Waste-based biodiesel: A viable and prompt solution for decarbonizing maritime transport

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Elin Verd in a nutshell

"Elin Biofuels" established as a 100% subsidiary of ELIN

2005

2007

Launching of biodiesel production in our new plant of Volos. New main Shareholder

2011

Establishment of our subsidiary Prasino Ladi waste oil collection company

ΠΡΑΣΙΝΟ ΛΑΔΙ

2013

Biodiesel production plant is retrofitted to utilize only waste material (used cooking oil and animal fat) for the production of biodiesel

2018

Elin Biofuels is further evolving with 3 new activities and renamed "Elin Verd"

- Oleo-chemicals
- Smart Energy Systems
- E-mobility

2021

Oleochemicals production unit and new R&D offices/lab are constructed

2022

Forthcoming Acquisition by Motor Oil Group

MOTOR OIL

OUR VISION

Our aim is that Elin Verd will continue to show consistent and dynamic growth, maintaining its moral values and the friendly, cooperative, family atmosphere, which have been part of it from the start. To remain flexible, innovative, farsighted and pioneering and to radiate a feeling of confidence and positive energy. To remain dedicated to the true protection of the Environment at all levels and to be active in sectors that do not conflict with its beliefs regarding Humans and Ethics, with a distinct emphasis on renewable energy sources. To yield the necessary profit that will allow the company to put all the above into practice for the benefit of its people and its shareholders.

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Maritime Sector key points

Emission Facts

- Global shipping GHG emissions**: 2.9% of global GHG emissions** caused by human activities. 3-4% at EU level[1]. **4-9% of SOx** and **10-15% of NOx** emissions[2]
- Shipping sector emissions are expected to increase from 90% to as much as 130% of 2008 emissions by 2050[1]

GHG Emissions Reduction Targets

- FuelEU Maritime Initiative

Improvement of GHG emissions of fuels in vessels by[1] (compared to 2020 levels):

2025	2030	2035	2040	2045	2050
2%	6%	13%	26%	59%	75%

- IMO Targets : Reduce of GHG **50% by 2050** compared to 2008 levels, Reduce CO_2 emissions 40% by 2030 and pursue for 70% by 2050 compared to 2008 levels[4]

Fuel Consumption

2014

330 mt/y,

75% Residual Fuel &

25% Distillate fuel [2]

2030

Estimated of over 450 mt/y

Higher Share of Distillc fuels and alternative fuels [3]

50% of operational cost is fuel

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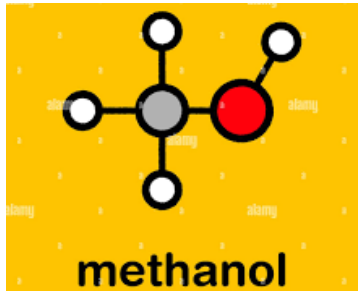
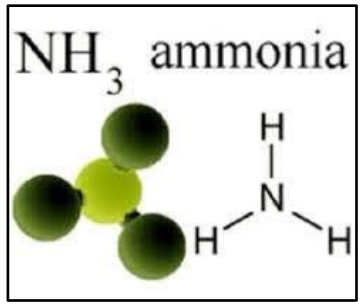
Sources:

1) https://ec.europa.eu/clima/eu-action/transport-emissions/reducing-emissions-shipping-sector_en
2) "Biofuels for the marine shipping sector," IEA Bioenergy: Task 39, 2017
3) "Public Final Report: Methanol as an alternative fuel for vessels", Maritime Knowledge Center, TNO, TU Delft, 2018, Netherlands

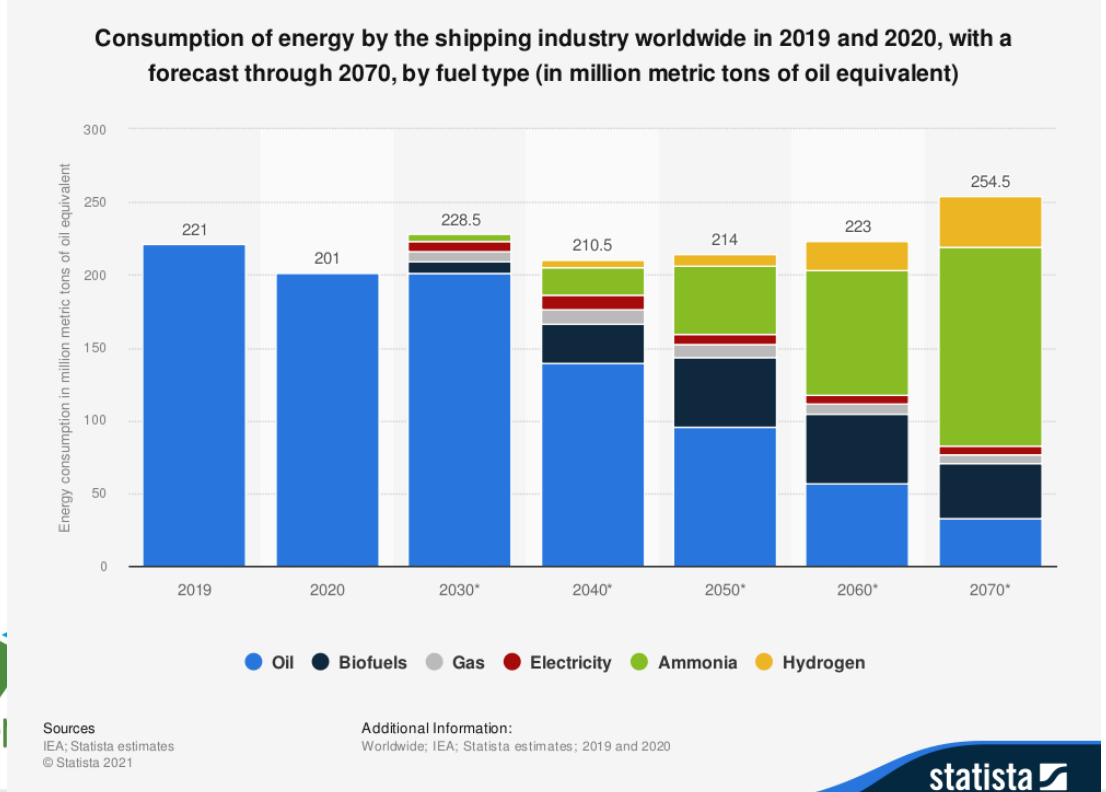
Paths towards decarbonization





Challenges: Technical (new engines), new vessels, Infrastructure, Availability, Cost?

Biodiesel: Prompt Solution



- In the long term: mix of solutions need to be deployed for decarbonizing maritime sector
- Biofuels expect to play a role throughout the years[5]:
  - 3,5% in 2030
  - 12 % in 2040
  - 22% in 2050

Sources:
5) IEA, Statista Estimates, 2021

Waste based biodiesel facts

Biodiesel Capacity Availability

- Capacity of Biodiesel Plants in EU: **20,3 mt** (2021)[6]
- Production of biodiesel in EU: **10,1 mt** (2020)[7]

Raw Material Availability

- Biodiesel sources: virgin vegetable oils, approx. 80%[6], rest being Used Cooking Oils (UCO) and Animal Fats
- UCO consumption in EU: **2,6 mt** (2021)
- NGO Transport & Environment (T&E) estimate: "**8.1 mt** of UCO will be needed for all transport sectors to decarbonize (assuming all biodiesel demand from transport comes from UCO)"[8]
- Competitive uses of waste lipids (UCO, Animal Fats): HVO or SAF via hydrogenation of lipids

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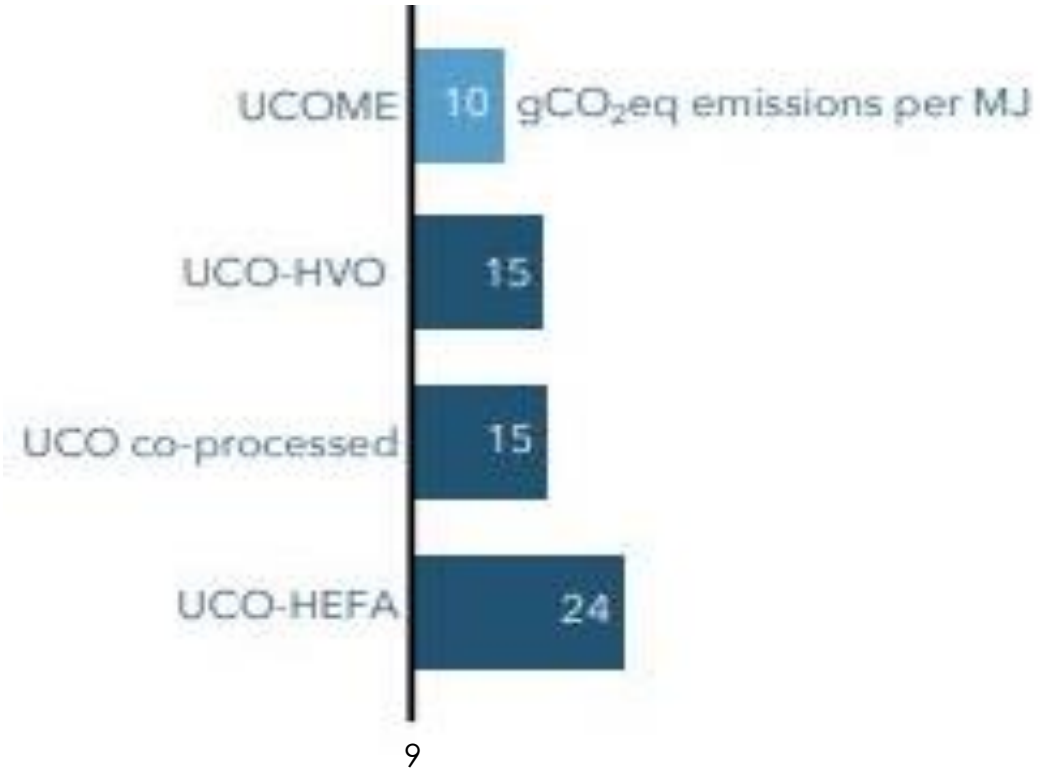
Sources:

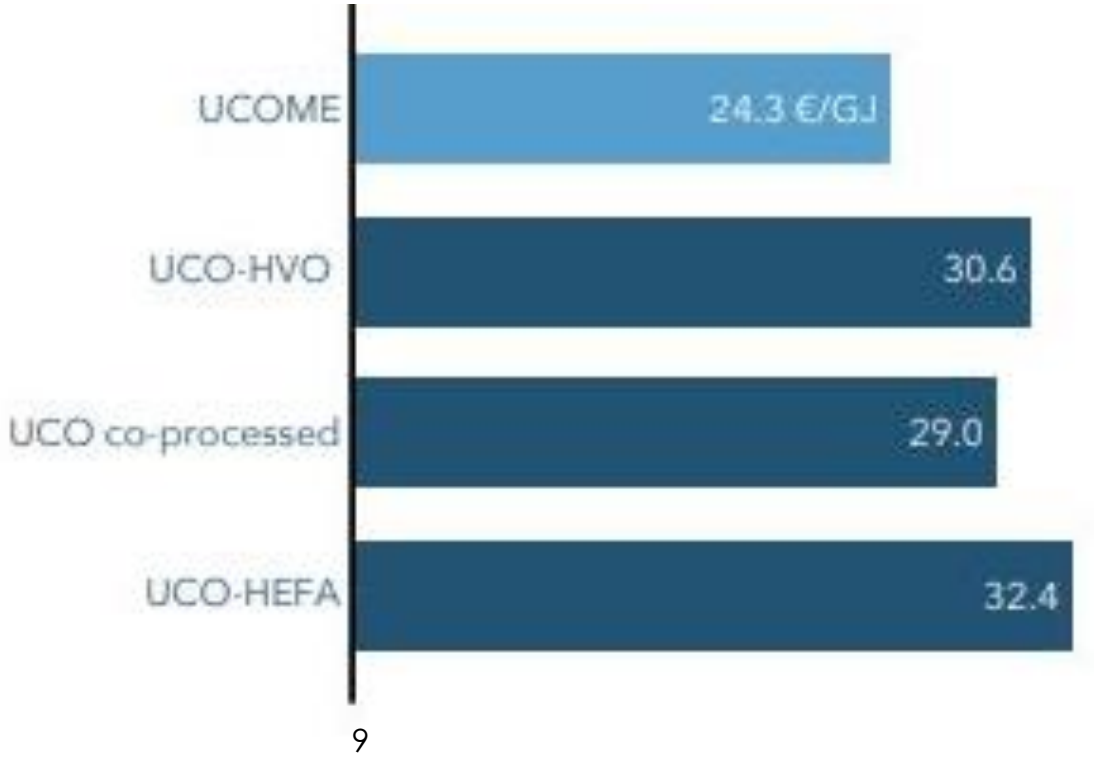
6) Transport & Environment briefing, "10 years of EU fuels policy increased EU's reliance on unsustainable biofuels", 2021
7) USDA, 2022
8) https://www.euractiv.com/section/biofuels/opinion/ensuring-the-best-use-of-uco-to-reduce-net-ghg-emissions-in-transport/

Waste based biodiesel environmental and price scores

GHG Emissions Factor [g CO_2 eq / MJ]



Cost [€ /GJ]



Waste Based Biodiesel (UCOME): Up to 90% GHG savings compared to fossil diesel

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Sources:

9) Used cooking oil: one feedstock, different renewable fuels – a comparative study, Carlo Hamelinck et al, February 2021 (https://www.studiogearup.com/used-cooking-oil-one-feedstock-different-renewable-fuels-a-comparative-study/)

Technical Standards

European Biodiesel Quality Standard

- **EN 14214:** Developed to cover the needs of road transport fuels
- 3 different fuels standards based on blending percentage: **EN 590** (7%, B7), **EN 16734** (10%, B10) and **EN 16709** (20 and 30%, B20 & B30)

Marine Fuels Quality Standard

- **ISO 8217:2017**
- EN 14214 FAME up to 7% is accepted
- Higher blends of up to at least 30% should be allowed
- Develop a biodiesel quality standard for maritime?

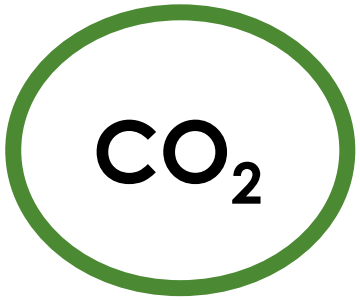
Table 1 — Distillate marine fuels

Characteristics		Unit	Limit	Category ISO-F-							Test method(s) and references
				DMX	DMA	DFA	DMZ	DFZ	DMB	DFB	
Kinematic viscosity at 40 °C		mm^2/s^a	Max	5,500	6,000		6,000		11,00		ISO 3104
			Min	1,400	2,000		3,000		2,000		
Density at 15 °C		kg/m^3	Max	—	890,0		890,0		900,0		ISO 3675 or ISO 12185; see 6.1
Cetane index			Min	45	40		40		35		ISO 4264
Sulfur[b]		mass %	Max	1,00	1,00		1,00		1,50		ISO 8754 or ISO 14596, ASTM D4294; see 6.3
Flash point		°C	Min	43,0	60,0		60,0		60,0		ISO 2719; see 6.4
Hydrogen sulfide		mg/kg	Max	2,00	2,00		2,00		2,00		IP 570; see 6.5
Acid number		mg KOH/g	Max	0,5	0,5		0,5		0,5		ASTM D664; see 6.6
Total sediment by hot filtration		mass %	Max	—	—		—		0,10[c]		ISO 10307-1; see 6.8
Oxidation stability		g/m^3	Max	25	25		25		25[d]		ISO 12205
Fatty acid methyl ester (FAME)[e]		volume %	Max	—	—	7,0	—	7,0	—	7,0	ASTM D7963 or IP 579; see 6.10
Carbon residue – Micro method on the 10 % volume distillation residue		mass %	Max	0,30	0,30		0,30		—		ISO 10370
Carbon residue – Micro method		mass %	Max	—	—		—		0,30		ISO 10370
Cloud point[f]	winter	°C	Max	-16	report		report		—		ISO 3015; see 6.11
	summer	°C	Max	-16	—		—		—		
Cold filter plugging point[f]	winter	°C	Max	—	report		report		—		IP 309 or IP 612; see 6.11
	summer	°C	Max	—	—		—		—		

Biodiesel Technical Opportunities

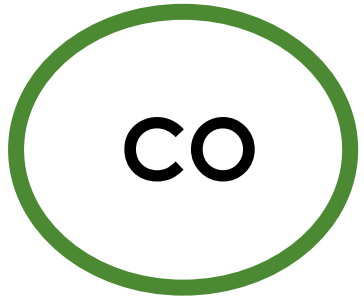
Emissions

Fuel Properties



- ✓ Proportionally reduced according to blending level, e.g. 30% blend of UCOME with MGO up to 27% CO_2 reduction

- ✓ Practically free from Sulfur (<10 ppm) biodiesel lead to significant less SOx emissions



- ✓ Oxygen presence improves burning efficiency and thus to lower PM and CO emissions

- ✓ Biodiesel improves fuel's lubricity
- ✓ Biodiesel burns more efficiently counteracting its lower heating value

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Biodiesel Technical Challenges and Solutions

NO_x

Higher NO_x emissions by increasing biodiesel blending due to increased oxygen content

- ✓ Studies have shown biodiesel or blends with MGO may lead even to decrease of NO_x[10]
- ✓ New "Unified Interpretation" of IMO's Marine Environment Committee on June 2022 states that blends up to 30% are regarded as regular oil-based fuels
- ✓ Emulsion fuel blends?

Microbial Growth

Presence of Oxygen (higher polarity) and incomplete reaction products (glycerides) may attract water and promote microbial growth

- ✓ Use of biocides
- ✓ Good housekeeping
- ✓ Use of distilled FAME with low levels of contaminants (glycerides)

Oxidation Stability

Presence of double bonds in contact with air and heat may promote oxidative degradation

- ✓ Use of anti-oxidant additives. Successful experience from road transport fuels

Low temperature properties

Typically waste based biodiesel has worse cold flow properties (CFPP, CP) due to the origin of the raw material (high saturates)

- ✓ Use CFPP additives
- ✓ Use of distilled waste based biodiesel which improves solubility and does not negatively affect cold flow properties of mineral fuel

Material Compatibility

Some elastomers degrade in contact with biodiesel

Some metals (e.g. zinc, copper, brass) may interact with biodiesel and form deposits

- ✓ Modern engines contain Biodiesel resistant elastomers and metals

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Sources:
10) W. Mohd Noor, Biodiesel as alternative fuel for marine diesel engine applications: A review, Renewable and Sustainable Energy Reviews 94 (2018) 127–142

Successful Commercial Use of Waste Biodiesel in Maritime

PRIO - ECO BUNKERS

15% OF BIODIESEL FROM RESIDUAL AND WASTE FEEDSTOCK STREAMS
UP TO 18% REDUCTION OF CO2
UP TO 10% REDUCTION OF FUEL CONSUMPTION

NEWS / PORTO DE AVEIRO

Port of Aveiro moves forward with the supply boat with biofuel

16 JUN. 2022

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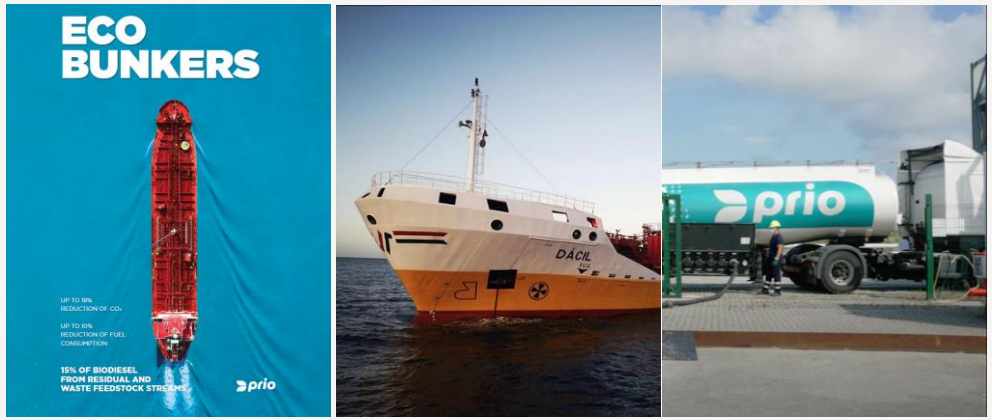

PRIO and PETROGAS team up for Green Fuel Bunkering

12 APRIL 2021

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Thank You!