Carbon Negative Biofuels are possible: Soil Organic Carbon and GHG performances of SAF





David Chiaramonti

Call: LCE-20-2016-2017 Topic: Aviation Biofuels Project title: Advanced sustainable BIOfuels for Aviation (BIO4A)





PROJECT CONCEPT

Politecnico

Accelerate the deployment of Aviation Biofuels, enabling commercial production.

Supporting the accomplishment of pre-commercial plant(s) for advanced biofuels for aviation based on sustainable biomass feedstock.

PROJECT OBJECTIVES

1) To bring HEFA to full commercial scale in new plant using residual lipids (Used Cooking Oil - UCO);

2) To investigate alternative **supply of sustainable feedstocks recovering EU MED marginal land** for drought resistant crop production;

3) To test the entire chain and logistic at industrial scale, and assess environmental performances.

4) Positive GHG and energy balance expected

Highlights:

eni 🕷

RE-CORD

SKYNRG

- INDUSTRIAL COMPONENT: New Aviation Biofuel plant producing HEFA
- Production and test of HEFA in commercial flights in non-segregated mode
- <u>R&D COMPONENT: Work on marginal land in Spain and Italy recovered by biochar/compost</u> addition producing nofood sustainable lipids
- Dedicated Dissemination, Communication and Exploitation action





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R&D Activities M1 - M52

<u>R&D on biochar and COMBI production and test from woodchips and agroresidues</u>

Why is it so important? What can this deliver?

R&D on UCO pre-treatment









EU actions on Carbon and Sust.Fuels







Official Journal of the European Union



DECISIONS

- * Council Decision (EU) 2022/997 of 7 April 2022 on the position to be taken on behalf of the European Union at the tenth meeting of the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants as regards the proposal for amendment of Annex A to that Convention
- * Council Decision (EU) 2022/998 of 17 June 2022 on the position to be taken on behalf of the European Union within the EPA Committee established under the Stepping Stone Economic Partnership Agreement between Ghana, of the one part, and the European Community and its Member States, of the other part, as regards the adoption of the Rules of Procedure for dispute settlement
- * Council Decision (EU) 2022/999 of 21 June 2022 appointing an alternate member, proposed by the Republic of Latvia, of the Committee of the Regions
- * Council Decision (EU) 2022/1000 of 21 June 2022 appointing a member, proposed by the Republic of Austria, of the Committee of the Regions .
- * Council Decision (EU) 2022/1001 of 21 June 2022 appointing a member, proposed by the Kingdom of the Netherlands, of the Committee of the Regions ...

(1) Text with EEA relevance.

Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited perior The titles of all other acts are printed in bold type and preceded by an asterisk

REGULATIONS

(Non-legislative acts)

OT

COMMISSION IMPLEMENTING REGULATION (EU) 2022/996 of 14 June 2022 on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land- use change-risk criteria

THE EUROPEAN COMMISSION

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (1), and in particular Article 30(8) thereof,

Whereas

27.6.2022

- (1) Directive (EU) 2018/2001 expands the role of voluntary schemes to include the certification of the compliance of biomass fuels with sustainability and greenhouse gas (GHG) emissions saving criteria and the compliance of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels with the respective GHG emissions saving criteria. Furthermore, the voluntary schemes can be used to certify biofuels, bioliquids and biomass fuels with low indirect land-use change-risk.
- (2)In order to establish whether biofuels, bioliquids, biomass fuels, renewable gaseous and liquid transport fuels of nonbiological origin and recycled carbon fuels comply with the requirements of Directive (EU) 2018/2001, the correct and harmonised functioning of voluntary schemes is essential. Harmonised rules should therefore be established, to apply across the certification system, bringing about the necessary legal certainty on the rules applicable to economic operators and voluntary schemes.
- With a view to minimising the administrative burden, the implementing rules should be proportionate and limited (3) to what is required to ensure that compliance with the sustainability and GHG emissions saving criteria and other requirements is verified in an adequate and harmonised manner that minimises the risk of fraud to the greatest extent possible. The implementing rules should therefore not be considered as a comprehensive standard but rather as minimum requirements. The voluntary schemes may accordingly complement these rules as appropriate.
- (4) Economic operators may decide at any time to participate in a different voluntary scheme. However, in order to prevent an economic operator that has failed an audit under one scheme from immediately applying for certification under another scheme, all schemes receiving an application from an economic operator should require that operator to supply information about whether it failed an audit in the previous 5 years. This should also apply to situations where the economic operator has a new legal personality but remains the same in substance, so that minor or purely formal changes, for instance, in the governance structure or the scope of activities, do not exempt the new economic operator from such a rule.

(2) OJ L 328, 21.12.2018, p. 82.

L 168/1

EU on Carbon and Sust.Fuels: REDII - IR

(a) greenhouse gas emissions from the production and use of biofuels shall be calculated as:

$$E = e_{ec} + e_{l} + e_{p} + e_{td} + e_{u} - e_{sca} - e_{ccs} - e_{ccr}$$

where

E	=	total emissions from the use of the fuel;				
e _{ec}	=	emissions from the extraction or cultivation of raw materials;				
e ₁	=	annualised emissions from carbon stock changes caused by land-use change;				
e _p	=	emissions from processing;				
e _{td}	=	emissions from transport and distribution;				
e _u	=	emissions from the fuel in use;				
e _{sca}	=	emission savings from soil carbon accumulation via improved agricultural management;				
e _{ccs}	=	emission savings from CO ₂ capture and geological storage; and				
e _{ccr}	=	emission savings from CO ₂ capture and replacement.				

 $e_{sca} = (CS_A - CS_R) \times 3,664 \times 10^6 \times \frac{1}{n} \times \frac{1}{P} - e_f$

27.6.2022	EN Official Journal of the European Union L 168/1								
п									
(Non-legislative acts)									
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COMMISSION IMPLEMENTING									
REGULATION (EU) 2022/996 of 14 June									
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- (3) With a view to minimising the administrative burden, the implementing rules should be proportionate and limited to what is required to ensure that compliance with the sustainability and CHG emissions saving criteria and other requirements is verified in an adequate and harmonised manner that minimises the risk of fraud to the greatest extent possible. The implementing rules should therefore not be considered as a comprehensive standard but rather as minimum requirements. The voluntary schemes may accordingly complement these rules as appropriate.
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(¹) OJ L 328, 21.12.2018, p. 82.



EC Expert Group on C removal certification

Most of the previously mentioned issues are addressed within this group

European Commission	English Search									
Climate Action										
Home About us 🗸 Climate change 🗸 EU Action 🗸 Citizens 🗸 News & Your Voice 🗸 Funding opportunities 🗸										
Home > EU Action > Sustainable carbon cycles > Expert group on carbon removals										
Expert group on carbon removals										
PAGE CONTENTS	The Expert Group on carbon removals assists the Commission's work on the voluntary certification of carbon removals.									
Kick-off meeting of the Carbon Removal Expert	Specifically, the Expert Group will:									
Group	 Assist in the preparation and implementation of policy initiatives and related legislative proposals in the field of carbon removals, including carbon farming and industrial carbon removal initiatives; 									
Contact	 Facilitate an exchange of experiences and good practices from existing public and private carbon removal initiatives including key issues of certification, quantification, monitoring and reporting in addition to assessing other criteria such as additionality, durability, environmental integrity and transparency; 									
	 Establish an effective cooperation between the Commission, Member States and stakeholders on questions relating to the implementation of EU legislation, programmes and policies in the field of carbon removals; 									
	Assist in the preparation of relevant delegated acts;									
	 Assist in the early preparation of implementing acts in accordance with Regulation (EU) N°182/2011; 									
	 Assist in identifying, assessing and realising synergies with other policy developments in the land use, forestry and agriculture sector, in particular with regard to Regulation (EU) 2018/841 on <u>Land Use, Land Use Change and Forestry</u> (EN (ex), and in the industrial sectors. 									
	The Expert Group comprises of around 70 members, securing a broad and equitable representation of independent experts and stakeholders from national authorities, public entities, businesses, industry, non-governmental organisations, certification bodies and research institutions in the field of carbon removals.									
	The group meets at least twice a year, both in person and remotely. The work and process of the Expert Group will be carried out openly, inclusively, and ensure transparency, in line with the <u>Commission's rules on expert groups</u> (Experiment).									

Kick-off meeting of the Carbon Removal Expert Group

The first meeting of the Expert Group took place on 7 March 2023 in Brussels:

- <u>Agenda</u> (EN | •••
- Recording, split up per agenda point
- Presentation

Your opinion is important to us and we would appreciate it if you could take a few minutes to complete our <u>post-event feedback survey</u>.

The meeting notes will follow shortly.

Next steps: There will be quarterly meetings in 2023 focused on best practices and challenges for certification methodologies: on carbon farming, industrial removals and on the certification process. In 2024, more targeted sub-groups will be formed.





Biochar A long-lived storage



Adapted from: The Oxford Principles for Net Zero Aligned Carbon Offsetting, September 2020, University of Oxford



Geoderma 416 (2022) 115810

Table 2 Kinetic parameters of the double first-order exponential decay model describing biochar decomposition in soils.Values represent means \pm standard errors

	Size	Decomposition rate	Mean residence time
abile C pool ecalcitrant	$3 \pm 0.6\%$ $97 \pm 0.6\%$	$0.0093\% \text{ day}^{-1}$ $0.0018\% \text{ year}^{-1}$	108 ± 196 days 556 ± 483 years

[..] We conclude that biochar can persist in soils on a <u>centennial</u> $_{C pool}$ <u>scale</u> and that it has a positive effect on SOM dynamics and thus on C sequestration.

GCB Bioenergy (2016) 8, 512–523, doi: 10.1111/gcbb.12266



Biochar - Carbon decay rate Models based on 10

Model of decay rates:

- labile fractions (3%) of biochar) = 3%/y (108 days)
- recalcitrant fractions (97% of biochar) = 0.0018%/y(556y)



Years experiments.

"Biofuels Done Right" can be Carbon Negative and support farming in EU

- Carbon NEUTRAL (Renewable) vs <u>Carbon NEGATIVE</u> and <u>REVERSE ILUC</u>
- <u>Biogas Done Right</u> and <u>Digestate</u>, or <u>Pyrolysis</u> of residues to <u>Biochar</u> are some examples
- Fully deploying <u>REDII-IR</u> (<u>Esca</u> factor → C in soil in GHG assessment)



Biochar and Combi production (REC)



Products preparation and characterization







This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No [789562]

BIKE

Bringing organic C back to soil, and promoting soil health and fertility, are key elements for Sustainable Bioeconomy chains as BDR, Climate Positive fuels, Agroforestry, Agroecology, etc. fully aligned with EU Mission and policy on soil, contrast to desertification/erosion, promoting sustainable agriculture



Comparing infiltration rates in soils managed with conventional and alternative farming methods: A meta-analysis Andrea D. BascheMarcia S. DeLonge

FOOD, FEED AND ENERGY (FUELS)

Reverse ILUC approach: 1. Barley & Camelina in recovered soil in Spain.

Food/feed otherwise 1. not produced.



No fertilization

100% fertilization Compost

Mineral

100% Biochar

Biochar+ Compost 10%









Sourcing Sustainable Lipids ... Domestic + International: Agrihub Africa











https://www.eni.com/en-IT/sustainable-mobility/biofuels-vegetable-oils.html



- ICAO, 2017 → 142 Mt CAF at 2010 → 570-860 Mt at 2050 (Intern. Aviation) + 400-600 % !!
- 100% CAF substitution (MAX scenario) 170 new biorefineries each year from 2020 to 2050 (15-60 \$B/y) -
- MAX would reduce CO₂ emission by 63%

LTAG Scenarios (ICAO, March 2022) Key messages from ICAO

<u>None</u> of the scenarios reach zero CO₂emissions (Net Zero) <u>using in-sector measures only</u>.

Offsetting needed.



2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 t Caution required with the interpretation of absolute CO₂ emissions levels after 2050 due to modelling assumptions e.g., frozen aircraft technology after 2050. Under these assumptions, CO₂ emissions are higher than in an alternative scenario (and modelling approach) where aircraft technology would continue to improve after 2050.

Figure 1. CO₂ emissions from international aviation associated with LTAG Integrated Scenarios

Aircraft Techn: Advanced tube and wing, unconventional airframe/propulsion concept aircraft, non-drop-in fuels such as battery electric etc

Operations: improvements in the performance of flights across all phases

Aircraft Technology

Gaseous Waste SAF

Operations

Biomass SAF

CONCLUSIONS

- HEFA Technology is ready: developing sustainable supply chains is key
 - ✓ New value chains (e.g. lignocellulosic) need to rump-up to full industrial scale
 - ✓ Main BARRIER for HEFA: sustainable lipid supply
- Value chain approach,
 - ✓ broader holistic view: transition in energy and transports represents an opportunity for the transition of other sectors (*inter-sector* measures)
- New REDIII \rightarrow
 - ✓ a <u>binding target of 14.5% reduction of greenhouse gas intensity</u> in transport from the use of renewables by 2030
 - ✓ or a binding share of at least 29% of renewables within the final consumption of energy in the transport sector by 2030.
- Carbon negative and climate friendly SAF are possible through carbonization
 - ✓ Biochar is a solid and evidence-based method to C-negative biofuels (CDR)
 - ✓ Biochar also widen the feedstock base
 - Proven in EU BIO4A project and in ongoing activities
 - ✓ ICAO and IMO likely next to implement Fsca (similar to the EU Esca factor)



Thanks for your attention!

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