

# What are the environmental benefits of solar calcination process?

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# Outline

- Introduction
- Methodology
- Results
- Conclusions



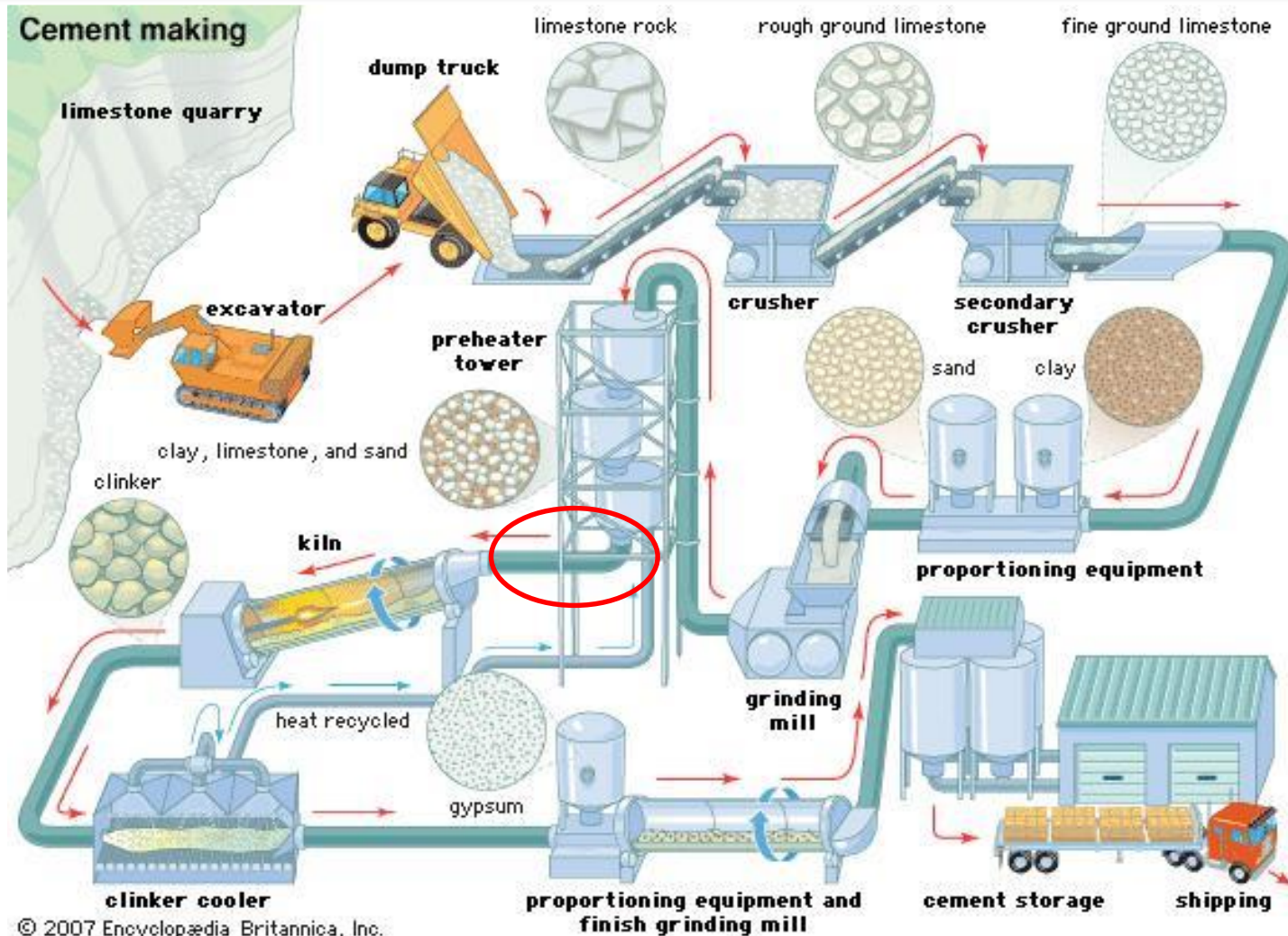
# GHG emissions from the cement industry

- Worldwide production of cement surpassed 4.65 bn t/yr
- The cement industry releases 7% of the global anthropogenic CO<sub>2</sub> emissions
- GHG emissions are mainly due to the limestone calcination (50%) and use of fossil fuels (40%)
- Emission control strategies include:
  - Use of alternative fuels
  - Carbon capture
  - Use of alternative feedstocks

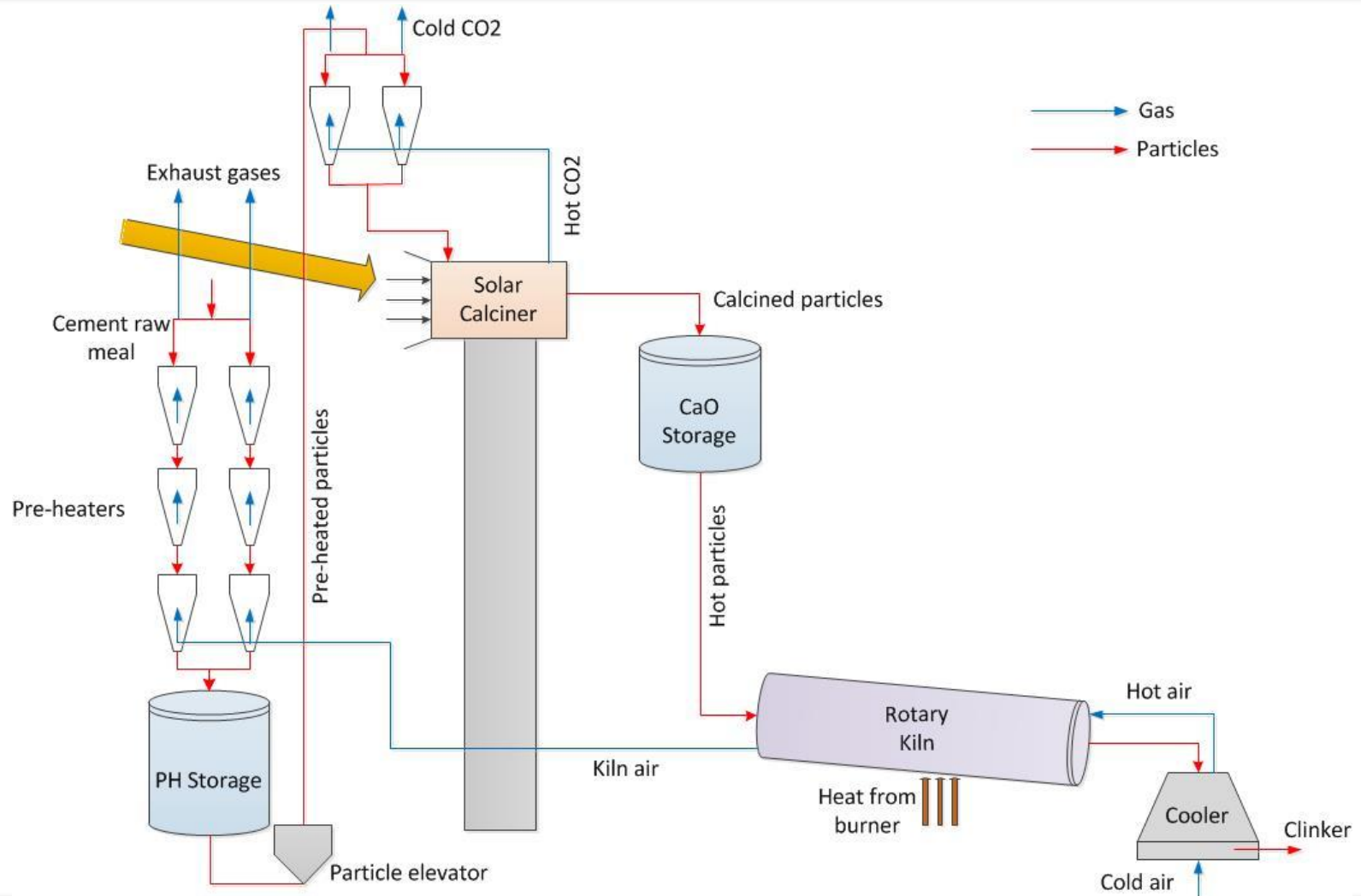
# Solar thermal for cement production

- Solar thermal energy is being investigated to provide energy for the calcination of raw materials
- It has the potential to replace completely fossil fuels for the calcination of raw materials
- Solar system includes
  - Solar field
  - Receiver tower
  - Solar reactor
  - Hot storage
  - 2<sup>nd</sup> stage preheater

# Overview of cement production



# Solar thermal system





# Solar thermal system

- Operating time of solar system: 8 hr/day (daylight)
- Plant productivity: 4,683 t cement/day
- Solar calciner:
  - Fluidized bed reactor (270 MW<sub>th</sub>)
- Solar field (heliostats 140 m<sup>2</sup> mirror area):
  - 4910 heliostats
- Receiver tower: 120 m high

# Life cycle assessment: an overview

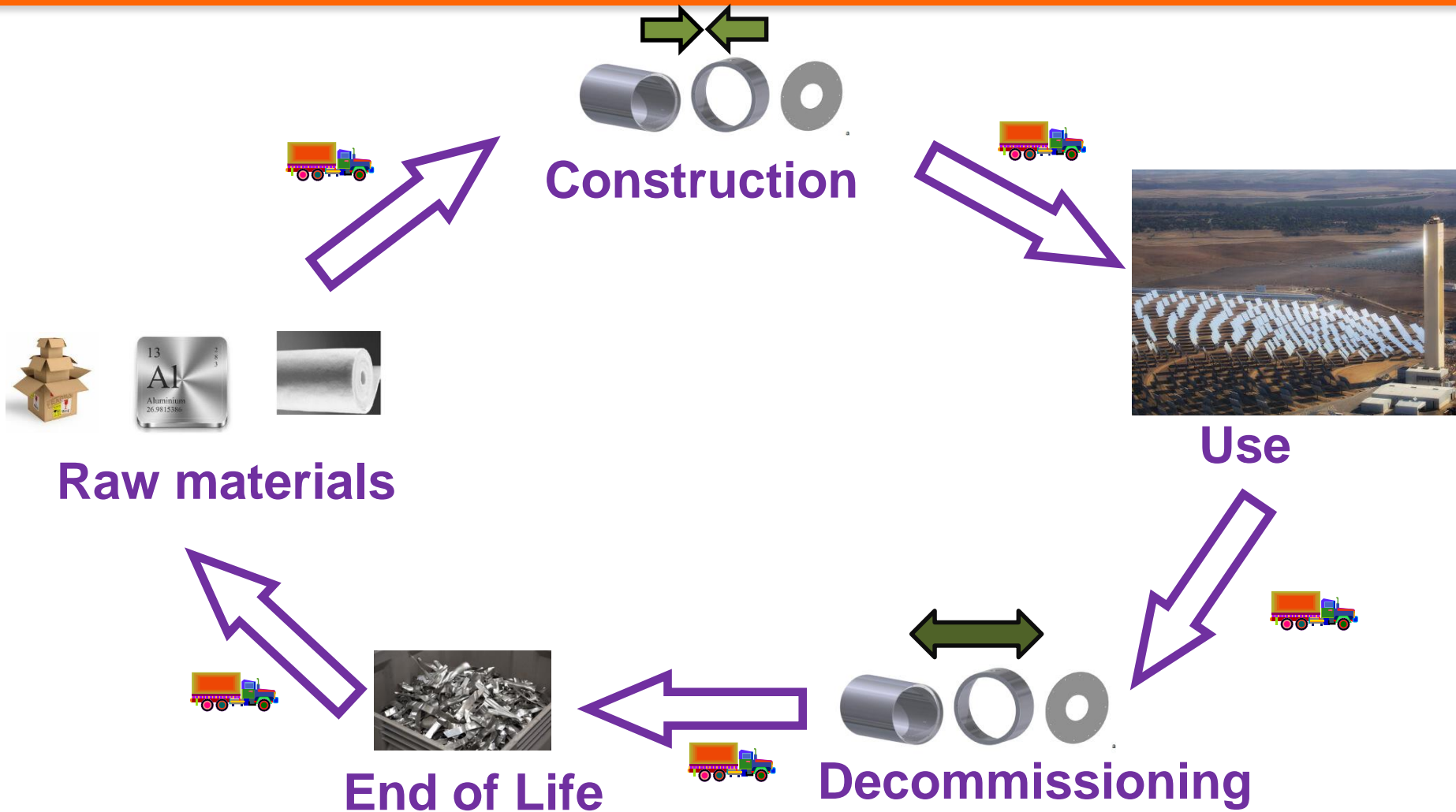
- LCA is a standardized method which requires
  - Quantification of environmental burdens of a product, process or activity
    - energy and materials used and wastes released to the environment
- Through LCA analysis it is possible
  - Quantification of environmental impacts
    - translating the burdens into potential impacts
  - Identification of opportunities for environmental improvements along the whole life cycle of a process, product or activity



# Goal of the study

- Determine the environmental sustainability of the SOLPART cement plant in comparison to a conventional cement plant
- Use life cycle assessment (LCA) to estimate the environmental impacts from 'cradle to grave'

# Scope of the study

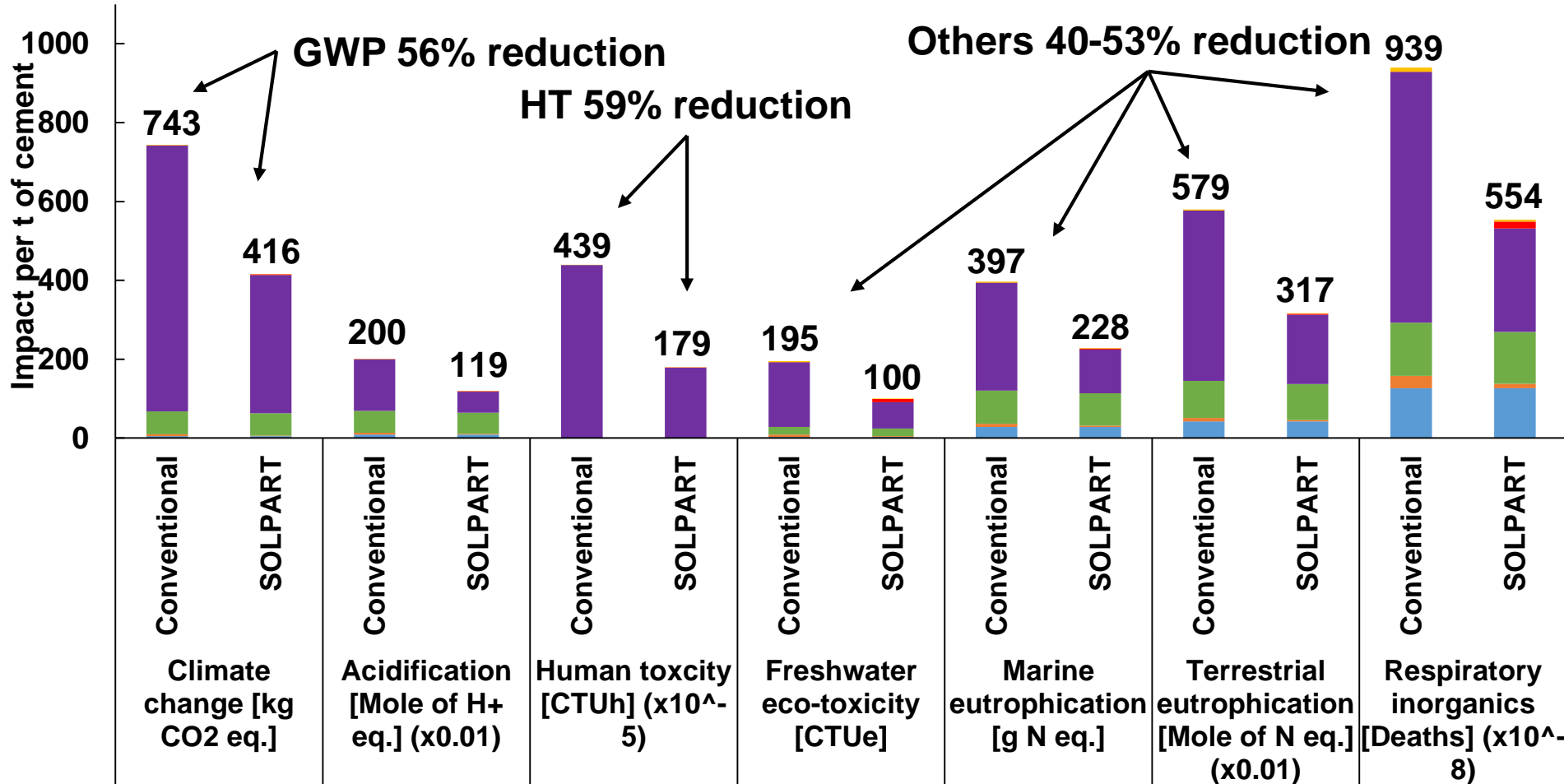


# Data and assumptions

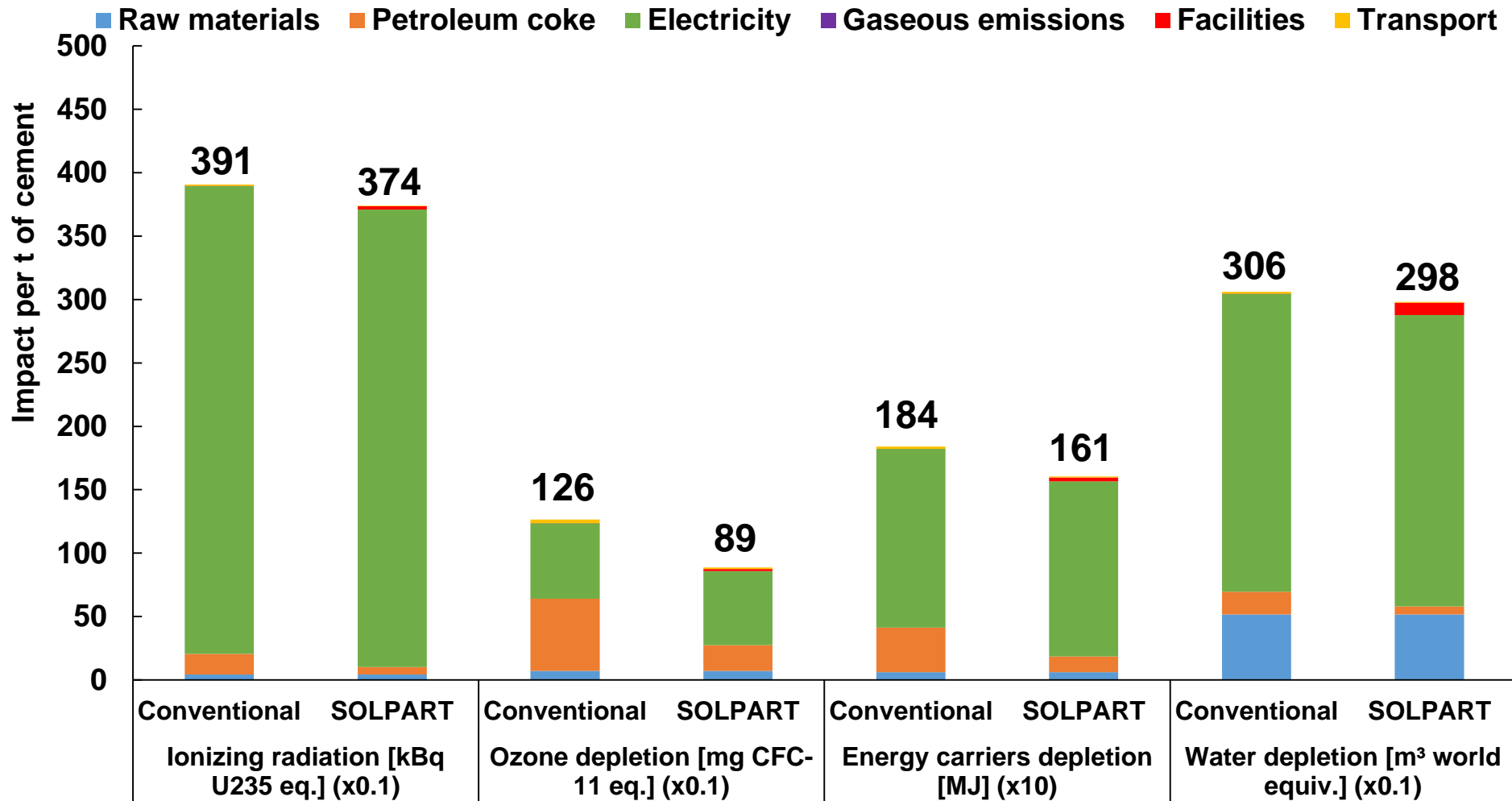
- Functional unit: 1 t of cement material
- Primary data
  - Laboratory and pilot plant testing for solar facilities
  - Conventional cement plant operation data
- Background data: Ecoinvent 3.5 database
- Fossil energy utilization (SOLPART plant)
  - 1,1 MJ/kg cement (57% MSW, 43% petroleum coke)
- Field efficiency
  - 60%
- End-of-life recycling
  - Steel: 75%
  - Glass: 73%
  - Concrete: 70%

# Results: gaseous emissions

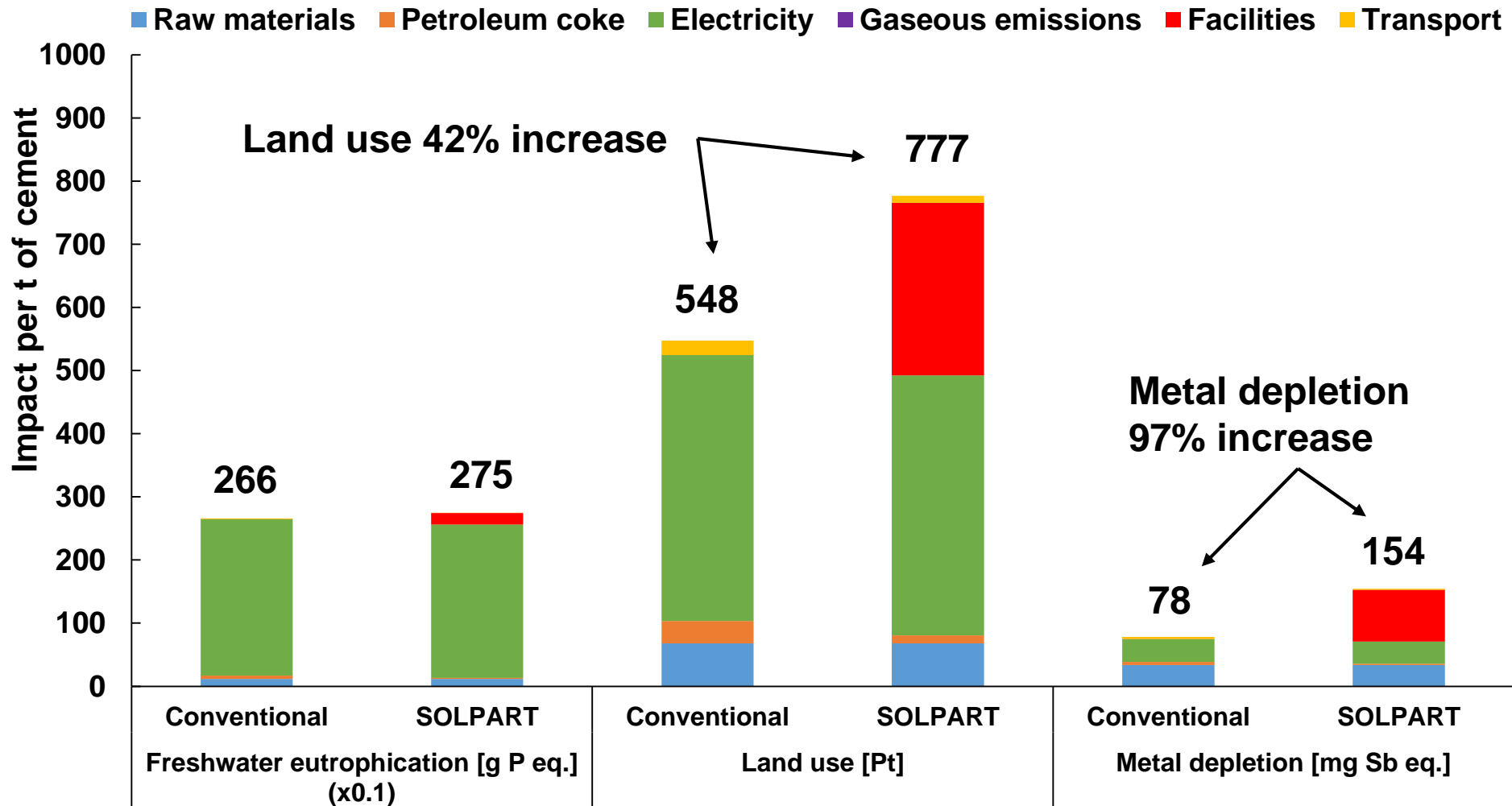
Raw materials Petroleum coke Electricity Gaseous emissions Facilities Transport



# Results: electricity



# Results: construction



# Conclusions

- The solar system reduces the impacts of cement production
  - GWP by 56%
  - Human toxicity by 59%
  - Respiratory inorganics by 41%
  - Other six out of 16 impacts by 40-53%
- However, the construction of solar facilities increase
  - Land use by 42%
  - Metal depletion by 97%
- Overall, the SOLPART cement plant shows lower impacts compared to the conventional production process
- SOLPART technology has the potential to reduce global CO<sub>2</sub> emissions by about 763 Mt/year (166 million cars out of the road)



# Acknowledgment

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**Thank you for your attention**