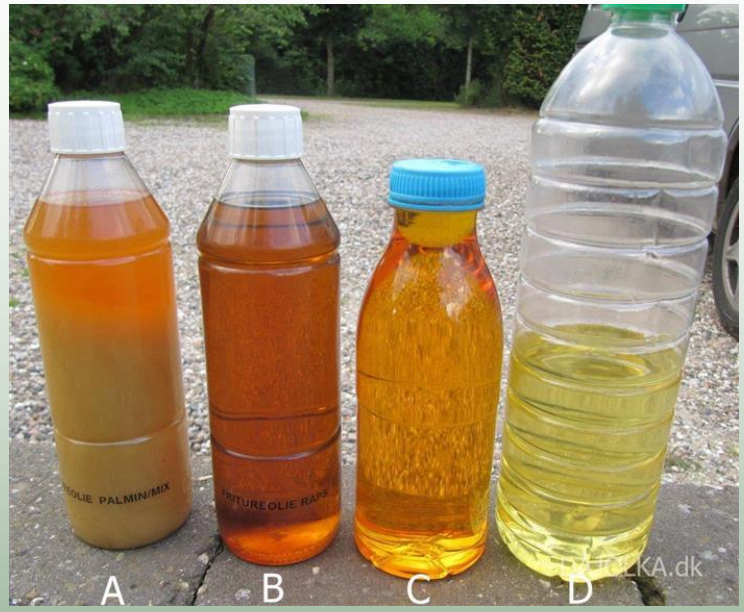
How does the exhaust smell

- The exhaust smells of fried oil.
- When the engine burns the fuel efficiently, exhaust smell is limited.
- Catalysator will reduce exhaust smell.
- On modern engines its hard to notise any smell of frying.

Erik Andersen, Samsø
PPO Pioneer farmer

Using Waste Cooking Oil, Denmark 2013



2 modern vans were converted in September 2013, to operate on waste cooking oil. One van belongs to a company selling new cooking oil(D) for the restaurants, and the other to a company collecting Waste Cooking Oil(B).

UPDATE 2017: The company selling new oil has closed down. The other car collecting WCO is now running on diesel because WCO is taxed, and by authorities considered as potential spreading risk of mad cow decease.

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Using WCO 2015

BMW X5 3,0D Commonrail, Converted in September 2015
Using WCO is legal in Norway and many other countries.
The fuel quality of WCO is very good when filtered well.

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Using WCO - 2015

Mercedes Sprinter 213 Commonrail
Converted in September 2015
Car distributes organic ice cream at ISROSA.no

Plant oil as a fuel in developing countries

PPO has has very high potential for Developing Countries

- Simple technology
- Low investment
- No need for highly educated personal
- Implementet decentralised where the resources are available (sunshine->biomass)
- Implemented where fossil fuel is relatively more expensive and need to be transported long distance under difficult conditions

Plant oil as a fuel in developing countries - SENEGAL

- PPO powered off-road transport vehicles for Senegal for sustainable char coal production

Plant oil as a fuel in developing countries

- Multifunctional All Terrain Electrical Hybrid Vehicle for developing countries and disaster areas
- Powered by PPO generator and PV panels

- More info:
- http://www.dajolka.net/news/multifunctional-all-terrain-electrical-hybrid

Plant oil as a fuel in developing countries – HONDURAS

Castor *(Ricinus communis)*

Jatropha *(Jatropha curcas)*

Sunflower *(Helianthus annuus)*

Tijgernoot *(Cyperus esculentus)*

Nabo Forrageiro
(Raphanus sativus L.)

Plant oil as a fuel in developing countries – HONDURAS

Around 45 car mechanics were trained during 1 week training course in Yoro, Honduras.

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Jatropha oil project Mali

Semi industrial oil pressing facility in Mali, supplied with power from a PPO powered genset.

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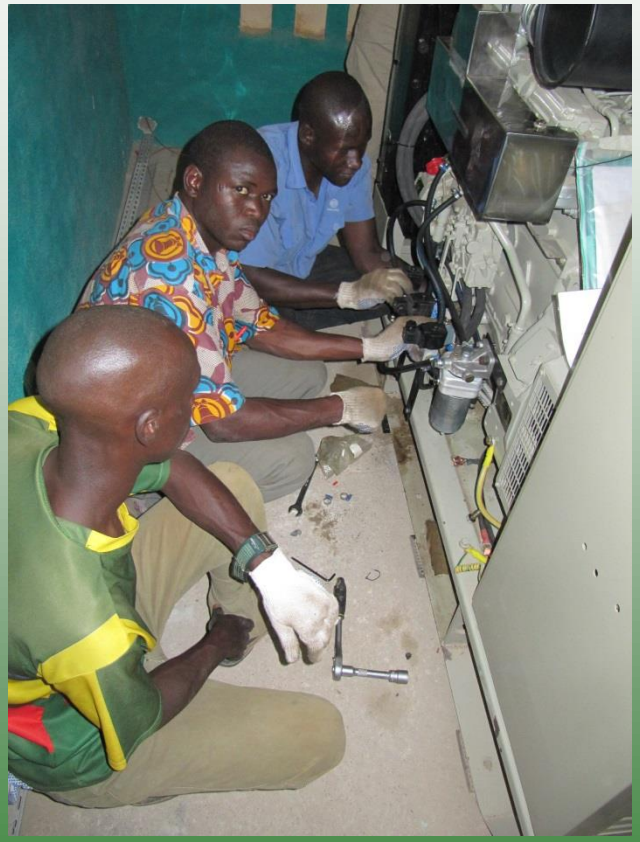
Jatropha oil project Mali



Converting gensets in Mali. We trained the local mechanics

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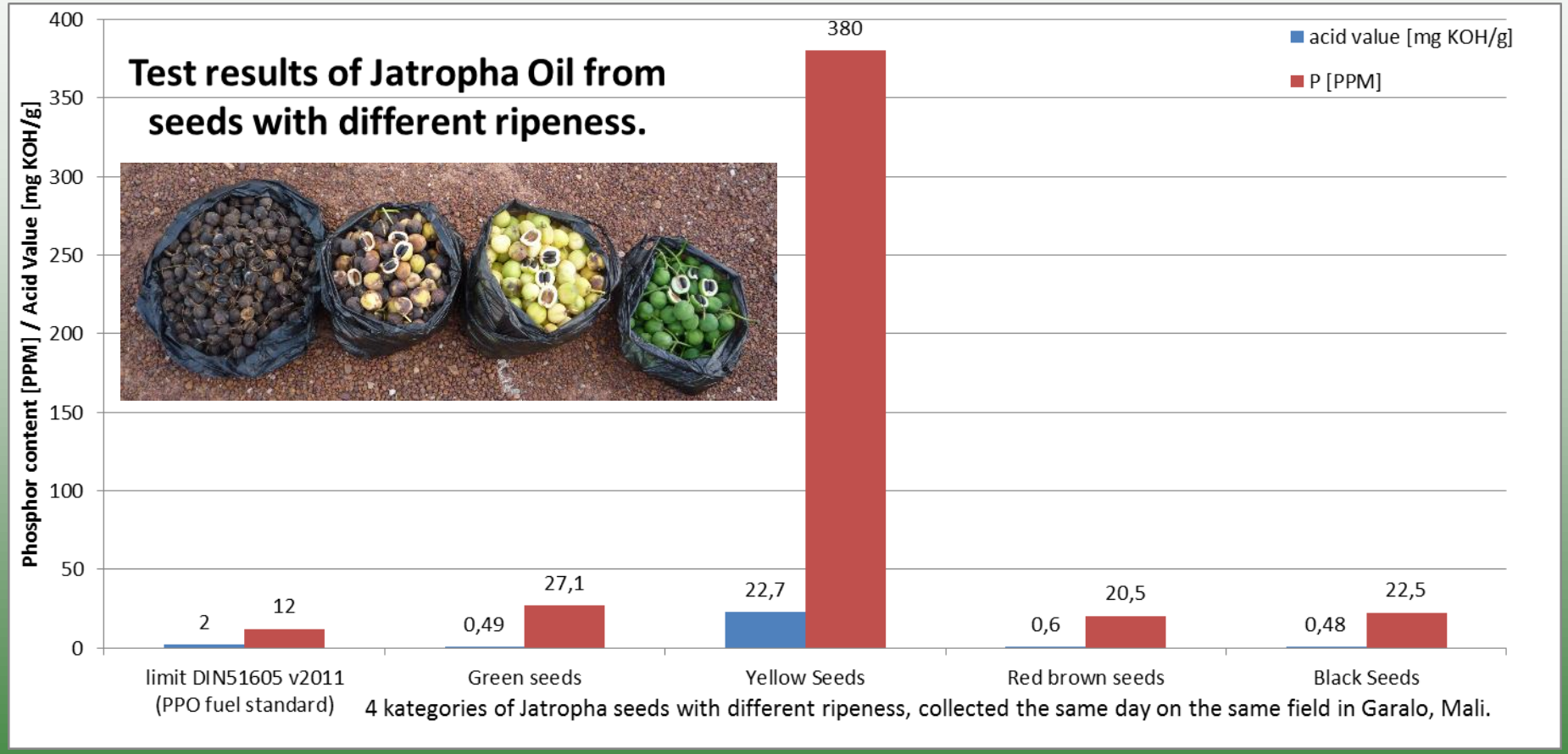
Jatropha oil project Mali



Testing Jatropha oil quality depending on seed ripeness.

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Jatropha oil project Mali

Building up small factory for producing steel tanks for fuel.

Jatropha oil project Guinea Bissau

Workshop training in converting gensets in August 2013

Participants with certificates

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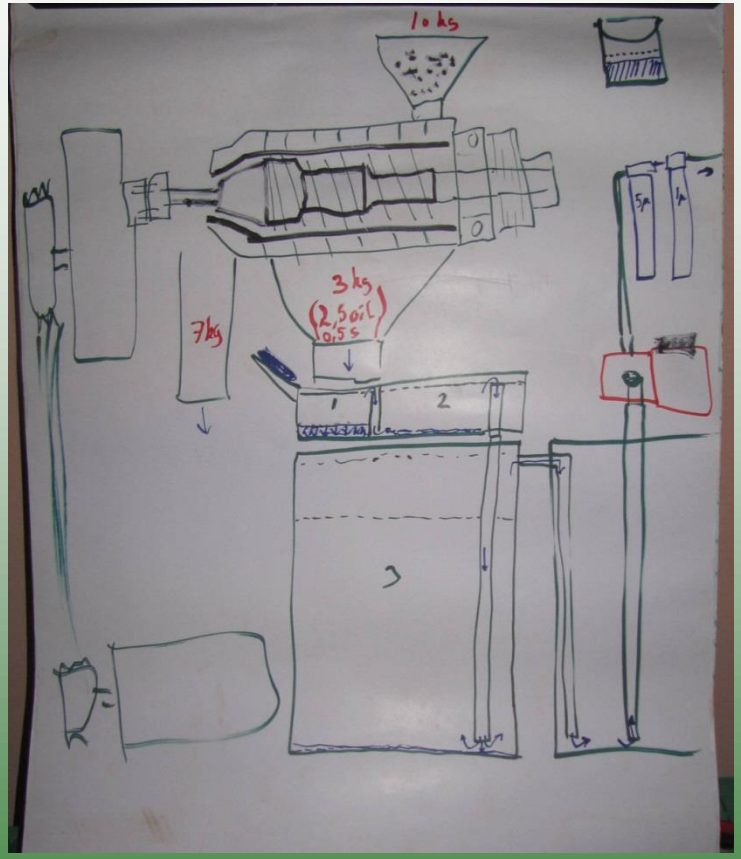
Jatropha oil project Guinea Bissau



Workshop training in PPO production in March 2014

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Jatropha oil project Guinea Bissau

Workshop training in PPO production in March 2014. Oil expeller from local market

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Jatropha oil project Guinea Bissau

Workshop training in PPO production in March 2014. Constructing sedimentation system for 1st filtration.

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Jatropha oil project Guinea Bissau

Workshop training in PPO production in March 2014.
Constructing pump filtration system for 2nd filtration.

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Jatropha oil project Guinea Bissau

Removing bad quality seeds

Jatropha oil project Guinea Bissau

Testing PPO quality

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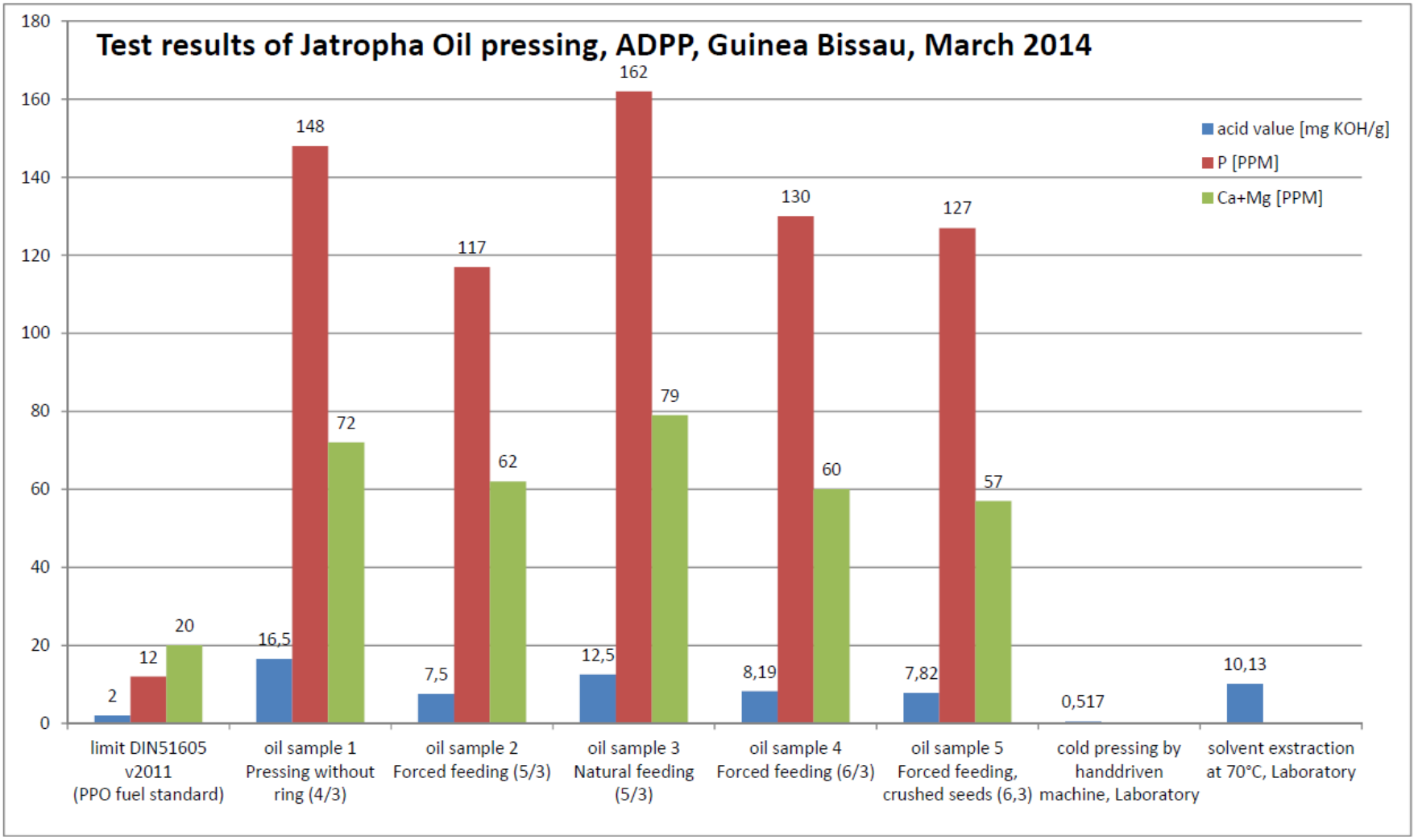
Jatropha oil project Guinea Bissau



Concluding that seed quality was fine, but oil expeller produce bad quality oil caused by too high temperature

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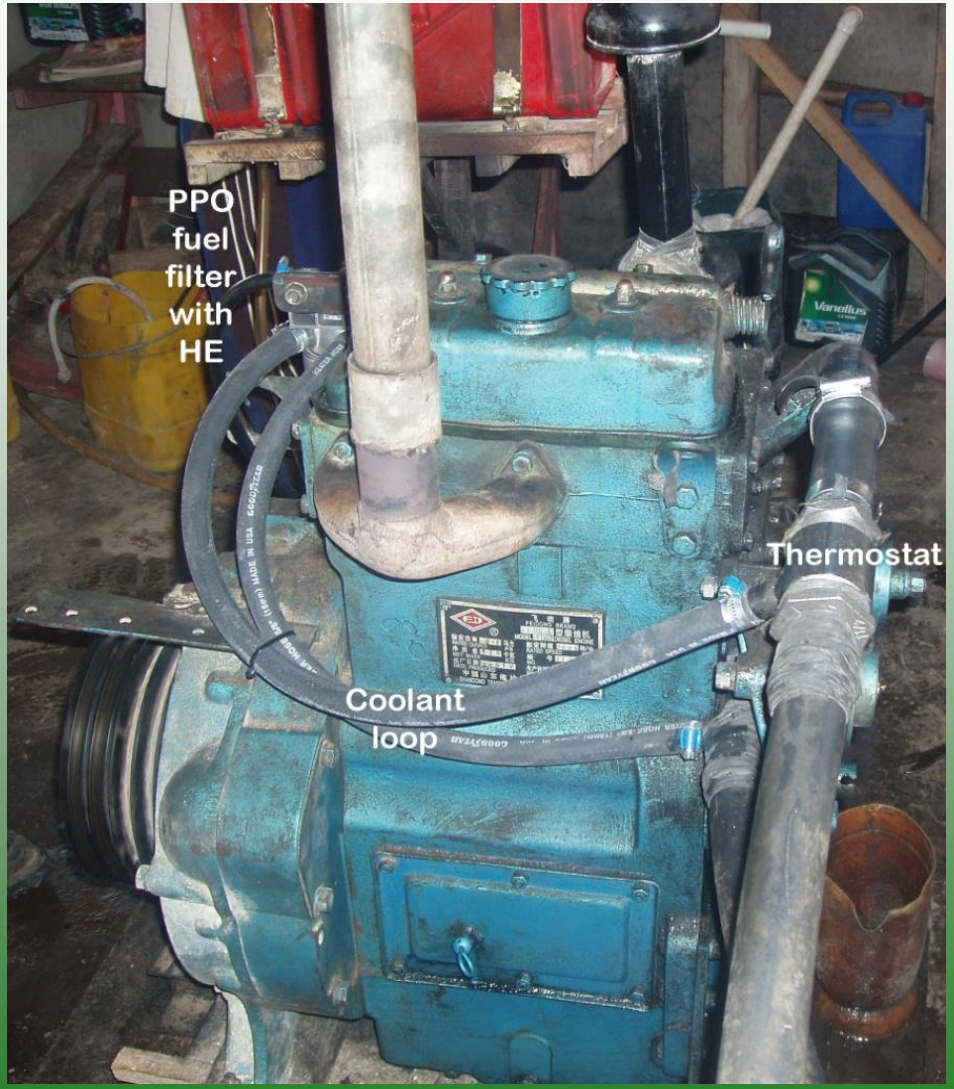
Jatropha oil project Mozambique



Installing coolant thermostat to ensure safe operation on PPO

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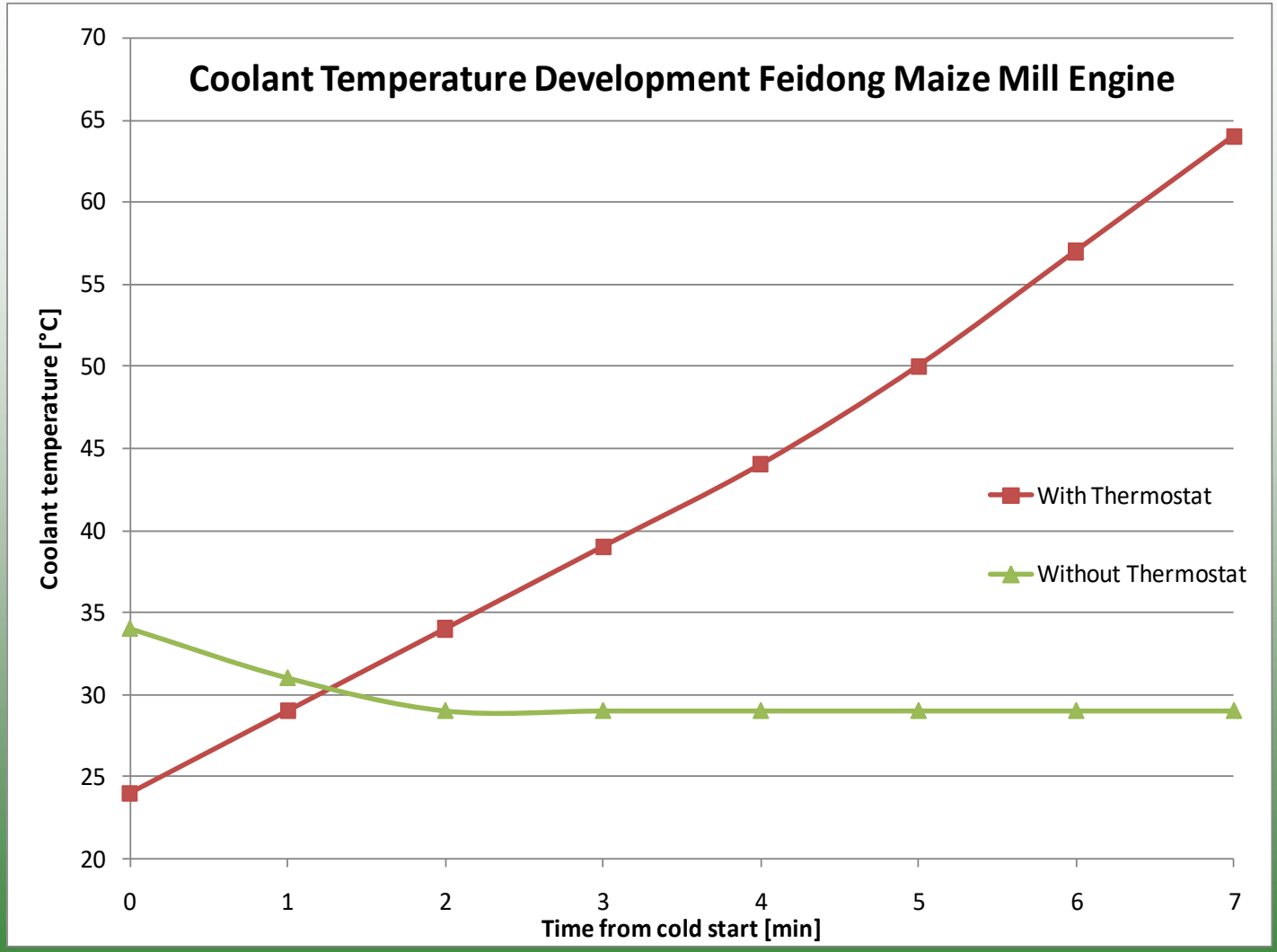
Jatropha oil project Mozambique



Installing coolant thermostat make the engine reach operating temperature in few minutes, ensuring safe operation on PPO

Jatropha oil project India – January 2014

Jatropha plants along the roads

Gensets supplying power for processing agricultural products

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Small scale palm oil project in DRC – 2013

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PPO a Success Story ?
What has the authories in Denmark done?

- In Denmark, only 2 pilot projects have been supported so far for testing PPO in engines - 1 for combined heat and power (~ year 2000) and 1 for transport (2007-2010).
- In 2007, 7.4 mill. DKK (1 mill €) was granted by the Danish Transport Agency(DTA) for testing PPO in transport
- The criteria from DTA was to test cold-pressed rapeseed oil in the most modern engines with Diesel Particulate Filters(DPF) running in big cities, ie. with very low load, although it is even not yet technically possible now in 2017, because of low load, and because cold pressed rape seed oil contains 6-7 times more ash (P, Ca and Mg) than allowed for engines with DPF.
- I informed the involved participant about these problems, and objected against these conditions when I converted some cars, but this is not mentioned anywhere in the reports.

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PPO a Success Story ?
What has the authories in Denmark done?

- Another criterion by the DTA was that constructive changes were not made to the engines, ie. change of injector nozzles and Engine Control Unit(ECU). That meant that no engines were optimized for PPO, and the most advanced conversion technologies from Germany (ELSBETT, VWP) were ruled out.
- The actors who performed the project had no experience of using PPO in engines – nor any interest - on the contrary
- Emissions test was performed with PPO quality that could not even comply with PPO quality for engines without DPF.
- Result: Many technical problems and bad results of emission measurements.
- Conclusion from DTA and the involved institutions:
  NO GO !, and these PPO hippies are irresponsible amateurs

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Another non critical article

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TENDENS SMART CITIES | VIRTUAL REALITY | KVANTETEKNOLOGI FOKUS VW-SAGEN | DRONER | 3D-PRINT | MALAYSIA AIRLINES MH370 | FEMERN-FORBINDELSEN

Øko-diesel sviner langt mere end gammeldags dieselolie

Drømmen om at kunne bruge rå, tyktflydende planteolie som ultra-grønt brændstof til sin dieselbil får sig et ordentligt skud for boven i ny undersøgelse. Udslippet af partikler, CO2 og kræftfremkaldende stoffer ligger langt over almindelig diesel, når dieselbilen kører på koldpresset rapsolie.

Af Nicolai Østergaard 13. dec 2010 kl. 07:02

FØLG

Det har været et skrækkeligt halvår for tilhængerne af koldpresset rapsolie som et af fremtidens vigtige, grønne drivmidler i transportsektoren.

I efteråret dokumenterede DTU-forskere, at de bilejere, der med gode hensigter forsøgte sig med koldpresset rapsolie i deres dieselbiler, har været ramt af det ene motorhavari efter det andet. Og nu viser oplysninger fra en endnu ikke offentliggjort rapport, forfattet af Center for Grøn Transport, at udslippet af partikler, CO2 og kræftfremkaldende stoffer ligger langt over almindelig diesel, når dieselbilen kører på koldpresset rapsolie.

Conclusion in technical news paper ING.dk, about the DTA project, without checking facts: “ECO-DIESEL pollutes much more than fossil diesel” – PPO hippies go home !

RME emits more CO2 than fossil diesel – HOW ?
Another non critical article

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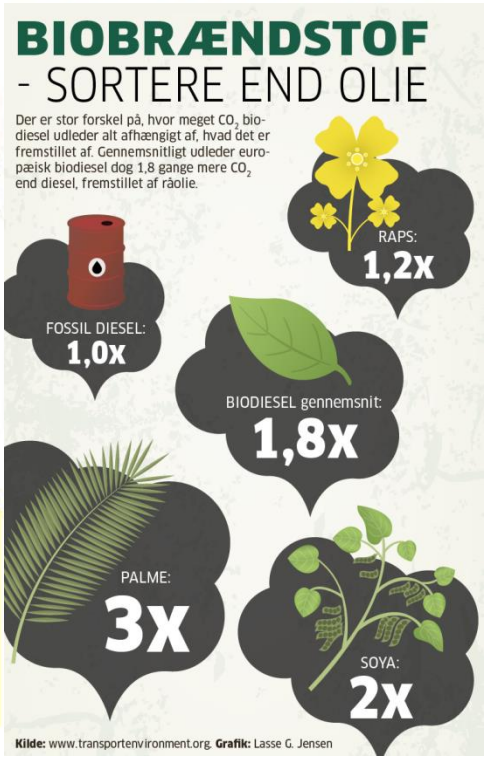
TENDENS SMART CITIES | VIRTUAL REALITY | KVANTETEKNOLOGI FOKUS VW-SAGEN | DRONER | 3D-PRINT | MALAYSIA AIRLINES MH370 | FEMERN-FORBINDELSEN

Biodiesel er næsten dobbelt så sort for klimaet som fossil diesel

"Biodiesel is almost twice as black for the climate as fossil diesel"



Biodiesel af planteolier - særligt palmeolie - udleder langt mere CO2 end traditionel diesel. Alligevel skal der tilsættes syv procent biodiesel herhjemme. Decideret dumt, siger dansk forsker.

Af Mads Lorenzen Følg @MadsLorenzorro 6. maj 2016 kl. 11:20

2016 report from Transport & Environment

RME emits more CO2 than fossil diesel – HOW ?
Another non critical article

Niels Ansø 11 måneder siden

Kreativ bogføring ?

Umiddelbart virker det for slemt til at være sandt – det kan ikke passe at f.eks. biodiesel fra raps(RME) har en negativ CO2 balance og udleder mere CO2 end fossilt diesel.
Man bør se kritisk på de tal og beregningsmetoder der anvendes.
For RME anvender TE notatet et tal på 46 g CO2/MJ i "direct emissions" – jeg formoder at det dækker over energiforbrug/CO2 udledning i fremstillingsprocessen inkl. dyrkning. CO2 udledning ved selve forbrænding af biodiesel ligger i størrelsesorden 74 g CO2/MJ. Dvs. at notatet antyder at den direkte CO2 omkostning til fremstilling af RME er på 46/74 [illegible] ligge på omkring 20% omkostning / 80% besparelse ifølge ENS's & COWI's beregninger (ca. Anno 2000). Dyrkningen alene ligger på omkring 10% omkostning ift. udbytte – De resterende 10% [illegible] proces til konvertering til biodiesel.

Fra 1 hektar dansk vinterraps (anno 2000) kan frembringes følgende mængder og energiindhold
1000kg rapsolie : 37 GJ (28,0%)
2000kg foderkage: 38,6 GJ (29,2%)
3900kg halm : 56,6 GJ (42,8%)
I alt :132,2 GJ (100%)

CO2 udledningen ved dyrkning af 1hektar er ca. 1600 kg CO2. (iflg. ENS/COWI, 2000)
Det giver 12,1 g CO2 udledning / GJ energiudbytte – [illegible]

Jeg gætter på at differencen skyldes at den energimæssige værdi af foderkagerne og halmen er udeladt af beregningerne - det har mange andre gjort.
Hvis foderkager og halm sættes til 0kg i ovenstående beregning, dvs. at alt energiforbruget til dyrkning og fremstilling ligges over på rapsolien, giver det en CO2 udledning på [illegible] rapsolie.
Dertil skal ligges lidt CO2 udledning til proc[illegible] rapsolie [illegible] – [illegible] meget fint med at foderkager og halm er udeladt. Halmen, som udgør den største del af energiudbyttet, kan så leveres "gratis" til et 2G anlæg [illegible]

Man kan da ikke regne på den måde !!
Hvis tallene for den direkte CO2 emission er 4[illegible] hvordan ser det så ud med LUC tallene. Hvordan [illegible] anvendes til vidt forskellige formål (mad, foder, råvare, energi, smøremiddel osv.) ?

Har ING.dk vurderet TE notatet eller blot videregivet konklusionen ukritisk?

Tilsvarende er det urimeligt hvis organiske spildprodukter for lov at rådne og frigive metan direkte til atmosfæren – det bør selvfølgelig opsamles og anvendes til energi – [illegible] beregningerne frem for et problem.

Jeg er ikke fortaler for hverken biodiesel eller tvungen iblanding af biodiesel i fossilt diesel – men beregningerne bør da alligevel være rigtige.

Jeg er derimod fortaler for at ren planteolie kan bruges til energi – i ren form – der hvor det kan gøre mest gavn – f.eks. i landbrugsmaskiner og andre køretøjer der har brug for stor trækkraft og rækkevidde – hvor der ikke umiddelbart findes andre alternativer (fra El og biogas m.fl.). Fordelen ved at bruge ren planteolie frem for biodiesel er at energiforbrug til proces er yderst beskedent, og der er ikke behov for hverken kemisk eller fossilt input, samt at der ikke fremkommer spildevand og andre affaldsprodukter ved fremstillingen.

Palmeolie kan også laves småskala og decentralt – fra oliepalmer der vokser vildt i regnskov. Jeg har været med til det i DR Congo. Udfordringen ved den rå palmeolie er at en stor del af olien "fryser" til [illegible] ligger sig pænt i bunden af opbevaringstankene, imens en helt flydende fase ligger øverst. Den [illegible] opvarme og køre på den halvfaste del af olien. Derfra [illegible] den kan starte på den rå flydende palmeolie.

[illegible] det der er relevant må være om jorden anvendes til dyrkning af energi eller fødevarer. Hvis vi skal have den [illegible] som i stedet anvendes til helt andre [illegible] produktion, men [illegible] mange udviklingslande, men har endnu ikke mødt lokale, som synes det er et problem at et produkt [illegible] begge formål.

+3 -2

Here I explain on ING.dk, in details that the report from T&E has very big errors on the numbers used for direct CO2 emission from production of rape seed biodiesel, by ignoring the energy content of the straw and press cake, which together has 2½ times more energy that the oil. Therefor the numbers used by T&E is 4 times higher than the real no´s. which can be measure. The indirect emission no´s are more hard to check.
But no comments from ING.dk !

DAJOLKA

Where is the future for PPO ?
PPO fits perfectly into agricultural sector

New John Deere tractor delivered in 2016
with PPO engine directly from factory

DAJOLKA

Conclusion:

- PPO technology works fine for people who are interested in success, but it is not a Foolproof technology
- PPO technology very suitable for agritural sector and in rural areas, and its available now.
- PPO technology is not suitable for large cities.
- A lot of misleading information are spread and mixed up with emotional feelings, and with economical and political interest.
- You can win over “the system” in arguments – but not in power and money. Therefor our efforts to have PPO officially accepted in Denmark and many other countries has failed.

Fossil oil create conflicts

Pure **P**lantoil for **P**eace !

Wishes for PPO technology in the future

- **Governments, Agencies, Institutions, Journalist, Interest organisations, Opinion makers etc. – Come to the facts – stop misinformation !**
- **To other technology promotors – promote your own technology – do what you are best at – leave PPO promotion for people dedicated for that.**
- **Same conditions for all alternative solutions, instead of favorising a few solutions.**
- **PPO technology will become an integrated part of the agricultural sector as well as help people in developing countries get power and mobility.**

Thank you for your attention