



# Designing Products & Engineering Systems for Circular Economy: More Insights with LCA Studies

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# Products Classification Based on Their Innovation Potential

## Incremental

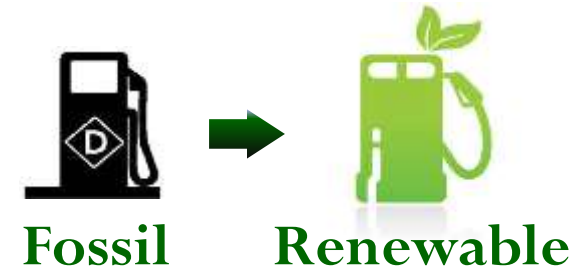
- Modifications Made to Existing Products
- Unsustainable in the Long Run
- Low Revenue Margins



Increase Camera Resolution

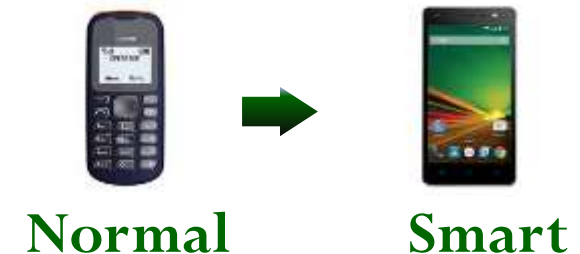
## Game Changers

- New Products Into Existing Markets
- Potentially Sustainable
- High Product Differentiation



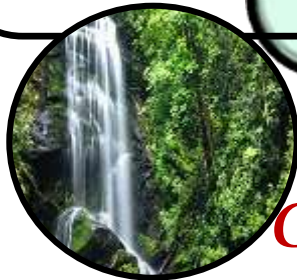
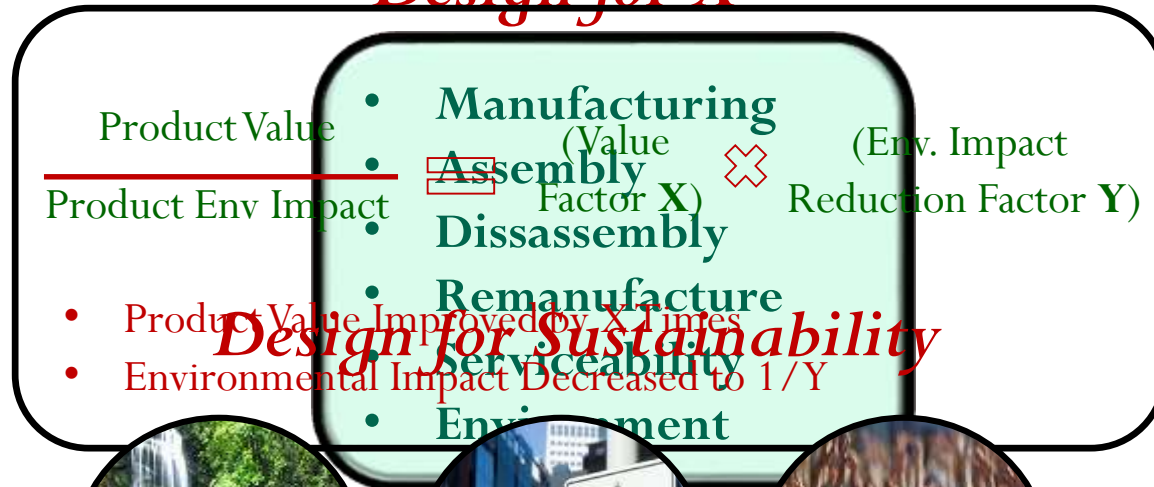
## Breakthrough

- Create New Products for New Markets
- Occur with Rarity



# Evolution of Product Design Philosophies

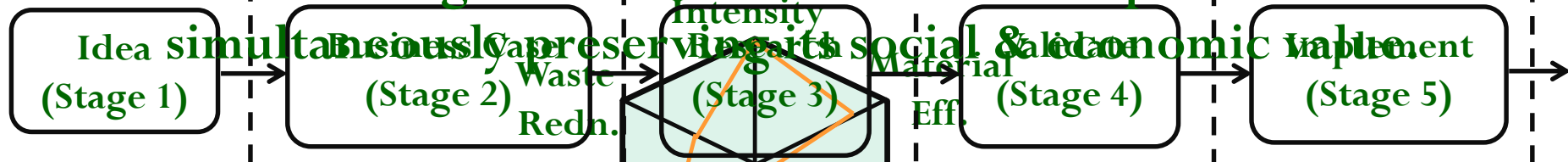
## Factor X Approach Design for X



## Gate 1 Eco-efficiency

Gate 2 Use Intensity  
Gate 3 Hse. & social & economic value  
Gate 4  
Gate 5

Minimizing Product's Environmental Impacts while



Quick Eval. of Env. Impacts

Res. Consr.

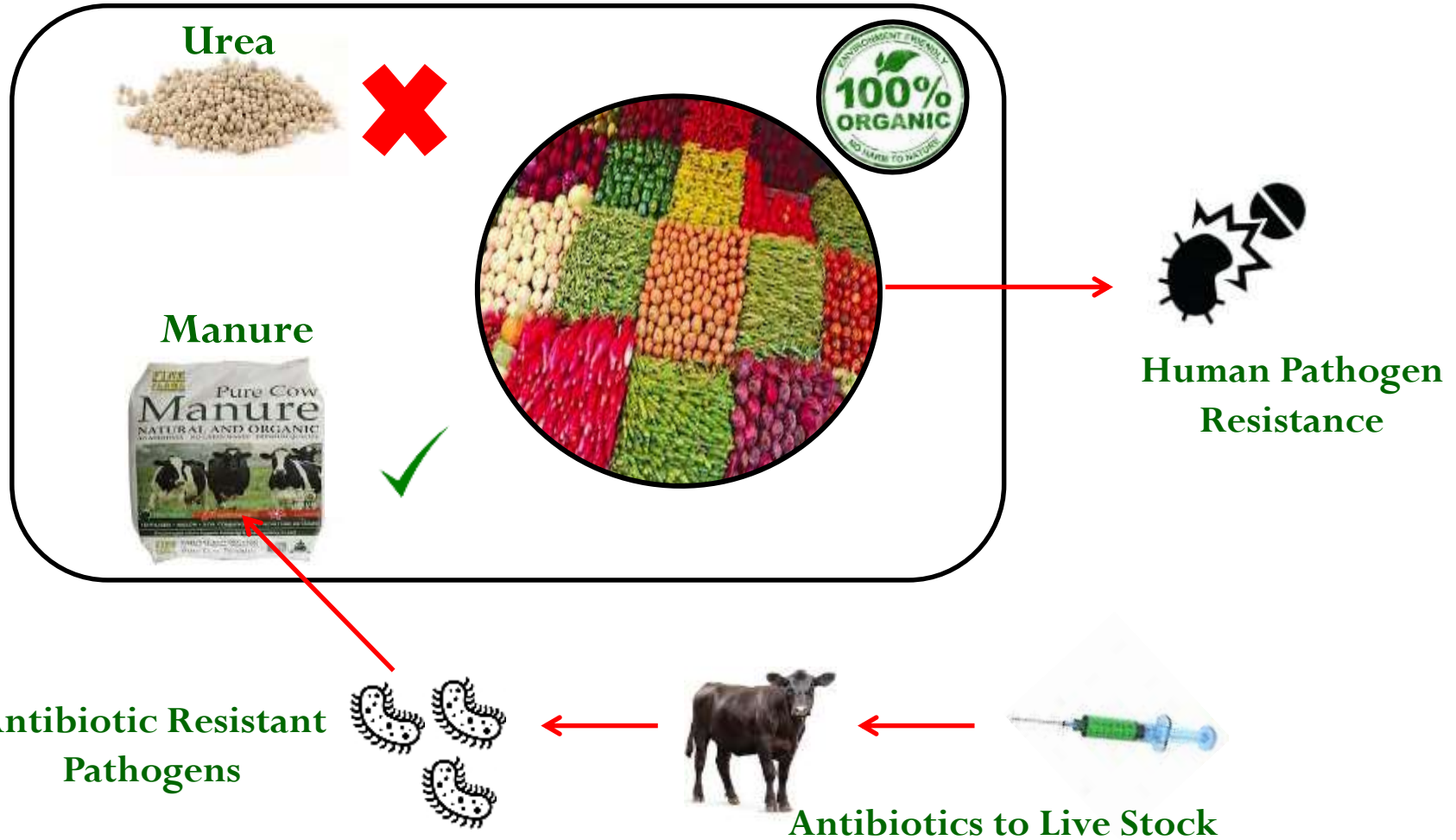
Env. Risk

Screening LCA  
Energy Eff.

Full LCA

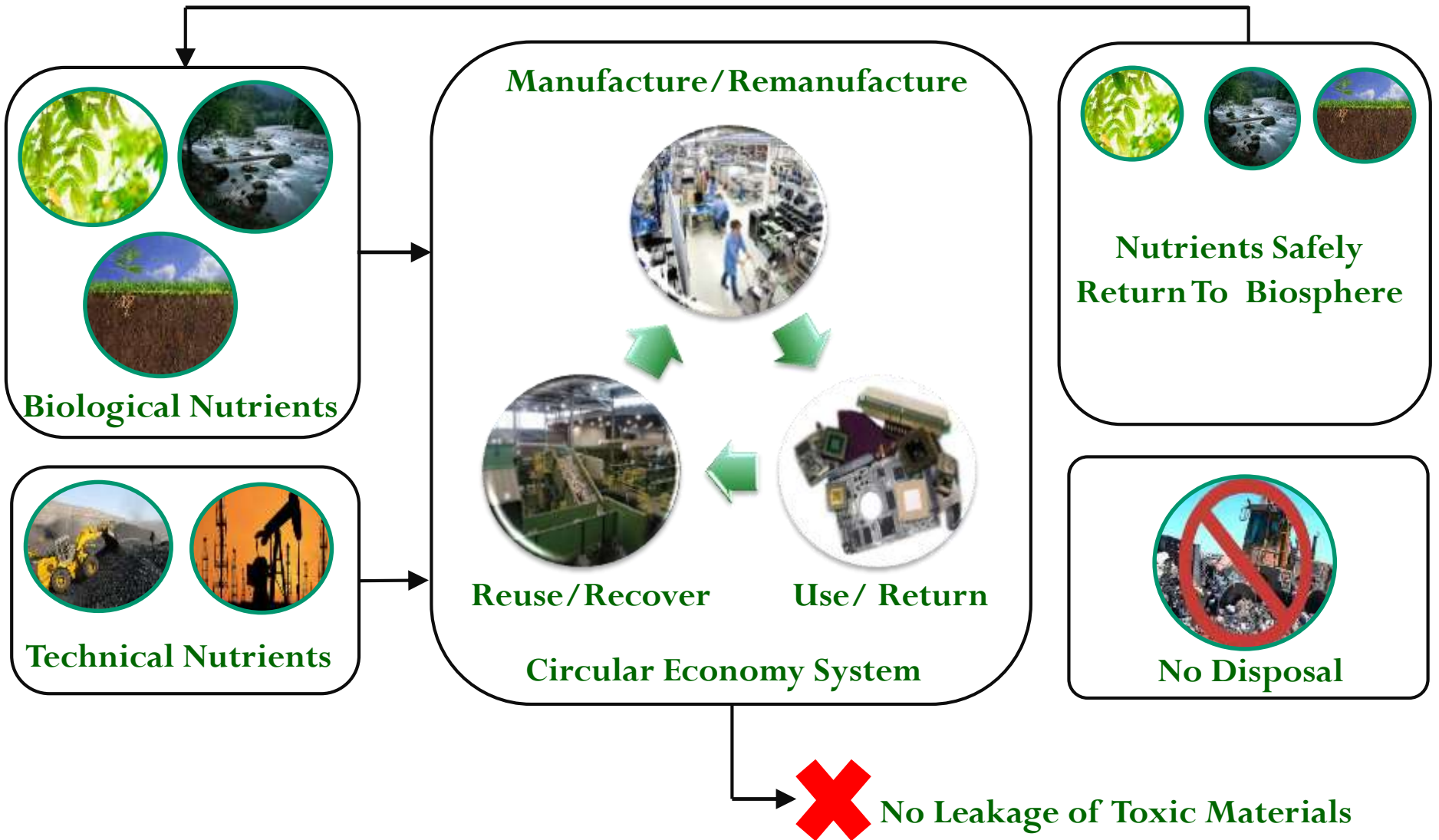
# D4S: A Product Centric Philosophy- But There Are Challenges

- Factors External to Product/System Cannot be Controlled



<https://www.nature.com/news/manure-fertilizer-increases-antibiotic-resistance-1.16081>

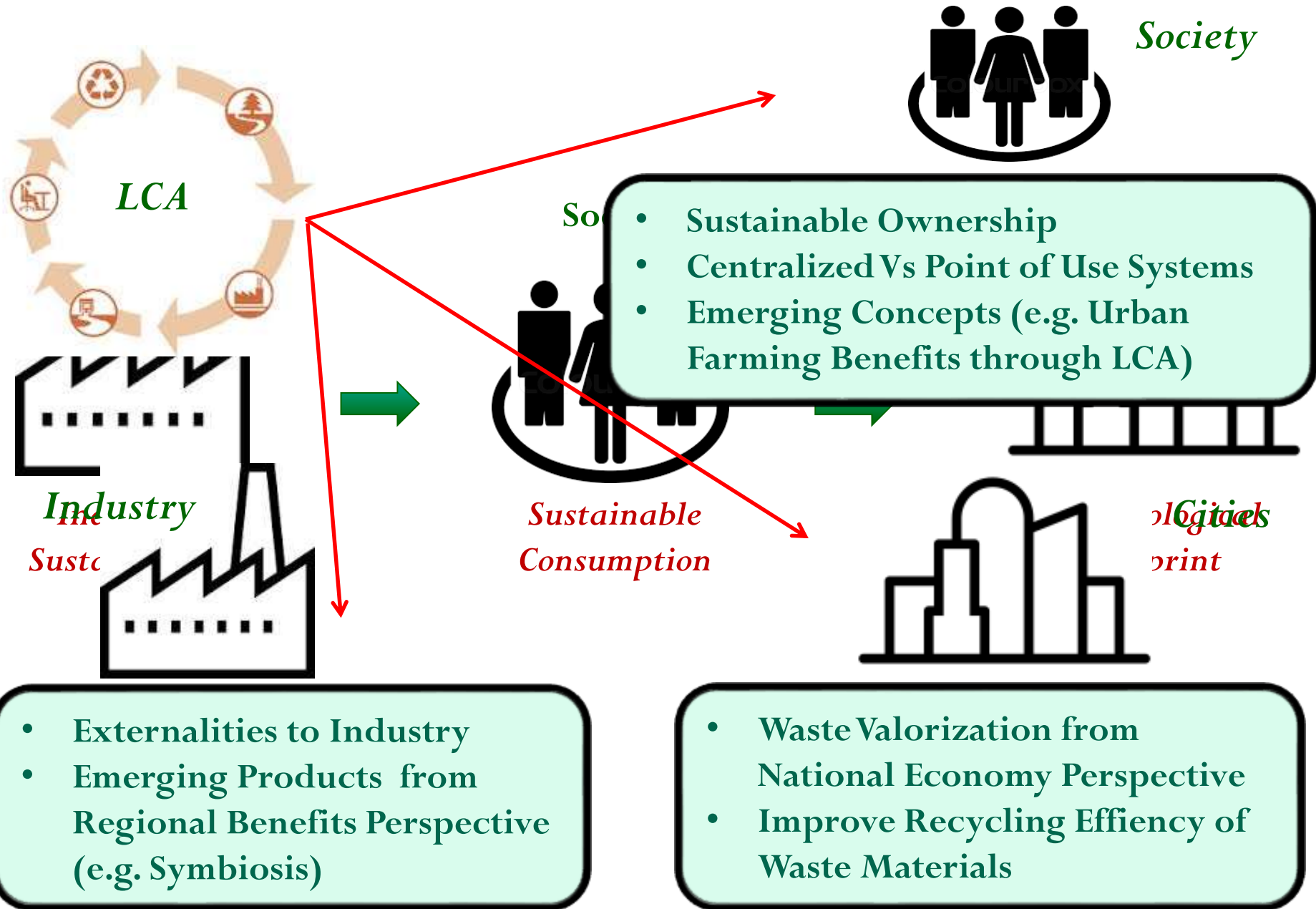
# Circular Economy Based Design Criteria



- **Decouple Environmental Externalities and Economic Growth**
- **Optimize Available Resources to Build Economic Potential**

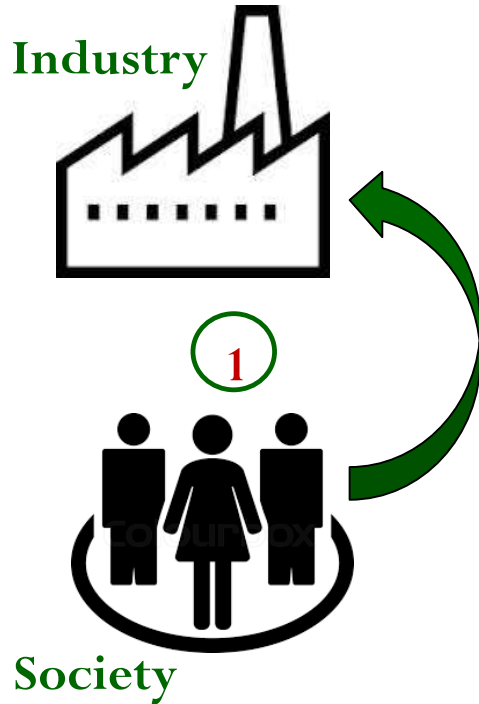


# Circular Economy Design Philosophy

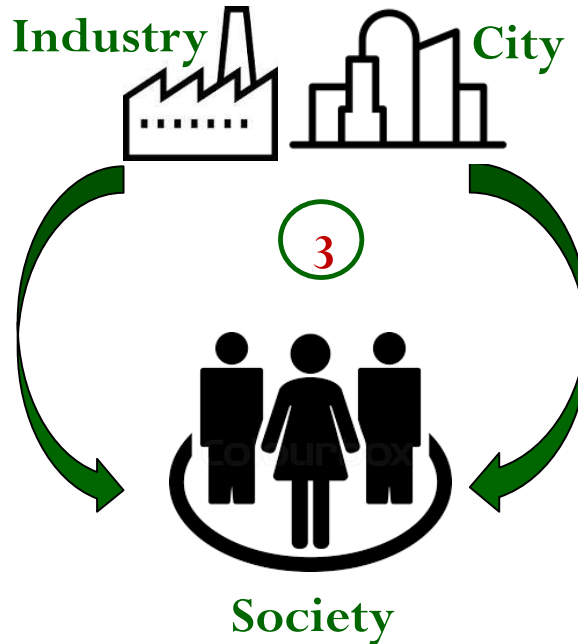


# LCA Projects of Circular Economy Design Concepts at Umea Univ.

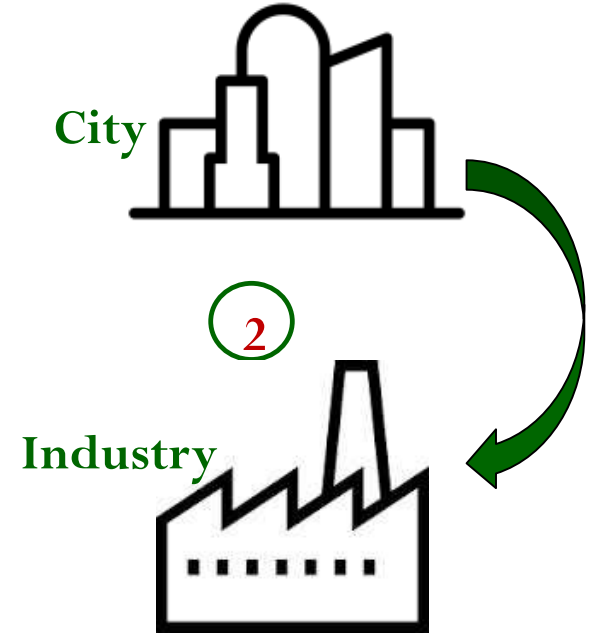
*Design Products to Minimize  
Env. Externalities*



*Business Models Promoting  
Sustainable Consumption*



*Waste- A Valuable Resource  
to Builds Economy*



# LCA of Nano Engineered Coatings for Biodiesel Infrastructure

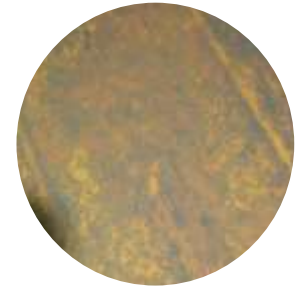


BioDiesel  
Storage Tank

- Biodiesel Hygroscopicity
- Hydrolysis Reactions a Labile Carbon Source

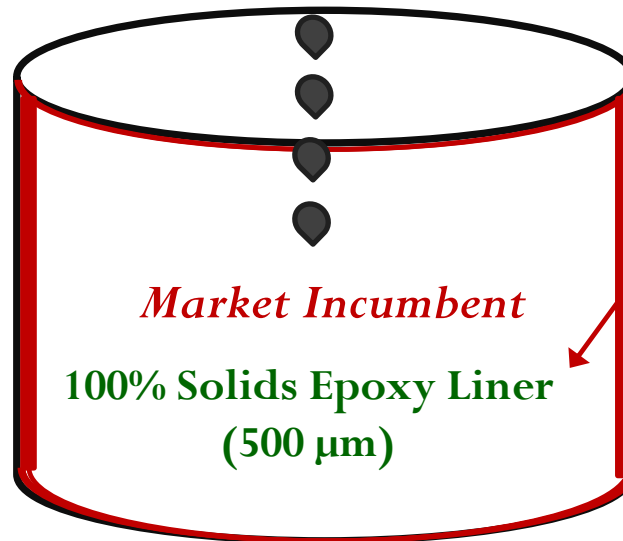


*Susceptible to Microbial Induced Corrosion*

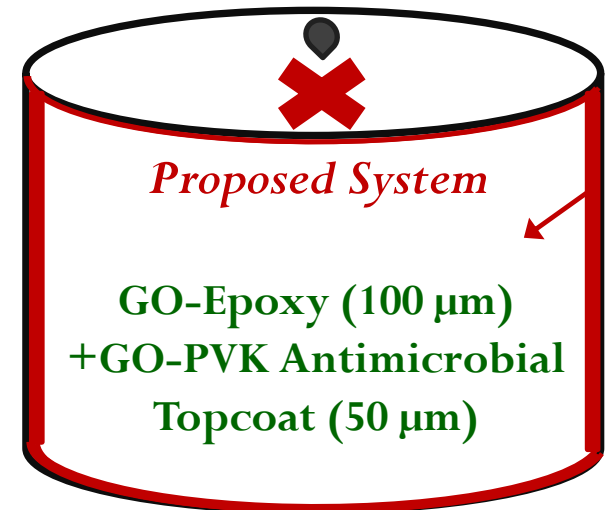


Tank  
Interior

Biocide as Fuel Additive

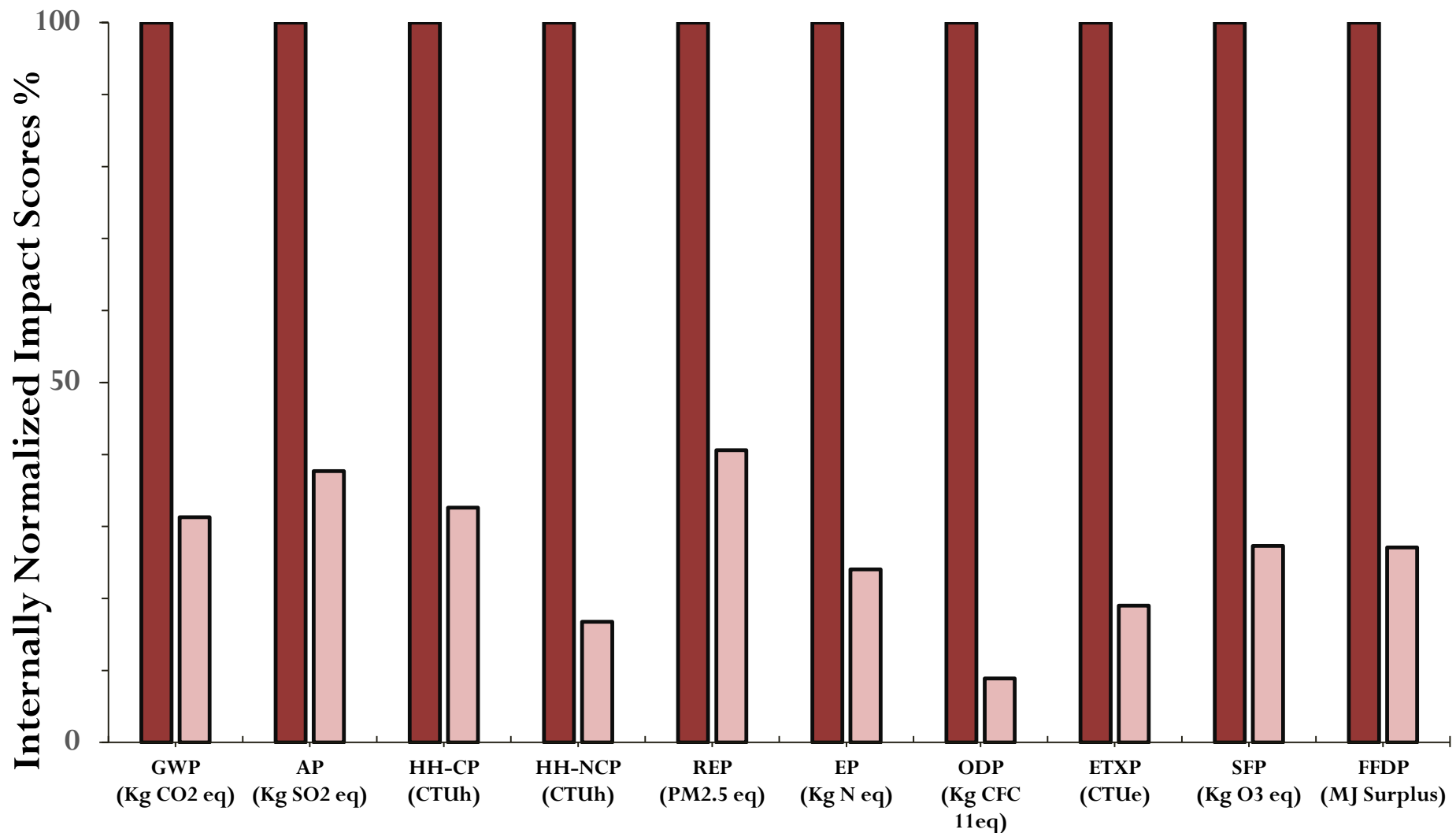


No Biocide Needed





# LCA of Nano Engineered Coatings for Biodiesel Infrastructure

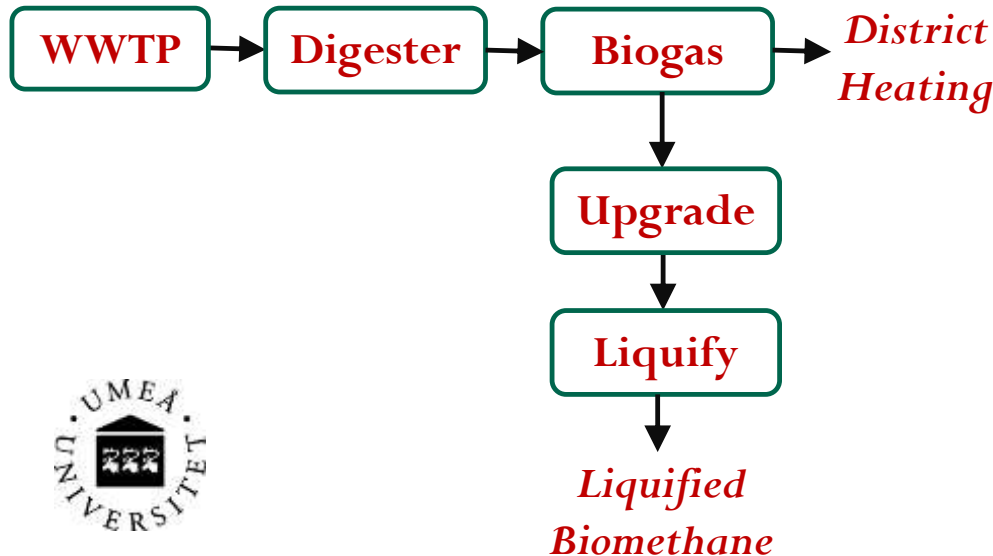
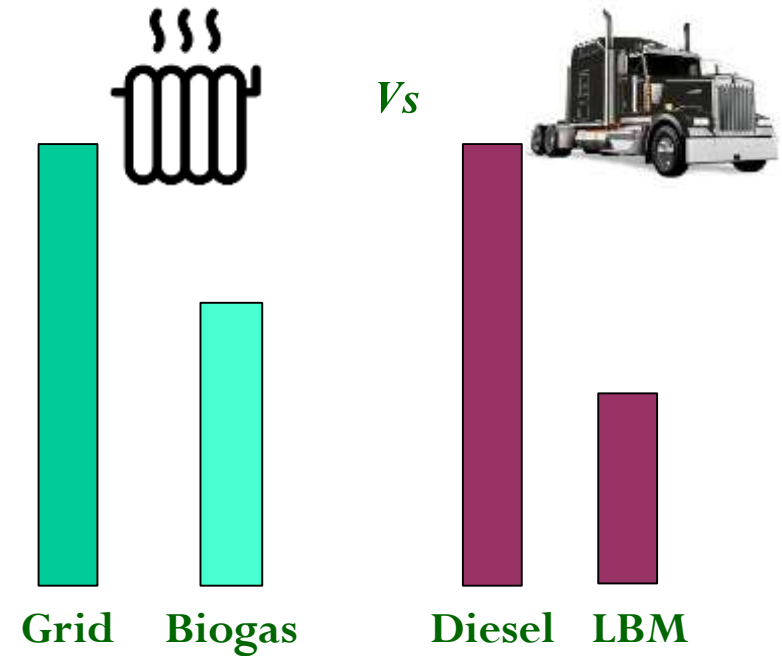


■ 100% Solids Epoxy Liner+ Triazine Biocide □ GO-Epoxy Undercoat+ GO-PVK Topcoat

# Biogas-More Beneficial for District Heating or Fuel for HDVs

## Sweden Biogas (SEA Report 2010)

BiogasPlants	No.	Energy (GWh/Yr.)
Wastewater	135	614
Co-Digestion	18	344
Farms	14	16
Ind. Wastewater	5	114
Landfills	57	298



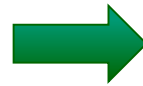
Evaluating Ecoefficiency of Biogas Utilization Options  
(Ongoing Project)



# Decentralizing Services to Promote Sustainable Consumption

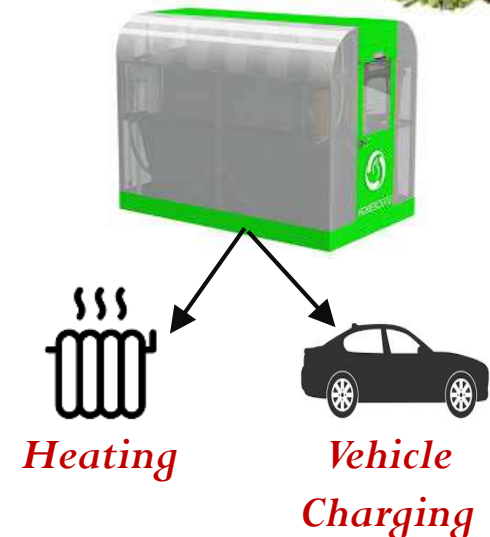
- LCA to Evaluate Sustainable Benefits of Decentralized Energy Infrastructure (Improved Consumer Ownership)

## Centralized System



## DeCentralized System

Home Biogas Unit  
<https://homebiogas.com/>





*Thank You*

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