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Sistemi e Tecnologie Industriali Intelligenti
per il Manifatturiero Avanzato
Consiglio Nazionale delle Ricerche

Agency for Science, Technology and Research
SINGAPORE

Coupling Brightway2 with the Stochastic Technology Choice Model

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Brightcon 2020 – 20th October

Summary

1. **Motivation and Methods**
2. **Results and discussion**
3. **Conclusions**

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Motivation and methods

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Model choice motivation

What are the potential impacts due to the introduction of the Gr3n technology into the European bottle-grade PET market?

New PET chemical recycling technology: Gr3n → market mixes cannot be available

TRADITIONAL LCA METHODS

Cannot explicitly model:

A. production capacities

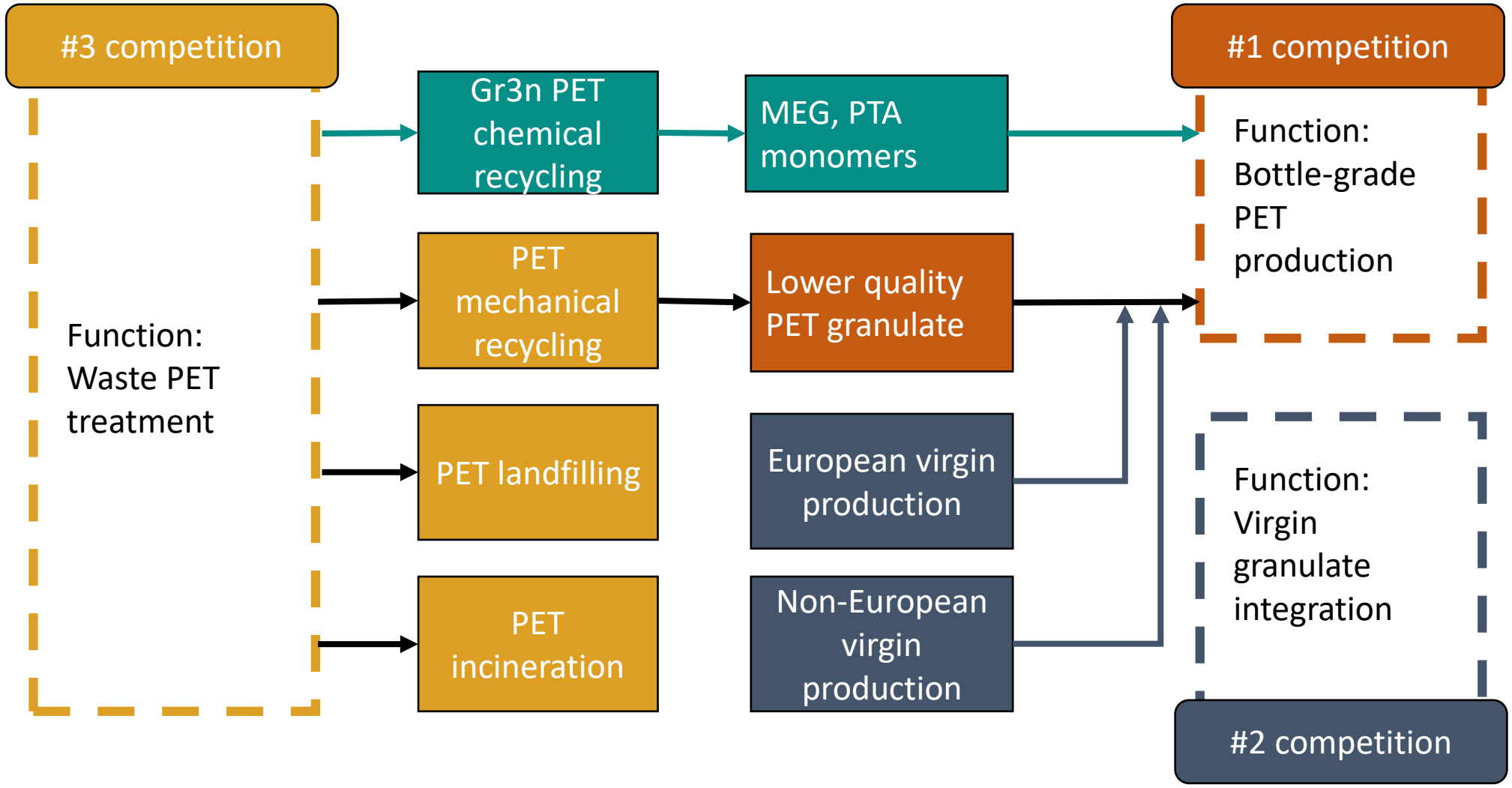
B. competition between different technologies which provide the same function.

STOCHASTIC TECHNOLOGY CHOICE MODEL

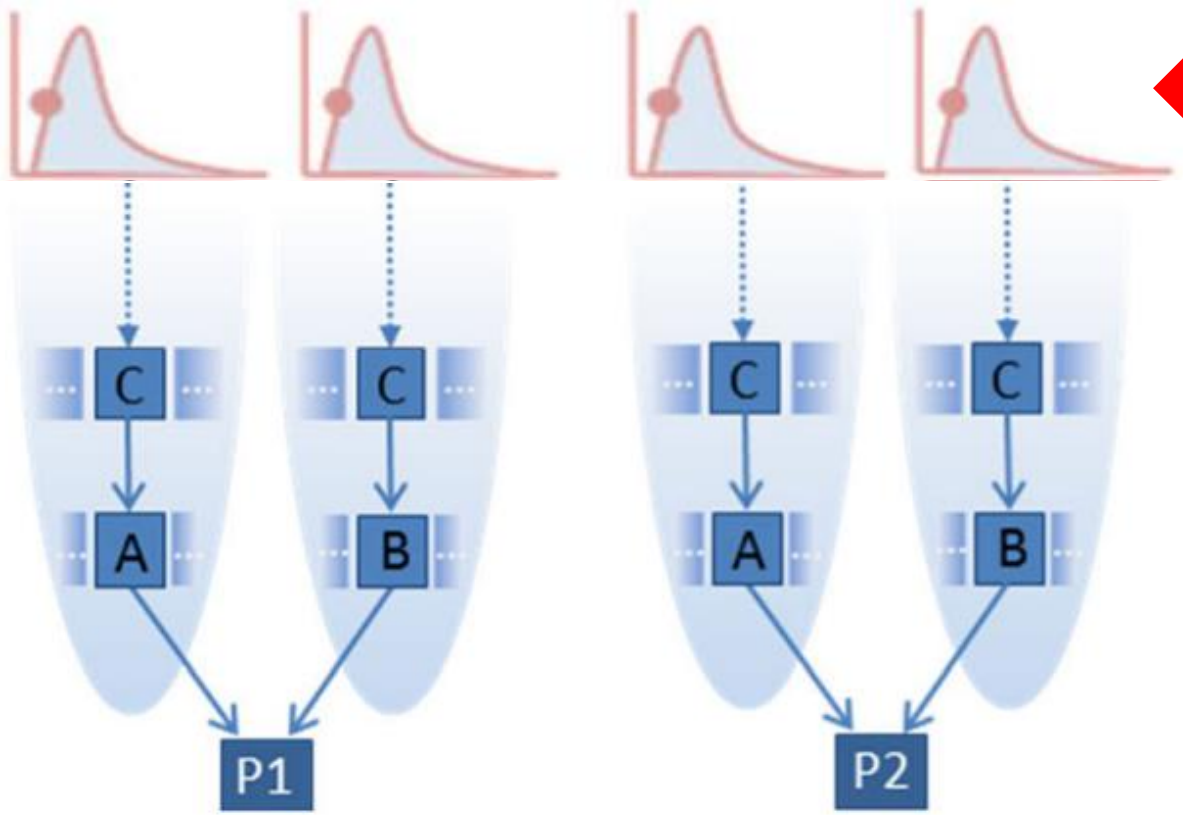
- >1 unit processes compete for providing the same function → rectangular technology matrix **A**
- Constraints on production capacities of the different technologies
- Optimized market mixes, under least-cost criteria
- Stochastic costs and constraints with lognormal distributions, additional gaussian component to model sub-optimal decisions. Monte Carlo Simulation.

Kätelhön, A., Bardow, A., Suh, S., 2016. Stochastic Technology Choice Model for Consequential Life Cycle Assessment.

Competition within the STCM



The problem: obtaining a dependent sampling



Comparative LCA of two products (P1 and P2), which both involve two processes, A and B, which are drawn from an LCI database.

→ In Brightway2: for each Monte Carlo run, being able to change both final demand vector and impact category while keeping the same generated technosphere matrix

Suh, S., Qin, Y., 2017. Pre-calculated LCIs with uncertainties revisited.

Schematic representation of the code structure

Ecoinvent uncertainty information (pedigree approach)

STCM uncertainty information

Part 1: Unitary impact assessment of the competing technologies with Brightway2

Monte Carlo runs

Impact categories

RandQ

Technologies

Part 2: Technological mixes determination and impact assessment with the STCM

Monte Carlo runs

Impact categories

LCA results

Sensitivity analyses

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Results and discussion

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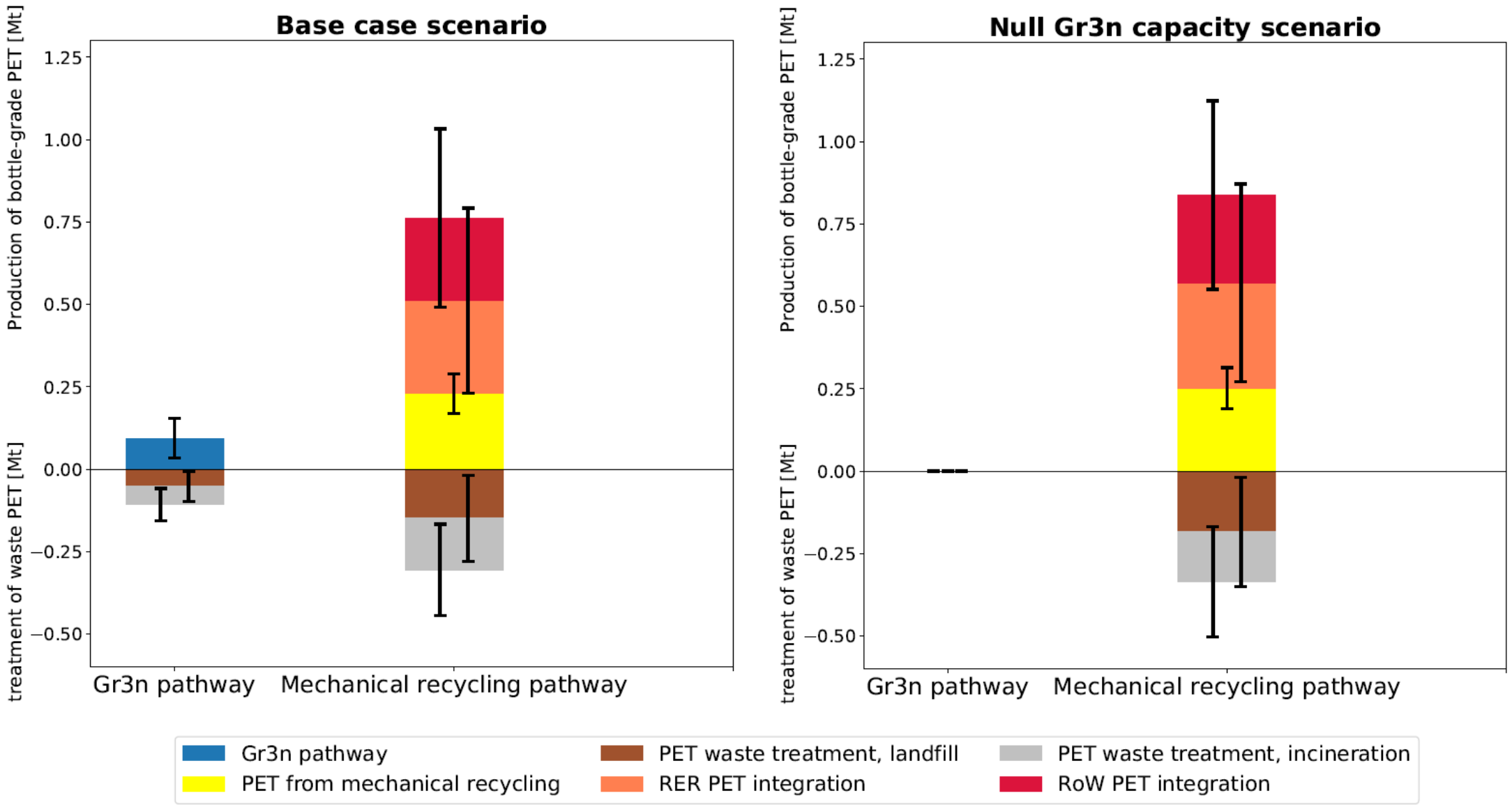
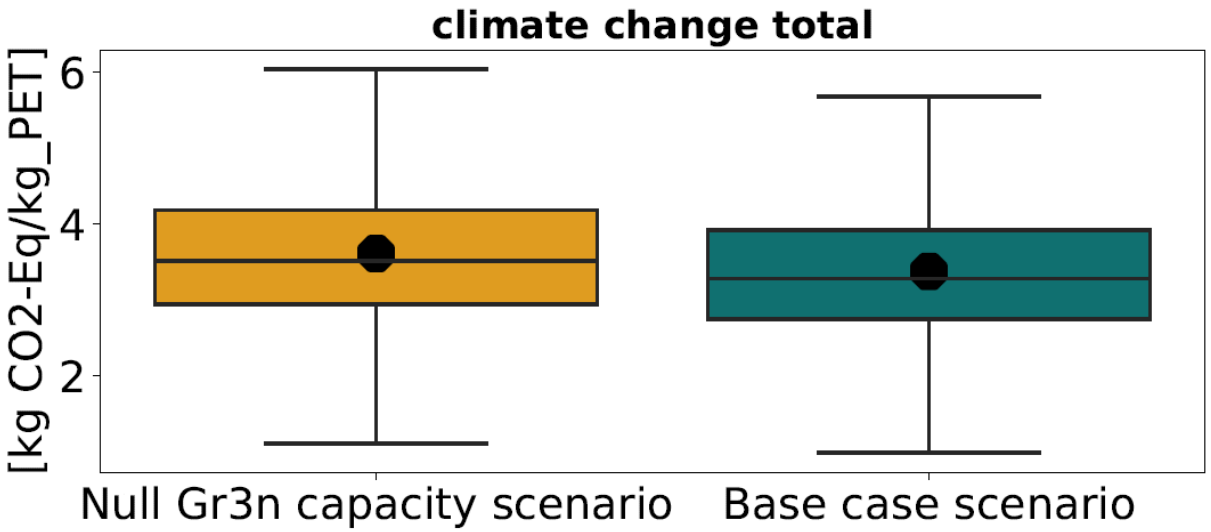
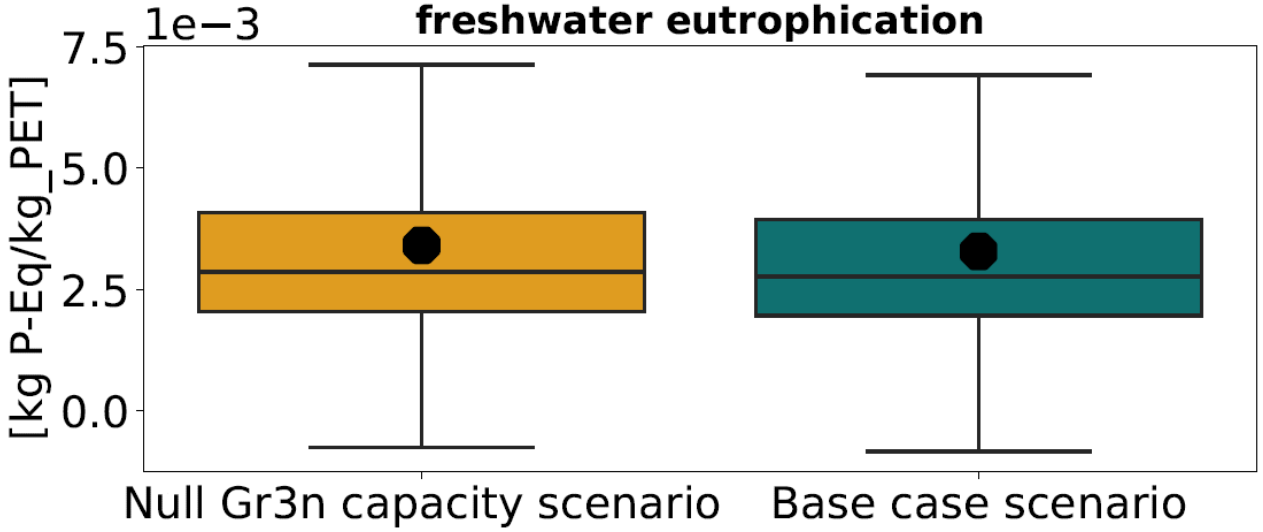
PET supply mixes



LCIA indicators distribution



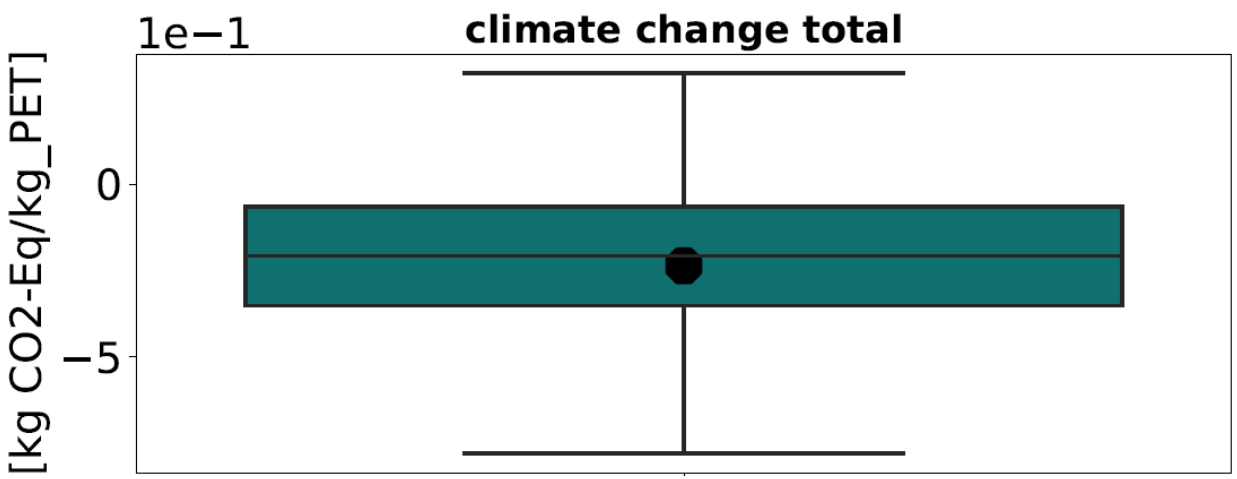


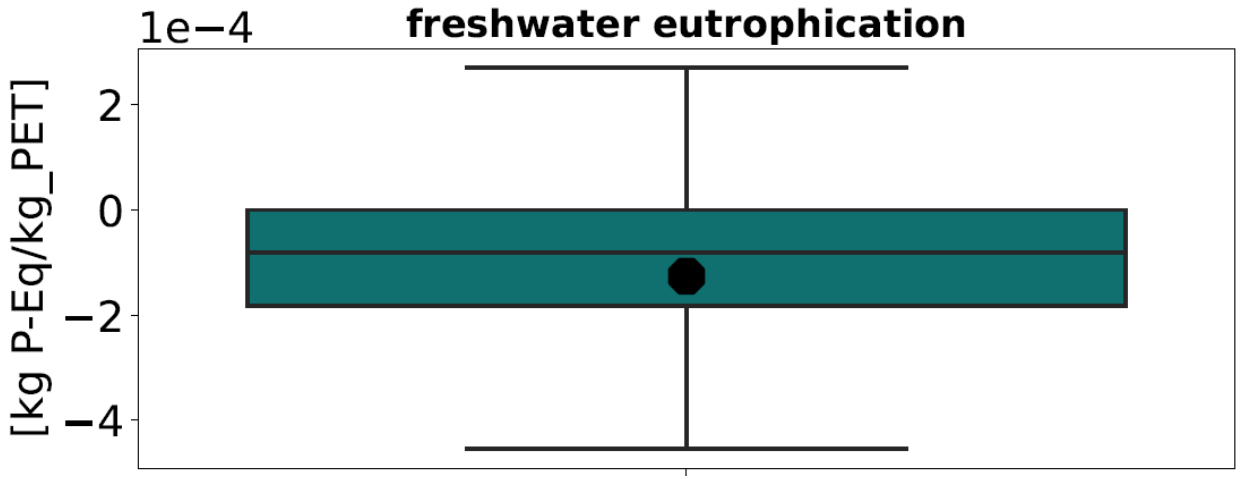
Considering the average values (black dots in the figures), 12 of the analysed 16 impact category indicators show a decrease due to Gr3n penetration.

Climate change:
-0.24 kg CO_2-eq variation (-7.0%)

Freshwater eutrophication:
-1.26e-04 kg P-eq variation (-3.8%)

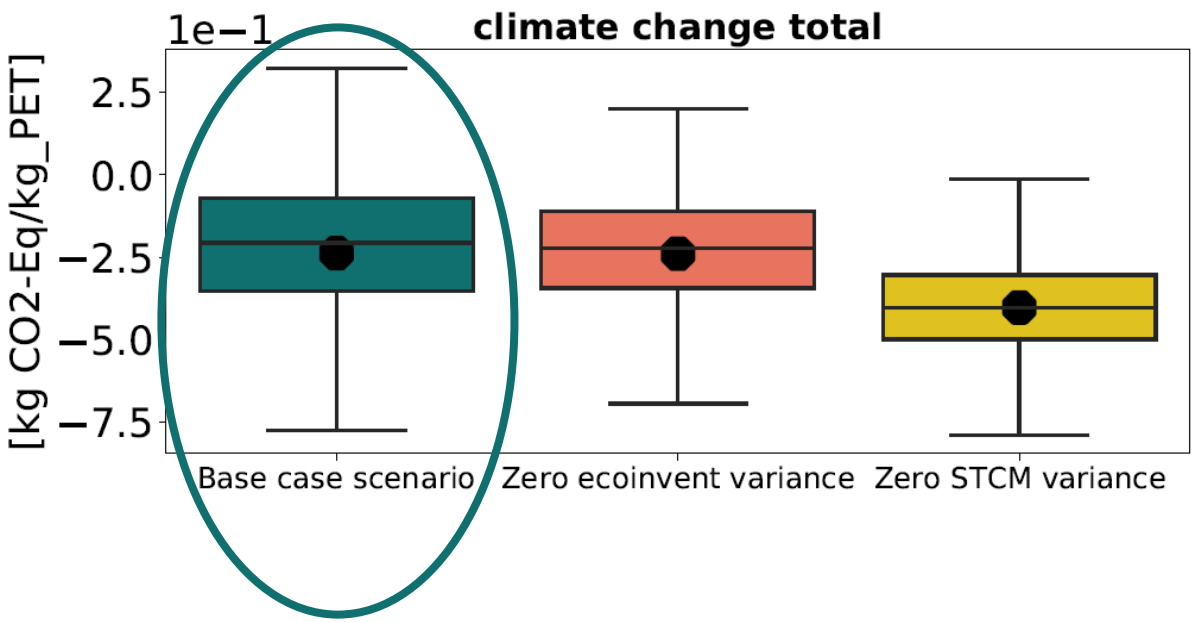
Differences of LCIA indicators distribution

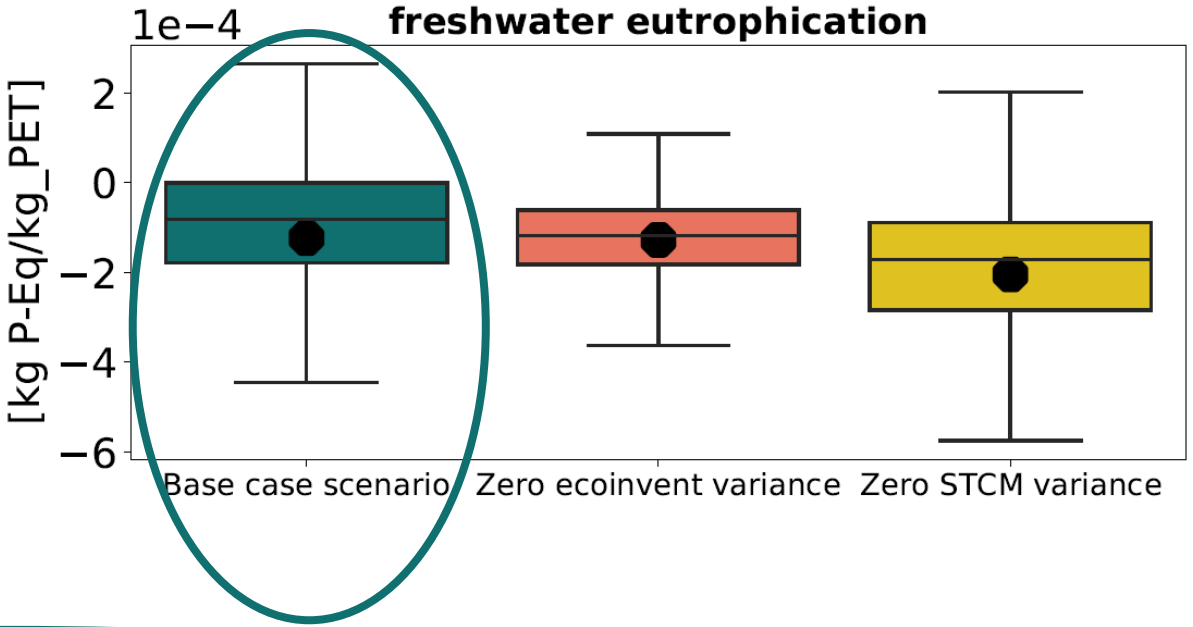


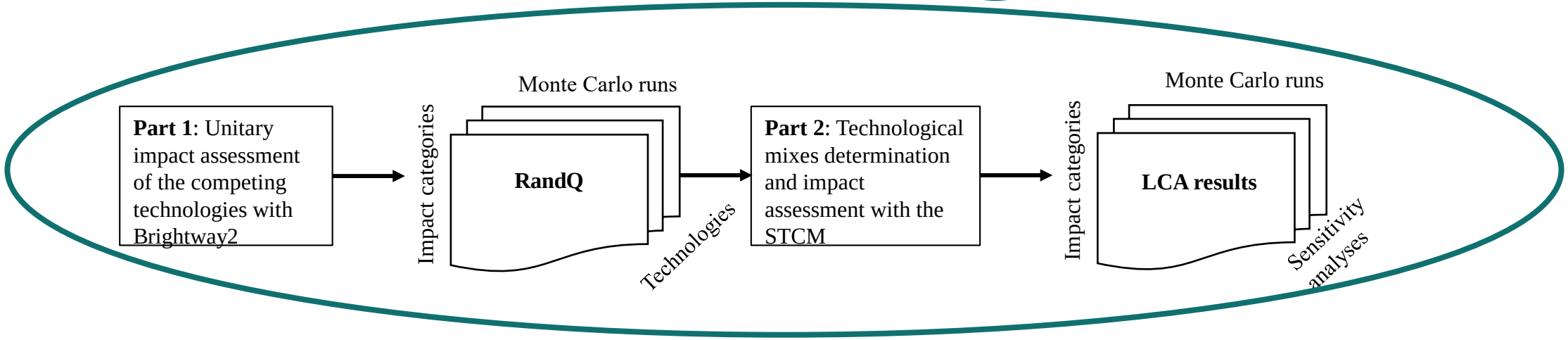


The differences vary on a much smaller scale

Attribution of variability of differences







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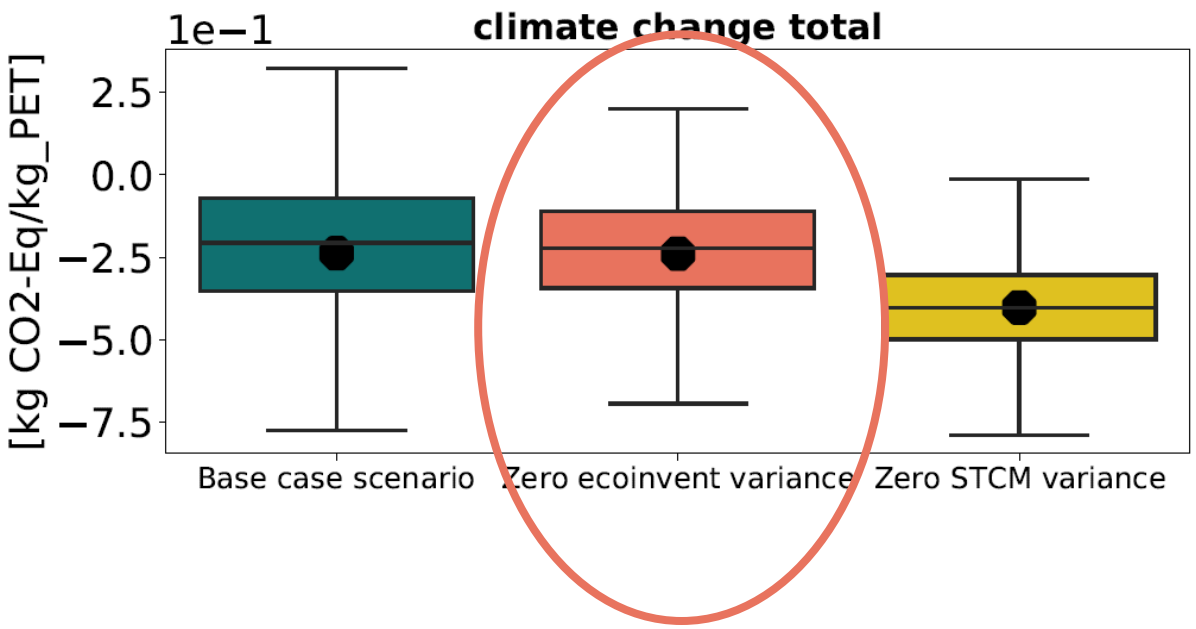

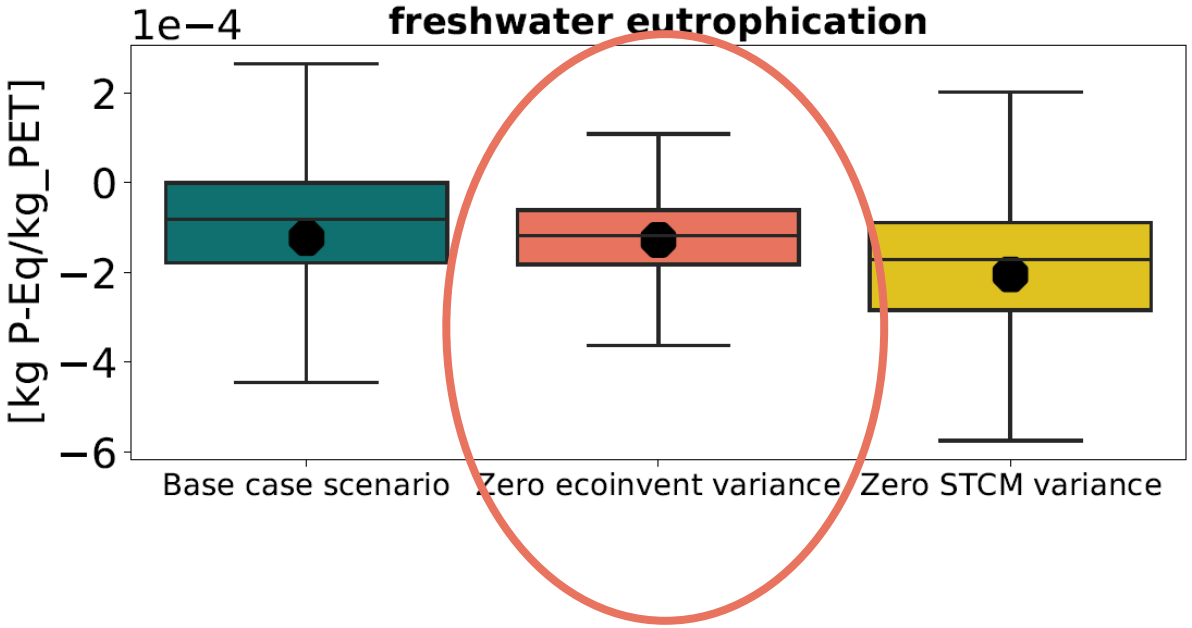

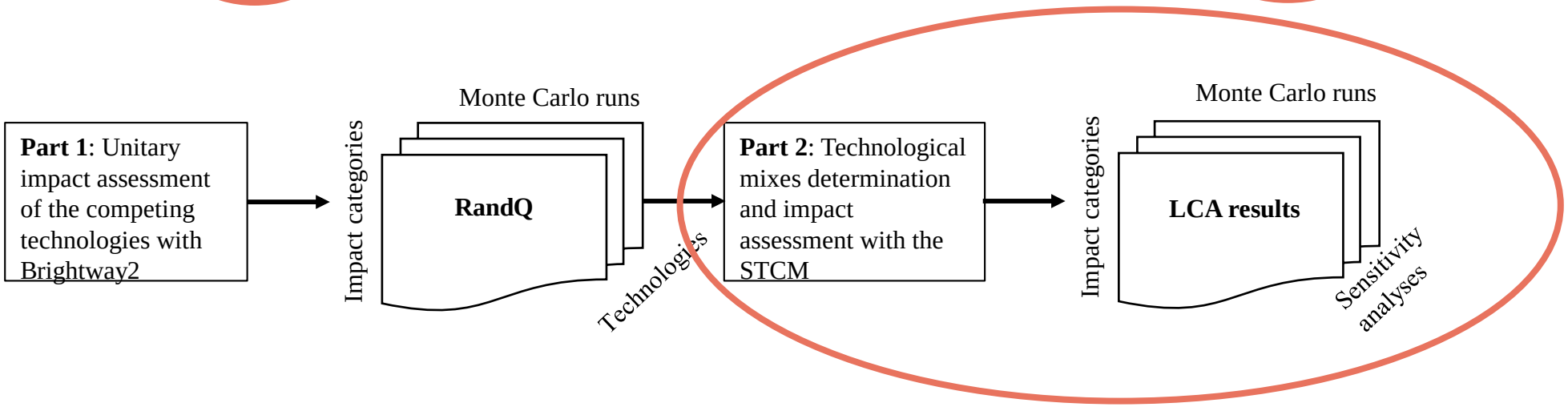

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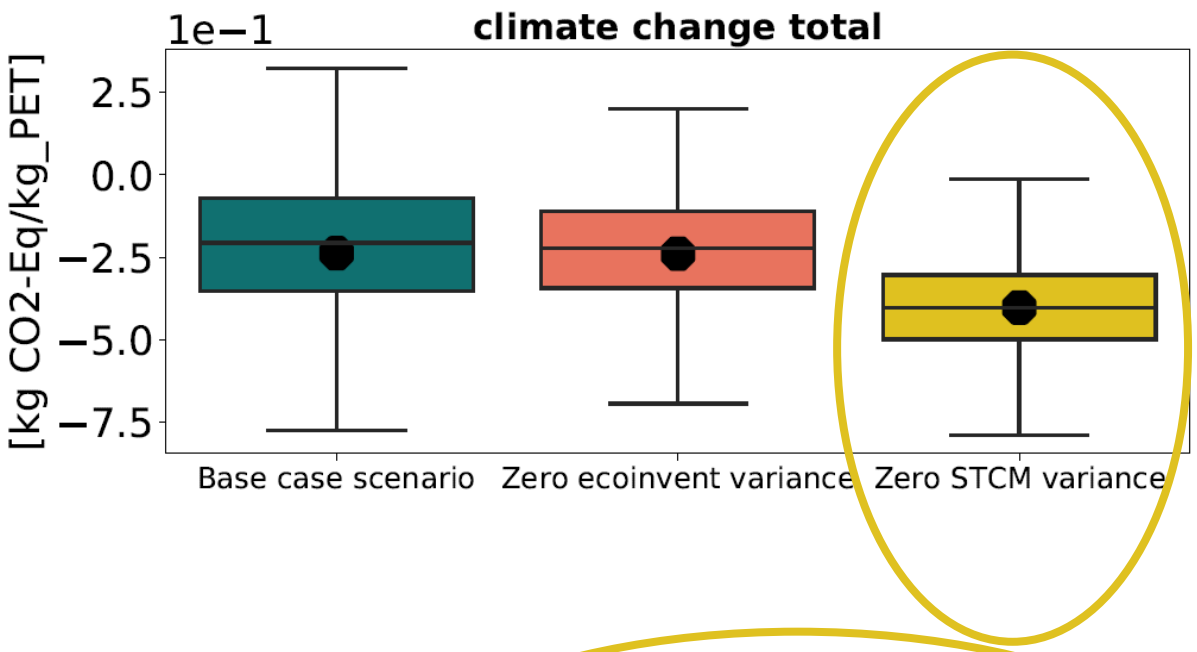

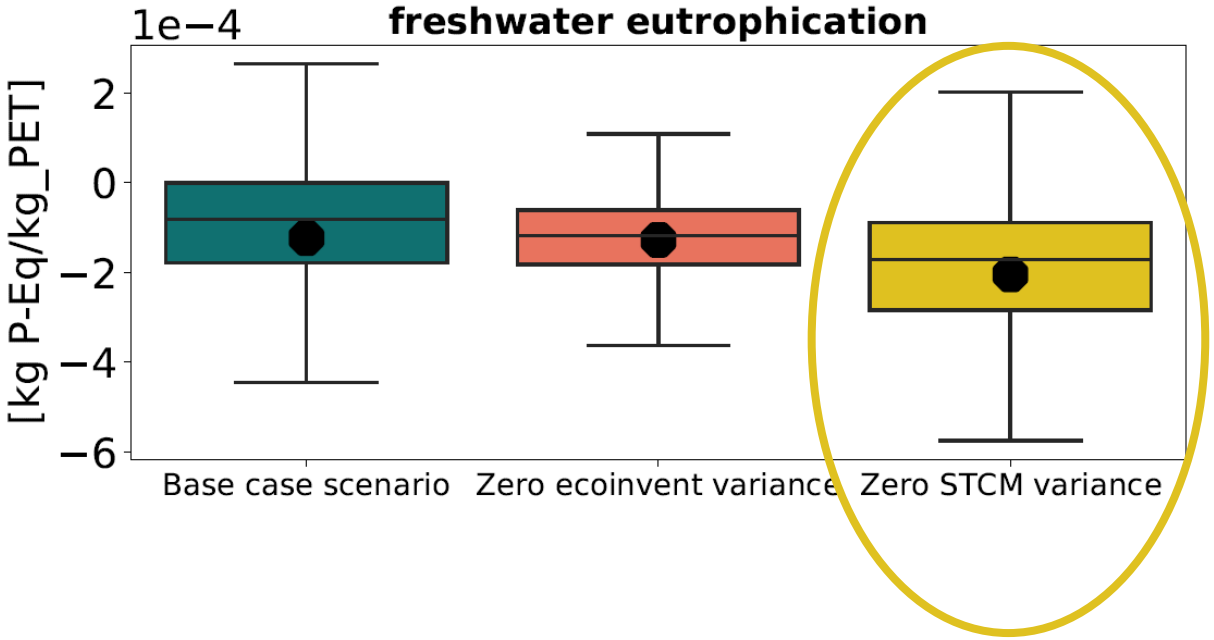

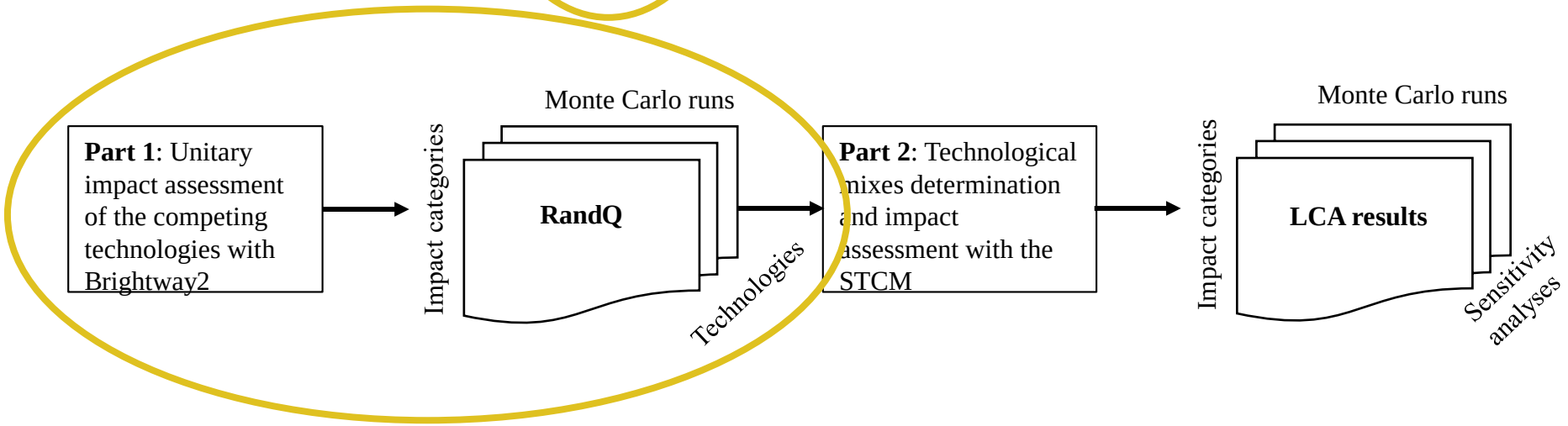

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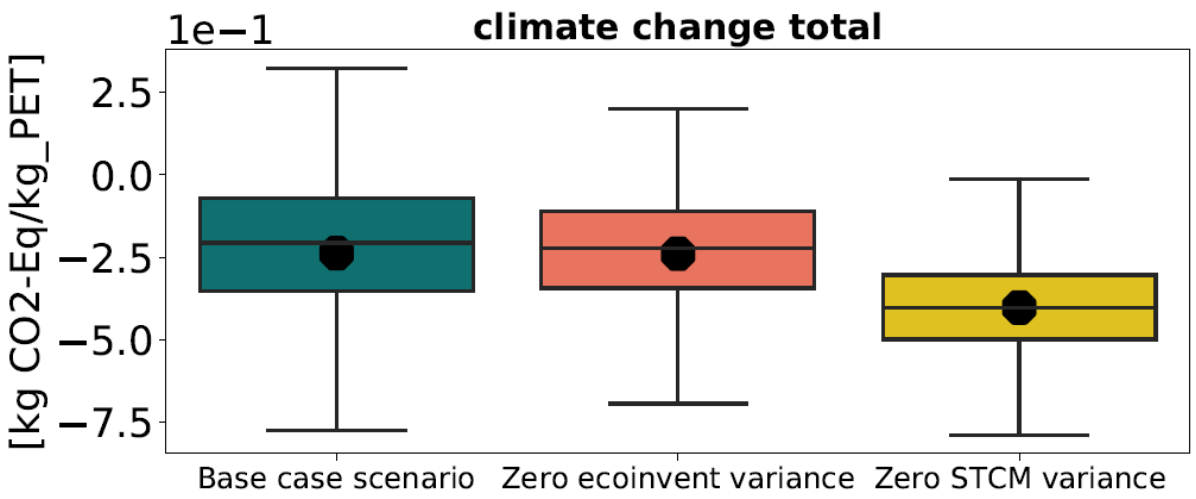

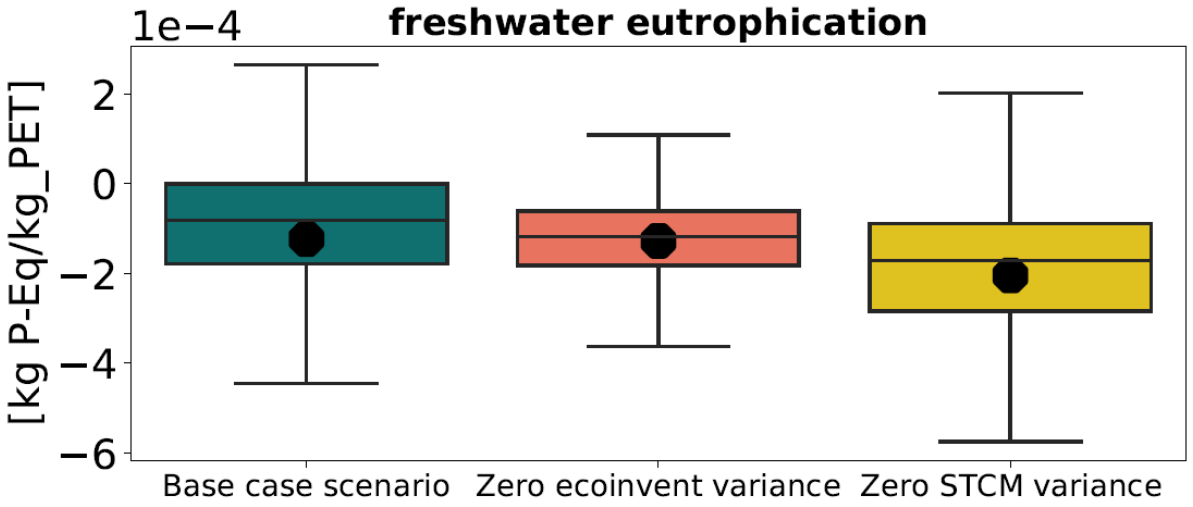

The **STCM** uncertainty information **shifts the average** point of the differences distribution

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Conclusions

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Outcomes and perspectives

The STCM helps investigating the uncertainty related to new potential market mixes due to the introduction of the Gr3n technology into the European bottle-grade PET market.

Brightway allowed to perform a **dependent sampling** in the Monte Carlo Simulation, i.e. keeping the same background system when calculating the LCIs of different processes.

Possibility to **manage the entire workflow** within the same software.

12 out of 16 ILCD 2.0 impact categories show a decrease of impact indicator results due to the introduction of the new technology.

The dependence of results variability on either Ecoinvent or the STCM depends on the selected impact category. The STCM moves the average of the distribution.

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Thank you!

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