Task 39, Biofuels to Decarbonize Transport

Oplæg ved:

"Bioenergi til hele verden – nyt fra Danmarks repræsentanter i IEA Bioenergy"

22-01-2025

Sune Tjalfe Thomsen, Lektor
Institut for Geovidenskab og Naturforvaltning, Københavns Universitet

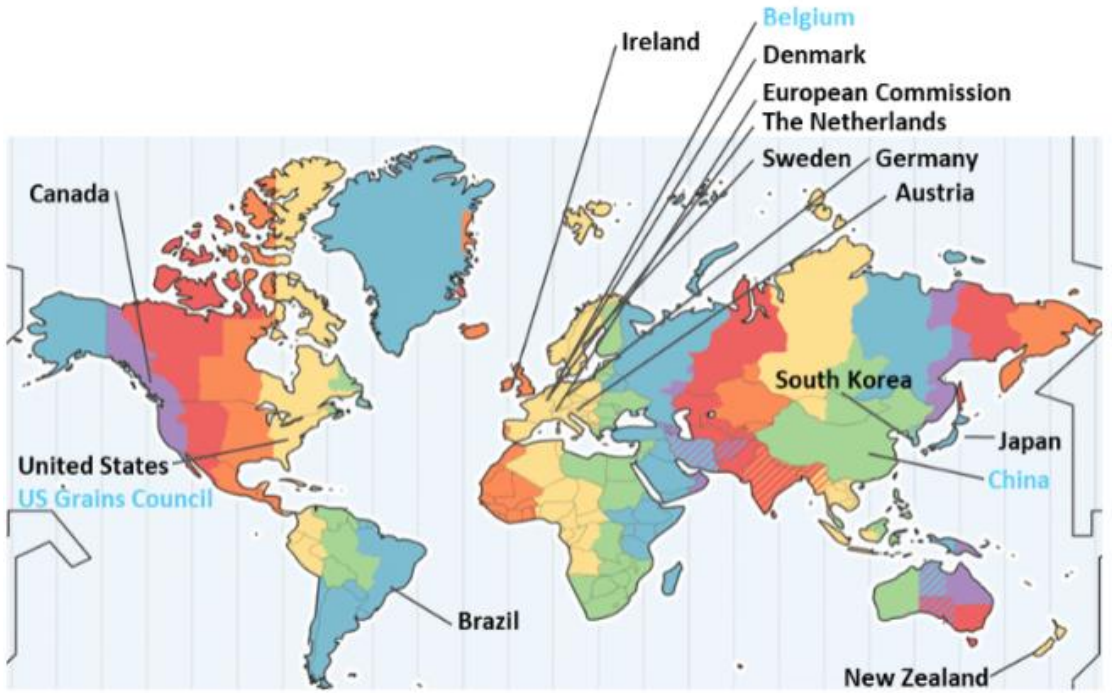
KØBENHAVNS UNIVERSITET

IEA Bioenergy Task 39 – Biofuels to decarbonise transport

16 participants/member countries

Analyses policy, technology, markets and sustainable biofuel implementation

SAF/biojet	Drop-in fuels	Implementation Agendas
Marine fuels	Demonstration Facilities	Certification
Biofuel policies	Sustainability	Commerzialisation progress
Synergies with green hydrogen	Emerging countries	Cooperations

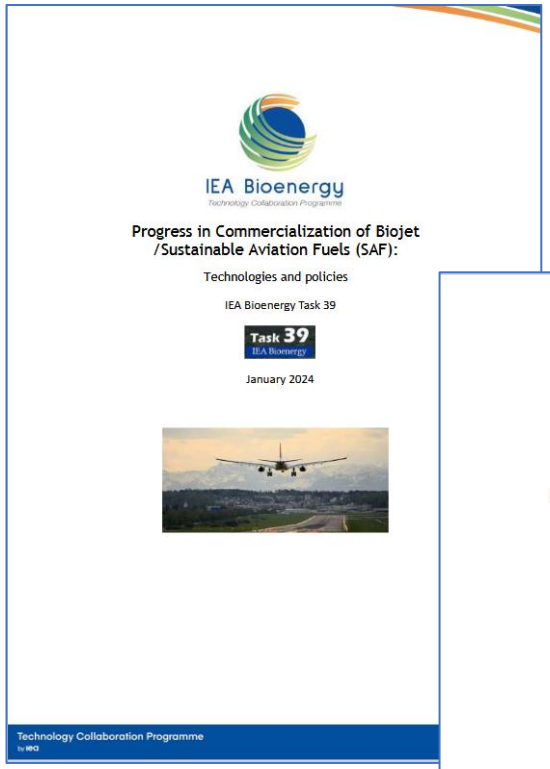


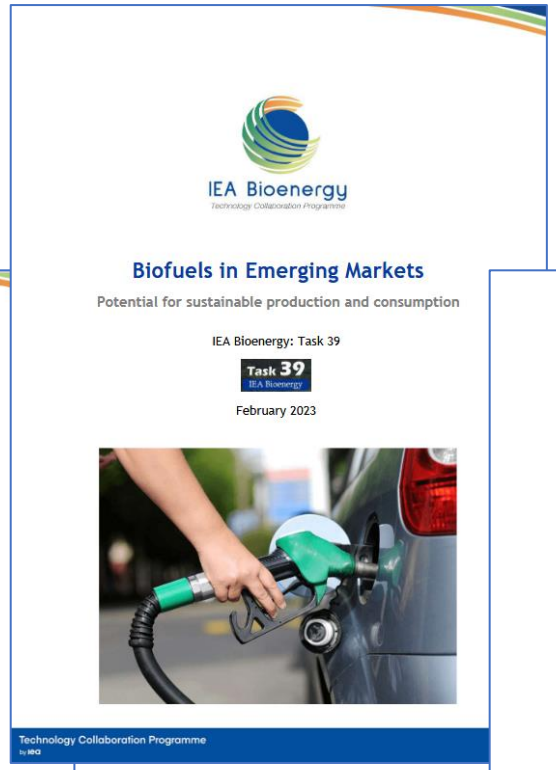
IEA Bioenergy

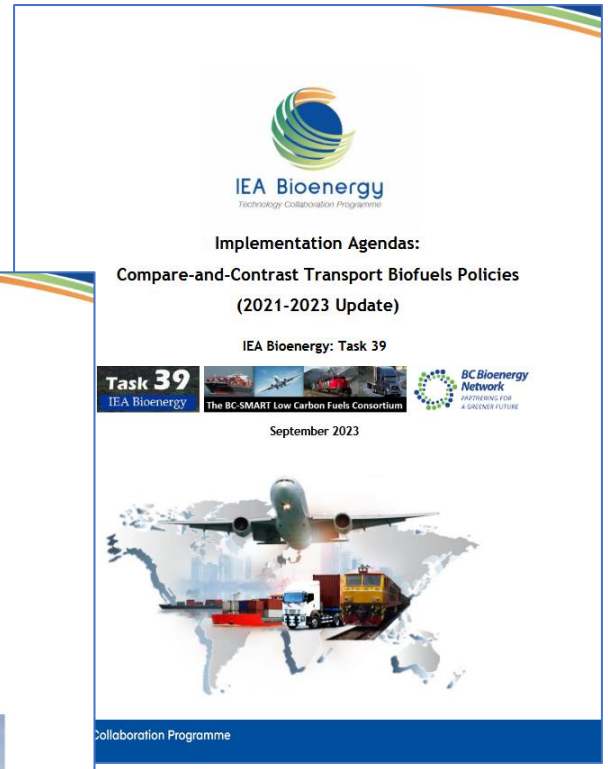
Slide adapted from Andrea Sonnleitner, T39 NTL Austria

IEA Bioenergy Task 39 - Reports

https://task39.ieabioenergy.com/publications-new/



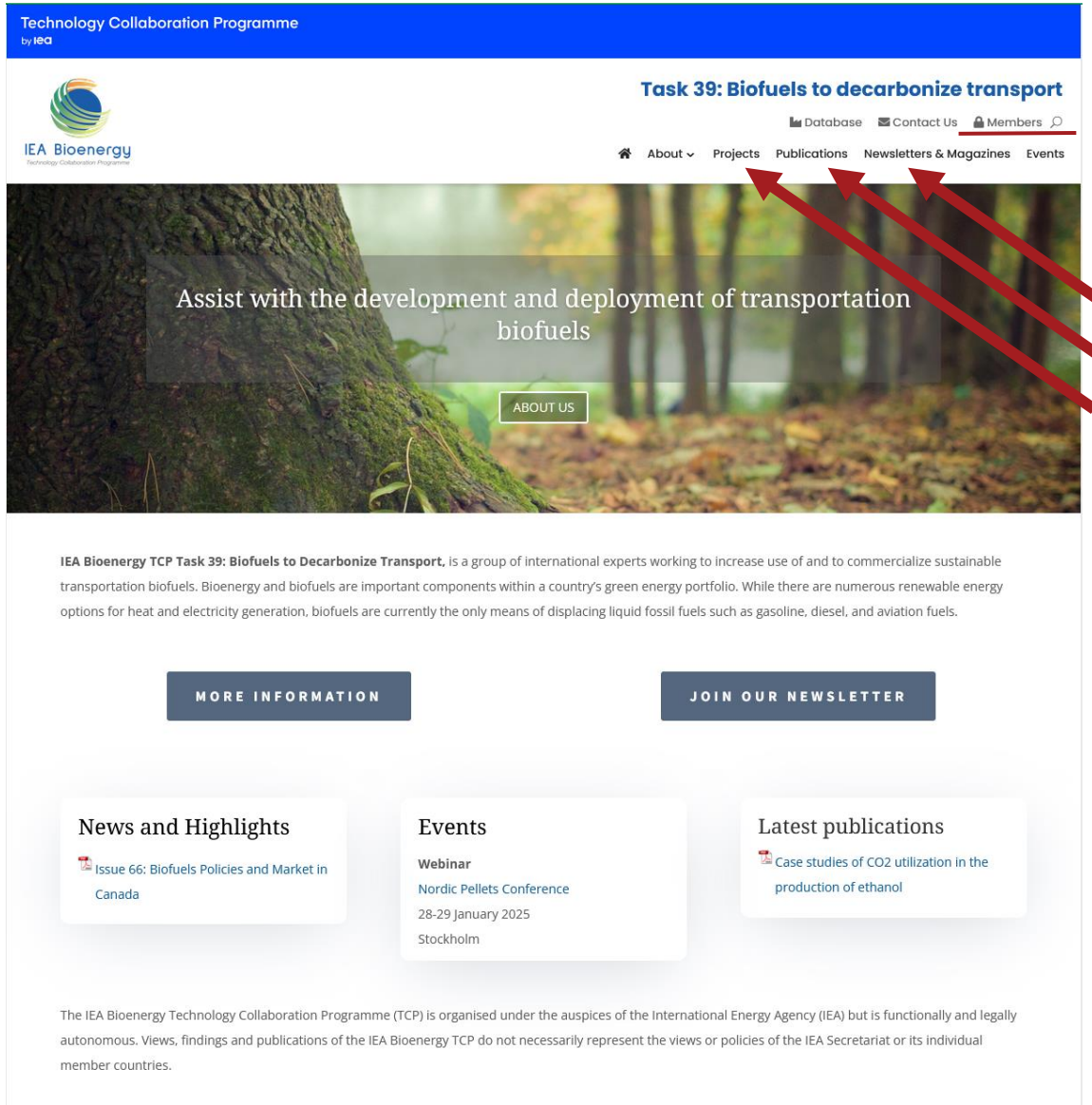


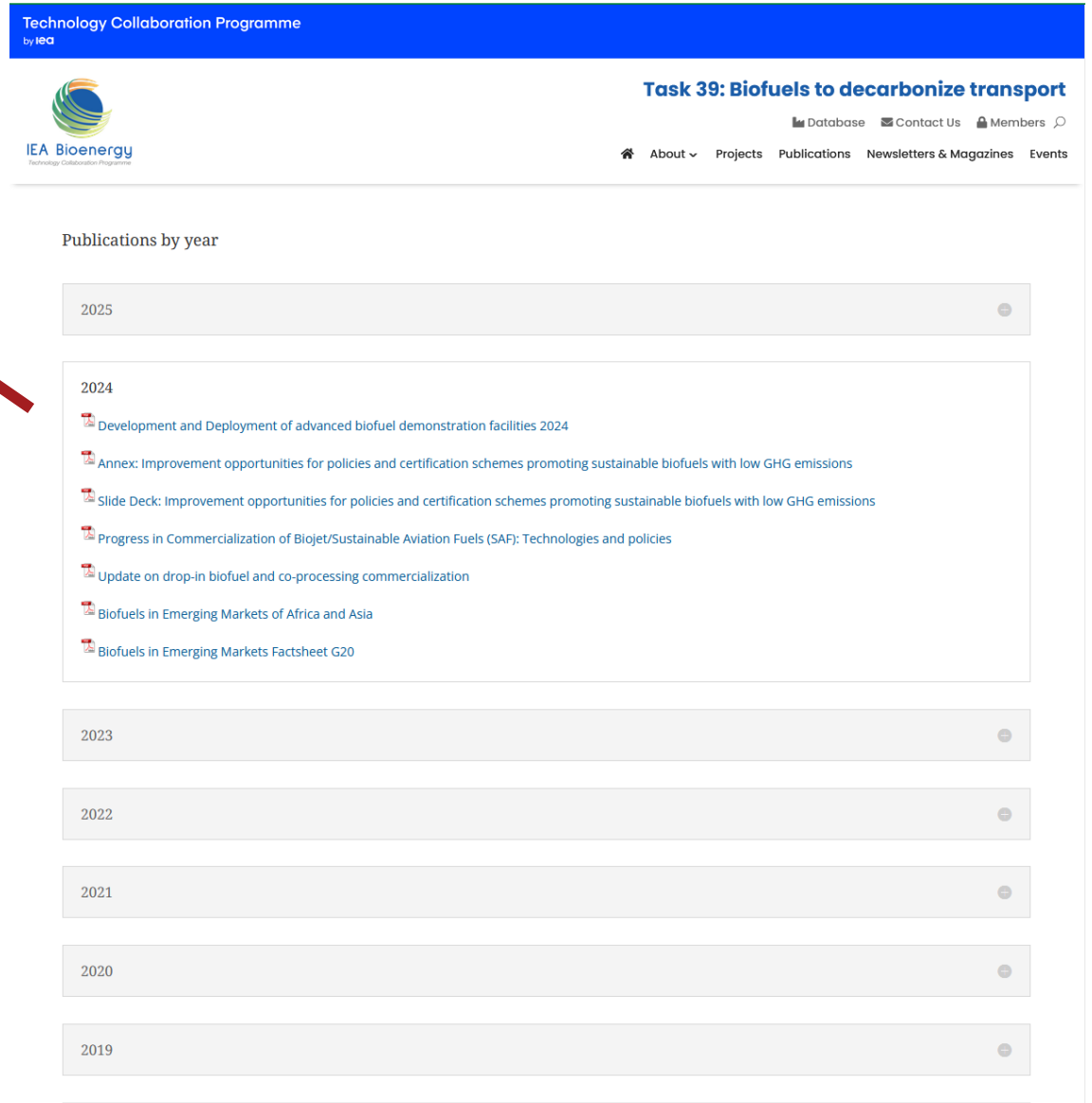


IEA Bioenergy

Slide adapted from Andrea Sonnleitner, T39 NTL Austria

Task'ens aktiviteter og publikationer





https://task39.ieabioenergy.com/publications-new/

2024

- Development and Deployment of advanced biofuel demonstration facilities 2024
- Annex: Improvement opportunities for policies and certification schemes promoting sustainable biofuels with low GHG emissions
- Slide Deck: Improvement opportunities for policies and certification schemes promoting sustainable biofuels with low GHG emissions
- Progress in Commercialization of Biojet/Sustainable Aviation Fuels (SAF): Technologies and policies
- Update on drop-in biofuel and co-processing commercialization
- Biofuels in Emerging Markets of Africa and Asia
- Biofuels in Emerging Markets Factsheet G20

2023

- Implementation Agendas: Compare-and-Contrast Transport Biofuels Policies
- Biofuels in Emerging Markets

Assessment of successes and lessons learned for biofuels deployment:

Vi har prioteret adgang til alle publikationer. Dvs. gennem den Danske Task-repræsentant (undertegnede) kan man tilgå alle publikationer så snart de er tilgængelige.

Advanced Biofuels Demoplants Database

Technology Collaboration Programme
by IEA

Task 39: Biofuels to decarbonize transport

Database on facilities for the production of advanced liquid and gaseous biofuels for transport

Filter Projects

Type
- TRL 1-3 Research
- TRL 4-5 Pilot
- TRL 6-7 Demonstration
- TRL 8 First-of-a-kind commercial
- TRL 9 Commercial

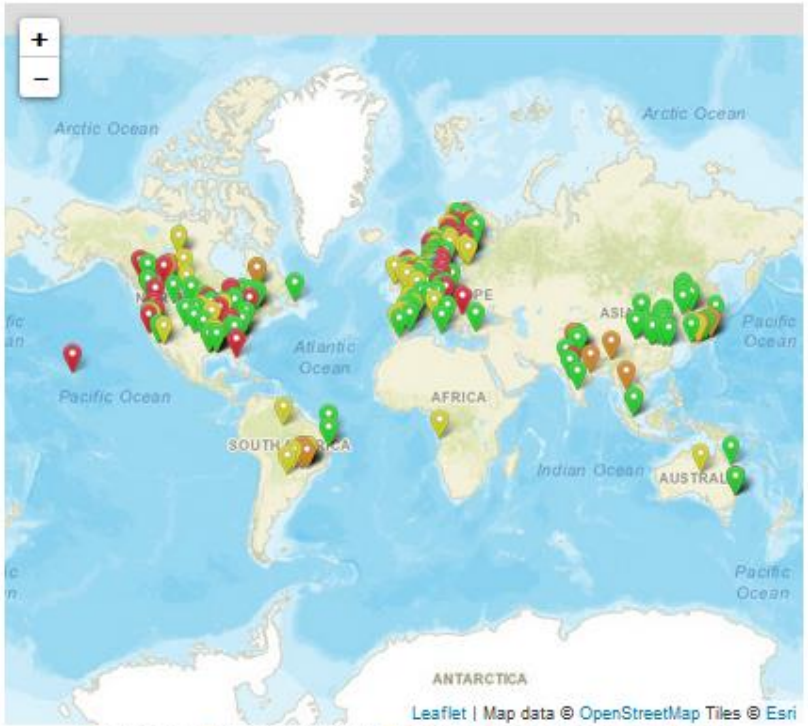
Technology
- Alcohol-to-jet
- E-Fuels Biomass Hybrids
- Fast Pyrolysis
- Fermentation
- Gasification
- Hydrothermal Liquefaction
- Hydrotreatment
- Lignin Depolymerisation
- Other Technology

Status
- no status
- planned
- under construction
- operational
- non operational
- cancelled
- idle
- on hold

Raw Material
- agricultural residues
- biomass / biomass coal blends
- forest residues
- lignocellulosics
- oilcrops, oils and fats
- organic residues and waste streams
- other
- sugar and starch crops
- unknown
- waste gases

Output
- bio-oil
- biogas
- butanol
- clean syngas
- diesel-type hydrocarbons
- diesel with biogenic content
- DME
- ethanol
- FT liquids
- gasoline-type fuels
- heat
- hydrogen
- isobutene
- methanol
- other
- pyrolysis oil
- renewable diesel (HVO)
- SNG
- sustainable aviation fuels SAF

Map



https://demoplants.best-research.eu/

This database has been elaborated and is maintained by BEST

IEA Bioenergy

Slide adapted from Andrea Sonnleitner, T39 NTL Austria

Examples of demonstration facilities

Pyrocell plant in Sweden

BTG-BTL pyrolysis technology

Production capacity:
25,000 t pyrolysis oil

Co-processing in existing refinery

BEST - Syngas Platform Vienna

Biomass gasification and FT-Synthesis

1 MW demonstration facility in Austria

Slide adapted from Andrea Sonnleitner, T39 NTL Austria

Danske eksempler der er blevet delt

Stiesdal SkyClean Pyrolysis Plant

World's Largest Pyrolysis Plant: Located in Vrå, Denmark, the SkyClean facility is the largest of its kind globally (20 MW).

CO_2 Capture Capacity: The plant has the capability to capture and displace 42.000 tons of CO_2 annually.

- The char is the main argument!

Meliora Bio

Commercial production of cellulosic ethanol (mainly from wheat straw)

Co-production of arabinoxylan, as pre-biotic fiber food ingreedience in partnership with Comet Bio Inc.

Meliora Bio have now acquired Comet

Sustainable Aviation Fuels (SAF) production

Many plants with (planned) SAF capacity and many announcements

SAF fraction can be increased

- SAF is one of the possible products, favorable fraction depending on economics and policies

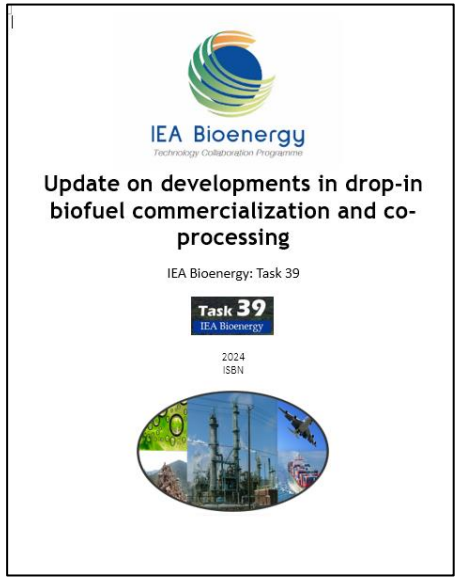
Technologies: **Hydrotreatment**, **Co-Processing**, Alcohol-to-Jet, Power to Liquid, Gasification

Examples of companies:

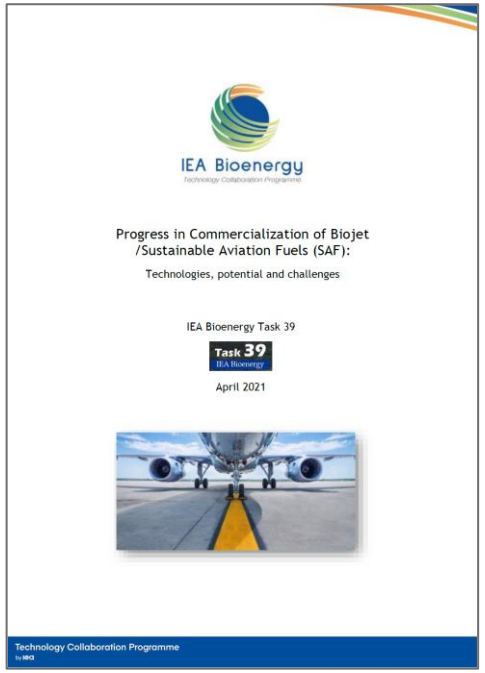
- World Energy, Neste, Eni, Cepsa, TotalEnergies, BP, …

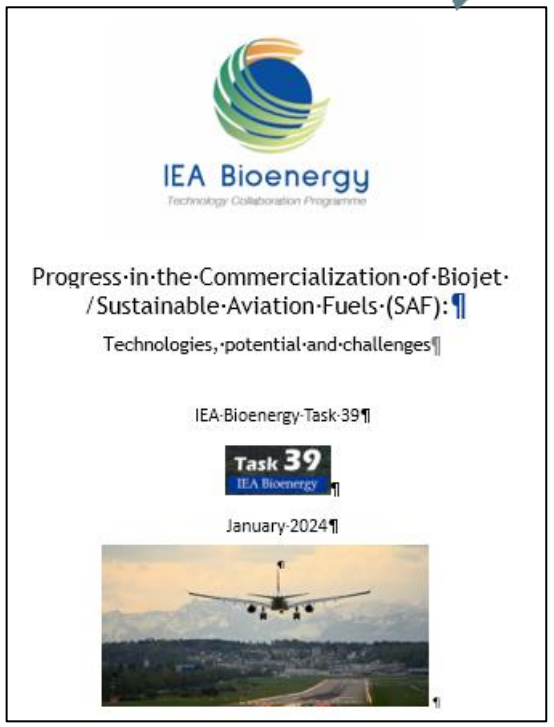
Slide adapted from Andrea Sonnleitner, T39 NTL Austria

IEA Bioenergy Task 39 - Drop-in biofuels and SAF reports (2014, 2019 & 2021, 2022, 2024)



SAF reports:





Latest biojet/SAF report available for download https://task39.ieabioenergy.com/wp-content/uploads/sites/37/2024/05/IEA-Bioenergy-Task-39-SAF-report.pdf

BC SMART Low Carbon Fuels Consortium

BC Bioenergy Network
PARTNERING FOR A GREENER FUTURE

IEA Bioenergy

Slide adapted from Jack Saddler and Susan van Dyke, T39 NTL Canada

Task 39
IEA Bioenergy

Key Takeaways from latest SAF report

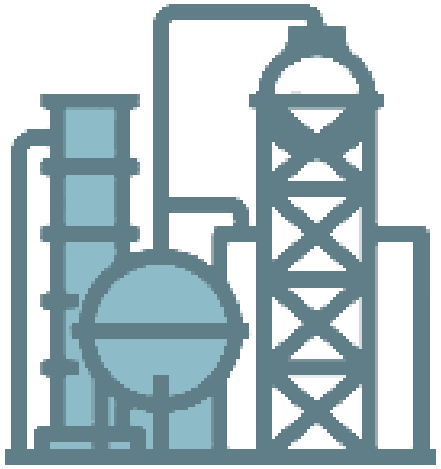
- Commitment to Net Zero by 2050 (ICAO & IATA).
- 62% of the emission reduction to come from SAF
- EU and USA policies accelerate SAF adoption

- Significant progress in SAF technologies.
- Challenges in sustainable feedstock and catalyst development.
- Policy certainty needed to boost investment.

Key Takeaways from latest SAF report - technologies

Main Technology Paths for SAF

1) HVO (Hydrotreated Vegetable Oil = HEFA)
   - Most commercially advanced, immediate impact.
   - Lack of sustainable lipids
2) Alcohol-to-Jet (AtJ)
   - Rapidly developing, near-term potential.
   - Potentially 2G
   - low overall yield
3) Gasification with Fischer-Tropsch
   - Significant advancements, medium-term impact. High costs
   - Environmental and Sustainability Concerns
4) Power-to-Liquids (PtL)
   - Emerging technology, long-term potential. High costs
   - The overall energy efficiency from renewable electricity to liquid fuel is relatively low



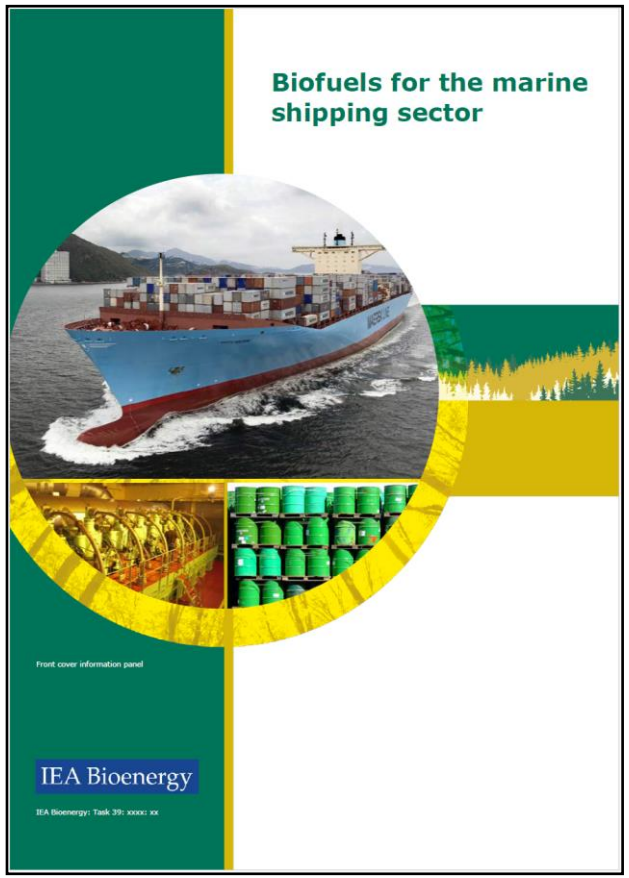
Without policy, biofuels development will be limited

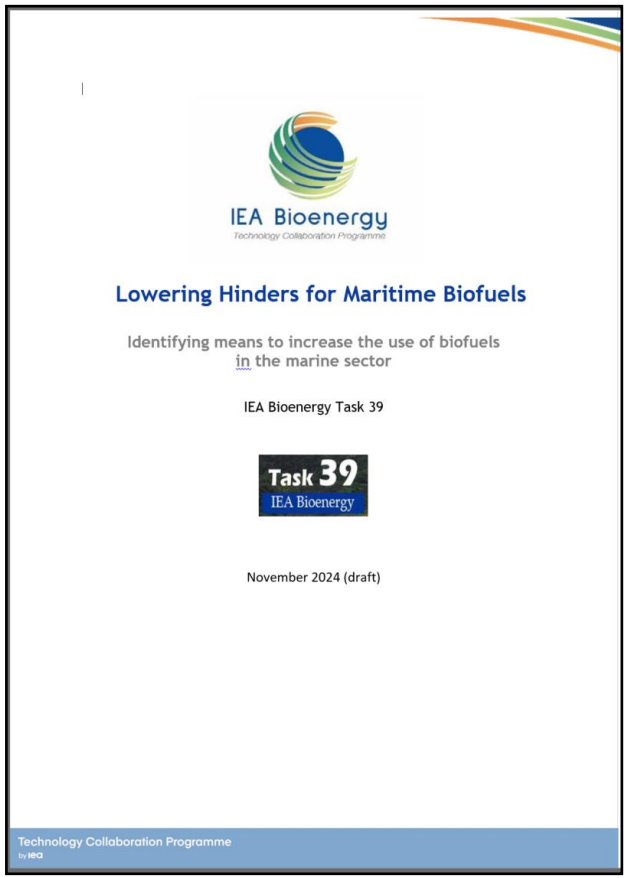
Effective policy characteristics:

- Stable over a long period of time e.g. 10-20 years
- Bridge the high price gap – e.g. producer or blender incentives
- Address high capital cost e.g. loan guarantees or capital grants
- Derisk investment to allow technology commercialization and scale-up
- Increase production and availability
- Address competition with road transport
- Ensure sustainability and emissions reductions

IEA Bioenergy Task 39 - Marine biofuels reports (2017, 2021 & 2025)

All reports with major contributions from Denmark

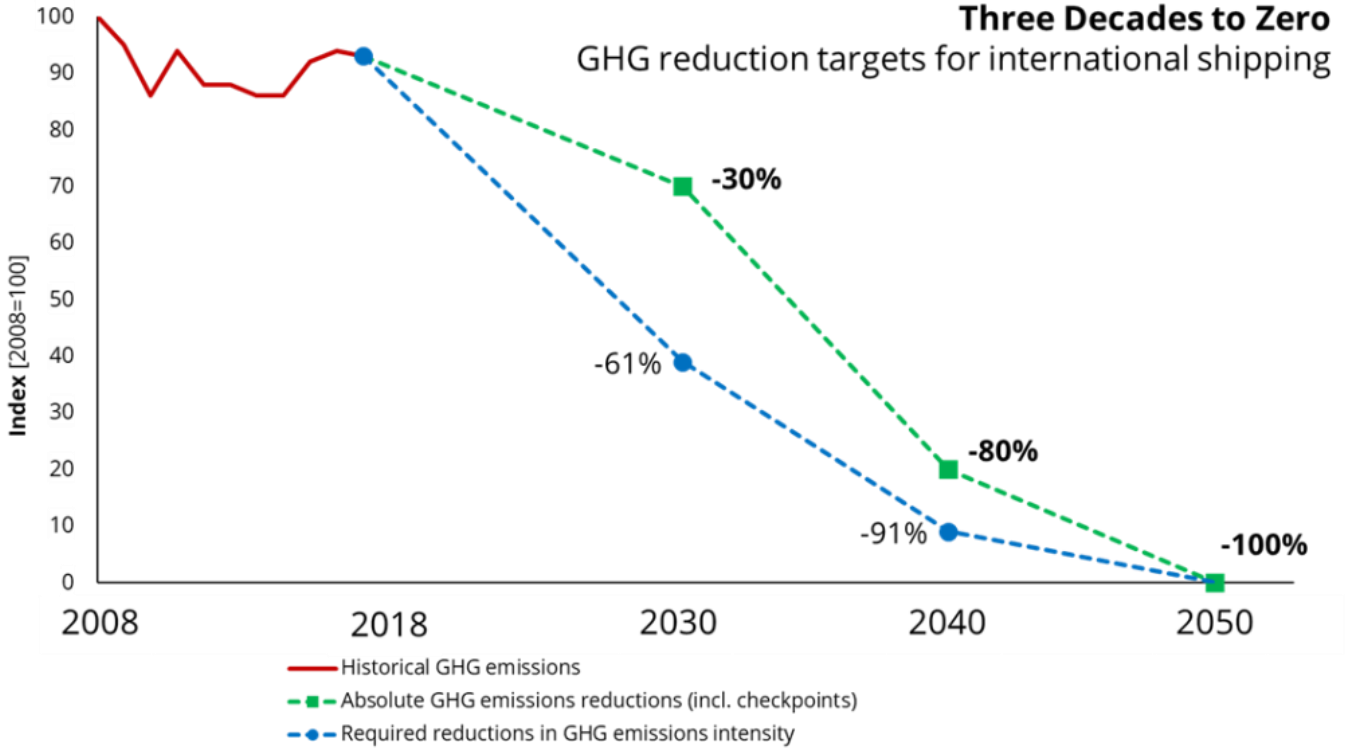


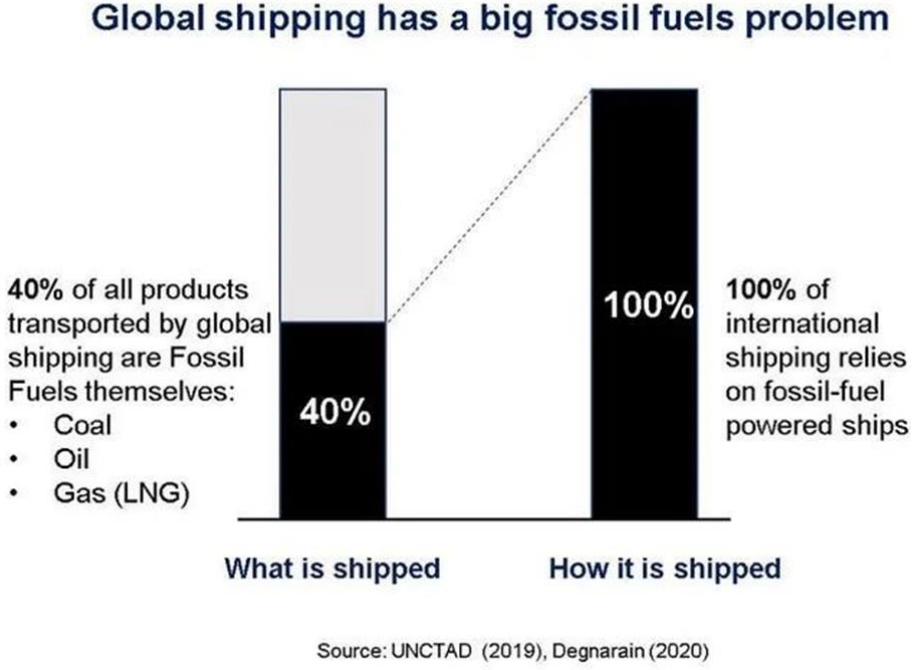


Will soon be published

Lowering Hinders for Maritime Biofuels – identifying means to increase the use of biofuels in the marine sector

Task 39-T3 Project-Maritime Biofuels (med Dansk deltagelse)





A new climate deal for shipping: Three decades to zero. (2023, June 13). World Bank Blogs. https://blogs.worldbank.org/transport/new-climate-deal-shipping-three-decades-zero

Slide adapted from David Bauner and Tom Walsh, T39 NTL Ireland

List of fuel characteristics - fossil vs biofuels

From Thomsen et al, IEA Task 39, 2021

Fuel type	Volumetric energy density	Gravimetric energy density	Carbon intensity	SO_x Emissions
	[MJ/L]	[MJ/kg]	[TCO_2e/TJ]	
HFO	38	39	77-87	High
MGO	37	43	87	High
LNG (liquid)	21	49	63	None- Low
RNG (liquid)	21	49	~10 [72]	None- Low
Methane (gas)	0.034	50	< ~10 [72]	None
Ethanol	16	20	24, 34**	None
DME	21	27	NA	None
Biodiesel	19	29	60 (oil crops)[72]	None
Biocrude	35	38	NA	None-Low
Pyrolysis Oils	16	17-20	NA	NA
HVO	25	33	8-25	None
Methanol*	16	20	~0, ~10 (wood)[72]	None
H2* (liquid)	8.5	120	~0	None
Ammonia* (liquid)	13	19	~0	None
Batteries**	1.3	0.7	~0	None

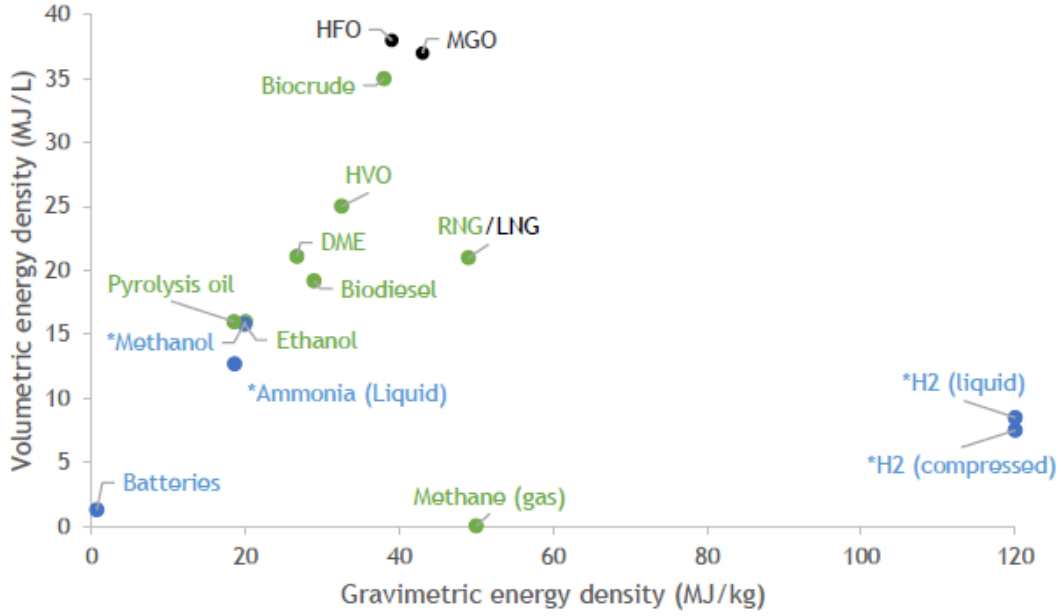
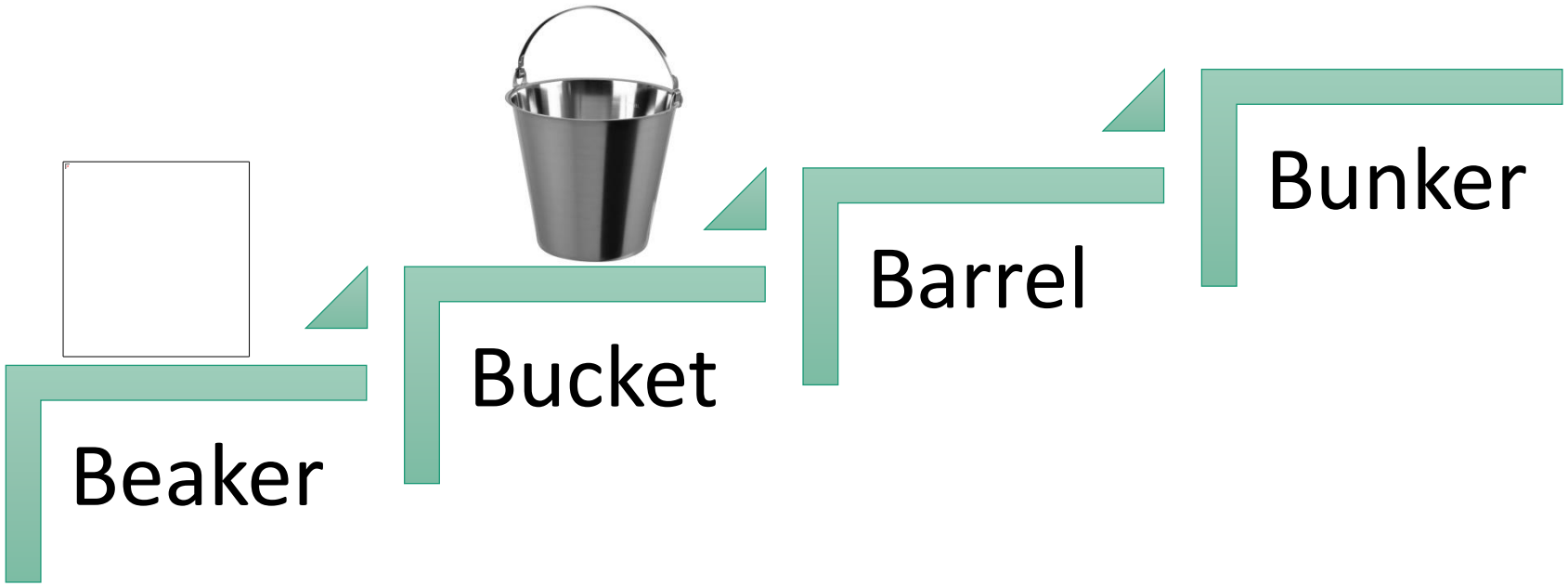


*Figure 5.1 Gravimetric and volumetric energy density of fossil and renewable fuels. Color indicate primary energy source. Black: Fossil. Blue: Electricity. Green: Biomass.*Ammonia, Methanol and hydrogen are currently primarily produced from fossil energy sources [73-75].*

Simonsen, Weiss, van Dyk, van Thuijl, and Thomsen (2021); *Progress towards biofuels for marine shipping; Status and identification of barriers for utilization of advanced biofuels in the marine sector*. IEA TASK 39, June 2021 (here)

Innovation ladder - from lab scale to commercial fuel use in engines



Regulation

- IMO CII, EEDI, EEXI
- New Chapter 5 of MARPOL Annex VI containing regulations on the IMO net-zero framework, to include:
  - a goal-based marine fuel standard regulating the phased reduction of the marine fuel's GHG intensity; and
  - an economic mechanism(s) to incentivize the transition to net-zero.
- EU ETS (Emissions Trading System) fpr ships > 5000 gross tonnes
- FuelEU Maritime Directive – on-board ship GHG intensity
- European Energy Taxation Directive – bunker fuel tax
- Revision of RED II – 13% renewable by 2030
- Singapore Workshop Agreement 2:2022 (marine biofuel)
- ISO 8217, 2024 modification including non-fossil sources (methanol
- International Sustainability and Carbon Certification (ISCC)

IMO; Hararap, Frauke et al, 2023

Slide adapted from David Bauner and Tom Walsh, T39, Ireland

EU Legislation to decarbonize transports and maritime

RES in transport: **14.5% reduction in GHG intensity**; or a share of at least **29% of energy**. RED III sets a binding combined **sub-target of 5.5% for advanced biofuels and RFNBOs** (min. 1%) by 2030

Recital 72 of **RED III** states that "Member States with maritime ports should endeavour to ensure that from 2030 the share of **RFNBOs** in the total amount of energy supplied to the maritime transport sector is at least 1.2%"

Official Journal of the European Union

EN
L series

2023/2413

31.10.2023

DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 18 October 2023

amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652

REGULATION (EU) 2023/1805 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 13 September 2023

on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC

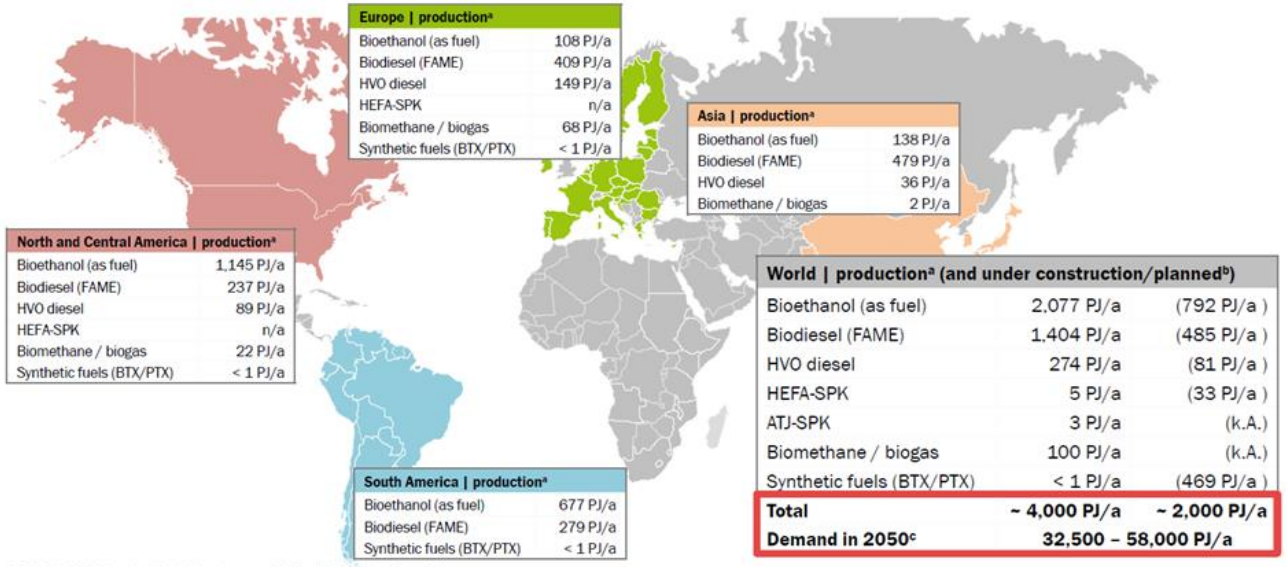
(Text with EEA relevance)

The eligible fuels under the **FuelEU Maritime** Initiative **are biofuels, biogas, RFNBOs and RCFs**, as well as **low-carbon gases** (e.g. fossil hydrogen + CCS). GHG accounting is the key element to define the sustainability and contribute to the EU targets.

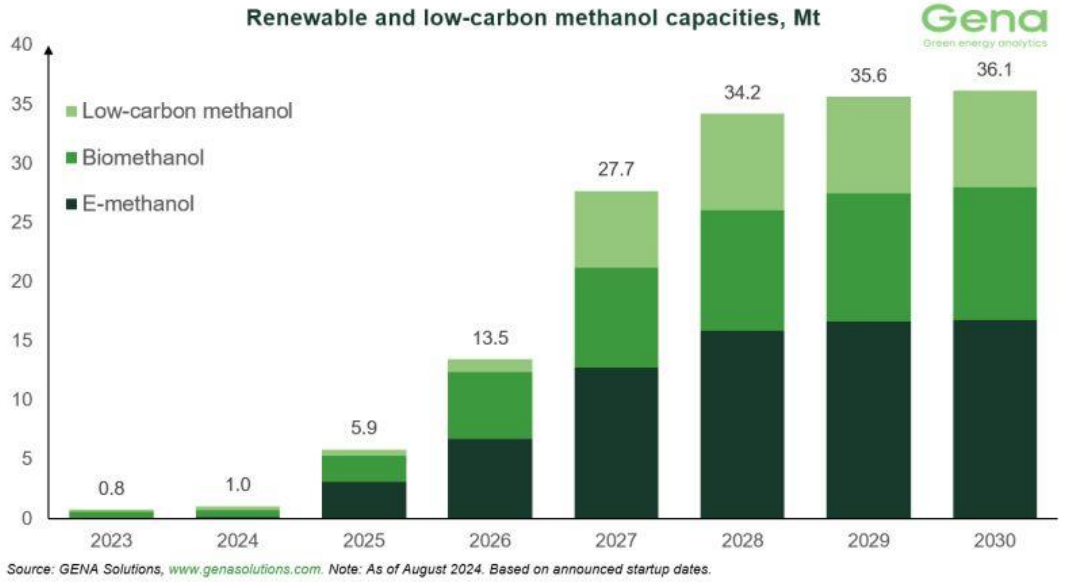
Slide adapted from David Bauner and Tom Walsh, T39 NTL Ireland

Renewable fuel in the international market

To which extent can regionalization be fostered?



Renewable fuel in the international market projected upto 2050 (Source DBFZ (2023))

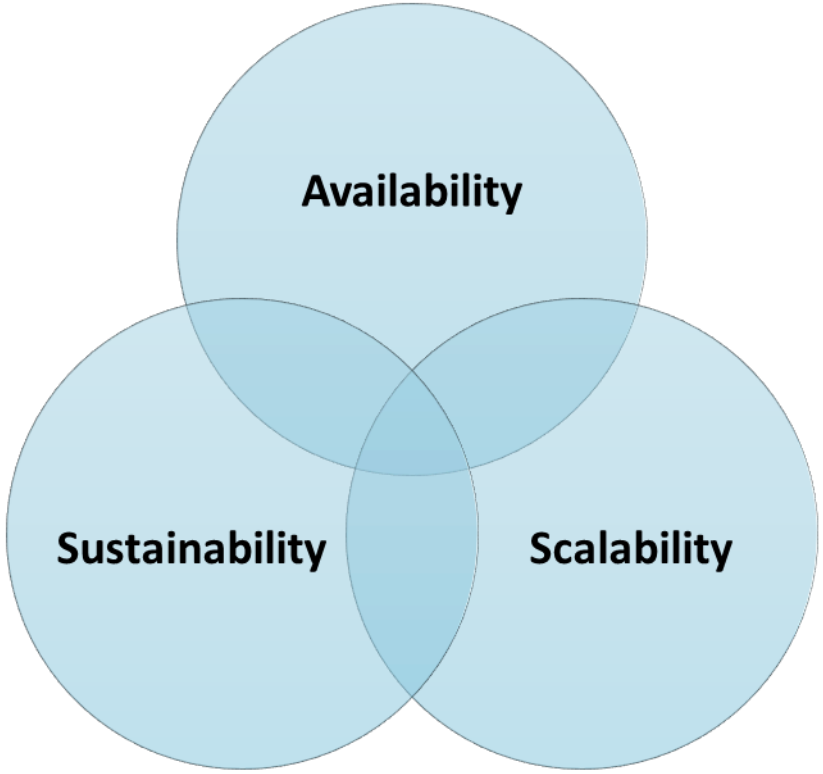


Coming green methanol pipeline globally as of August (MI, 2024)

Slide adapted from David Bauner and Tom Walsh, T39 NTL Ireland

Conclusions (Marine)

- Availability, Scalability, Sustainability
- Innovation from Beaker to Bucket
- Green Corridors and Alliances expand the market
- 95% of projects are sitting before FID
- Barrell to Bunker is about Implementation (Funding, In-house R&D & Engineering)
- Drop-In Fuels has started (increasing from 1 million tons p a 2023), Dual fuel orders
- Planned Investment is Doubling



Slide adapted from David Bauner and Tom Walsh, T39 NTL Ireland

Eksempel på en landerapport med stor relevans for Danske stakeholder's:

Ireland Report Update

- Biomethane Strategy is launched May 2024 – 5.7 TWH by 2030 P.A. – reduction of 2.1 million tons of CO2 per annum – Slurry from 1.3 million cattle (20% of winter slurry volume) – 120,000 hectares of land (5% of available land) – 1 TWH of Biomethane by 2025
- 2 Biomethane production facilities (producing 75 GWH) and 43 biogas plants (580 GWH)
- 90 to 250 AD plants by 2030 with grid injection (40 GWH)
- Capital Grant Scheme from the Department of Agriculture, Food and the Marine – 40 million capex. – 20% of total capex. – planning secured – Offer Letters Sept. – 18 plants
- Gas Networks Ireland supporting rapid expansion of Biomethane production – 30% of primary energy supply
- 3 Bn € network, 14,725 km of gas pipeline network – wrap around Irelands coastline 4 times – Mitchelstown CGI – planning, testing, trialing, safety

Afrunding

- Store mængder viden om transportbrændsler bliver dissemineret fra IEA Bioenergy t39
  - Adgang til rapporter, databaser, mm
- Der bliver holdt øje med Dansk udvikling
  - Især indenfor pyrolyse, biogas, og udviklingen i den marine sektor
- Jeg rapportere løbende fra møder og konference i IEA regi via LinkedIn
  - Tag endeligt kontakt
- Jeg Netværker på Danske interessenters vegne
  - Igen, ræk ud!

KØBENHAVNS UNIVERSITET

Sune Tjalfe Thomsen
IGN, Københavns Universitet
stt@ign.ku.dk