



Residue

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

Potential for biochar application – case studies from our current projects

Dmitri Drabkin, René Schatten, Robert Wagner

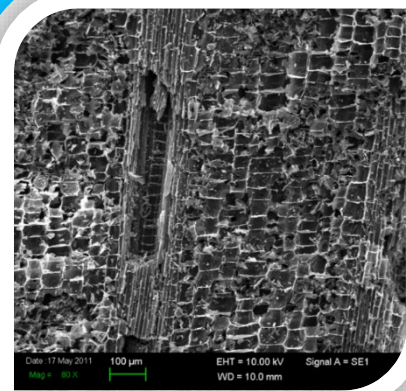
WG Geoecology, Freie Universität Berlin

Mai 23th, 2023 Spring School RESIDUE REACTIVE

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.

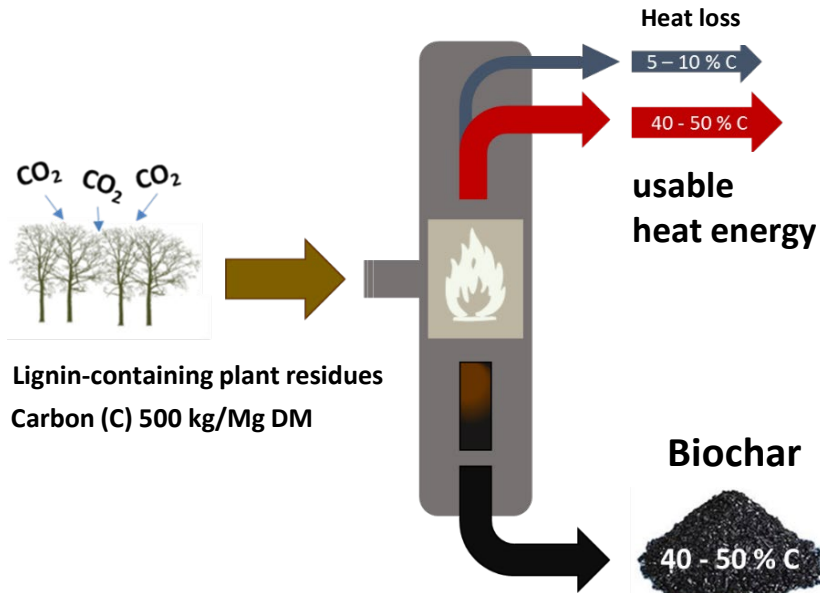


- C storage
- Nutrient storage
- Water retention

Biochar, close-up SEM

Pyrogenic carbon is a key component of the high fertility of Terra Preta do Indio.

(Source: Glaser & Woods, 2004; Lehmann & Joseph, 2009)



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



Soil as a carbon sink
(stability ≈ 80 % over 100 years)

Green waste or other biomass



nutrient-poor

nutrient-rich

Soil as a carbon sink



Negative Emission Technologies (NETs)

Finger Lakes biochar
Plant Waste Wisely®

Afforestation/Reforestation
Planting of trees to store atmospheric carbon in biomass and soils

Biochar
Converting biomass to biochar and using the biochar as a soil amendment

Soil Carbon Sequestration
Adopting agricultural practices to increase carbon storage in soils

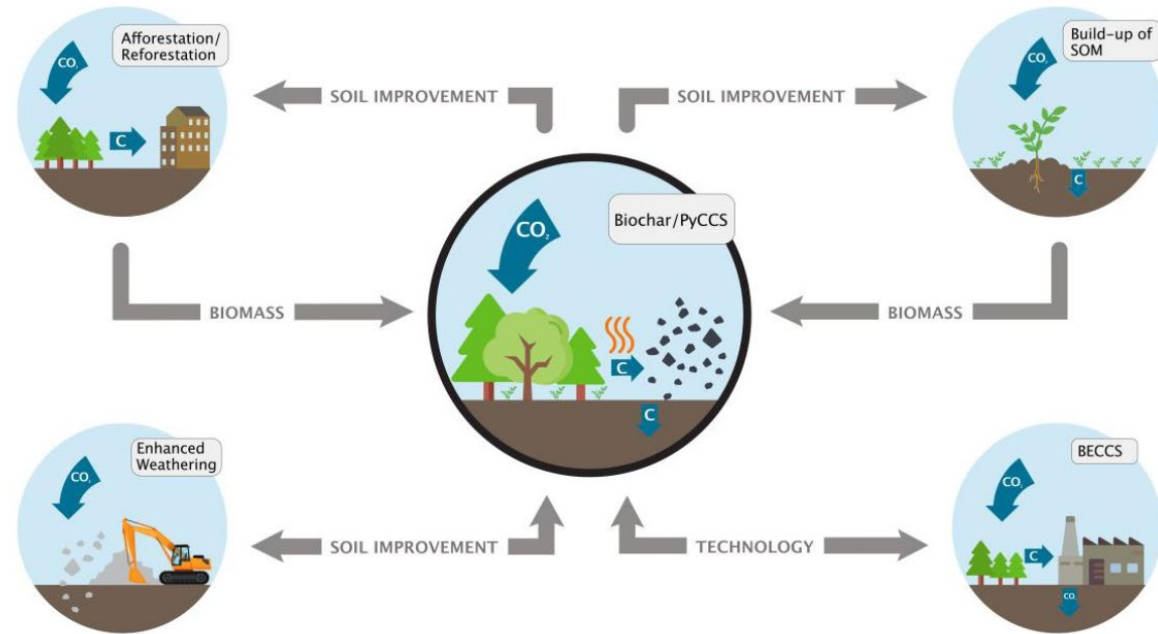
Negative Emissions Technologies
2018 IPCC Special Report

BECCS
Bioenergy with Carbon Capture & Sequestration
Removal of CO₂ from the air by plants into biomass, combustion of the biomass to produce energy and CO₂, which is captured & stored

DACCS
Direct Air Capture
Removal of CO₂ from ambient air by engineered systems

Enhanced Weathering
Enhancing the weathering of minerals, where CO₂ in the atmosphere reacts with silicate minerals to form carbonate rocks

ithaka institute



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

Currently six NETs 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. (Source: EBI Whitepaper, 2020)

Biochar projects carried out/ongoing at our working group

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



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



Biochar projects carried out/ongoing at our working group



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



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



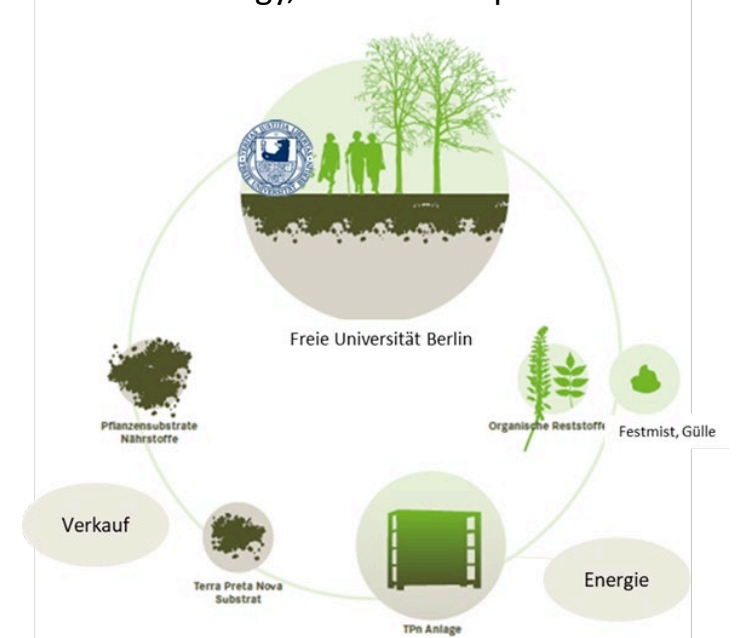
Horizon2020/EU

www.residueproject.it
<https://twitter.com/ResidueProject>



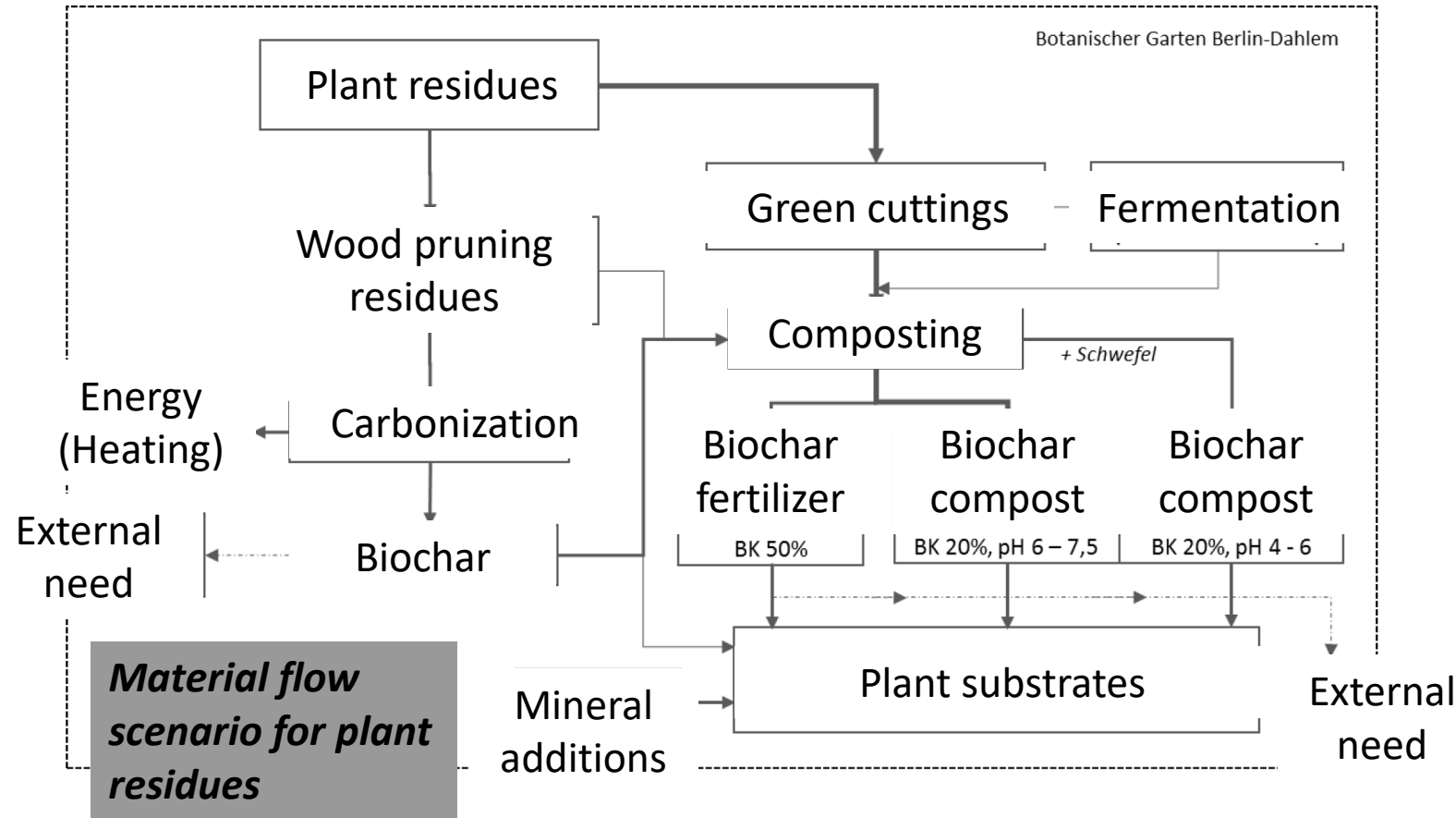
CarbonThink –

Closing the cycle and recycling organic waste at the Freie Universität Berlin through the production of energy, biochar and plant substrates



TerraBoGa Project

- Annually 2000 m³ Biomass -> Mostly not reused
- At the same time 250 m³ of compost/substrates annually needed



(Source: Manual for the use of organic residues for the production of fertile biochar substrates and their use in horticulture [in german]. Published by Shaker 2016)



Handlungsanleitung zur
Verwertung von organischen
Reststoffen zur Erzeugung fruchtbarer
Pflanzenkohlesubstrate und deren
Nutzung im Gartenbau



TerraBoGa Project

- higher temperature during composting, better hygienization
- reducing moisture
- reducing smell and GHG (50 t/a CO₂eq)
- reducing carbon decomposition
- better structure – crumble
- reducing nutrient leaching

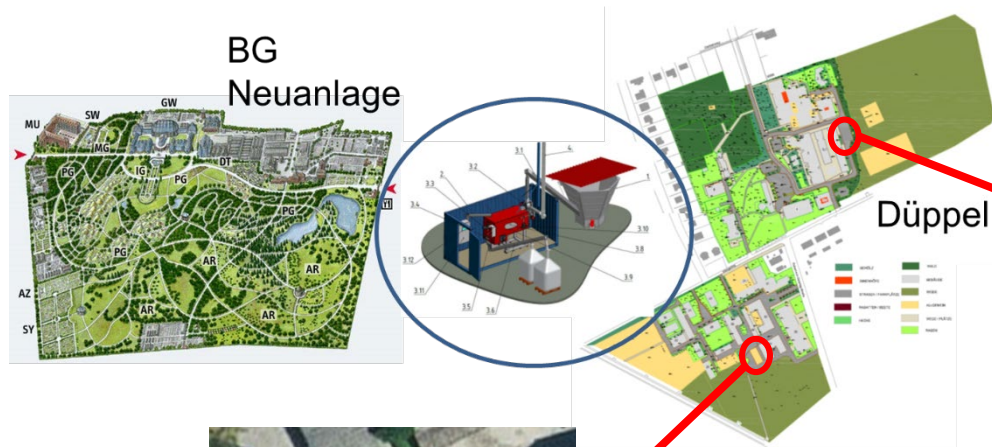
Before: + 160 t/a CO₂/CO₂eq
After: - 42 t/a CO₂/CO₂eq



**Handlungsanleitung zur
Verwertung von organischen
Reststoffen zur Erzeugung fruchtbarer
Pflanzenkohlesubstrate und deren
Nutzung im Gartenbau**



CarboThink Project



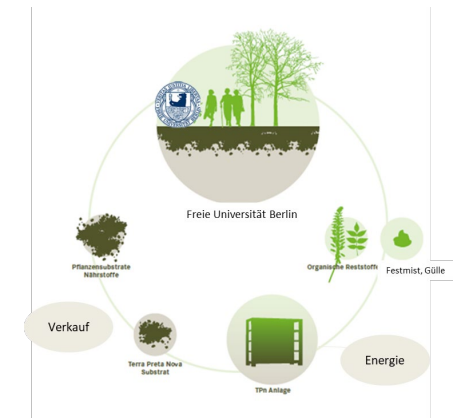
Düppel, Dung pit, cattle clinic



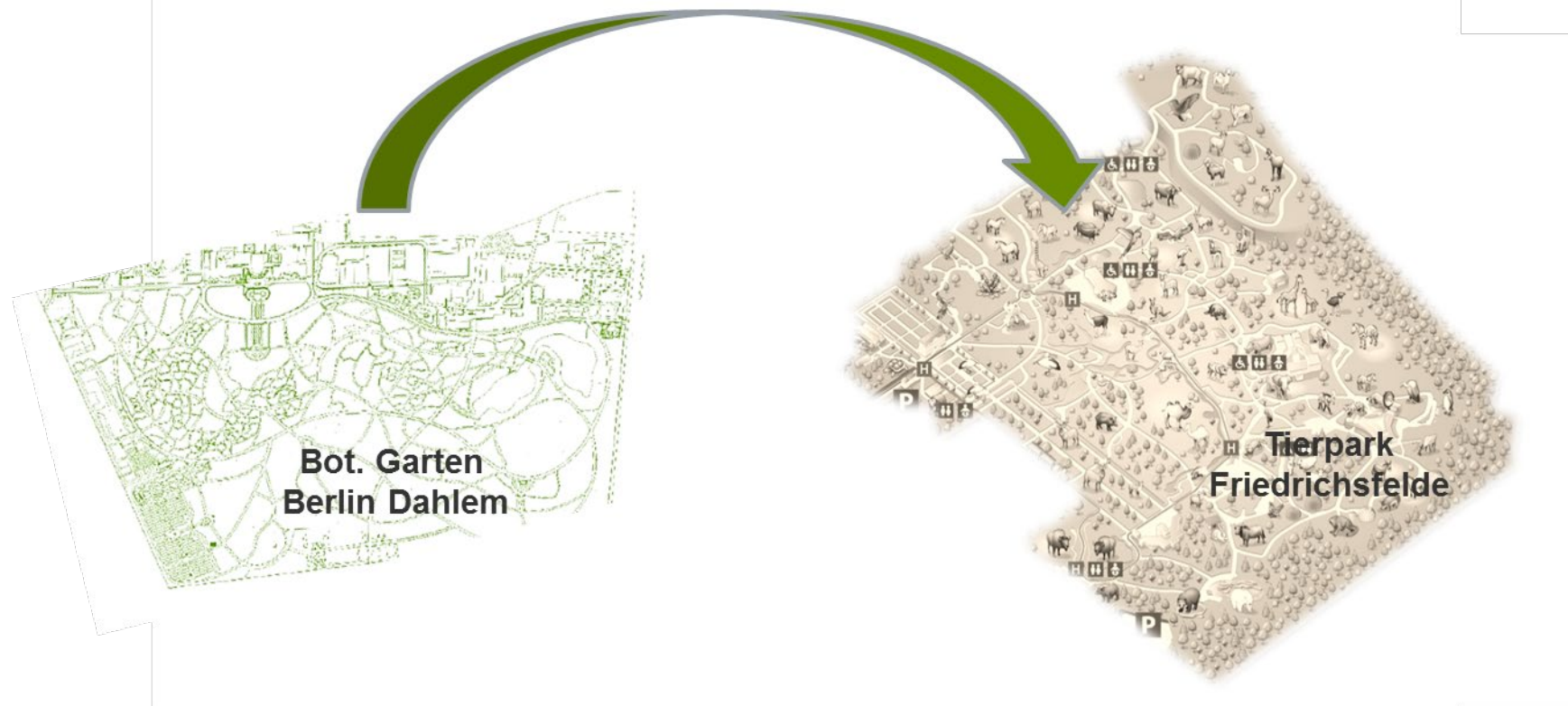
Düppel, Dung pit horse clinic

Selection criteria:

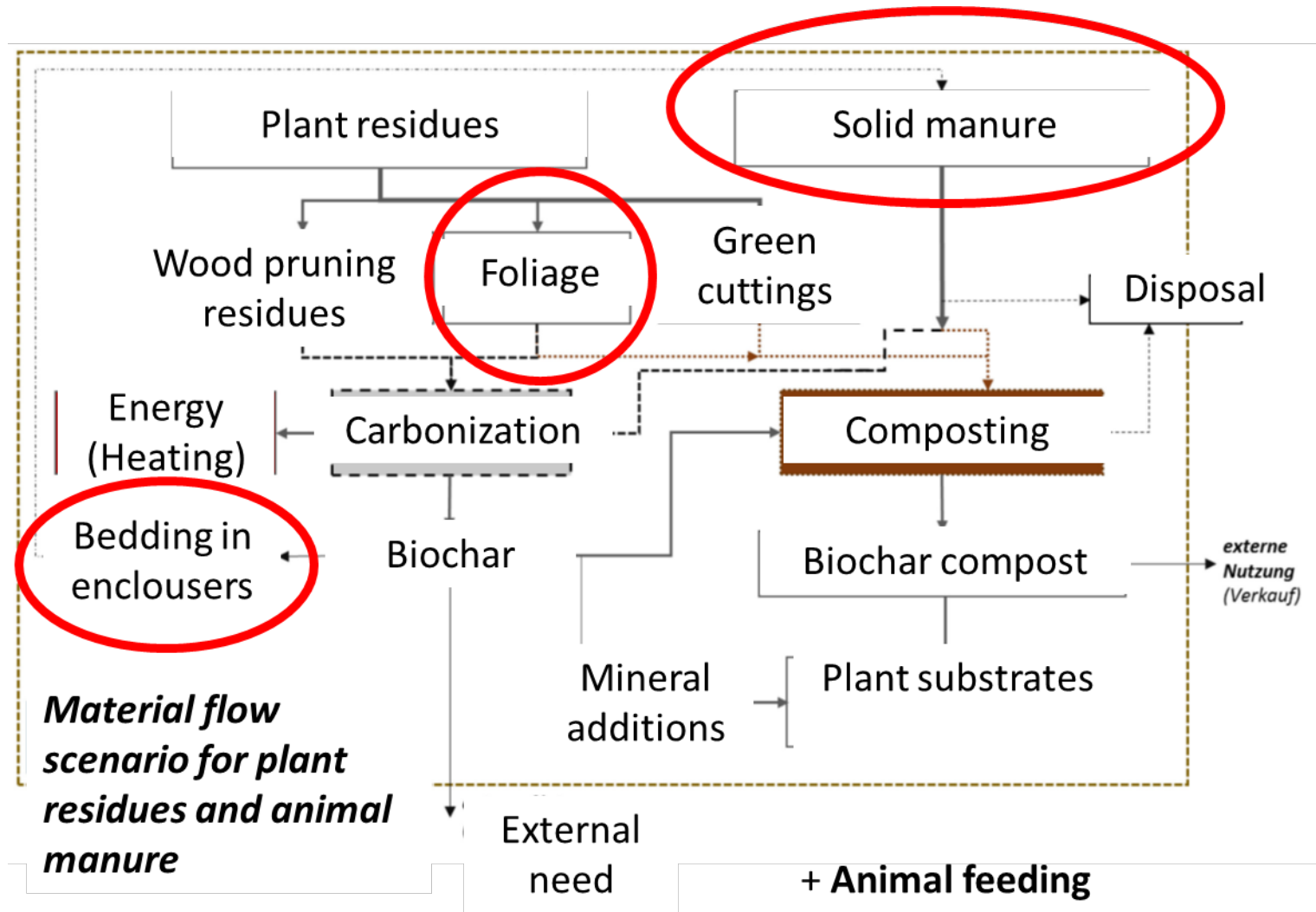
- Enough Biomass
- Enough space
- Year-round heat consumption



Knowledge and Technik Transfer

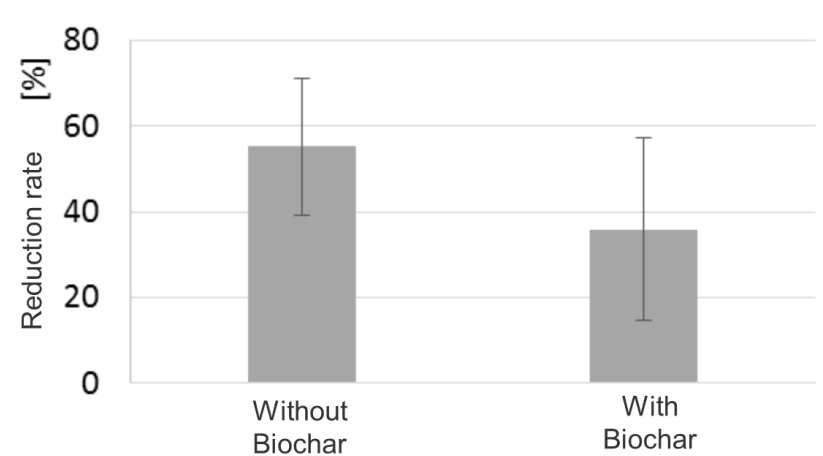


CarboTIP Project



(Source: Manual based on the results of CarboTIP project. Unpublished)

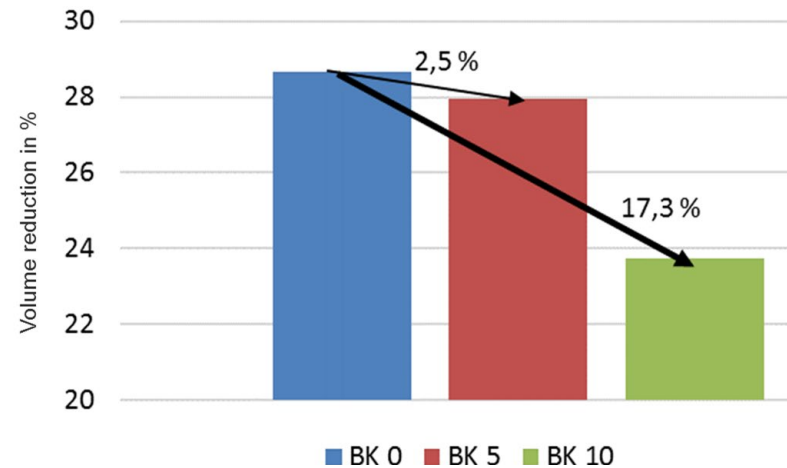
TerraBoGa/CarboTIP Projects



Reduction rate of organic carbon in the composting trials (Average from 4 trials). Reduction rate refers to the organic carbon of the composted green waste. The carbon content from biochar was subtracted out.



Reduction rate elephant manure compost



(Source: Manual for the use of organic residues for the production of fertile biochar substrates and their use in horticulture [in german]. Published by Shaker 2016 (left) and unpublished data (right))



Handlungsanleitung zur Verwertung von organischen Reststoffen zur Erzeugung fruchtbarer Pflanzenkohlesubstrate und deren Nutzung im Gartenbau



CarbonStoreAge Project



"Urban Soils Berlin - C-sinks 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>

CarbonStoreAge Project – potential input materials

Waste type	Amount in t
Organic waste	77.189
Composted organic and green waste	100.939
Christmas trees	1.895
Organic waste foliage	6.639
Tree and shrub pruning	50.182
Street foliage	58.928
Street green waste	7.792
Green cutting	43.600
Horse manure	9.282



(Source:
https://www.berlin.de/sen/uvk/_assets/umwelt/kreislaufwirtschaft/abfall-behoerde/abfallbilanzen/stoffstrom_klimagas_umweltbilanz_2020.pdf)

CarbonStoreAge Project – potential input materials

Basis: Planing instruction for soil protection

Low level of protection need (degree of sealing 0 to <30%)

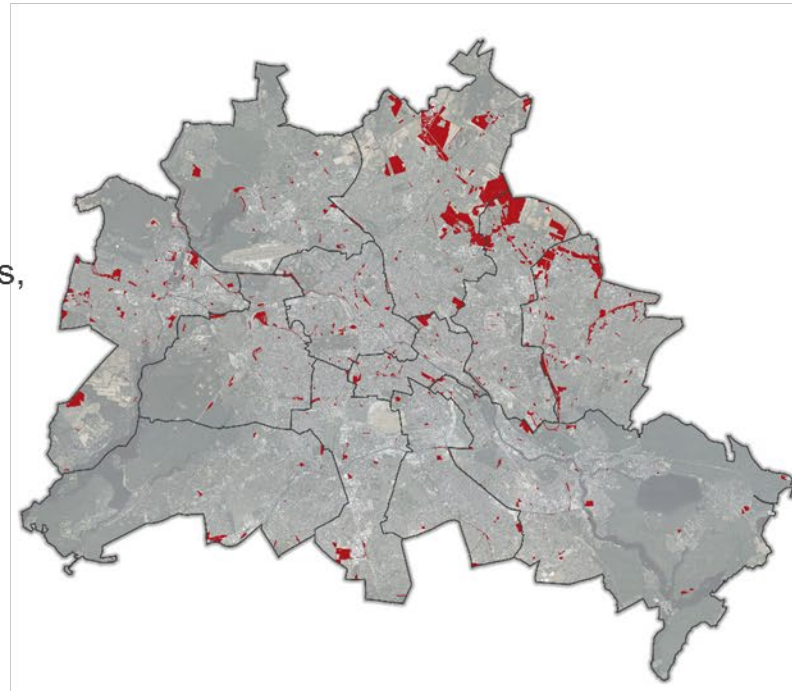
Exclusion of protected areas

Nature and landscape protection areas, natural monuments, nature park, FFH areas and bird protection areas

Exclusion of sealed surfaces

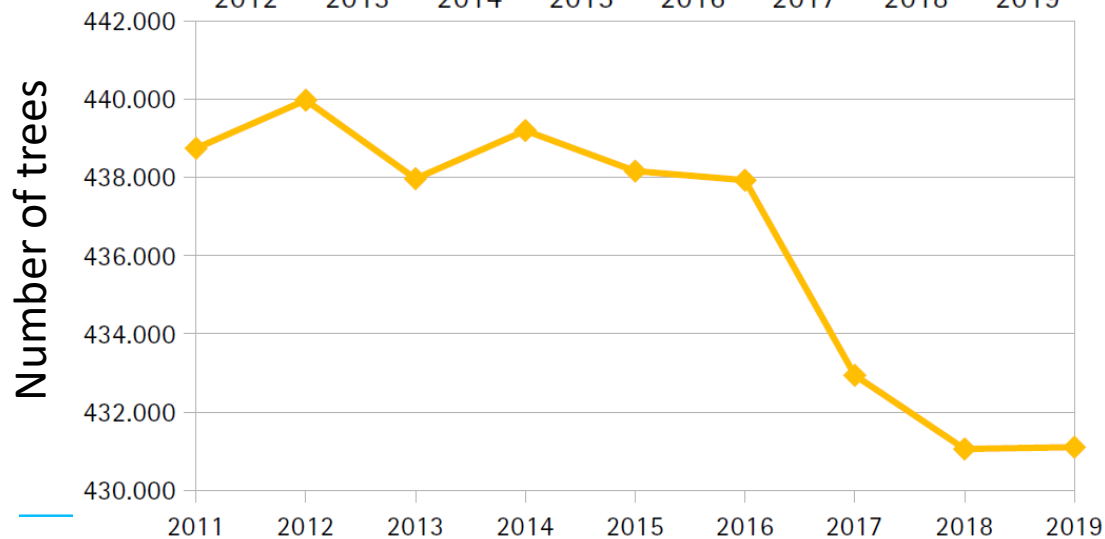
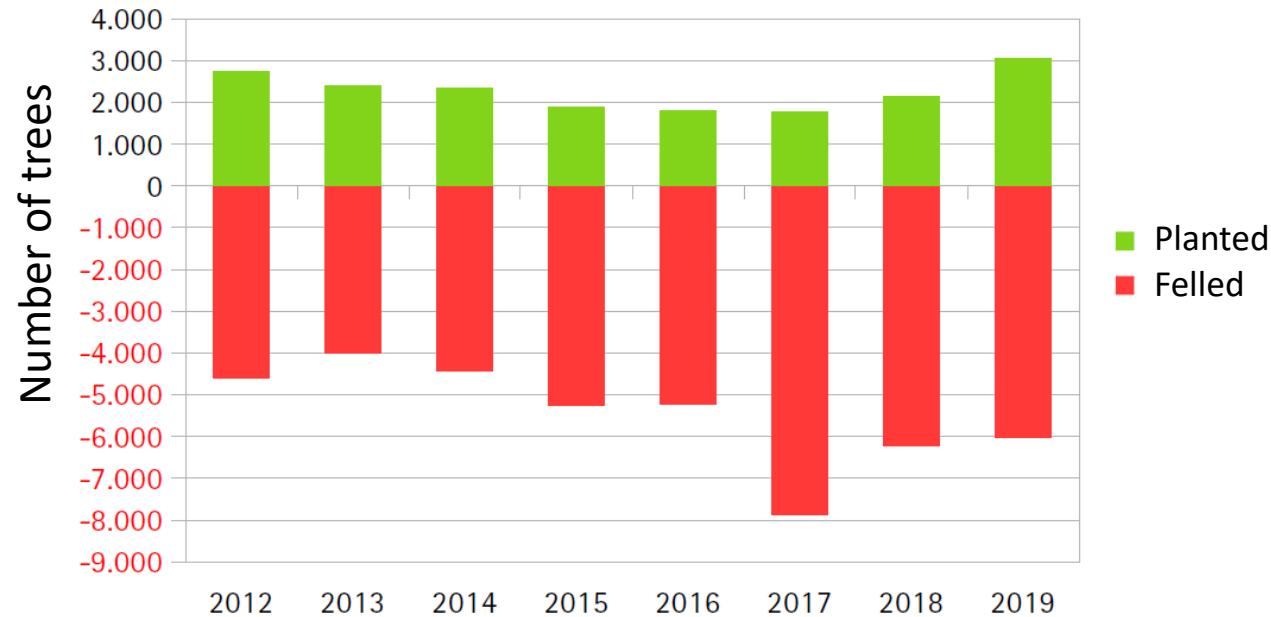
Sealing of block and partial block areas or street areas

Overall potential: 2.962,6 ha



Source: Geoportal (FIS-Broker) - Berlin

CarbonStoreAge Project – urban trees – current situation



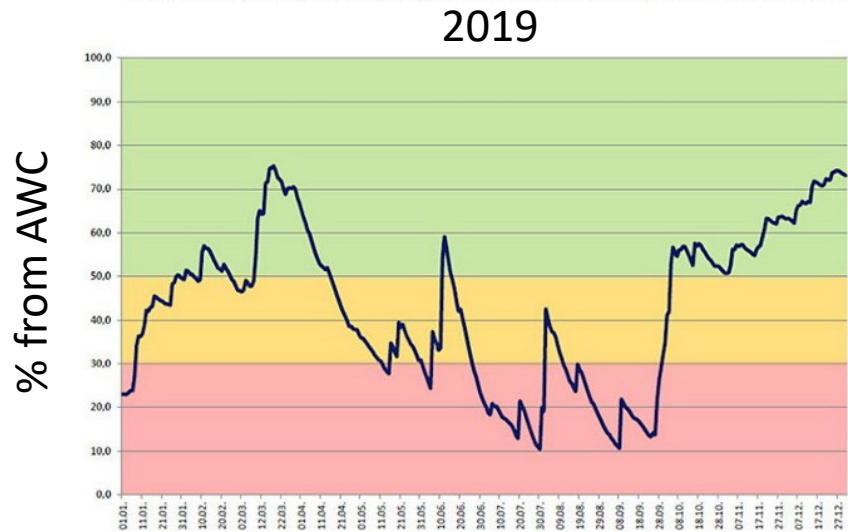
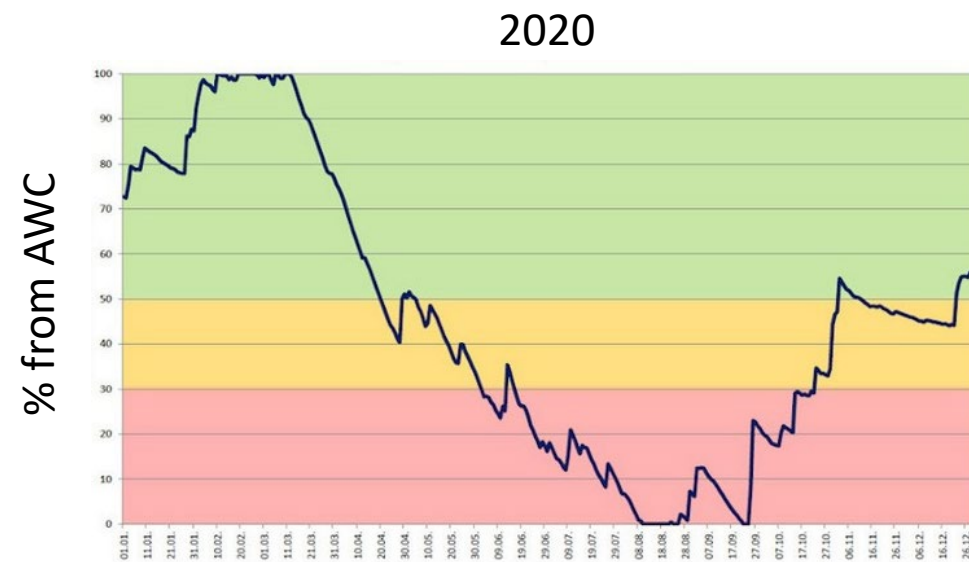
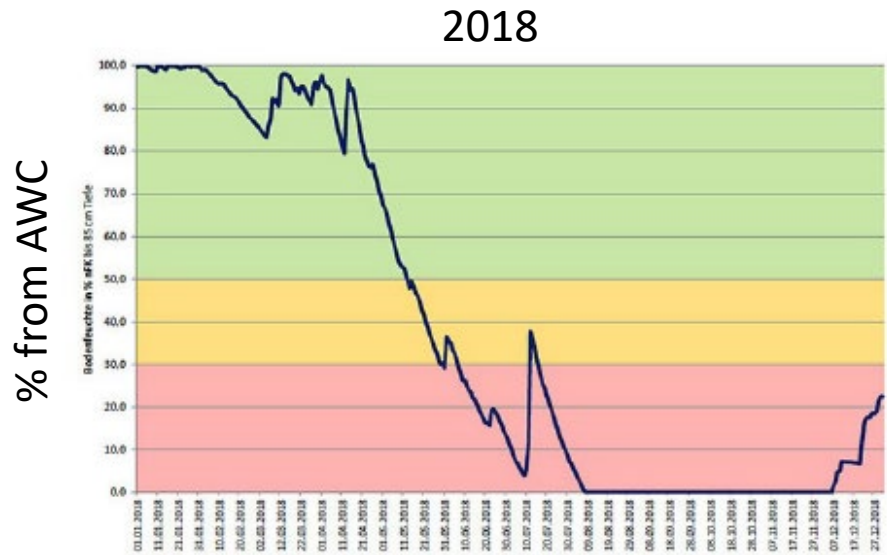
BUND Baumreport

Berlin 2012 - 2019

Die Bestandsentwicklung der Straßenbäume

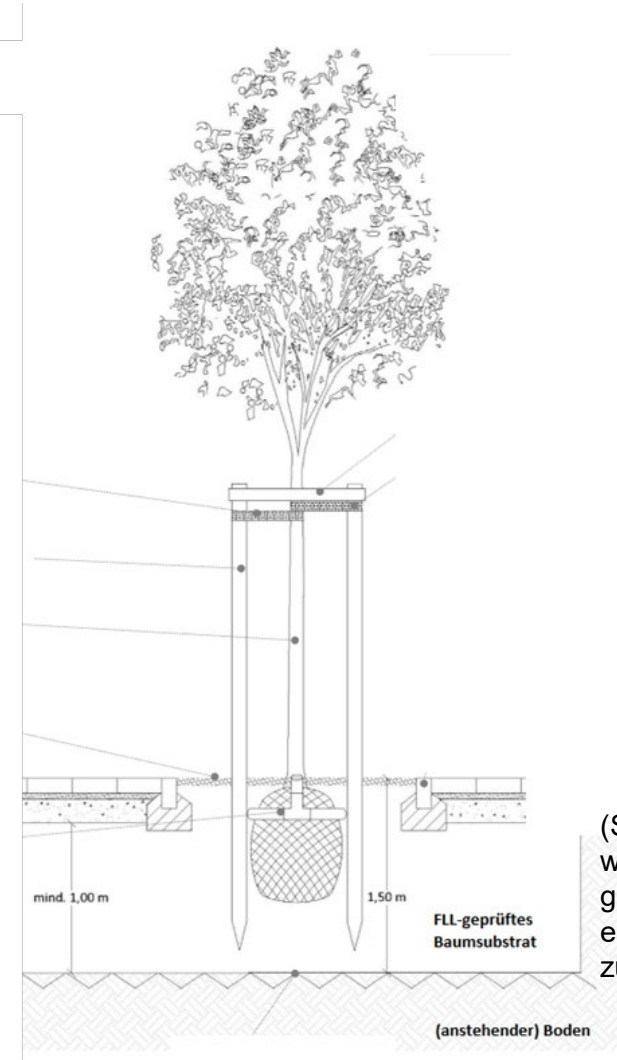
Development of the number of trees in Berlin (Source: BUND Baumreport Berlin 2012-2019)

CarbonStoreAge Project – urban trees – current situation



Actual soil moisture in % from available water capacity (AWC) plotted on watering recommendation for Berlin. (Source: Pflanzenschutzamt Berlin; DWD)

CarbonStoreAge Project – urban trees – trial set-up

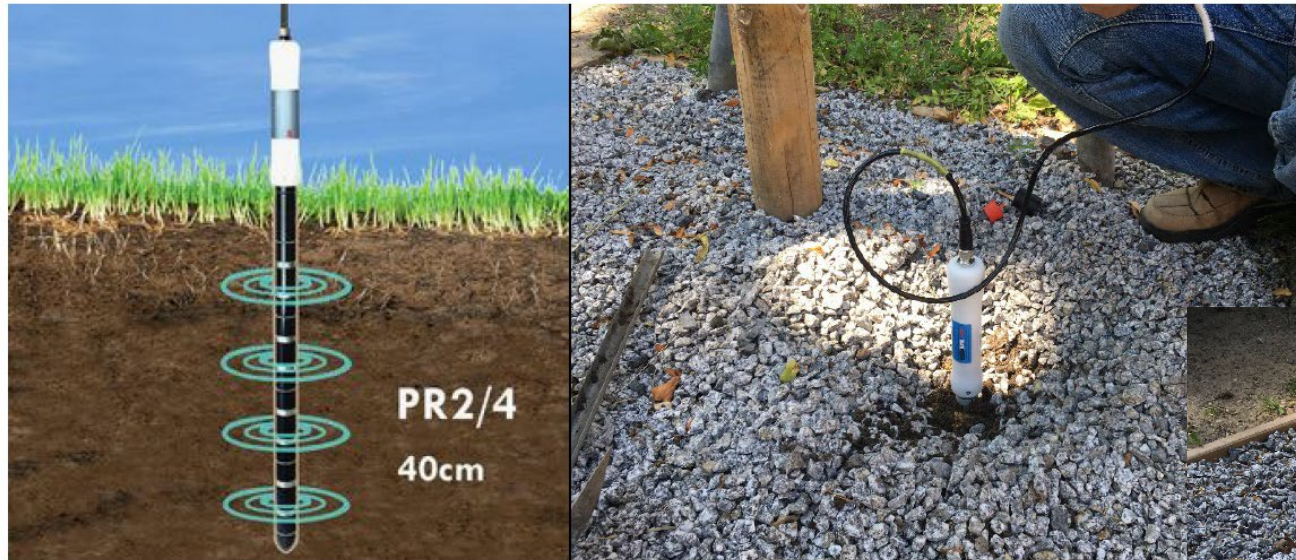


(Source: www.dresden.de/media/pdf/gruenflaechen/20191015_Merkblatt_Strassenbaumpflanzung.pdf)

600 Liter Biochar (120 kg DM) pro planting pit with 3.000 street trees = 360 t Biochar/year

CarbonStoreAge Project – urban trees – trial set-up

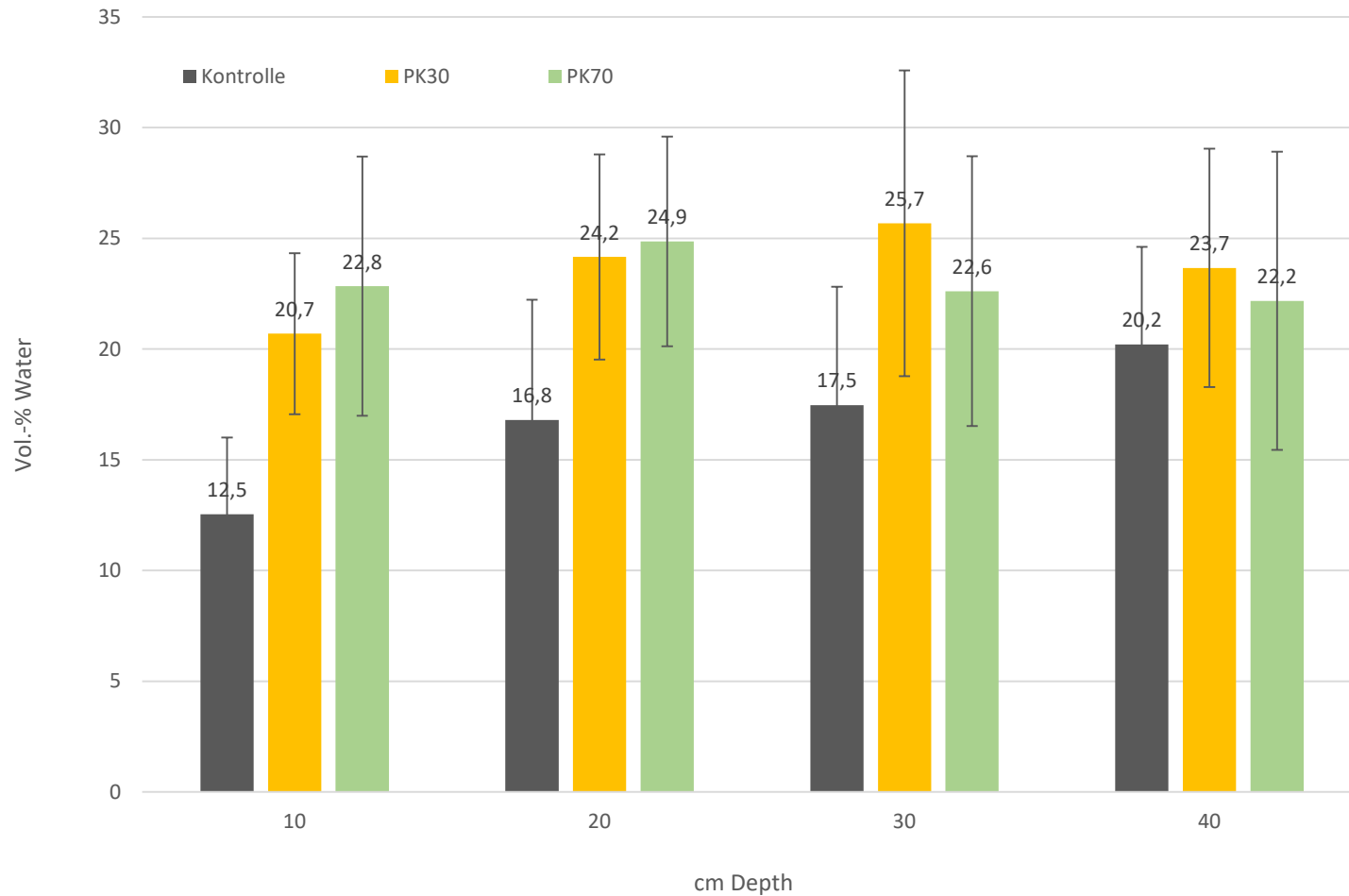
(Source:
<https://www.upgmbh.com/produkte/detailansicht/single/pr2-profilsonde>)



Measurement of soil moisture with Delta-T PR2 Profile Probe in 4 depth: 10,20,30 and 40 cm (above) and of soil gases using Honold Gas Analysator in 3 depth at 20, 40 and 60 cm (right)

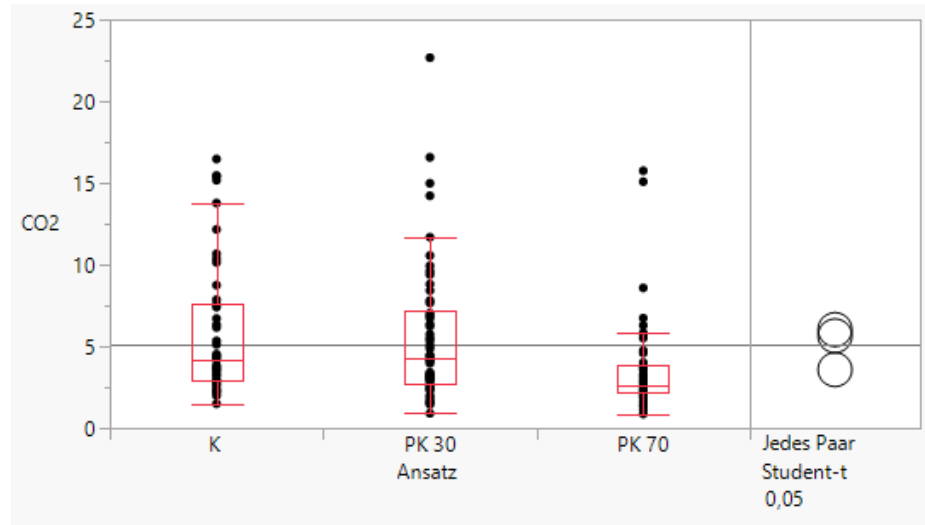


CarbonStoreAge Project – urban trees – preliminary results

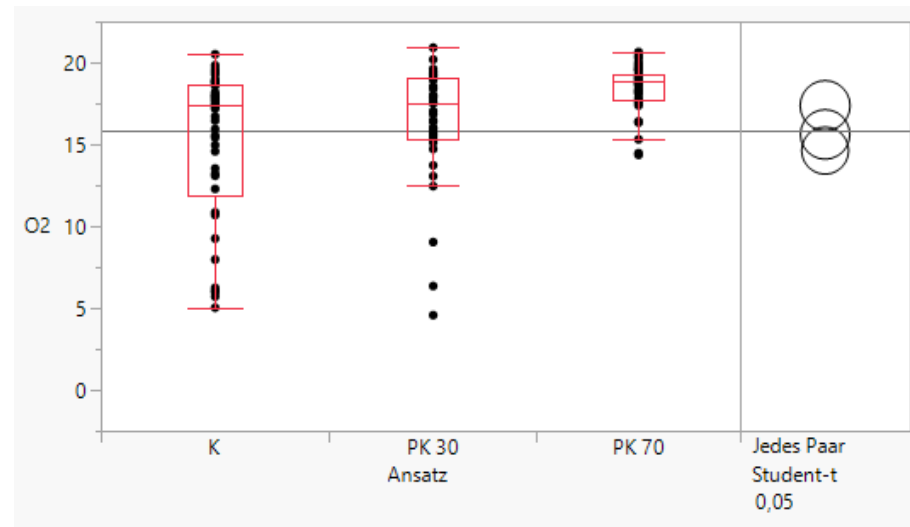


Water content in Summer 2022
(all test sites) at different depth.
(Source: unpublished data)

CarbonStoreAge Project – urban trees – preliminary results



CO2 (left) and O2 (below) content in tree substrates (total through 3 depth).
(Source: unpublished data)



CarbonStoreAge Project – urban trees – outlook



FHK 161108

STRUCTURAL SOIL WITH BIOCHAR

The City of Stockholm have set as a goal to create sustainable and durable plant beds from locally sourced materials. Structural soils with biochar binds carbon from the atmosphere and reduces leaching of nutrients.



After one year with biochar



The root system has grown, which has resulted in greener and more compact foliage.

(Source: <https://www.hamk.fi/wp-content/uploads/2019/04/Mattias-Gustafsson-pieni.pdf>)

CarbonStoreAge Project – sewage fields - overview

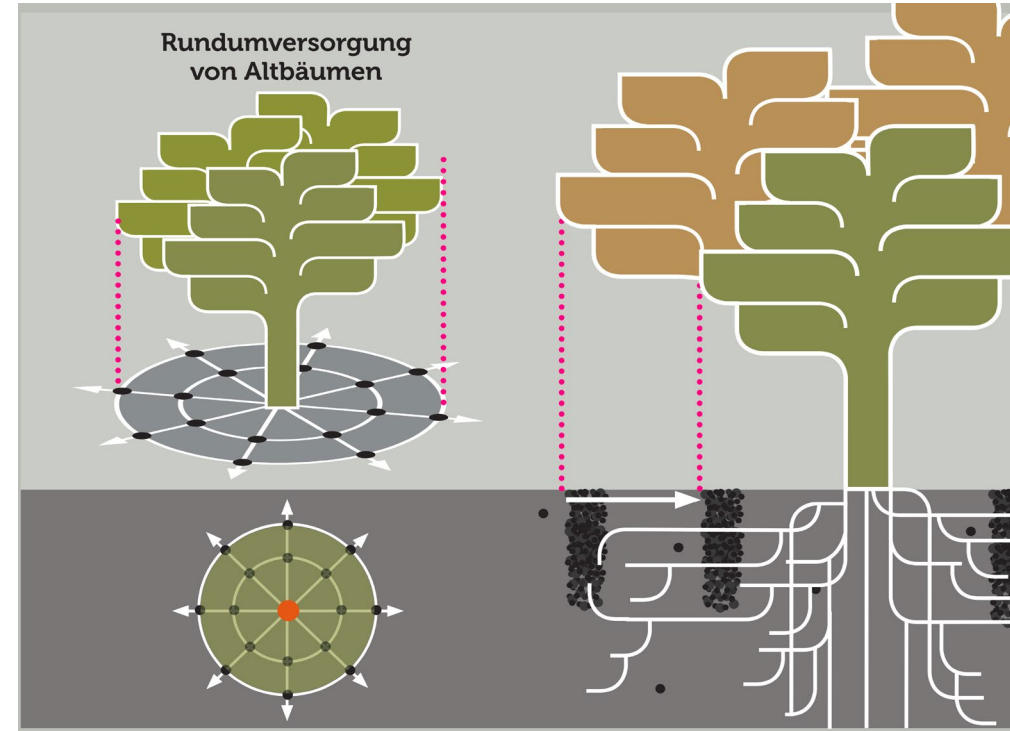


(Source: Anne Zeisler, Presentation at Workshop of the CarbonStoreAge Project, Berlin 2023)

CarbonStoreAge Project – urban trees – outlook



(Source: <https://www.garten-baeume-rose.de/bodeninjektion.html>)



(Source: Ron Richter, Presentation at Workshop of the CarbonStoreAge Project, Berlin 2023 after C.Mattheck „Klimafester Baum“ Karlsruhe Institut of Technology KIT)

Many thanks for your attention

Contact

dmitri.drabkin@fu-berlin.de

Follow us on:



www.residueproject.it



<https://twitter.com/ResidueProject>