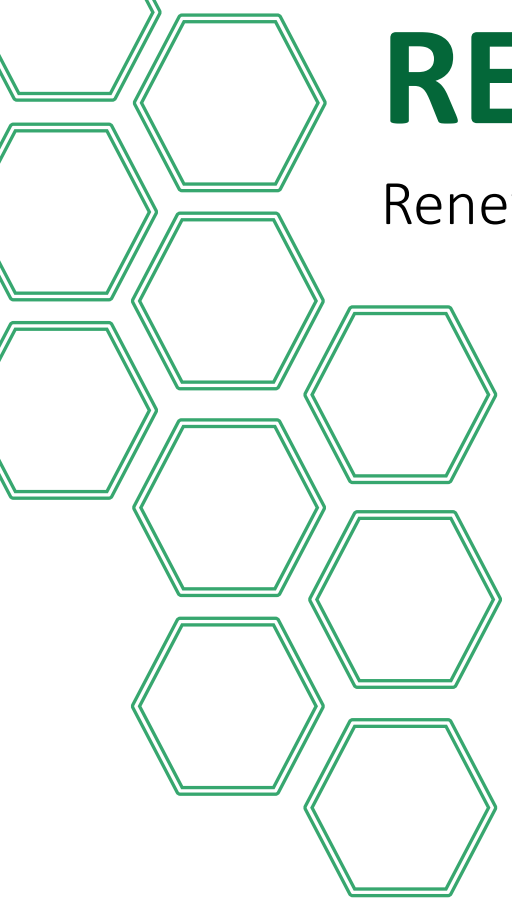




RE-CORD

Renewable Energy COnsortium for Research & Demonstration



Energy transition, circular economy, agriculture

Biochar: a challenge for innovation and climate

Francesca Tozzi, BU AGRO-BIO-CLIMA

European Week of Regions and Cities

SQUARE Brussels Meeting Centre, Silver hall

10 October 2023

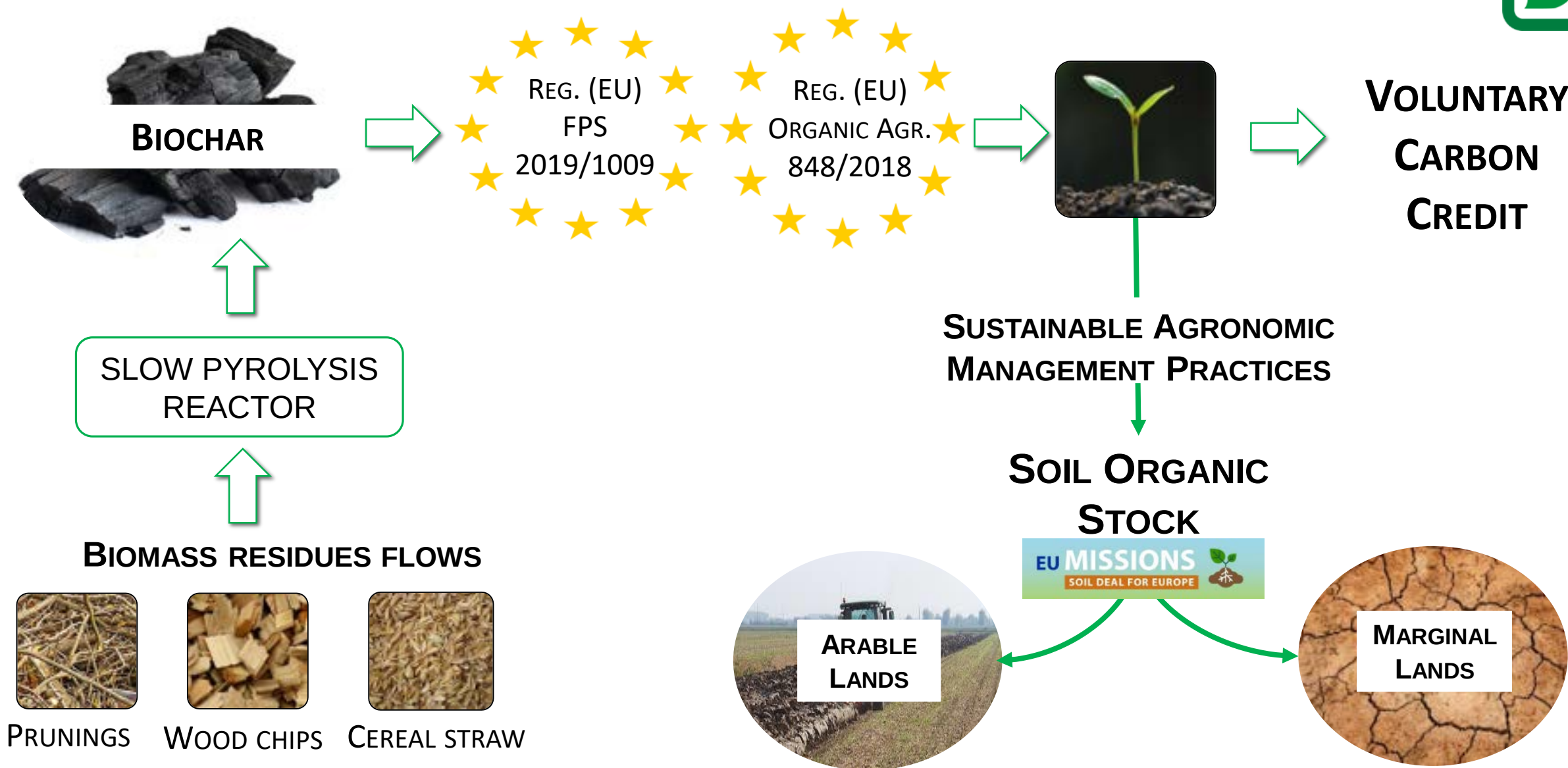


Politecnico
di Torino



UNIVERSITÀ
DEGLI STUDI
FIRENZE

CONTENTS OF THE PRESENTATION



BIOCHAR DEFINITIONS



BIOCHAR REFERS TO SOIL APPLICATION

*“Lehmann and Joseph (2009) distinguished biochar operationally from charcoal. Primarily, the difference between these two terms lies in the end use. **The charcoal is a source of charred organic matter for producing fuel and energy whereas the biochar can be applied for carbon sequestration and environmental management**”*

M. Ahmad et al. (2014). Biochar as a sorbent for contaminant management in soil and water: A review. Chemosphere. Vol. 99. Pg. 19-33.



*“The pyrolysis of biomass to biochar, a stable solid form of carbon similar to charcoal, **can improve the properties of soils while storing carbon for the long term**”*

COMMUNICATION FROM THE
COMMISSION TO THE EUROPEAN
PARLIAMENT AND THE COUNCIL
Sustainable Carbon Cycles

*“Biochar is a charcoal whose primary application is as **soil amendment** for increasing **soil fertility** while ensuring **long-term carbon storage**”*

International Biochar Initiative



EUROPEAN REGULATION ON FERTILISER PRODUCTS

REG. EU 2019/1009



2019 → 2022

CMC 14 BIOCHAR FROM **PYROLYSIS** AND **GASSIFICATION**
(DELEGATED REG. EU 2021/2008)

PFC 3 (A) ORGANIC AMENDMENT

AUTHORIZED FEEDSTOCK

MANY MORE WASTE MATRIX AND RESIDUES OF DIFFERENT
ORIGINS ARE PERMITTED FOR BIOCHAR PRODUCTION.

EXCLUDING MUNICIPAL WASTE, SEWAGE SLUDGE, INDUSTRIAL
SLUDGE, DREDGING SLUDGE.

PARAMETERS AND LIMITS TO BE RESPECTED VERY SIMILAR
TO THE ITALIAN REGULATION NOW IN FORCE

ORGANIC CARBON, STABILITY (H:CORG MOLAR RATIO),..
HEAVY METAL, HYDROCARBONS, DIOXINS AND FURANS, PCBs

EUROPEAN REGULATION ON ORGANIC AGRICULTURE

IMPL. REG. EU 2019/2164



REG. EU 848/2018

- ❖ ONLY FROM PLANT ORIGIN (NOT TREATED)
- ❖ PAHs <4 MG/KG DRY BASIS





REORGANIZATION AND REVIEW OF THE FERTILIZERS REGULATION

D.Lgs 75/2010



AUTHORIZED FEEDSTOCK

CARBONISATION (BIOCHAR FROM PYROLYSIS AND GASSIFICATION) PROCESS OF **PRODUCTS AND RESIDUES OF PLANT ORIGIN FROM AGRICULTURE AND FORESTRY**, AS WELL AS OLIVE POMACE, GRAPE MARC, FRUIT STONES AND SHELLS, **UNTREATED WASTE FROM WOOD PROCESSING AS BY-PRODUCTS** OF RELATED ACTIVITIES.

COMPLIANCE WITH NUMEROUS PARAMETERS WITH ASSOCIATED LIMIT VALUES AND QUALITY CLASSES REQUIRED

ORGANIC CARBON, STABILITY (H:CORG MOLAR RATIO), PH, EC, MOISTURE, ASHES,..

HEAVY METAL, HYDROCARBONS, DIOXINS AND FURANS, PCBs

WITH MINISTERIAL DECREE 10/10/2022 (OJ NO. 303 OF 29/12/2022) **BIOCHAR WAS INCLUDED IN ALL. 13 OF LEGISLATIVE DECREE 75/2010 (FERTILISATION ALLOWED IN ORGANIC FARMING)**



- ❖ ONLY FROM VEGETAL ORIGIN (NOT TREATED)
- ❖ PAHS <4 MG/KG DRY BASIS

VOLUNTARY QUALITY STANDARDS



SOIL APPLICATION

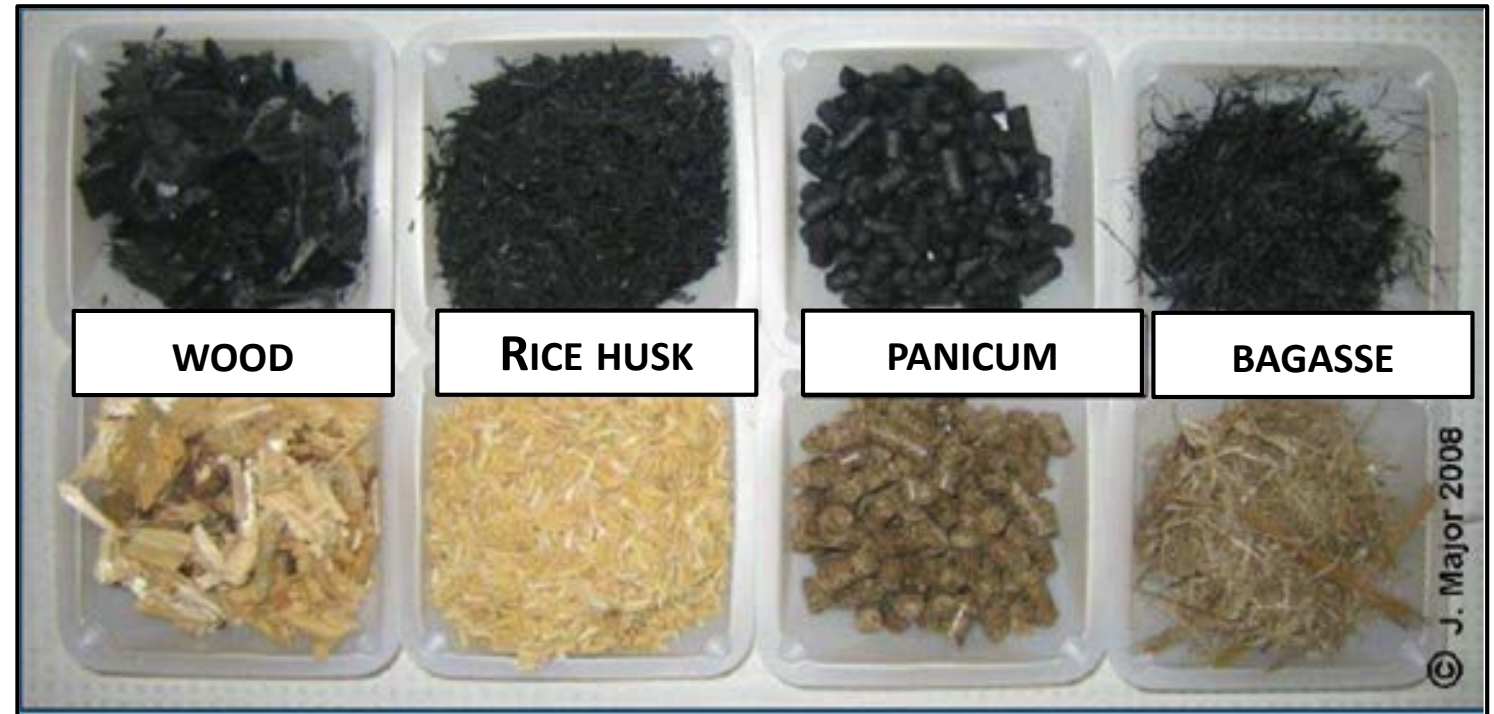




MULTIPLE POTENTIAL FEEDSTOCKS FROM AGRICULTURE AND FORESTRY

**THE QUALITY OF THE BIOCHAR OBTAINED
DEPENDS ON SEVERAL FACTORS:**

- ❖ ON THE **TYPE OF STARTING BIOMASS:**
MOISTURE, SIZE, ASH, ETC..
- ❖ ON THE **MAIN PROCESS PARAMETERS:**
MAXIMUM PROCESS TEMPERATURE
(T_{MAX}), **VAPOUR RESIDENCE TIME** (VRT),
SOLIDS RESIDENCE TIME (SRT), **HEATING**
RATE (HR), ETC.



**BIOCHAR IS A VERY GENERIC TERM, ENCOMPASSING A HUGE NUMBER OF SIMILAR BUT ALSO
PROFOUNDLY DIFFERENT PRODUCTS**

BIOCHAR FEEDSTOCK



MULTIPLE POTENTIAL FEEDSTOCKS FROM AGRICULTURE AND FORESTRY



LEGEND
TON D.B./YEAR

- 0 o N.D.
- 1 - 30.000
- 30.000 - 70.000
- 70.000 - 140.000
- 140.000 - 200.000
- 200.000 - 400.000
- 400.000 - 800.000
- > 800.000

CEREAL STRAW
BIOMASS 14.330.000
TON D.B./YEAR



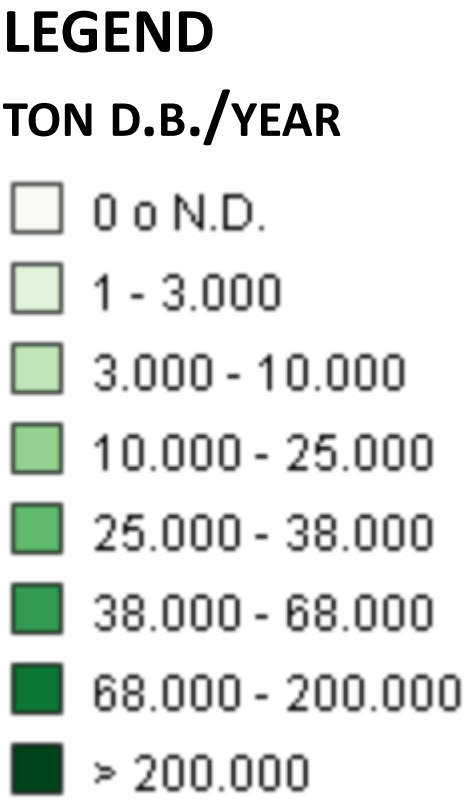
WHEAT, RYE, BARLEY, OATS, RICE,
MAIZE, SORGHUM, OTHER
CEREALS, RAPESEED, SUNFLOWER
AND SOYA

ENEA 2021 - ATLANTE BIOMASSE/MAPPE

BIOCHAR FEEDSTOCK



MULTIPLE POTENTIAL FEEDSTOCKS FROM AGRICULTURE AND FORESTRY



PRUNINGS BIOMASS FROM AGRO
SECTOR
2.264.000 TON D.B./YEAR



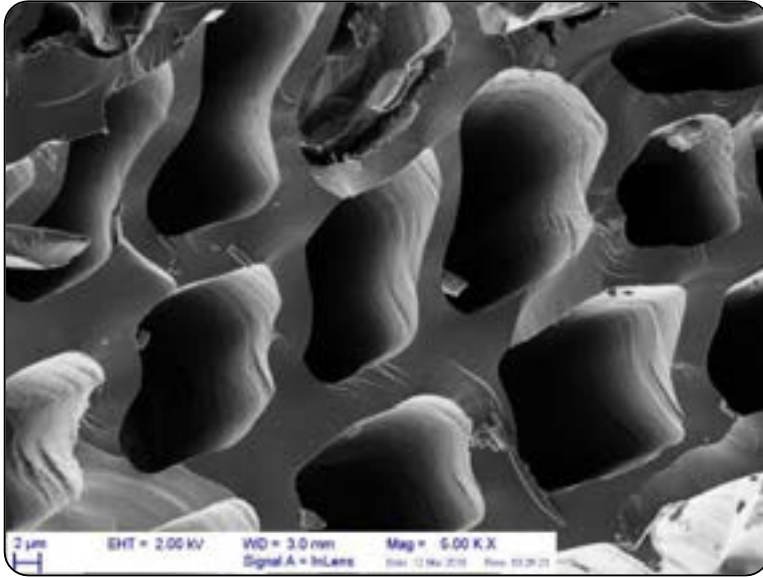
APPLE, PEAR, APRICOT, CHERRY, PEACH,
NECTARINE, PLUM, HAZELNUTS,
ALMONDS, PISTACHIOS, FIGS, ORANGE,
MANDARIN, CLEMENTINE, LEMON, TABLE
GRAPES, WINE GRAPES, OLIVE...

ENEA 2021 - ATLANTE BIOMASSE/MAPPE

BIOCHAR MAIN PROPERTIES – POROSITY

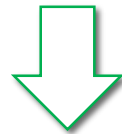
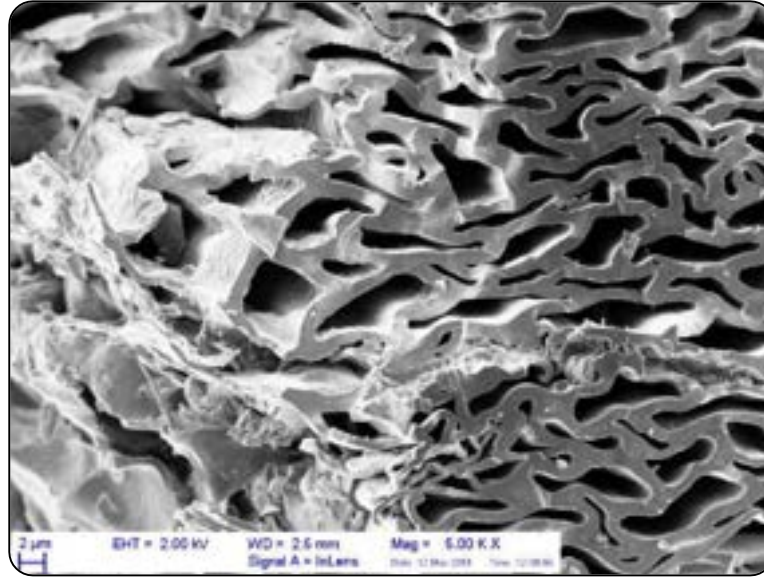


MACROPORES (>50 nm)



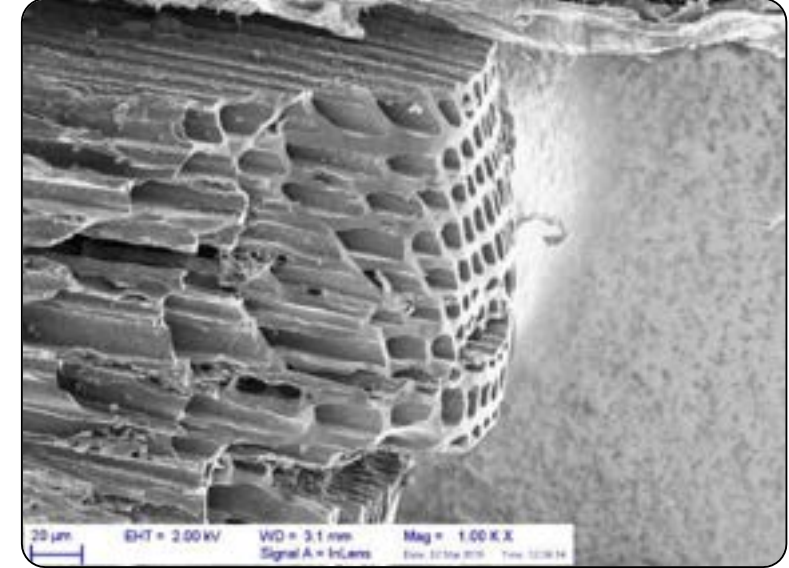
ABSORPTION OF LIQUIDS, SOLIDS,
BACTERIA AND LARGER MOLECULES
AFFECTING THE MAIN VITAL FUNCTIONS
OF THE SOIL

MESOPORES (50 – 2 nm)



ADSORPTION OF LIQUID AND SOLID
SUBSTANCES, IN PARTICULAR OF SMALL
MOLECULES

MICROPORES (< 2nm)

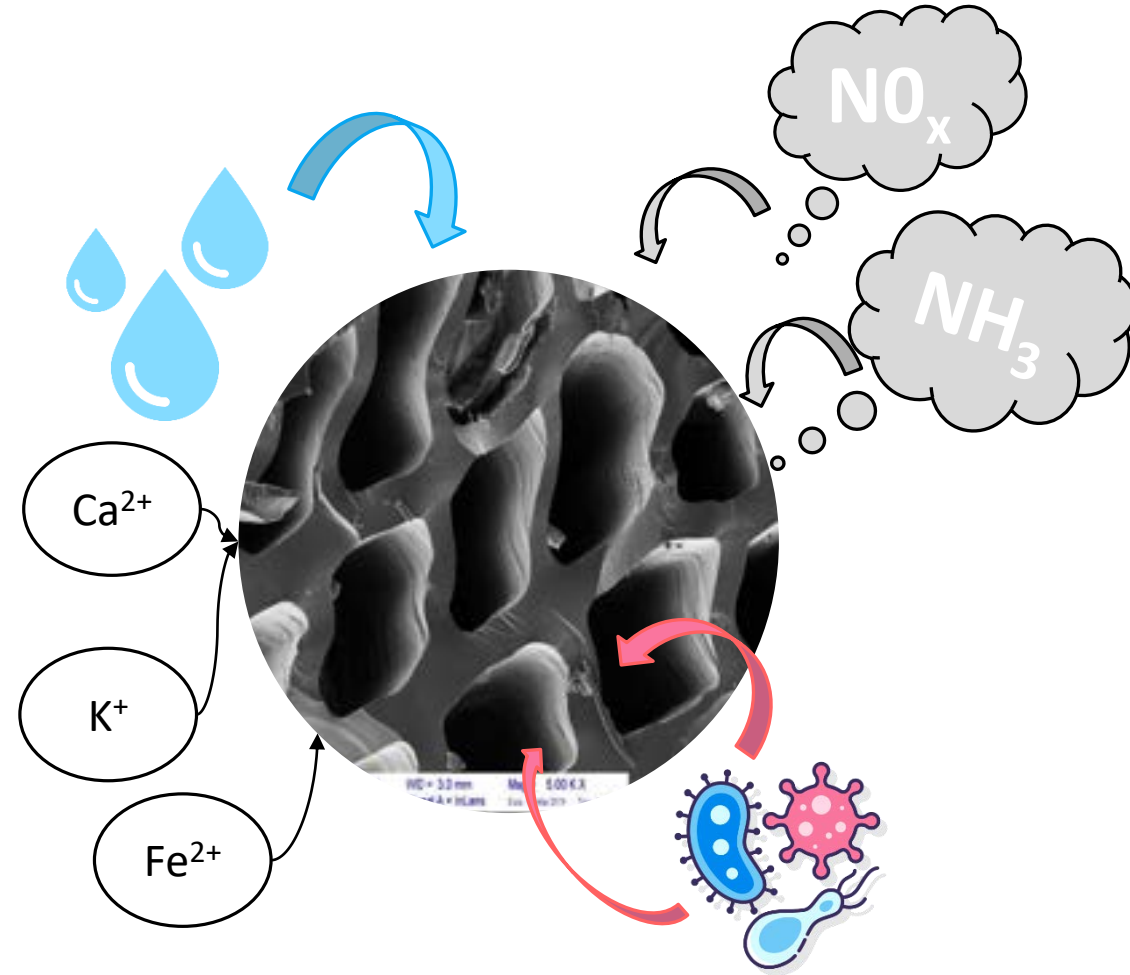


ABILITY TO ADSORBE VERY SMALL
MOLECULES AND GASES (I.E. ACTIVE
CARBON)

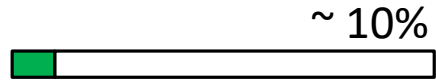
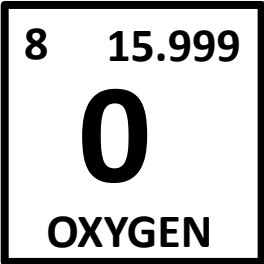
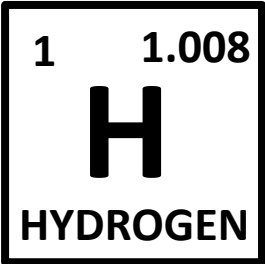
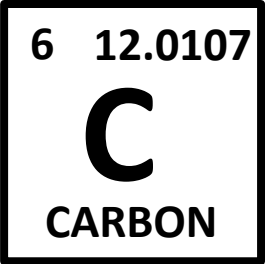


CONSEQUENCES OF A HIGHLY DEVELOPED **POROUS STRUCTURE**

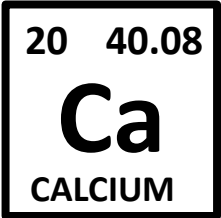
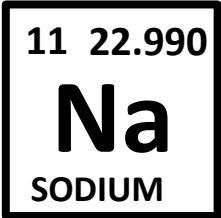
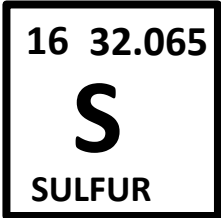
- ❖ INCREASE SOIL WATER RETENTION CAPACITY
- ❖ POTENTIAL TO COUNTERACT LEACHING AND NUTRIENT LOSS
- ❖ **HIGH REACTION SURFACE AREA**, PRESENCE OF REACTIVE FUNCTIONAL GROUPS (SIGNIFICANT CATION AND ANION EXCHANGE CAPACITY)
- ❖ IDEAL HABITAT FOR BENEFICIAL SOIL MICROORGANISMS



BIOCHAR MAIN PROPERTIES – ORGANIC CARBON

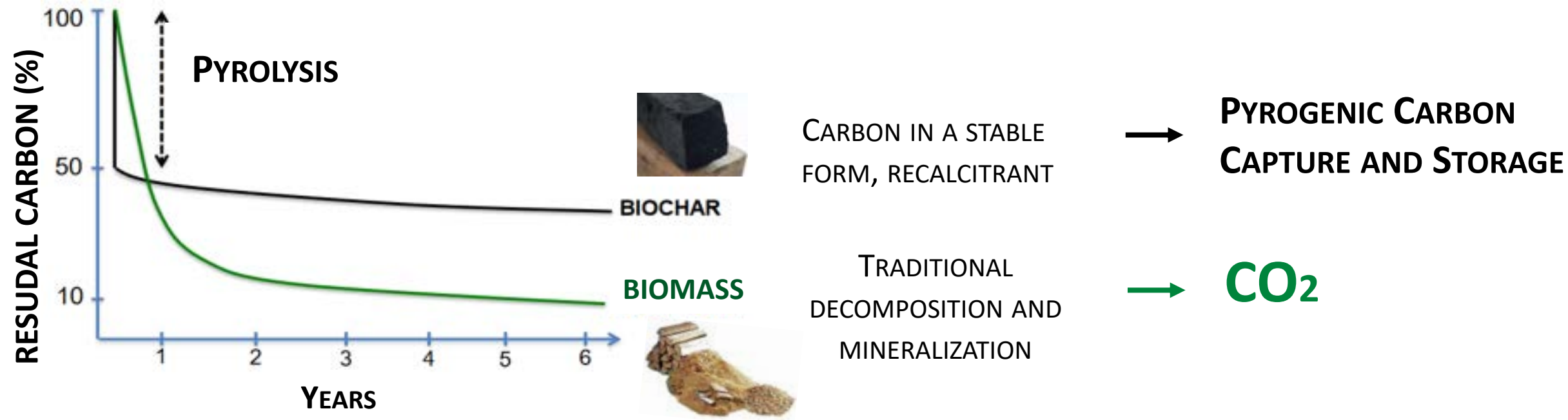


ASHES

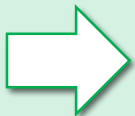


BIOCHAR	TOTAL CARBON (% d.b.)	ORGANIC CARBON (% d.b.)	H:C org molar ratio
Poplar	86.9	86.4	0.2
Olive	90.6	90.3	0.3
Elm	85.3	85.1	0.3
Birch	88.6	88.4	0.3
Robinia	81.8	81.5	0.3
EU Reg. 1009/2019 CMC14, PFC3(a) Organic amendment	>20	>7.5	<0.7
IT D.Lgs 75/2010 Annex II, Biochar pyrolysis and gass.	-	>60 for Class 1 20-60 for Class 2 >20 for Class 3	<0.7

BIOCHAR MAIN PROPERTIES – RECALCITRANT CARBON



A CONSERVATIVE AVERAGE **DEGRADATION RATE OF 0.3% PER YEAR** MAY BE ASSUMED FOR HIGHER TEMPERATURE BIOCHARS WITH A **H : C_{ORG} MOLAR RATIO BELOW 0.4** (IPCC, EUROPEAN BIOCHAR CERTIFICATE IN CERTIFICATION OF THE CARBON SINK POTENTIAL OF BIOCHAR 2020)



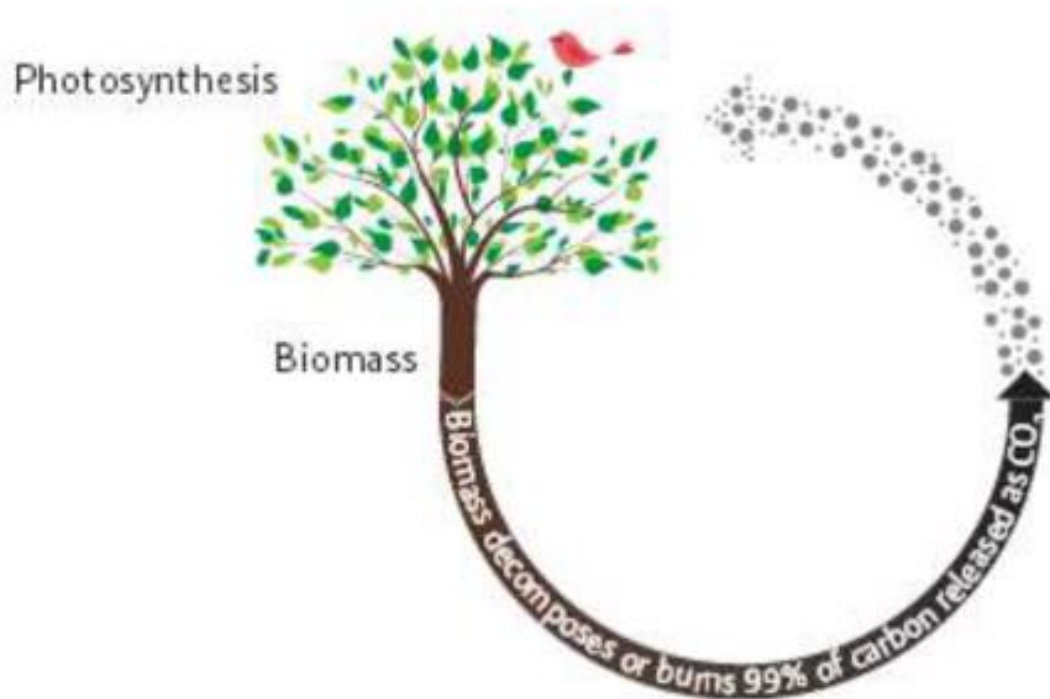
100 YEARS AFTER SOIL APPLICATION, 74% OF THE ORIGINAL CARBON IN BIOCHAR COULD STILL BE ACCOUNTED FOR AS SEQUESTERED CARBON

BIOCHAR MAIN PROPERTIES – RECALCITRANT CARBON

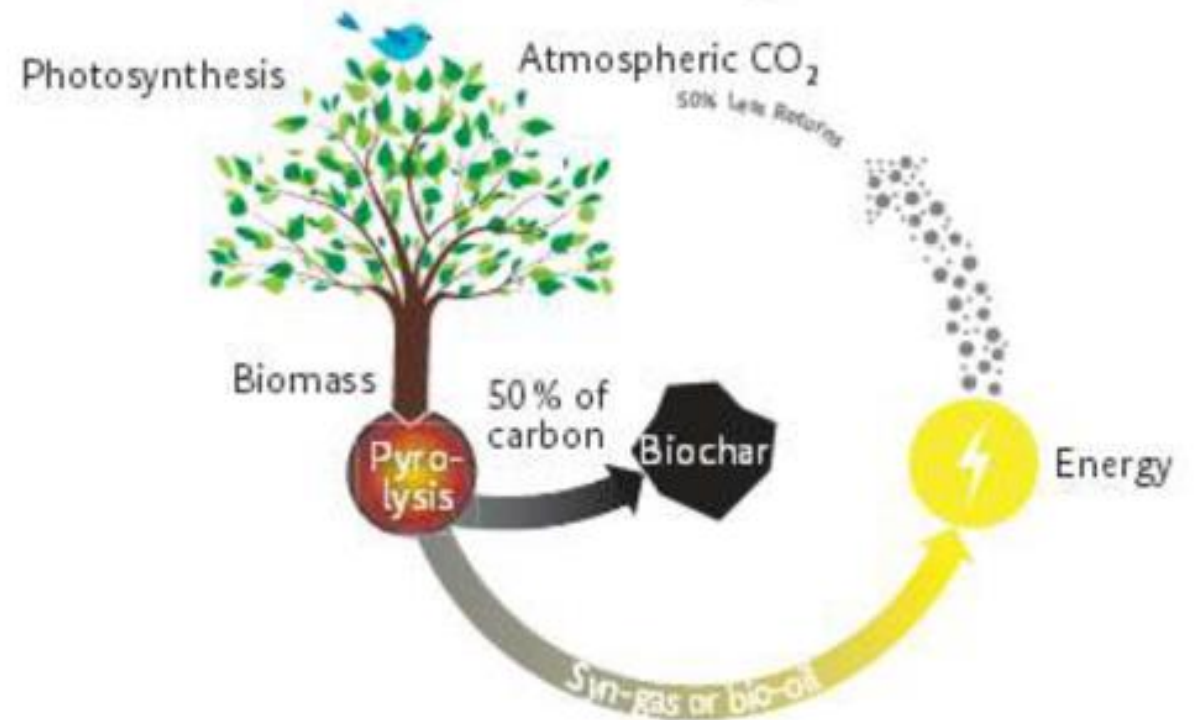


POTENTIAL IN THE CARBON CAPTURE AND STORAGE (CSS)

CARBON NEUTRAL



CARBON NEGATIVE



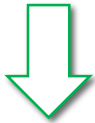
Source: adapted from Wilson (2013), based on Biochar Solutions Inc. (2011)

BIOCHAR AS SUSTAINABLE AGRONOMIC PRACTICE FOR CARBON FARMING



BIOCHAR CAN BE INTEGRATED WITH
OTHER SUSTAINABLE AGRONOMIC
PRACTICES

- ❖ **REDUCTION OF SOIL DISTURBANCE**
(*MINIMUM TILLAGE*)
- ❖ **MIXED OR CO-COMPOSTED WITH**
OTHER ORGANIC BIOMASS SUCH AS
MANURE, COMPOST, DIGESTATE,..)



**CARBON FARMING PRACTICES
TO INCREASE ORGANIC
CARBON STOCK IN SOIL**



SOIL ORGANIC CARBON AND SOIL ORGANIC STOCK



- ❖ **ORGANIC CARBON IS ONE OF THE MOST INDICATIVE PARAMETERS FOR ASSESSING SOIL CHEMICAL AND PHYSICAL FERTILITY**

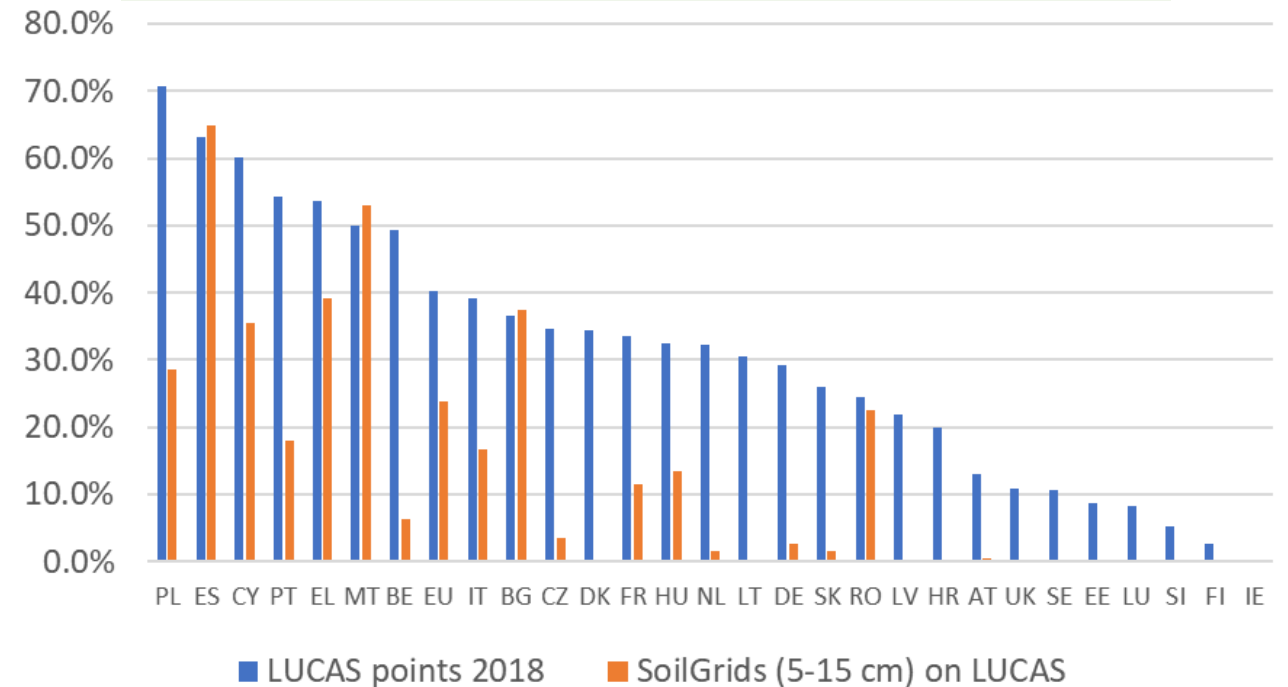


*...means land that, for a significant period of time, has either been significantly salinated or presented significantly **low organic matter content** and has been severely eroded.*

ALTHOUGH A DEFINITION OF 'SEVERELY DEGRADED LANDS' IS GIVEN, THE LIMITS FOR IDENTIFYING 'LOW ORGANIC MATTER CONTENT' ARE NOT PUBLISHED

- ❖ **THE QUANTITATIVE KNOWLEDGE OF THE CARBON STORED WITHIN THE SOIL (**CARBON STOCK**) ALLOWS THE ESTIMATION OF THE CARBON RATE EXCHANGE AMONG THE SOIL-ATMOSPHERE SYSTEM**

40% of European agricultural area with Soil Organic Carbon (SOC) content < 1.5%

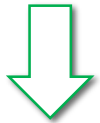


BIOCHAR FOR THE CARBON MARKET



CARBON MARKETS CAN BE BROADLY DIVIDED INTO TWO SEGMENTS:

- ❖ **COMPLIANCE MARKETS:** DRIVEN BY BINDING EMISSION REDUCTION TARGETS (E.G. **ETS FOR EU**) OR OTHER TYPES OF REGULATION (E.G. TAX) => **BIOCHAR FOR SOIL APPLICATION IS NOT STILL INCLUDED AS C REMOVAL STRATEGY - DG AGRI GAVE A FAVORABLE OPINION ON THE ENTRY OF BIOCHAR INTO THE ETS**
- ❖ **VOLUNTARY MARKETS:** CORPORATES OR INDIVIDUALS WHO WISH TO OFFSET THEIR EMISSIONS (“VOLUNTARY OFFSETTING”)



NOVEMBER 2022: PROPOSAL FOR A REGULATION THAT ESTABLISHES A VOLUNTARY UNION CERTIFICATION FRAMEWORK FOR CARBON REMOVALS



PERMANENT STORAGE

E.g. Bioenergy with Carbon Capture and Storage (BECCS), Direct Air Carbon Capture and Storage (DACCS)

Industrial leadership for climate-neutral technologies



CARBON FARMING

Soil and forest activities in the scope of the LULUCF Regulation, including: Peatland restoration, agroforestry, sustainable forest management, soil carbon sequestration,

Strong synergies with biodiversity



CARBON STORAGE IN LONG-LASTING PRODUCTS

E.g. wood-based construction materials and other carbon-storing construction products

New European Bauhaus

BIOCHAR FOR THE CARBON MARKET AND FOR THE SOIL MISSION



AUGUST 2023: AMENDMENT PROPOSAL FOR A REGULATION THAT ESTABLISHES A VOLUNTARY UNION CERTIFICATION FRAMEWORK FOR CARBON REMOVALS

Amendment 40
Proposal for a regulation
Article 2 – paragraph 1 – point g

Text proposed by the Commission

(g) ‘permanent carbon storage’ means a carbon removal activity that, under normal circumstances and using appropriate management practices, stores atmospheric or biogenic carbon for *several centuries*, including bioenergy with carbon capture and storage and direct air carbon capture and storage;

Amendment

(g) ‘permanent carbon storage’ means a carbon removal activity that, under normal circumstances and using appropriate management practices, stores atmospheric or biogenic carbon for *a significant period of time*, including bioenergy with carbon capture and storage, **biochar** and direct air carbon capture and storage;

Amendment 42
Proposal for a regulation
Article 2 – paragraph 1 – point h a (new)

(ha) ‘carbon farming storage’ means a carbon farming activity that stores atmospheric and biogenic carbon in living biomass, **biochar**, soils and dead organic matter as defined per carbon farming activity in the certification methodology;

BIOCHAR IS A **VERIFIABLE, MEASURABLE AND STABLE** FORM OF CARBON, VERY HIGH C-REMOVAL THRESHOLD AND IS ONE OF THE CHEAPEST WAY TO ENSURE LONG- LIVED CARBON REMOVAL IN AGRICULTURE

➡

THE USE OF BIOCHAR IN AGRICULTURE SUPPORT THE **EU MISSION SOIL** FOR RESTORING ORGANIC CARBON STOCK IN SOIL IN ARABLE LAND TO COUNTERACT MARGINALIZATION

RE-CORD PROJECTS



THANK YOU!

FRANCESCA.TOZZI@RE-CORD.ORG