ZERO EMISSION AGRICULTURE

CLIMATE IMPACT FROM PRODUCTION AND USE OF

BIOCHAR

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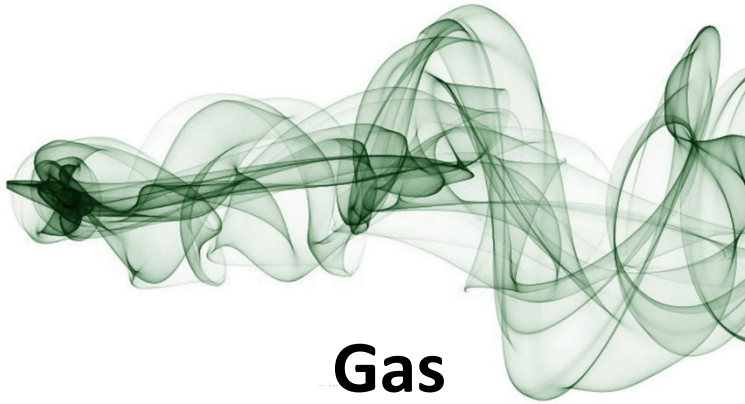
XE

Almost all P, K, Mg etc.
+ around half of C & S
+ small part of H and N

BioChar
15-40%$_{mass}$

The rest …



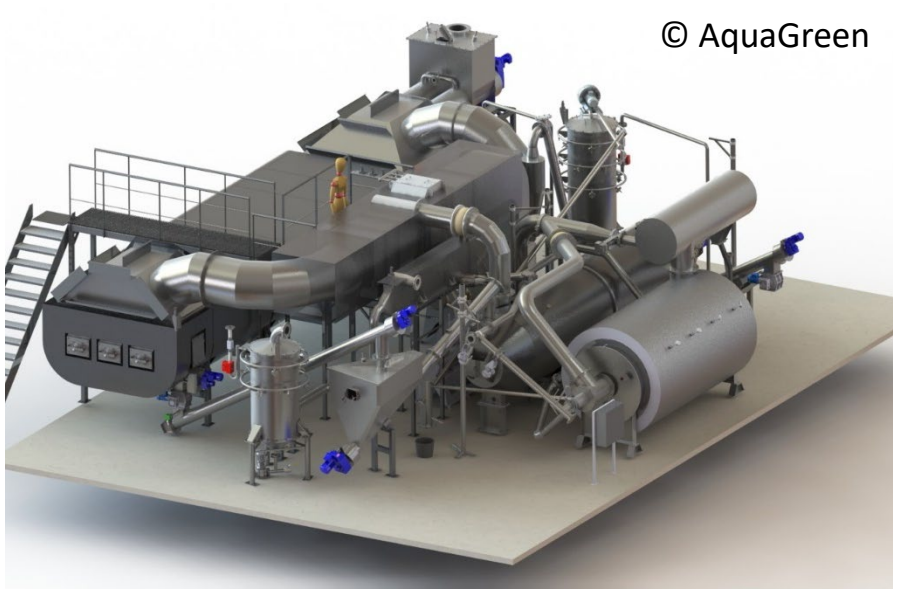
Gas
15-40%$_{mass}$

Bio-oil
30-70%$_{mass}$

Pyrolysis of biomass e.g. cereal straw

Temperatures typically 500-700 °C

Retention time from seconds to hours, no O_2!



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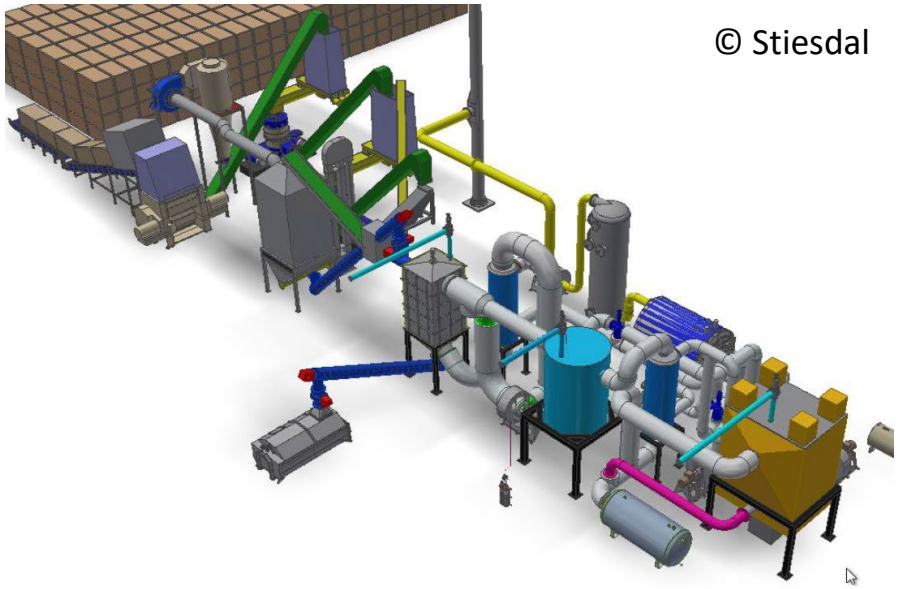
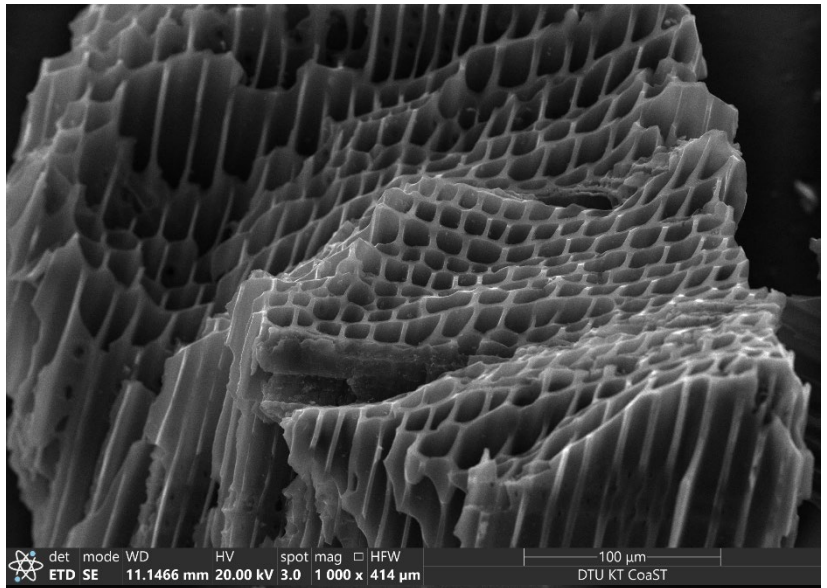
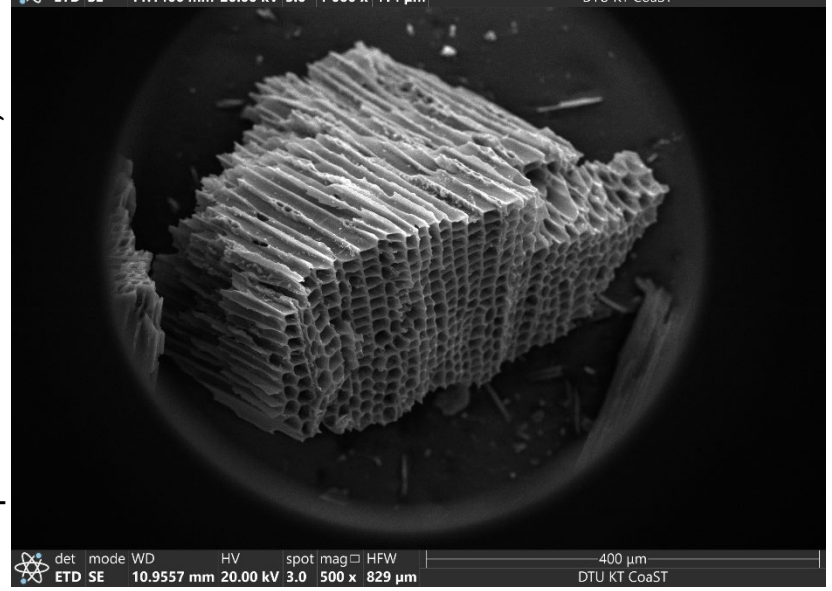


© Stiesdal





SEM pictures © Giulia Ravenni, DTU KT

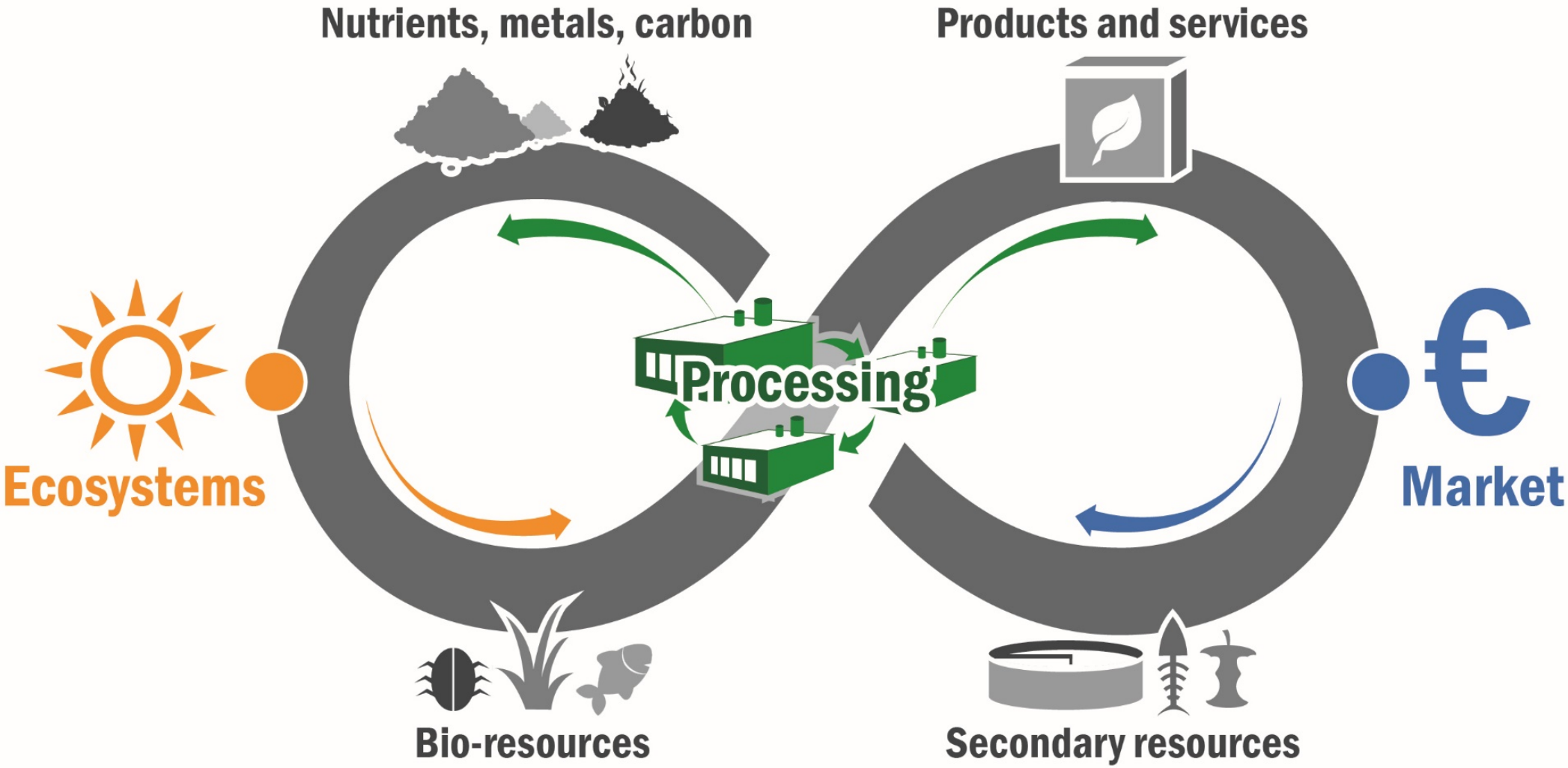
EBC* BioChar definition:

- Carbon content > 50%, dry mass
- H/C ratio < 0.7
- O/C ratio < 0.4

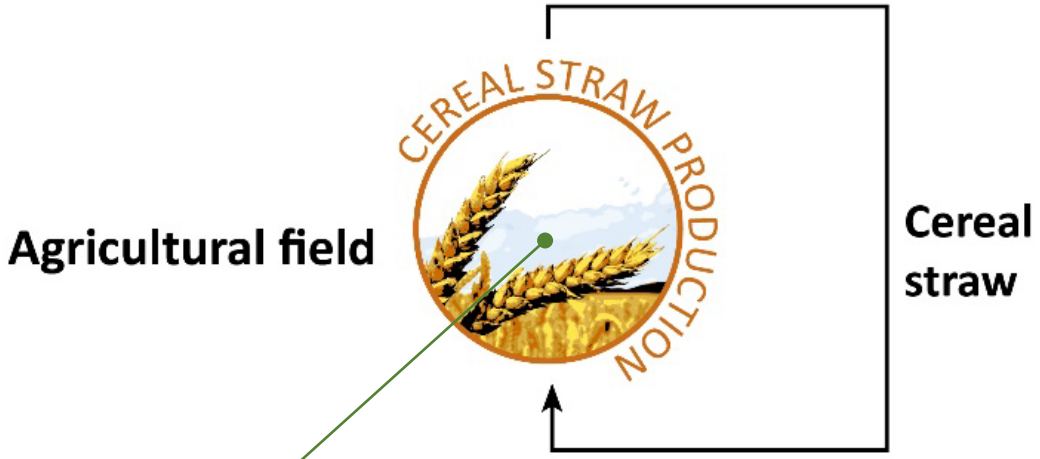
Commonly found characteristics:

- High pH ~ 8-12 (liming effect at high dose)
- Porous structure and large surface area, up to 1000+ m^2/g
- Increase soil water and nutrient holding capacity
- Increase soil cation exchange capacity
- Slow-release of PK & micro nutrients
- Contains large amounts of highly recalcitrant carbon

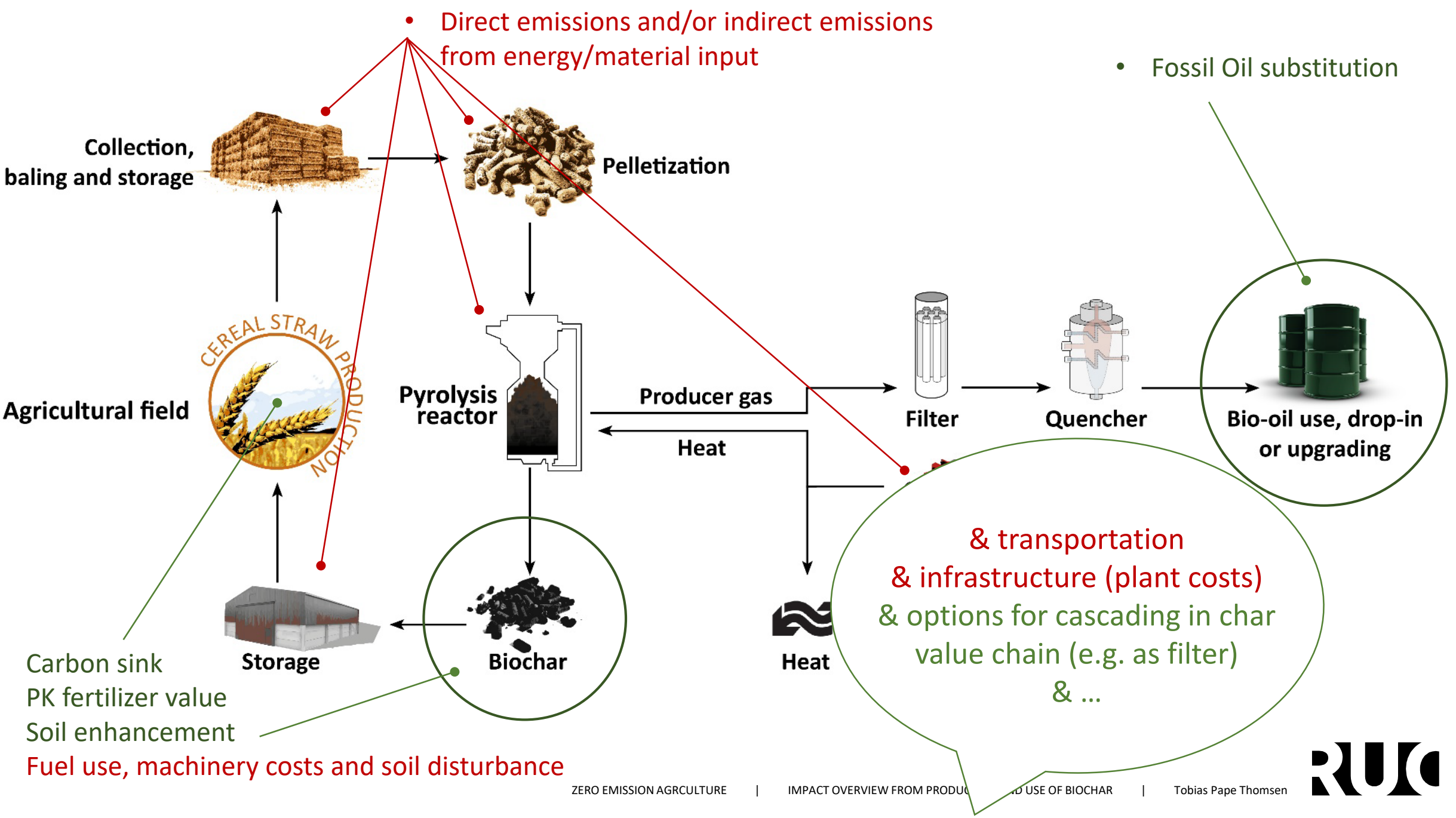
* European Biochar Certificate: https://www.european-biochar.org/biochar/media/doc/ebc-guidelines.pdf

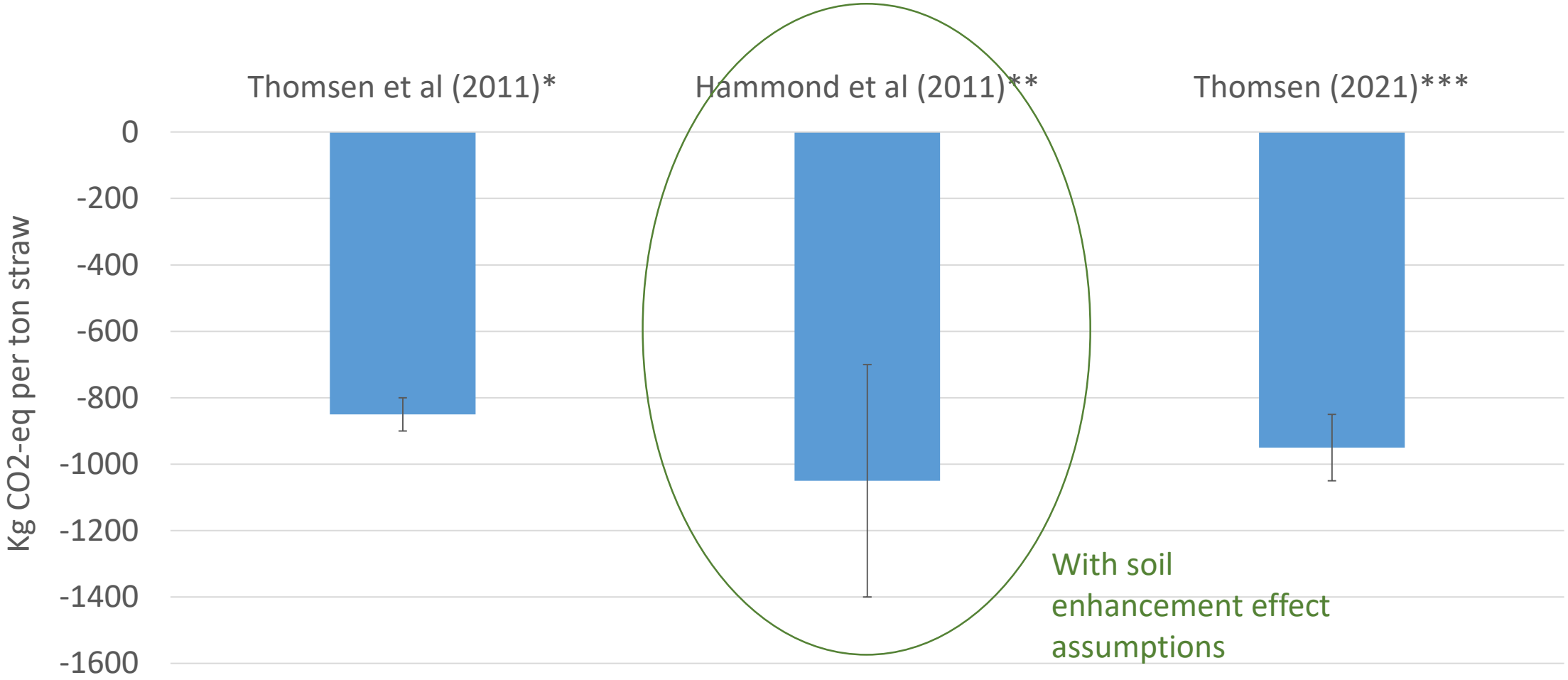

Nutrients, metals, carbon
Products and services
Ecosystems
Processing
Market
Bio-resources
Secondary resources

Case 1 | Primary residues



- Carbon sink
- NPK Fertilizer value
- Soil enhancement effects
- Fuel use, machinery costs and soil disturbance

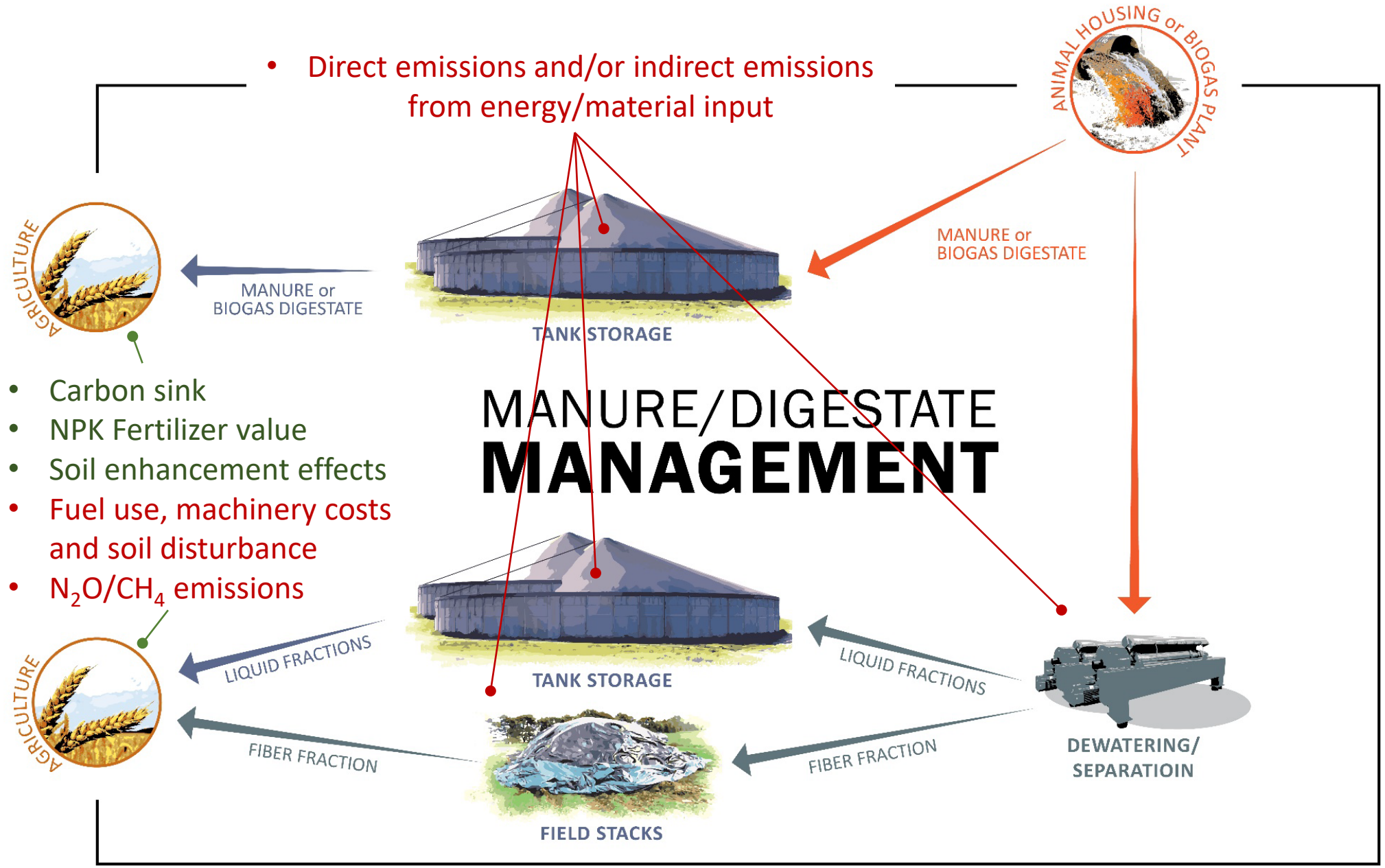

• Direct emissions and/or indirect emissions from energy/material input
• Fossil Oil substitution
Collection, baling and storage
Pelletization
CEREAL STRAW PRODUCTION
Agricultural field
Pyrolysis reactor
Producer gas
Heat
Filter
Quencher
Bio-oil use, drop-in or upgrading
Storage
Biochar
Heat
& transportation
& infrastructure (plant costs)
& options for cascading in char value chain (e.g. as filter)
& …
• Carbon sink
• PK fertilizer value
• Soil enhancement
• Fuel use, machinery costs and soil disturbance



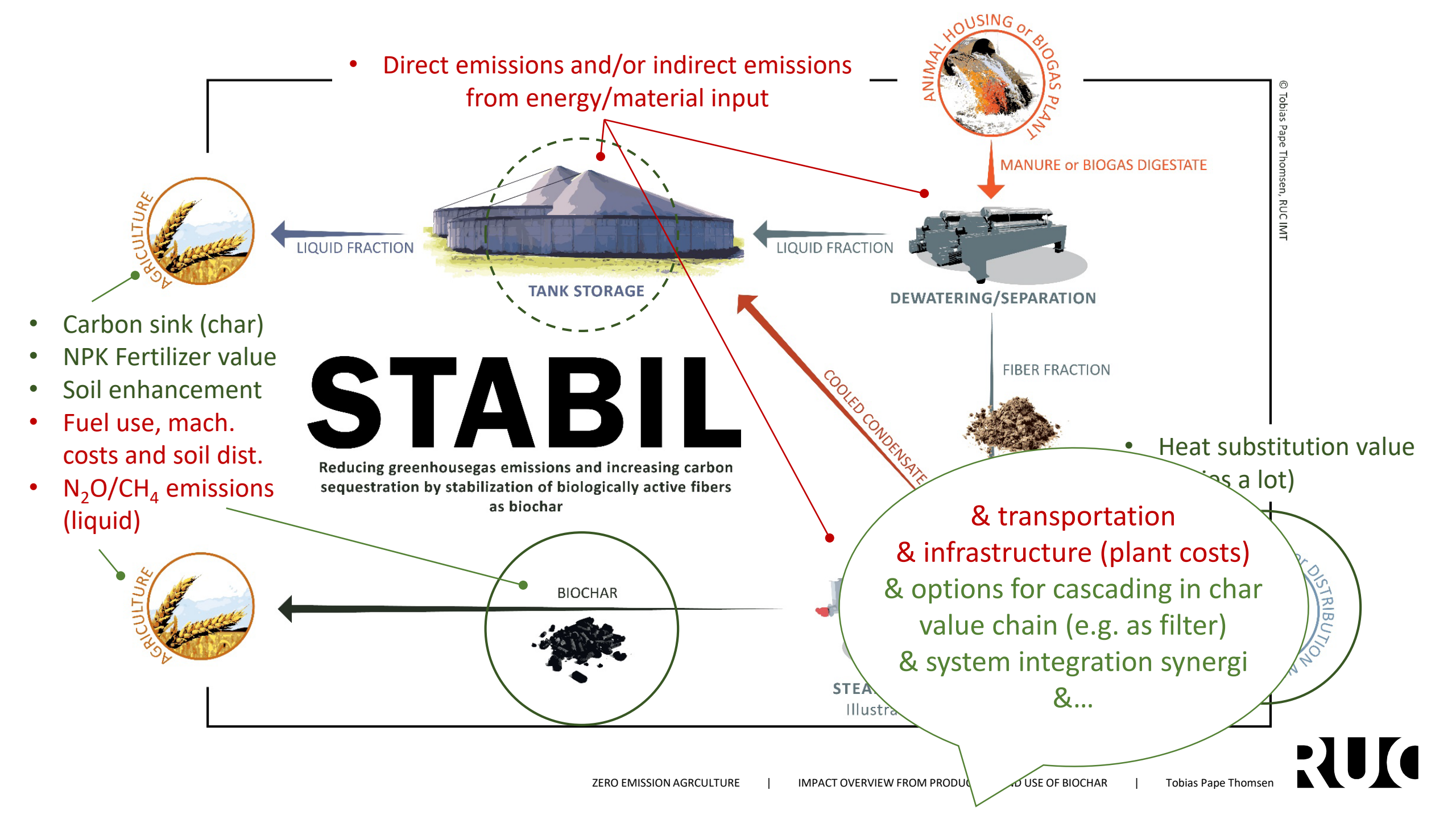
* https://forskning.ruc.dk/da/publications/the-potential-of-pyrolysis-technology-in-climate-change-mitigatio
** https://www.sciencedirect.com/science/article/pii/S0301421511001236
*** Under review

Case 2 | Secondary residues

- Direct emissions and/or indirect emissions from energy/material input



- Carbon sink
- NPK Fertilizer value
- Soil enhancement effects
- Fuel use, machinery costs and soil disturbance
- N_2O/CH_4 emissions


• Direct emissions and/or indirect emissions from energy/material input
ANIMAL HOUSING or BIOGAS PLANT
MANURE or BIOGAS DIGESTATE
AGRICULTURE
LIQUID FRACTION
TANK STORAGE
LIQUID FRACTION
DEWATERING/SEPARATION
FIBER FRACTION
COOLED CONDENSATE
• Carbon sink (char)
• NPK Fertilizer value
• Soil enhancement
• Fuel use, mach. costs and soil dist.
• N_2O/CH_4 emissions (liquid)
STABIL
Reducing greenhousegas emissions and increasing carbon sequestration by stabilization of biologically active fibers as biochar
• Heat substitution value
& transportation
& infrastructure (plant costs)
& options for cascading in char value chain (e.g. as filter)
& system integration synergi
&...
AGRICULTURE
BIOCHAR
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Rough estimation of maximum carbon footprint reduction potential from pyrolysis of Danish **manure/digestate fibers** [mio t CO2-eq]