Hemant Sharma

PhD candidate at CEA Grenoble, France
s.hemant@protonmail.com

INSIGHTS ON USING BRIGHTWAY2 WITH ENERGY SIMULATIONS

How Brightway2 has facilitated the design and assessment of small scale energy systems

BACKGROUND

French commission for atomic and alternative energies

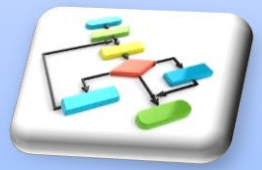
LSED – Laboratory of energy systems and demonstrations

ENERGY SIMULATIONS: LCA INDICATORS MISSING

Technology inputs

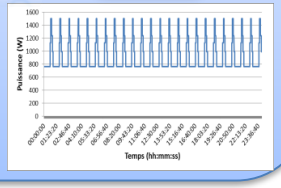
- Components, models (performances, ageing) and parameters (ex: sizing, costs)

- Control strategy



Case specific inputs

Weather, energy demand time Series

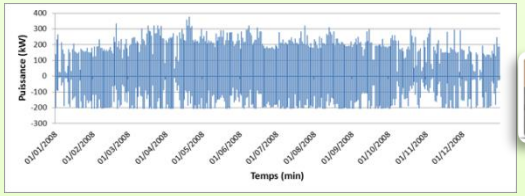


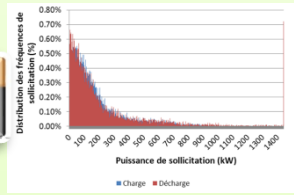
SIMULATION

GLOBAL SENSITIVITY ANALYSIS + OPTIMIZATION

Outputs

- Simulation results specific to each component (time series, mass/energy balances, statistics)





- System Performances Indicators

Technical indicators

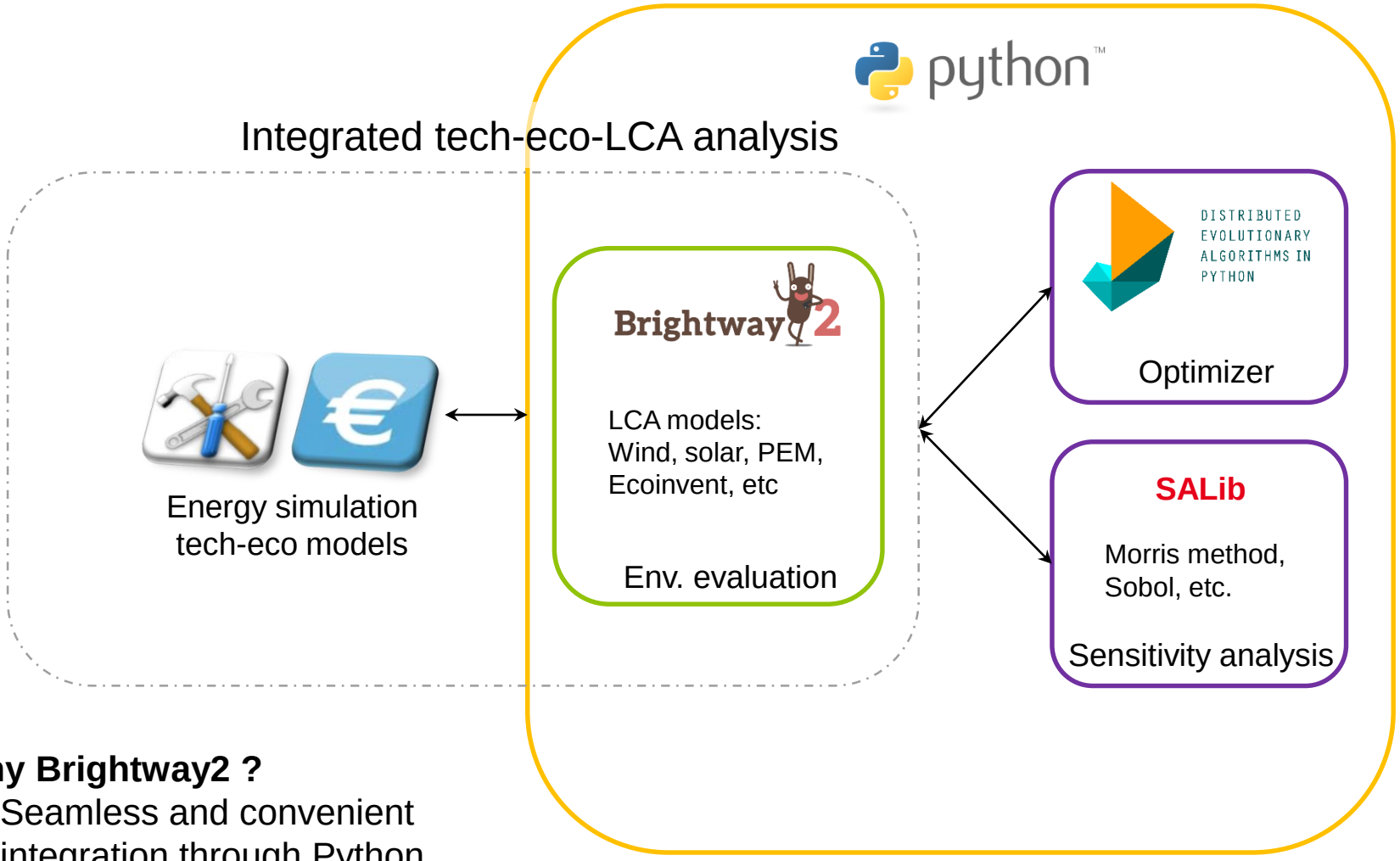
Use rate of RE potential, system footprint, load satisfaction rate, etc.

Economic indicators

Investment costs, payback time, profit, etc.

How to add environmental analysis ?

SOFTWARE ORGANISATION



Why Brightway2 ?

- Seamless and convenient integration through Python
- Access to python libraries

APPLICATION: CASE STUDY

Context:

Hydrogen production

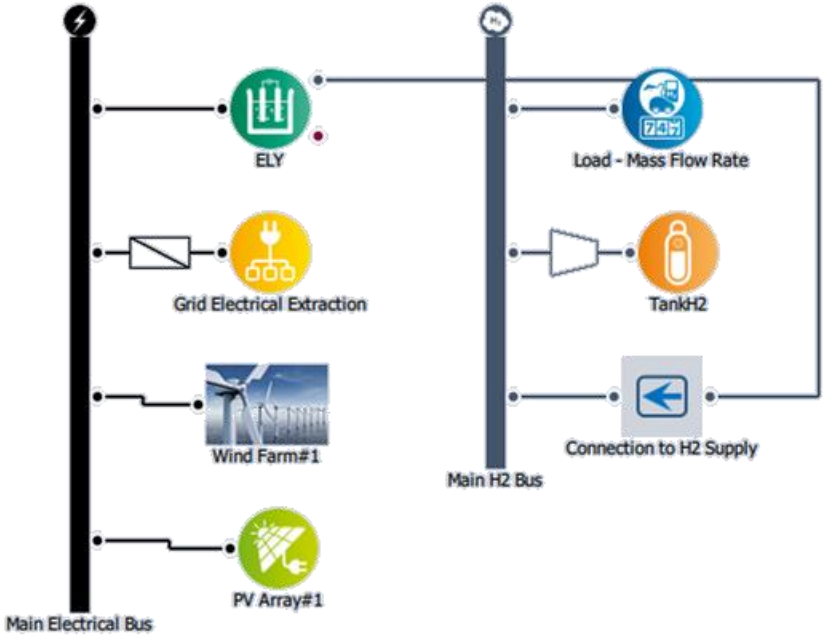
Aim:

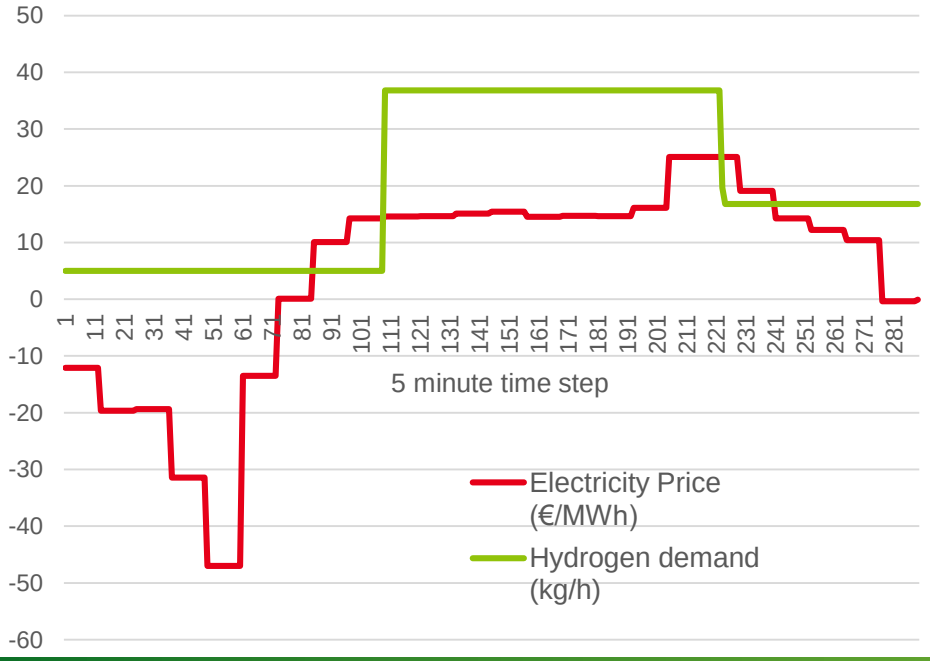
Optimise the system size to save money

Constraints:

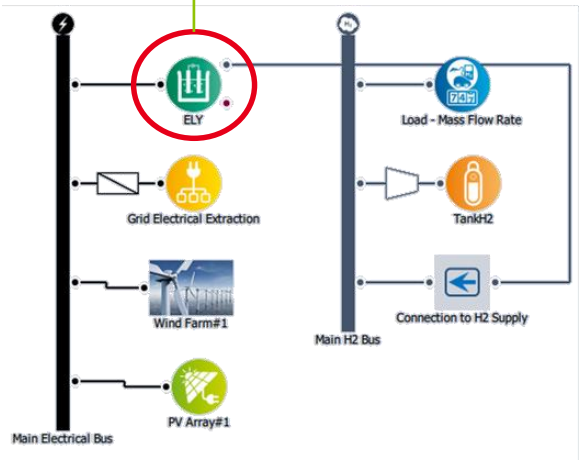
Variable electricity price

Variable load demand





SENSITIVITY & IMPORTANCE INDICES



Parameterised model of PEM Electrolyser

New, LCA relevant parameters
- Material scaling
- Recycle rate

Tech-eco parameters
- Efficiency
- Stack lifetime
- Capital, O&M cost

LCA modelling
- Materials required
- Materials end of life

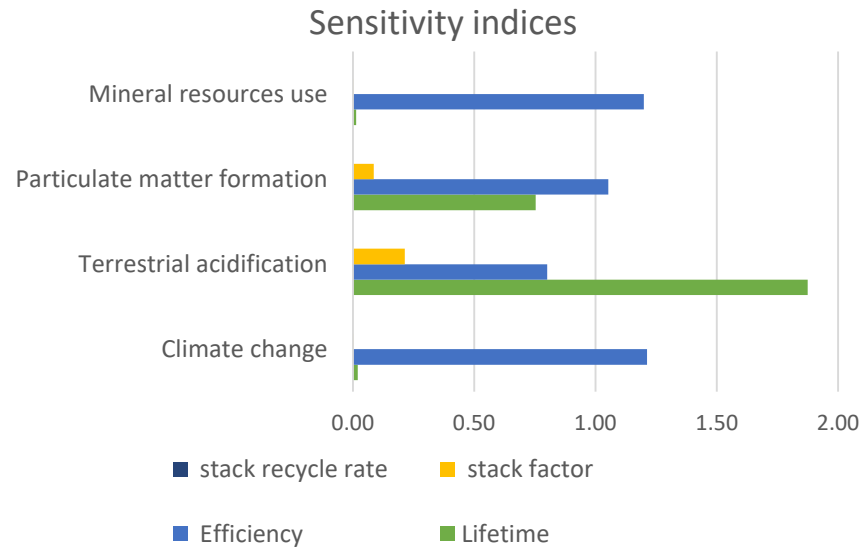
Energy simulations
- Consumption of utilities, energy conversion

Ecoinvent v3.6

LCIA

LCA inventories
- Stack manf. impact
- ....
- Electricity production

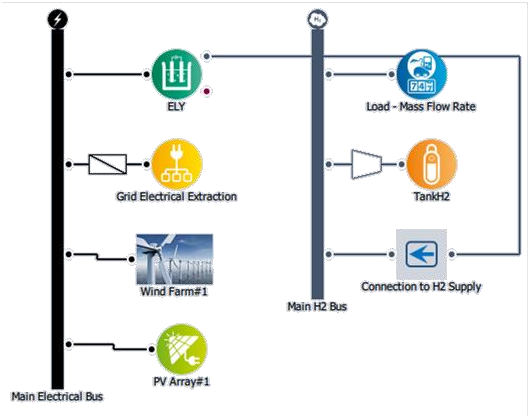
Impact



Importance indices = Sensitivity indices × impact contributions

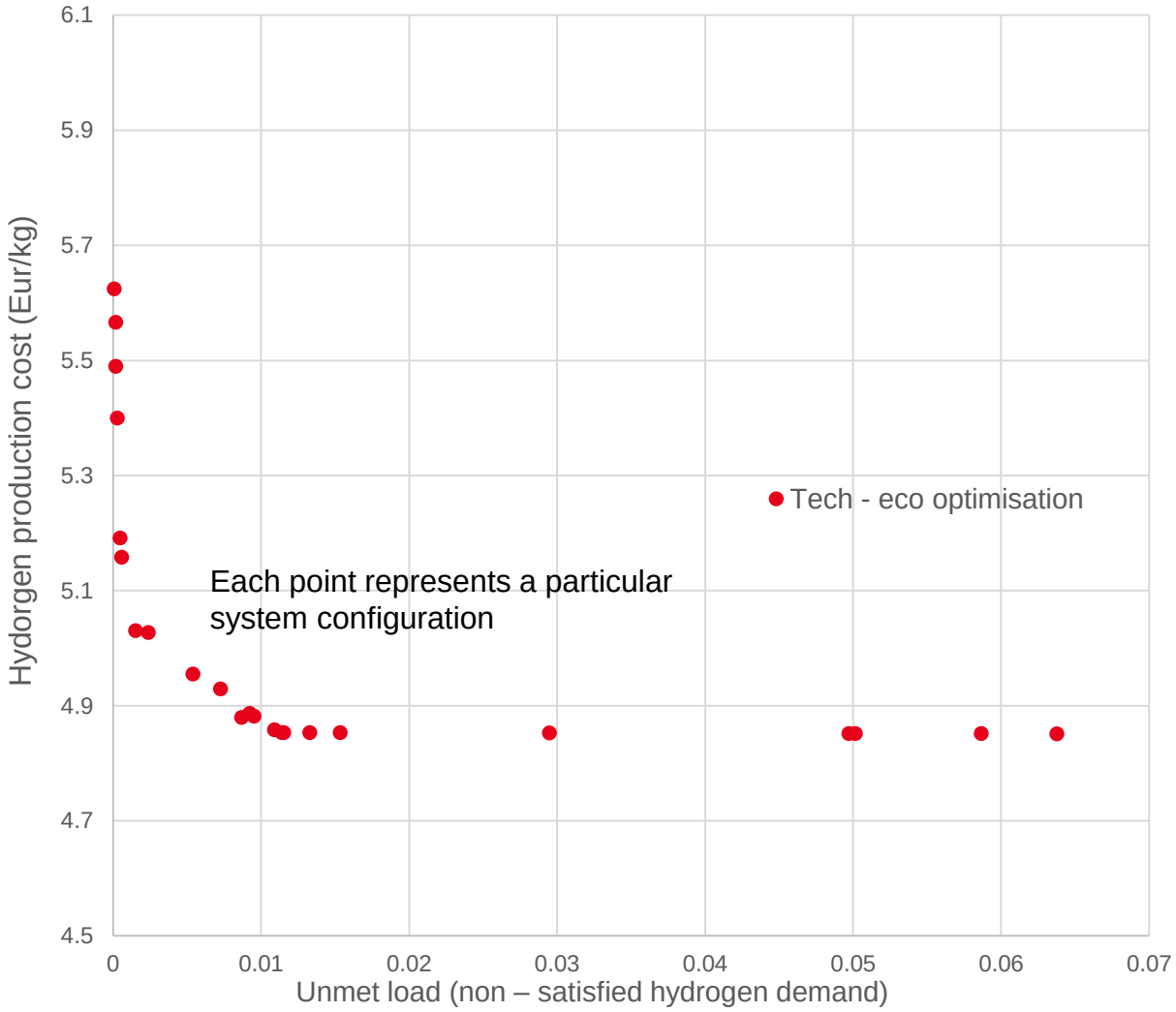
	Climate change	Terrestrial acidification	Particulate matter formation	Mineral resources use
market for titanium, primary	0.00	0.04	0.04	0.00
market for tetrafluoroethylene	0.00	0.00	0.00	0.00
market for activated carbon, granular	0.00	0.00	0.00	0.00
market for platinum	0.02	2.04	0.79	0.01

SIZING WITH TECH – ECO INDICATORS



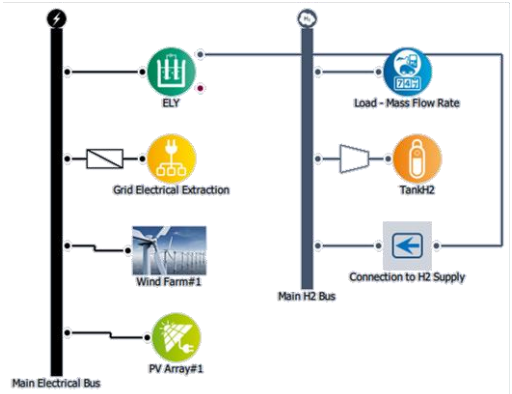
Exclusion of low-carbon sources in the design alternatives if LCA indicators are not included

Electrolyser	0,9 – 1,24 MW
No. of tanks	11 – 26
Wind	0 MW
Solar PV	0 kW
Carbon footprint	~ 4,85 kg CO_2-eq/kg H2

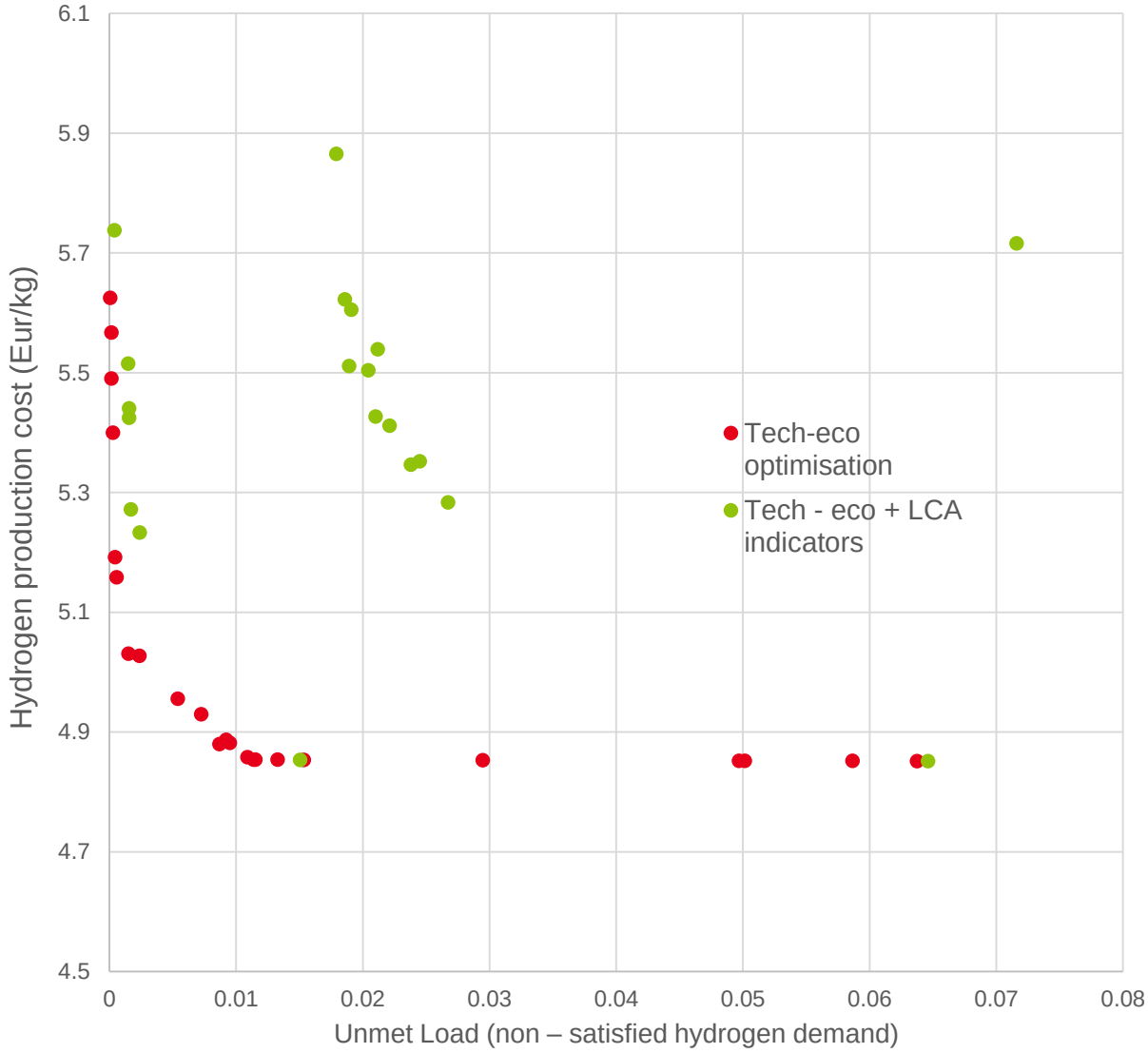


SIZING WITH TECH – ECO – LCA INDICATORS

Inclusion of low impact configurations in the design alternatives

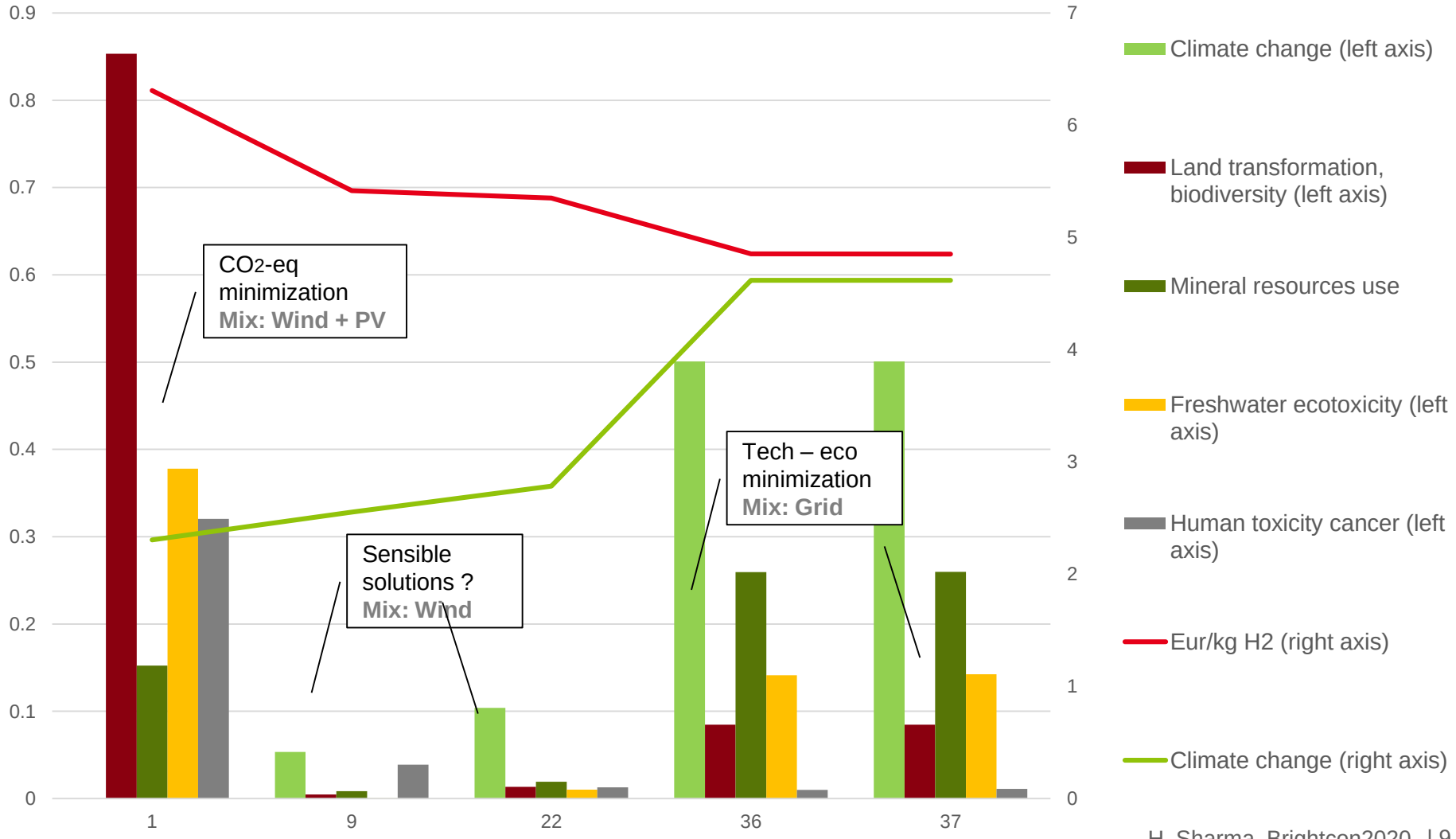


Electrolyser	0,8 – 1,24 MW
No. of tanks	3 – 26
Wind	0 – 1,6 MW
Solar PV	0 – 500 kW
Carbon footprint	2,3 - 4,85 kg CO_2-eq/kg H2



DECISION-MAKING: TRADE-OFFS BETWEEN INDICATORS

$$\frac{I_{abs} - I_{min}}{I_{max}}$$



ACKNOWLEDGEMENTS

- Brightway2 (obviously ☺) and the online community
- Activity browser
- Deap evolutionary algorithms
- SALib sensitivity analysis
- Parameterized wind models

Thank you, life is much easier with you !

Let’s continue the sharing chain !

THANK YOU FOR YOUR ATTENTION ☺

Hemant Sharma
PhD candidate at CEA Grenoble
s.hemant@protonmail.com

Hydrogen prices are only for illustration, they do not represent real world conditions