



# Sustainability and Life Cycle Assessment EU-India collaboration opportunities

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# Overview

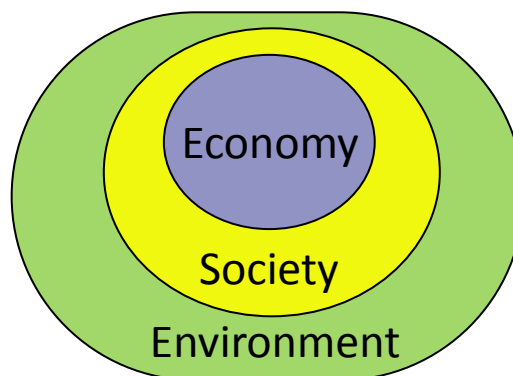
- Sustainability
- Competencies
- Research Highlights
- Collaboration





# Sustainability

- Brundtland report – Our common future



- Multiple criteria





# Competencies

- Energy analysis
- Process modeling
- Economic analysis
- Life Cycle Assessment
- Macro system modeling
- GIS modeling





# Competencies

- Technology assessment

- PROSUITE
- CatchBio
- Surfucell
- CATFUR ...

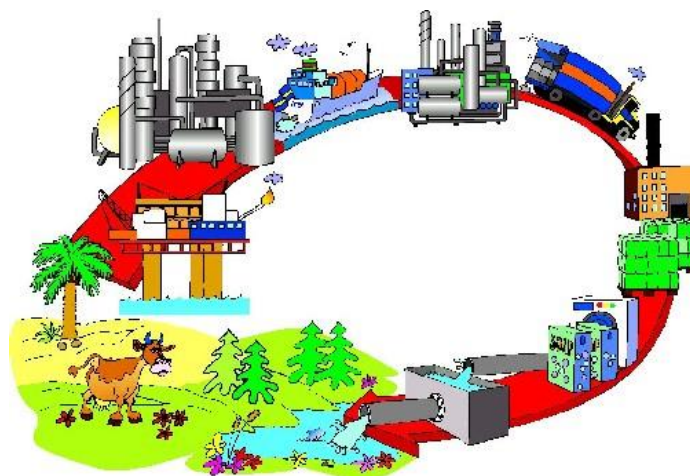
- System analysis

- CCS
- Port of Rotterdam
- Recycling
- Bioenergy trade
- Integrated global modeling...



# Life cycle assessment

- Assessment of Environmental impacts



- Standards (ISO 14040, 14044)
- EU-ILCD Handbook



# Environmental Impact Categories (ReCiPe method)

Midpoint level

1. Climate change (CC)
2. Ozone depletion (OD)
3. Terrestrial acidification (TA)
4. Freshwater eutrophication (FE)
5. Marine eutrophication (ME)
6. Human toxicity (HT)
7. Photochemical oxidant formation (POF)
8. Particulate matter formation (PMF)
9. Terrestrial ecotoxicity (TET)
10. Freshwater ecotoxicity (FET)
11. Marine ecotoxicity (MET)
12. Ionising radiation (IR)
13. Agricultural land occupation (ALO)
14. Urban land occupation (ULO)
15. Natural land transformation (NLT)
16. Water depletion (WD)
17. Mineral resource depletion (MRD)
18. Fossil fuel depletion (FD)

Endpoint level

Damage to

1. Human health (HH)
2. Ecosystem diversity (ED)
3. Resource availability (RD)





## Green Chemistry principles

## LCA

## Sustainability assessment

Apply principles as guiding rules

Qualitative assessment (+, -, 0)

Multicriteria analysis

Ex-ante LCA

Full-fledged LCA

Environment/health

Economy

Social aspects

Ex-ante

Full

Anastas (2000)  
Sheldon (1992-)

Sugiyama, Ph.D.  
thesis, ETHZ, 2007

ISO standards

“PROSUITE” project

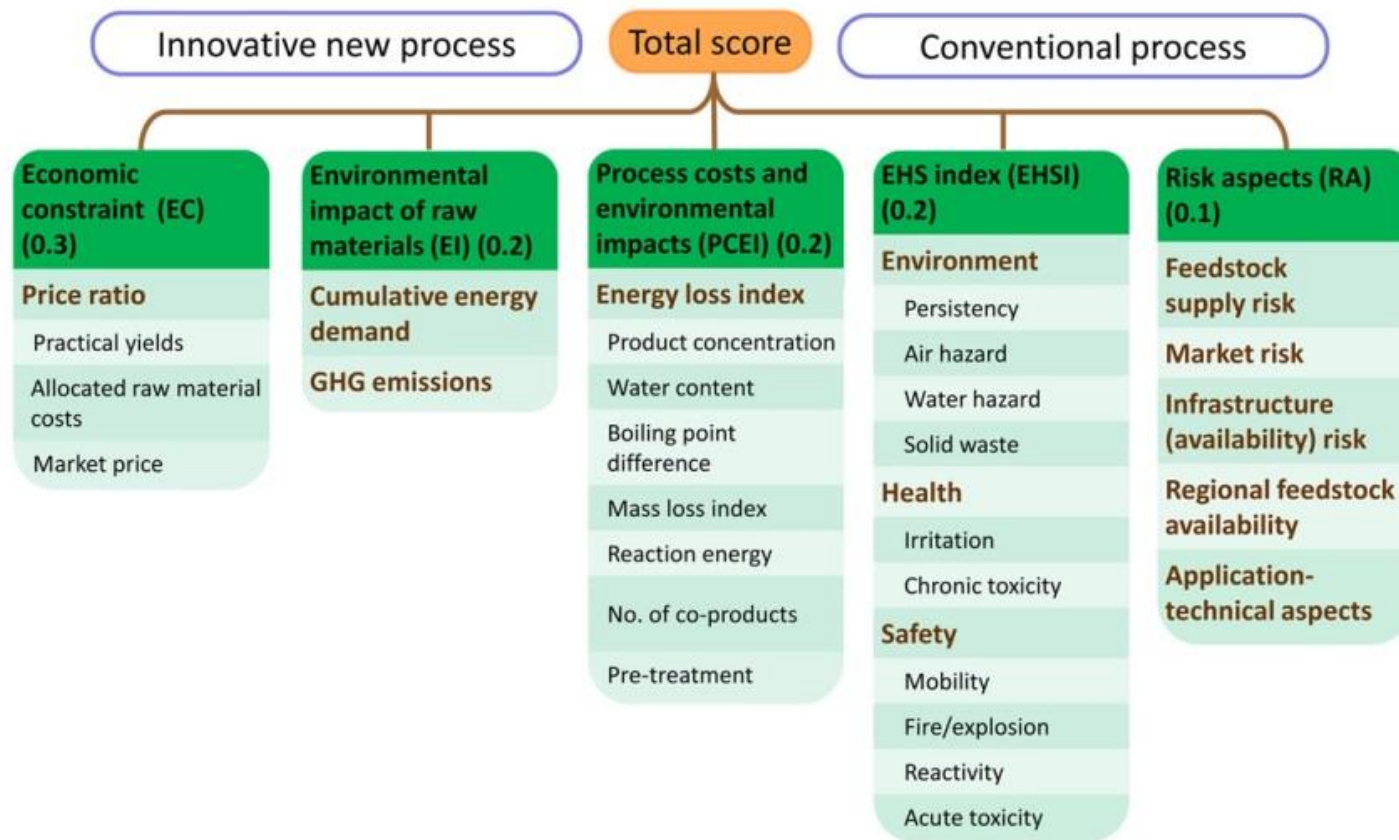
Early R&D stage







# Early assessment

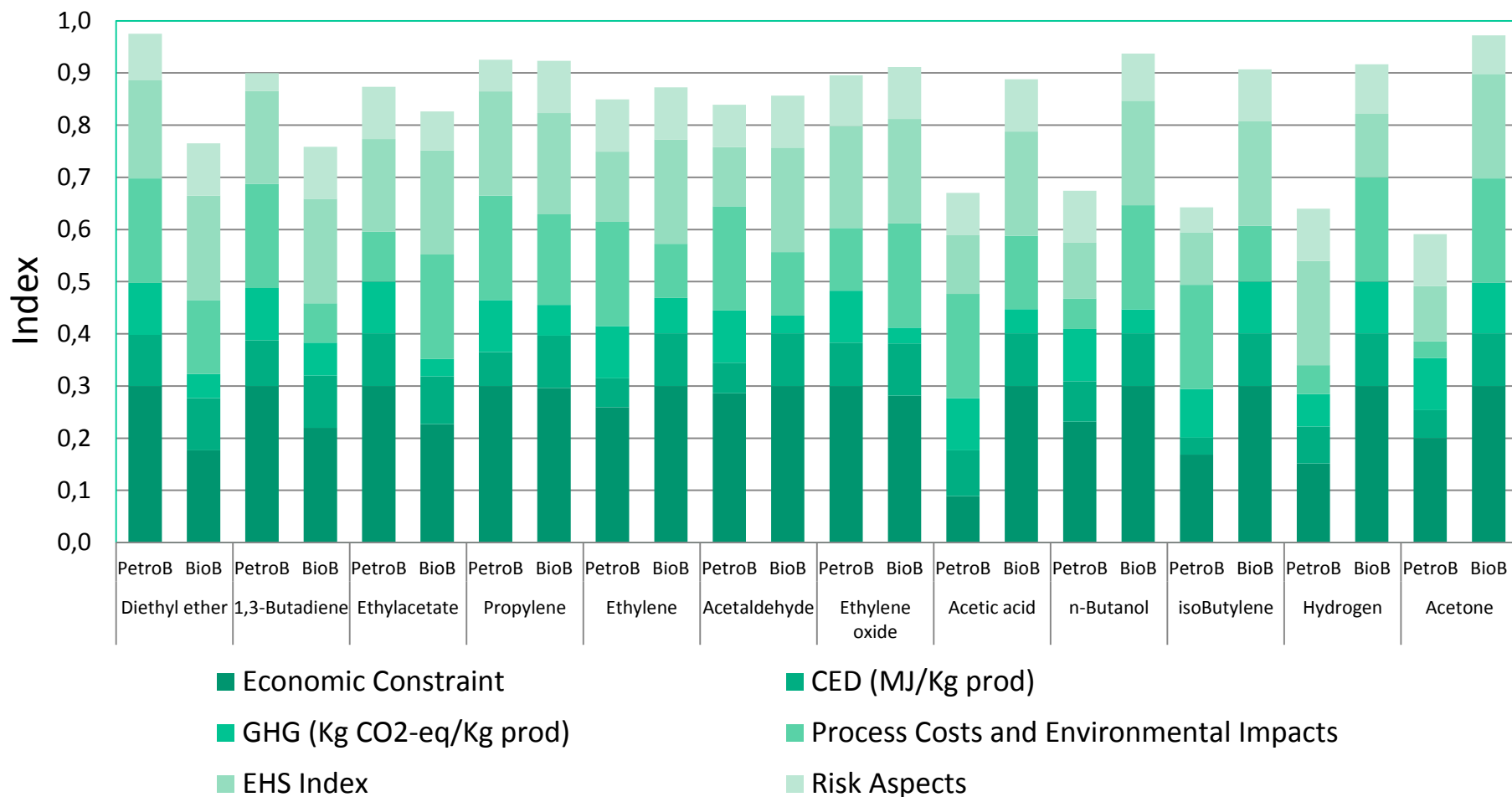


Patel, A.D. et al., Sustainability assessment of novel chemical processes at early stage: Application to biobased processes. *Energy Environ. Sci.*, 2012, 5, pp. 8430-8444

Patel, A.D. et al., Early-Stage Comparative Sustainability Assessment of New Bio-based Processes. *ChemSusChem.*, 2013, 6, pp. 1724-1736



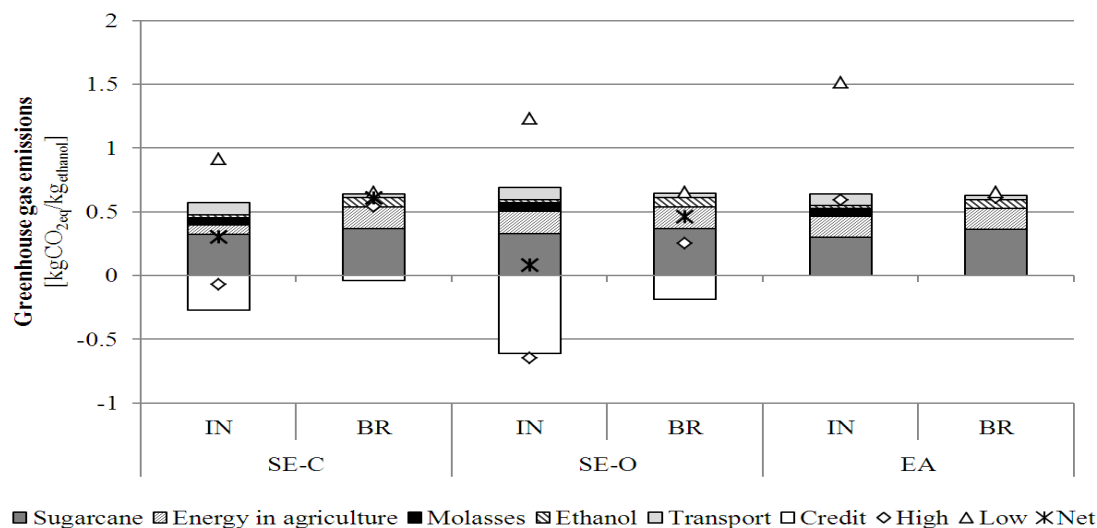
# Potential of bio-ethanol as building block





# Sugarcane Ethanol LCA

- India and Brazil comparison

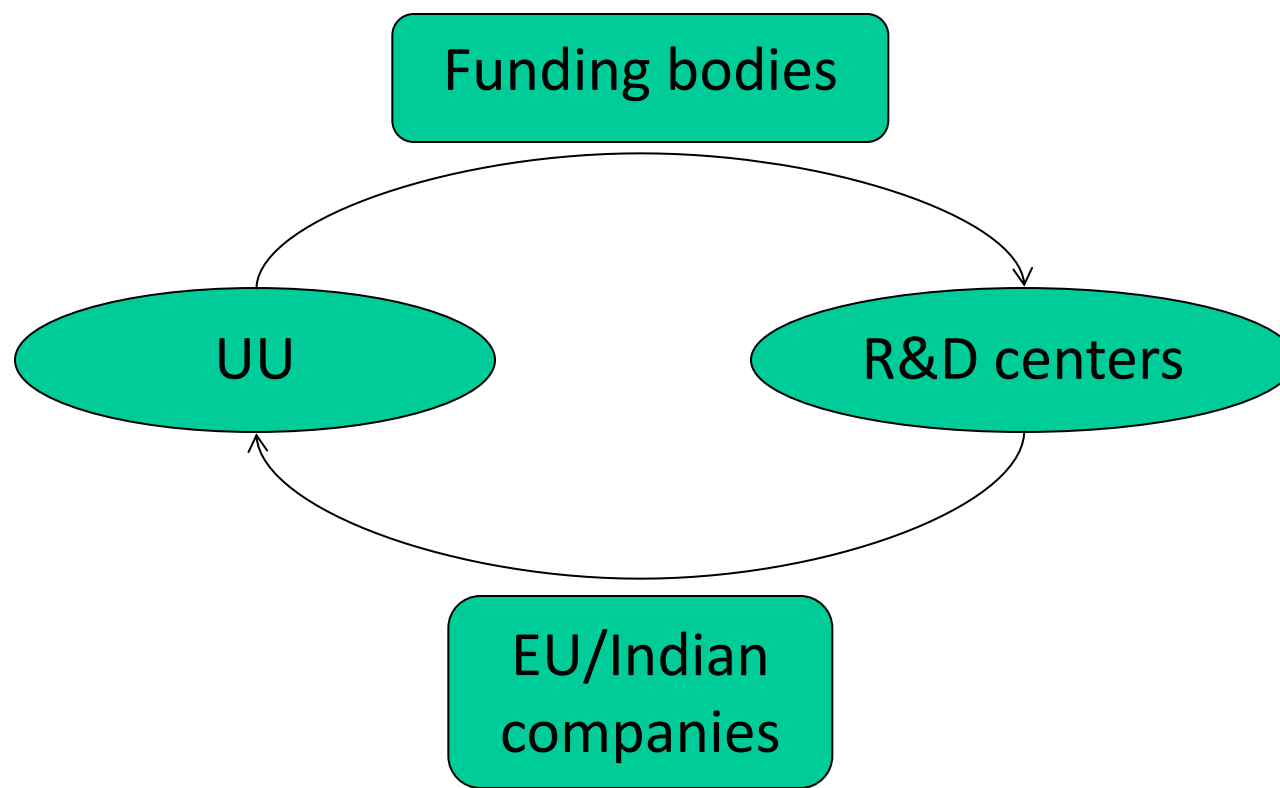


- Human health, Water stress



# Collaboration opportunities

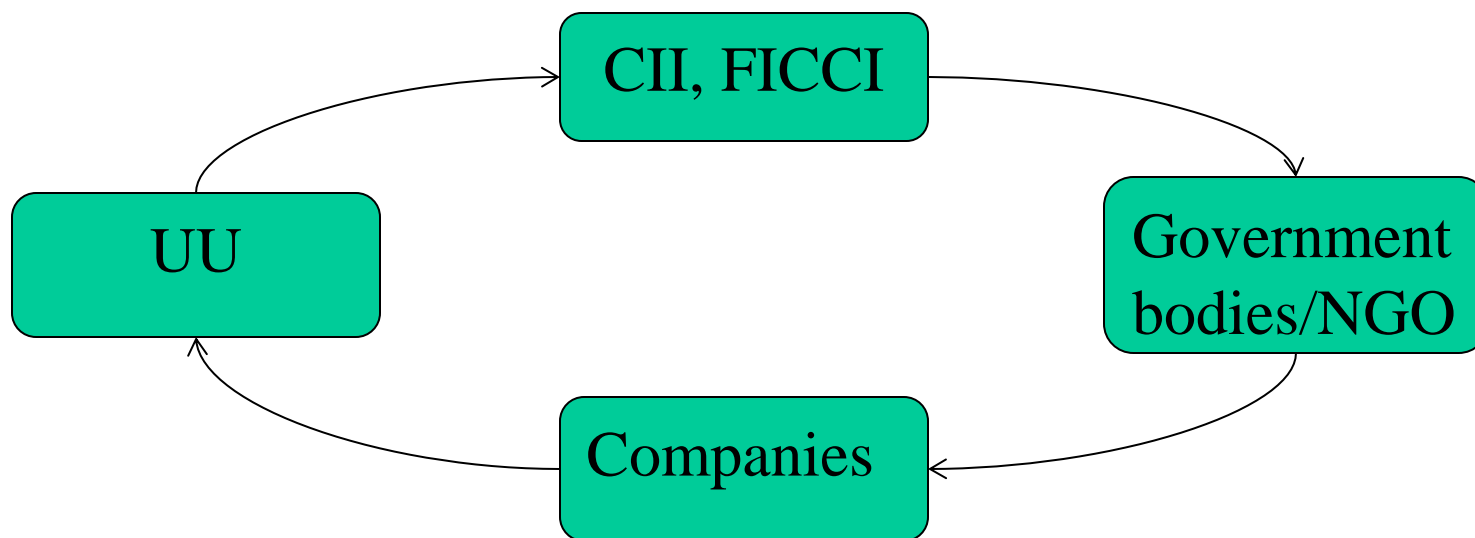
Ex-ante technology analysis and feedback





# Collaboration opportunities

Life Cycle Assessment – Methodology adaptation, data and studies





*Thank you*

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