



LCM
2021

Life cycle assessment and material flow analysis of **urban biochar applications** A case study in Uppsala, Sweden

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Elias Azzi, PhD Candidate at KTH/SEED



Agenda

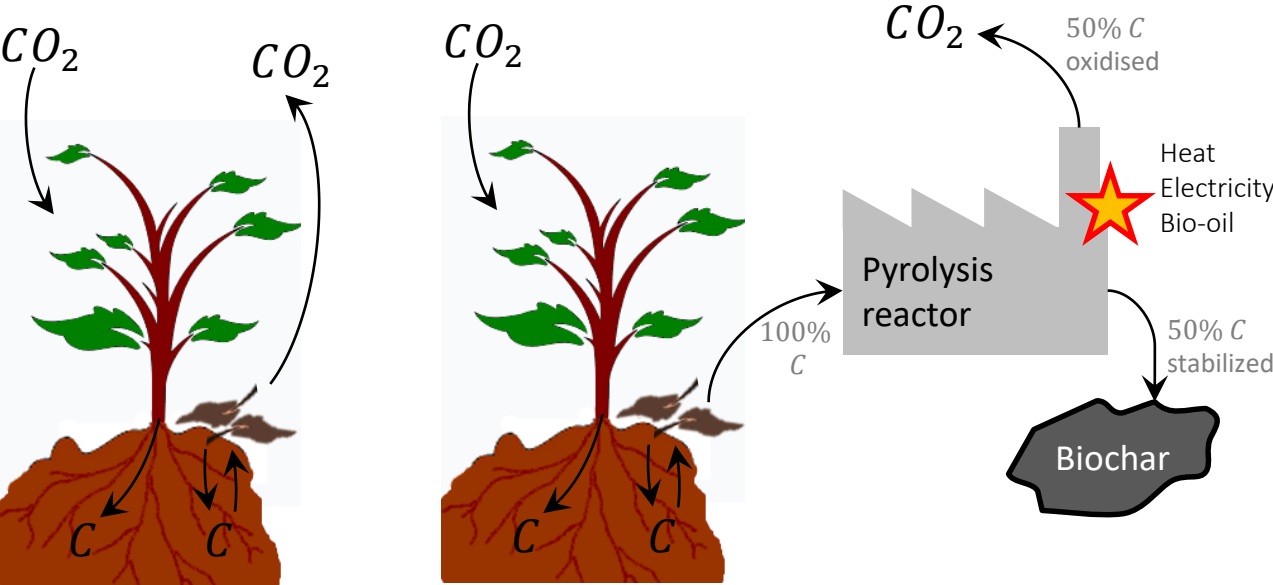
- Biochar, in brief
- 3 LCA questions on biochar in urban environments
- Reflections on biochar in the scope of today's session

Biochar, in brief

“Biochar is the solid residue obtained from the pyrolysis of biomass. It is similar in appearance to charcoal, but differs by its applications.”

Pyrogenic material, carbonized biomass, charcoal, bio-coal, activated carbon, biochar

Carbon Dioxide Removal



≠ biomass

≠ reactors

Garden waste



Forest residues



Wood pellets



Willow cropping

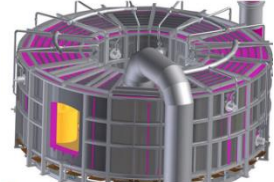


Sludge



other residues

...



Biochar, in brief

Agriculture



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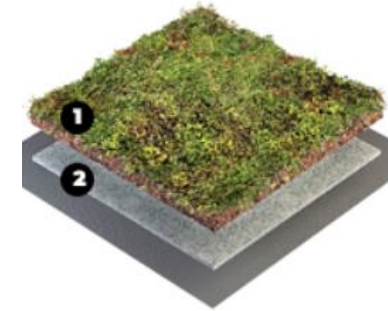
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Some urban & industrial applications



© Stockholm city



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© Hasselfors AB



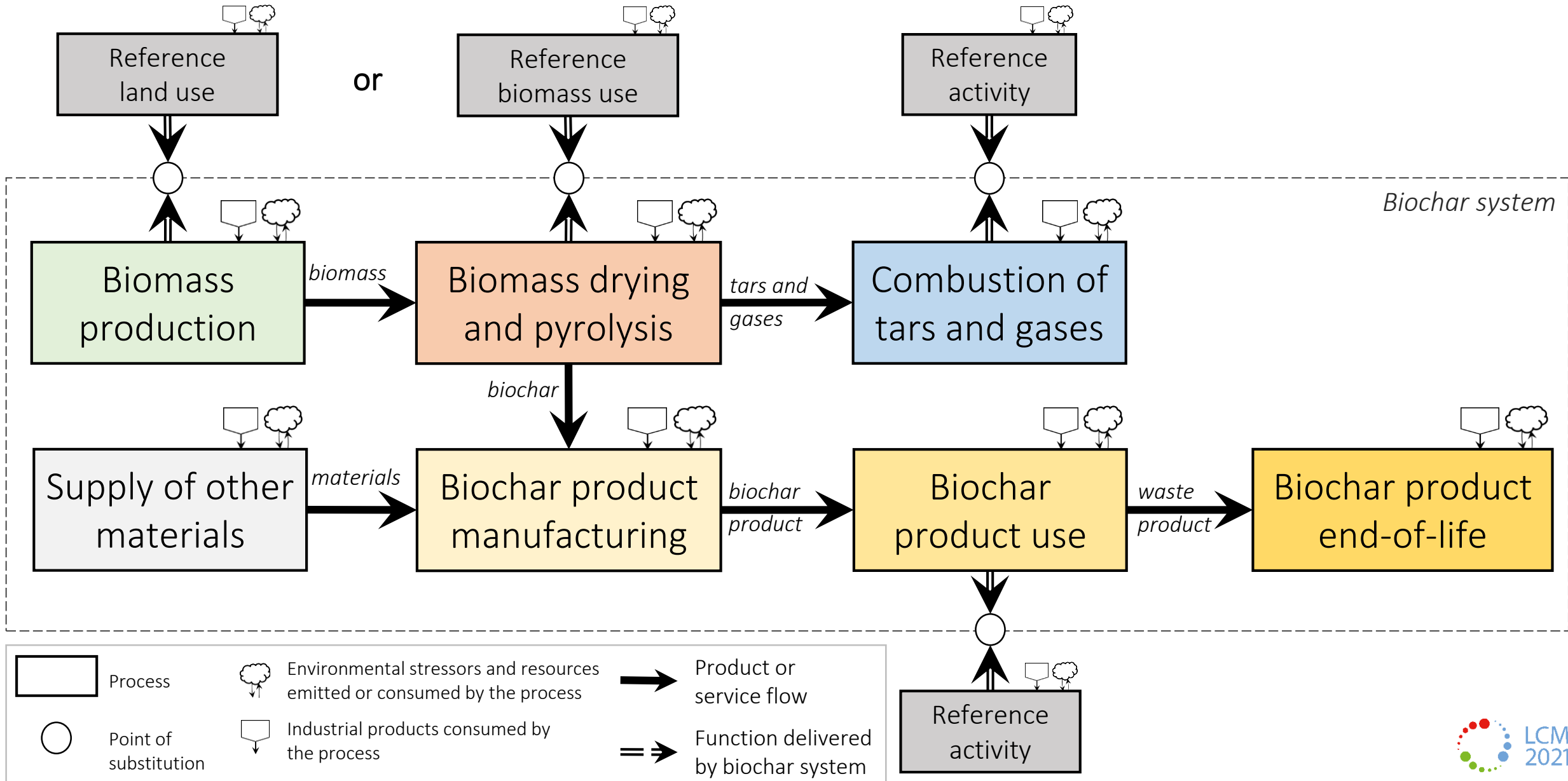
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Asphalt,
Electronics,
Remediation

...

Biochar systems, in brief



3 LCA questions on biochar in urban environments

What are the environmental impacts & benefits of biochar-based products?

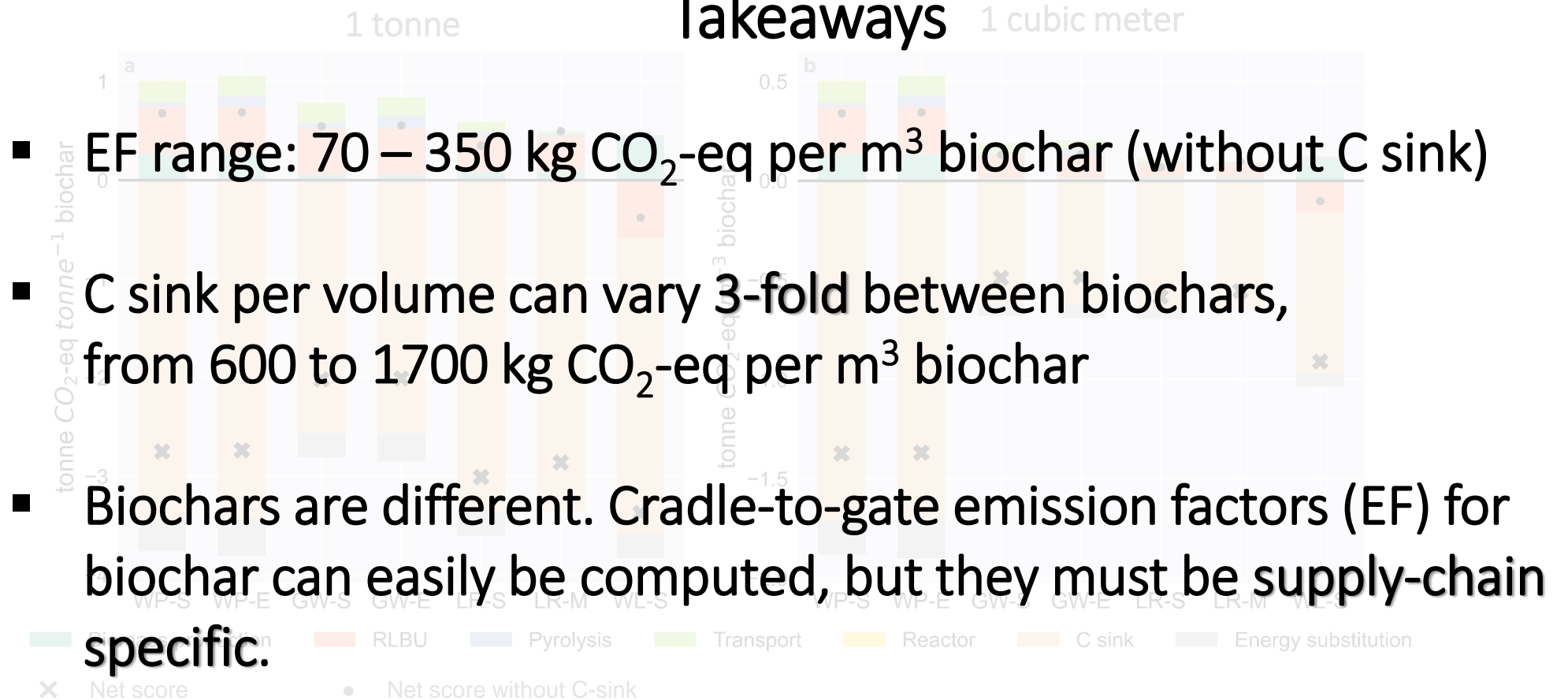
1. What is the climate impact of producing biochar?

WP = Wood Pellets
 GW = Garden Waste
 LR = Logging Residues
 WL = Willow chips

S = Syngas
 E = Electricity
 M = Mobile

In Swedish
 average energy
 system
 &
 Natural gas
 energy system

Takeaways

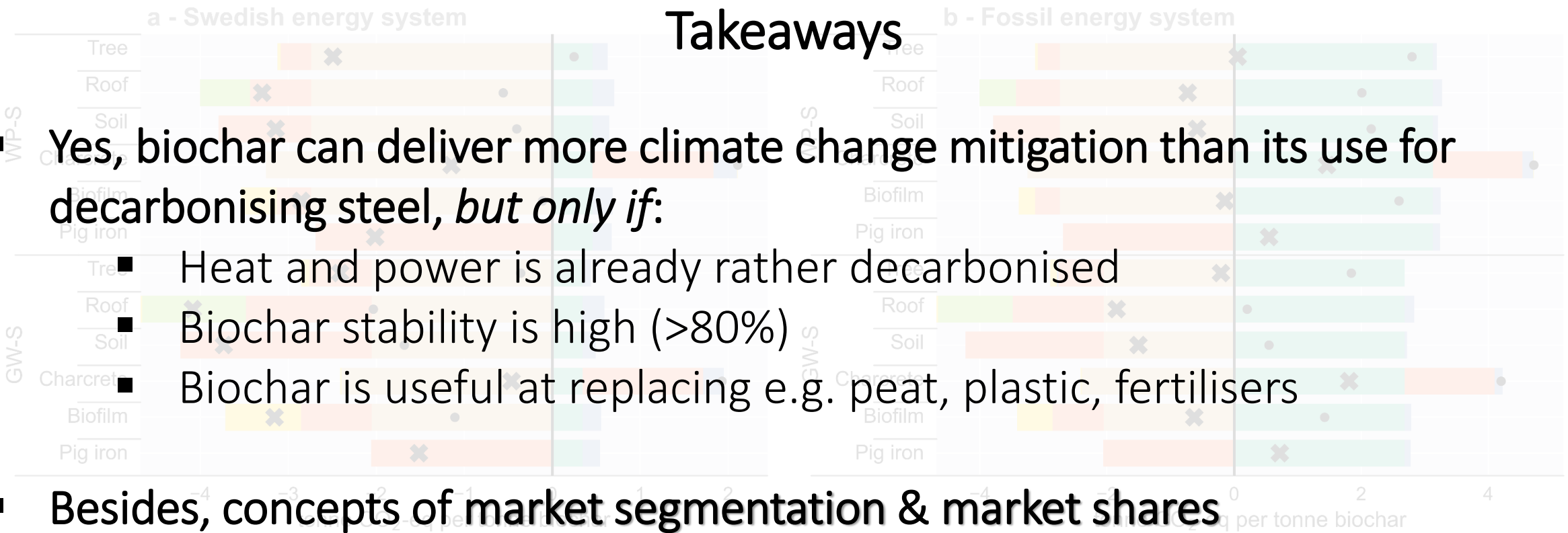


2. Is it a climate-efficient use of biomass?

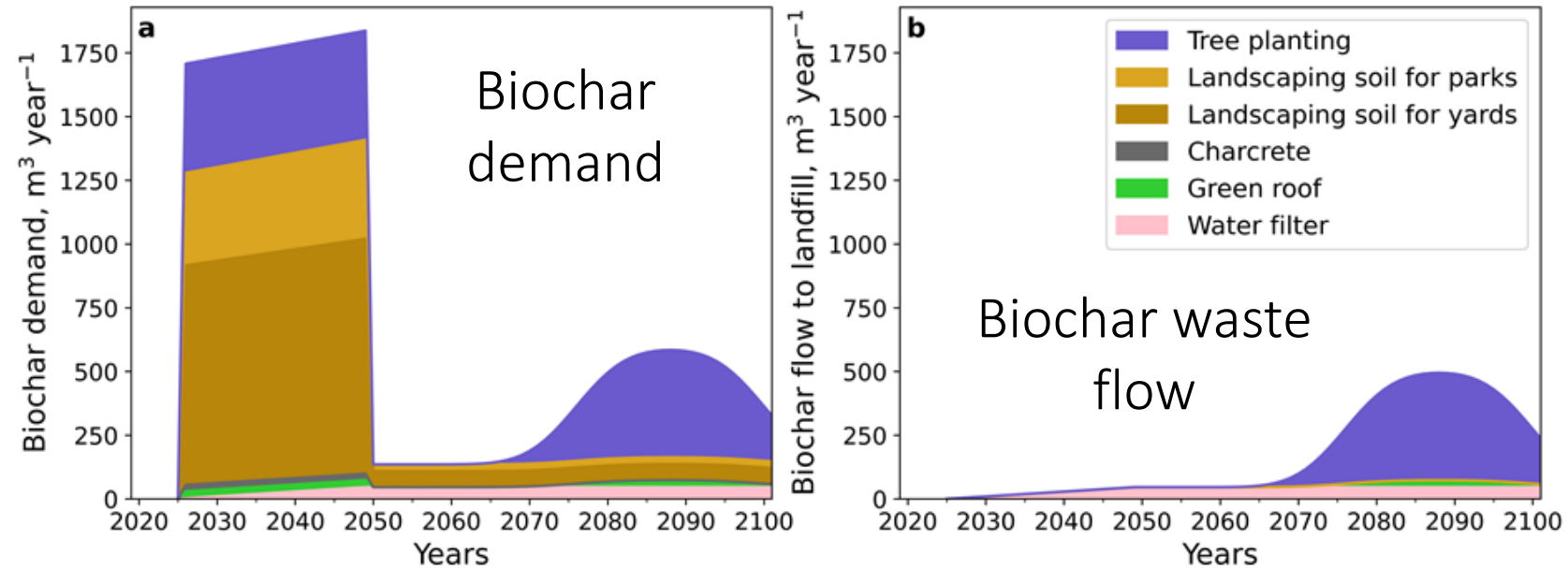
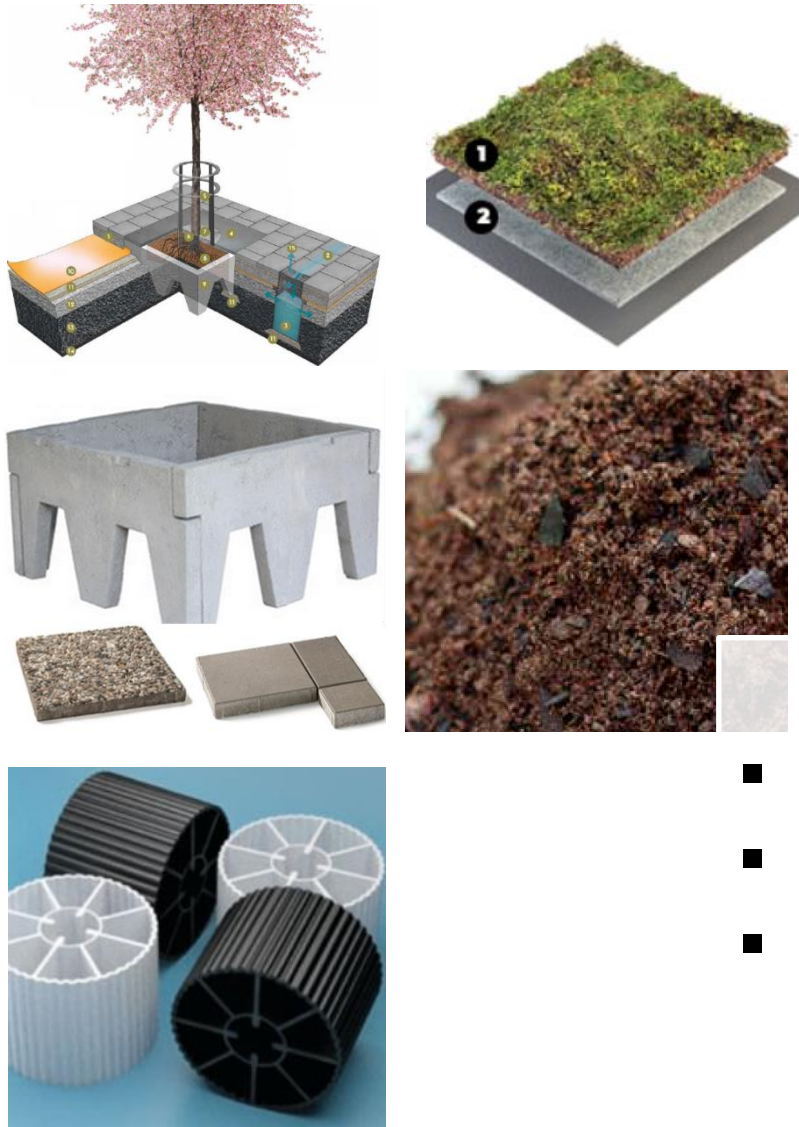
Functional Unit = 1 tonne of resource produced and used

Takeaways

- Yes, biochar can deliver more climate change mitigation than its use for decarbonising steel, *but only if*:
 - Heat and power is already rather decarbonised
 - Biochar stability is high (>80%)
 - Biochar is useful at replacing e.g. peat, plastic, fertilisers
- Besides, concepts of market segmentation & market shares
 - Biomass markets are segmented: not all biomass is suited for all uses
 - A market is shared between several technologies, biochar is one of them



3. At the city scale, to how much does it add up?



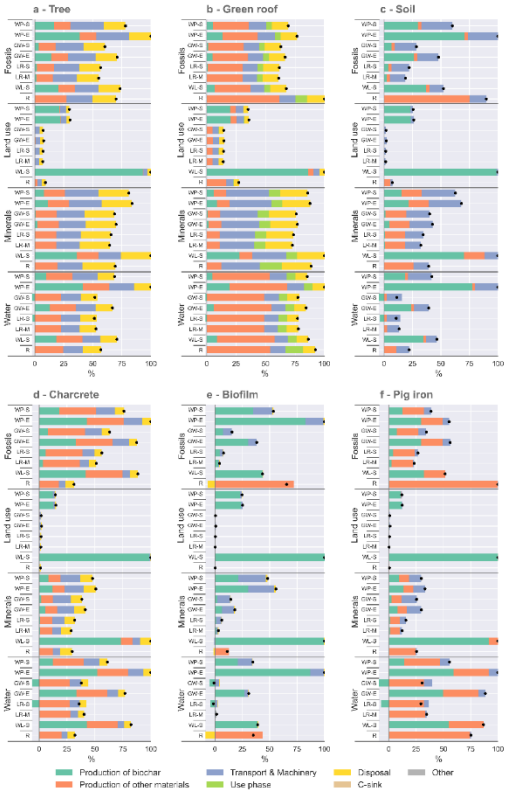
Takeaways

- About $2000 \text{ m}^3 \text{ year}^{-1}$ of biochar for 25 years (57 000 inhabitants)
- C sink is up to $1/10^{\text{th}}$ of the emissions from building construction
- Fixed lifetime of infrastructure will lead to biochar waste flows to be managed in end of the century

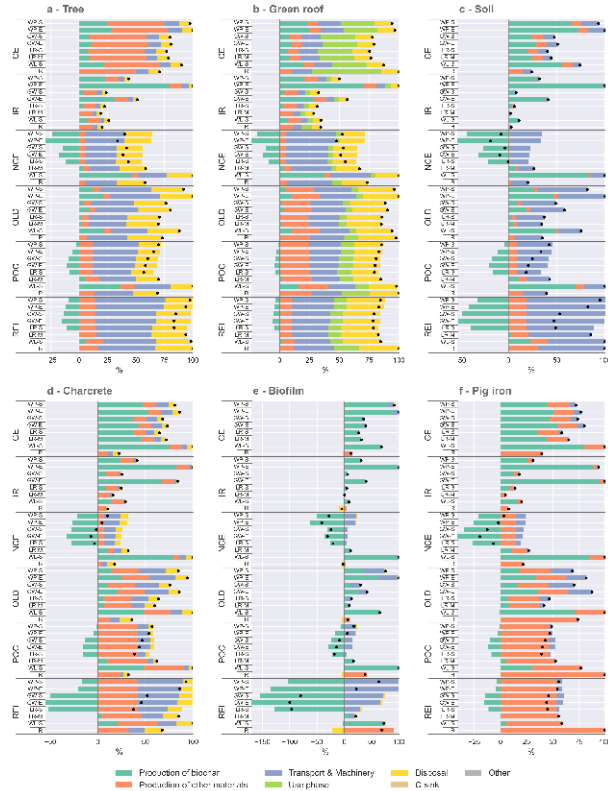
4. [bonus] What about other environmental impacts?

ILCD impact categories

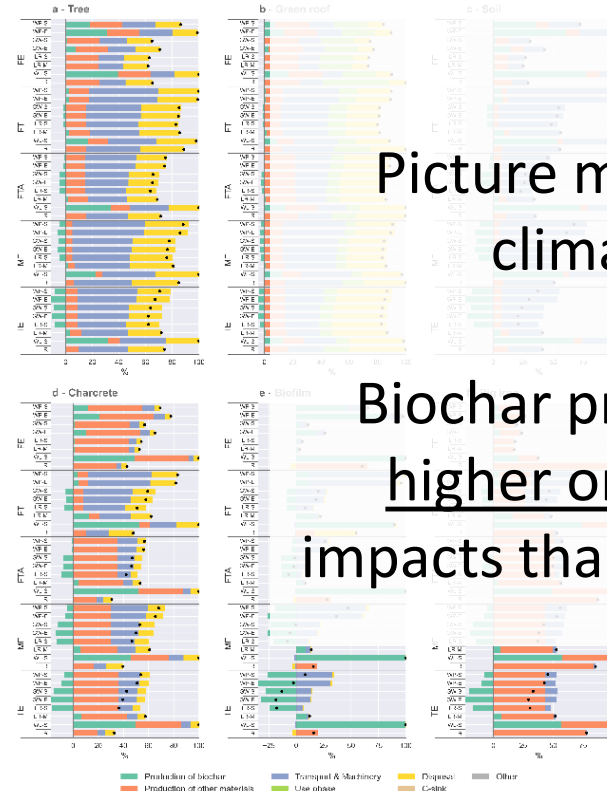
Resource use



Human toxicity



Ecotoxicity



Takeaways

Picture much less clear than for climate change impact

Biochar products can have either higher or lower environmental impacts than the reference products.

Reflections on biochar in the scope of today's session

“Carbon inventory and Management of bio-based materials for a post-fossil economy”

- Like the bio-based economy, biochar systems are flourishing of **diversity** (feedstock, conversion, application) with differentiated **environmental** profiles & involving **dynamic carbon flows**. They are more challenging to assess than the fossil-based economy.
- Unlike other biomaterials & fossil products, biochar is **not valorised as energy** when it reaches end-of-life. That is part of the energy penalty of long-term carbon sequestration via biochar. Alternatively, many biomaterials reaching end-of-life could be turned into biochar for a secondary use.
- Biochar products are a local carbon sink, spread in the urban and rural environment. Keeping track of such carbon stocks and flows is not straightforward. LCA data must be re-shaped before it can be used for municipal accounting purposes. Same data, but different accounting framework.

Keywords:

Industrial ecology

Life cycle assessment

Energy, agriculture and climate

Biochar

Elias Azzi
eazzi@kth.se



Previous work

Case study 1 – Prospective large-scale biochar production in Stockholm, and use in dairy farming

<https://pubs.acs.org/doi/10.1021/acs.est.9b01615>

Case study 2 – On-farm small-scale biochar production at Lindeborgs farm

<https://doi.org/10.1016/j.jclepro.2020.124873>, https://github.com/ntropy-esa/P2_farm_biochar

Case study 3 – Biochar from wood waste used for contaminated soil remediation

<https://doi.org/10.1016/j.scitotenv.2021.145953>

Methodology – Assessing the diverse side-effects of biochar

<https://doi.org/10.1016/j.jenvman.2021.112154>

2019 Webinar – Overview of biochar deployment in Sweden & related life cycle assessments

<https://www.youtube.com/watch?v=Wd1aSp3Fp-E>

2021 Webinar – Life cycle assessment of 6 urban applications of biochar & case study in Uppsala

<https://www.youtube.com/watch?v=PfIGIUWJnkw>

Erik Karlton
erik.karlton@slu.se



Cecilia Sundberg
cesu@kth.se

