

# Multi-Objective Optimisation of Energy System Models through Life Cycle and Planetary Boundaries Assessment

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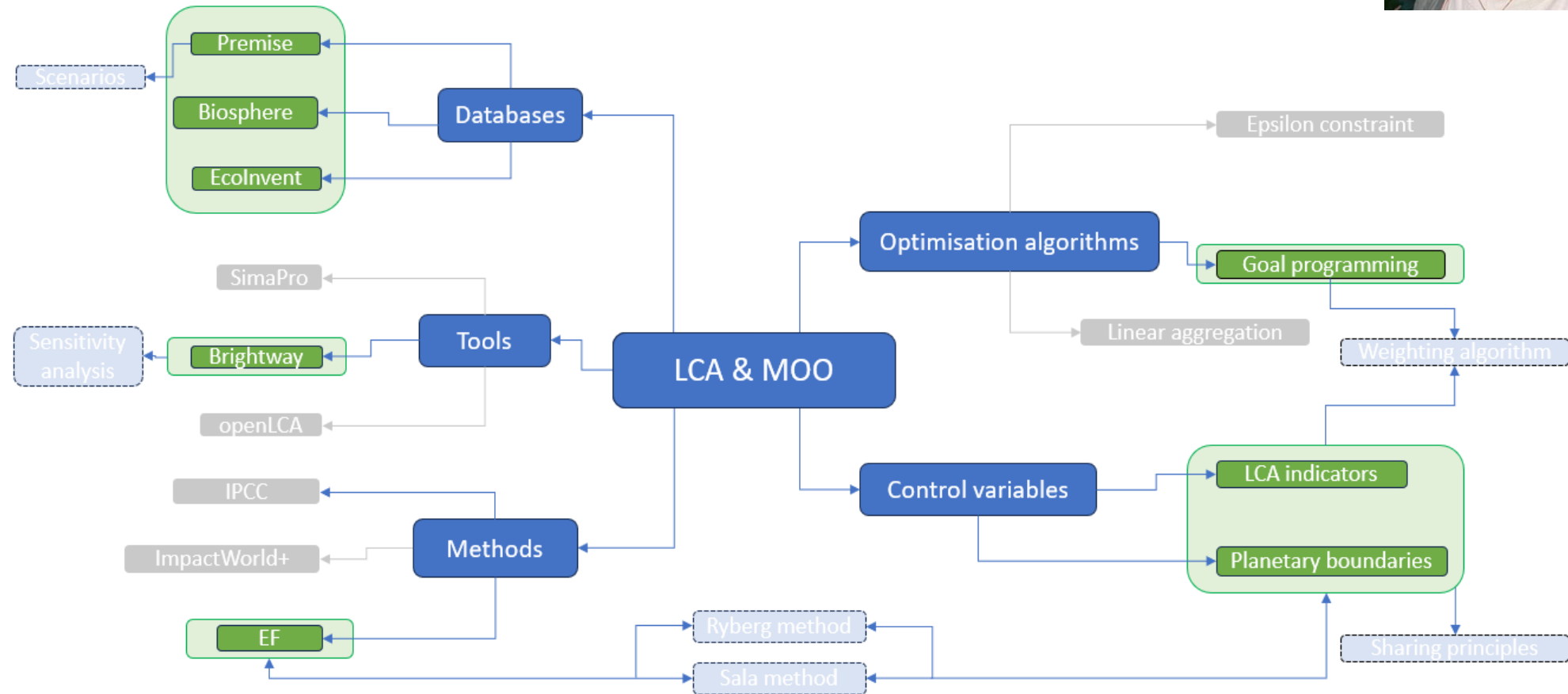
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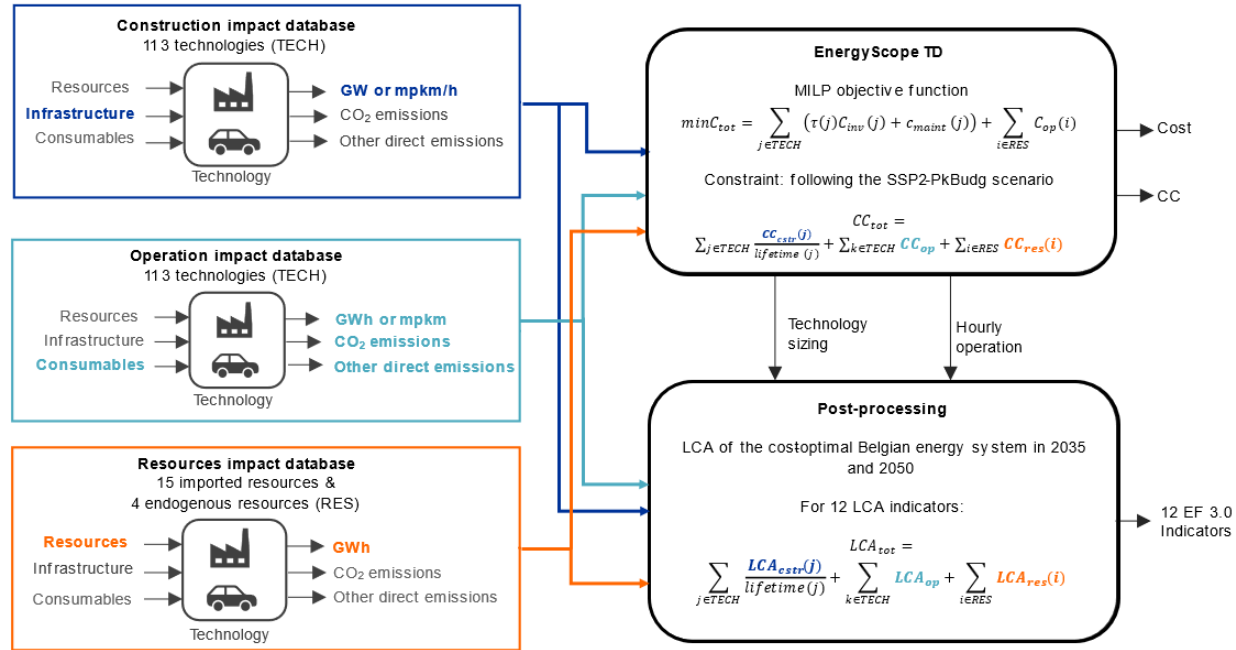
# My research

- 2<sup>nd</sup> year PhD student
- Collaborating with VUB, EPFL and CIRAIG on life cycle assessment integration into EnergyScope



# Methodology

## Databases construction



$\tau(j)C_{inv}(j)$  = annualized investment cost of technology j  
 $c_{maint}(j)$  = maintenance cost  
 $C_{op}(i)$  = operation cost of resource i

$CC_{cstr}(j)$  = construction climate change impact of technology j  
 $CC_{op}(j)$  = operation climate change impact  
 $CC_{res}(i)$  = extraction and transport climate change impact of resource i

CC = Climate change  
EROI = Energy Return On Investment  
MILP = Mixed-Integer Linear Programming

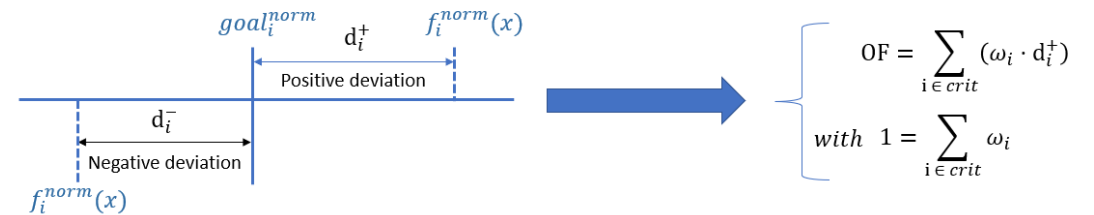
## Sharing principles choice

$$LCA_{tot} \leq \alpha \times PB$$

$\alpha_{util} = \frac{GDP_{BE}}{GDP_{world}}$   
 $\alpha_{egal} = \frac{POP_{BE}}{POP_{world}}$   
 ...

## Objective function modification

	Work with non-convex pareto front	Easy to add new criteria	Robust to initialization
Linear aggregation	?	✓	✓
Epsilon-constrained	✓	?	✓
Min-max	✓	✓	?
<b>Goal programming</b>	✓	✓	✓



## Optimisation algorithm choice

Chebyshev

$$\min(\max_i (LCA_{tot,i}))$$

Pareto Dominance

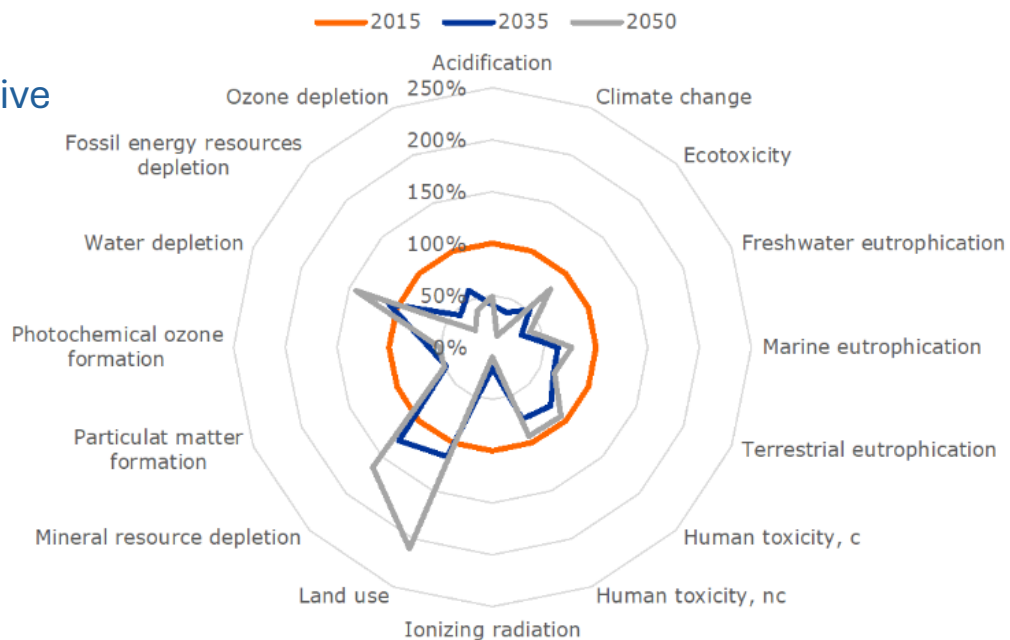
$$\forall i, f_i(x_1) \leq f_i(x_2) \quad \text{and} \quad \exists j, f_j(x_1) < f_j(x_2)$$

...

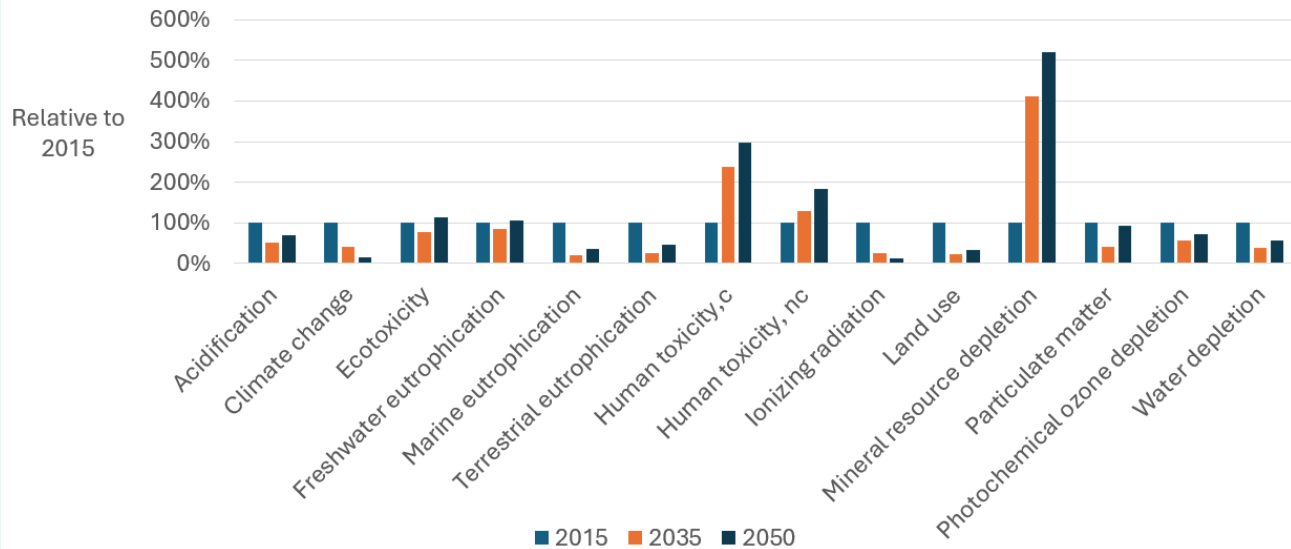
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# Typical results

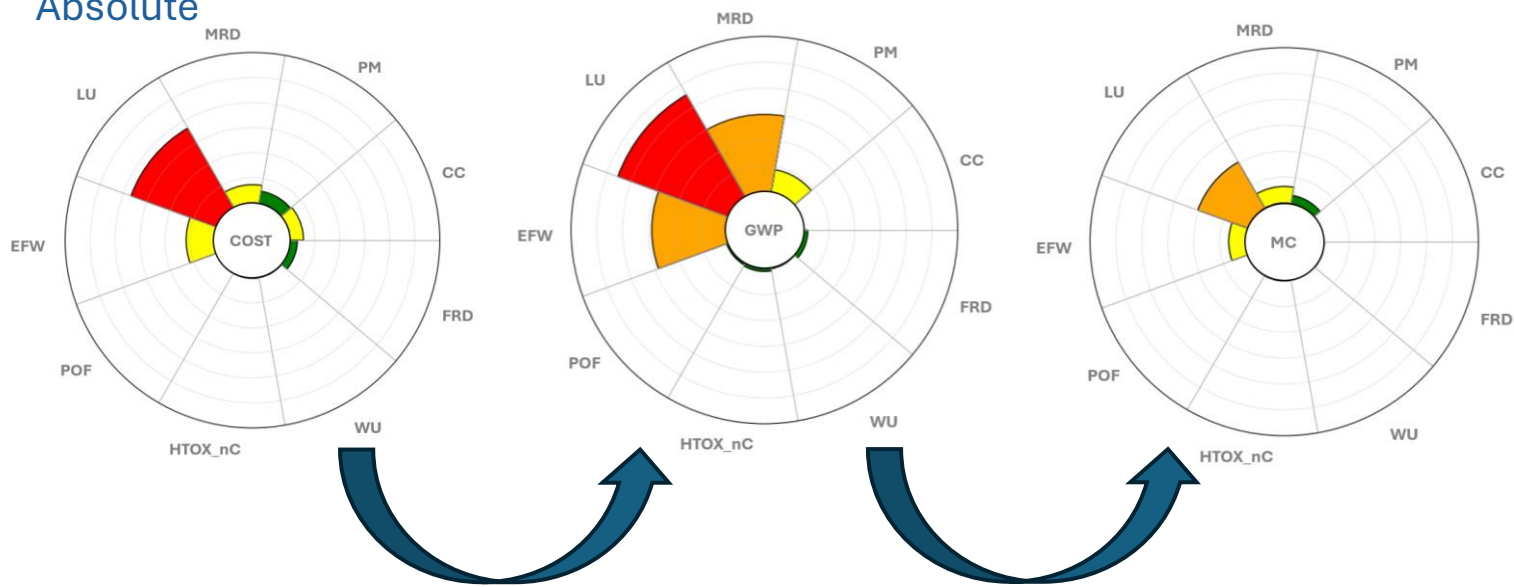
## Relative



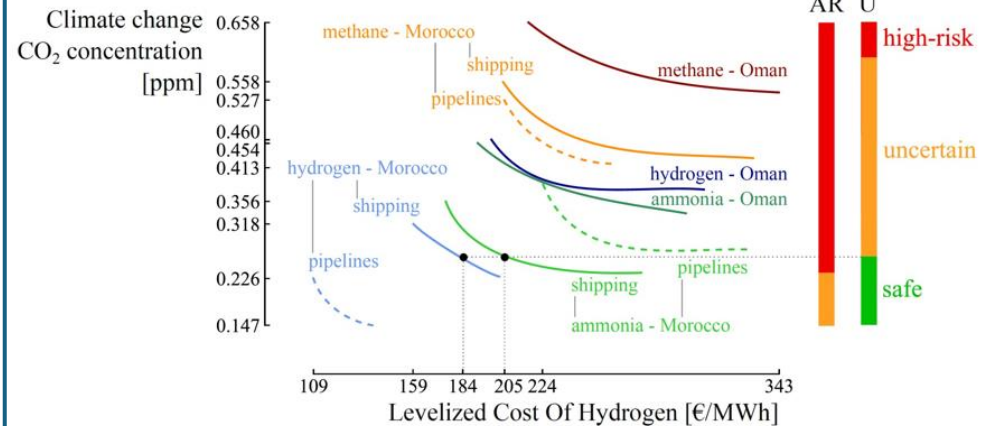
## Prospective



## Absolute



## Near optimal



# What I can bring and what I need

- I can bring :
  - Knowledge regarding LCA integration into Energy System Models
  - Knowledge regarding Planetary Boundaries sharing principles
  - Support regarding LCA tools such as Activity-Browser and Brightway
- I need :
  - People interested in LCA methods to determine the best choice for control variables
  - People interested in Planetary boundaries to determine best approach regarding sharing principles
  - People interested in Planetary boundaries to determine the best optimisation algorithm for energy system design