

Local circular bioeconomies in cities

Evaluation of alternative regulatory mechanisms to support transitions to a green economy



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DECISIVE

A DECENTRALISED MANAGEMENT SCHEME FOR
INNOVATIVE VALORISATION OF URBAN BIOWASTE

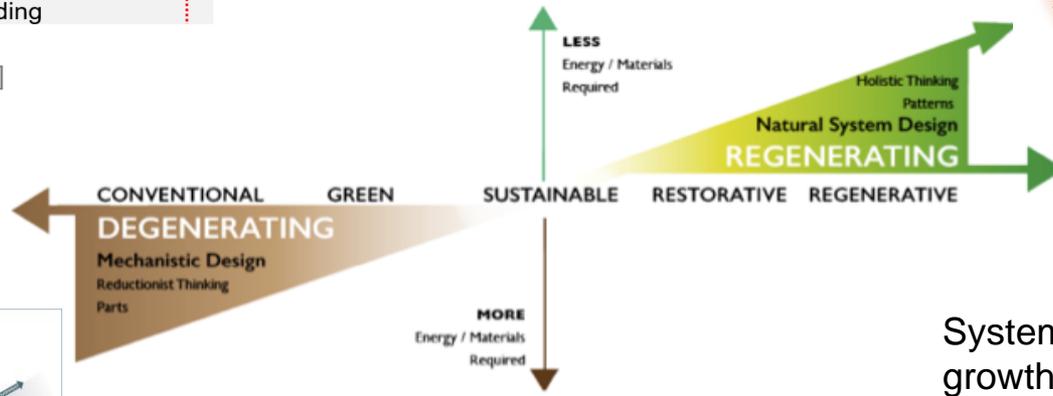
How to enter regenerative CE systems?

- Biosphere Integrity – Genetic Diversity
- Biosphere Integrity – Functional Diversity
- Biochemical Flows – Nitrogen
- Biochemical Flows – Phosphorous
- Land-system Change
- Climate Change
- Ocean Acidification
- Freshwater Use
- Stratospheric Ozone Depletion
- Novel Entities
- Atmospheric Aerosol Loading

- Below boundary (safe)
- In the zone of uncertainty (increasing risk)
- Beyond zone of uncertainty (high risk)
- Boundary not yet quantified (high risk)
- Planetary boundary

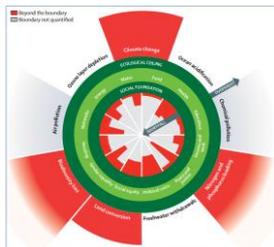
[1]

AN ECONOMY
Place - Culture - Enterprise - Government - Commons



[3]

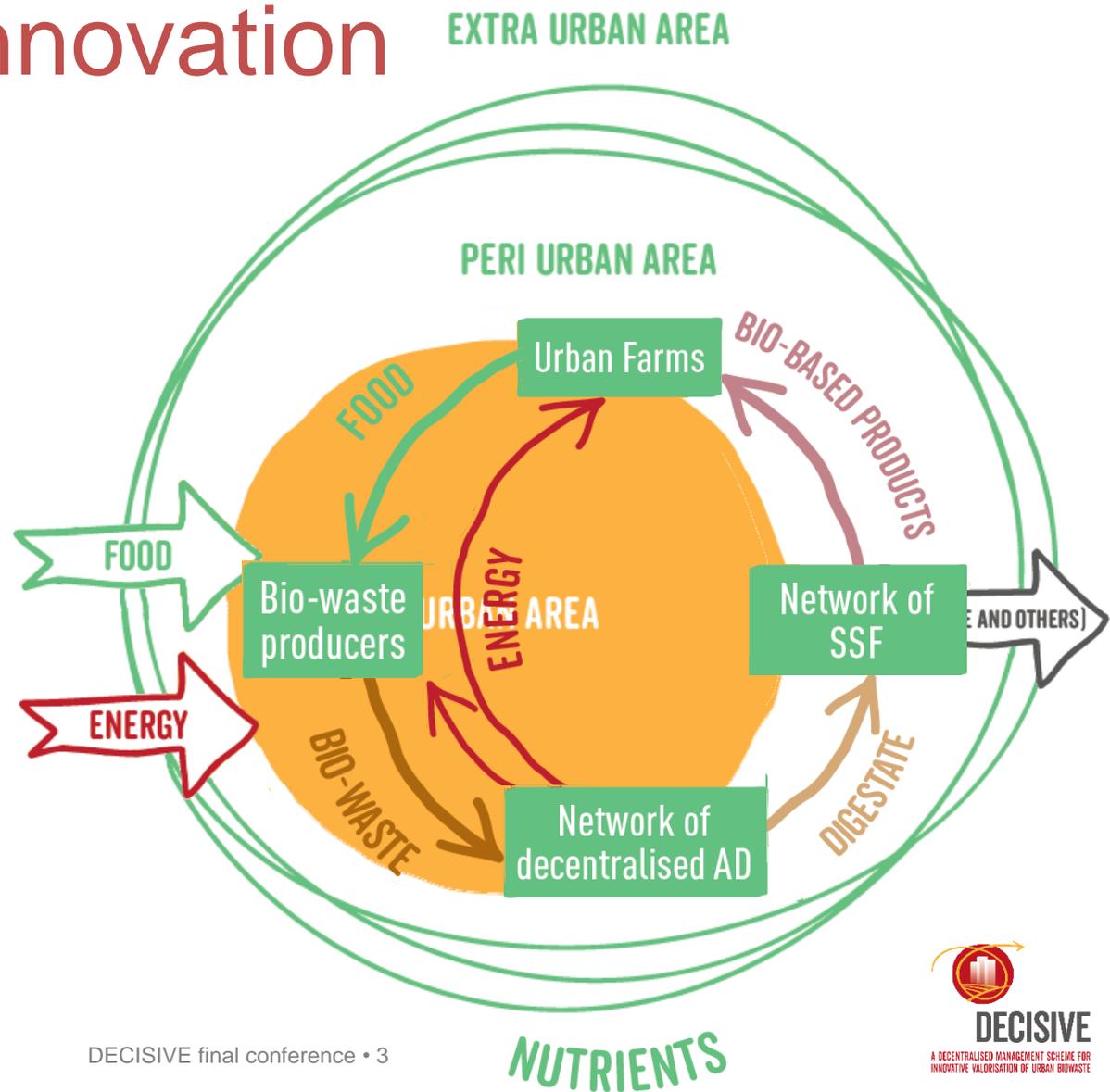
System value from growth positive targets



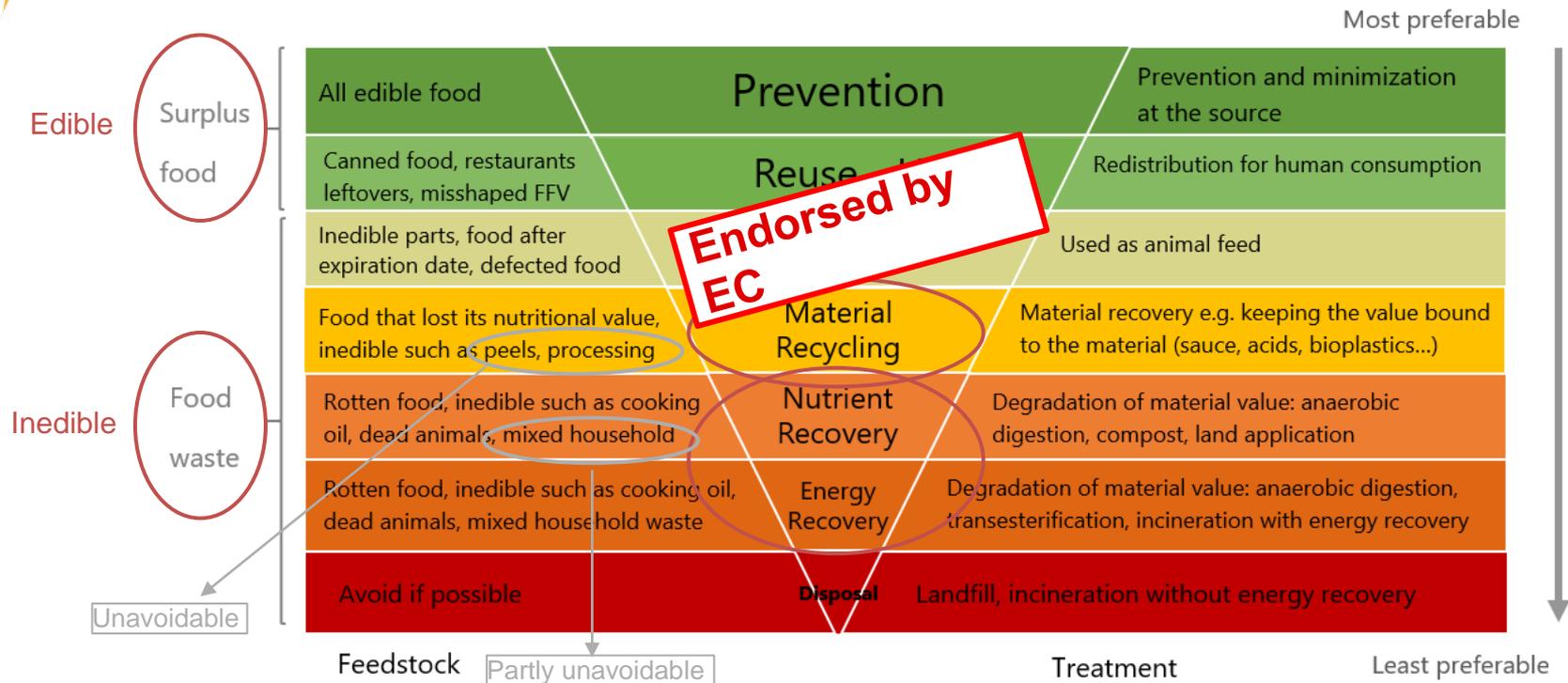
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System Innovation

- **Organisational innovation:**
 - A method to plan efficient decentralised management scheme for urban organic solid waste based on urban metabolism study
- **Technological innovations:**
 - Micro-AD and biogas valorisation
 - SSF
- **Policy and economic innovation**
 - Guidelines/advice for environmental Policy
 - Urban farm concept
 - New waste business



Updated food waste pyramid



Reference: Teigiserova, D.A., Hamelin, L., Thomsen, M., 2020. Towards transparent valorization of food surplus, waste and loss: Clarifying definitions, food waste hierarchy, and role in the circular economy. *Sci. Total Environ.* 706, 136033. <https://doi.org/10.1016/J.SCITOTENV.2019.136033>

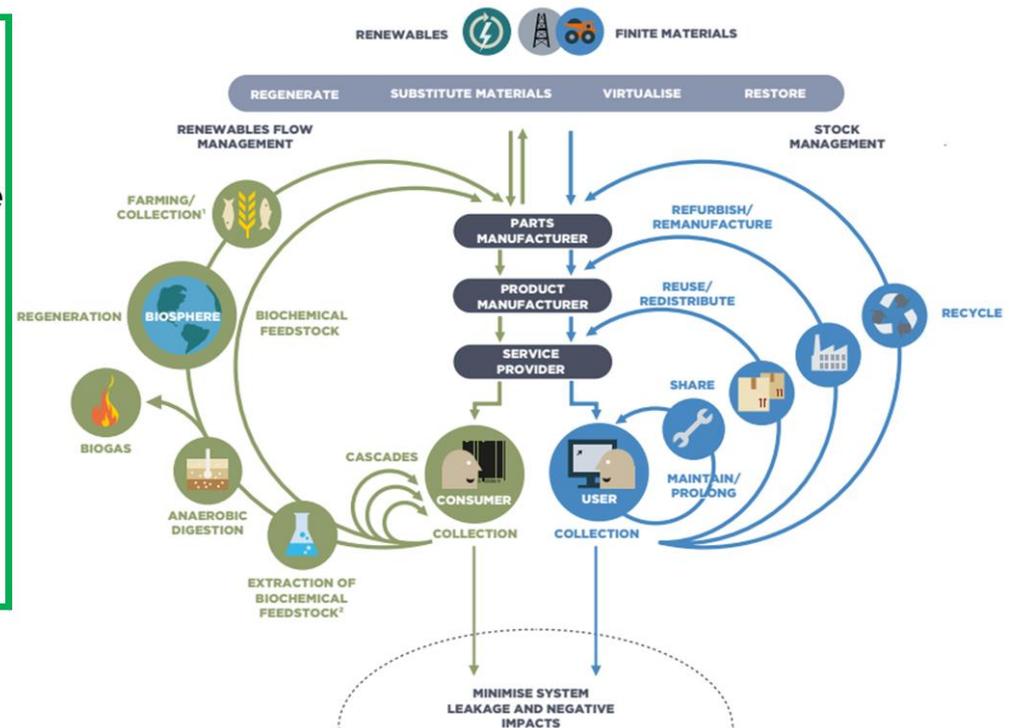
The left side Circular Bioeconomy

- How does the four principles works when looking at the circular bioeconomy wing of the butterfly?

1. Inner circle
2. Cycling longer *
3. Cascade use**
4. Pure circles

*Emission Capture Utilisation and Emission Capture Sequestration

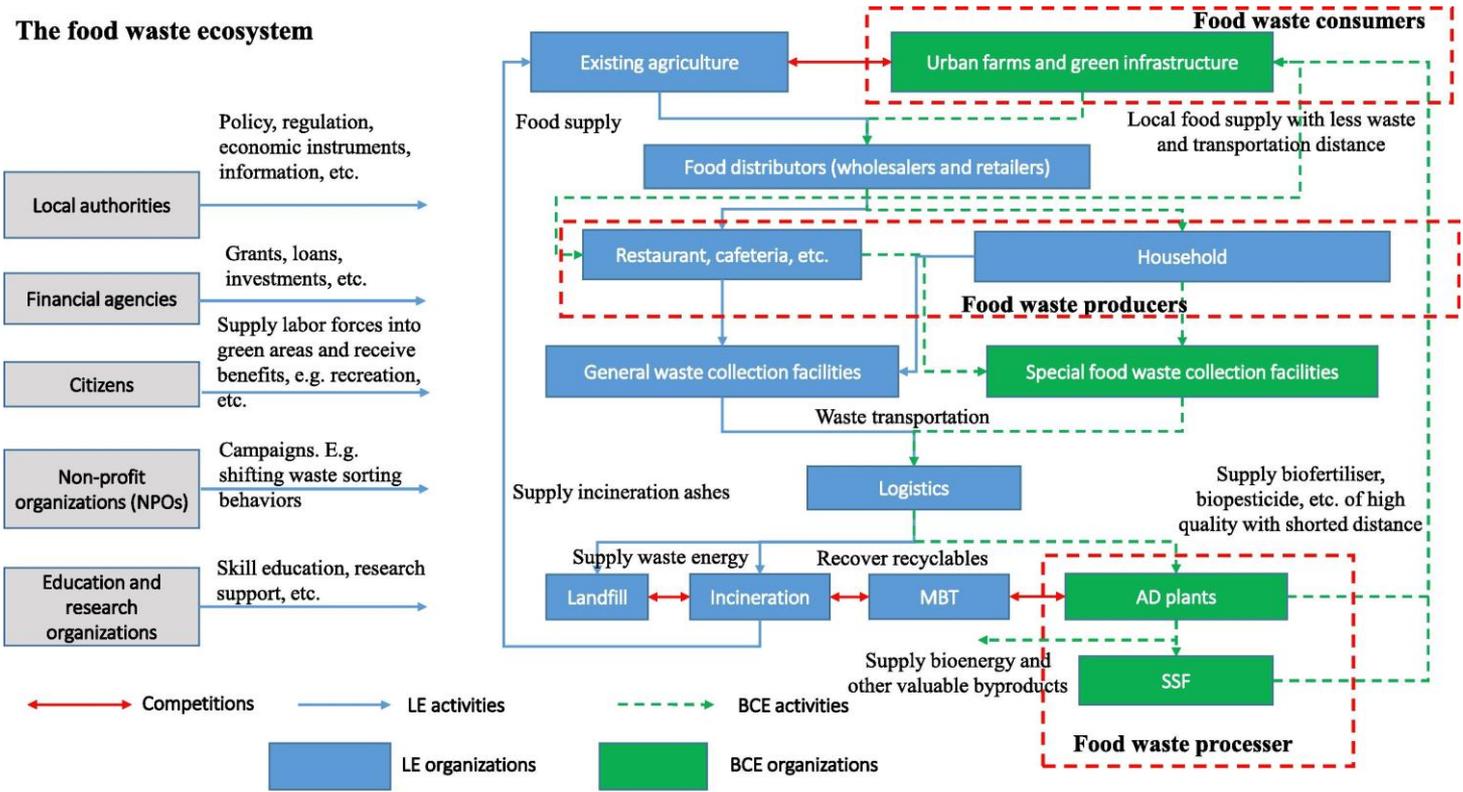
**Hides the potential of the circular bioeconomy



SOURCE
 Ellen MacArthur Foundation
 Circular economy systems diagram (February 2019)
 www.ellenmacarthurfoundation.org
 Drawing based on Braungart & McDonough,
 Cradle to Cradle (C2C)

Co-existence of LE and CE systems as part of the transition

The food waste ecosystem



Reference: Cong, R—G., Thomsen, M., 2021. Review of ecosystem services in a bio-based circular economy and governance mechanisms. Ecosystem Services 50, 101298 <https://doi.org/10.1016/j.ecoser.2021.101298>



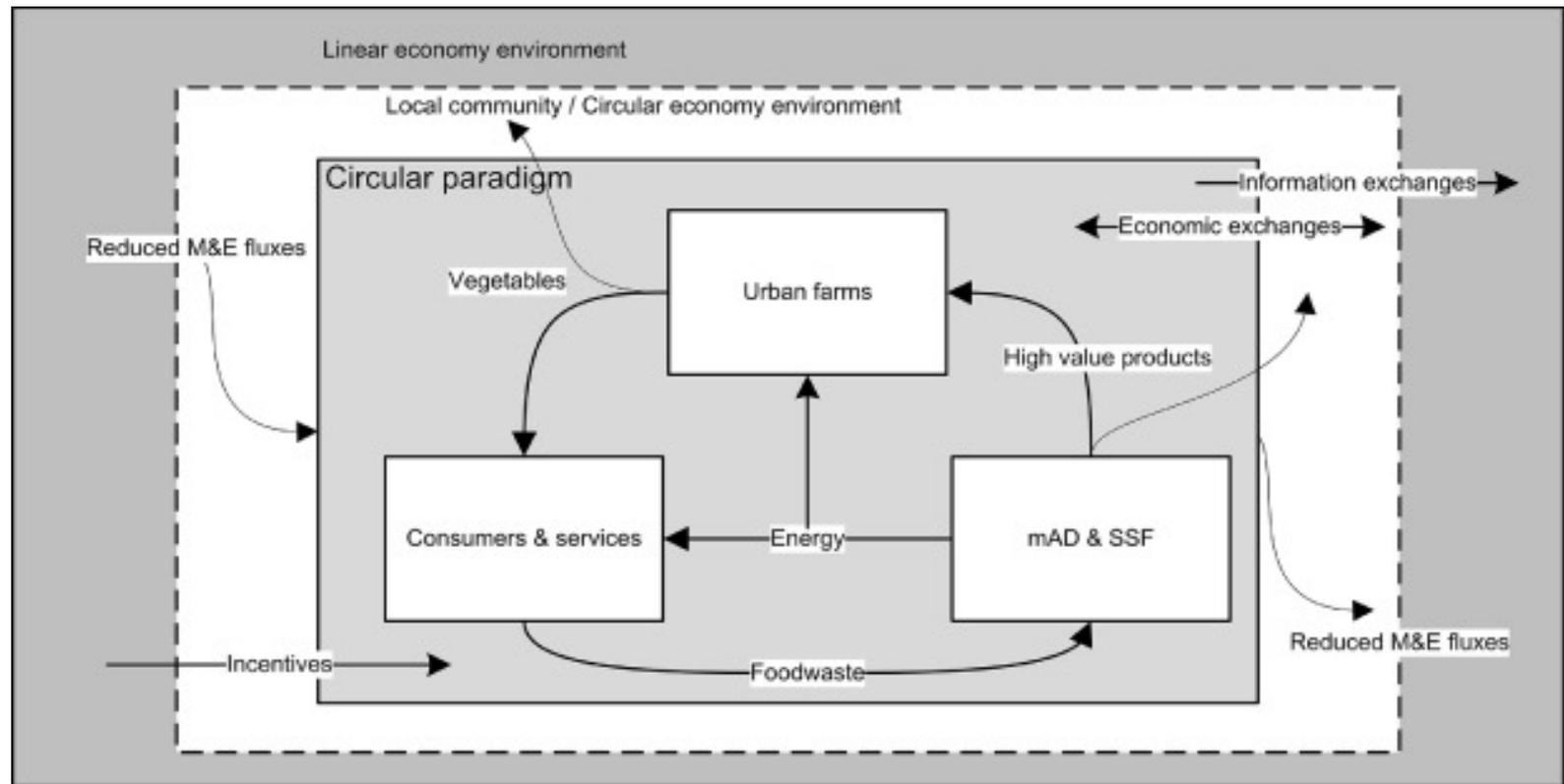
Ecosystem Services from CBEs

- The Circular BioEconomy ecosystem redefined as an analogy to natural ecosystems
 - 1) provisioning services
 - FW generators providing feedstock, FW processors providing bioenergy, biofertilizers, biopesticides and platform chemicals, UF providing local fresh food
 - 2) supporting services
 - nutrient cycling and soil formation
 - Biodiversity increase from UF and green infrastructure habitat provision
 - Indirect and induced effects of CBE of the local economy
 - 3) regulating services
 - Function of the green inedible infrastructure improving air and soil quality or by increased permeability for flood control
 - 4) cultural services
 - aesthetic inspiration, cultural identity, recreational values, tourist and spiritual experience, job creation, environmental awareness, health

Why LE has a competitive advantage in the current market settings

1. the negative environmental and social impacts (externalities) of LE operations are not fully penalized in the current market setting (market failure)
2. the impact of cumulative effects of production and consumption in LE (such as resource depletion, pollution, and climate change) are ignored by companies
3. short-term profits and dividends to shareholders are often prioritized compared to long-term targets such as sustainable development
4. efforts to establish a CE model through price instruments (such as fees, taxes and subsidies) are seen as a burden to existing dominating markets players, rather than an essential adjustment to the market failure in LE

Assessment framework



Reference: Angouria-Tsorochidou, E., Teigiserova, D.A., Thomsen, M., 2021. Limits to circular bioeconomy in the transition towards decentralized biowaste management systems. Resources, Conservation and Recycling 164, 105207 <https://doi.org/10.1016/j.resconrec.2020.105207>

Indirect and induced effects of BCE in the decentralised economy

- Direct effects:
 - revenues and employment
- Indirect effects
 - purchase of inputs to the BCE (BtB transactions)
- Induced effects
 - the results of increased personal income caused by both the direct and indirect
 - impacts on the value chain:
 - BCE business purchases inputs from different sectors and sells products and service through different market channels;
 - trade substitution effect
 - Reduced import of foods from other regions
 - change citizens' consumption patterns
 - E.g. adapting to local organic food and choosing local tourism instead of travelling abroad which may impact other sectors of the local economy

System level performance



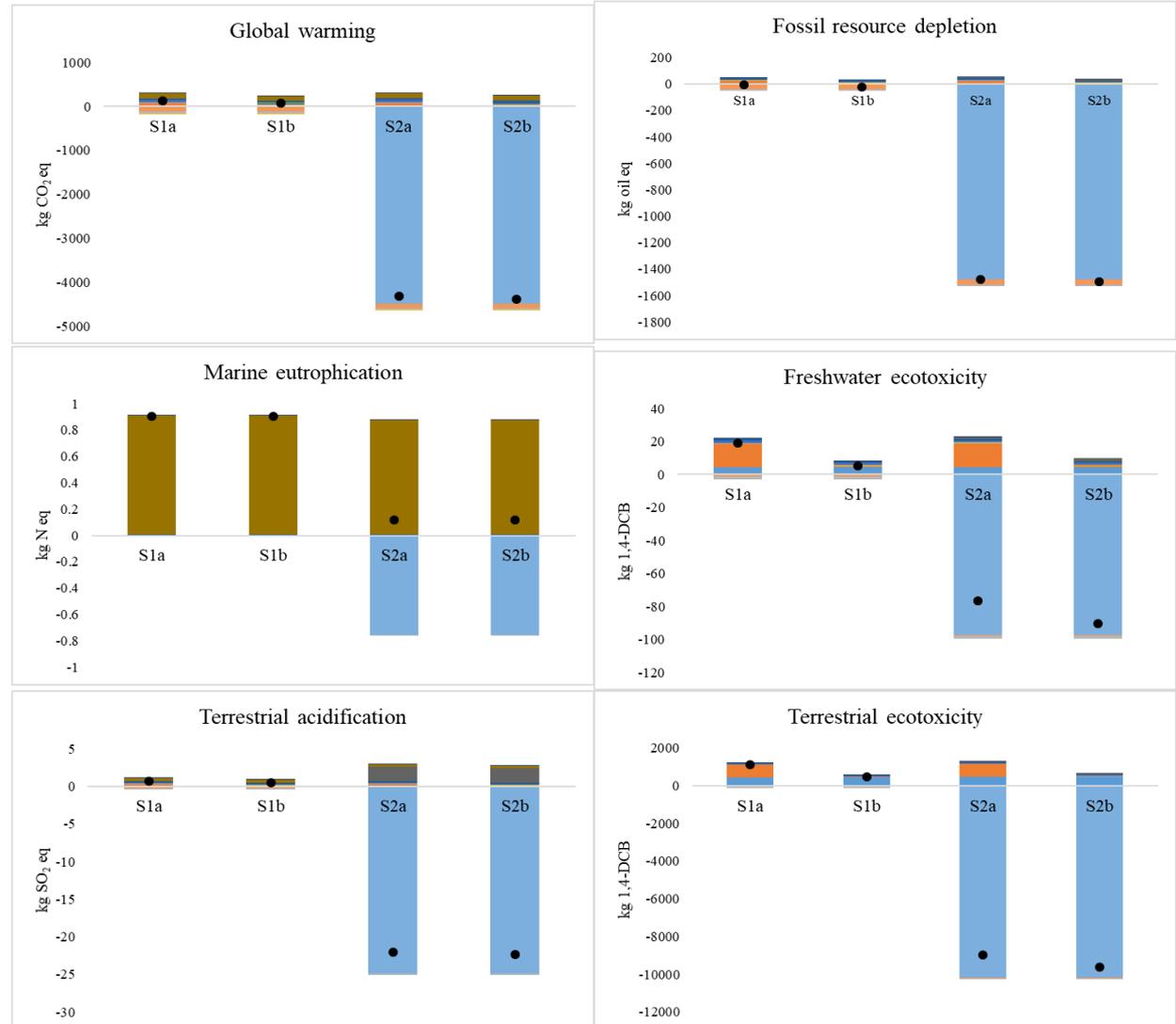
- Global warming
- Fossil resource depletion



- Marine Eutrophication
- Freshwater ecotoxicity



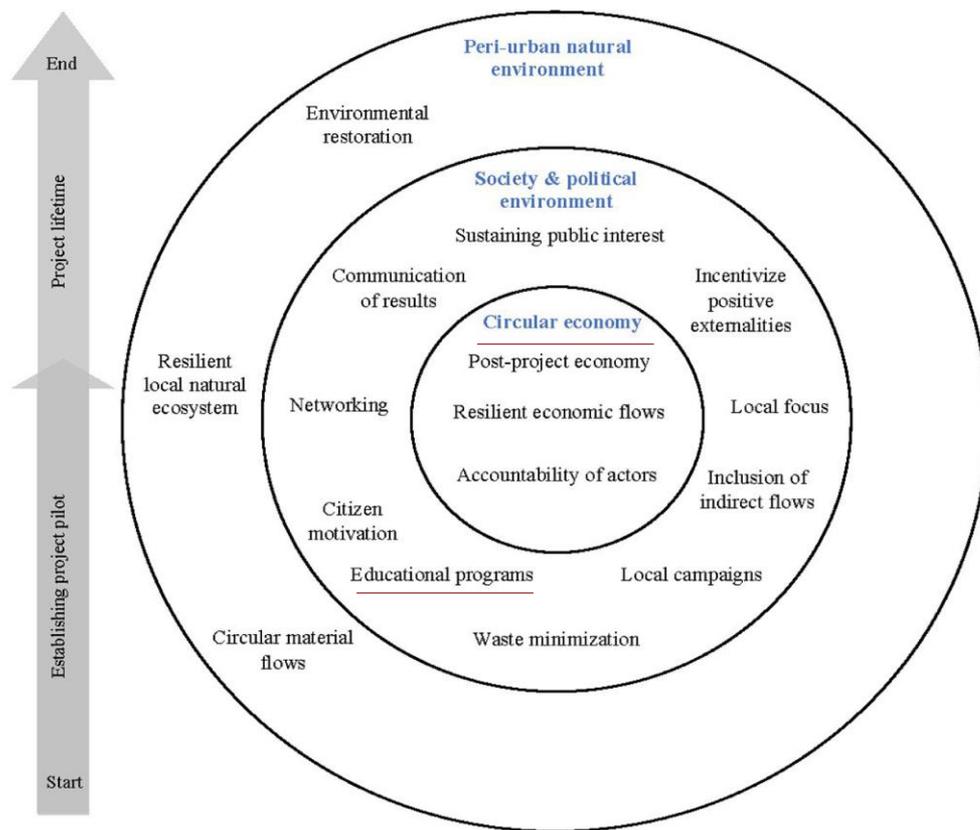
- Terrestrial ecotoxicity
- Terrestrial acidification



Method – semi-structured survey

- Which characteristics in the regulatory environment can act as supportive or inhibitory?
- Which institutional characteristics can accelerate or complicate the implementation of a DBMS?
 - (i) the perception of the stakeholders for the future of the project
 - (ii) the impact of the project during its course of implementation
 - (iii) recommendations for alternative actions based on their current knowledge

Transition to decentralized biowaste management systems



Lack of initial capital investment and high interest rates on short payback period, which needs support from both public and private investors

during the transition to the CE there are usually skill gaps in the current workforce, which could require public investments in special education

Influential factors

Regulatory factors

- Governmental engagement
- Status and maturity
- Legal framework & rigidity
- Externalities



Need for monetary reflection of quality

Institutional factors

- Environmental focus & status
- Bureaucracy of administration
- Familiarity and maturity
- Network and advocacy



Need for committed and conscious individuals

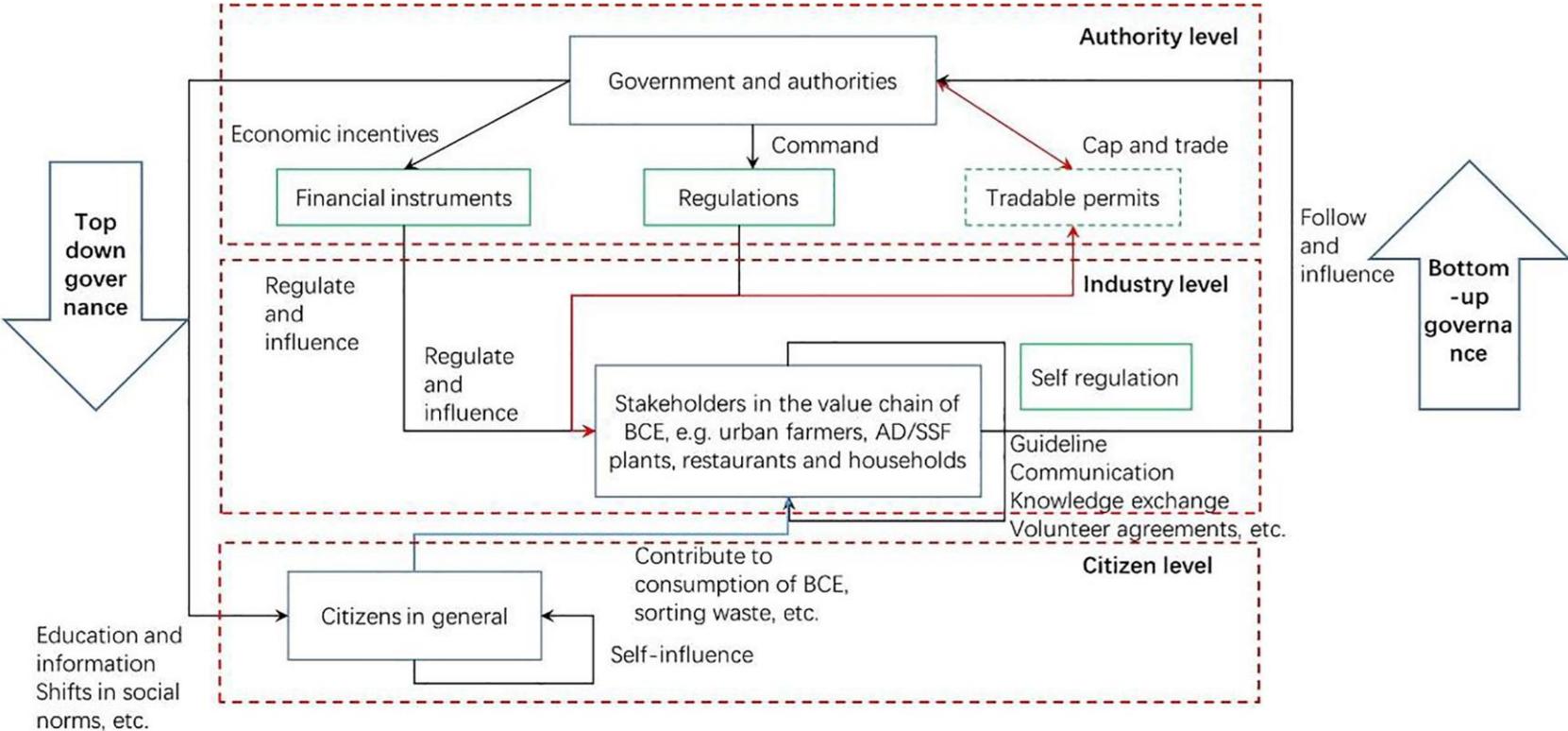
Economic factors

- Accountability and liability
- Financial viability
- Post-project economy
- Incentivizing positive externalities



CAPEX vs OPEX concerns
Post-project viability

Multi-level regulatory systems for the successful implementation of BCE



Reference: Cong, R—G., Thomsen, M., 2021. Review of ecosystem services in a bio-based circular economy and governance mechanisms. *Ecosystem Services* 50, 101298 <https://doi.org/10.1016/j.ecoser.2021.101298>



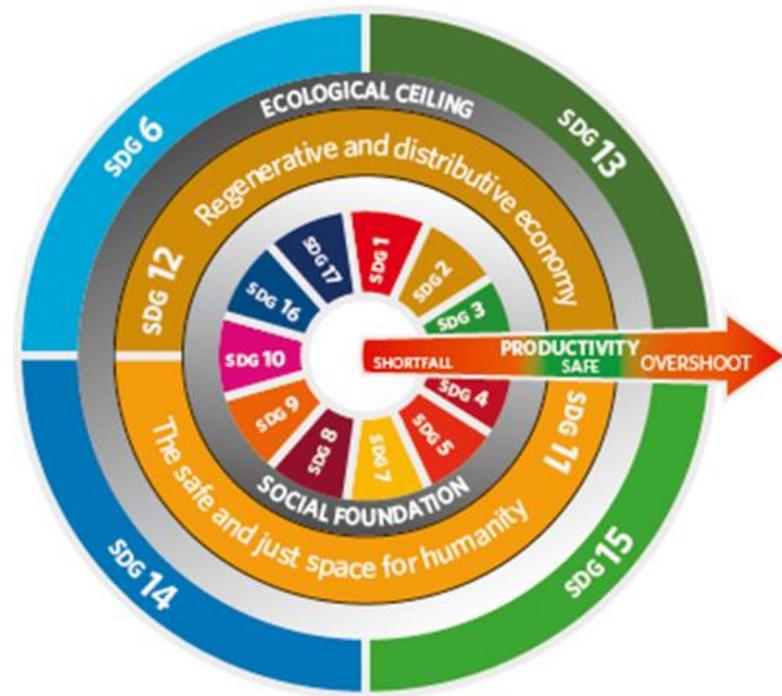
ES framework into the CBE field

- The ES framework can be a reference to guide practitioners, companies and public actors to reorganize their activities and collaborate in the ecosystem settings, informing them of market (provision services) and non-market benefits (supporting, regulating, social and cultural services) we can enjoy from the transition from LE to CBE in a broad sense, while considering risk mitigation strategies to insure quality and safety of CBE products

Expressed In SDG language

SOLUTIONS

- **Restorative local bioeconomies**
 - Restoring and enhancing local ecosystem services for local self-supply
 - Educating people as ecosystem health preservers and enhancers
- **Policy instruments for**
 - **Regenerative multi-actor business models**
 - Restorative resource management and technology transfer
 - Emission capture and utilization
 - Biodiversity conservation, environmental restoration and climate change mitigation profit
 - System value from growth positive targets



Further Readings - DECISIVE

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- Teigiserova, D.A. Tiruta-Barna, L. Ahmadi, A. Hamelin, L., Thomsen, M., 2021. The energy transition is a precondition to a sustainable circular bioeconomy: life cycle assessment of scaled-up cascading biorefinery of orange peel waste, submitted to STOTEN
- Teigiserova, D.A., Bourguine, J., Thomsen, M., 2021. Closing the loop of cereal waste and residues with sustainable technologies: An overview of enzyme production via fungal solid-state fermentation. *Sustainable Production and Consumption* 845-857. <https://doi.org/10.1016/j.spc.2021.02.010>
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Potential barriers and regulatory instruments

- 1) cultural barriers such as residents could be reluctant to sort food waste or purchase BCE products (SRL)
- 2) market barriers where economic feasibility of BCE highly depends on the policy support
 - 1) high investment costs
 - 2) competitive LE product prices
 - 3) insufficient compensations for social and environmental benefits
- 3) technological barriers, infrastructural challenges and transportation (TRL)

Important!

- Regulatory instruments needs to support systems value in terms of growth positive targets (e.g. climate change mitigation and environmental restoration)
- The technology assessed follows a circular model by turning waste into secondary resources and energy but the economic model remains linear, with value created by selling products while no monetary tangible social or environmental benefits are defined

Potential barriers and regulatory instruments

- Multi-level regulatory systems for the successful implementation of BCE
 - we propose a three-level (government, industry and citizen) mixed (both top down and bottom-up) regulatory and supporting system for facilitating the CBE transition
 - Top down and bottom up
 - On the top level, the **government and authorities** could set up an overall strategy and policy targets with the necessary regulation tools and resources
 - Regulation and economic instruments are examples of top-down instruments.
 - On the **business level**, it could be beneficial for them to self-organize and self-regulate because they know better how to adapt to local condition
 - On the **citizen level**, shifting people behaviors in the short-term may require external drives from the top-down governance
 - bottom-up self-governance is initiated by regulation target groups through e.g. self-regulation, education and social-norm shifting

Regulatory instruments of governments and authorities

- three types of instruments available to compensate externalities of BCE and correct potential market failures
 - 1) financial instruments (incentive-based)
 - waste charge and landfill tax
 - Subsidies (for good sorting quality)
 - Financing public ES through investment models
 - Grant/loan (e.g. DK Biogas Action program or European investment bank) or shared financing (PPP model)
 - 2) regulations (command and control)
 - Waste framework directive (EU level)
 - Separate collection is obligatory as of 2015 for paper, metal, plastic and glass, by 31 December 2023 for bio-waste and by 1 January 2025 for textile and hazardous household waste
 - Self-regulation
 - Industrial self-regulation – an institutional complement to government regulation process
 - Urban community self-regulation –
 - a strategy to impact potential government regulatory systems when new policy targets are emerging
 - Social support system
 - Educational
 - -KAB (Knowledge-Attitude-Behavior) theory
 - and norm shifting
 - Nudge to change peoples behavior without changing their economic incentives, e.g. making the recycling bins bigger than waste bins
 - 3) cap and trade (CAT)

Alternative regulatory instruments

- multi-level mixed (both top-down and bottom-up) regulatory and supporting system and some alternative policy instruments such as tradeable permits, which is expected to utilize the advantages of government, BCE industry and citizens in a harmony way to maximum the policy efficiency and avoid policy failure
- integration of existing knowledge of current and potential instruments with a focus on the roles of stakeholders at different levels
- regulatory and supporting system, for SMEs and citizens to have more incentives to be part of the CBE as producers and consumers of products and services (local fresh food, sorted food waste of high-quality, recreational and functional urban environment), aligning with the sustainable development goals
- The proposed multi-level mixed regulatory and supporting system can contribute to the solutions for pricing public goods and minimizing the policy monitor and implementation costs, through combinations of top-down governance, self-regulations and volunteer agreements and shift of social norms