A sustainable oil company

Creating more value by doing less.

Dr. Panos Kouris, Co-founder & CTO

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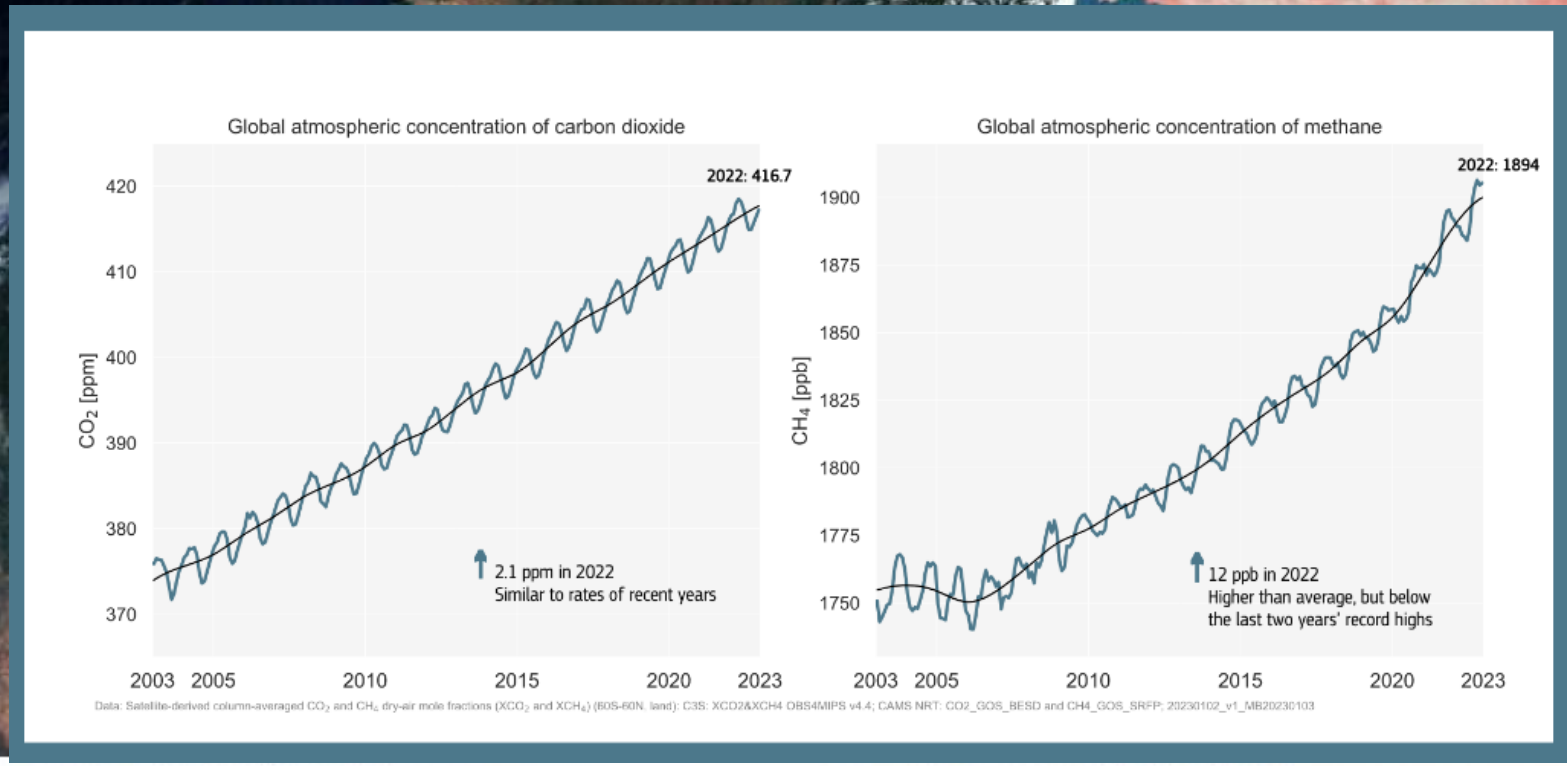
No Atom Left Behind®

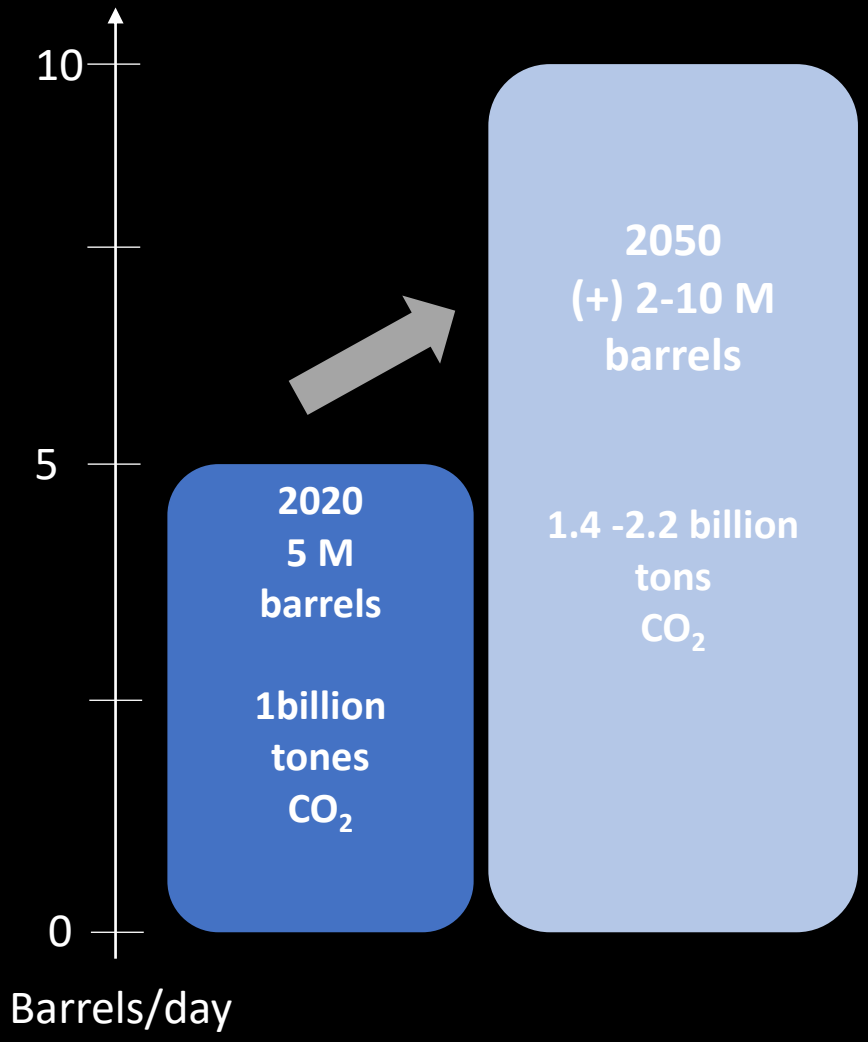
vertoro

Problem 1
Need for sustainable carbon

- In 2022 average temperature in EU > 2 degrees Celsius
- Atmospheric Greenhouse Gases continue to increase
- CO2 & CH4 main drivers for climate change



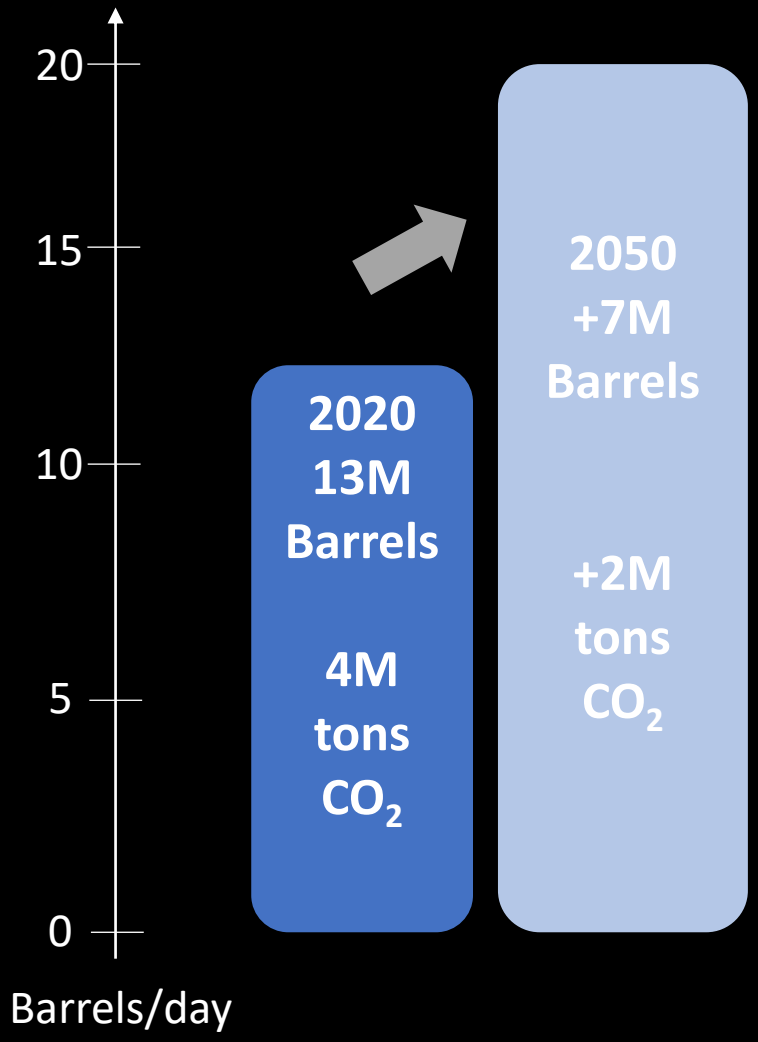
Maritime Sector



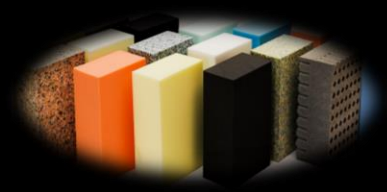
obvious

CO_2

International Maritime Organization (IMO 2020)



Petrochemicals



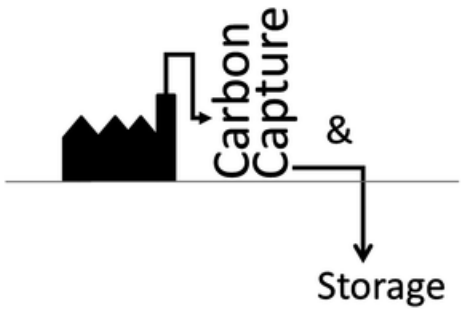
hidden

CO_2

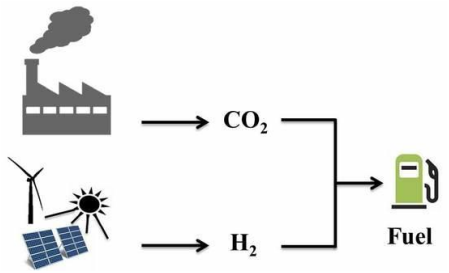
International Energy Agency (IEA)

Solutions for circular economy

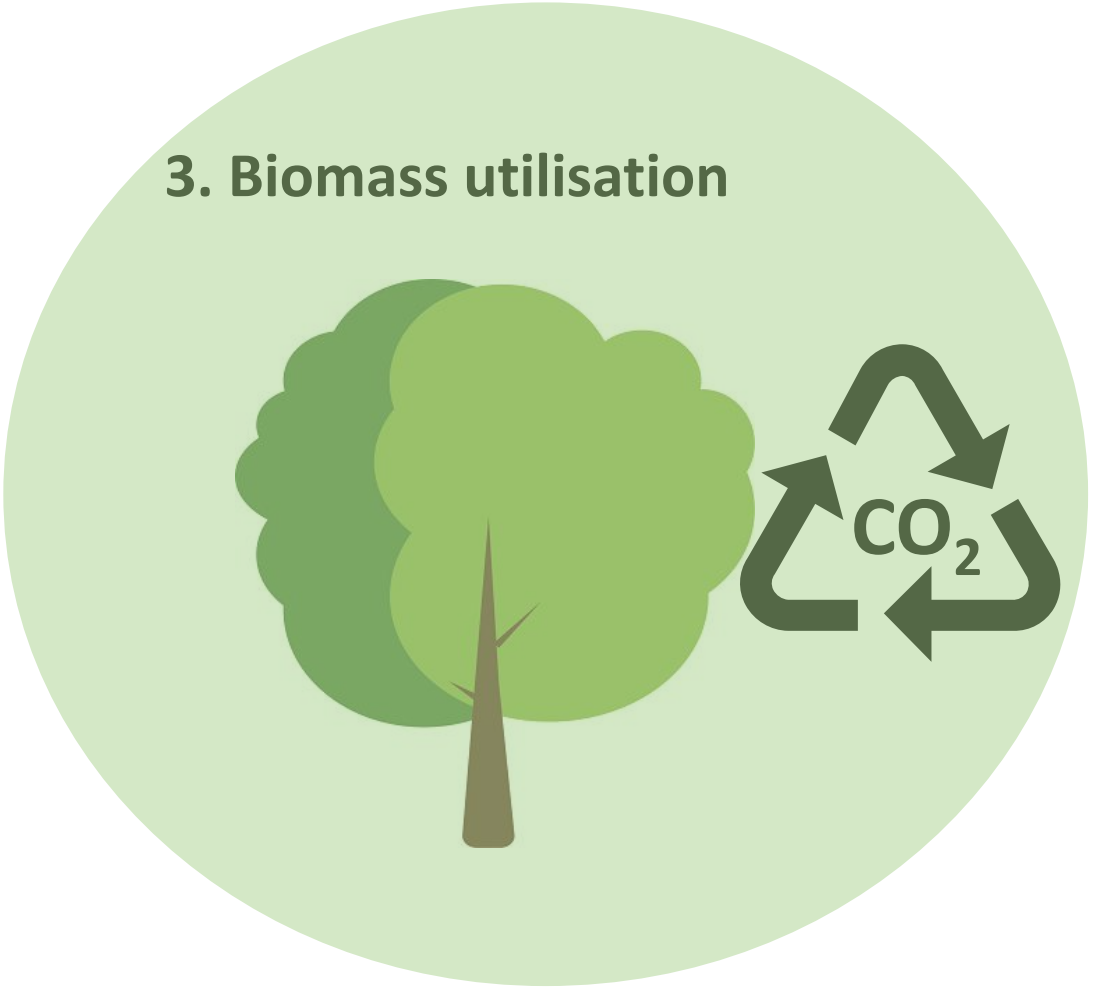
1. Carbon capture & storage



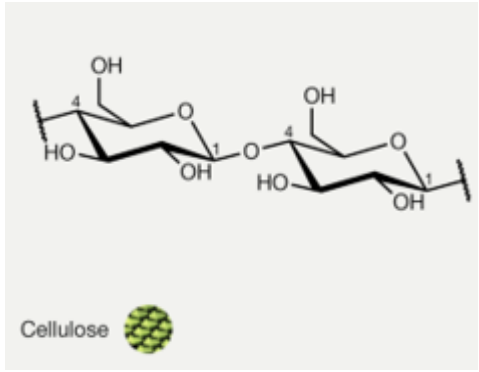
2. Carbon capture & utilization

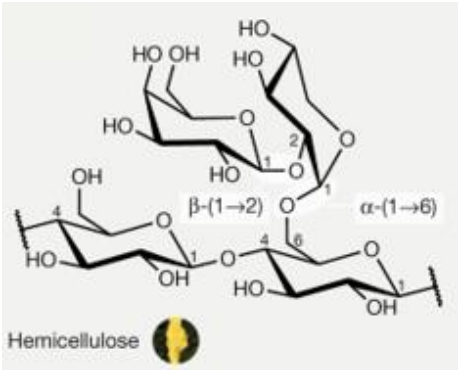


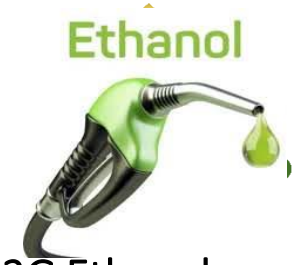
3. Biomass utilisation



How can 2G biomass replace petroleum ?

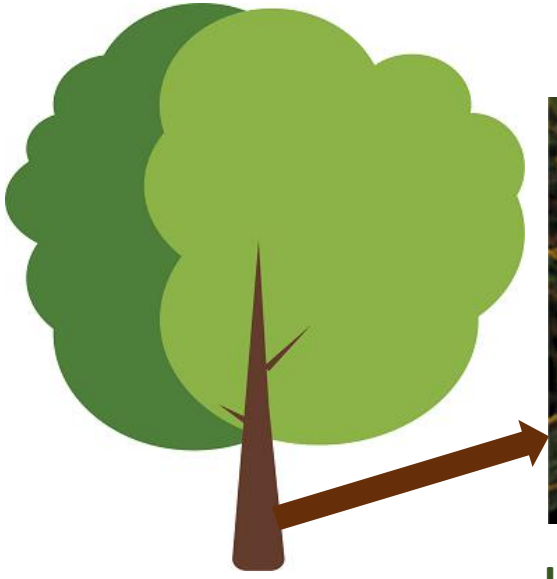


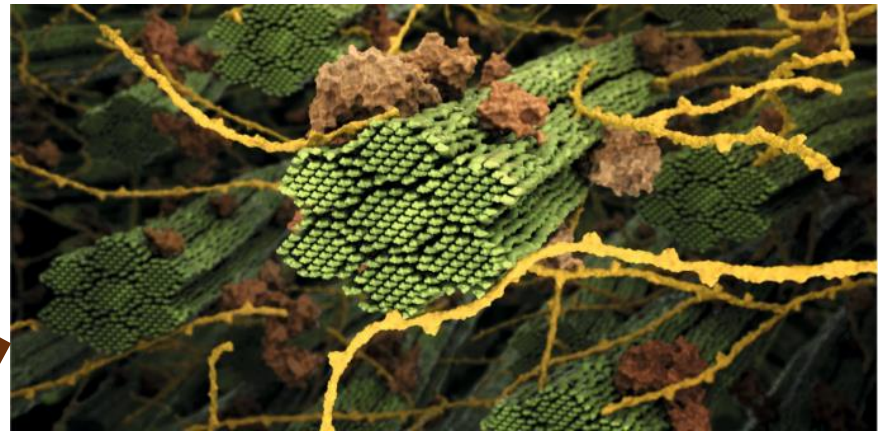




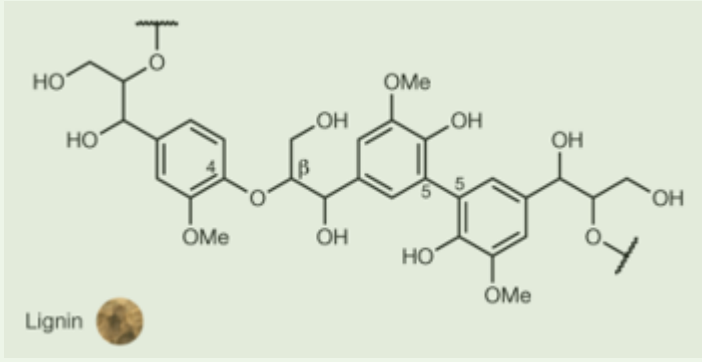
2G Ethanol

Biobased plastics





Lignocellulosic Biomass



Treated always as
Low-value side solid stream

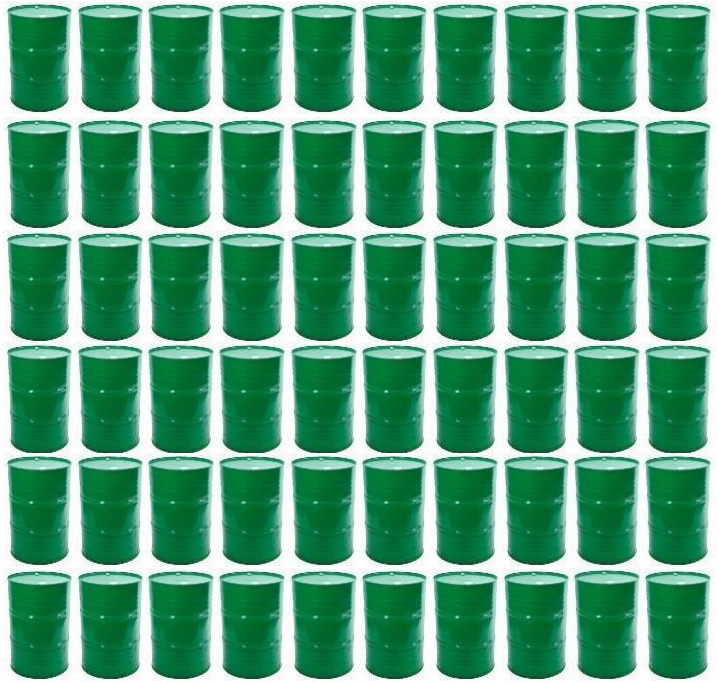
Is Biomass enough?

Fossil oil

5 billion tons / y

Extracted from Mother nature

Lignocellulosic Biomass



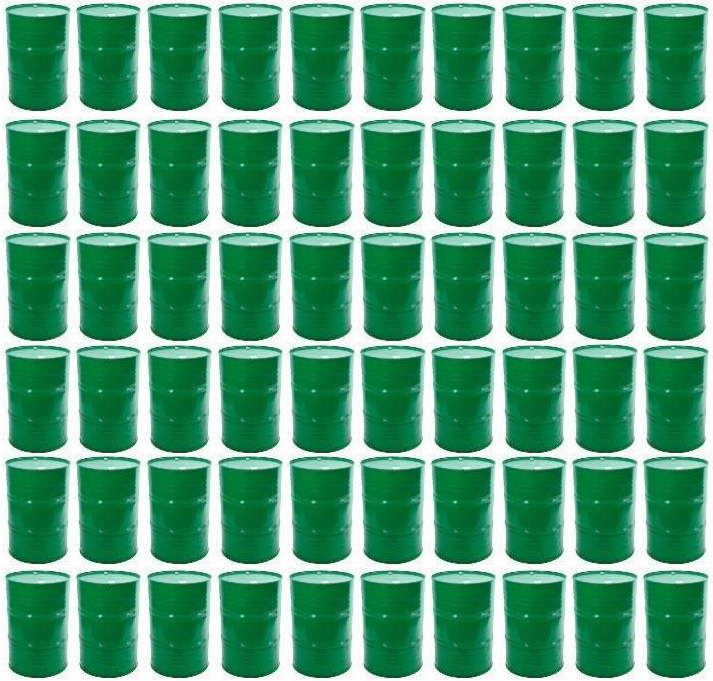
180 billion tons / y *

Produced by Mother nature

* *Wood Research 60(6):2015 973-986*

Is Biomass enough?

Lignocellulosic Biomass



180 billion tons / y

Produced by Mother nature

Sustainably utilize

Wood & Processing wastes

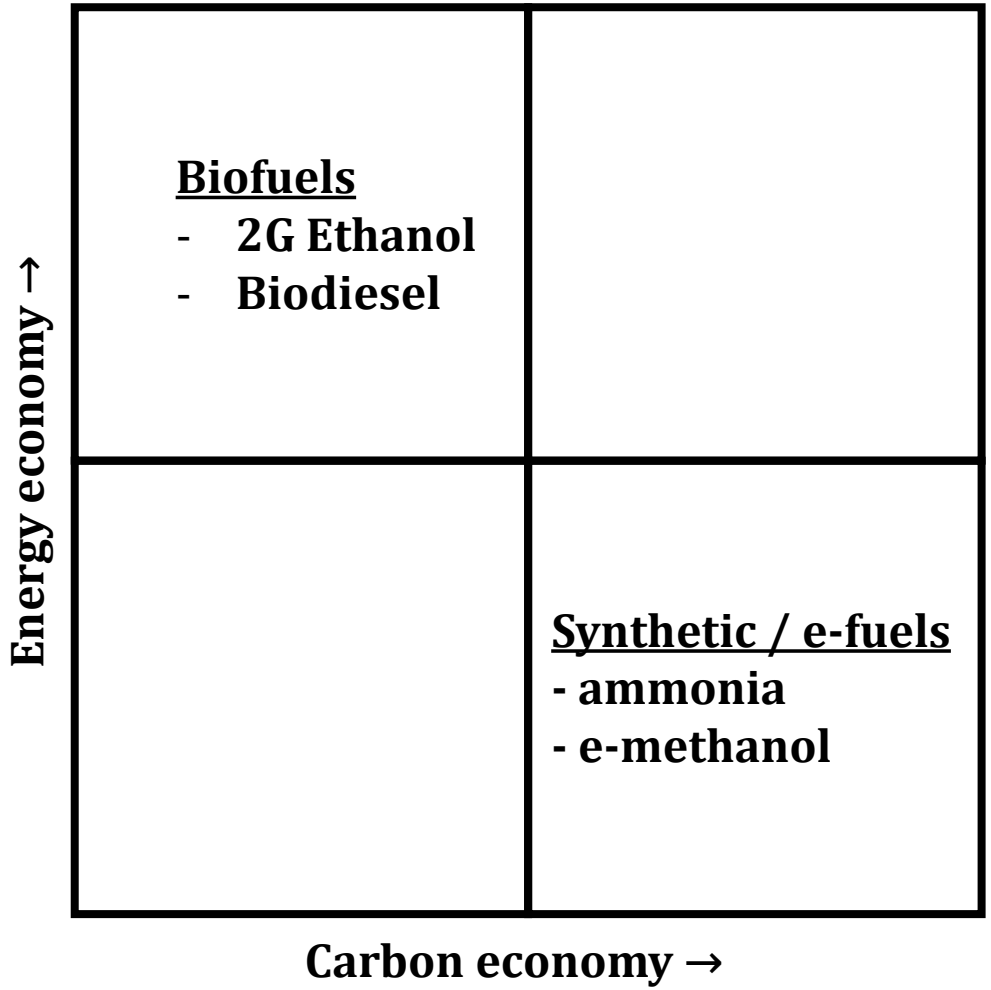
Agricultural crops

25 billion tons / y

Available

Problem 2

Sustainable energy carriers have <u>poor resource efficiency</u>

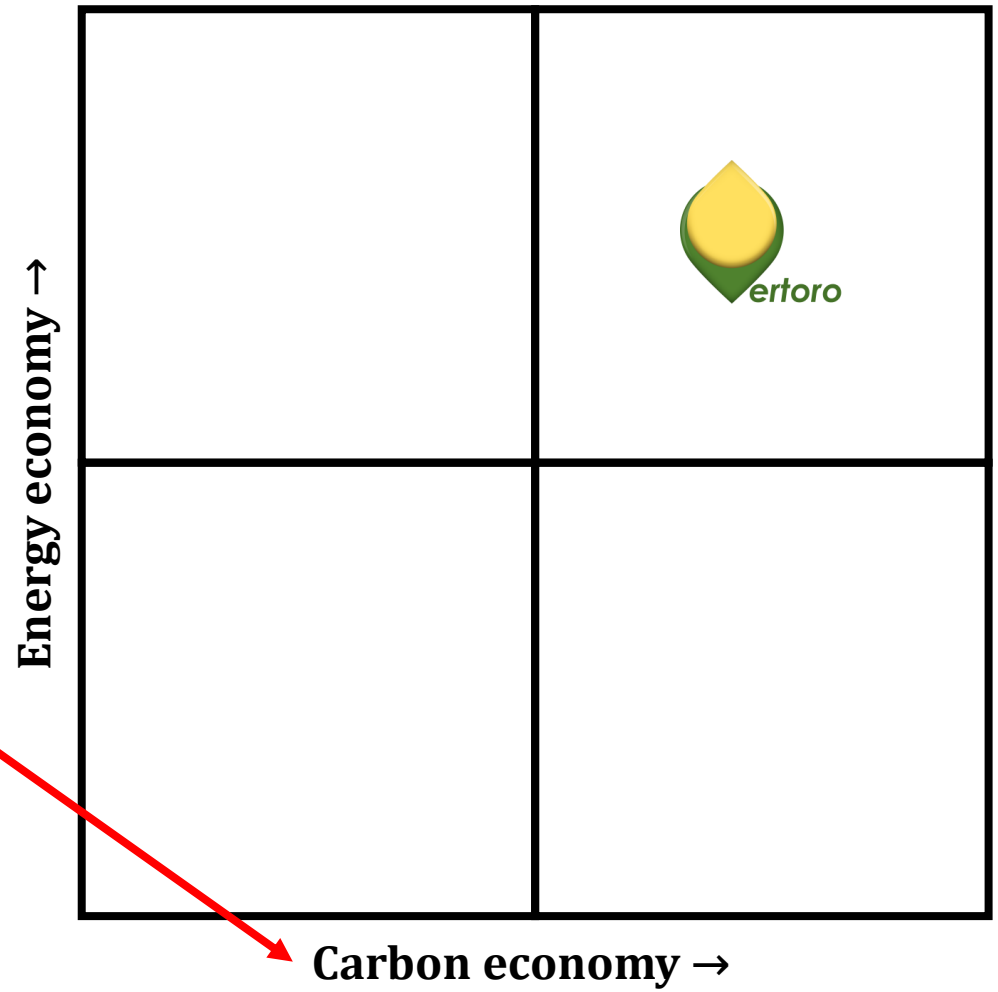


Solution

Sustainable energy carriers with <u>excellent resource efficiency</u>

<u>Goldilocks® technology</u>
Mobilize, don't crack

<u>No atom left behind™</u>
Near 100% yield to oil



Decarbonization 2.0 – Resource management

Mission: Creating future-proof low carbon solutions, produced with minimal consumption of precious resources (biomass, land, energy, metals, …)

Our mission	Problem
At Vertoro, we believe in Decarbonization 2.0, which holds that creating affordable low carbon solutions does not go far enough. **These solutions should furthermore be produced with maximal resource efficiency.**	Little attention is paid to **requisite inputs** for low carbon solutions, such as electricity, hydrogen, biomass, and precious metals. Though acceptable today, undue consumption of precious resources is not future proof.

Vission

What we do. Produce patented **bio-based crude oils** from sustainably sourced 2G biomass residues/wastes. **Revolutionize biorefinery approach.**

Vision. Become both the world's first **sustainable oil major**.

Solution

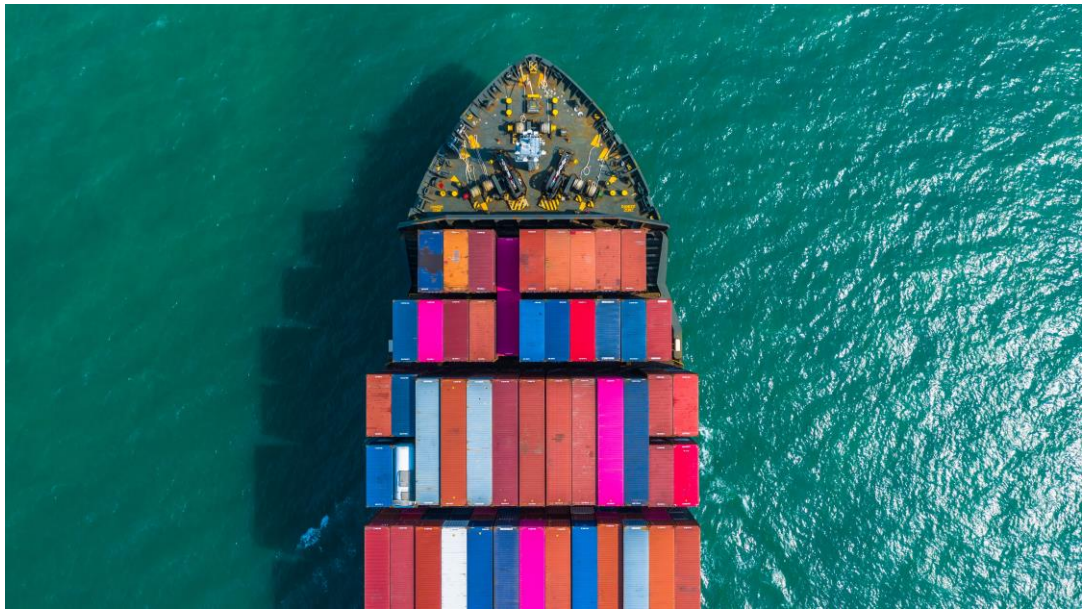
Cheap sustainable crude oil **platforms**

Lignocellulose

Cellulose

	Espresso	Recipe #1	Recipe #2	Recipe #3
Solvent	Water	(m)ethanol	(m)ethanol + dilute acid	Water + dilute acid
Biomass	Coffee beans	**Lignin** (ex-2G ethanol or ex-paper & pulp plant)	**Lignocellulose** (saw dust, stover, bagasse)	**Cellulose** (own process, paper sludge, beet pulp, EOL textiles)
Temperature	90 °C	200 °C	180 °C	150 °C
Liquid product	Espresso	**Crude lignin oil (CLO) (~50%)**	**Crude lignin oil (CLO) (~50%)**	**Crude sugar oil (CSO) (>95%)**
Solid product	Coffee residue	“Biochar” (~50%)	Cellulose (~50%)	Ash → fertilizer (<5%)

Our 1st grand challenge: Transportation
International shipping & Aviation

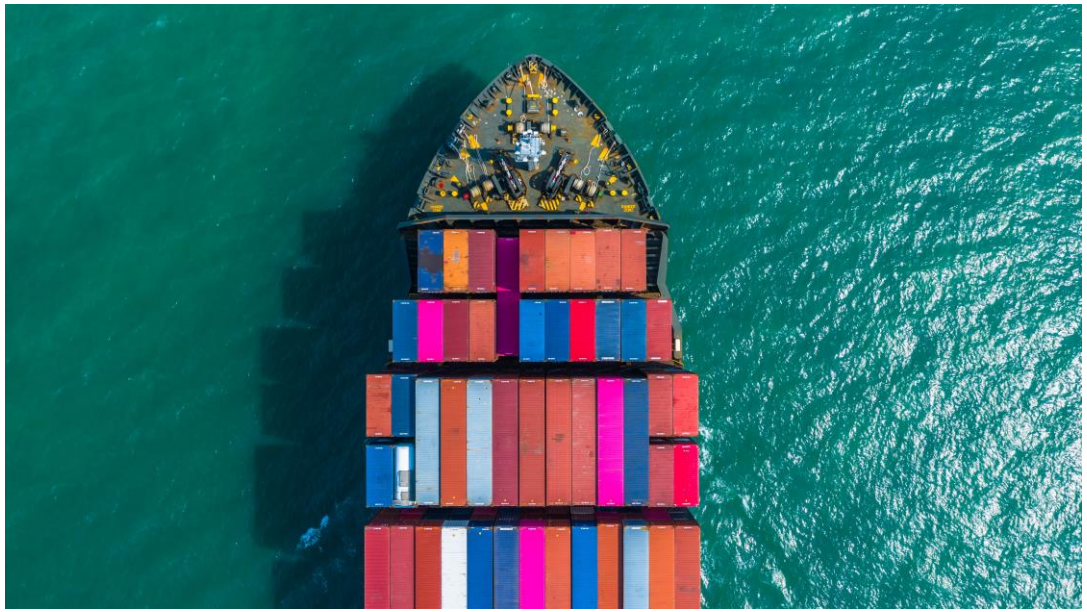


3% global CO2 emissions

2.5% global CO2 emissions

The maritime sector consumes **300 million tons of fuel oil per year** and emits **3%** of global GHG emissions.

Solution
Low carbon fuels

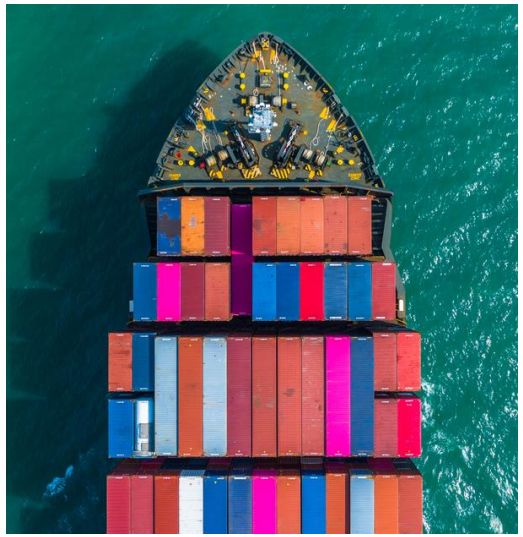


Crude Lignin Oil (CLO®)
Crude Sugar Oil (CSO®)
Initial focus

CSO®-derived 2G ethanol & CO2
for Alcohol-to-Jet & e-Kerosene

Market

Killer **apps**, traction & key performance indicators

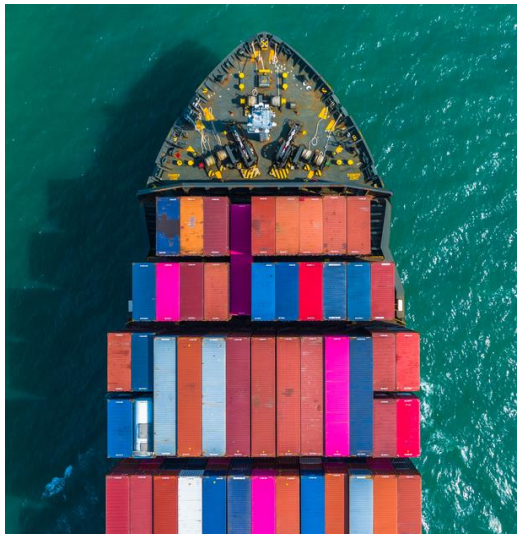


Crude lignin oil (CLO®)

Drop-in for new 2-stroke dual-fuel (m)ethanol vessels (e.g., Maersk)

Ethanol

Key performance indicators: Compliance (e.g., RED) & $/GJ



Crude sugar oil (CSO®)

Drop-in via emulsification with HFO for existing vessels (e.g., MSC via our partner Quadrise)

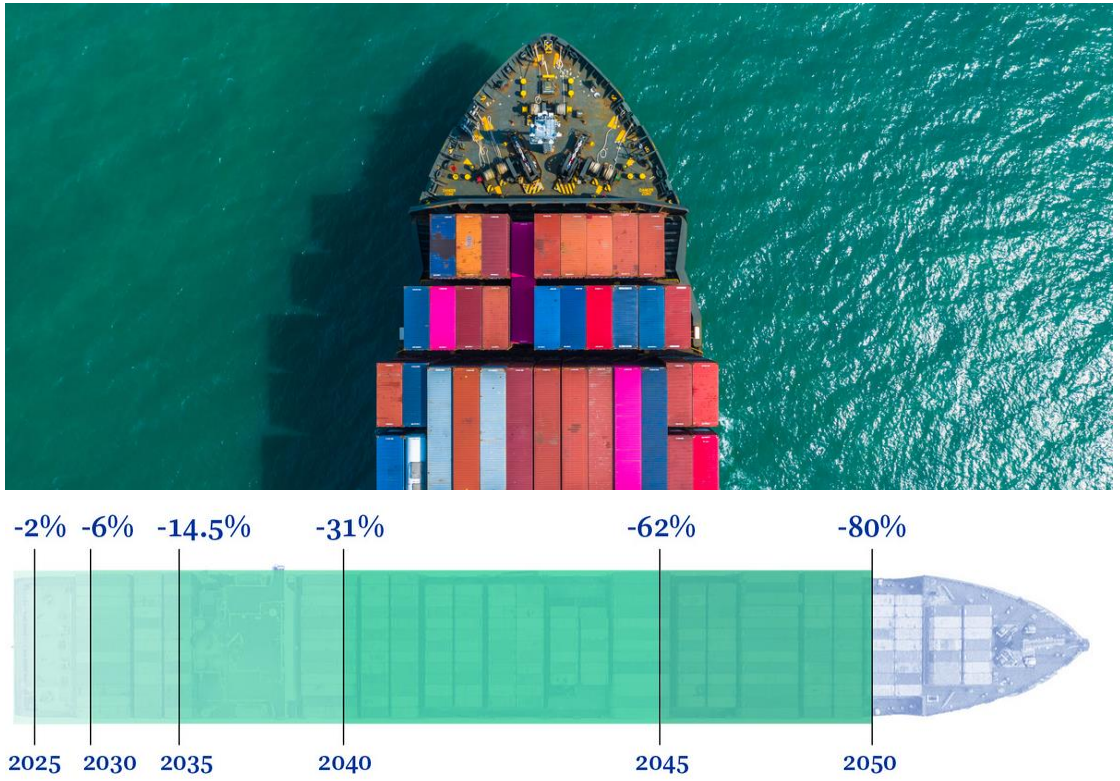
Beachhead market & traction

Large, low entry barriers, harsh new legislation

Crude lignin oil (CLO)

Drop-in for new dual-fuel vessels (Maersk, CMA, Cosco)

MAERSK



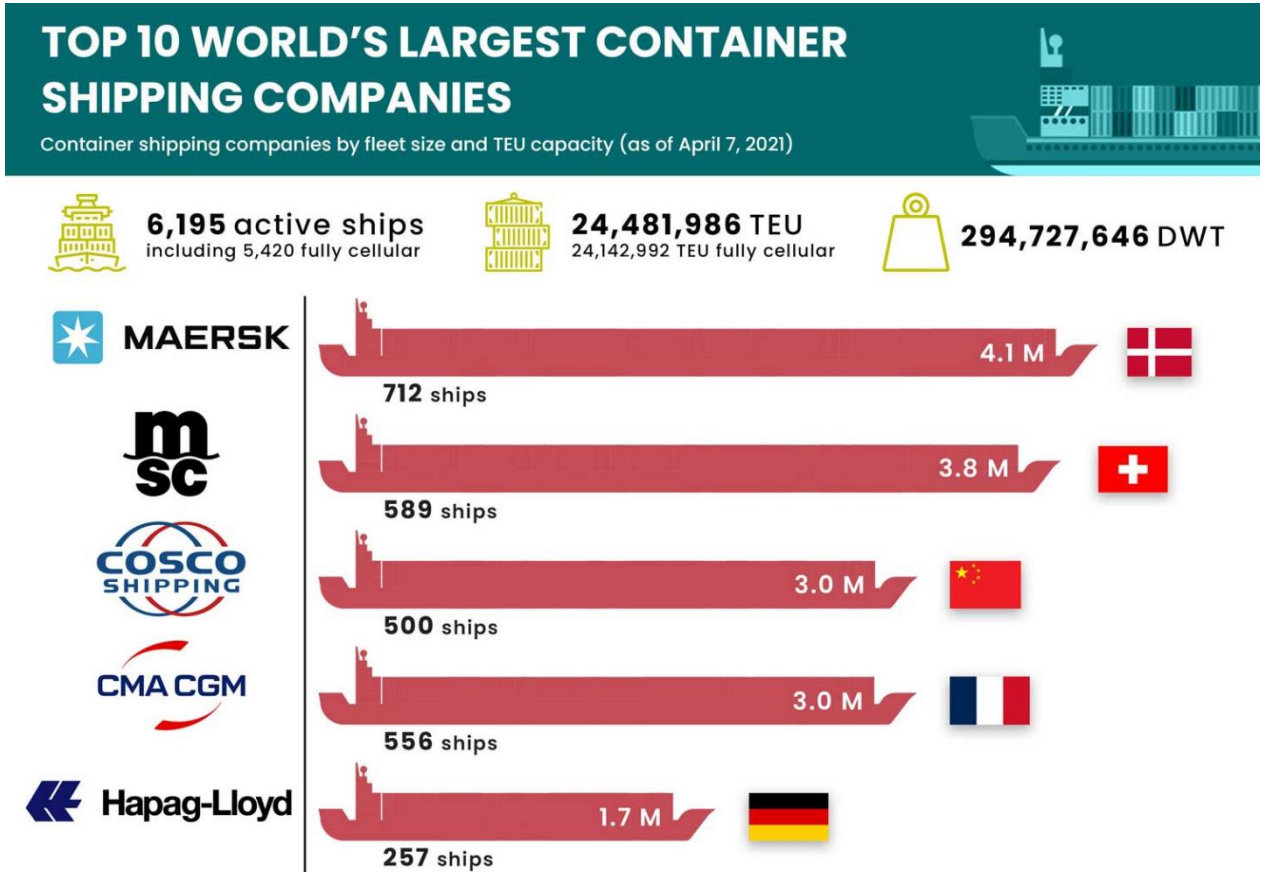
FuelEU Maritime (part of EU Fit for 55 package)

Crude sugar oil (CSO)

Drop-in (via emulsification with HFO) for existing vessels)

Quadrise Fuels International plc

Launching market – Container Shipping



https://www.alcottglobal.com/top-10-worlds-largest-container-shipping-companies/?utm_source=rss&utm_medium=rss&utm_campaign=top-10-worlds-largest-container-shipping-companies

Rationale

- No **viable** alternatives to liquid fuels
- Engines can digest pretty much anything
- 100% green premium → **< 1% increase** consumer prices

Competitors

	Fuel	Key advantages	Key limitations/risks
Shell	**Biodiesel** e.g., Used Cooking Oil Methyl Ester (UCOME)	• Can be used as drop-in fuel in existing vessels and engines	• Limited availability of biomass feedstock a challenge to scalability • Price pressure due to high demand from competing industries
METHANEX	**Methanol** (bio-methanol and e-methanol)	• Already in operation as marine fuel • Engine is available • Liquid at normal conditions, well-known handling	• Bio-methanol: Production at scale is challenged by uncertainty over availability of biomass • E-methanol: Availability of biogenic CO_2 source at production site, cost and maturity of electrolyser technology
ertoro	**Lignin fuels** A new biofuel based on biomass residue (lignin) and alcohols (methanol or ethanol)	• Lignin fuels are potentially the most price-competitive net zero fuel with the lowest price estimate almost on a par with fossil fuels	• In development stage, production needs to be scaled up to create a new value chain and infrastructure for supply • Engine requirements would be the same as for methanol, but additional handling of contaminants may be required
SIEMENS	**Ammonia** (green ammonia)	• Fully zero emissions fuel • Can be produced at scale from renewable electricity alone	• Safety and toxicity challenges • Infrastructure challenges at ports • Future cost depends on cost of renewable electricity and cost/maturity of electrolyser technology

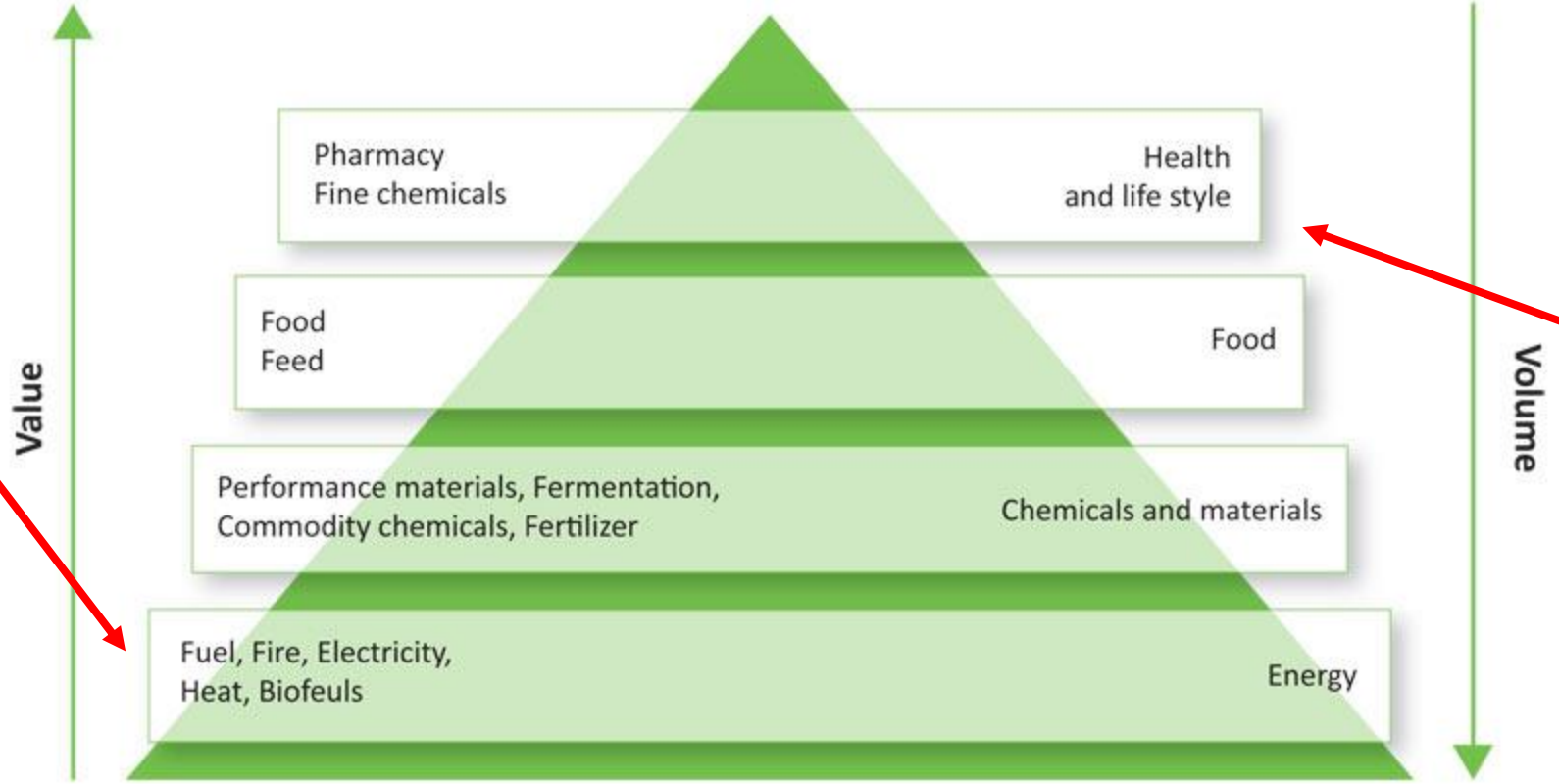
Source: https://www.maersk.com/about/sustainability/reports

Creating more value by doing less

Natural functionality open many high value markets

MAERSK

Energy
Marine fuel



Health
Antioxidant

History & next moves

Frugal, yet logarithmic scaling

kansen voor west

INNOVATION FUND
Driving clean innovative technologies towards the market

Rijksdienst voor Ondernemend Nederland

MAERSK

SHIFT

Brightlands Venture Partners

LIOF

USD 20+M raised

Name plate capacity (dry biomass)

University lab	Pilot plant (Geleen)	Demo plant (Geleen)	Commercial plant (Port of Rotterdam)
1 kgpa	*1 tpa*	*1 ktpa*	*10 ktpa*

2017	2020	2023	2026
TRL 3-4 (lab) √	TRL 5-6 (Pilot) √	TRL 7-8 (Demo) √	TRL 9 (Commercial)

Key take-away messages

- Residual biomass streams do not stay cheap for long!

3 pillars of future-proof strategy for lignocellulosic biomass valorization

- Maximize yield from feedstock to product(s)
- Low CAPEX/OPEX production process
- High value outlets to support margins over time

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