

Eco-designing heat pumps: Tackling efficiency, refrigerants, and the embodied impact of components

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“Design is an art, and as such, it can be neither imposed nor truly taught.”

Prof. V. Nunziata



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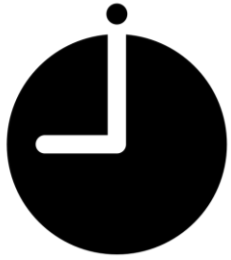
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- What can be modeled with LCA?

What can be modeled with LCA?

Based on technical, scientific, and economic knowledge:

- A technological system
- Environmental cause-and-effect relationships
- Market relations



- We need to be market experts (for market relationships)

Attributional LCA



What part of the environmental burdens should be assigned to the product?

Consequential LCA



What are the consequences of purchasing a product?

Two types of LCA to respond to two different questions



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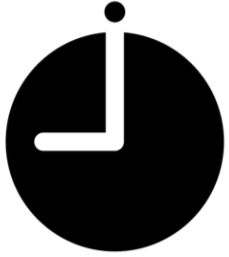
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Weidema B.P., 2003. Geographical, technological and temporal delimitation in LCA. Technical guidelines for product life cycle assessment no. 3 (final draft). Project: "LCA-metodeforbedring/metodeudvikling og konsensususkabelse; Delprojekt 2: Systemafgrænsning." Danish Environ Prot Agency, Copenhagen, Denmark 2003:1-58.
<https://lca-center.dk/wp-content/uploads/2015/08/Geographical-technological-and-temporal-delimitation-in-LCA.pdf>



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- We need to be market experts (for market relationships)



- We need to be environmental scientist (for cause-effect relations)



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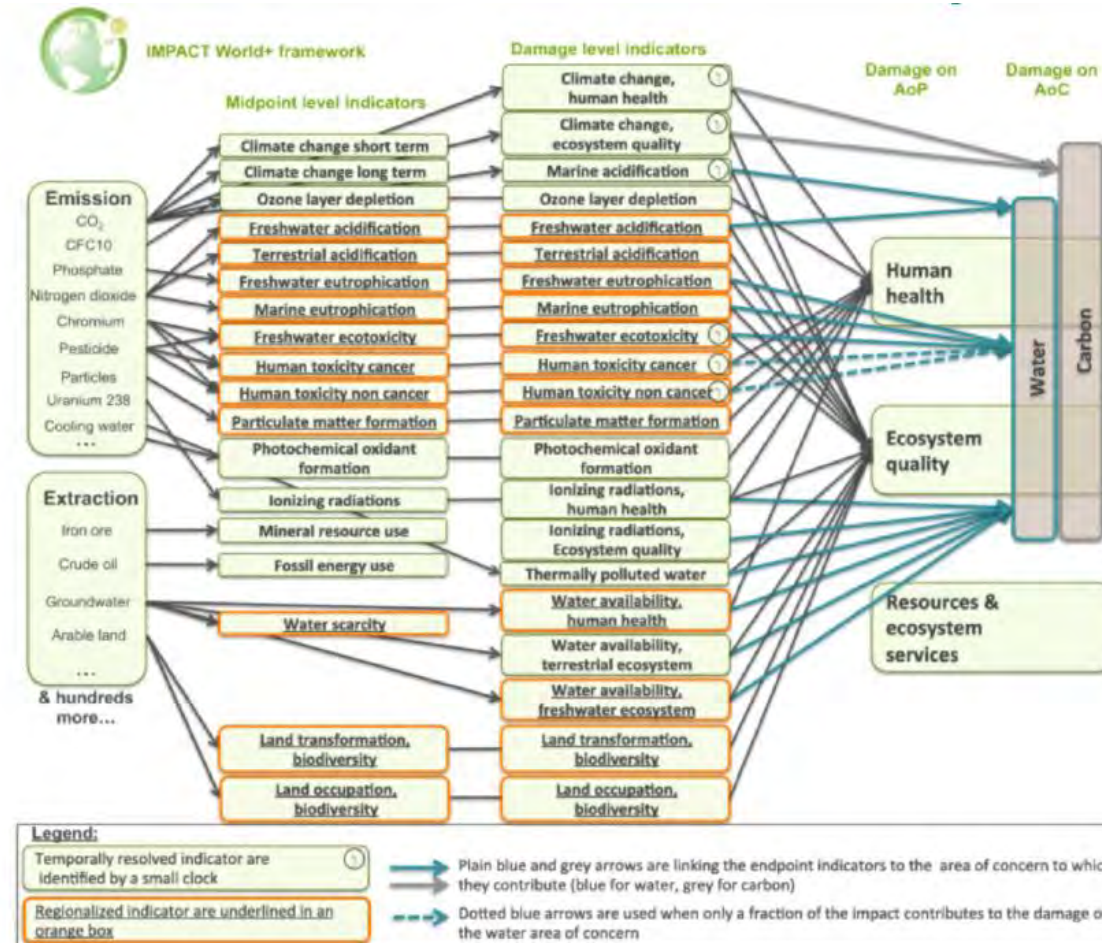


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- We need to be environmental scientist (for cause-effect relations)



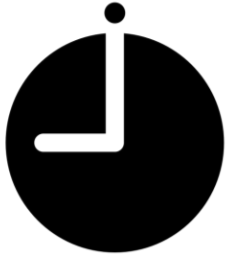
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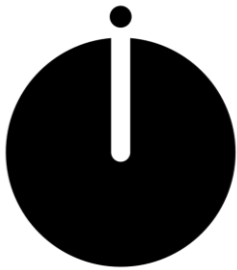
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- We need to be market experts (for market relationships)



- We need to be environmental scientist (for cause-effect relations)



- We absolutely need to be HVAC engineers (technological system)



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By its nature, LCA requires a multidisciplinary approach, so networking is not only an opportunity but a necessity.



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TWO DOUBLE
CLIMATIC
CHAMBERS



ANECHOIC
CHAMBER FOR
ACOUSTIC TESTS



MEASURES OF
FLUID MIXTURES
PROPERTIES



ADSORPTION
SYSTEM LAB



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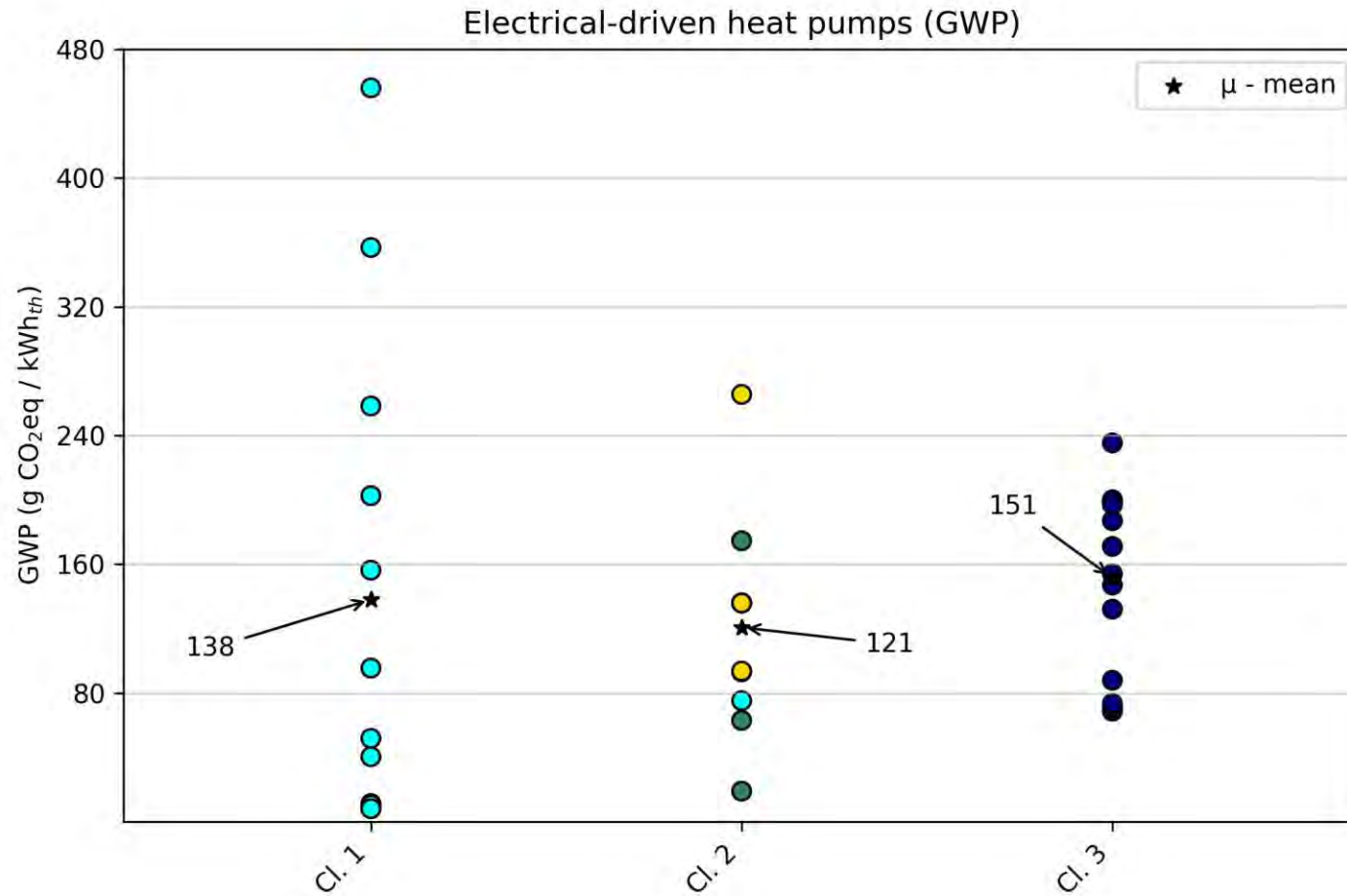
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- Cluster 1: industrial heat pumps.
- Cluster 2: heat pumps in district heating networks.
- Cluster 3: heat pumps for civil application.

Famiglietti, J., Acconito, L., Toppi, T., Arpagaus C., 2025. Environmental life cycle assessment of industrial high-temperature to residential small-size heat pumps: A critical review.
<https://doi.org/10.1016/j.ecmx.2025.100947>



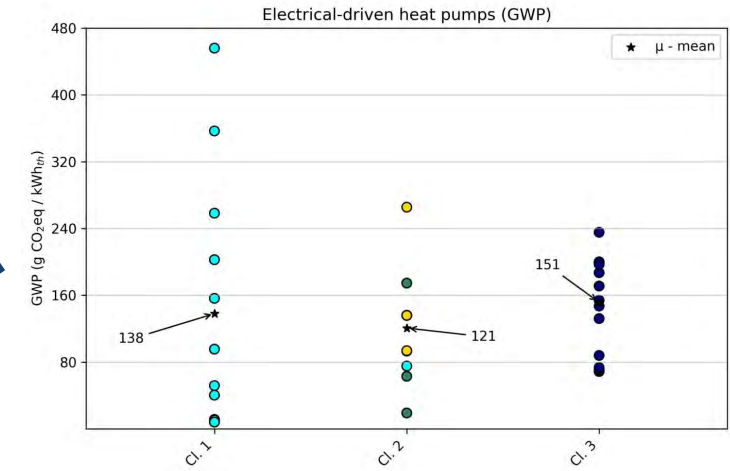
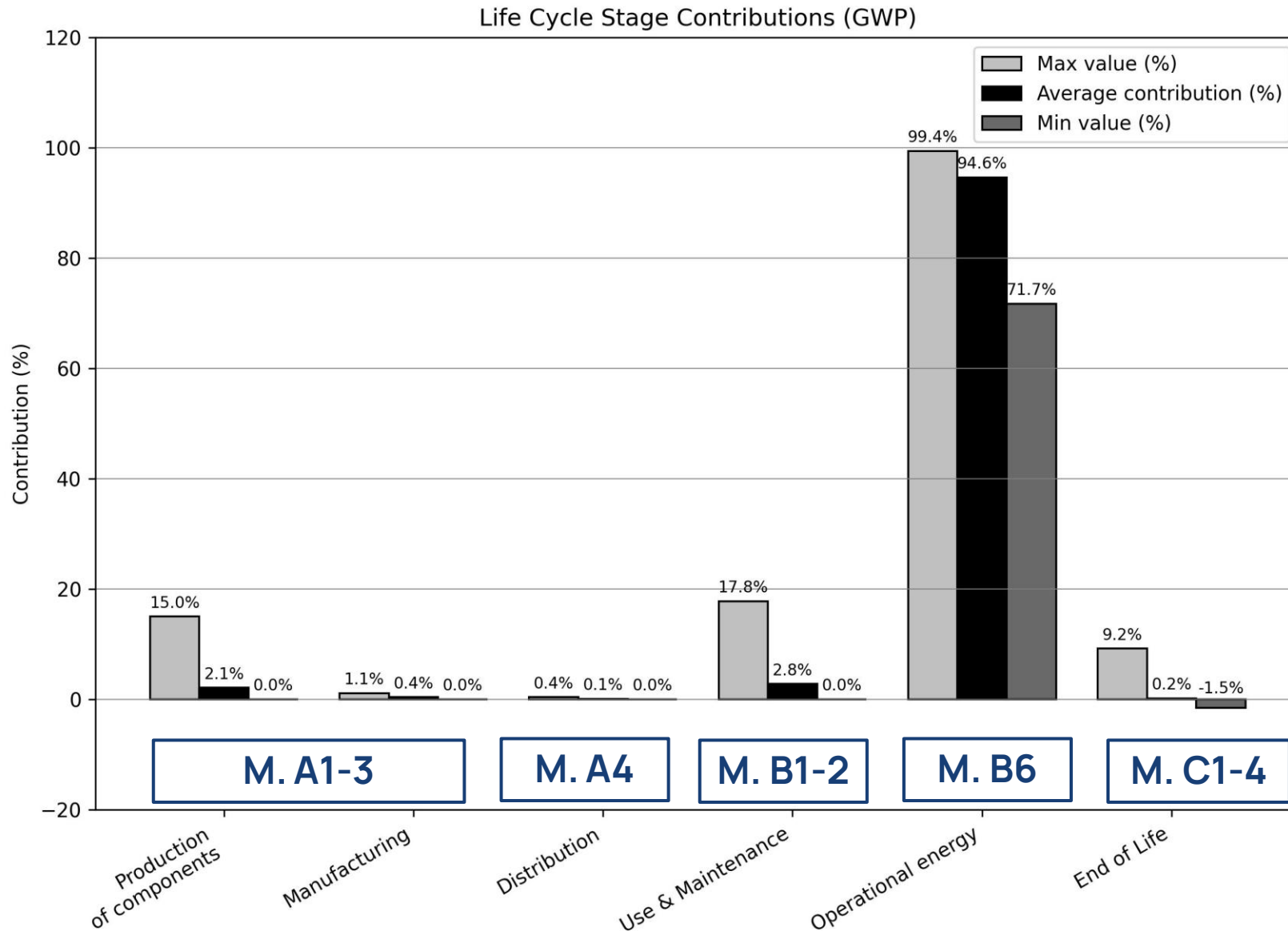
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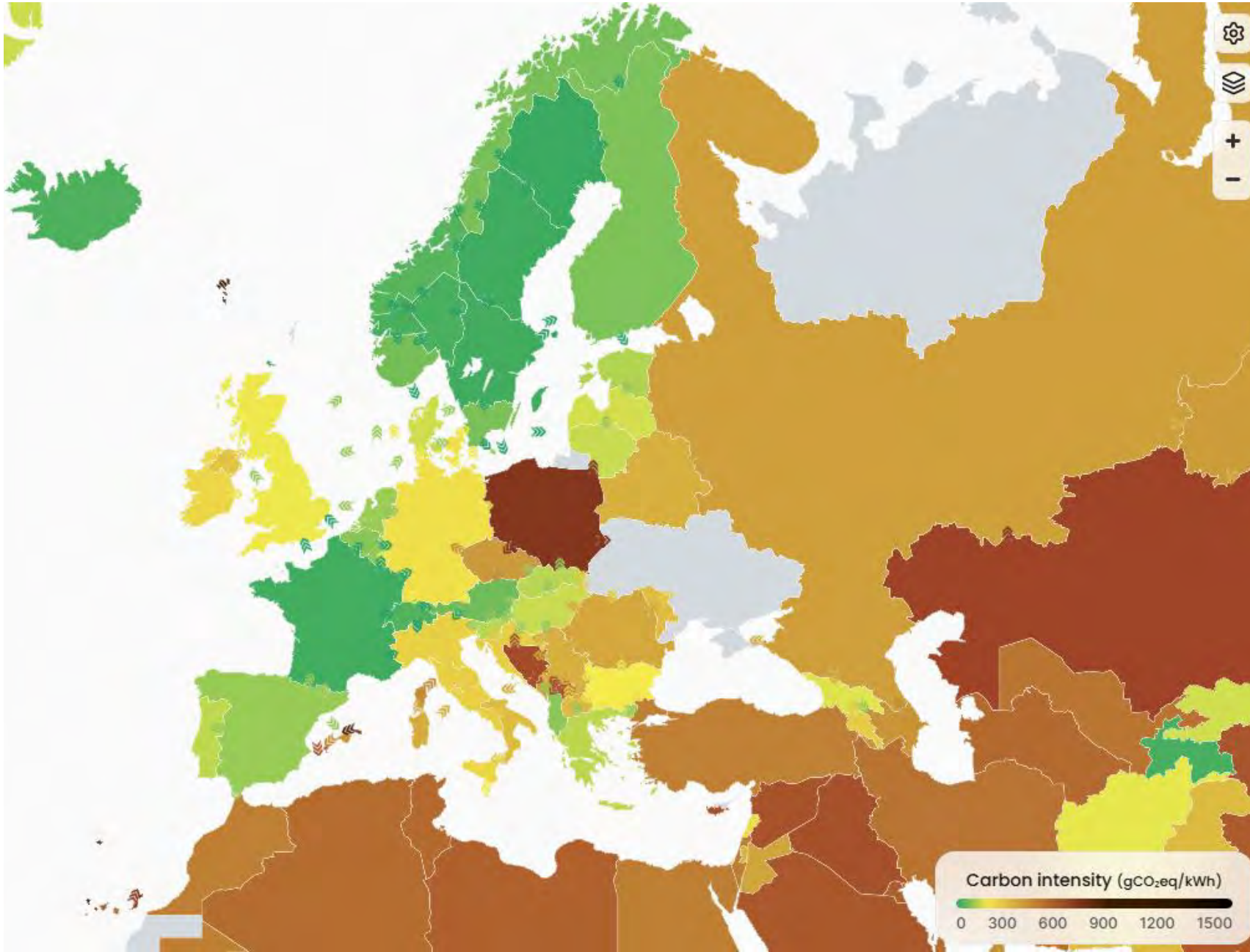
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Approximating

Famiglietti, J., Acconito, L., Toppi, T., Arpagaus C., 2025. Environmental life cycle assessment of industrial high-temperature to residential small-size heat pumps: A critical review.
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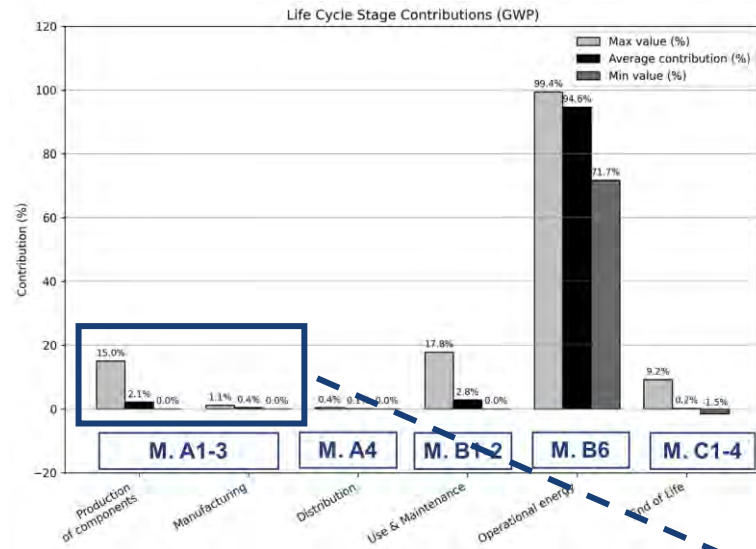
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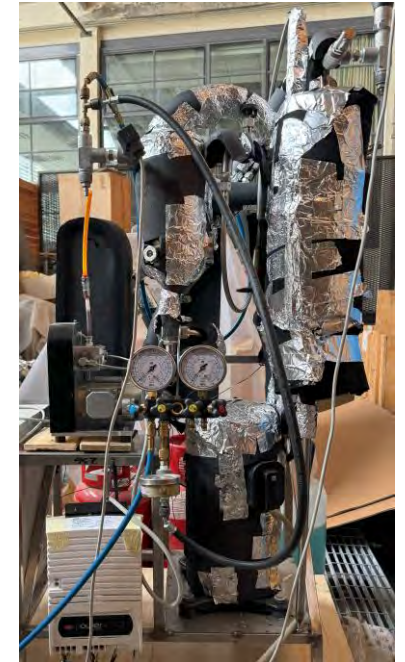
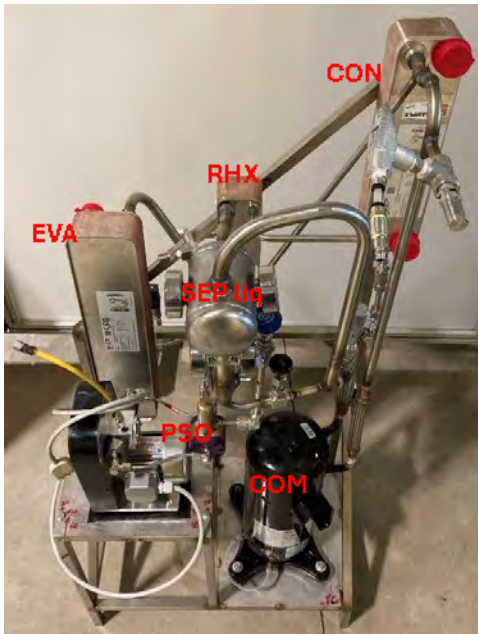
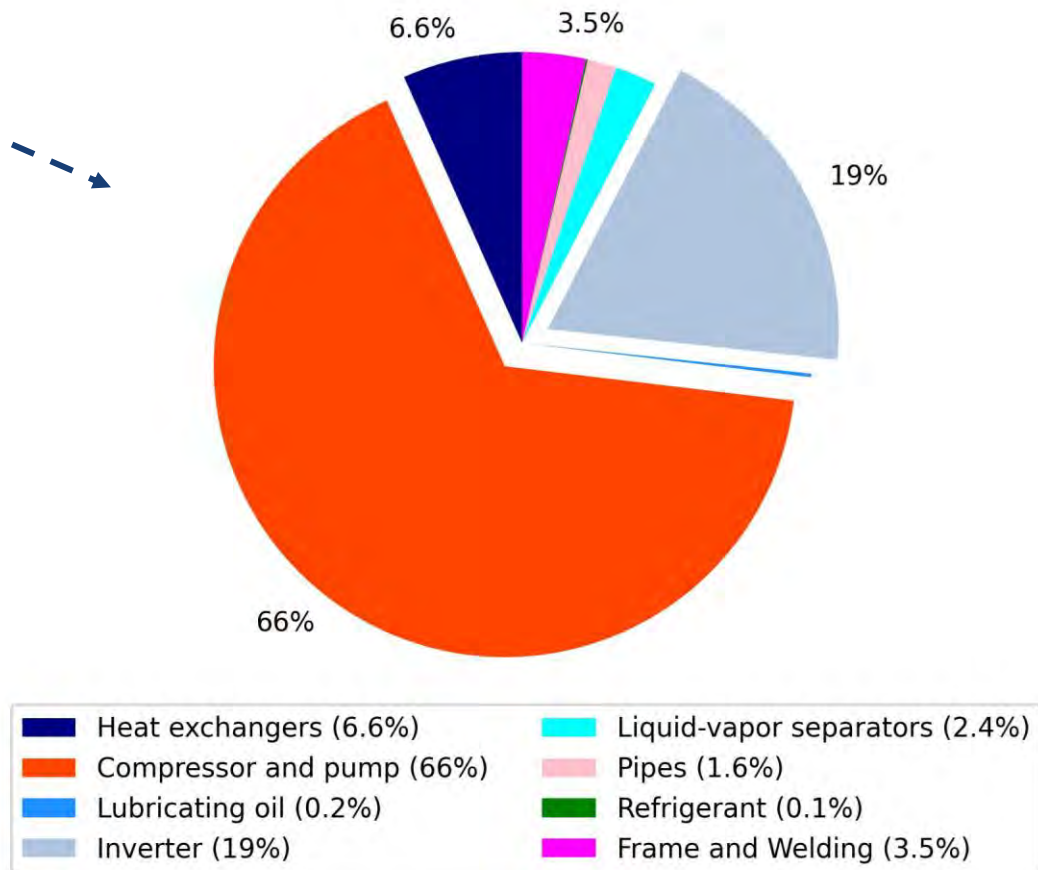
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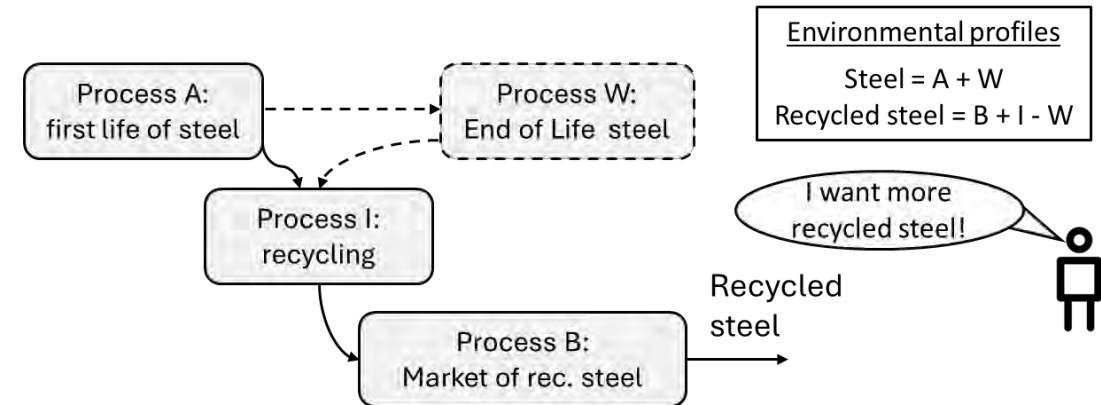
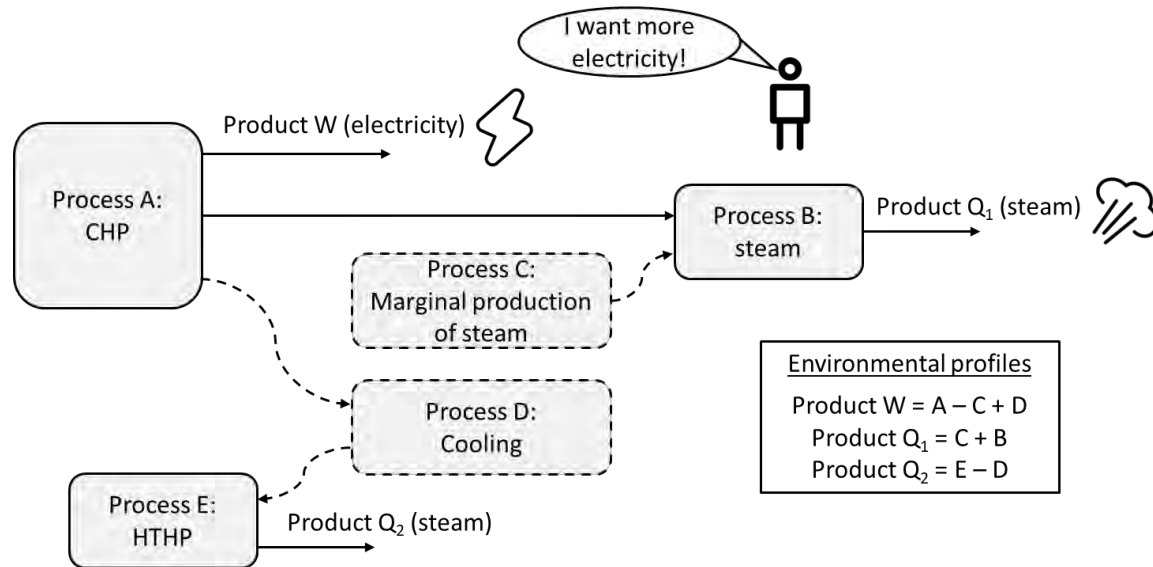
Embodied burdens



Embodied burdens (GWP and beyond)



Who are the marginal suppliers?





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"Understanding a product's life cycle isn't bureaucracy — it's the foundation of better design."

THANK YOU FOR THE ATTENTION!

Contatti

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