Fully integrated hybrid LCA implementation: merging AusLCI and IELab

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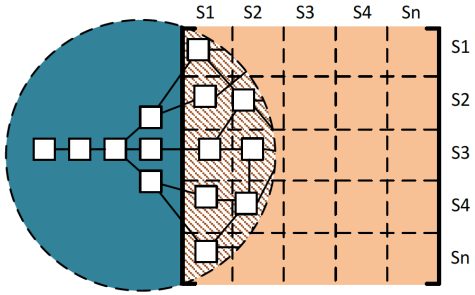
(source: https://ielab.info/)

Introduction

Hybrid Analysis

Tiered

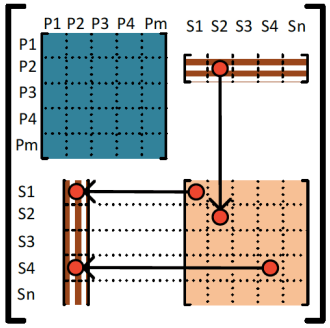


P-LCI

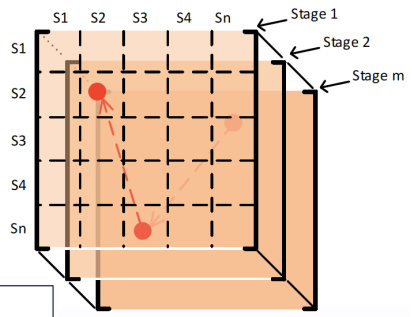
Input-Output LCI

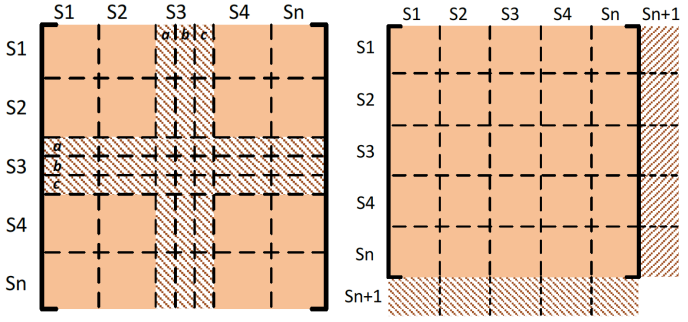
Path Exchange

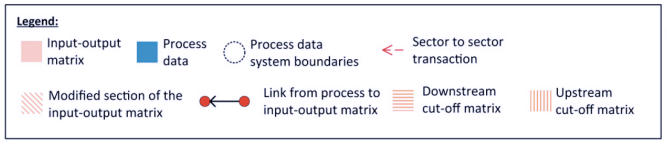
Integrated



IO-Based







(Source: Adjusted from Crawford et al., 2018, Hybrid life cycle inventory methods – A review. Journal of Cleaner Production, 172, 1273-1288.)

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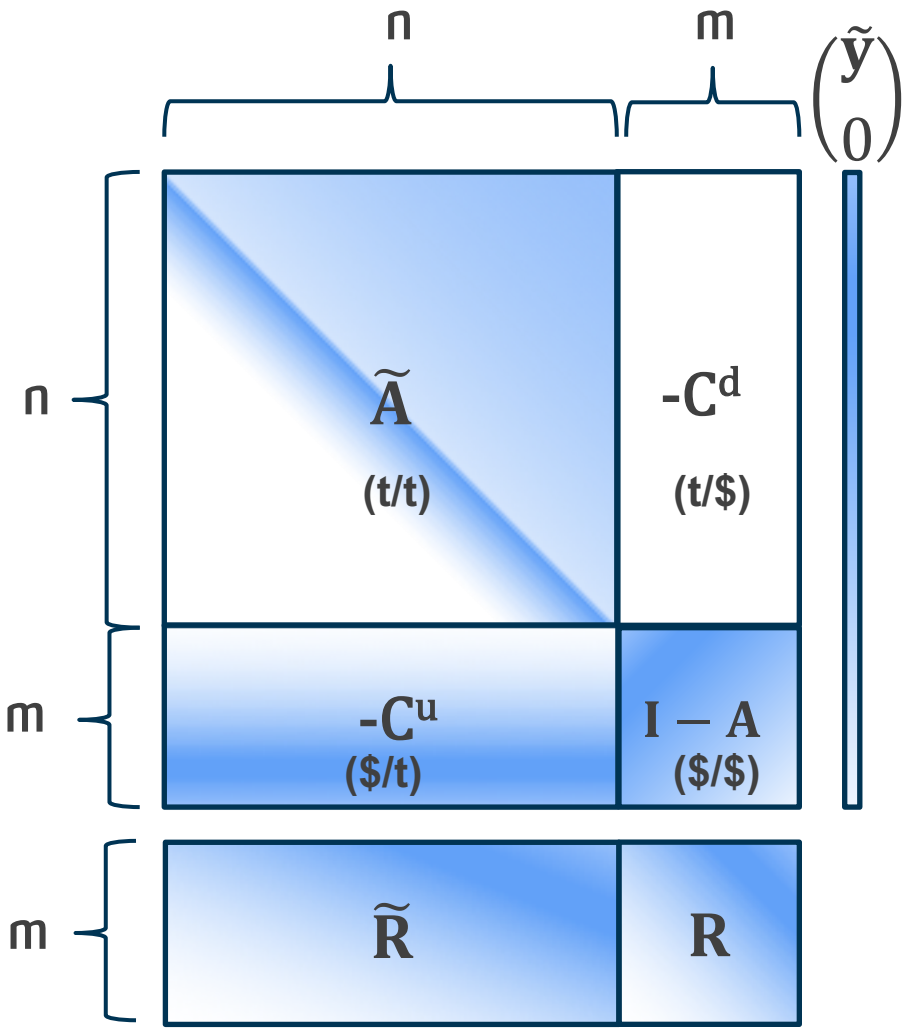
Method & Data

Integrated Hybrid LCA Model

$$\mathbf{E_{IH}} = \begin{bmatrix} \widetilde{\mathbf{R}} & 0 \\ 0 & \mathbf{R} \end{bmatrix} \begin{bmatrix} \widetilde{\mathbf{A}} & -\mathbf{C^d} \\ -\mathbf{C^u} & \mathbf{I} - \mathbf{A} \end{bmatrix}^{-1} \begin{pmatrix} \tilde{\mathbf{y}} \\ 0 \end{pmatrix}$$

$\mathbf{E_{IH}}$ = total (direct and indirect) environmental impact;
$\widetilde{\mathbf{R}}$ = diagonalized process inventory environmental extension ($m \times n$);
$\mathbf{R}$ = diagonalized IO environmental extension ($m \times n$);
$\widetilde{\mathbf{A}}$ = matrix representation of process inventory ($n \times n$);
$\mathbf{I}$ = identity matrix ($m \times m$);
$\mathbf{A}$ = IO technology coefficient matrix ($m \times m$);
$\mathbf{C^u}$ = upstream cut-off matrix ($m \times n$);
$\mathbf{C^d}$ = downstream cut-off matrix ($n \times m$);
$\begin{pmatrix} \tilde{\mathbf{y}} \\ \mathbf{0} \end{pmatrix}$ = final demand column ($(n + m) \times 1$).



(Source: Suh and Huppes 2000; Acquaye et al. 2011; Dadhich et al. 2015; Nakamura and Nansai 2016)

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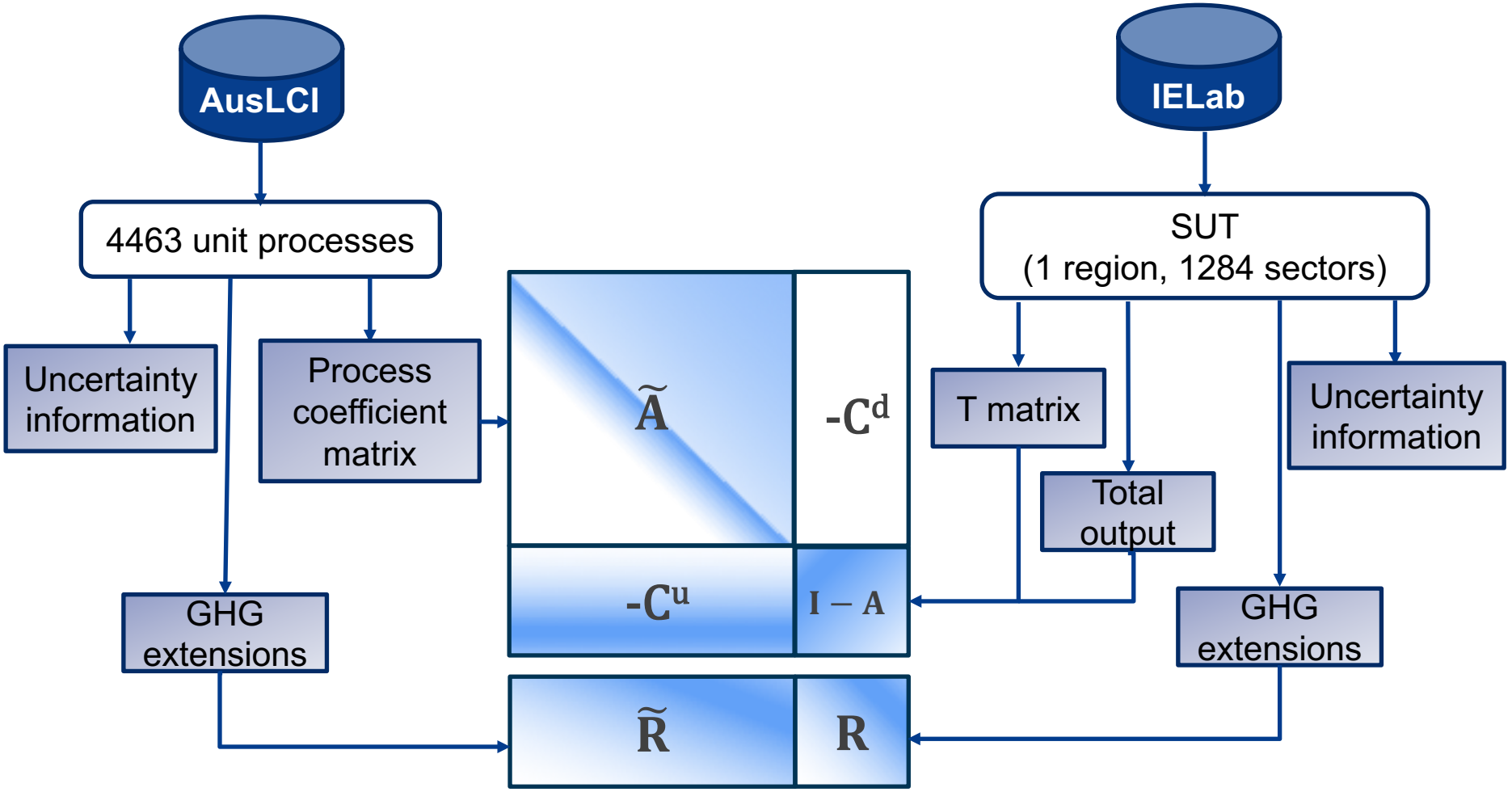
Method & Data



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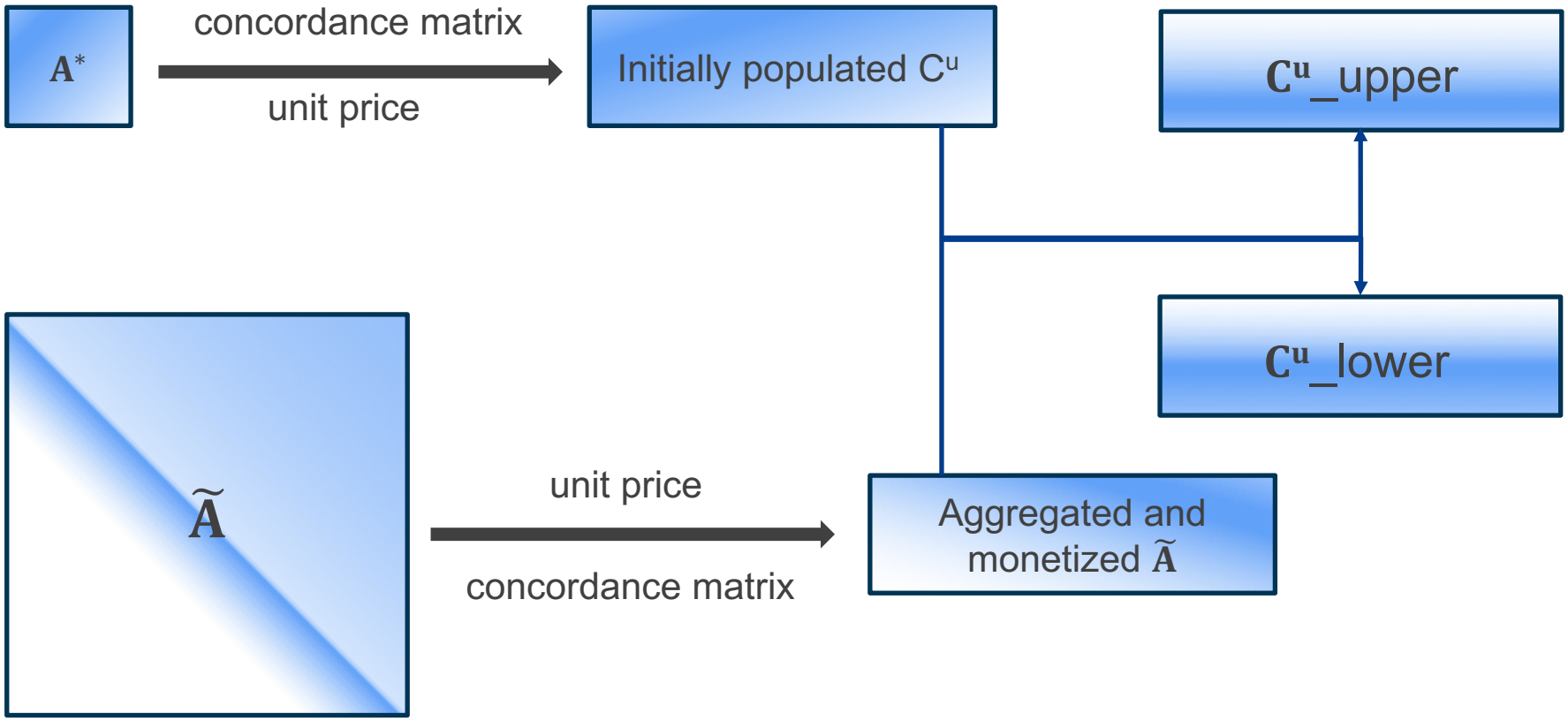
Method & Data

Upstream cutoff matrix C^u



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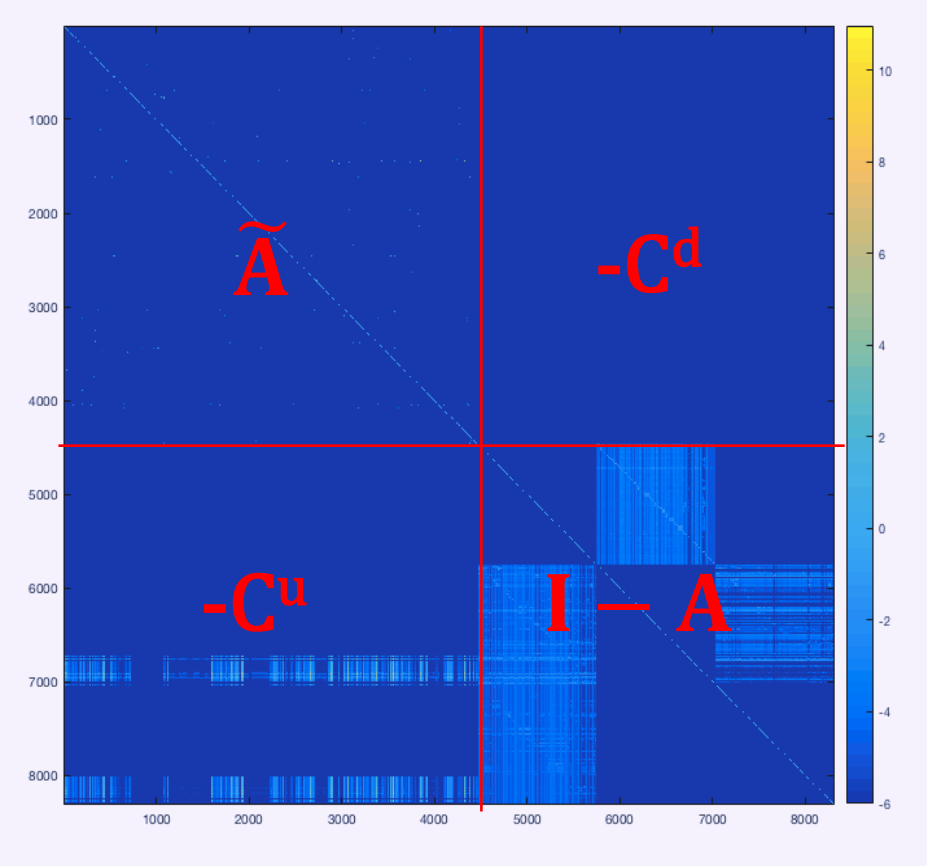
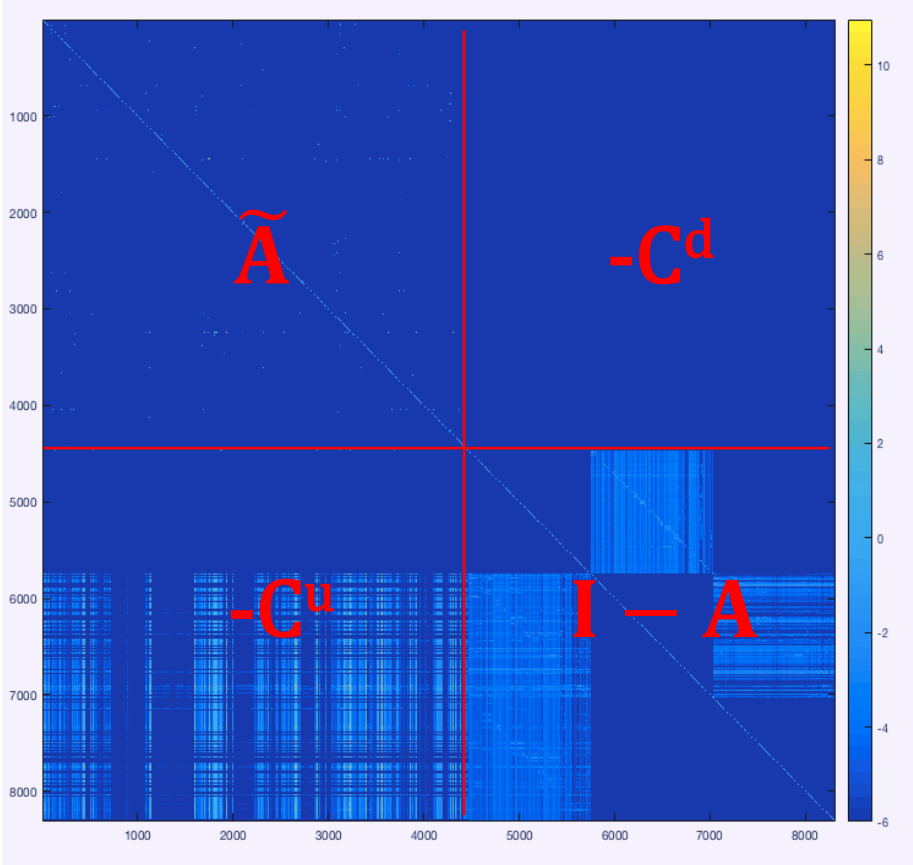
Results

Heatmap of hybrid matrix



lower bound



upper bound

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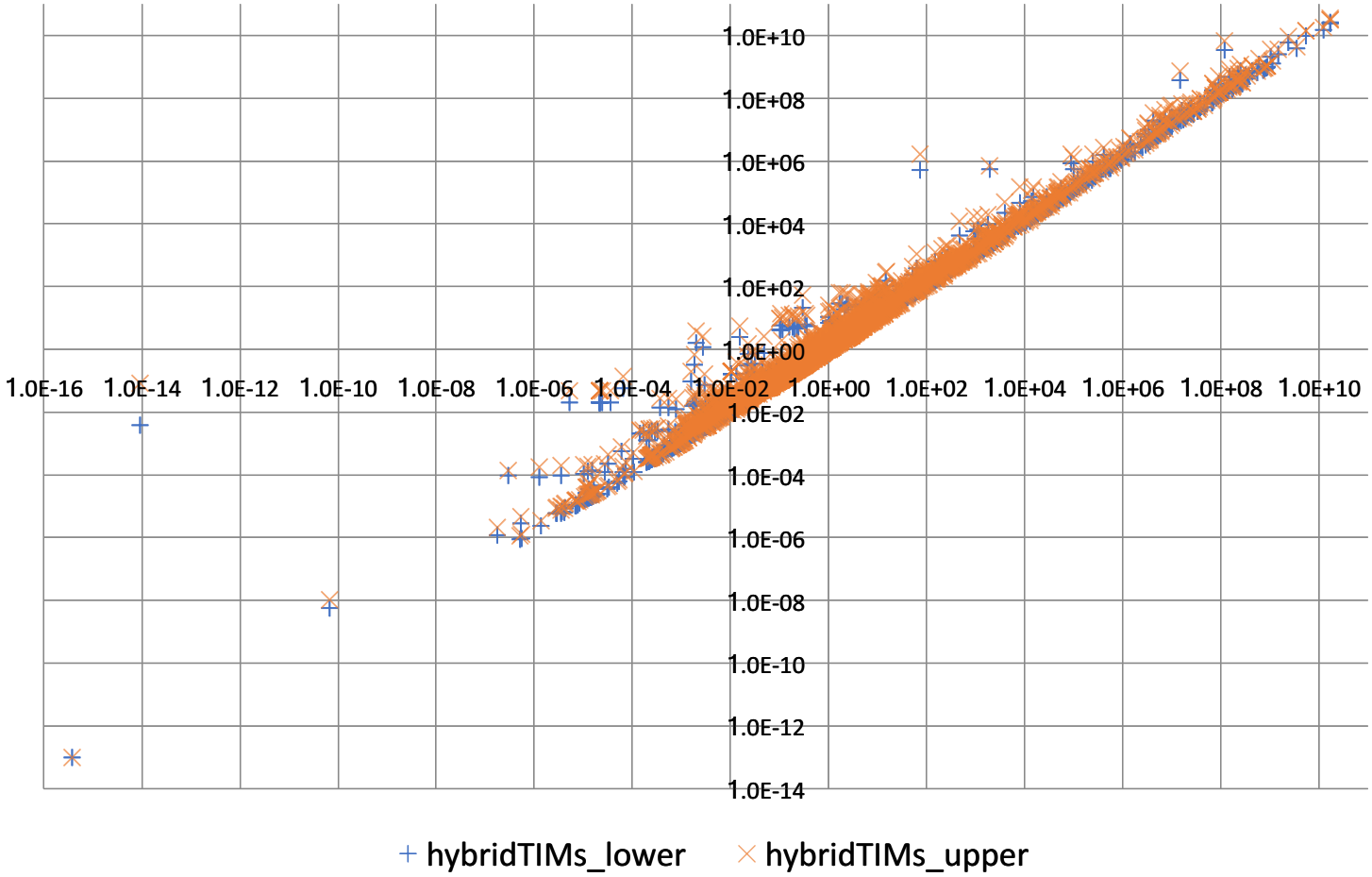
Results

Hybrid TIMs of 4331 AusLCI processes (unit: $kgCO_2e$/functional unit)

(in 4463 processes, 132 processes have either 0s or negatives for their hybrid TIMs and/or process TIMs, see appendix)



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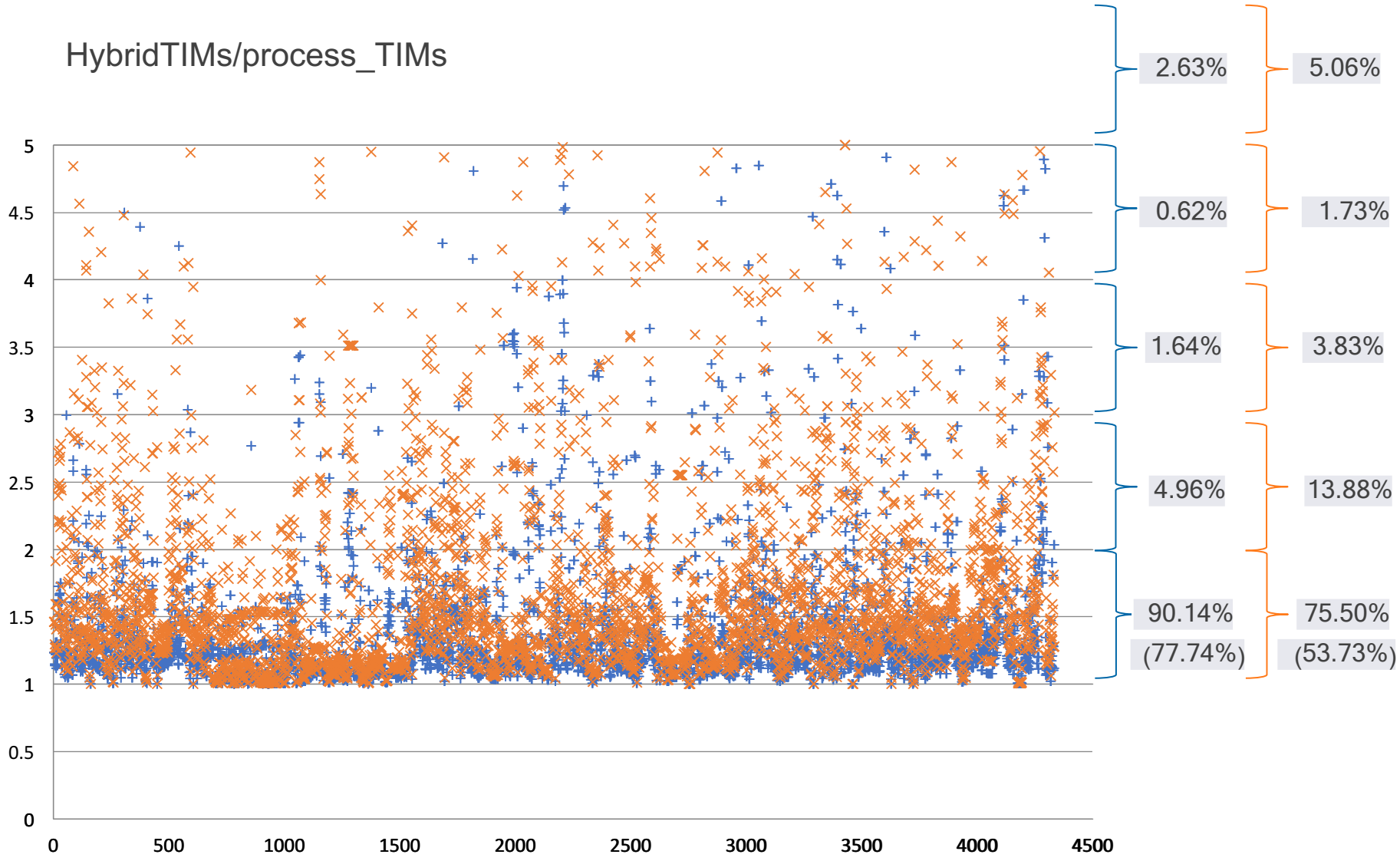
Results



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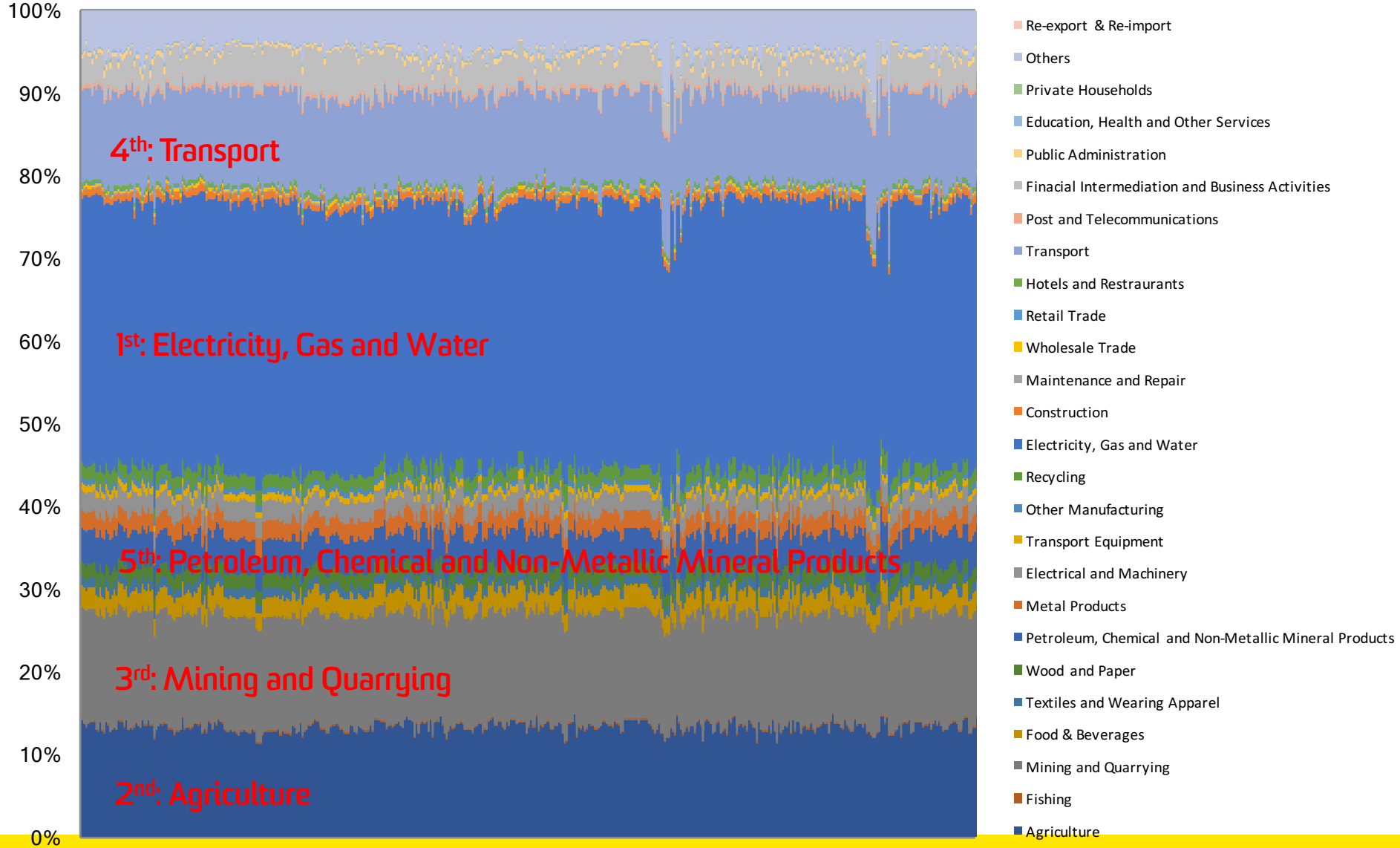
Results (relative contribution to hybridTIMs_lower from aggregated IO system)



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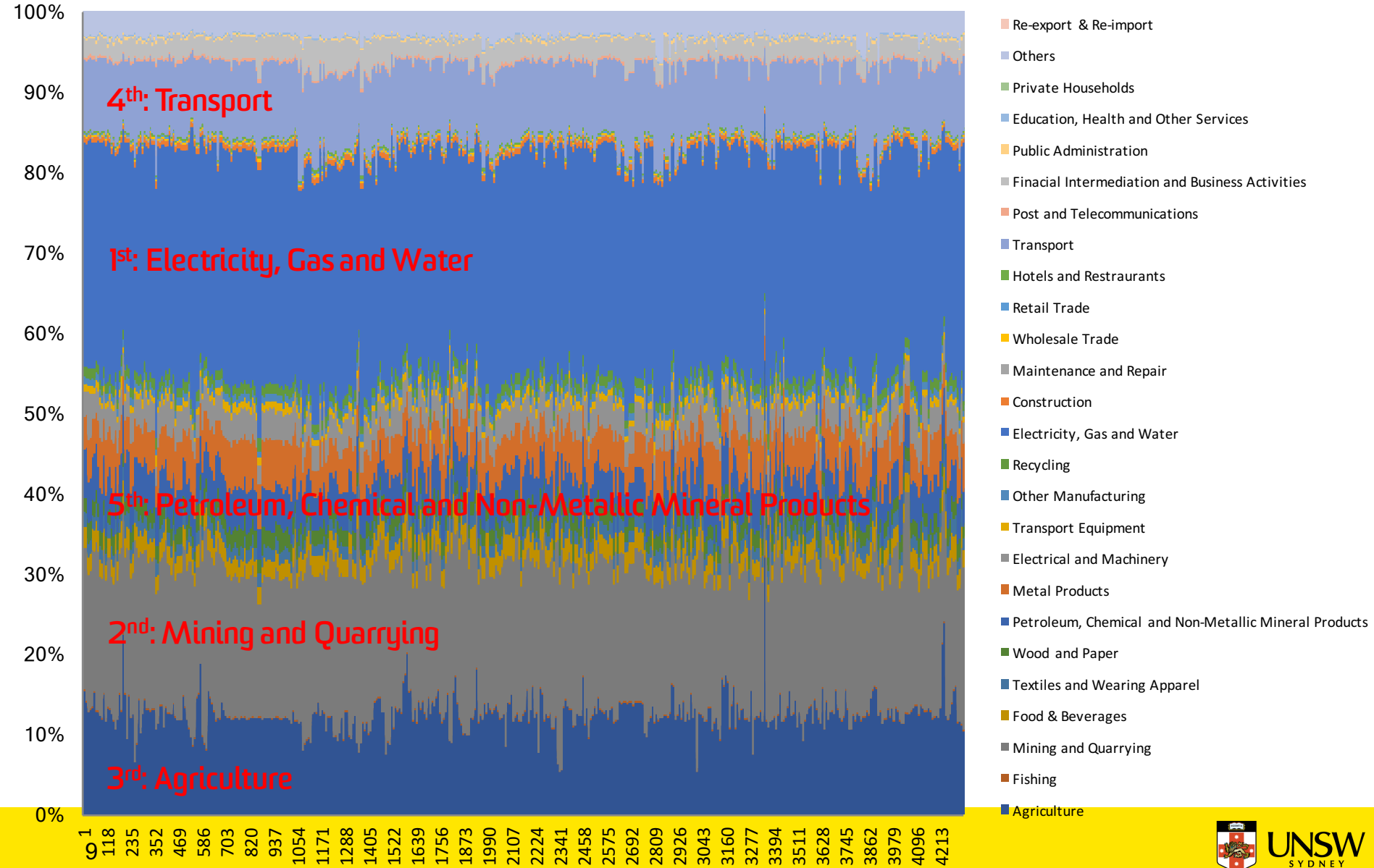
Results (relative contribution to hybridTIMs_upper from aggregated IO system)



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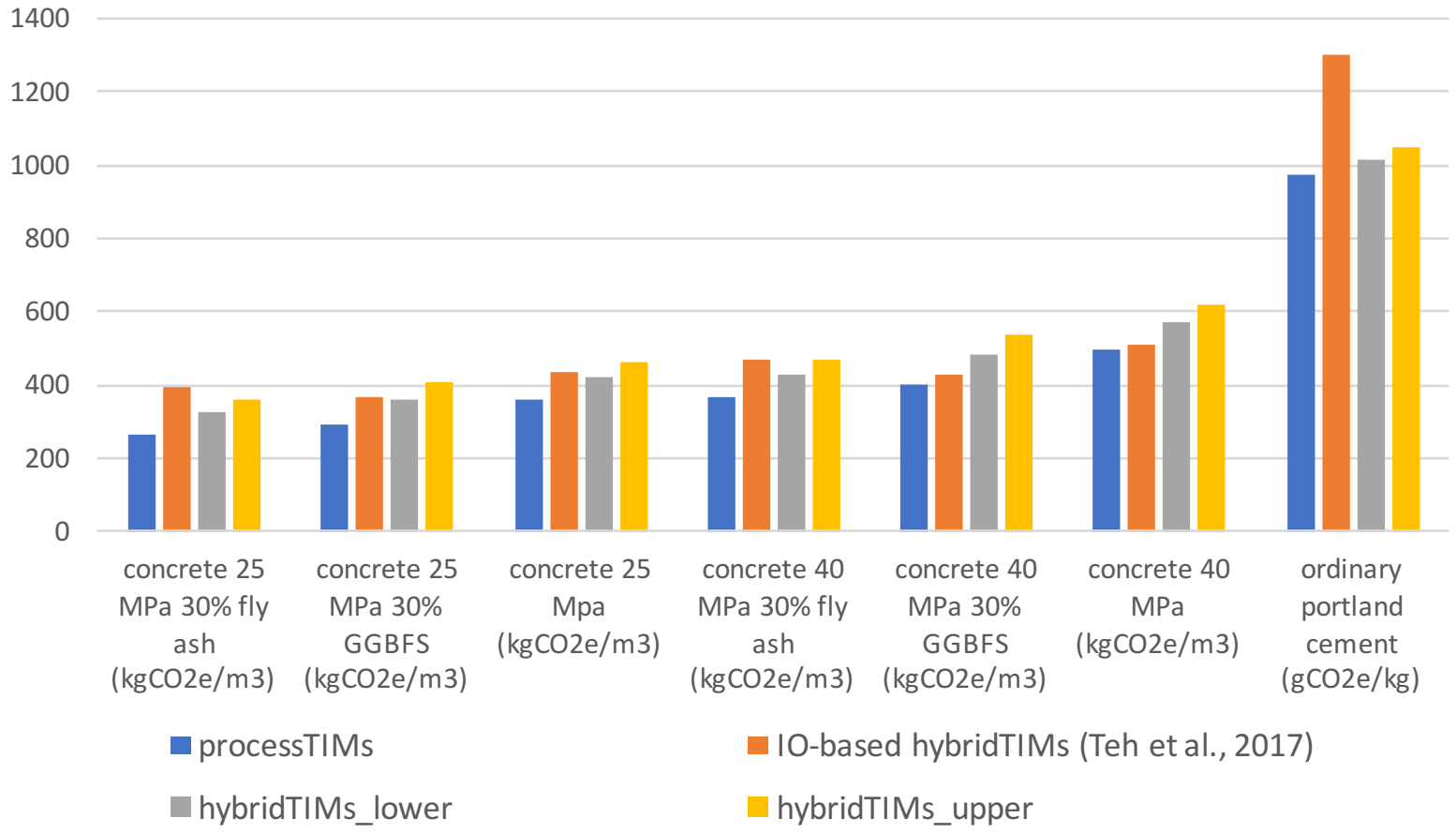
Results

Comparison of hybrid carbon footprint intensities of seven types of construction materials between this study and (Teh et al. 2017)



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Subsequent Work

- Model development
  - Uncertainty / Sensitivity Analysis
  - Automation

  - Regionalization

- Model application

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Thank You

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(Image credit: Shutterstock)

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