European Commission

MUSIC
Market Uptake Support for Intermediate Bioenergy Carriers

Bioenergy EUROPE

Sustainable biofuels for shipping

Felipe Ferrari

GoodFuels
better world

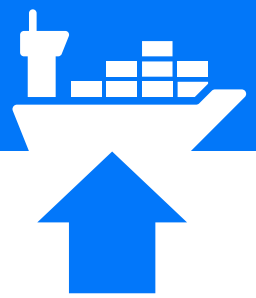
INTERNATIONAL SHIPPING GOALS

CHALLENGE

2.5% of Global CO2 emissions

2030 → **40%** Reduction

2050 → **50%** GHG reduction
70% CO2 reduction



Initiate consideration of mid-term measures under Phase I of the Workplan (October-November 2021)

Further consideration of assessment of impacts on States of candidate GHG measures (October-November 2021)

EEDI phase 3 in effect for certain ship types with up to 50% carbon intensity reduction for new build large containerships

EEXI survey requirements take effect (November 2022)

Carbon intensity measures enter into effect

Revision of the IMO Initial GHG Strategy

Start of carbon intensity data (CII) collection under the short-term measure

EEDI phase 3 in effect - up to 30% reduction in carbon intensity for newbuild ship

IMO Initial GHG Strategy objective of 40% reduction of CO_2 emissions per transport work compared to 2008, as an average across international shipping

IMO Initial GHG Strategy objectives of 50% reduction of the total annual GHG emissions and 70% reduction of CO_2 emissions per transport work compared to 2008 whilst pursuing efforts towards phasing them out - as a point on a pathway of CO_2 emissions reduction consistent with the Paris Agreement temperature goals

2022 2023 2024 2025 2030 2050

IMO-UNEP **Maritime Zero-Low Carbon Innovation Forum** (September 2021)

Revision

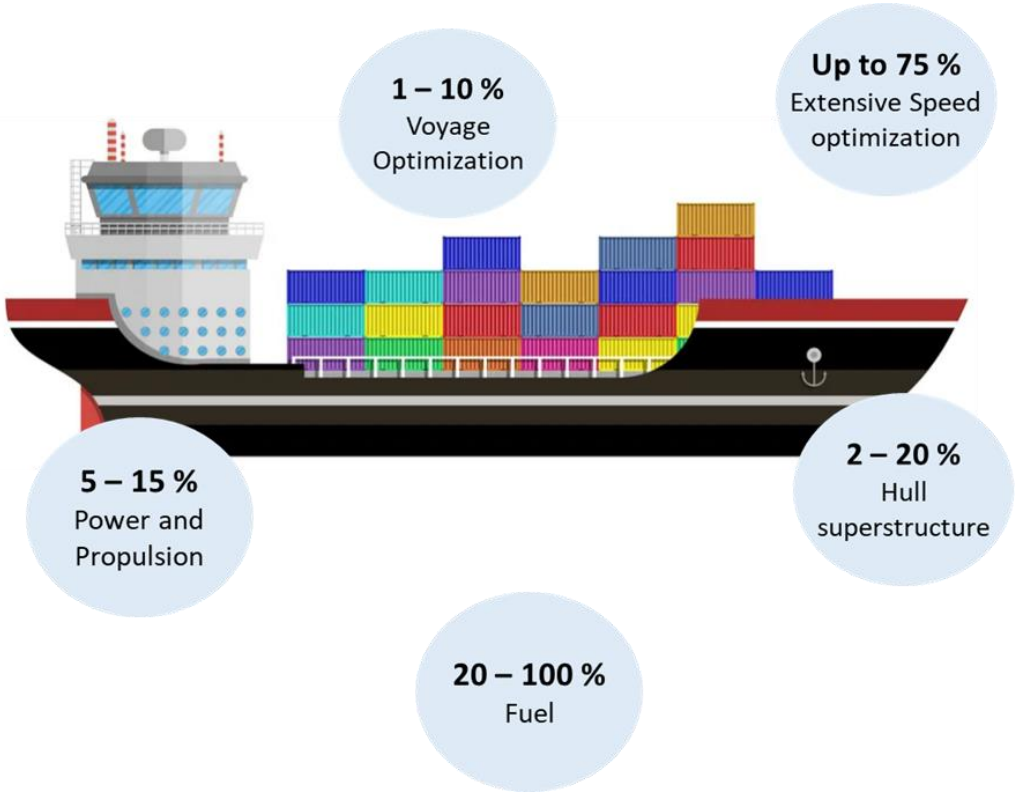
ETS shipping – Internationalization

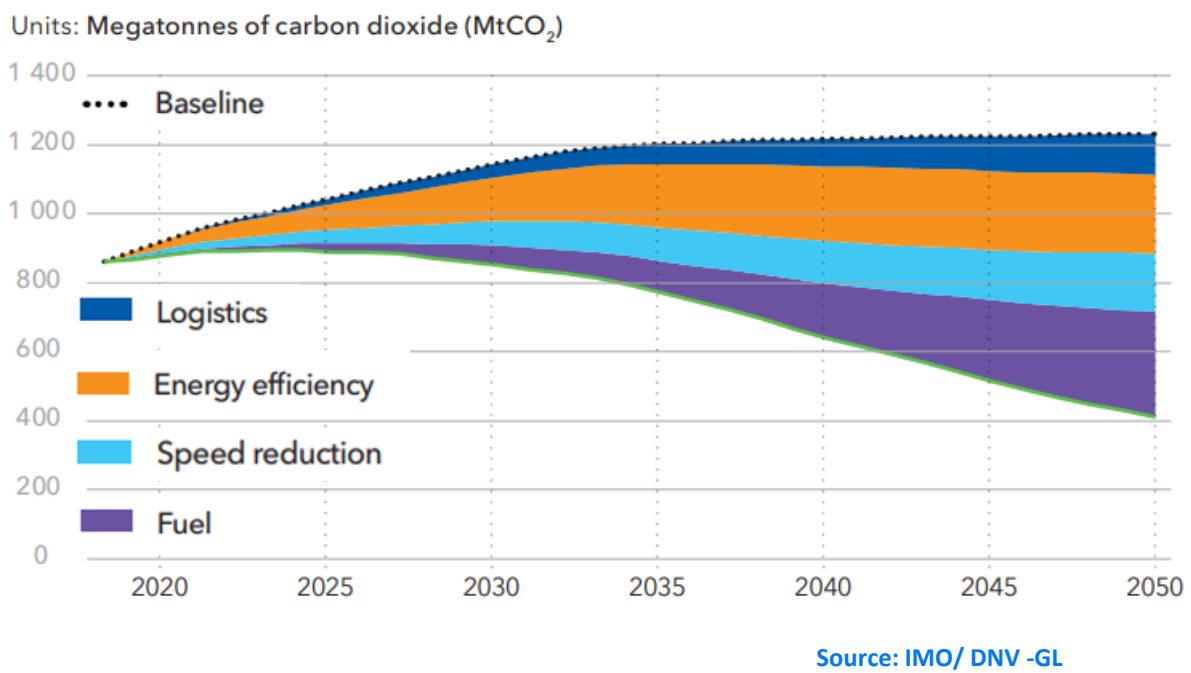
RED III

GHG MITIGATION STRATEGIES

2050 Transport work increase **40-100%**

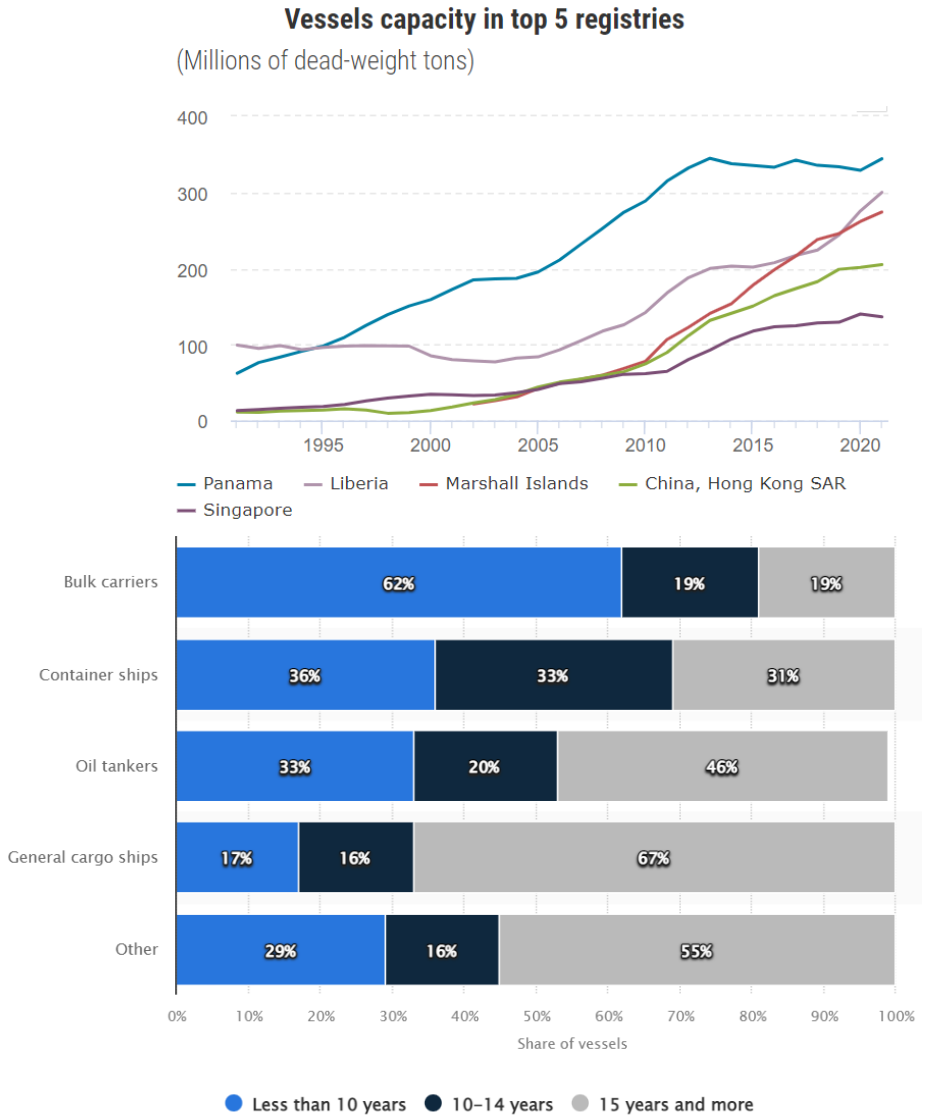
2020 Business as usual **90-130%** vs. 2008





Source: IMO/ DNV -GL

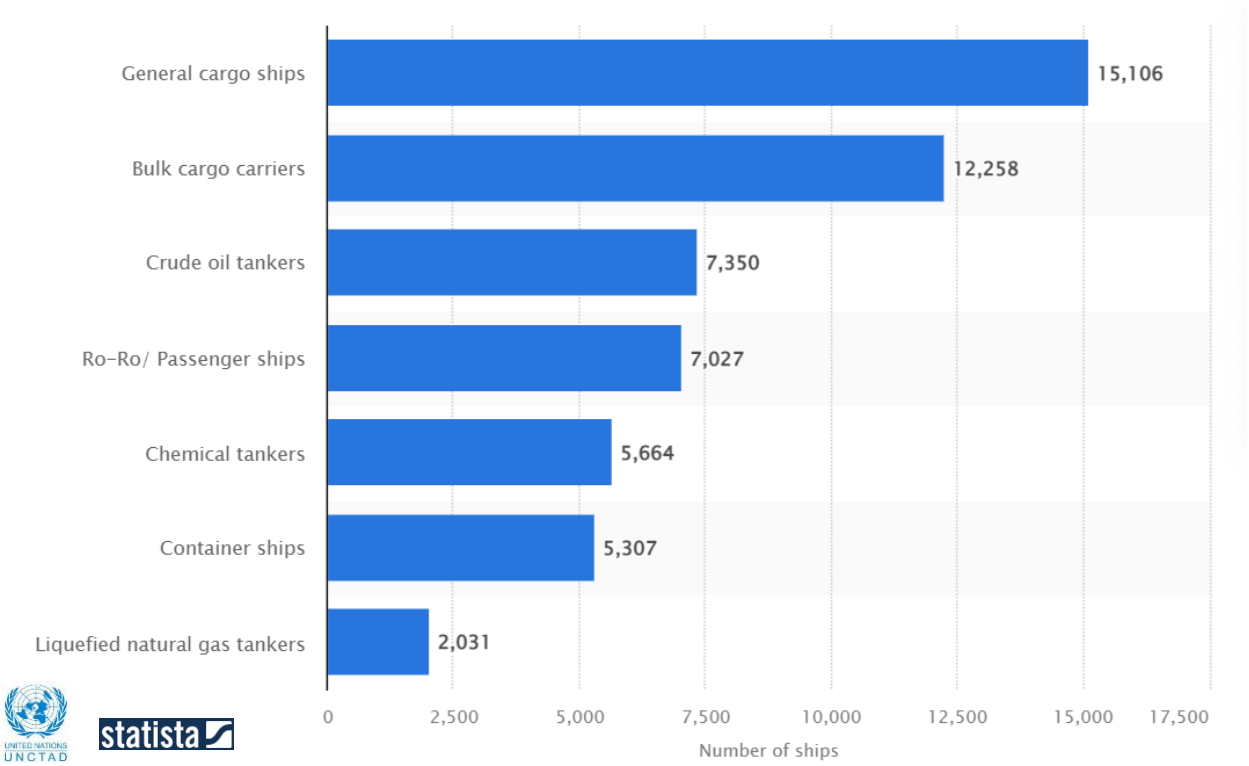
THE OPPORTUNITY: DECARBONIZING DEEP SEA SHIPPING



Biofuels are the only option that have the potential to reduce up to 90% CO_2 WTW, today at scale

Existing marine engines → 100.000 HP

Fuel friendly engines



Source: UNCTAD statista

OUR APPROACH

IMMEDIATE SOLUTION FOR SECTORS IN WHICH OPTIONS TO DECARBONIZE ARE LIMITED

Five key questions:

1. Is it sustainable?
2. Does it work?
3. Is it affordable?
4. Is it available?
5. Is it scalable?

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CONCEPT DEVELOPMENT

PRODUCT (CO)-DEVELOPMENT

TECHNOLOGY INTRODUCTION

MARKET DEVELOPMENT

LOBBY & LEGISLATION

CONNECTING THE LIKEMINDED

SUSTAINABILITY

Sustainability principles

Waste and residue based only

No **competition** with food

No direct or indirect **land use change**

No **deforestation** or **biodiversity** loss

No **higher quality application** possible

Minimum of 75% co_2-reduction

No negative **social** or **legal** impacts

Sustainability board

ANNE MARIT POST-MELBYE
Head of industry policy
Miljøstiftelsen ZERO

MARTIN JUNG NGER
Profe sor of
bio-basec economy
Utrecht l niversity

PATRICIA OSSEWEIJER
Professor of sustainability
TU Delft

Certification & partners

ISCC International Sustainability & Carbon Certification

CARBON WAR ROOM

ZERO

NATUUR & MILIEU

RSB MEMBER

OUR PROGRESS

2015
GoodFuels founded, focusing on Marine, Road & Rail

2017
GoodShipping enters the market

OCTOBER 2017
Tony's Chocolony's first GoodShipping customer

DECEMBER 2017
Partnership DHL Global Forwarding

NOVEMBER 2018
World's first **Bio Fuel Oil** bunkering

2020
Extending experience with Bio Fuel Oil applications

NEAR, MEDIUM AND LONG-TERM SOLUTIONS
We work on bringing the best solutions to current business

- Advanced biofuels
- Sustainable biomass
- alternative fuel carriers

2015

2017

2020

SEPTEMBER 2015
First marine biofuel bunkering with Boskalis and Wärtsilä

JUNE 2017
First inland waterway pilot with HEINEKEN

OCT/NOV 2017
Winner TEDx and Accenture Innovation Award

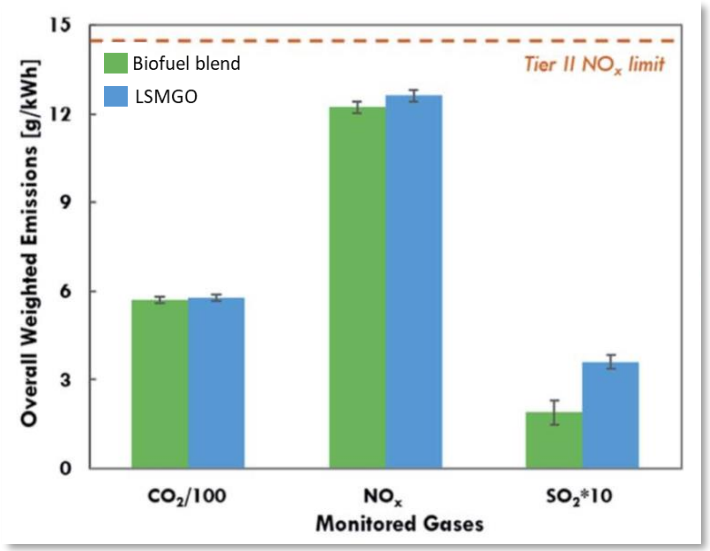
SEPTEMBER 2018
First blockchain bunkering with Samskip

MARCH 2019
World's first container vessel on Bio Fuel Oil

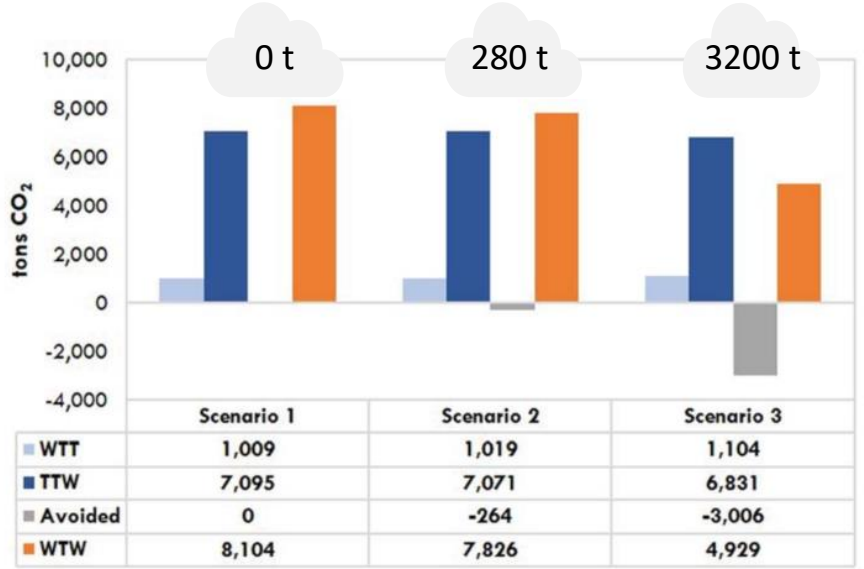
FEBRUARY 2022
GoodFuels Expansion Asia-Pacific Singapore

BIOFUEL REAL DROP-IN: THE LIFECYCLE BENEFIT

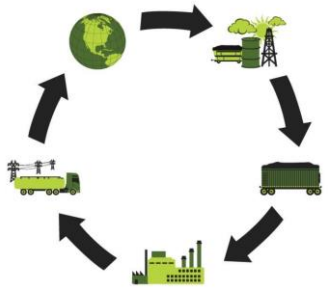
Pipe emissions

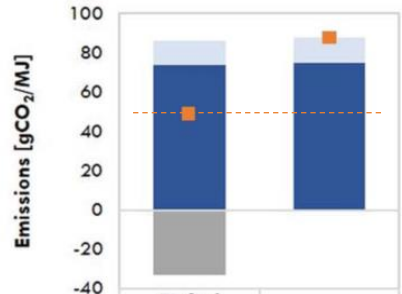


Lifecycle



	Scenario 1	Scenario 2	Scenario 3
WTT	1,009	1,019	1,104
TTW	7,095	7,071	6,831
Avoided	0	-264	-3,006
WTW	8,104	7,826	4,929





	Biofuel blend	LSMGO
WTT	12	13
TTW	74	75
Avoided	-33	0
WTW	53	88

Sustainable Energy & Fuels

ROYAL SOCIETY OF CHEMISTRY

PAPER View Article Online View Journal

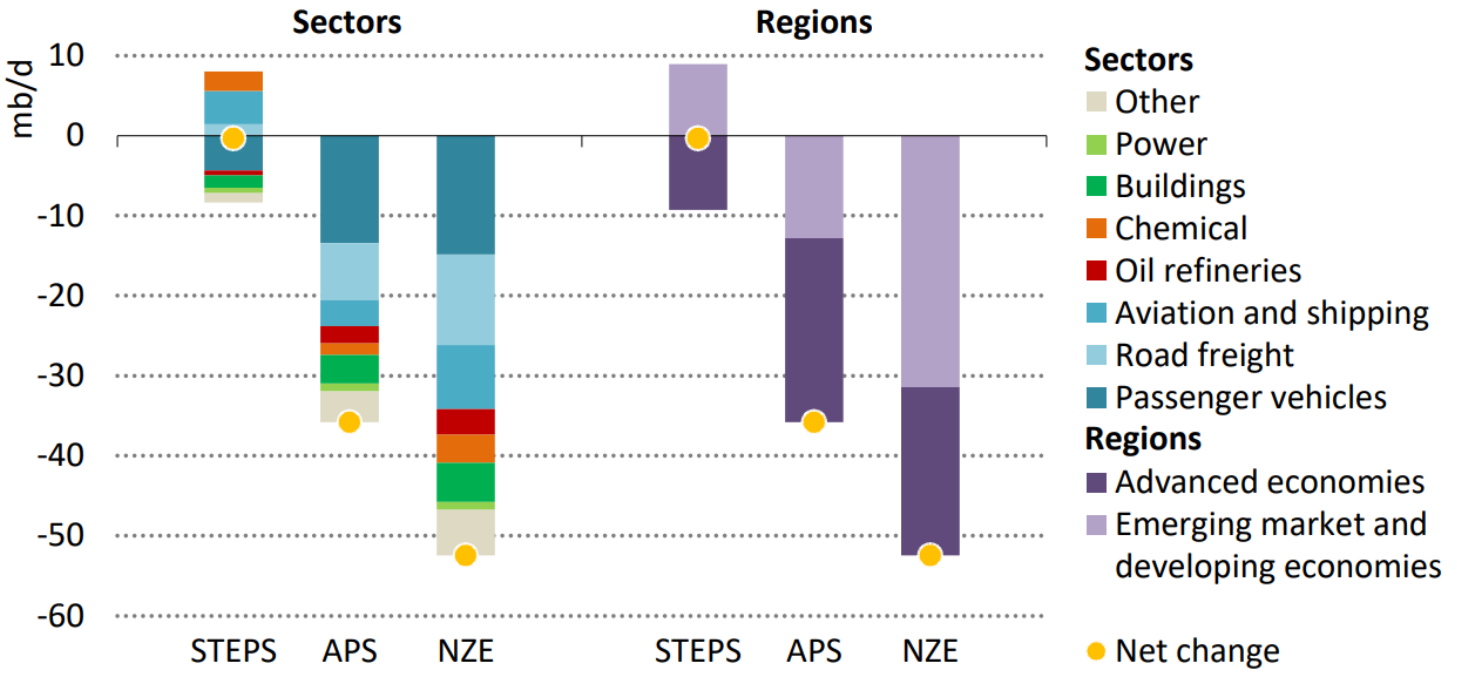
Towards decarbonization of shipping: direct emissions & life cycle impacts from a biofuel trial aboard an ocean-going dry bulk vessel†

Patritsia Maria Stathatou, *[a] Scott Bergeron,[b] Christopher Fee,[b] Paul Jeffrey,[b] Michael Triantafyllou[c] and Neil Gershenfeld[a]

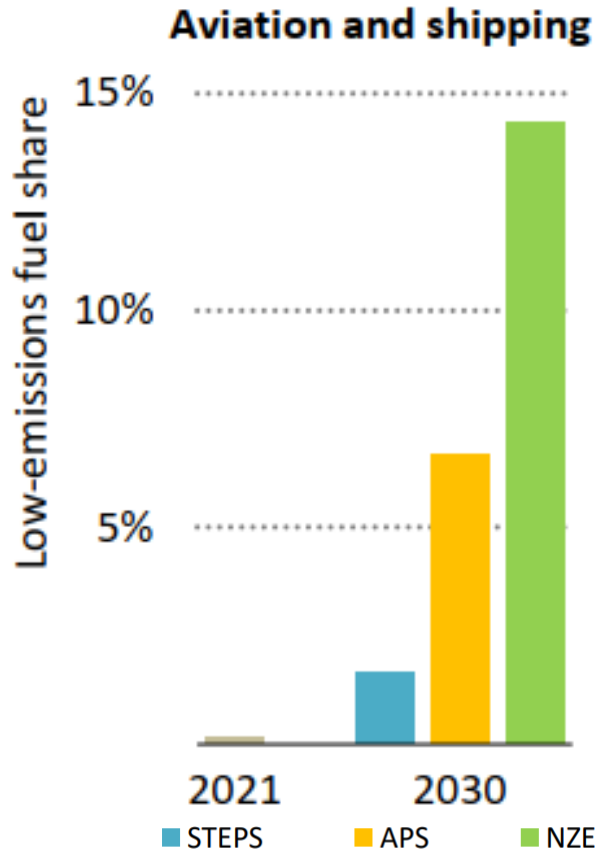
GoodFuels' MDF – 100 (50%) / MGO (50%)

The Sustainability of Biofuels

Figure 7.4 ▷ Change in oil demand by scenario, 2030-2050

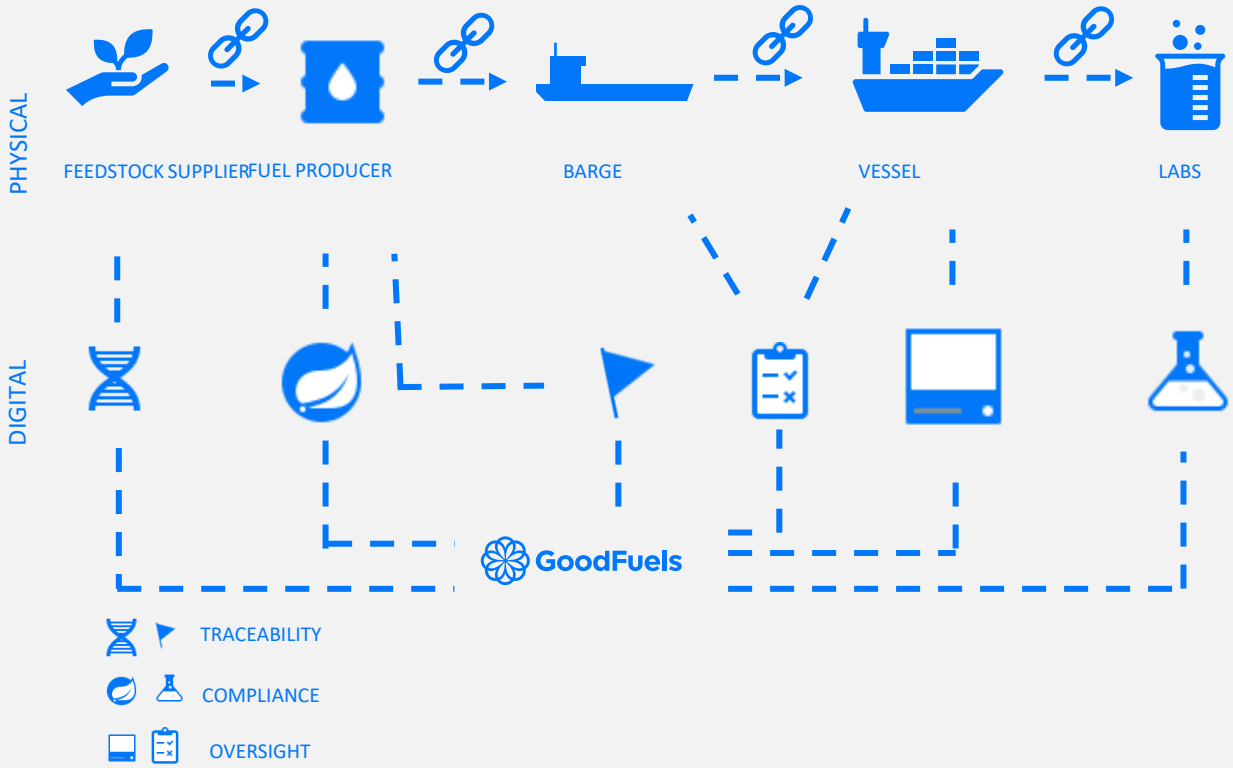


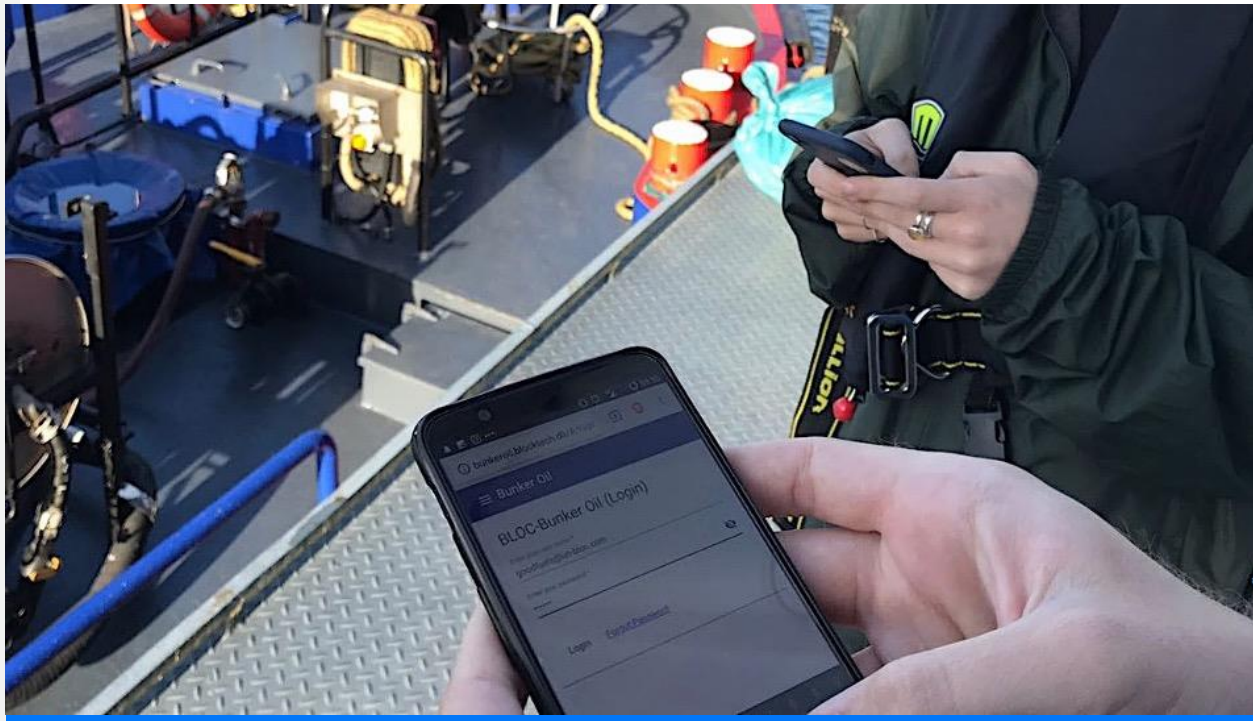
IEA. CC BY 4.0.



NEXT LEVEL ASSURANCE OF SUSTAINABILITY AND SOURCING

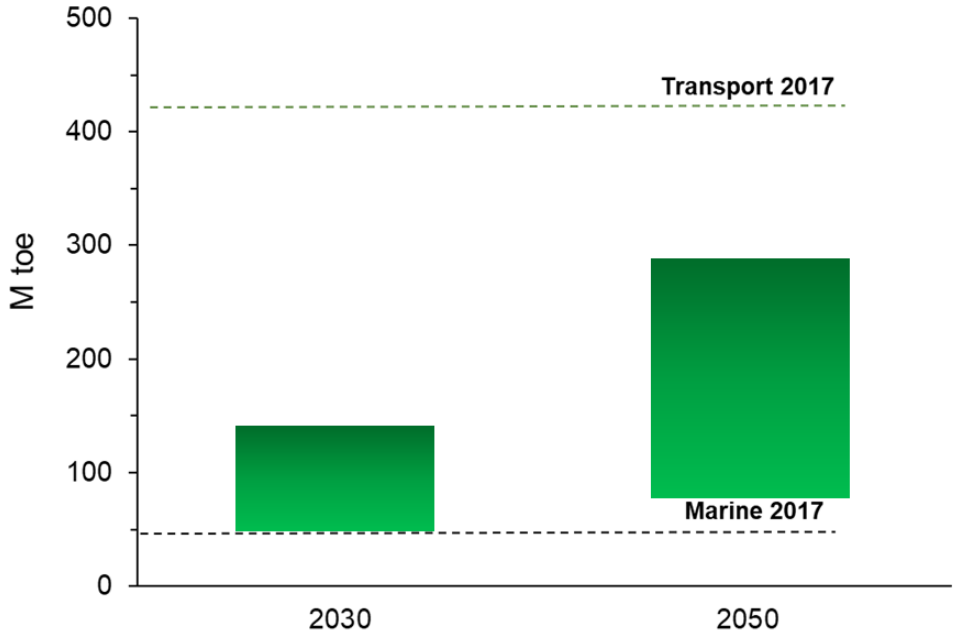
Digital technology and physical tracing will help to provide clients with the right sustainability and quality guarantees





FEEDSTOCK DIVERSIFICATION

Biofuel	Feedstock	2030 estimated advanced biofuel quantity (Mtoe)	2050 estimated advanced biofuel quantity (Mtoe)
Hydrotreated vegetable oil/ renewable diesel	Waste oils and fats	1.9	1.9
	Used cooking oil	2.6	6.5
Biomethane	Sewage sludge	0.1–0.2	1.0–1.2
	Manure (solid and liquid)	1.1–1.3	0.4–0.4
	Agricultural residues (high moisture, sugar beet leaves, etc.)	0.1	0.1
Ethanol and hydrocarbons from enzymatic hydrolysis and fermentation	Agricultural residues (straw-like)	21.0–25.3	N/A
	Lignocellulosic crops (grassy)	5.5–16.6	6.5–19.6
	Biowaste	9.2–16.8	13.2–24.4
Fischer Tropsch from gasification + catalytic synthesis	Solid industrial waste (secondary agricultural and forest industries)	27.9–40.1	56.8–84.0
	Agricultural residues (straw-like)	N/A	54.4–62.4
	Agricultural (woody) and forestry residues	1–1.5	2.4–3.2
	Lignocellulosic crops (woody)	7.6–22.7	16.8–50.8
Totals		**78.0–129.1**	**160.0–254.5**
Total liquid advanced biofuels taking into account the total sustainable biomass for bioenergy		**76.7–127.5**	**158.5–252.8**
Average conversion yield on an energy basis		**37%**	**70%**
Average conversion yield on a dry mass basis		**15%**	**29%**



Source: Imperial College London Consultants

SCALING BIOFUEL

Scaling biofuel first requires increasing the supply of suitable blending components

- Calorific value
- Deposit formation (injector and cylinder)
- Compatible with sealings
- Compatible with Purification unit
- Acceptable combustion quality;
- Emissions (NOx and SOx)
  - Not exceed regulatory NOx and SOx limits
- Exhaust After Treatment systems

ISO 8217 Residual fuel specification

- ✓ **Stability**
- ✓ **Corrosion**
- ✓ **Flash point**
- ✓ **Cold Flow prop.**

SCALING UP

GoodFuels will continue to scale as fast as possible to supply the world's ships with the most sustainable fuels available…

… collaborating with different suppliers using **different feedstocks and technologies** without compromising **quality or sustainability**

- ✓ Sourcing **residual products**
- ✓ **Offtake** of future plants
- ✓ **Participation** in future plants
- ✓ **Co-creation and commercialization**

CONCLUDING REMARKS

COLLABORATION: INTEGRATE STAKEHOLDERS

TECHNOLOGY DEVELOPMENT

SUSTAINABILITY

LEGISLATION AND PUBLIC AFFAIRS

BUSINESS CASE POTENTIAL AND PARTICULARITIES

TECHNICAL SUPPORT DURING BIOFUEL TRIALS

INTERNATIONAL SUPPLY AND VALUE CHAINS

CONTACT

LONG TERM INNOVATION

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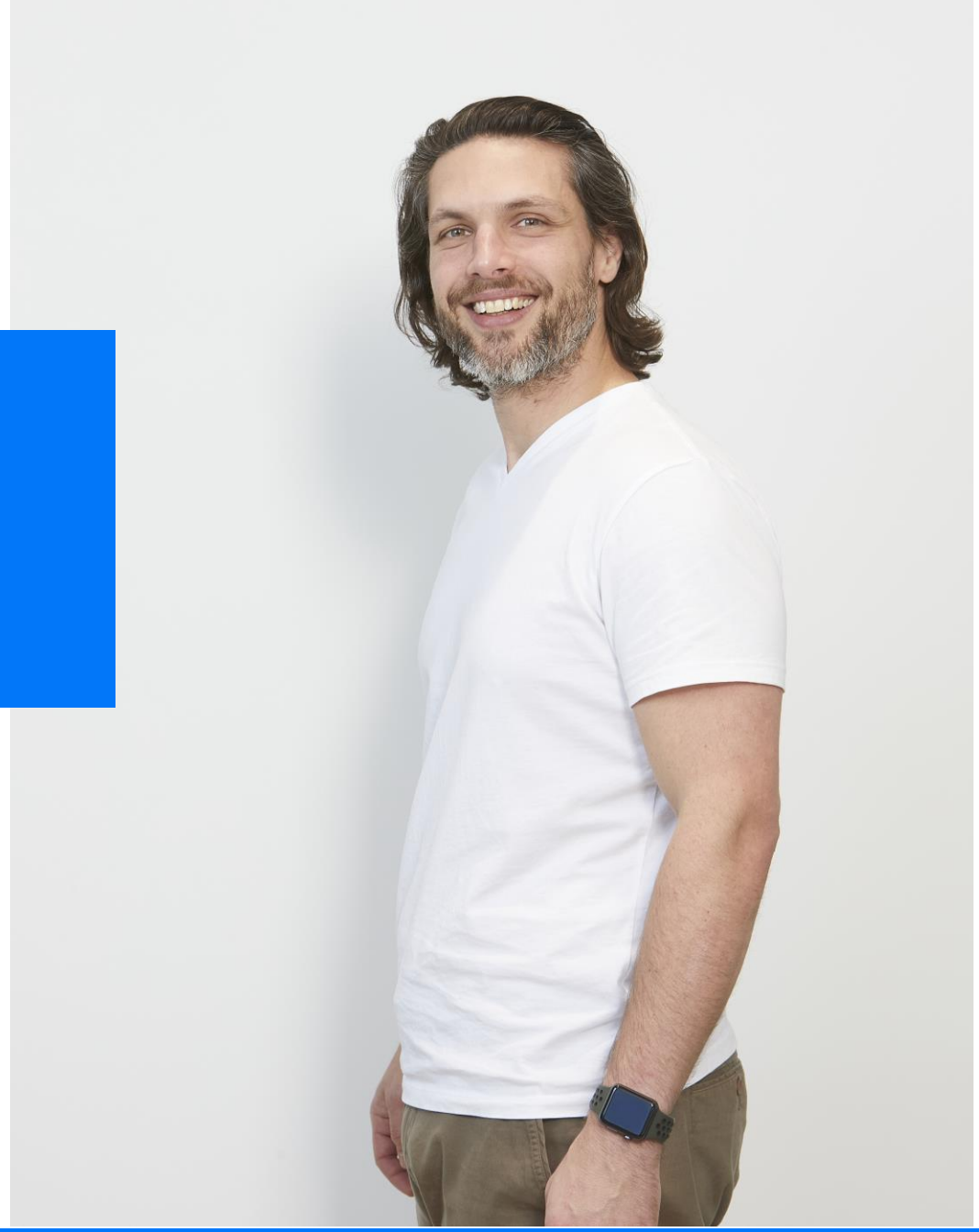
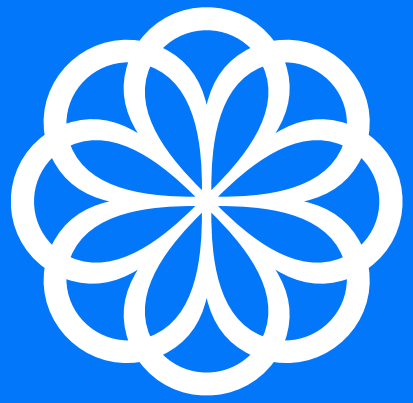




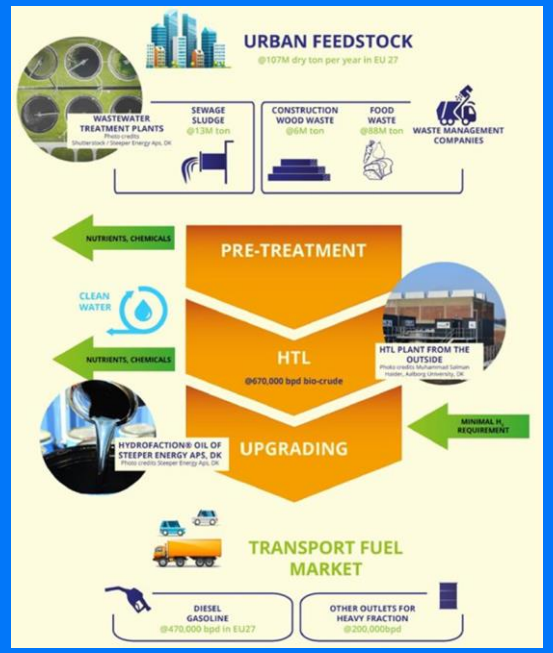
GoodFuels

OUR STRENGTHS: INNOVATION

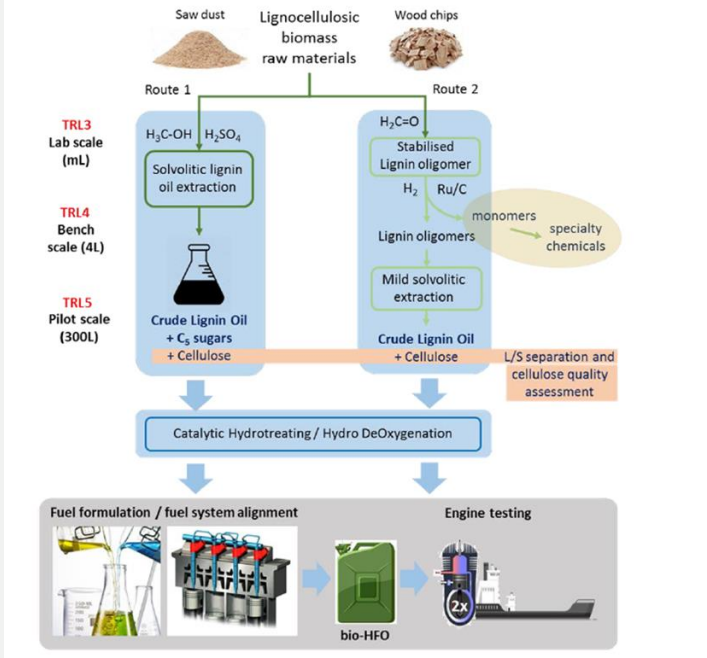
Theses projects have received funding from the European Union's Horizon 2020 research and innovation programme under bellow grant agreements No 818413, No 883753, No857806

Some examples of our current innovation projects:

NEXTGEN roadfuels

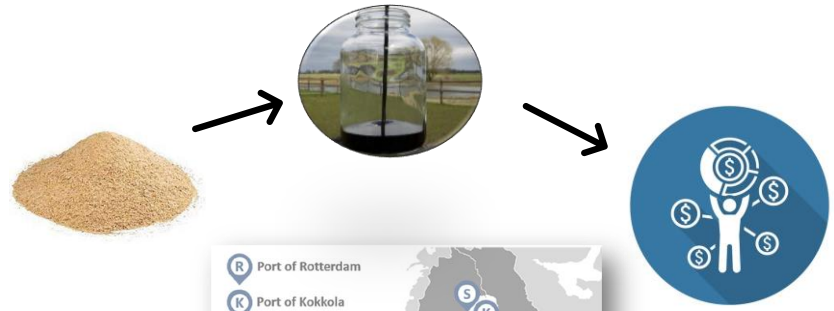


IDEAL FUEL



MUSIC
Market Uptake Support for Intermediate Bioenergy Carriers

Intermediate bioenergy carrier uptake

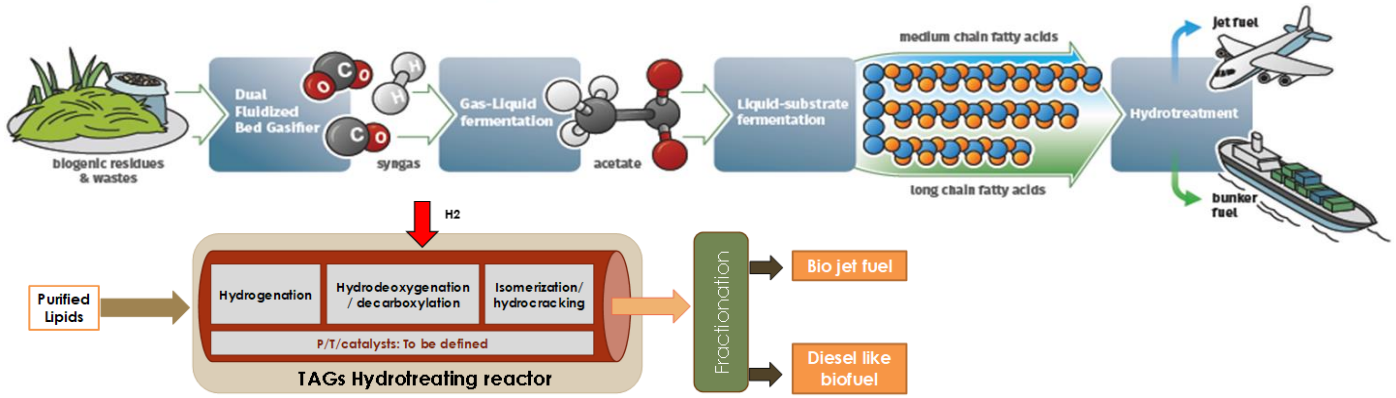


OUR STRENGTHS: INNOVATION

- Techno-economic analysis
- Incentives and legal framework
- Operation and logistics
- Market assessment
- Product development and fuel specification
- Digital tracing – blockchain

Some examples of our current innovation projects:

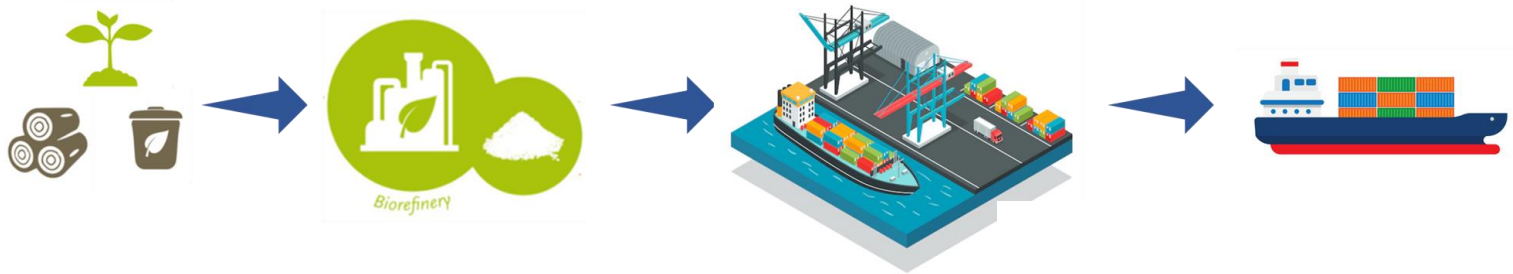
BioSFerA
Biofuel for biotravels



MAGPIE
SMART GREEN PORTS

Blockchain

MULTI-MODAL GREEN PORTS



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Hybrid Tandem Catalytic Conversion Process Towards Higher-oxygenate E-fuels (**E-TANDEM**)

European Commission

Electricity

- Wind Power
- EU matrix 2050

Carbon Source

- Biogas
- Cement off-gases
- DAC

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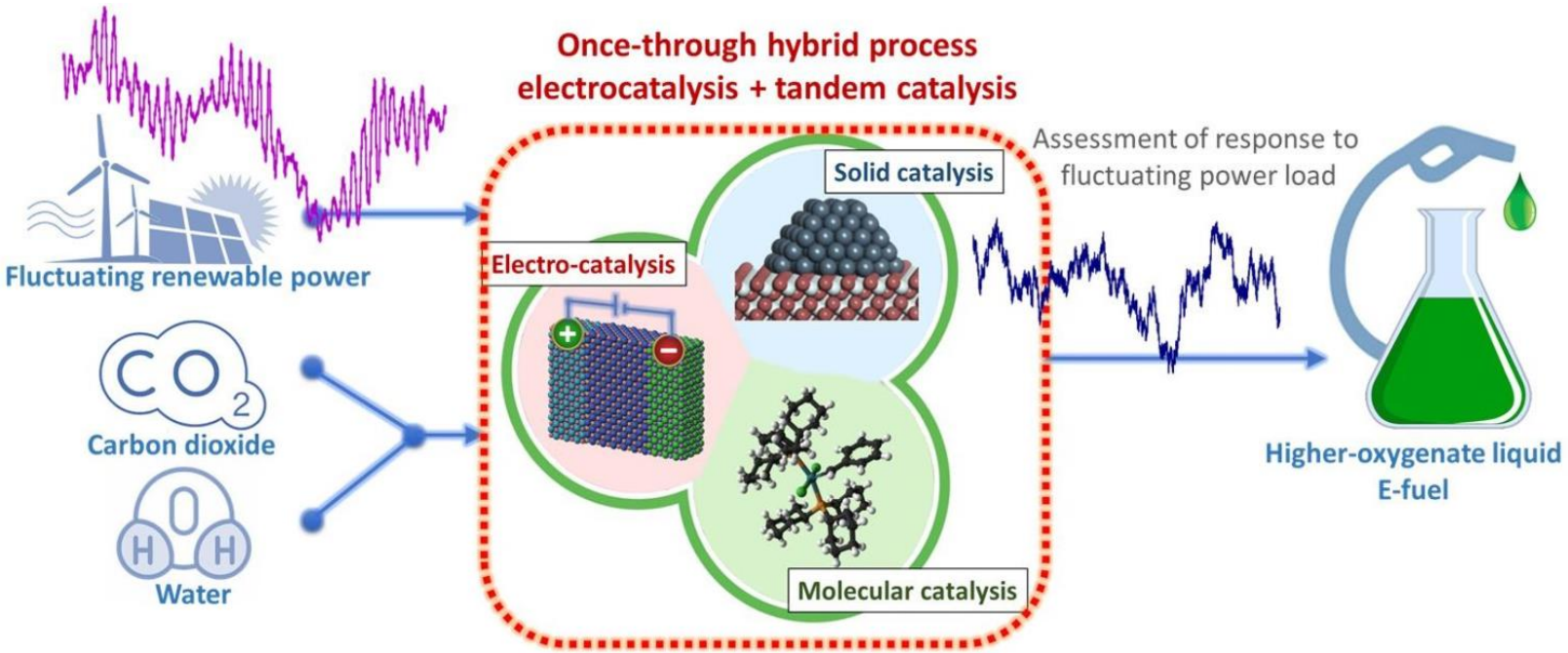
- Product specifications and testing
- Techno-economic analysis
- Market assessment and uptake strategy



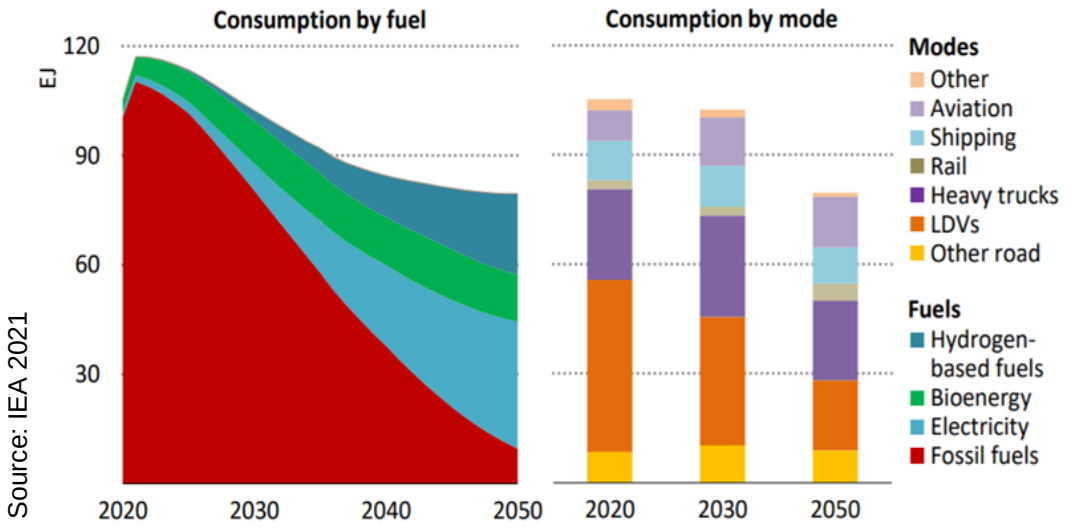
Unlock an **efficient and direct production** of a new **higher-oxygenate diesel-like e-fuel** for the **marine and heavy-duty** transport sectors

e-syngas production from **CO_2** and **H_2O** and **single step** reaction for **molecule elongation** (reductive polymerization) and **oxygen reaction** (oxo-functionalization)

Single step reaction (**Tandem** process) designed to **improve energy efficiency** and **conversion yields**

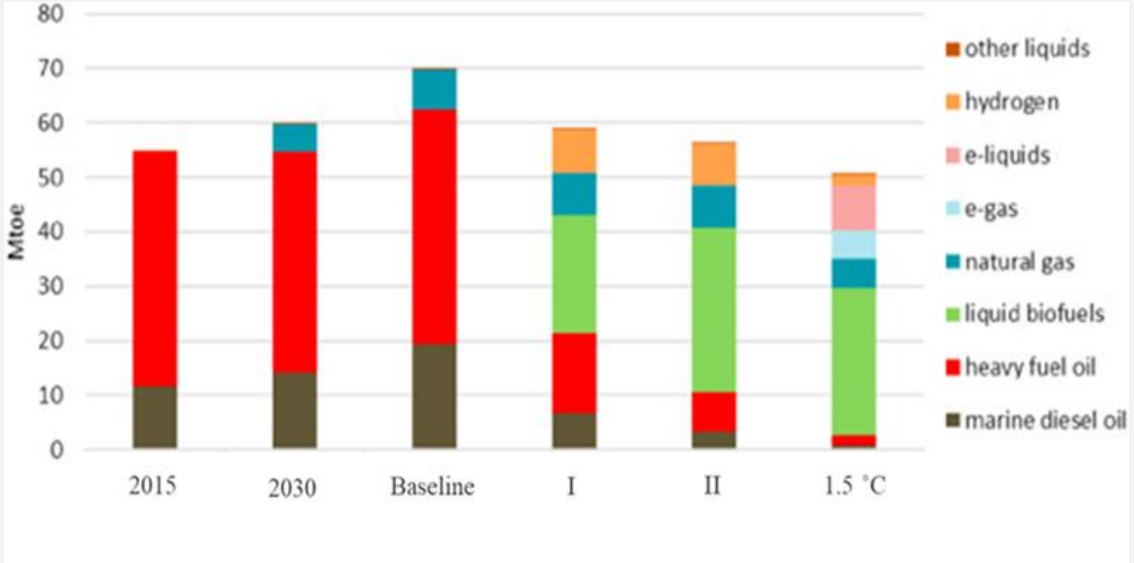
Partners: CSIC, Max Planck Gesellschaft, UNIRESEARCH, DTU Danmarks Tekniske Universitet, University of Cape Town, Tec4Fuels, AVL, FSB, KAUST, Science4Fuels OWI an der RWTH Aachen

FUTURE PERSPECTIVES



Source: IEA 2021

ELECTRIFICATION EXPECTED TO CONTRIBUTE TO A BIG SHARE ON ROAD TRANSPORT ABETTING BIOLIQUID AVAILABILITY TO MARINE.



Source: EU Commission (2019)

ONBOARD USE TECHNOLOGY