Residue

Risk reduction of chemical residues in soils and crops: impact due to wastewater used for irrigation

Biochar and its use as an amendment in the composting process

Dr. Dmitri Drabkin & Dipl.-Geogr. René Schatten

WG Geoecology, Freie Universität Berlin

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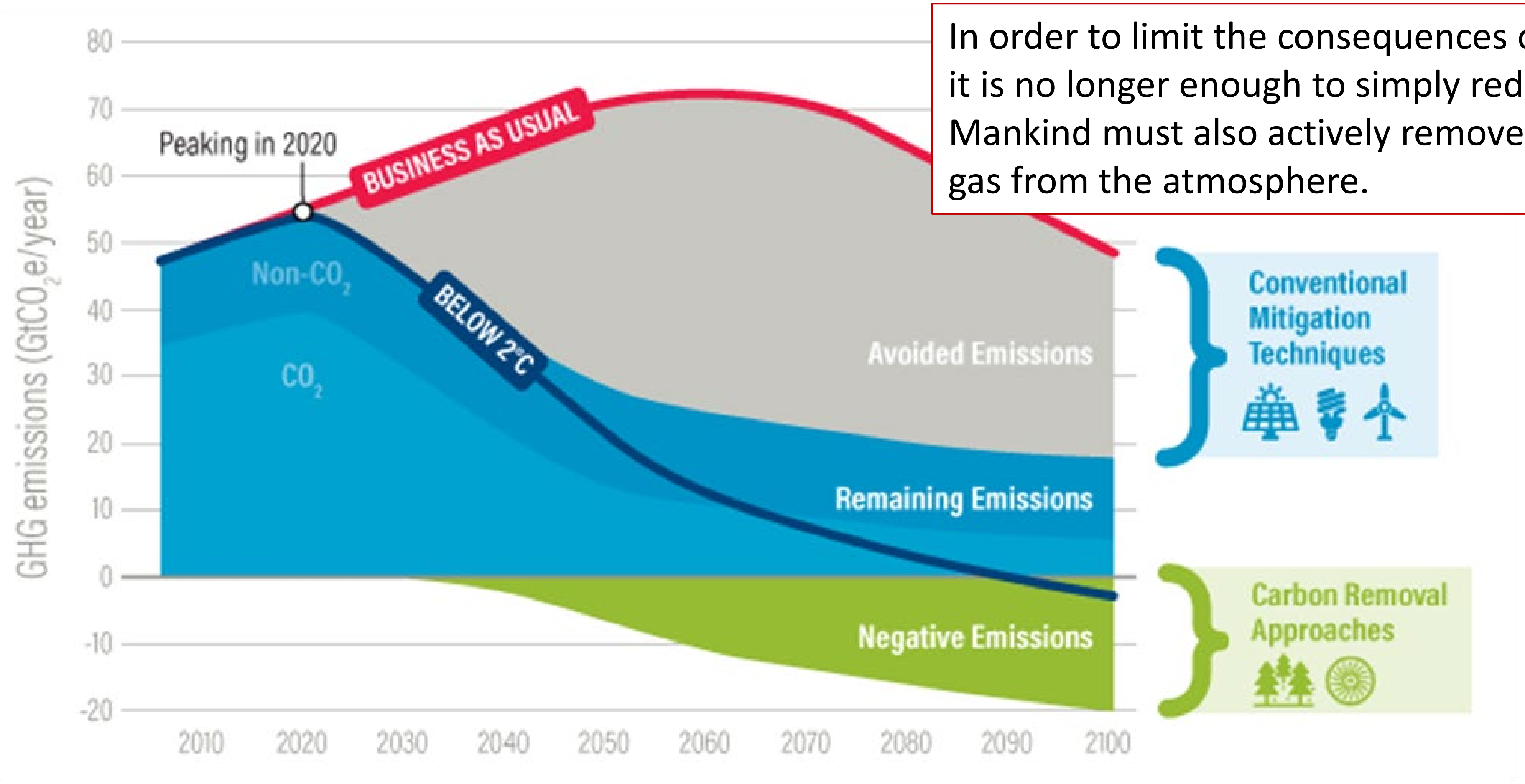
PRIMA PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA | Fraunhofer IME | Freie Universität Berlin | CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS | PHYTOR | Consorzio Italbiotec | האוניברסיטה העברית בירושלים THE HEBREW UNIVERSITY OF JERUSALEM

Climate change and Carbon Removal Approaches

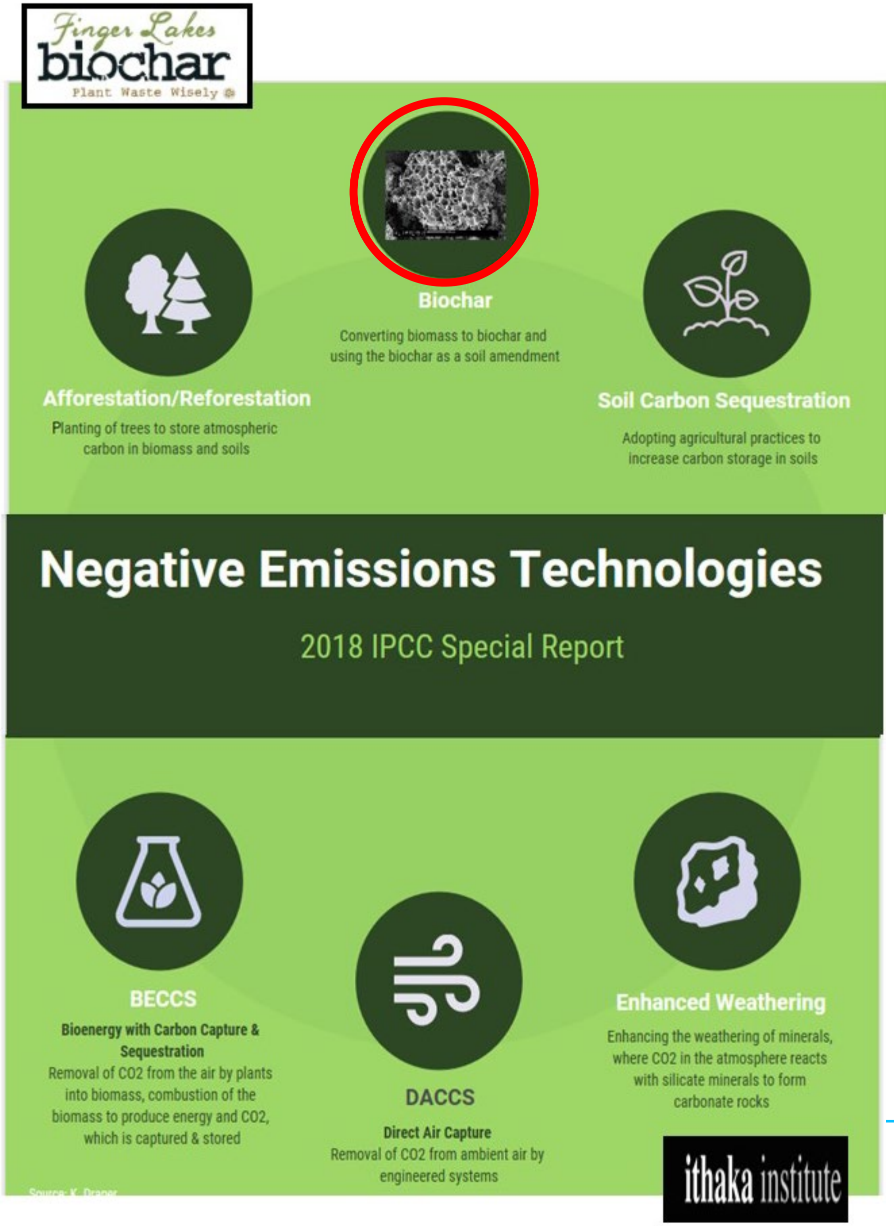
In order to limit the consequences of global warming, it is no longer enough to simply reduce CO2 emissions. Mankind must also actively remove the greenhouse gas from the atmosphere.

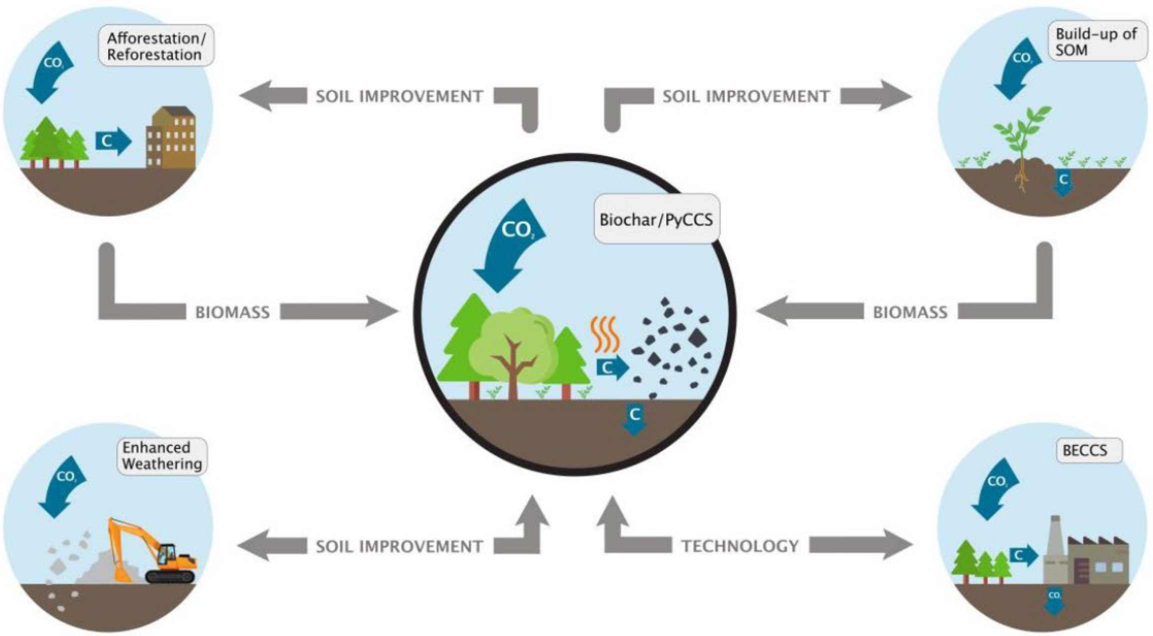


Source: Adapted from a visual in The UNEP Gap Report 2017 (Figure 7.2)

WORLD RESOURCES INSTITUTE

Negative Emission Technologies (NETs) currently discussed





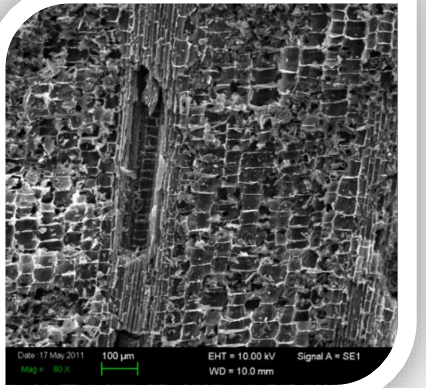
Synergies of biochar with other NETs (EBI Whitepaper, 2020; http://www.biochar-industry.com/wp-content/uploads/2020/10/Whitepaper_Biochar2020.pdf)

Currently six negative-emission technologies have sufficient potential for C-sequestration under current or foreseeable economic conditions including a risk profile that is at the very least manageable in terms of its ecological impact. **Biochar is one of these NETs.** (EBI Whitepaper, 2020)

What is biochar?

Product of carbonization of biomass (or other) residues

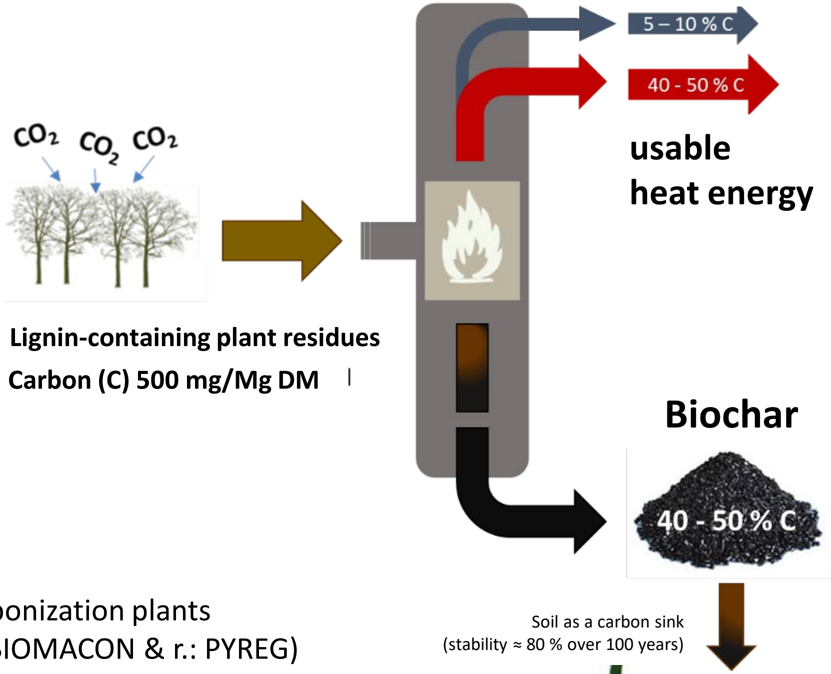
With the production of biochar, about 920 kg of CO2 can be stored from one ton of wood.



- C storage
- Nutrient storage
- Water retention

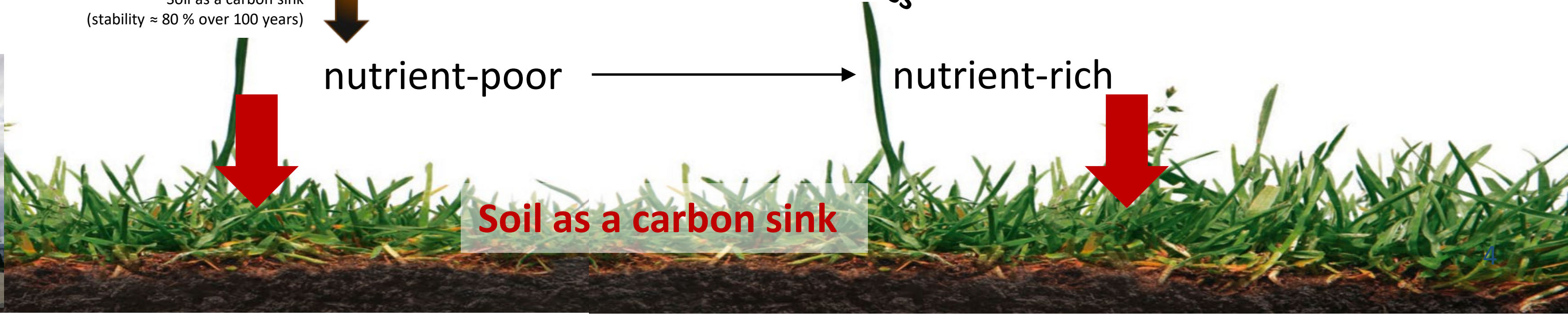
Biochar, close-up SEM

Pyrogenic carbon is a key component of the high fertility of Terra Preta do Indio. (Glaser & Woods, 2004; Lehmann & Joseph, 2009)

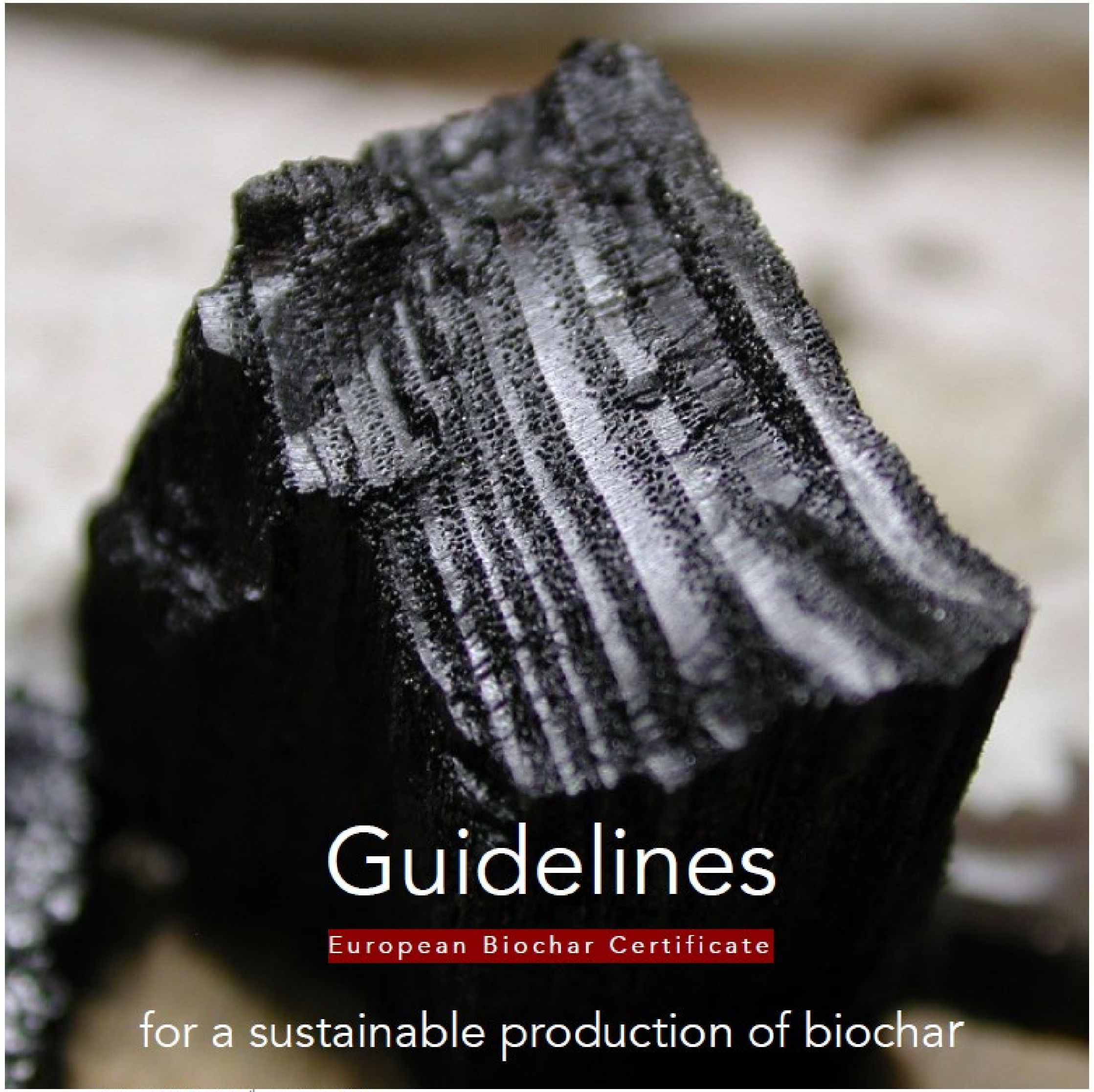


+ Green waste or other biomass =

Carbonization plants
(l.: BIOMACON & r.: PYREG)



Biochar production – Guidelines EBC - permissible biomasses



Version 10.1E of 10th January 2022

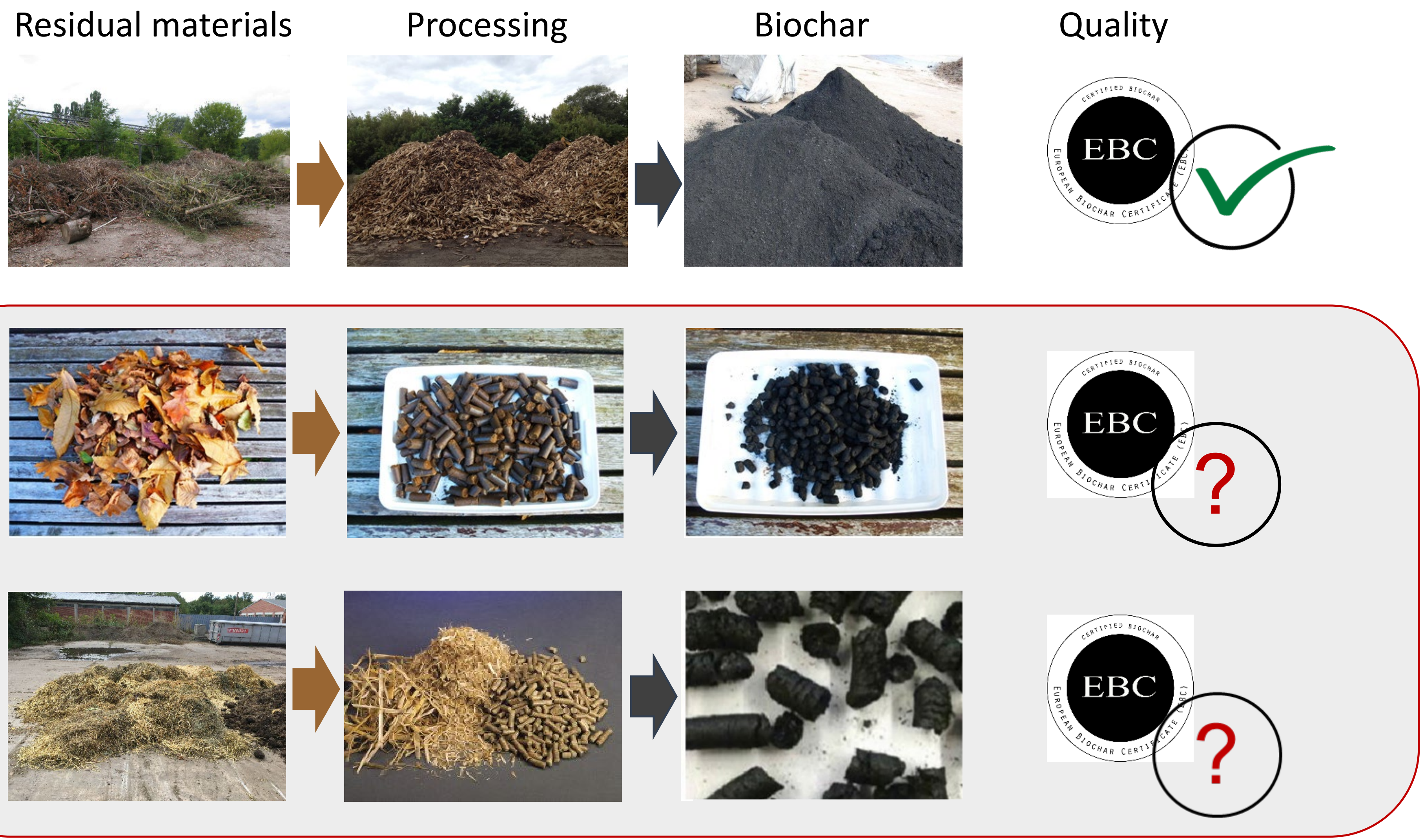
"All biomasses included in the EBC Positive list may be used individually or in combination as feedstock for the production of EBC biochar." (EBC, *Version 10.1 from 10th Jan 2022)*

- https://www.european-biochar.org/media/doc/2/positivlist_en_2022_1_v10_1.pdf
- Feedstock from agriculture, forestry and wood processing, landscape management, recycling economy, food processing etc.
- Currently mostly wood, woody materials, plant residues

- non-plant biomasses (e.g. **sewage sludge**, livestock manure, manure containing biogas digestates or bones and slaughterhouse wastes) are planned to include **mid 2022 in the EBC feedstock list** following a key review publication about the product safety and conditions of use

EBC (2012-2022) 'European Biochar Certificate - Guidelines for a Sustainable Production of Biochar.' European Biochar Foundation (EBC), Arbaz, Switzerland. (http://european-biochar.org). Version 10.1 from 10th Jan 2022

Biochar production



Challenge: Reduction of Water and mineral components, especially for sewage sludge

Co-composting biochar

Residual materials

5 - 20 % by volume

Composting with biochar
(8 - 12 weeks)

BC-compost

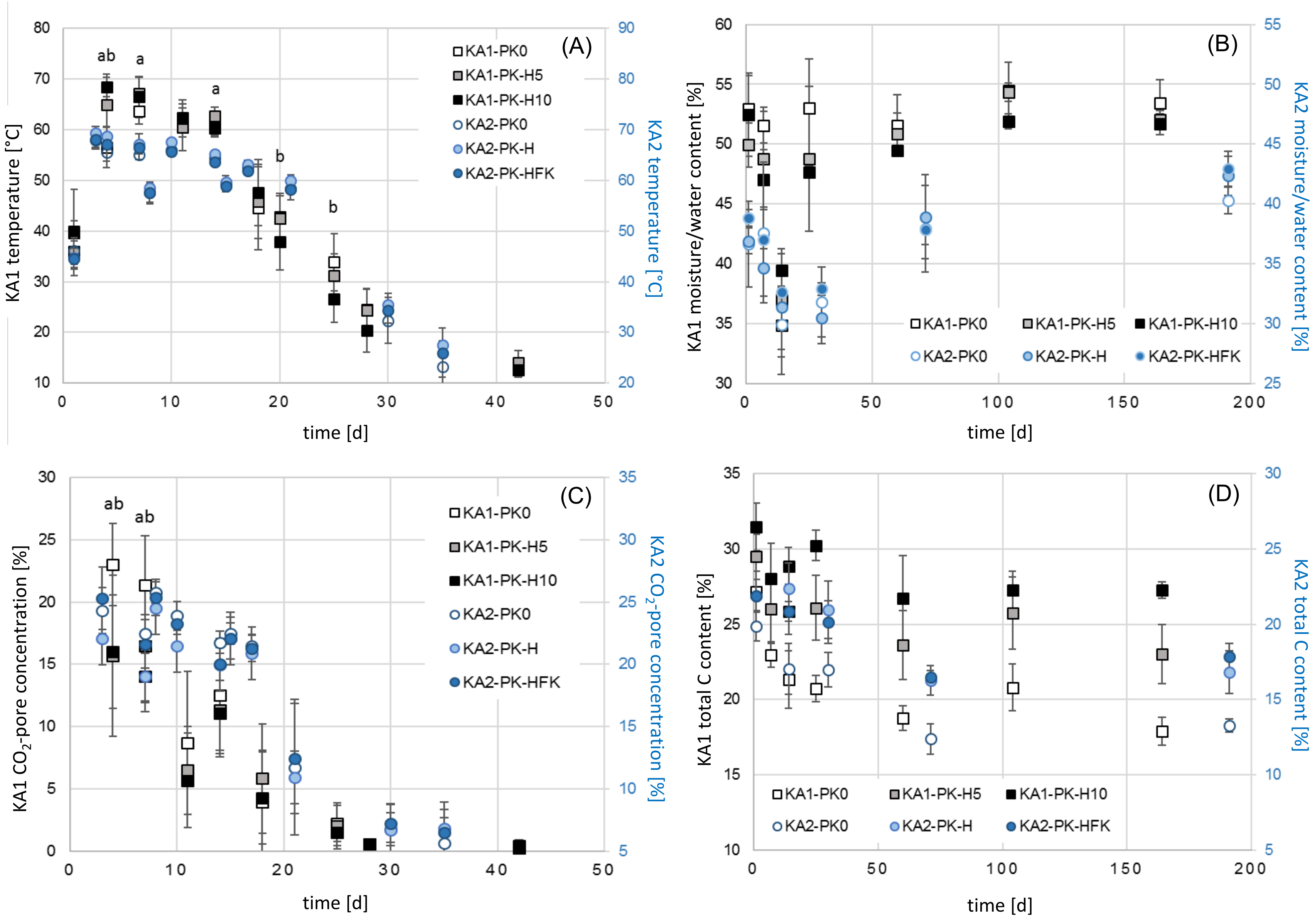
To be considered:

- C/N-ratio compost mix: approx. 30:1
- Chopping/shredding biomass residuals
- Moisture: optimal is 40-60 %
- Mixing (depends on temp. & CO_2)

Check regularly:

- Smell
- Moisture
- Temperature
- CO_2
- (Other GHG)

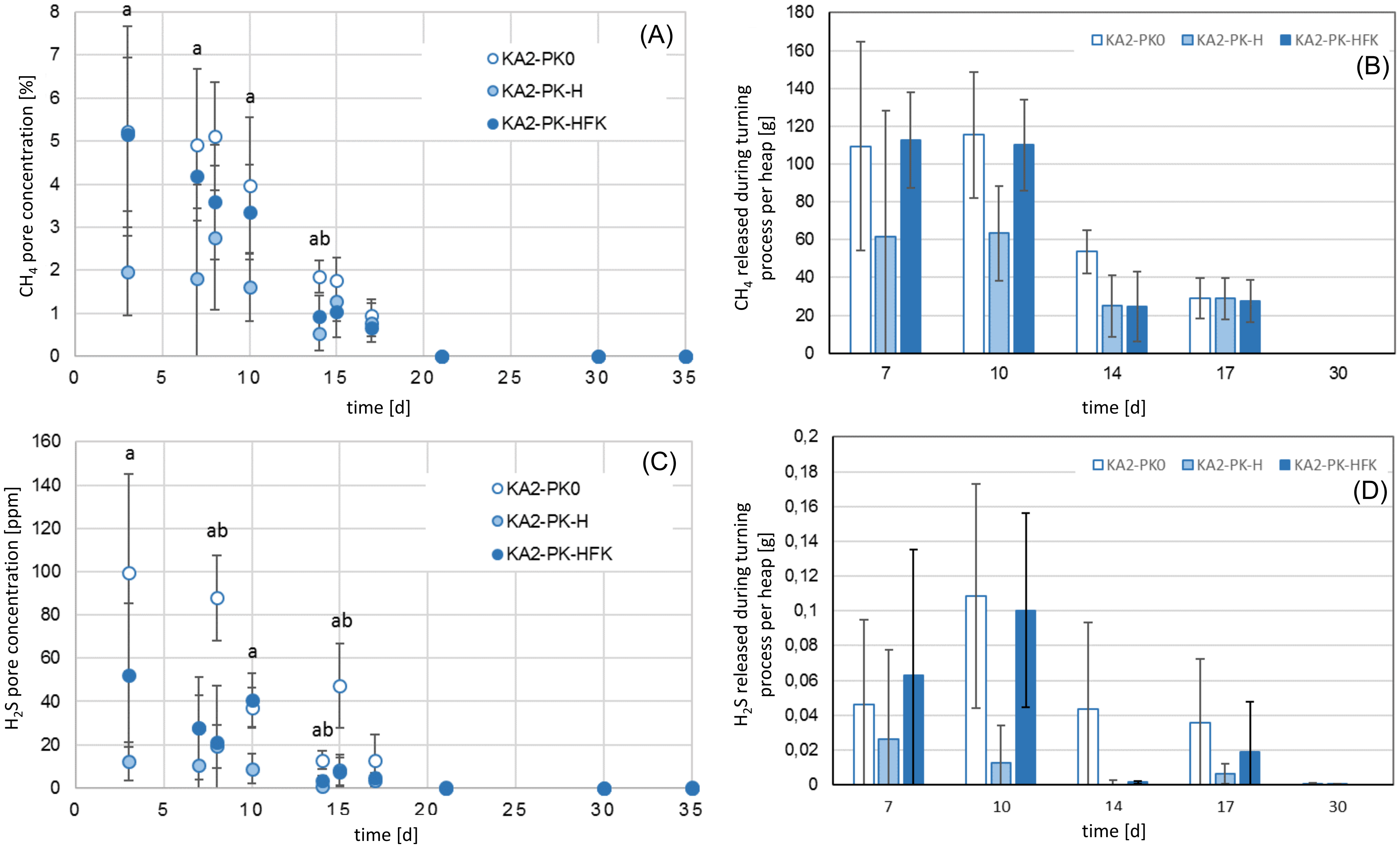
Parameters composting process (with/without biochar) I



PK = BC (biochar)

Mean values and standard deviations of the change over time of temperature (n = 12) (A), moisture resp. Water content (n = 6) (B), CO2 pore concentration (n = 12/6) (C), and total carbon content (n= 6) (D) of compost variants KA1-PK0 (control), KA1-PK-H5, and KA1-PK-H10 (in black) and compost variants KA2-PK0 (control), KA2-PK-H, and KA2-PK-HFK (in blue); letters indicate significances compared to control (Anova/ Tukey's HSD, PK-H5: a, PK-H10: b)

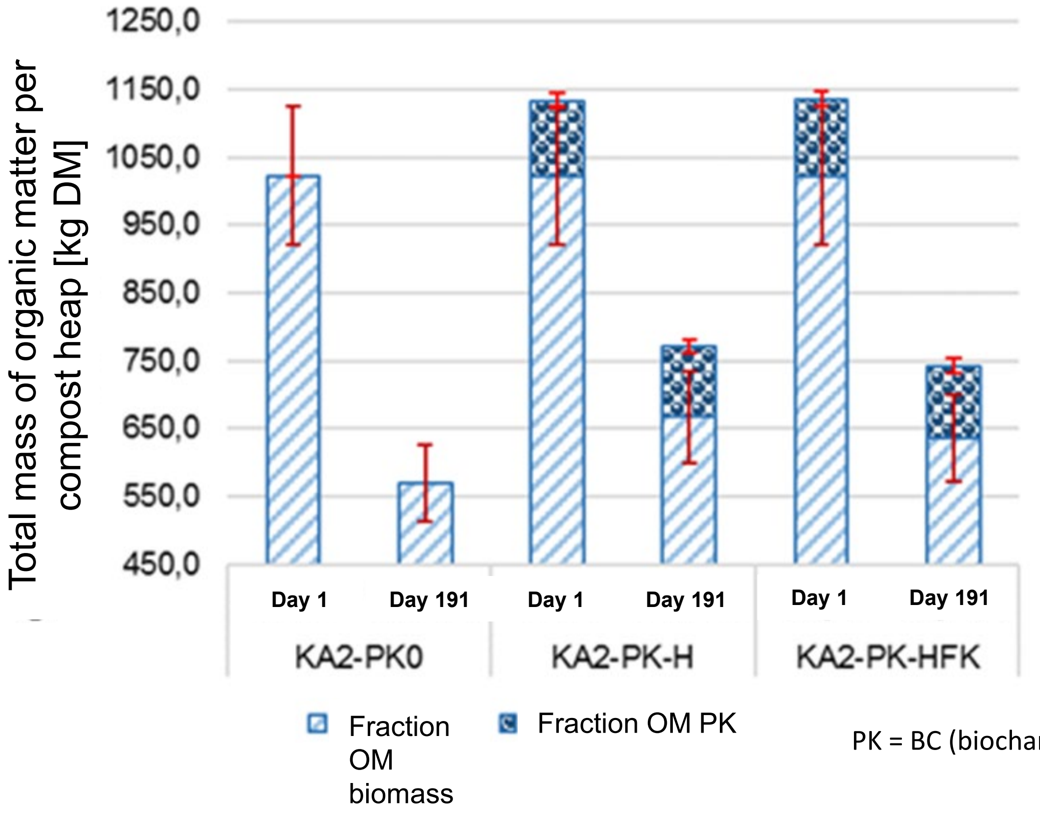
Parameters composting process (with/without biochar) II



PK = BC (biochar)

Means and standard deviations of change over time in CH4 pore concentration (n = 6) (A), CH4 release during turning (n = 6) (B), H2S pore concentration (n = 6) (C), and H2S release during turning (n = 6) (D), letters denote significances vs. PK0 (t-test, $p<0.05$; PK-H: a, PK-HFK: b)

Parameters composting process (with/without biochar) III



PK = BC (biochar)

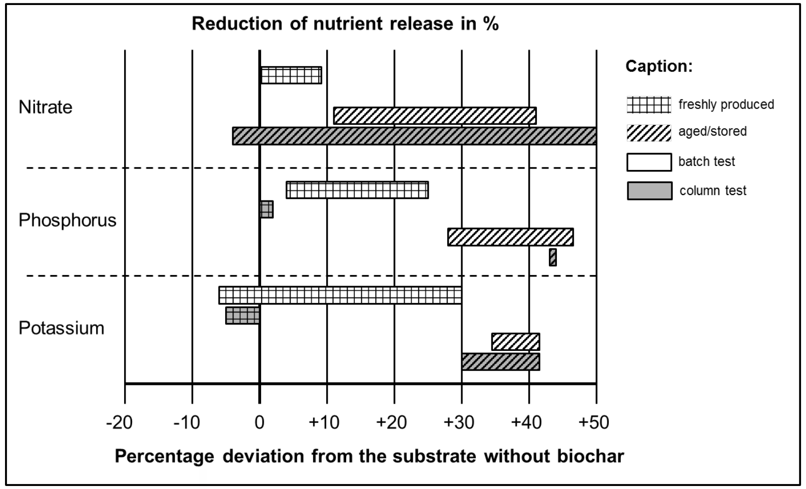
Means and standard deviations of organic matter (OM) degradation in the KA 2 approach comparing OM on day 1 (start of composting) to day 164 and day 191 (end of composting), respectively, separated by plant charcoal and solid manure/green waste fraction (n = 6)

Biochar composts - Characterization

Comparison of various biochar composts with values from the Federal Compost Quality Association Germany and the quality criteria for substrate composts

Parameter	KA1-BC0	KA1-BC5	KA1-BC10	Biochar composts project TerraBoGa		Value range (BGK eV[1])	Quality criteria substrate compost (BKG eV[1])	
				Mean	SD		Type 1	Type 2
pH	7.19	7.61	7.79	7.75	0.18	6.9 – 8.3		
Bulk density g/L FS	804	788	689	813	87.3	500 – 820		
Salt content g/L FS	3.00	2.03	1.63	1.76	0.53	1.9 – 8.0	max 2,5	max 5
Organic Substance %	22.1	26.2	29.7	32.3	8.9	24 – 51		
C %	12.6	19.2	23.1	21.3	6.9	16 - 37		
N %	0.82	0.82	0.80	0.76	0.16	0.5 – 1.5		
P mg/kg	1,585	1,841	1,647	1,382	129			
K mg/kg	6,279	6,774	6,277	7,354	2,044			
Nmin mg/L FS	820	635	310	373	221	0 - 740	< 300	< 600
P_{avail} mg/L FS	226	276	221	324	301	176 - 704	< 520	< 1.040
K_{avail} mg/L FS	1,428	1,440	1,488	2,232	853	1,245 – 4,565	< 1.660	< 3.320

[1]BKG eV = Federal Compost Quality Association Germany



The composts produced with biochar can comply with the BGK value ranges and can be classified according to quality criteria for substrate compost type 1. Amendment of BC reduced nutrient leaching

Summary of Co-composting with Biochar:
Experiences with green waste & animal manure in Botanic Garden Berlin



- higher temperature during composting, better hygienization
- reducing moisture
- reducing smell and GHG
- reducing carbon decomposition
- better structure – crumble
- reducing nutrient leaching

Biochar projects carried out at WG Geoecology

terra|BoGa

Closing cycles through energy and material flow management when using terra preta technology in the Botanical Garden with regard to resource efficiency and climate protection - Urban farming model project (*TerraBoGa*)

www.terraboga.de

LaTerra

Flächen-inwertsetzung

Klimaschutz

Terra Preta

Ressourcen-effizienz

Sustainable land use through regional energy and material flow management when using terra preta technology on military conversion areas and low-yield sites (*LaTerra*)

www.laterra-forschung.de

Carbo TIP

Development and establishment of an emission-reducing material flow/waste management system at the Berlin-Friedrichsfelde Zoo using the CO2 sequestration potential of biochar (CarboTIP)

www.carbotip.de

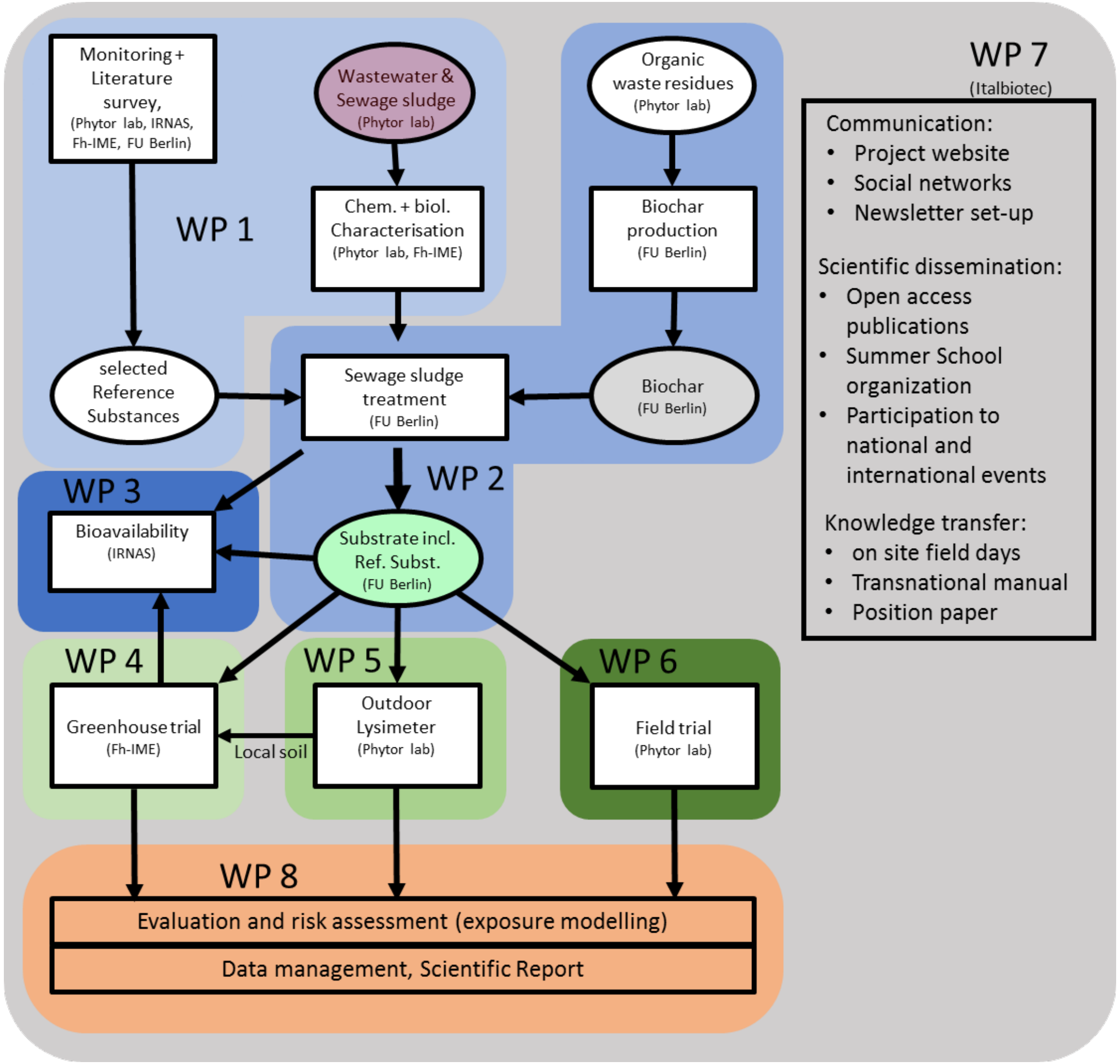
NEW

"Urban Soils Berlin - C-stores of the future?" (*CarbonStoreAge*)

- Testing the suitability of soils of former sewage fields
- Testing the suitability of biochar as an additive in tree substrates for street tree plantings

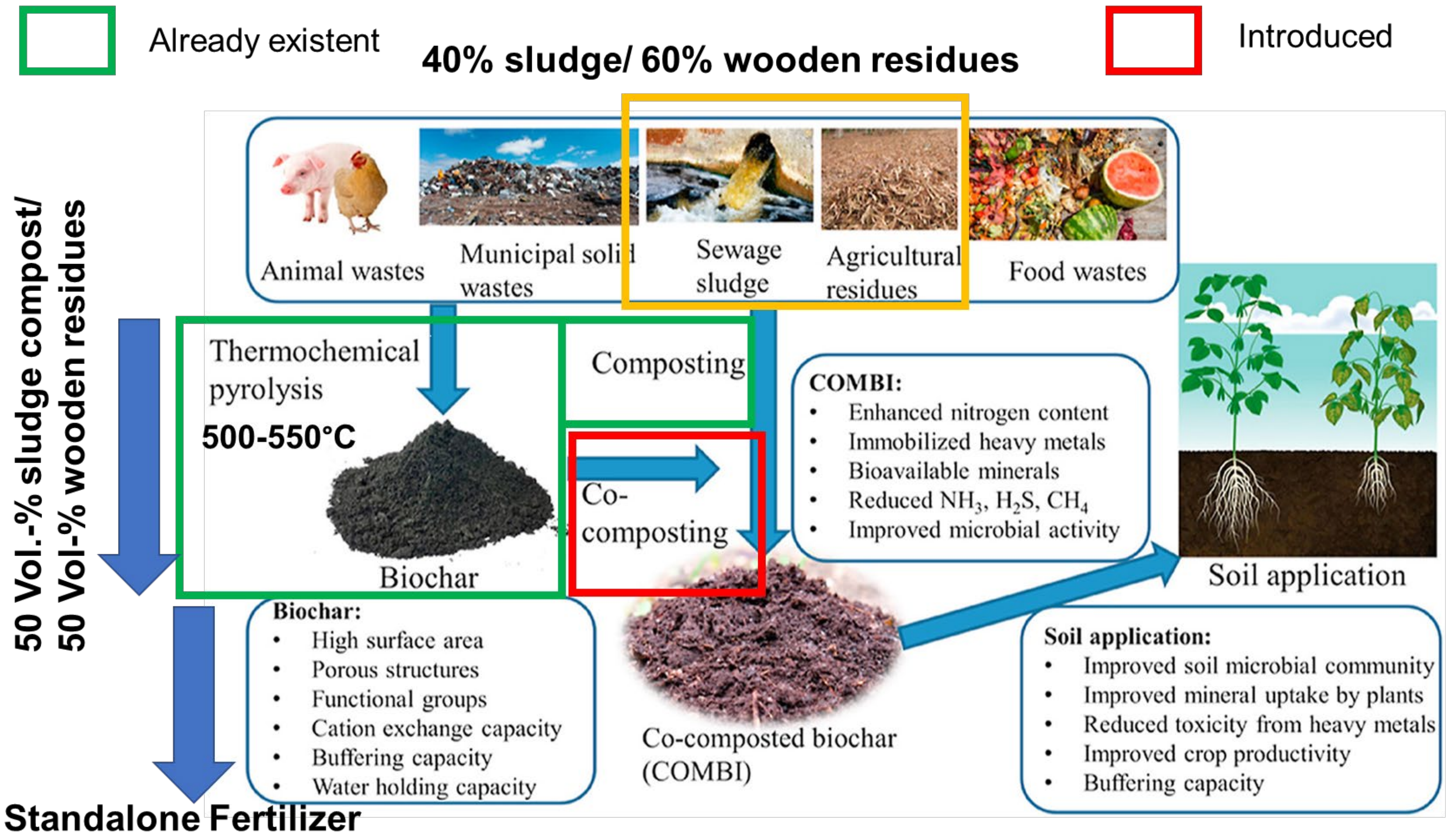
https://www.geo.fu-berlin.de/v/carbonstoreage/index.html

Biochar project RESIDUE – What´s new?



- Transfer the experiences into RESIDUE
- sewage sludge as main input material for carbonization & composting
- More wood chips and less green waste

Main idea biochar amendment in RESIDUE



Source: Adapted from Antonangelo et al. 2021

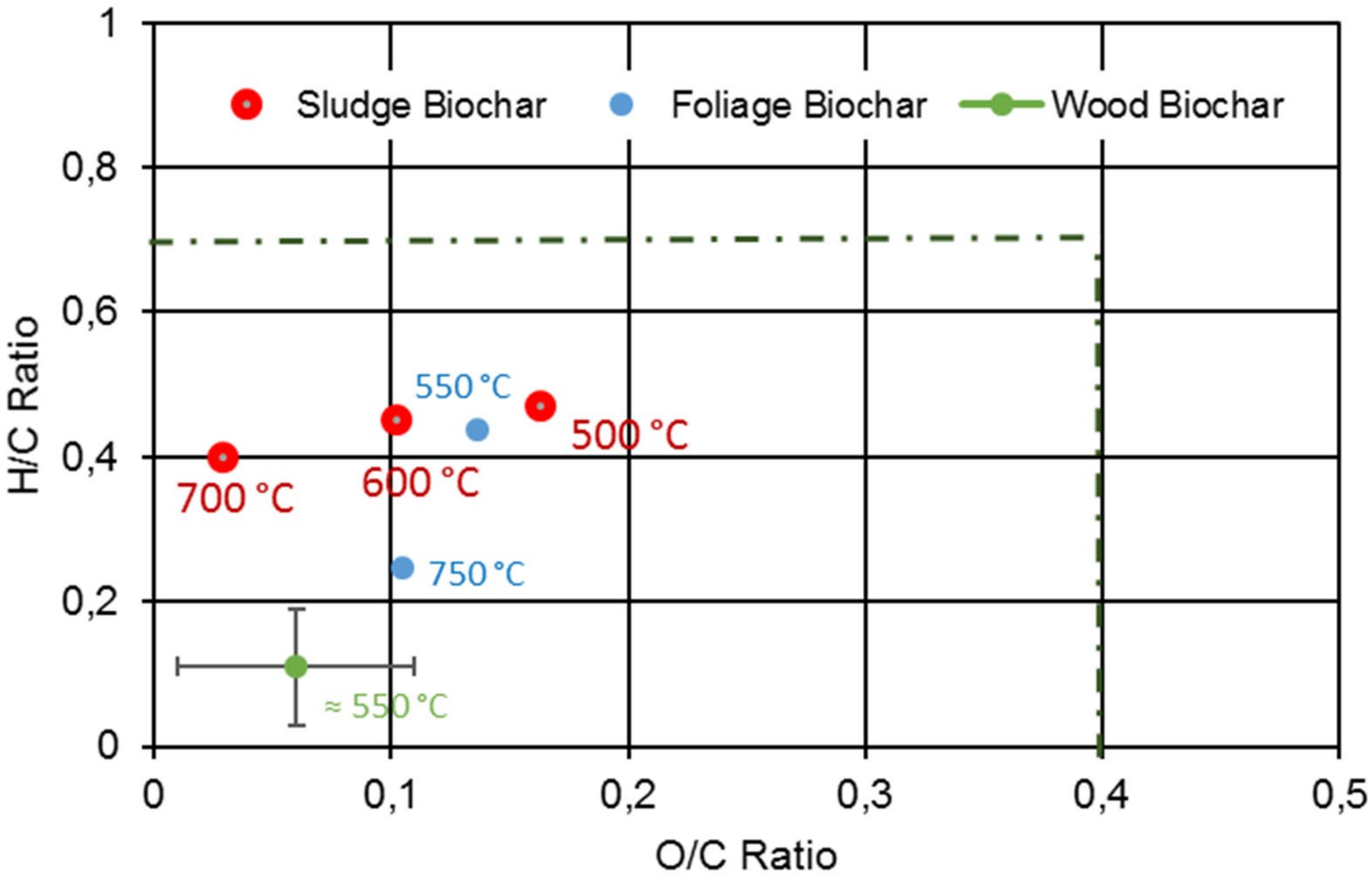
Already exist:

- sludge composting
- sludge biochar from composted sludge

New:

- Co-composting of sludge biochar with sludge

Biochar from sewage sludge



Van-Krevelen-Diagram shows stability of different biochars derived from H/C- and O/C-ratio. Sludge biochars produced at different temperatures show high stability

Biochar from sewage sludge

Pflant available nutrients		Composted Sewage Sludge	Sludge Biochar 500°C	Sludge Biochar 600°C	Sludge Biochar 700°C
Phosphorus (P)	mg/100 g	**620**	**74**	**55**	**32**
Potassium (K)	mg/100 g	**312**	**110**	**90**	**87**
Magnesium (Mg)	mg/100 g	**67,4**	**4,7**	**0,61**	**0,14**

Co-composting: first trial

Mixing of 3 components: wood chips, sludge and biochar (from left to right)

Co-composting: trial set-up at Compost Or facility in Israel

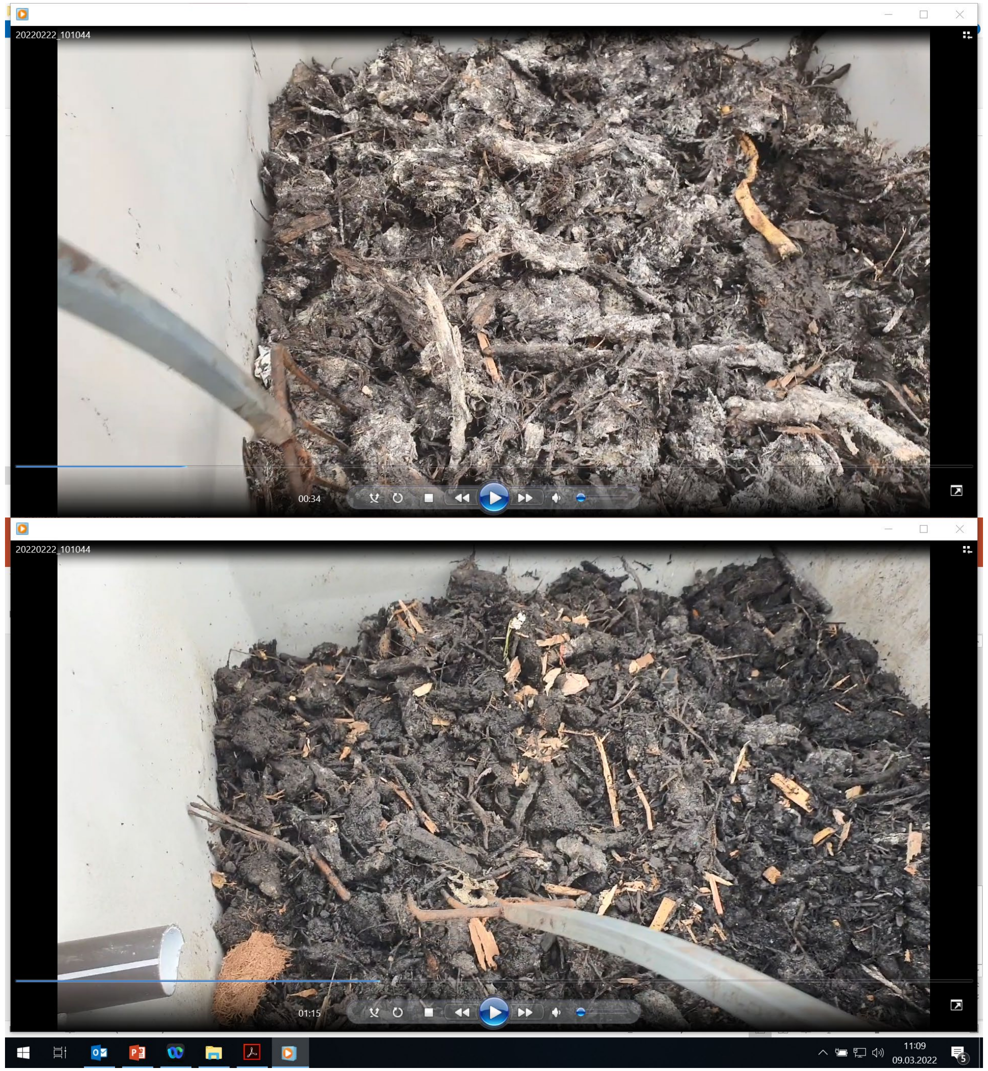
Source: Nadav Ziv

Co-composting trial with forced ventilation established at Compost Or Facility

4 Variants:

- control (without biochar)
- 10% biochar
- 20% biochar
- 30% biochar

Co-composting: results



- prevents mold
- prevents smell
- significantly better compost structure (crumble)
- Further trial at larger scale planned at Compost Or

Resulting composts –
control (top) and with
30% biochar amendment
(bottom).
Source: Nadav Ziv

References

- Antonangelo et al. (2021): The roles of co-composted biochar (COMBI) in improving soil quality, crop productivity, and toxic metal amelioration. *Journal of Environmental Management 277.*
- *EBC (2012-2022) 'European Biochar Certificate - Guidelines for a Sustainable Production of Biochar.' European Biochar Foundation (EBC), Arbaz, Switzerland. (http://european-biochar.org). Version 10.1 from 10th Jan 2022*
- *EBC* Positive list of permissible biomasses for the production of biochar https://www.european-biochar.org/media/doc/2/positivlist_en_2022_1_v10_1.pdf
- EBI Whitepaper, 2020; http://www.biochar-industry.com/wp-content/uploads/2020/10/Whitepaper_Biochar2020.pdf
- Racek et al. (2019): Biochar – Recovery Material from Pyrolysis of Sewage Sludge: A Review. *Waste and Biomass Valorization 11:3677–3709.*

Many thanks for your attention

Save the date_

SETAC Europe 2022 in Copenhagen

Poster presentation Thu May 19th

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Contact

rene.schatten@fu-berlin.de

dmitri.drabkin@fu-berlin.de

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