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# Optimal integrated facility for waste processing

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## Highlights

- -Cattle, pig, poultry and sheep manure are evaluated for power and digestate processing
- -5 technologies are compared for the recovery of P and N
- -FBR technology producing struvite is the selected technology
- -Poultry shows larger yield to biogas, but smaller biomass availability
- -Power production is competitive as long as nutrients are sold as fertilizers.

## Abstract.

A mixed-integer nonlinear programming strategy is proposed to design integrated facilities to simultaneously recover power and nutrients from organic waste. The facilities consider anaerobic digestion of different types of manure (cattle, pig, poultry, and sheep). The products from this step are biogas and a nutrient-rich effluent. The biogas produced is cleaned and used in a gas turbine to produce power while the hot flue gas obtained from combustion produces steam that is fed to a steam turbine to produce additional power. The nutrient-rich effluent is processed to recover the nutrients using different technologies that include filtration, coagulation, centrifugation, and struvite precipitation in stirred and fluidized bed reactors. This processing step provides a mechanism to prevent phosphorus or nitrogen release to the environment and to avoid the development of eutrophication processes. It is found that struvite production in fluidized beds is the technology of choice to recover nutrients from all manure sources. Furthermore, power production depends strongly on manure composition and exhibits high cost variability (from 4000 €/kW in the case of poultry manure to 25000 €/kW in the case of cattle and pig manure).

Keywords: Biogas, Digestate, Anaerobic digestion, Manure, Power production, Mathematical optimization

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