Supplementary information to

Sensitivity Analysis of the Climate Effect of Using Pyrochar Biofuel for Heat and Electricity Generation

This supporting information contains 2 tables presenting chemical properties of sludge and pyrochar, as well as transfer coefficients to processes, and 6 figures demonstrating the sensitivity of climate change impact of Pyrochar Scenario to various parameters.

Table S1. Major chemical elements (% dry matter) in pulp and paper mill sludge (mixed fibre sludge and biosludge) and pyrochar [1-3].

Elements	**Sludge**	**Pyrochar**
Nitrogen (N)	3.15	1.41
Phosphorus (P)	0.44	0.04
Potassium (K)	0.16	0.05
Magnesium (Mg)	0.13	0.3
Calcium (Ca)	11.58	10.4
Carbon (C)	46.4	49.79
Oxygen (O)	29.2	32
Sulphur (S)	1.48	0.52
Hydrogen (H)	6.0	4.37
Chlorine (Cl)	0.02	0.01

Table S2. Transfer coefficients (TC) for pyrochar application in combined heat and power plants.

Process	Material	TC [%]
Dewatering	Biosludge	5.7
	Carbon	100
Drying	Biosludge	40.7
	Carbon	100
Pyrolysis	Biosludge to Pyrochar	30.3
	Carbon	38.5
Combustion in CHP	Pyrochar to Ash	33
	Carbon	6.3

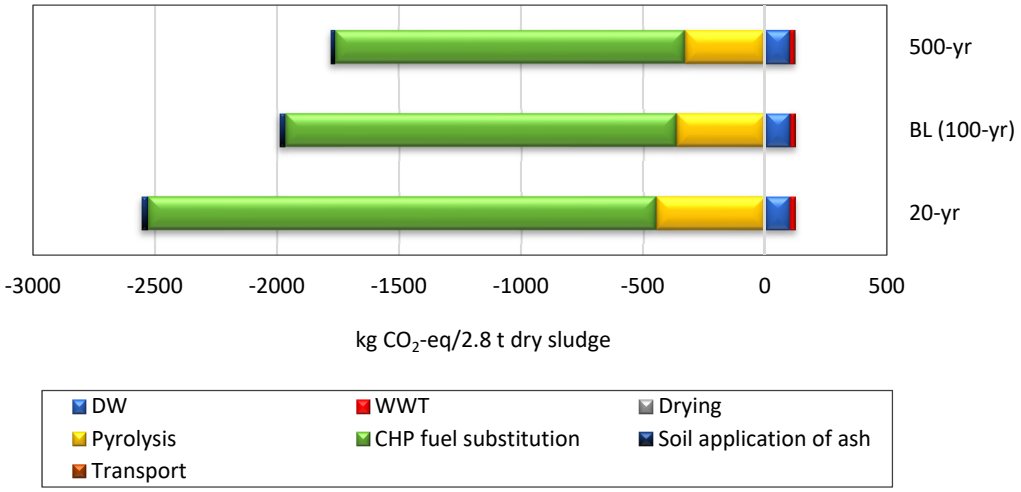

Figure S1. Sensitivity of climate impact of Pyrochar Scenario calculated based on time horizon of 20-, 100- (baseline-BS) and 500-year.

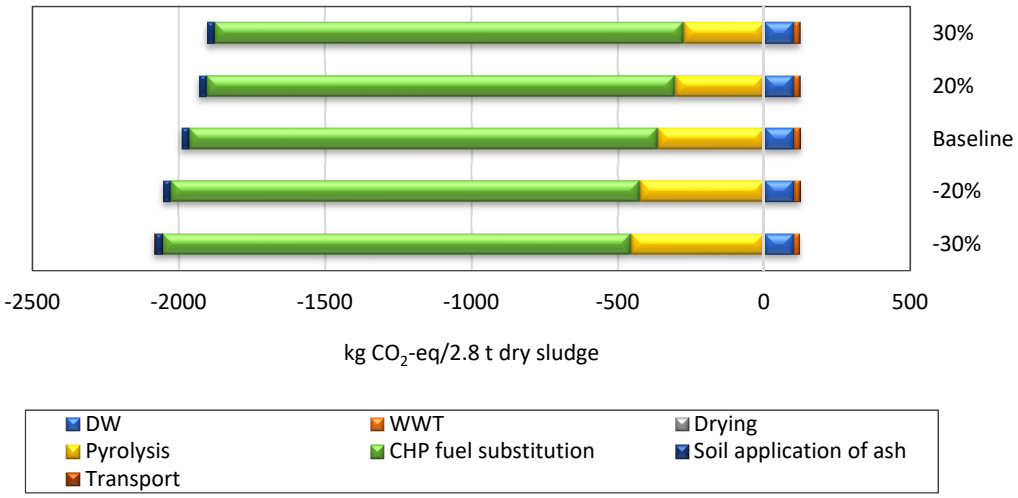

Figure S2. Sensitivity of the GHG emissions abatement of Pyrochar Scenario to the rate of energy recovery through incineration process in Reference Scenario (the baseline value is increased/decreased by ± 20% and ± 30%).

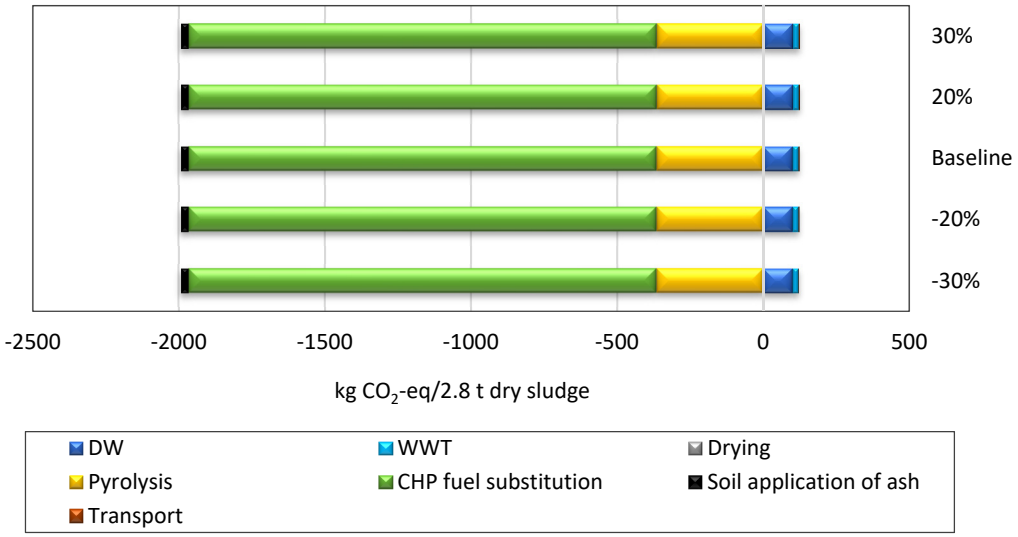

Figure S3. Sensitivity of the GHG emissions abatement of Pyrochar Scenario to the transport distance (the baseline value is increased/decreased by ± 20% and ± 30%).

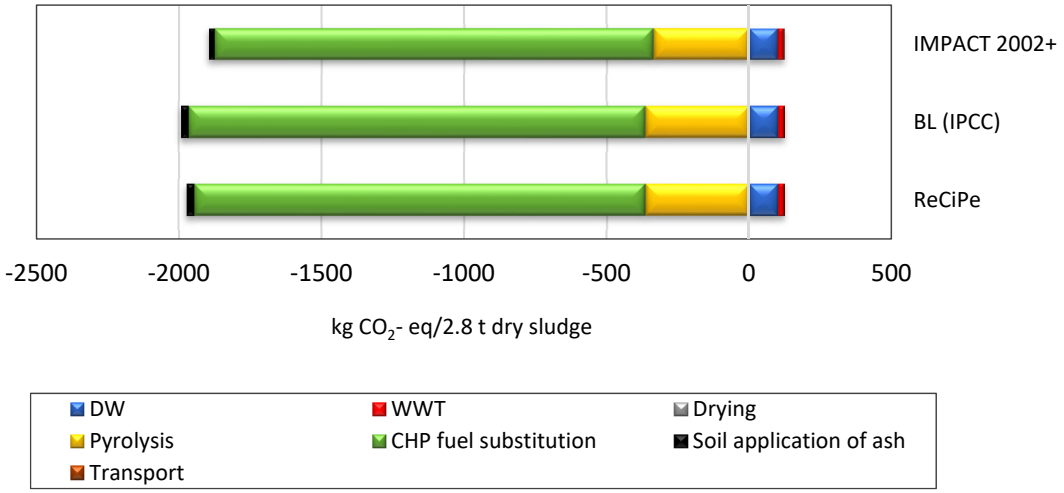

Figure S4. Sensitivity of the climate impact of Pyrochar Scenario to the impact assessment methods (IMPACT 2002+ and ReCiPe Midpoint).

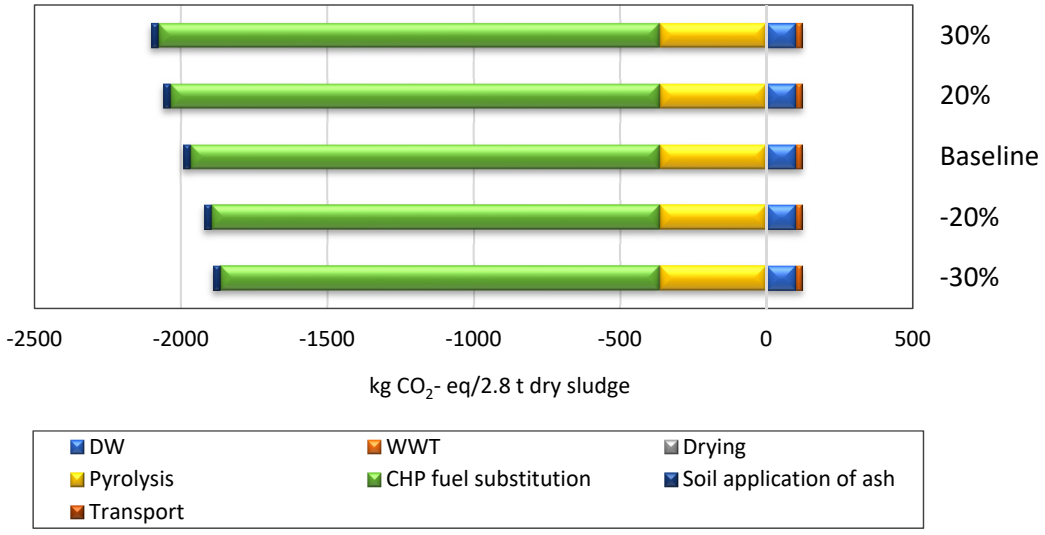

Figure S5. Sensitivity of the climate effect of Pyrochar Scenario to the electricity conversion efficiency in CHP plant (the baseline value is changed by ± 20% and ± 30%).

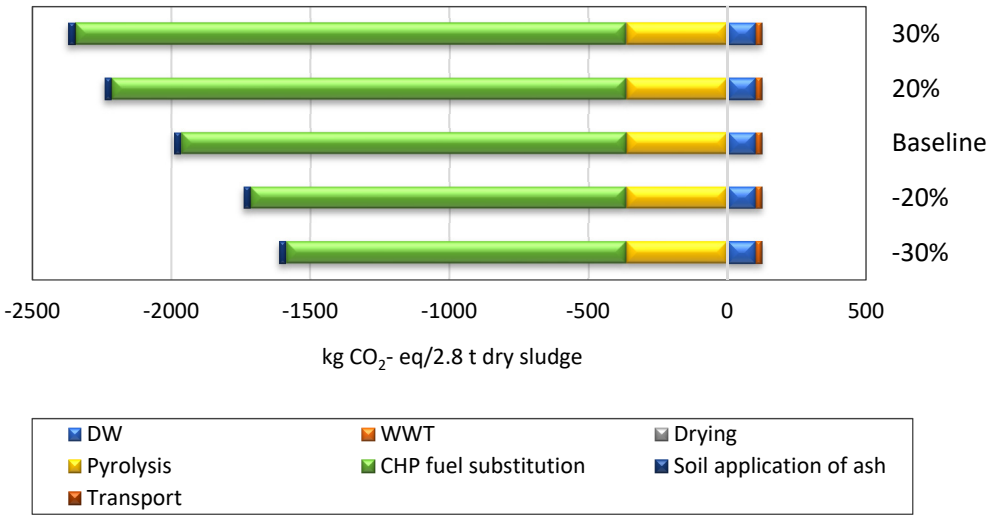

Figure S6. Sensitivity of the climate change impact of Pyrochar Scenario to the heat conversion efficiency in CHP plant (the baseline value is changed by ± 20% and ± 30%).

References

[1] Ahlroth, M.; Bialik, M.; Jensen, A. Hydrothermal carbonization of pulp- and paper mill effluent sludge. Åforsk project 15–489, **2017,** ÅForsk Foundation: Stockholm, Sweden.

[2] Rasa, K.; Pennanen, T.; Peltoniemi, K.; Velmala, S.; Fritze, H.; Kaseva, J.; Joona, J.; Uusitalo, R. Pulp and Paper Mill Sludges Decrease Soil Erodibility. J. Environ. Qual. **2021**, 50, 172–184.

[3] Mohammadi, A. Biochar pellets, a soil nutritional and liming agent or a source of energy: effects of ash and lignin on the physical and chemical properties. ÅForsk project 19-622, **2021**, ÅForsk Foundation: Stockholm, Sweden.