Environmental impact evaluation of technologies to recover phosphorous from incinerated waste streams

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ABSTRACT

The annual demand for P based fertilizers is constantly growing of about 3%, inducing to an inefficient use of P particularly in agricultural sector (e.g. eutrophication) and the depletion of phosphate rocks. A promising way to efficiently recover P is to address incinerated waste streams (P rich sources) as potential substitute of phosphate rocks. We report a simplified and novel approach for sustainability evaluation of new technologies, based on the use of two parameters (i.e. embodied energy and CO_2 footprint) that account for the energy and emissions involved in the formation of a material. A dimensionless index, defined as ESCAPE index, compares the results about the environmental impact of selected substituting material/process. The approach aims to represent a milestone in the evaluation of strategies to handle with resources depletion and to suggest opportunities for legislative evolution, in support of sustainable alternative to raw materials.

INTRODUCTION

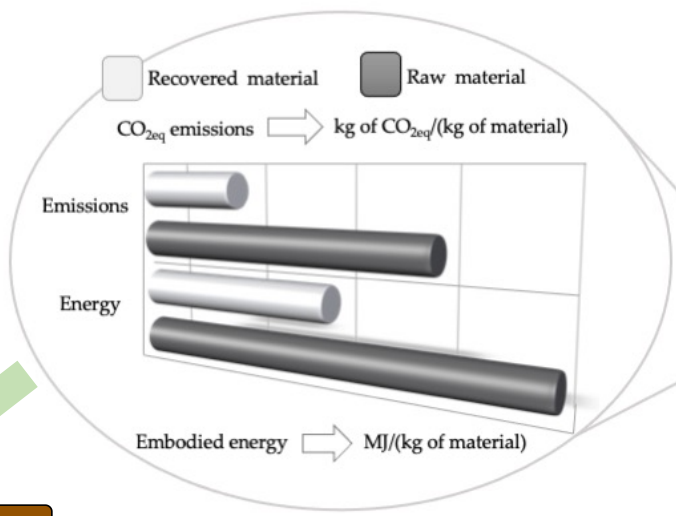
Phosphate rocks were added to the list of the Critical Raw Materials (European Commission, 2014) and policies to assess P recovery processes are promoted. In this frame, it is urgent to encourage the development of environmentally sustainable recovery technologies. Among the available organic waste management technologies, incineration is able to reduce volume up to 80%, eliminate pathogens as well as toxic organic substances and increasing about five times the P content in the residue. Therefore, a global and straightforward study is needed to assess the environmental sustainability of the technologies available in literature. We proposed a new approach to directly evaluate the sustainability of the technologies to recovery P derived from secondary waste streams.

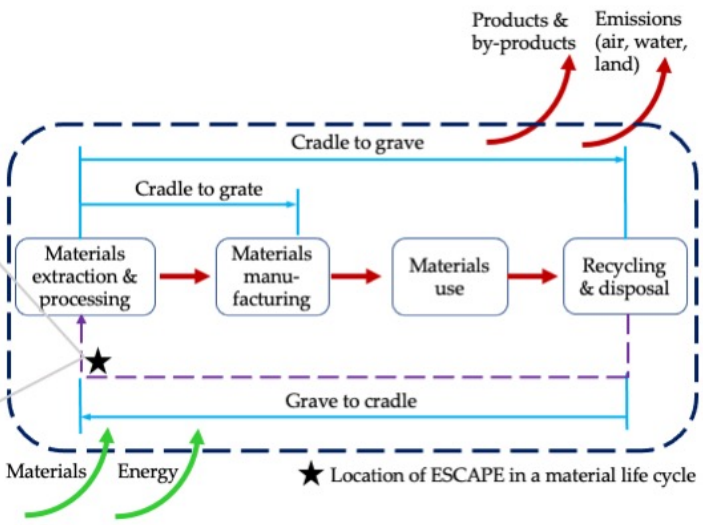
METHOD

ESCAPE approach: Evaluation of Sustainability of material substitution using CArbon footPrint by a simplifiEd approach

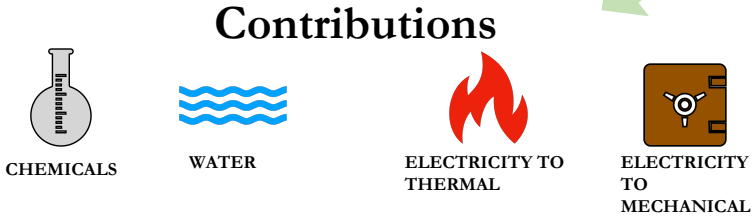
Legend

EE=embodied energy
CF= CO_2 footprint
RAW= virgin process
SUB= substitutive process





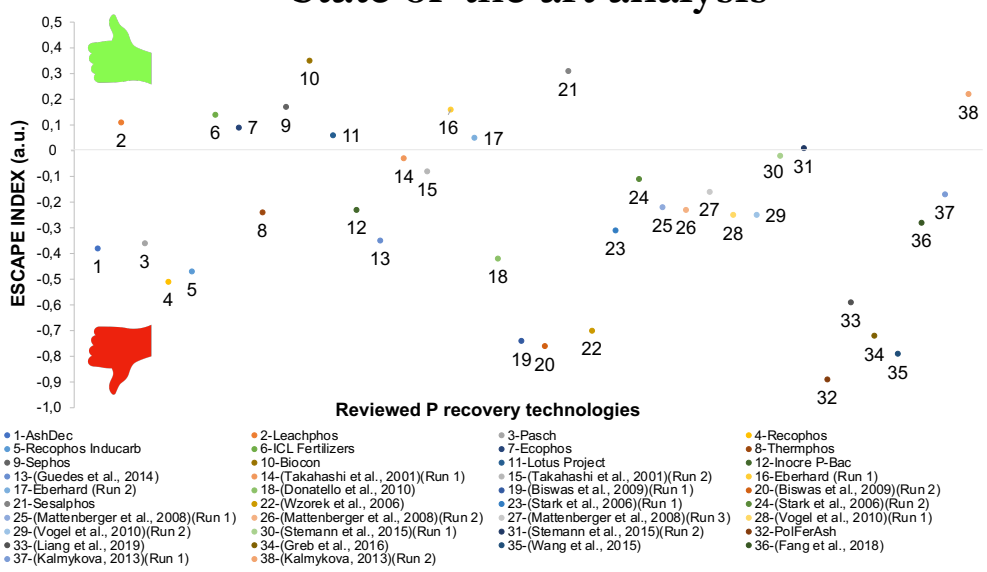
Contributions



ESCAPE index=$[\log(EE_{RAW})-\log(EE_{SUB})+\log(CF_{RAW})-\log(CF_{SUB})]/2$

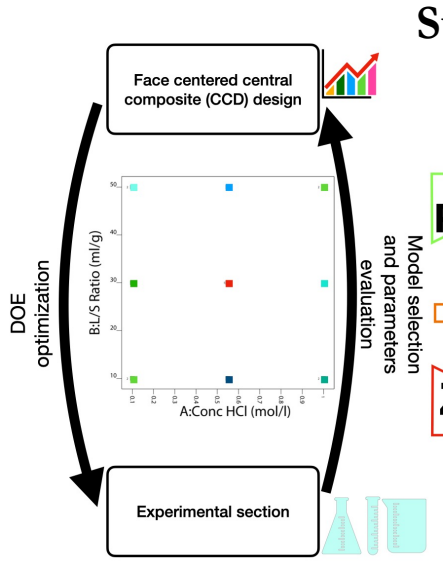
APPLICATIONS

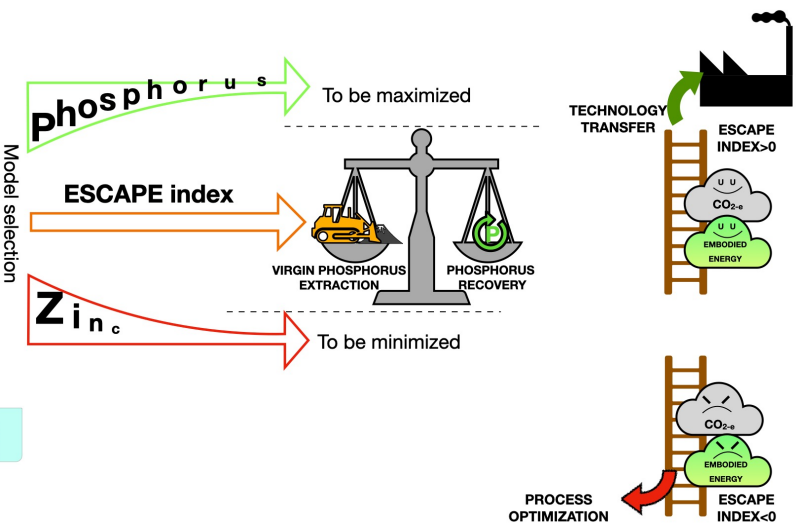
State of the art analysis



Fahimi, A., Federici, S., Depero, L.E., Valentim, B., Vassura, I., Ceruti, F., Cutaia, L., Bontempi, E., Evaluation of the sustainability of technologies to recover phosphorus from sewage sludge ash based on embodied energy and CO2 footprint, Journal of Cleaner Production, Volume 289, 2021, 125762, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2020.125762.

Support to statistical case studies





Fiameni L, Fahimi A, Marchesi C, Sorrentino GP, Zanoletti A, Moreira K, Valentim B, Predeanu G, Depero LE, Bontempi E. Phosphorous and Silica Recovery from Rice Husk Poultry Litter Ash: A Sustainability Analysis Using a Zero-Waste Approach. Materials. 2021; 14(21):6297. https://doi.org/10.3390/ma14216297

CONCLUSIONS

- The ESCAPE approach is a screening step preliminary to Life Cycle Assessment (LCA) that evaluates the sustainability of recovery processes at low TRL (technology readiness level).
- It appears to be time saving and simplified (based on two parameters, so it is easily understandable also by non-specialists) tool for the valorisation of wastes, residues and by-products, so promoting the circular economy strategy.

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