Optimal selection and location of nutrient recovery systems considering standalone and coordinated strategies

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Agenda

I. Nutrient pollution

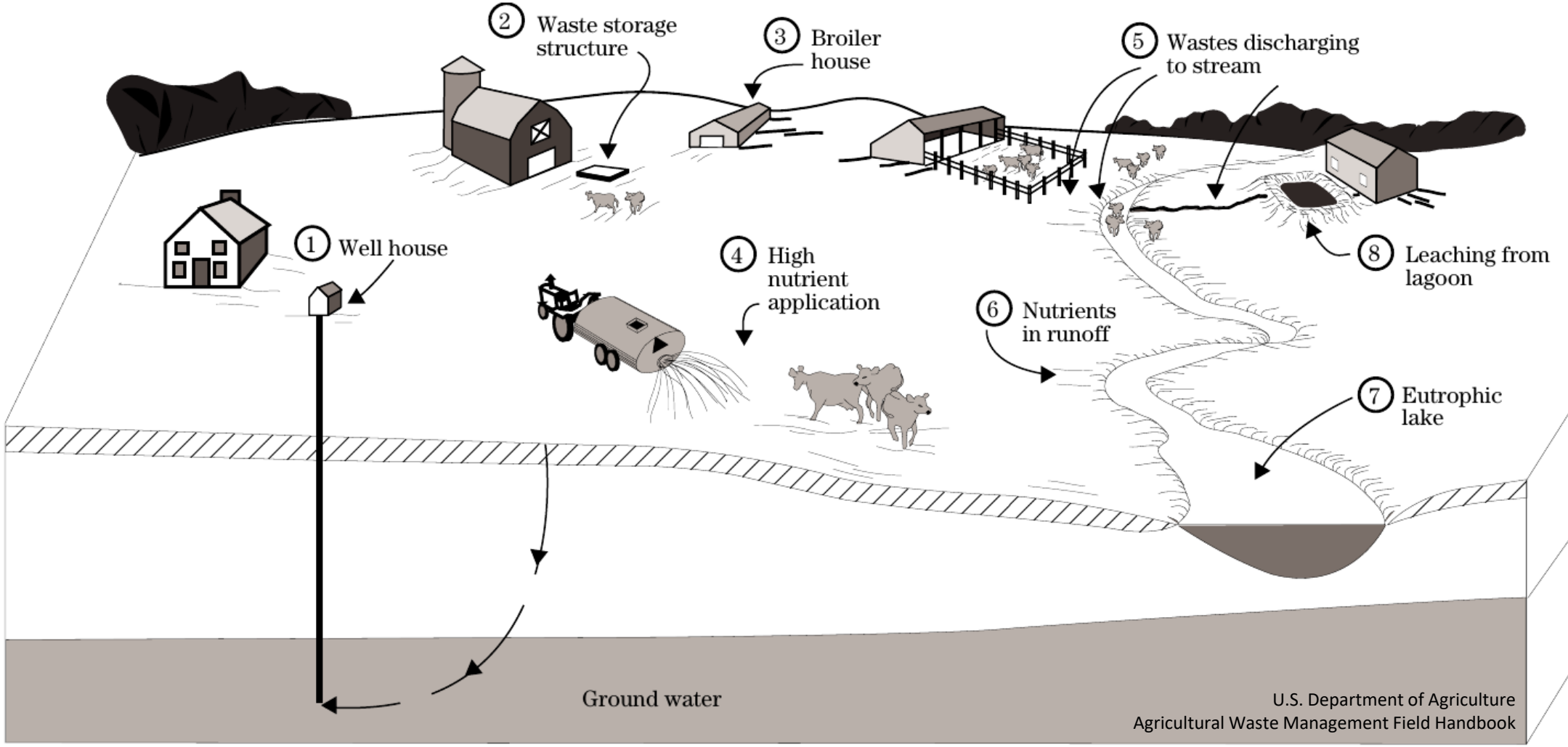
II. Nutrient recovery from livestock waste

III. Study of incentive policies

IV. Results

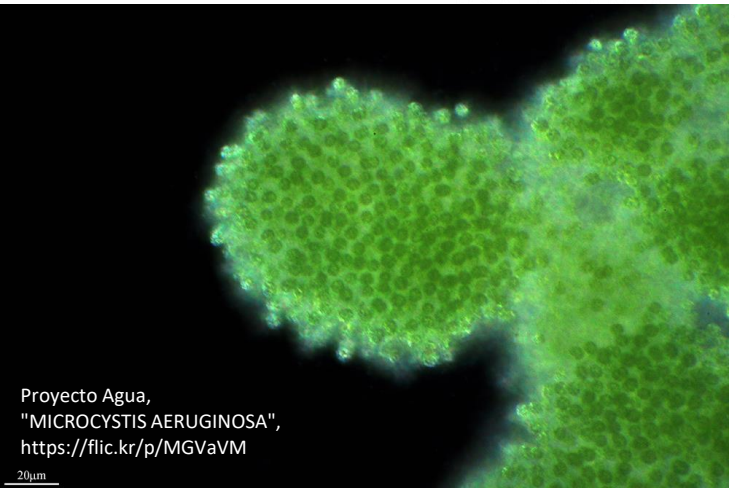
V. Conclusions

I. Nutrient pollution



U.S. Department of Agriculture
Agricultural Waste Management Field Handbook

I. Nutrient pollution



Proyecto Agua,
"MICROCYSTIS AERUGINOSA",
https://flic.kr/p/MGVaVM

Exponential growth of algae

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Harmful algal blooms (HABs)

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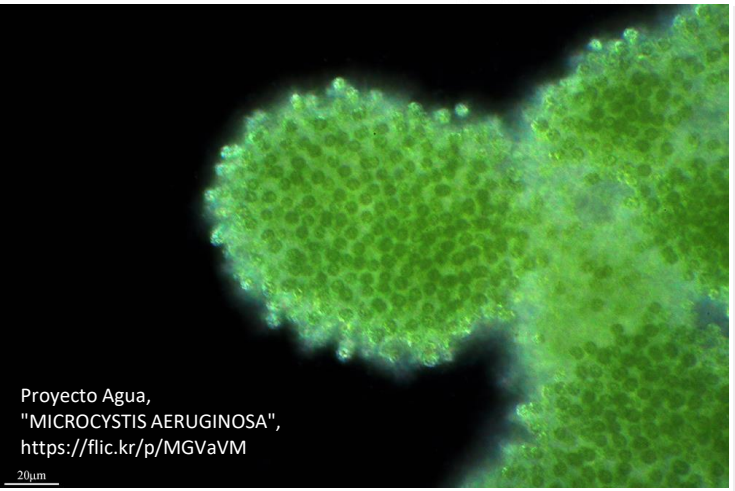

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Lake Erie, United States

NASA, 2015, https://earthobservatory.nasa.gov/images/86327/algae-boom-in-lake-erie

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Environmental and public health issues

II. Nutrient recovery from livestock waste

Presence of CAFOs

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Excessive soil phosphorus concentration

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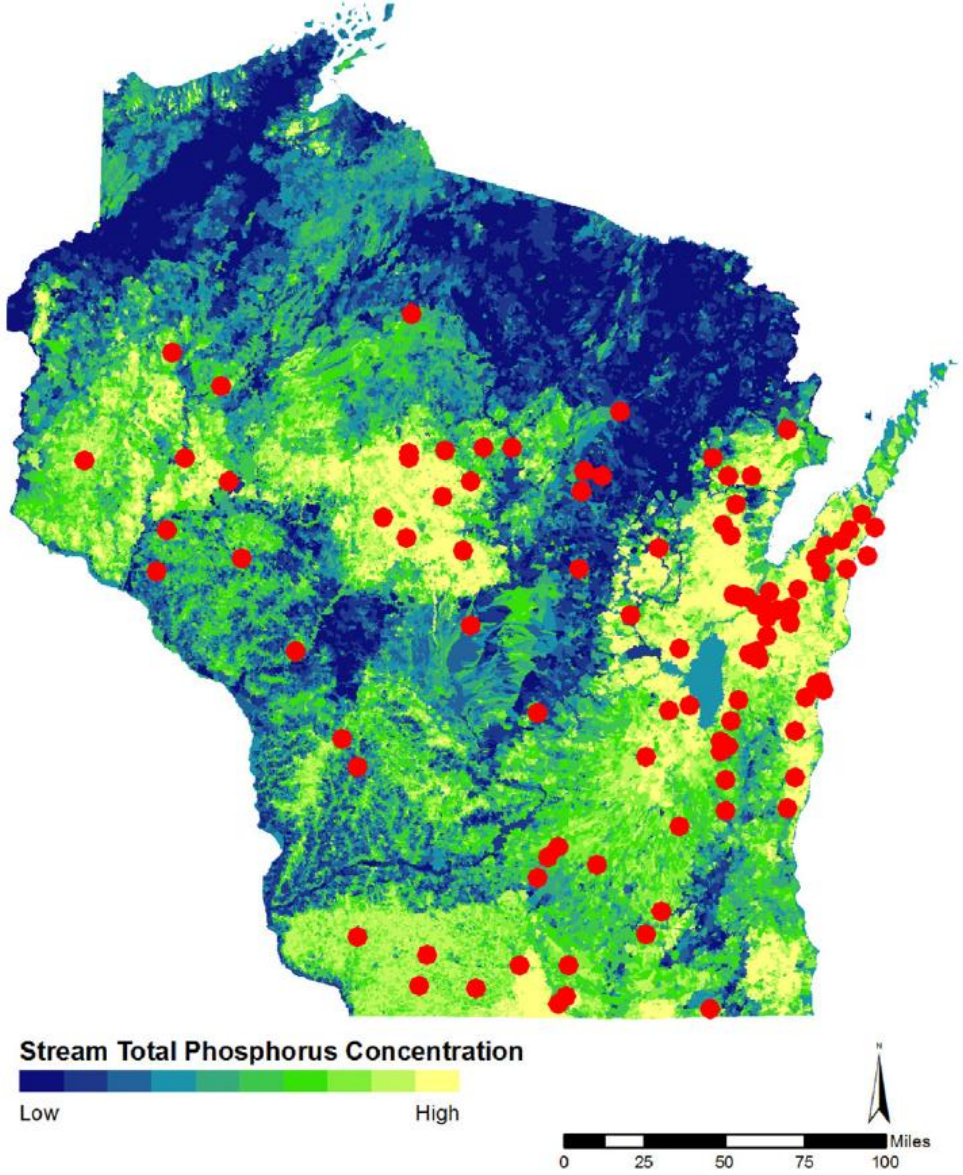
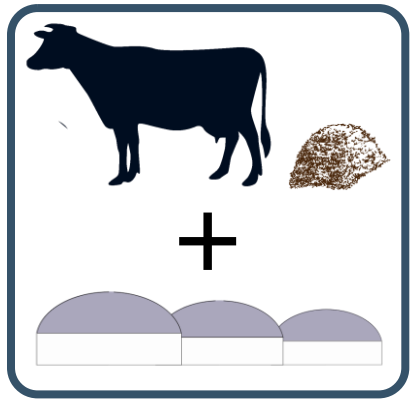
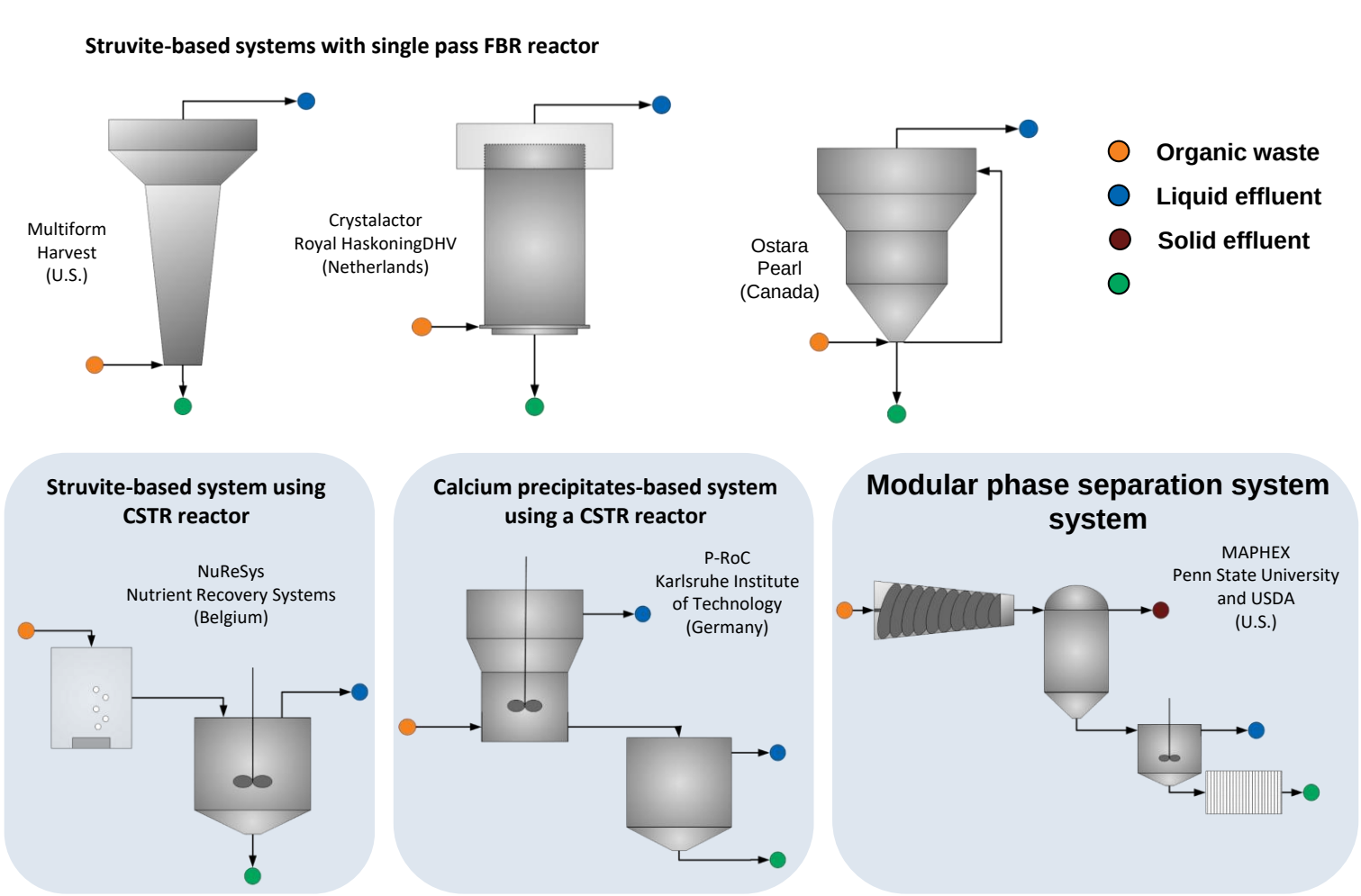
Runoff of phosphorus to water bodies



Apoorva M. Sampat, Edgar Martin, Mariano Martin, Victor M. Zavala. Optimization formulations for multi-product supply chain networks, Computers & Chemical Engineering, 104, 2017,296-310.
DOI: 10.1016/j.compchemeng.2017.04.021.

II. Nutrient recovery from livestock waste





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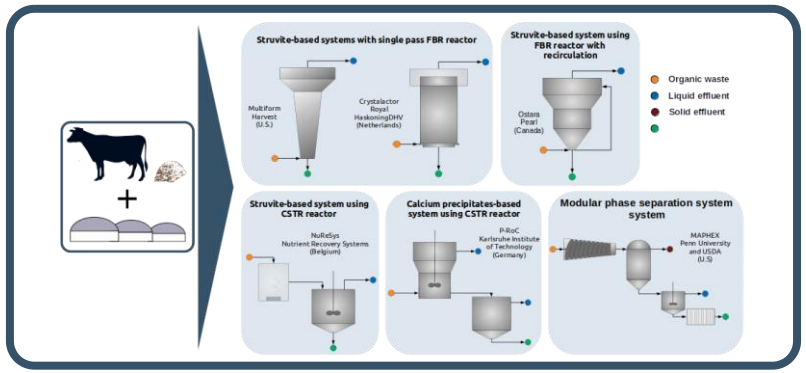

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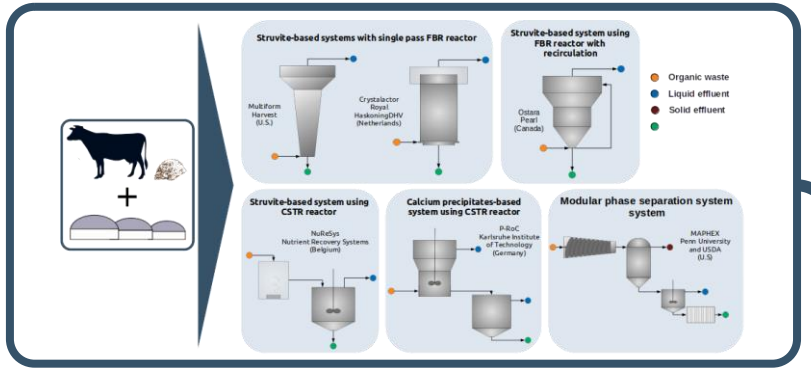

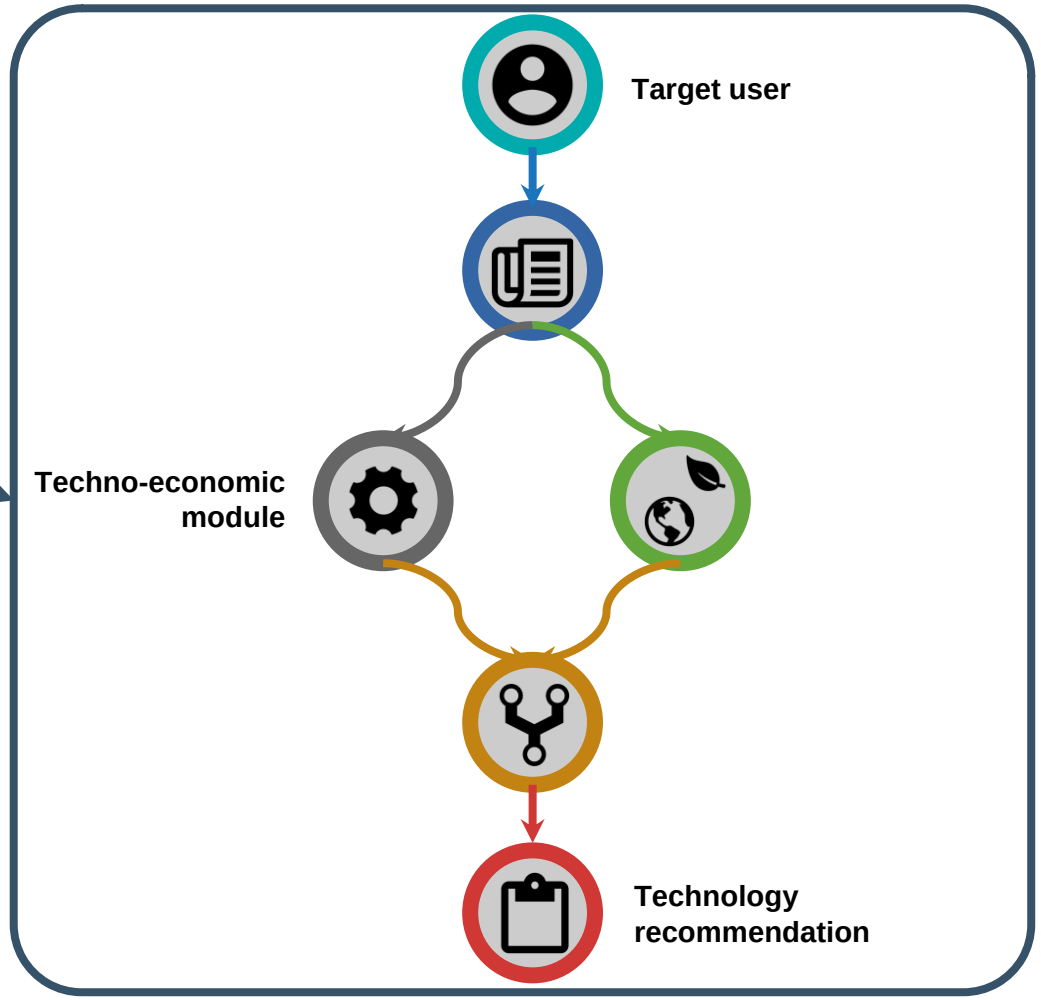

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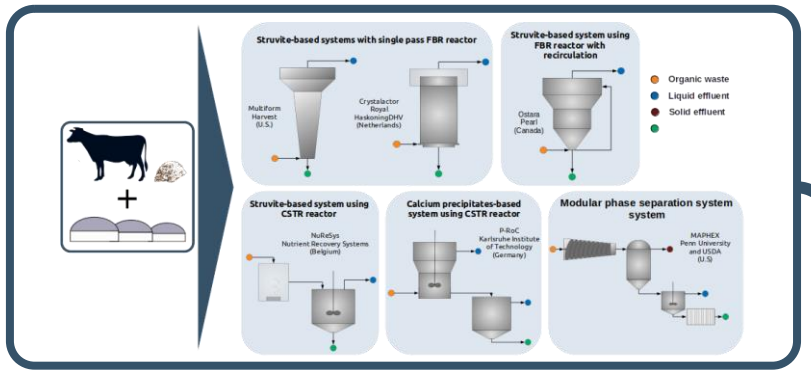
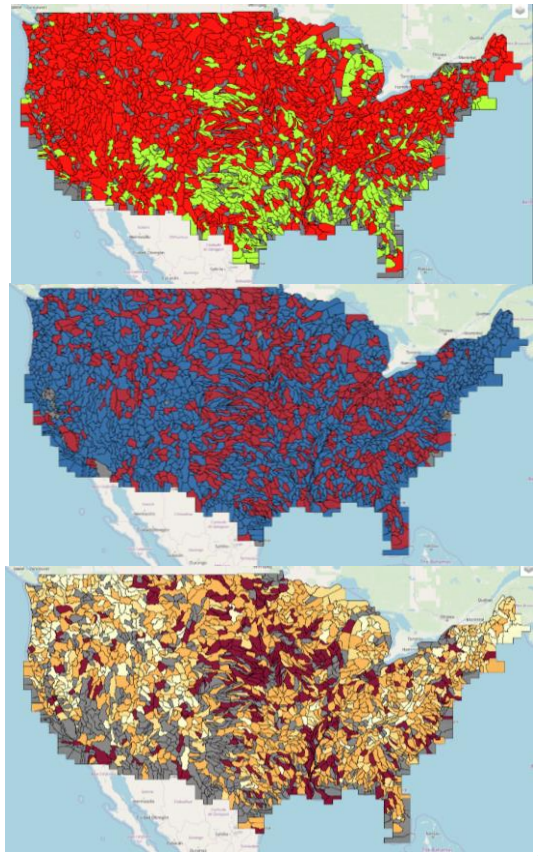


Environmental GIS module

Soils condition:
Mehlich 3 phosphorus

Anthropogenic phosphorus balance:
techno-ecological synergy (TES) sustainability metric

Water condition:
Trophic State Index (TSI) oflakes



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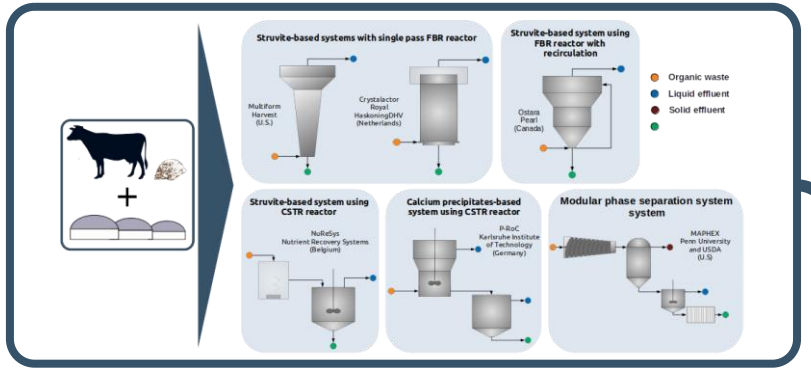

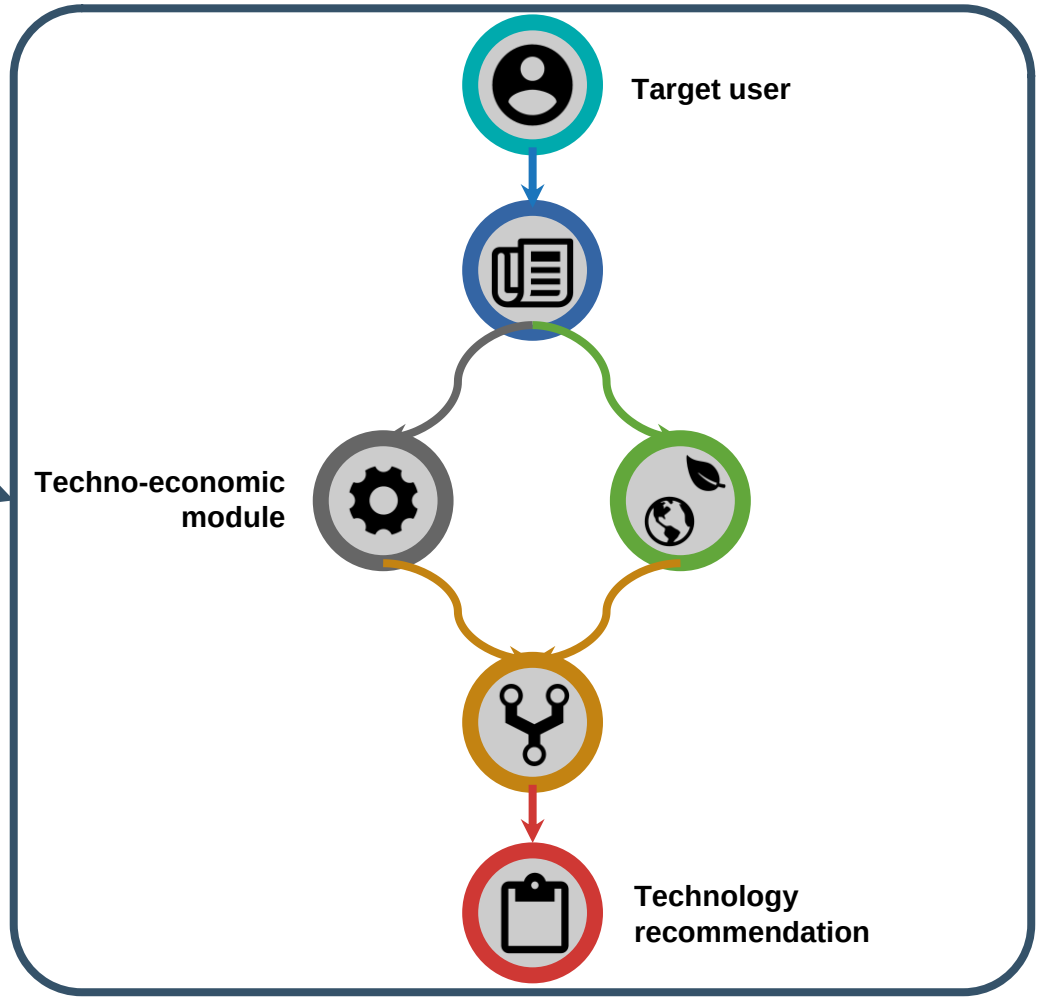

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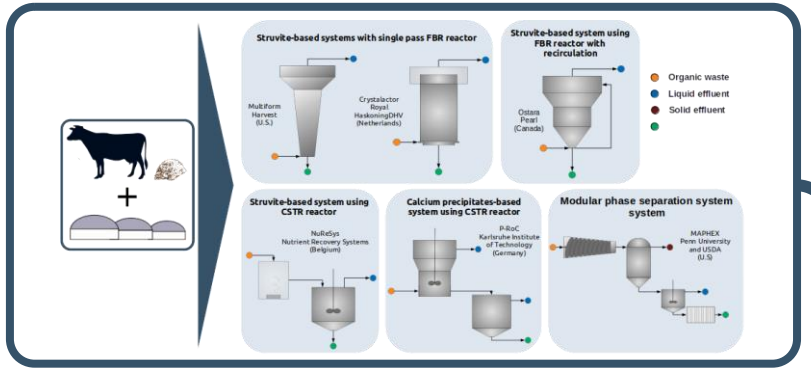
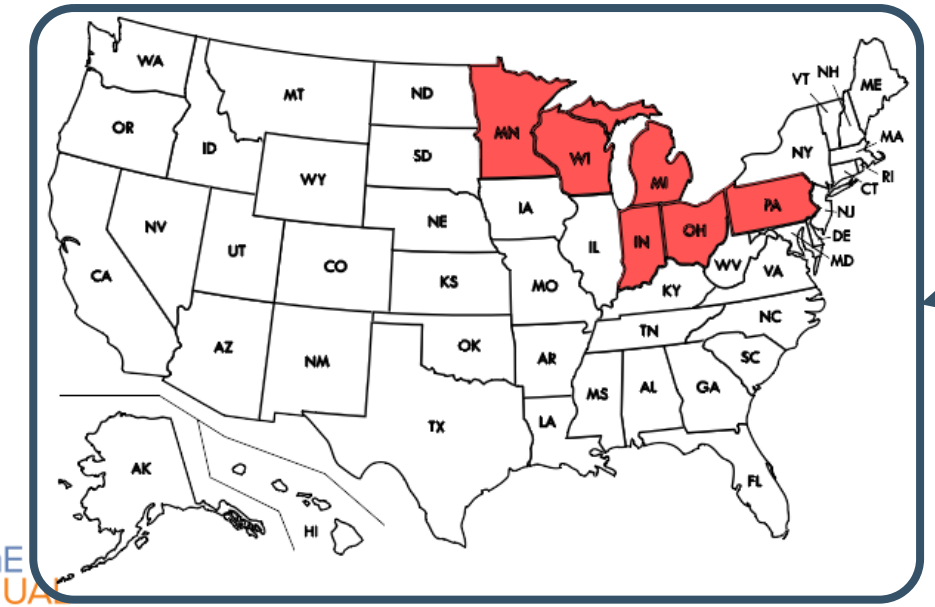
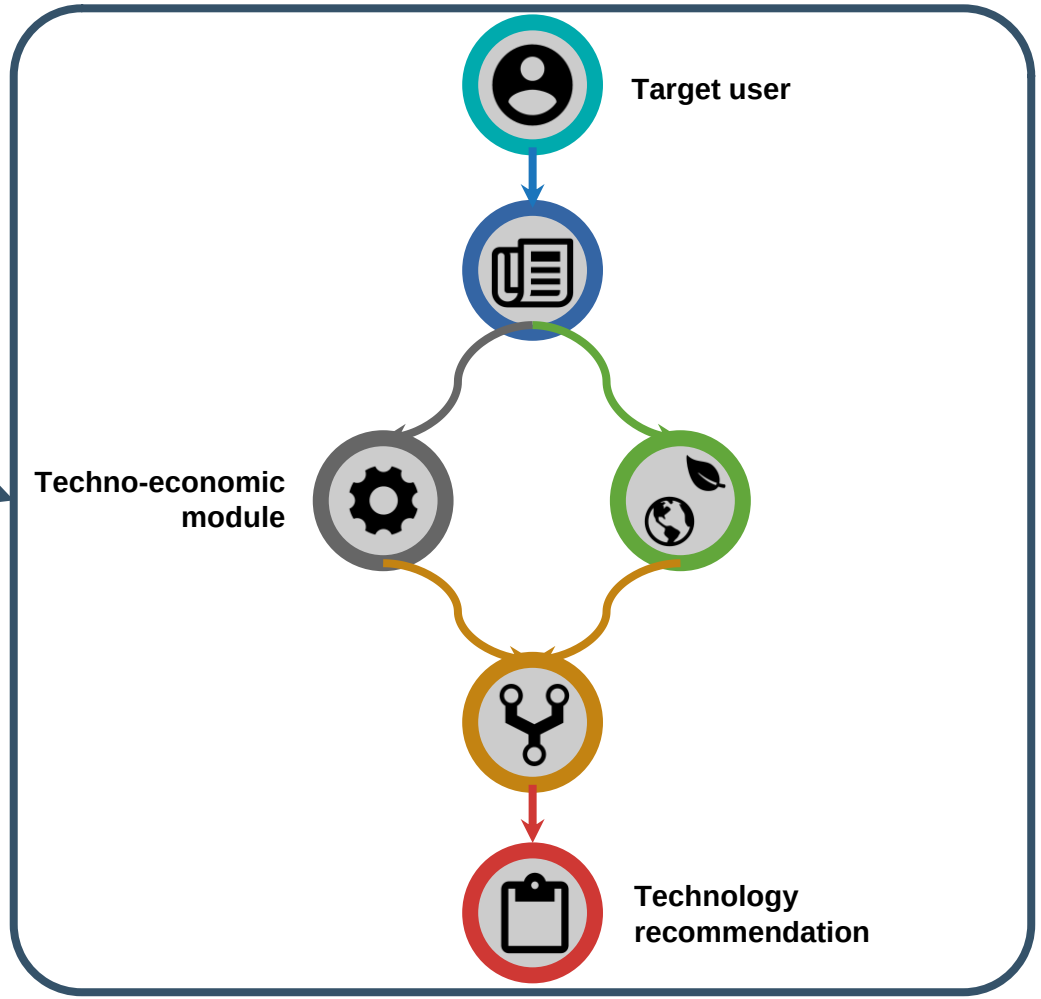
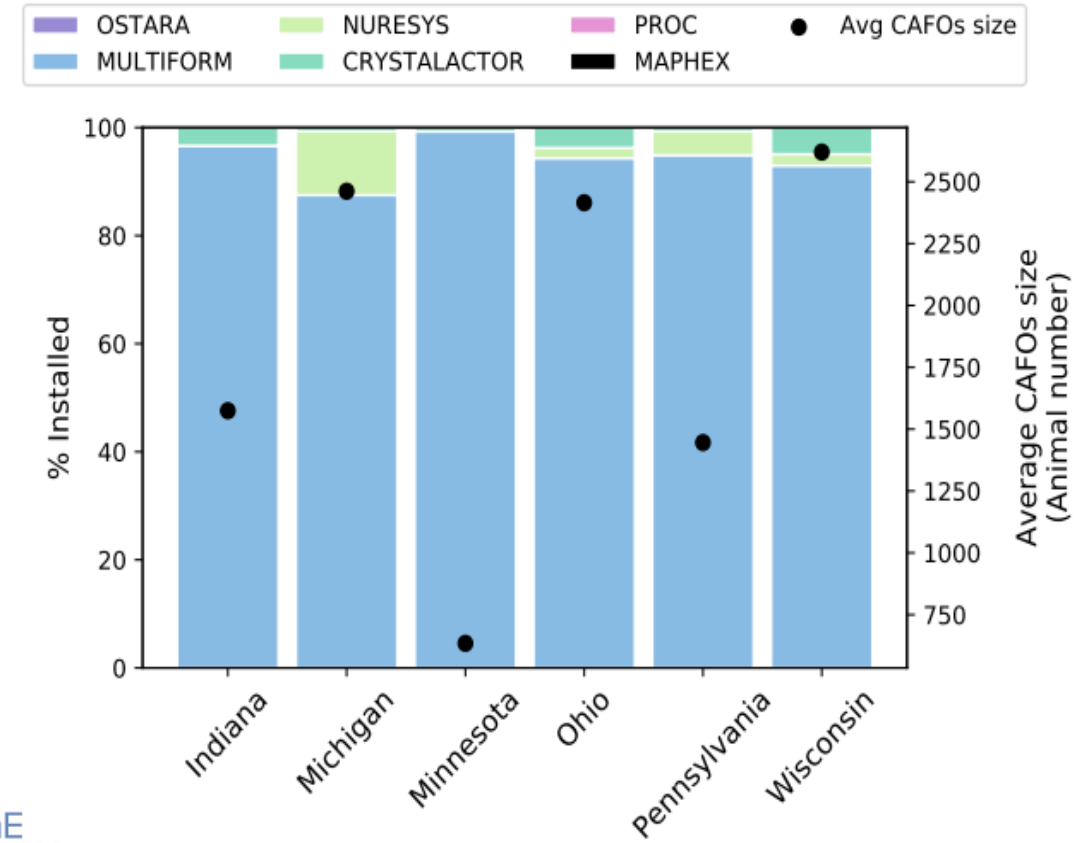






IV. Results

w/o anaerobic digestion



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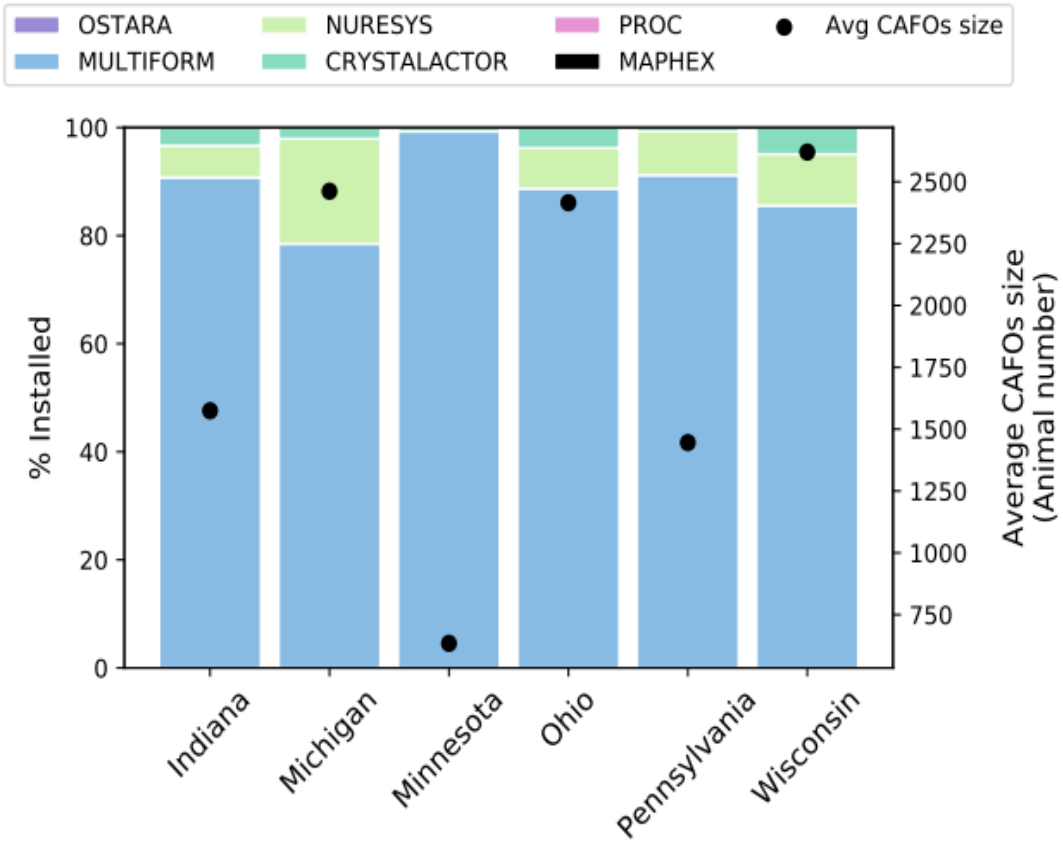


IV. Results

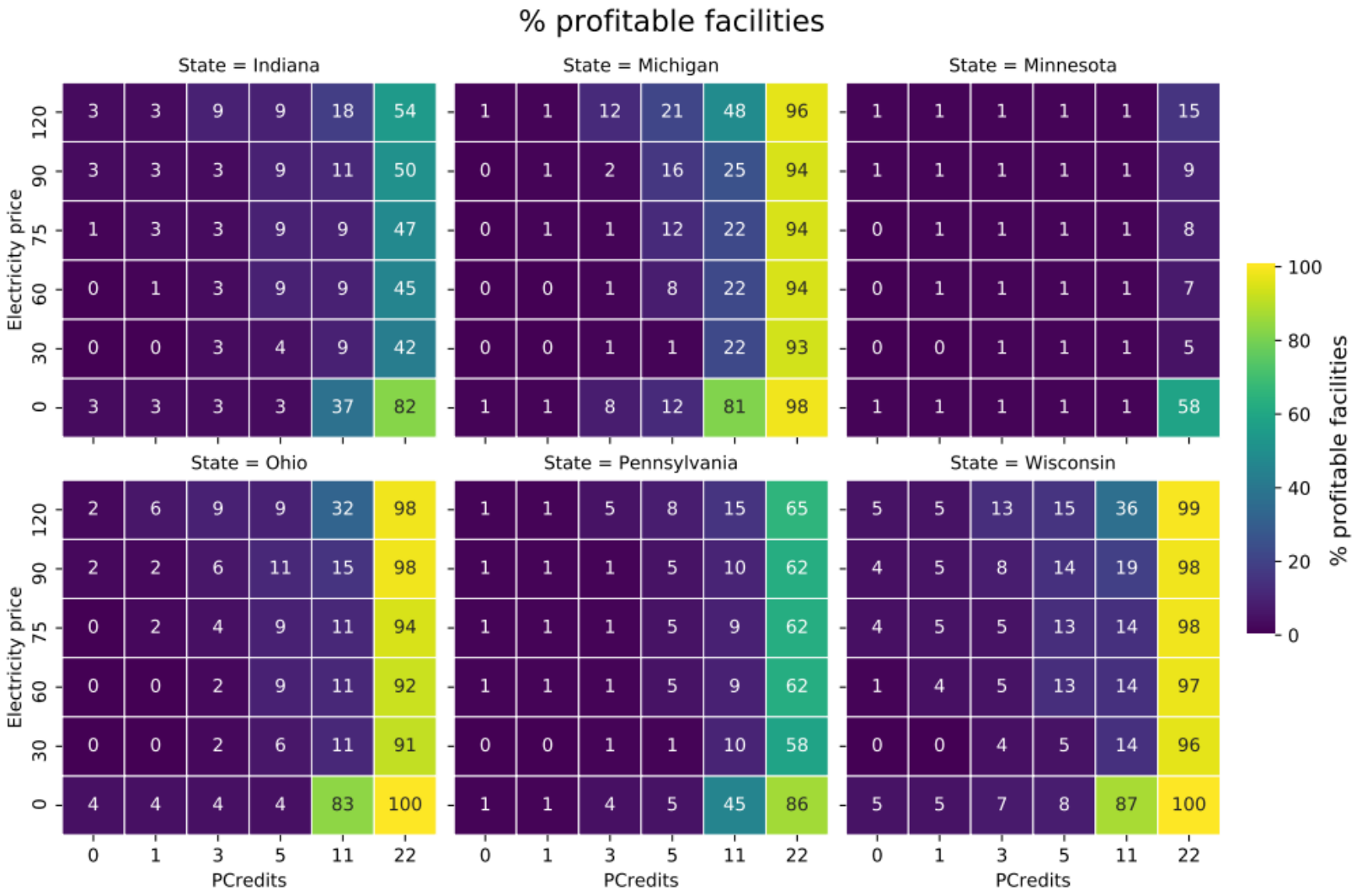
Technologies considered

Electricity price > 0

- Manure pretreatment
- Anaerobic digestion
- Electricity generation
- Nutrient recovery

Electricity price = 0

- Manure pretreatment
- Nutrient recovery



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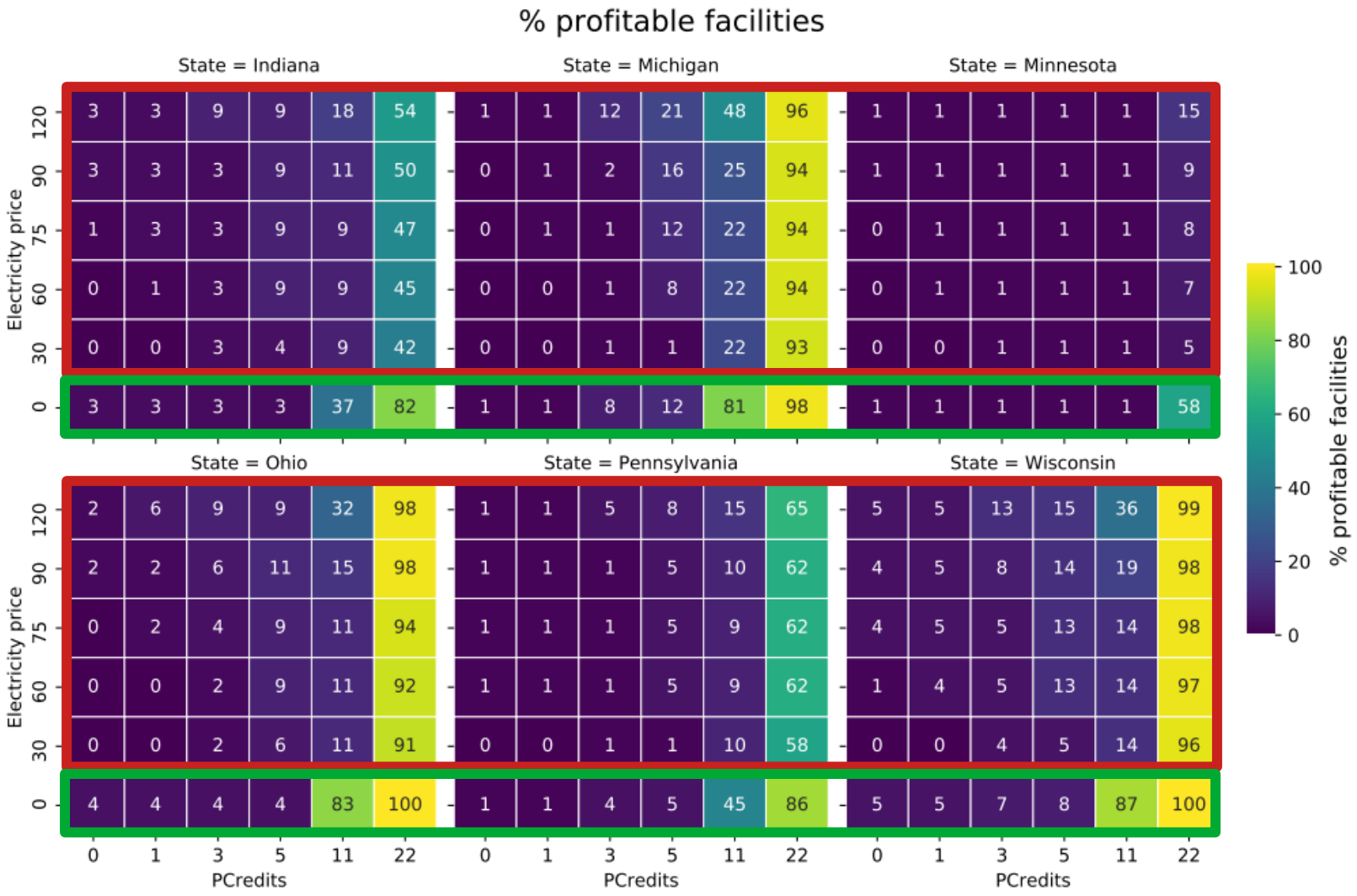

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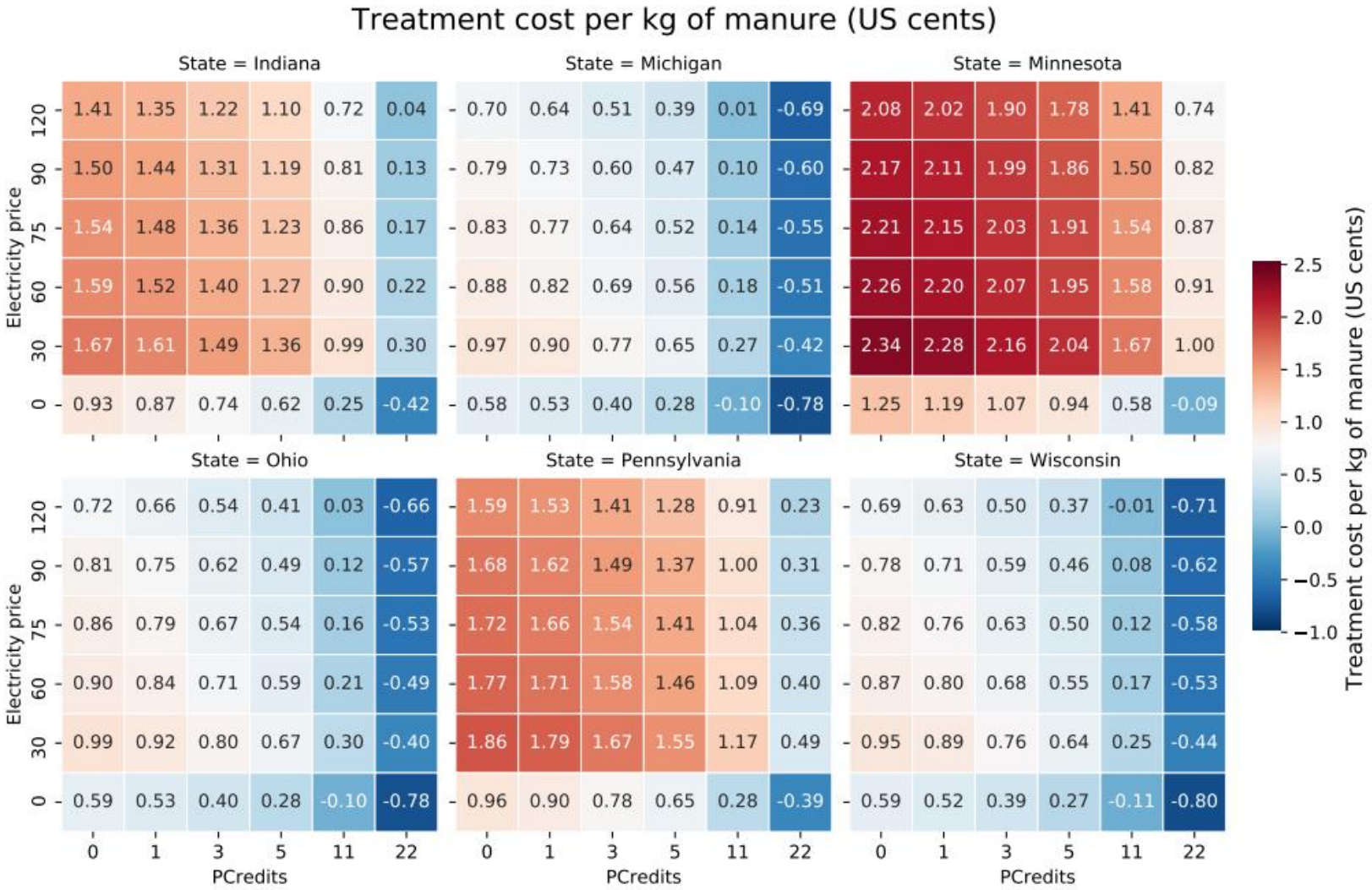

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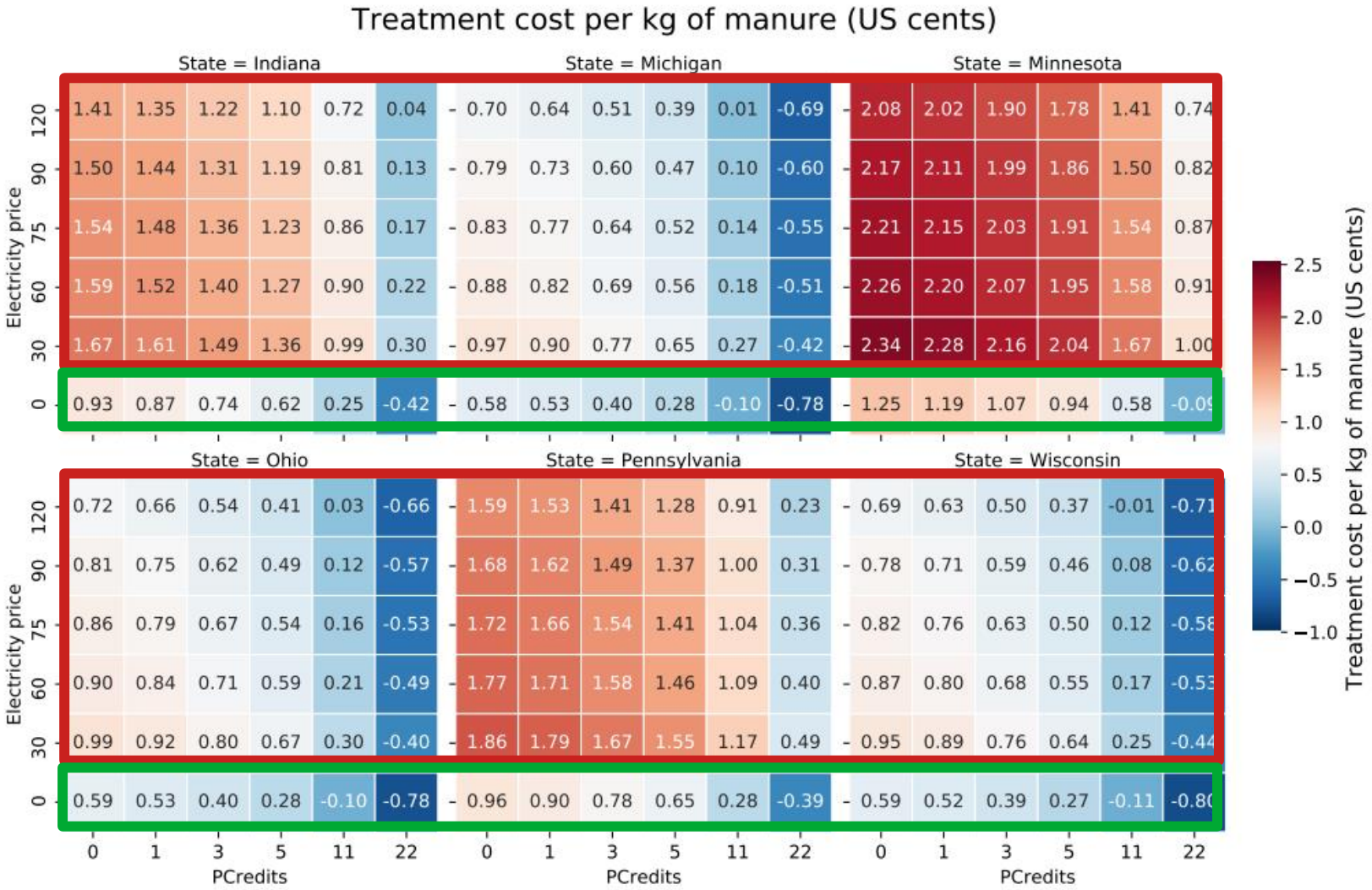

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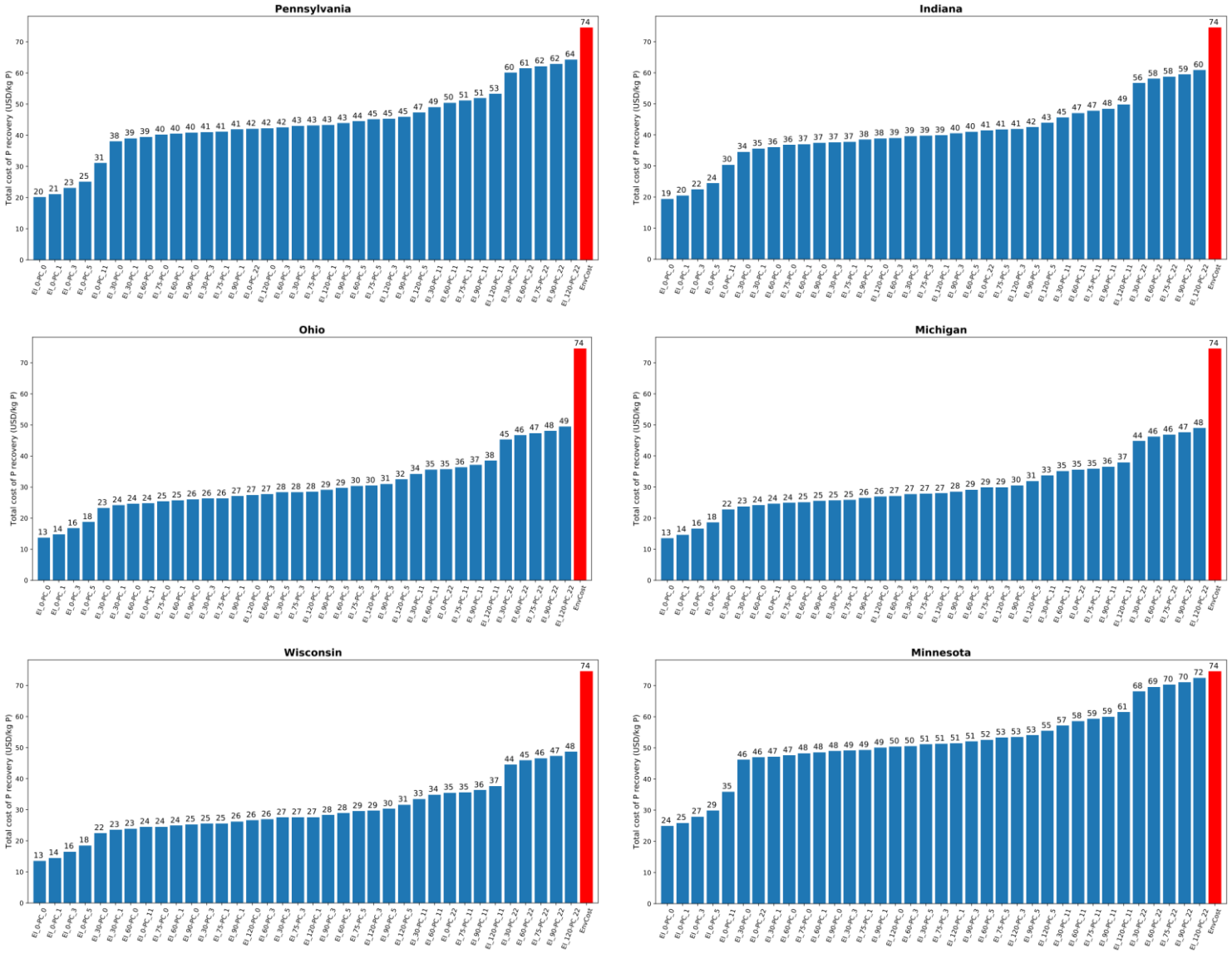

Long-term environmental impact of phosphorus releases: 74.5 USD/$kg_{P\ released}$

Sampat, A. M., Hicks, A., Ruiz-Mercado, G. J., & Zavala, V. M. (2020). Valuing economic impact reductions of nutrient pollution from livestock waste. Resources, Conservation and Recycling, 164, 105199.

Phosphorus recovery (including CAPEX and OPEX) is economically better than disposal

IV. Results

1. Electricity prices < 60 USD/MWh do not improve the economic performance of the nutrient recovery systems

2. The largest facilities can reach self-profitability through the sales of struvite, especially for P credits incentive > 10 USD/kg_P

3. Phosphorus recovery (including CAPEX and OPEX) is economically better than disposal

4. The deployment of large livestock facilities seems advantageous for the implementation of phosphorus recovery systems

Thank you for your attention

Questions?

emartinher@usal.es

The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.