Consequential Life Cycle Assessment of Biochar Comparing Different Biochar Production and Application Pathways



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5 – 8 June | Conference & Exhibition 9 June | Technical Tours



Work in progress





CONTEXT





















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BACKGROUND – project

BASTA stands for

processes, growing media & (future proof) open-field cultivation

Project partners are

ILVO (Flemish institute for agricultural and fisheries research) and UHasselt-CMK (biology, chemistry, law, economics)













Biochar's Added value in Sustainable land use with Targeted Applications in











BACKGROUND – biochar

Biomass





Dedicated crops or residual streams











Pyrolysis

Biochar



Heating (400°C – 800°C) in the absence of oxygen

Charcoal-like substance









BACKGROUND – biochar



Lataf et al. (2022). The effect of pyrolysis temperature and feedstock on biochar agronomic properties. Journal of Analytical and Applied Pyrolysis, 168, 105728.



















BACKGROUND – biochar applications









Composting

Faster decomposition Lower greenhouse gas emissions Less odour

Field application

Higher crop yield Increased WHC Carbon sink (NET) Metal immobilisation

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Anaerobic digestion

Higher biogas yield Higher biogas purity

Other

Replacement of cement in concrete Waste water treatment









BACKGROUND – societal techno-economic assessment





TEA

Business perspective Private costs and benefits

External costs and benefits, expressed in physical units (e.g., CO₂ equivalents).













LCA

TEA + LCA

Societal perspective Monetization of the external costs and benefits and integration with the private costs and benefits.









LIFE CYCLE ASSESSMENT

. . .





GOAL AND SCOPE



What?

Assess the lifecycle environmental consequences of using different biochars in different applications, in Belgium Map the uncertainty regarding biochar to deploy this negative emissions technology in Belgium













Why?



How?

Consequential life cycle assessment of treating 1 tonne of waste (functional unit)









DEVELOPED SYSTEMS – general



Reference system

What is the current waste treatment?

Waste collected at pyrolysis plant. Biochar transported to fields and applied directly.













Biochar Direct use



Biochar Cascading use

Waste collected at pyrolysis plant. Biochar transported to anaerobic digestion facilities. Digestate containing biochar applied to fields.









DEVELOPED SYSTEMS – woody fraction of green waste (wood)





























DEVELOPED SYSTEMS – chicken manure pellets (manure)



















RESULTS – manure	Glob kg 1500 —
	1000 —
	500 —
	0
CM-450 PYROd	-500 —
	-1000 —
CM-600 PYROd	-1500 —
CM-450 PYROc	-2000
CM-600 PYROc	kg
CM REF	0
	-2
	-4
	-6
	-8
	-10
	-12

-14

RESULTS – wood (weighting)

-40															
-60										- 11-					
-80															
-100										_					
-120										_					
-140															
Stepwise 2	Human toxicity, carcinogens	Auman toxicity, non-carc.	Respiratory inorganics	on / EUR	Ozone layer depletion	Ecotoxidity, aquatic	Ecotoxidity, terrestrial	Nature occupation	Global warming, non-fossil	Global warming, fossil	Acidification	Eutrophication, aquatic	Eutrophication, terrestrial	Respiratory organics	Photochemical ozone, vegetat.
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RESULTS – manure (weighting)

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RESULTS – sensitivity Biochar field application rate (wood)

GW-450 PYROd

GW-600 PYROd

GW-450 PYROc

GW-600 PYROc

GW REF

0

-200

-400

-600

-800

-1000

-1200

-1400

-1600

0.5

0

-0.5

-1

-1.5

-2

ReCiPe 2016 Midpoint (H) V1.04 / World (2010) H

RESULTS – sensitivity Biochar field application rate (manure) CM-450 PYROd CM-600 PYROd

CM-450 PYROc

CM-600 PYROc

CM REF

1500

1000

500

0

-500

-1000

-1500

0 -2 -4

-6

-8 -10

-12 -14

ReCiPe 2016 Midpoint (H) V1.04 / World (2010) H

RESULTS – sensitivity Different electricity (wood)

ReCiPe 2016 Midpoint (H) V1.04 / World (2010) H

RESULTS – sensitivity Electricity vs. heat (wood, part 1)	Glo k 0 -200 -400 -600 -800	
GW-450 PYROd	-1200	
GW-600 PYROd	-1400	
GW-450 PYROc	Glo k	k
GW-600 PYROc	0 -200	
GW REF	-400 -600 -800	
	-1000	
	-1200 - -1400 -	
	-1600	
	-1800 -	-

-2000

RESULTS – sensitivity	Hun ki
Electricity vs. heat (wood, part 2)	0.5
	-0.5
GW-450 PYROd	-1.5 —
GW-600 PYROd	-2 —
GW-450 PYROc	Hum kg
GW-600 PYROc	6 — 5 —
GW REF	4 —
	2
	1

-1

-2

RESULTS – sensitivity	Glc 1500
Electricity vs. heat	1000 500
(manure, part I)	0
	-500
CM-450 PYROd	-1000
CM-600 PYROd	-1500
CM-450 PYROc	Glo
CM-600 PYROc	1500
	1000
CM REF	500
	0
	-500
	-1000
	-1500

-2000

RFSIIITS - concitivity	G				
NEJUEIJ - SCHSILIVILY	200				
Different reference					
(wood)	-600				
	-800				
	-1000				
GW-450 PYROd	-1200				
GW-600 PYROd	-1400				
	-1600				
GW-450 PYROc	H				
$CW_{-600} PVPOc$	1				
	0.5				
GW REF	0				
GW REF (landfill)	-0.5				
CW/DEE(road)	-1				
UW KLF (IUdu)	-1.5				

-2

otox	
СВ	

CONCLUSIONS – as it stands

Biochar does what it is supposed to, namely mitigate climate change required

reference system

benefit from carbon sequestration.

However, when using the woody feedstock, a cascading use of the biochar is

- For other impact categories, both biochar feedstocks tend to perform slightly worse than the
 - However, the increased external costs are outweighed by the increased external

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Thank you

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