# Environmental impacts of water optimization strategies developed within SPOTVIEW

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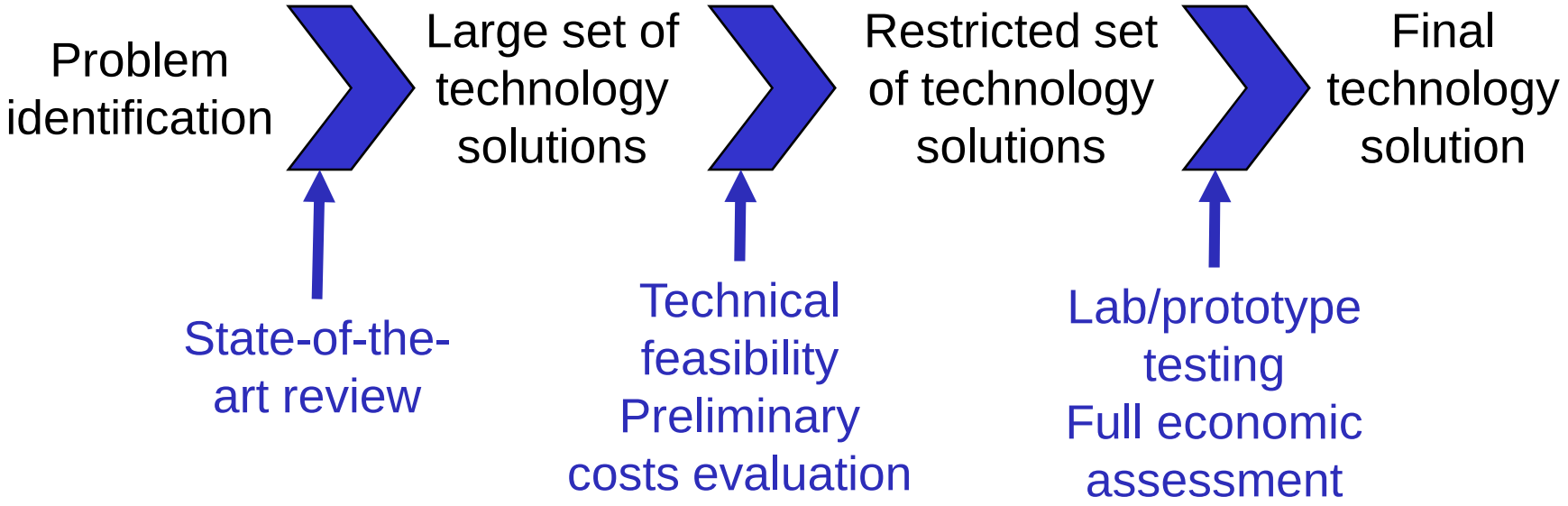
# Introduction
## *Context*

- Decision process to implement water use optimization strategy at industrial scale

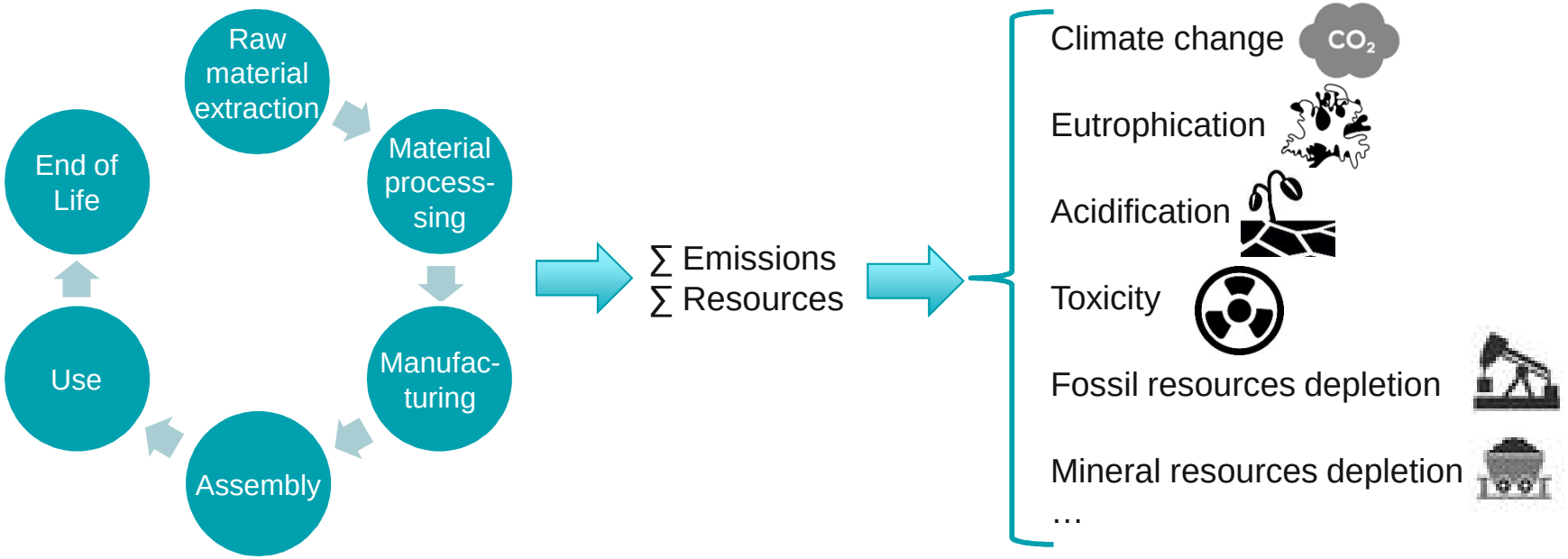



*What about environmental considerations?*

# Introduction

## *Life cycle assessment (LCA)*

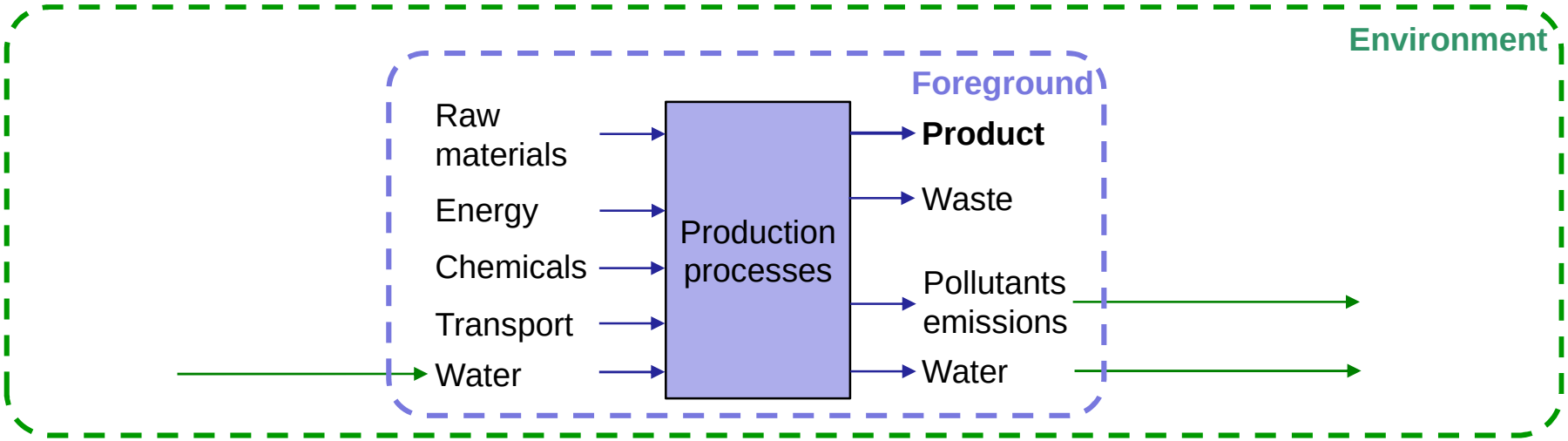
- Life cycle assessment (LCA):
  - Standardized methodology to evaluate the potential environmental impacts of products/processes along their lifecycle



# LCA of SPOTVIEW strategies

## *Goal and scope*

- Apply LCA to support the development of SPOTVIEW strategies (hotspots, best scenarios, trade-offs)
- Scope of the study
  - Operation of production processes (focus on water management)
  - Reference flow: the production of 1 ton (X ton /year) of product
  - **Foreground:** industry data (2016-2020) + simulations



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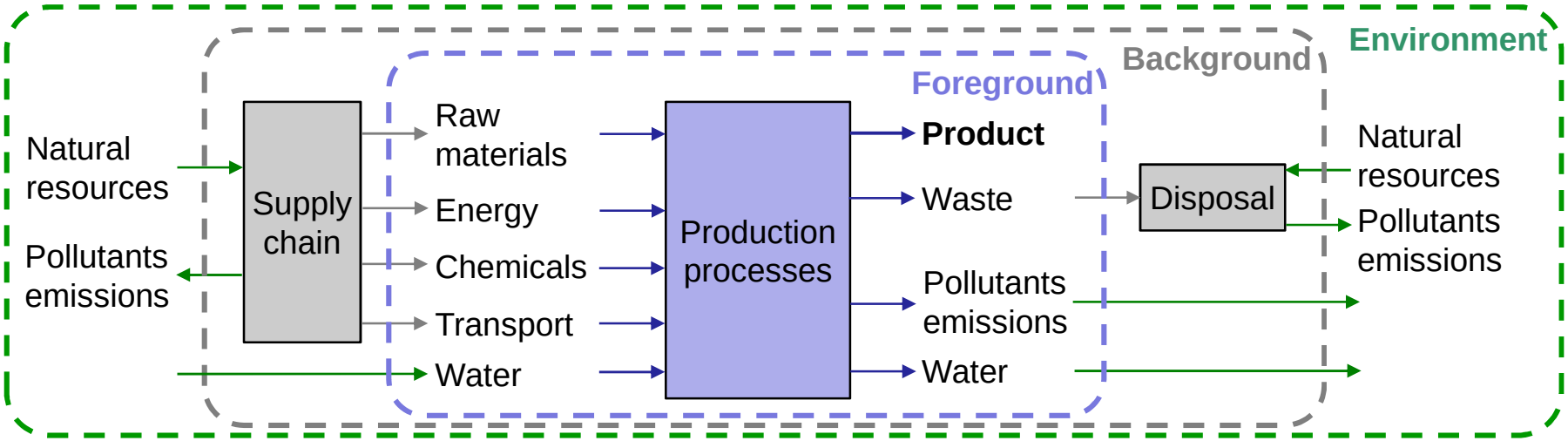
  - **Background:** ecoinvent (v3.5) database



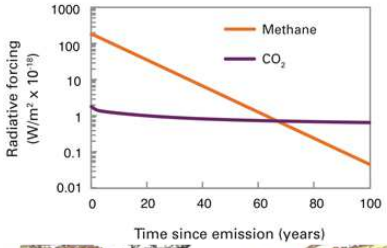
# LCA of SPOTVIEW strategies

## *Life cycle impact assessment (LCIA)*

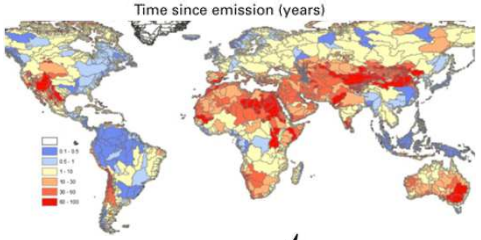
- Evaluation of environmental impacts following EC recommendations (Fazio et al. 2018)

Water footprint

Greenhouse gases (GHGs) → ***IPCC factors*** → Carbon footprint (kg $CO_2$-eq)




Water consumption (water volume not discharged to the same watershed) → ***AWARE country-based factors*** → Water scarcity ($m^3$ world-eq)

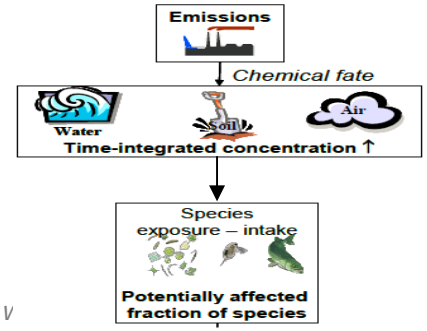


N-based emissions → ***ReCiPe 2008 factors*** → Marine eutrophication (kg N-eq)

P-based emissions → ***ReCiPe 2008 factors*** → Freshwater eutrophication (kg P-eq)

***Increase of N and P concentration in sea and freshwater***

Toxic substances emissions → ***USEtox factors*** → Freshwater ecotoxicity (PAF.$m^3$.d)



# Application to ESSITY case
## *Scenarios*

- **Case 0:** baseline scenario for tissue paper production at ESSITY in Finland (**2017** data)
- **Case 1:** cut unnecessary freshwater addition (reuse of dust washers and Nash water, DIP white water system improvements…), completed in **2018**
- **Case 2:** cross-rotational filtration (CR-filter) unit to reuse PM showers water, implemented in **2018**
- **Case 3:** 3 CR-filters for the maximal reuse of PM showers water (**simulation**)


- **Case 4:** Recycling of bio-treated effluent for PM showers (**simulation**)

# Application to ESSITY case
## *Results*

| | Case 0 | Case 1 | Case 2 | Case 3 | Case 4 | Total Case 1+3+4 |
|---|---|---|---|---|---|---|
| Freshwater intake | 42.7 $m^3$/t | -22% | -3% | -9% | -22% | -54% |
| Water losses | 2.5 $m^3$/t | = | = | = | = | = |
| Heating | | -13% | -2% | -6% | -10% | -29% |
| Additional inputs | | | Electricity, detergents, membrane | | | |
| Carbon footprint | | -10% | -1% | -4% | -7% | -21% |
| Water scarcity | | = | = | = | = | = |
| P-eutrophication | | = | = | = | = | = |
| N-eutrophication | | -2% | = | -1% | -1% | -4% |
| FW ecotoxicity | | = | = | = | = | = |

- Significant decrease of the carbon footprint thanks to the energy savings for freshwater heating →maximum reduction of **12.5 kT $CO_2$-eq./yr**
- Small effects on water footprint (equal water losses, limited impacts of heating use on the related indicators)

# Main LCA findings for SPOTVIEW
## Scenarios impact

- Significant impacts decrease (> 20%)
  - Combination of optimized scenarios for tissue paper (carbon footprint only, minimal effects on other categories)
  - Replacement of river water by sea water for steel production (water scarcity only, significant increase on other categories)
  - Recovery of milk compounds via submerged ultrafiltration
- Minimal effects for other strategies
- How to further improve the environmental performances of the developed strategies?
  - Reduce water losses
  - Reduce energy use
  - Explore the recovery of valuable substances

# Main LCA findings for SPOTVIEW
## Limitations of the evaluation

- Reliability of performances data used:
  - Real operational data vs. simulations
  - Process / environmental conditions variability
  - Limited coverage of the consequences of strategies

- LCA methodology
  - Water footprint methods do not consider the dependency on freshwater availability
  - Representativeness of background processes and LCIA methods

# Key messages

- Life cycle assessment (LCA) should be further included in the early-phase of technology development to identify the main environmental drivers and anticipate trade-offs
- LCA was successfully applied to 15 SPOTVIEW strategies and compared to the reference scenario for each sector
- Significant reductions of impacts were observed for 3 strategies, including one with a major trade-off between impact categories
- The developed strategies should further reduce water losses, energy use and recover valuable compounds to improve their environmental performances
- These outcomes should be interpreted carefully due to the limitations of the evaluation

# Acknowledgement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