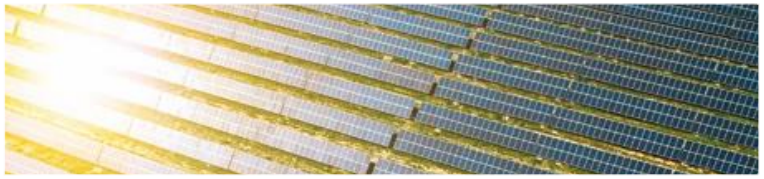
IChemE

Sustainable Circular Economy: Technical, economic, political and social dimensions

Dr Anne Velenturf, Prof. Phil Purnell











Today

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1. Resource flows between people & environment are integrated
2. We have to dematerialise for a sustainable circular economy
3. Future of circular business models
4. Facilitating transition processes that work

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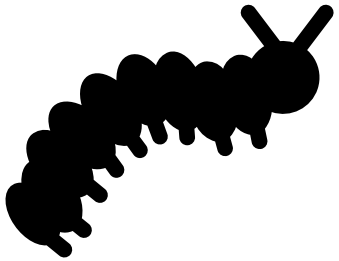

1. Resource flows between people & environment are integrated

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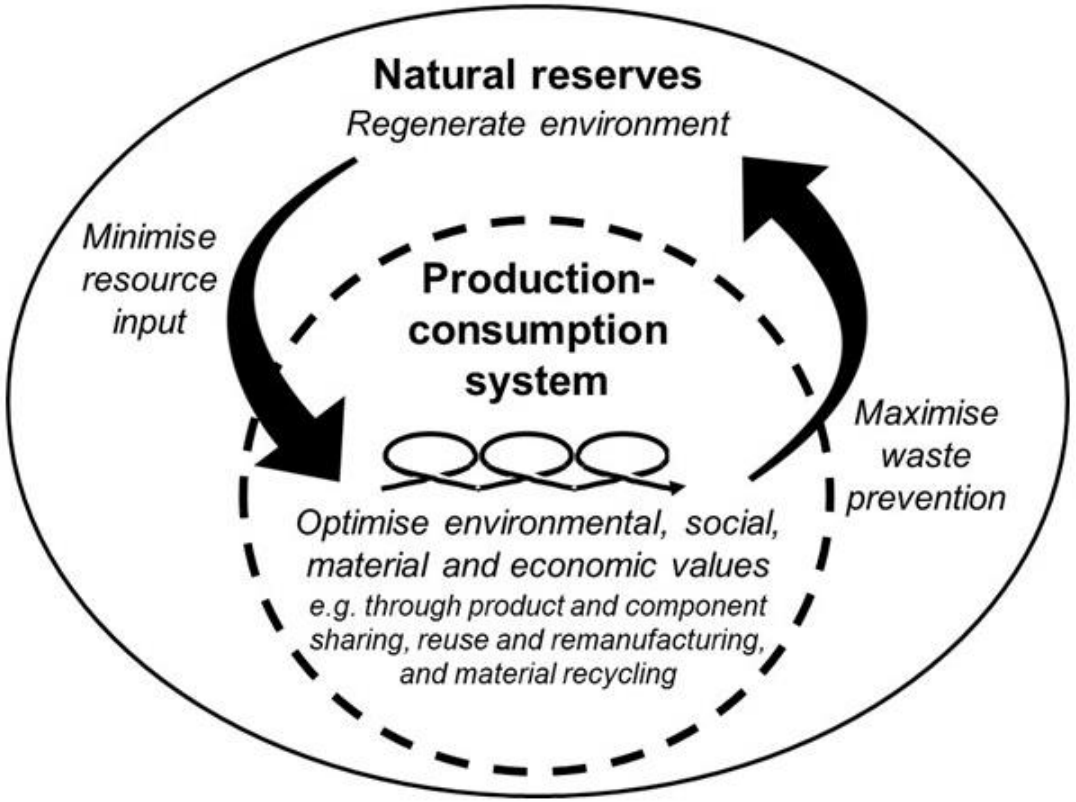
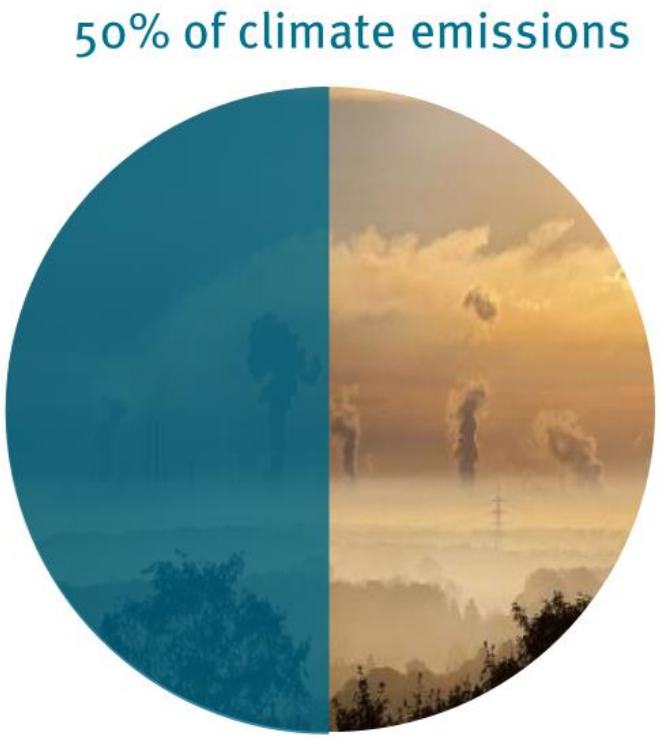
Sustainable circular economy



- Alternative to the linear take-make-use-dispose economy
- Make better use of materials, components and products
- Optimise economic, technical, social and environmental values of materials and products
- Whole system approach
- Improve social and environmental quality while maintaining economic prosperity

Velenturf and Purnell (2021) Principles for a Sustainable Circular Economy

Impacts of resource use



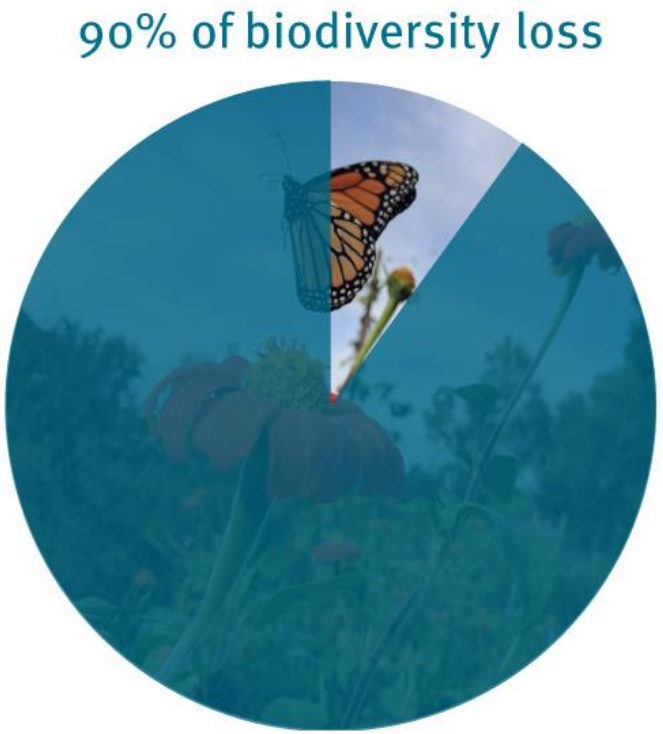


Image courtesy of Green Alliance

Butterfly diagram

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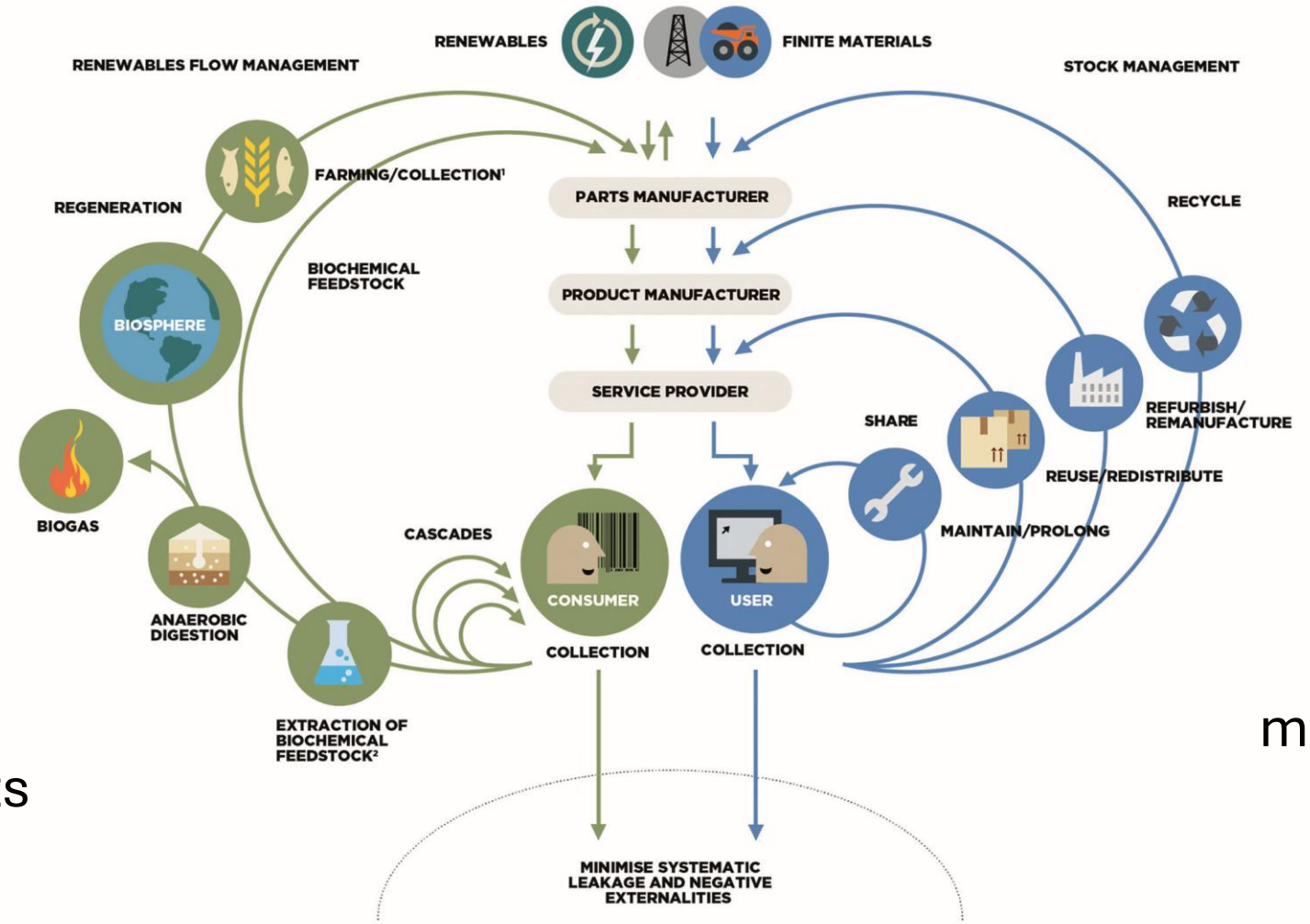
Assumes perfect wasteless natural environment

In practice claimed as bioeconomy, part of circular economy

Biological nutrients to return to biological cycles



People exist in technosphere separate from nature

Technical nutrients, in practice considered minerals / metals, to stay in technosphere

EMF (2019) Circular economy system diagram. Based on Braungart and McDonough Cradle 2 Cradle.

Conceptual issues with butterfly diagram

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[1] Focus on minimising and compensating impacts for “net-zero”. Mindset change to positive relations with environment.

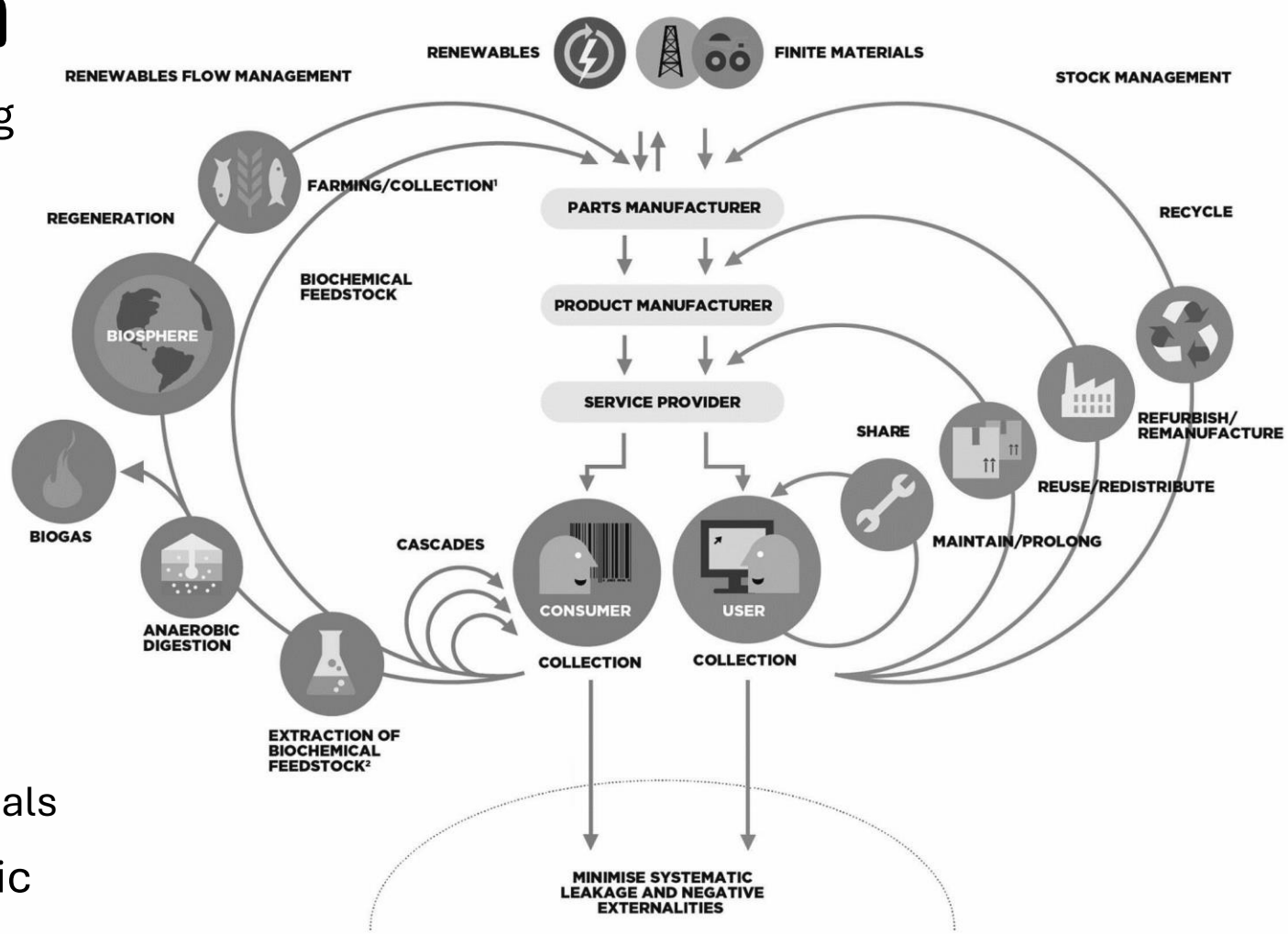
[2] Energy and water costs for maintaining flows exceed what’s sustainably available.

[3] Unavoidable losses of material quality over multiple lifecycles.

[4] Inputs and outputs from society out of scope, but should not be, e.g.:

- High input of materials for sustainable living transitions e.g. renewables
- Phasing out unsustainable unhealthy materials

[5] Both wings contain organic and inorganic materials, by nature or human design. “Confusion of flows” across wings.



Velenturf et al (2019) Circular economy and the matter of integrated resources.

A new conceptual model for sustainable circularity

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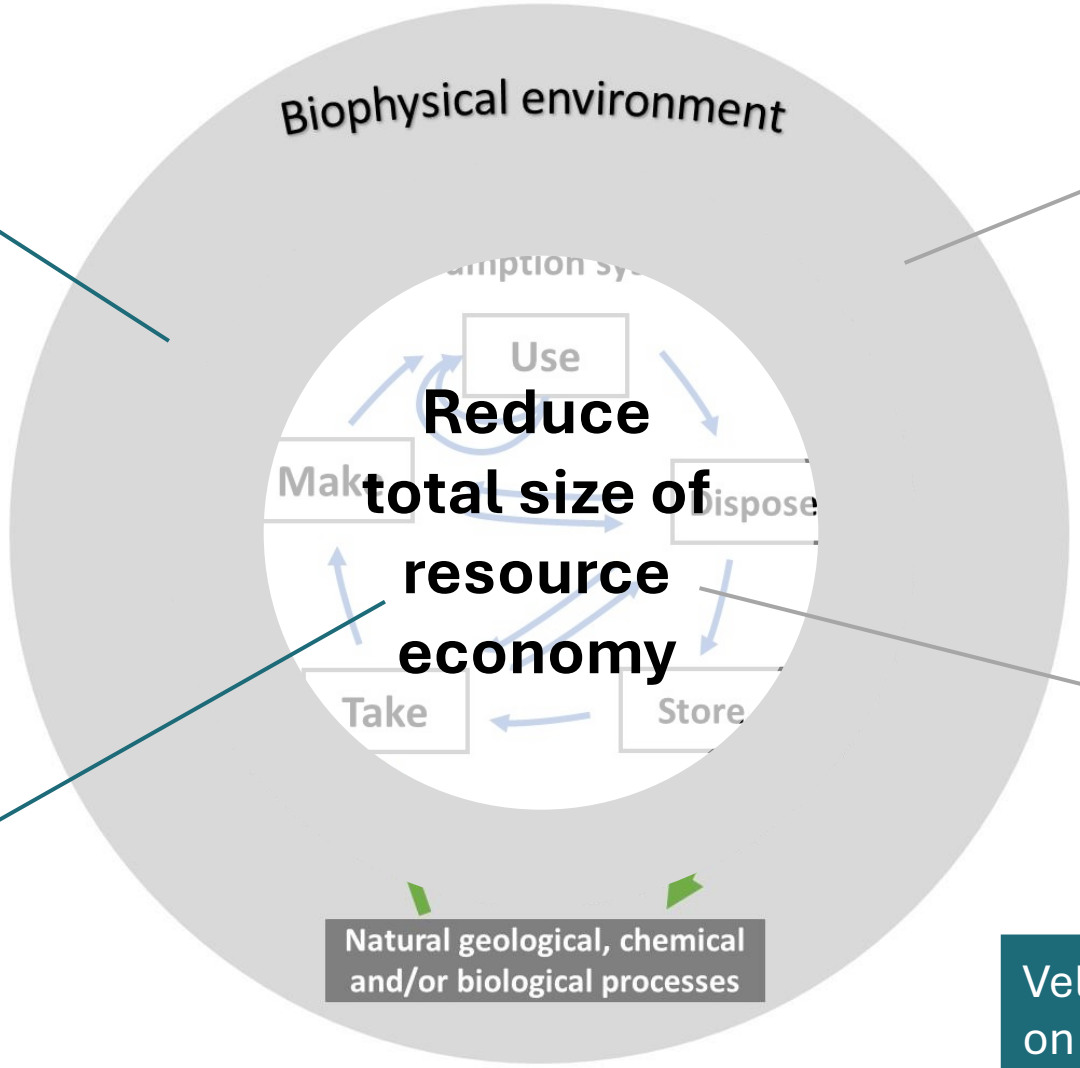
Not controlled, but likely influenced, by people

Controlled by people



Natural materials: not directly controlled by people; of natural or engineered origin; take part in natural bio/geo/chemical processes without causing harm

Industrial materials: transformed through production/consumption; can at end of use safely reintegrate into biophysical environment without harm

Velenturf et al (2019) A new perspective on a global circular economy.

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2. We have to dematerialise for a sustainable circular economy

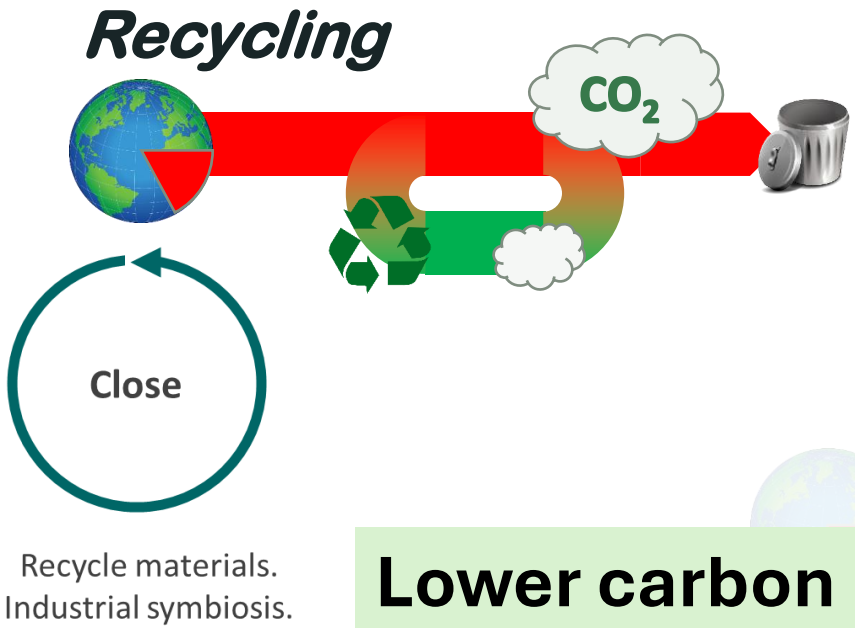
Recycling

Substitution

Business as usual

Reduction

All of the above = SCE?



Lower carbon saving than a 28% decrease in production would achieve

UK Plastics

- Consumption = 4000 ktpa
- Recycling capacity = 800 ktpa
  - *Losses ~30%*
- Virgin : recycled = 2.4 : 0.4 kg CO_2 per kg plastic
- Best practice recycled content = 40%
  - *Average <10%*
- Move to best practice across the entire industry would save around 2400 kt CO_2 pa and require a 200% - 300% increase in the amount of recycling infrastructure, >£3 billion

Sources: British Plastic Federation, 2021, Recycling Roadmap: Improving UK recycling by 2030

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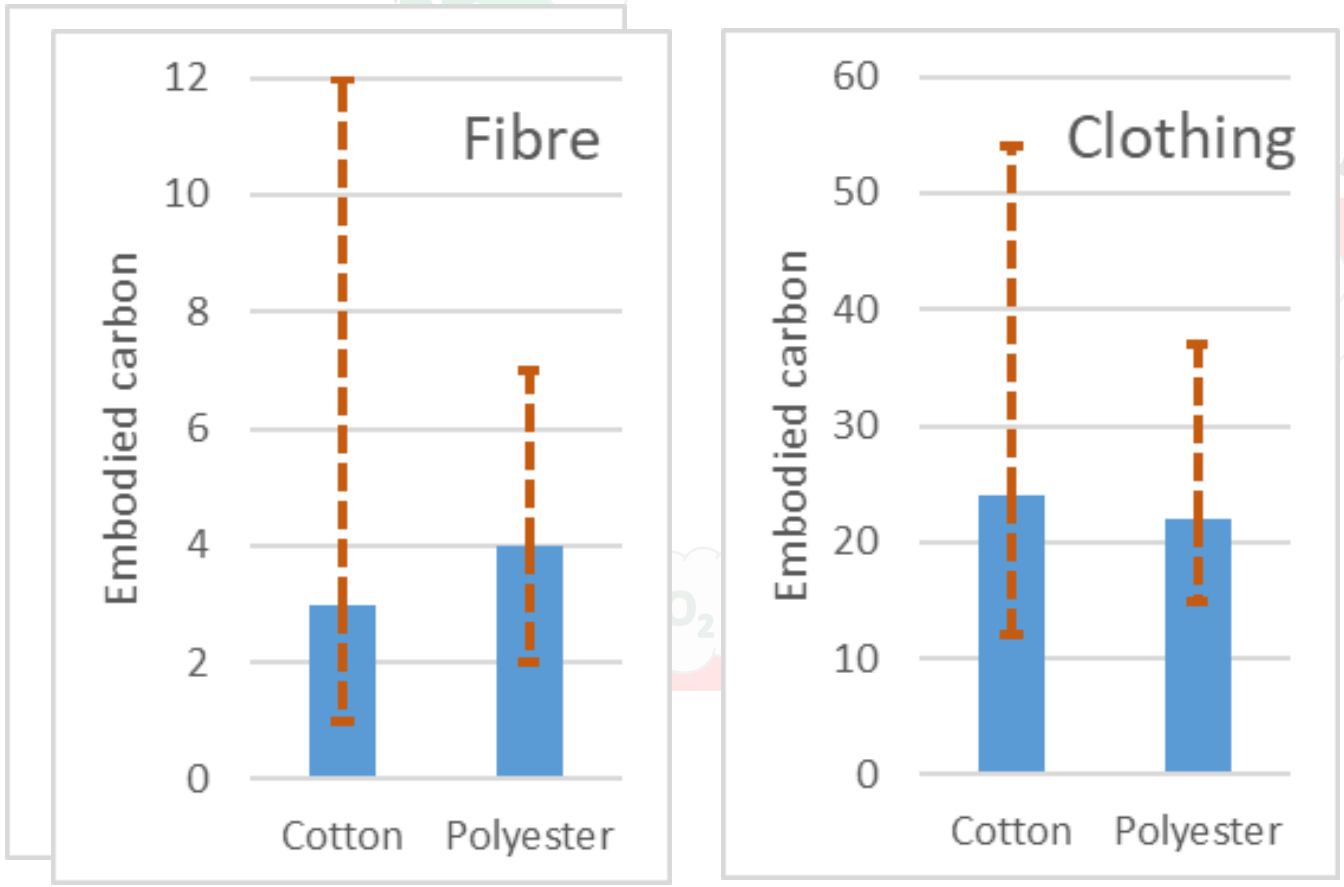
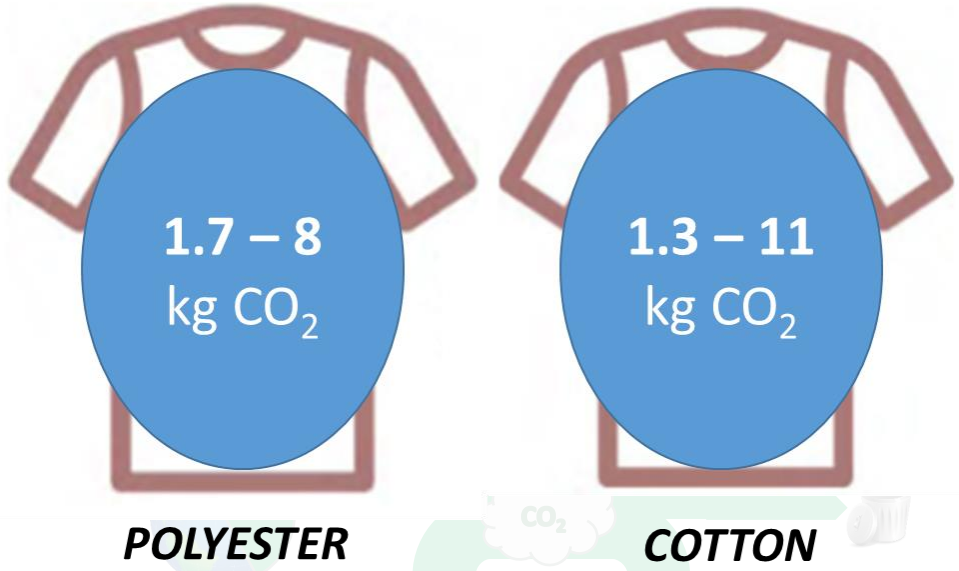
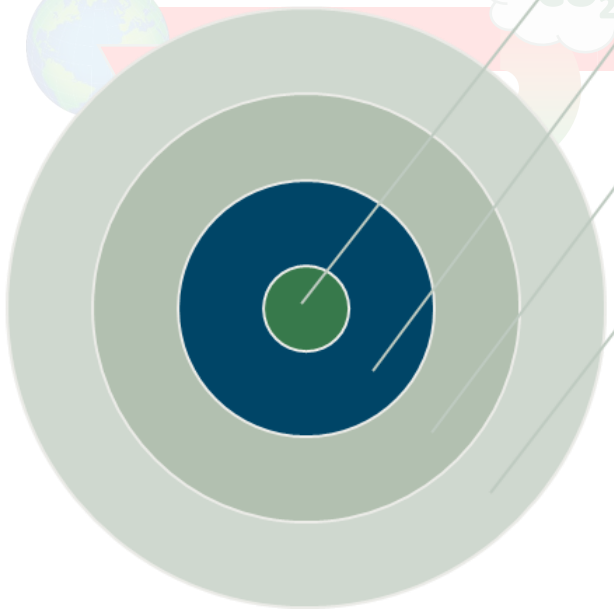
One polyester shirt has a 5.5kg carbon footprint, compared to just 2.1kg for a cotton shirt – Greenpeace, 2019







Design: to preserve and recover value

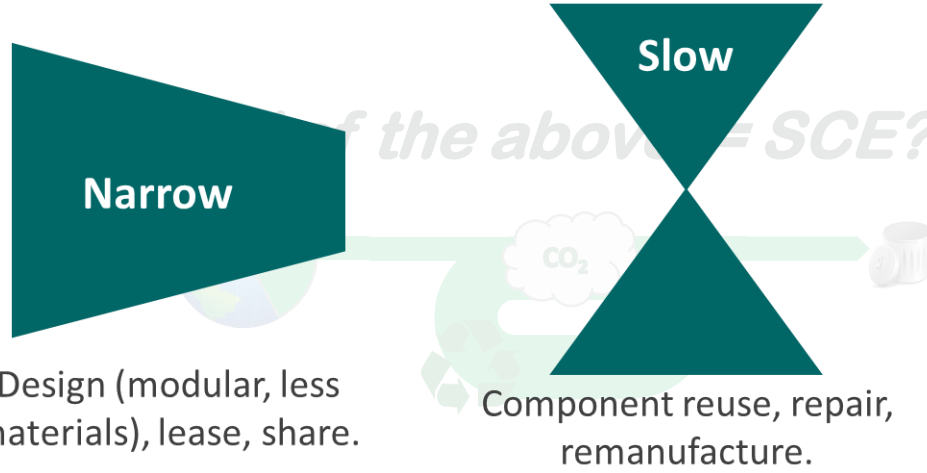
Information: to identify and classify value

Market: to distribute and quantify value

Business models: to appropriate an recycle value

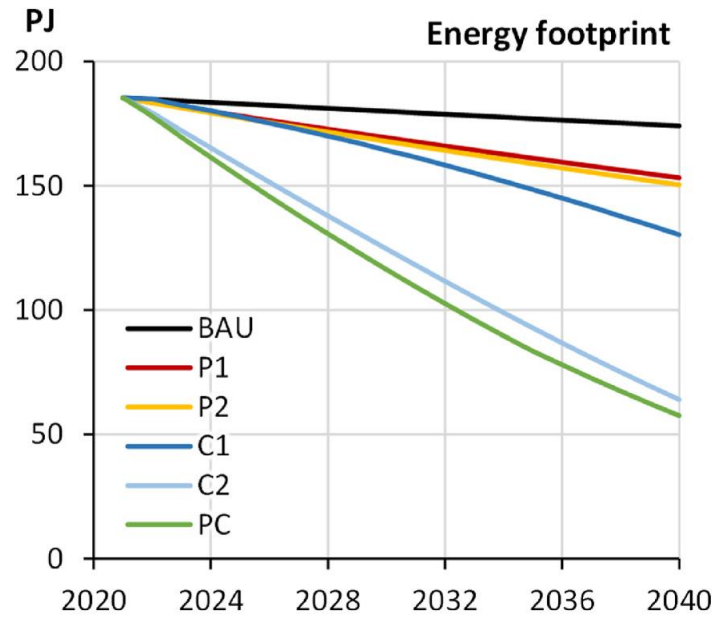
- **The value of a component is in its function, not its materials. To recover function – i.e. reuse – information about components is valuable.**
- **An information and inventory infrastructure is required to support this.**

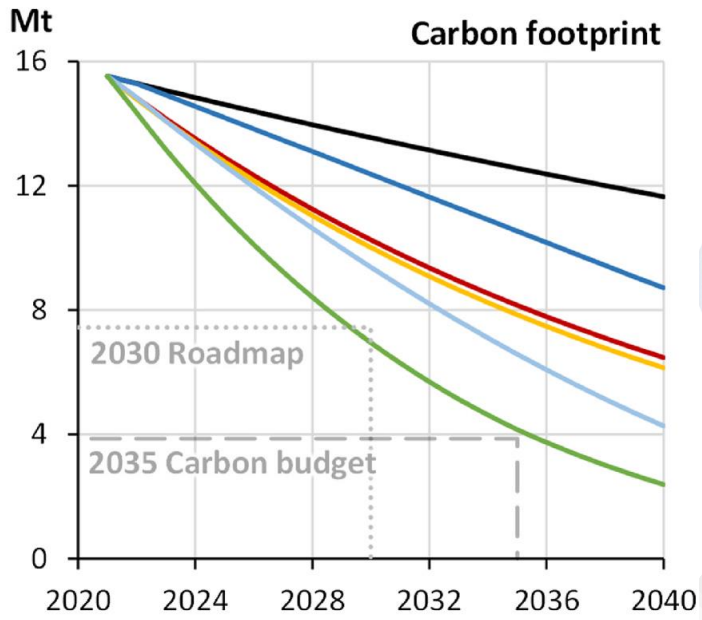
Reduction

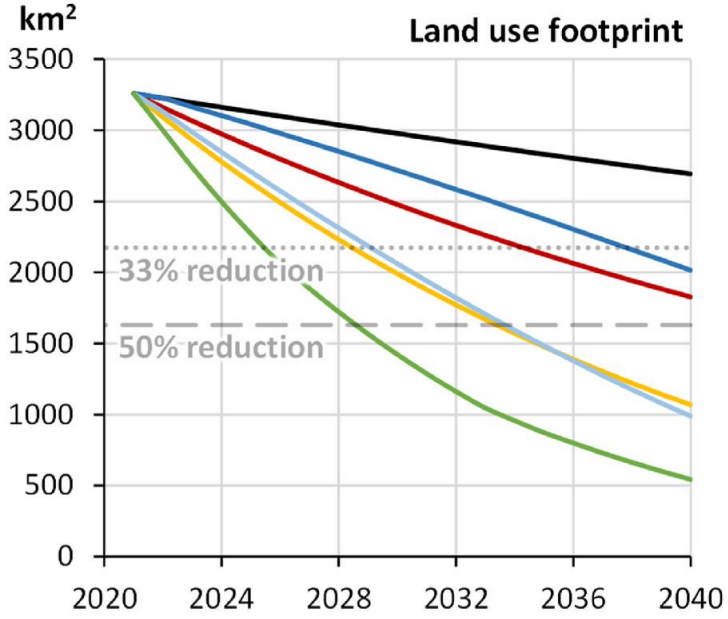


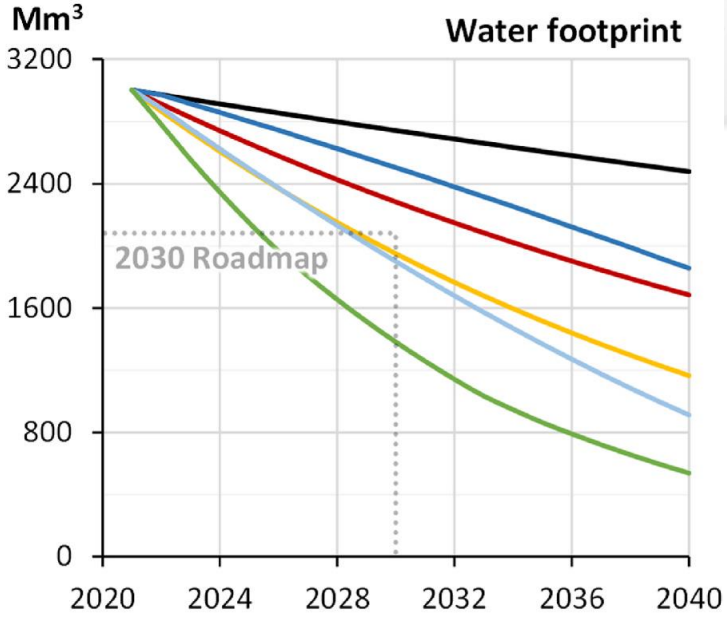
Design (modular, less materials), lease, share.

Component reuse, repair, remanufacture.



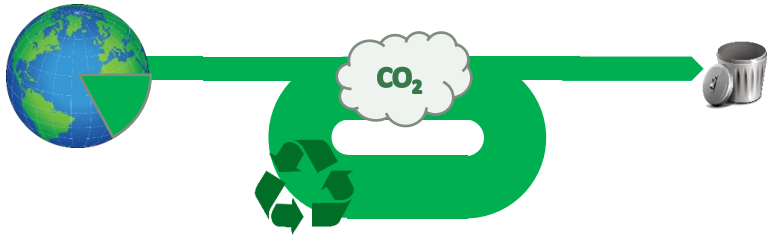






Textiles: In all scenarios modelled, only recycling + substitution + reduction gets anywhere near net zero by 2050.

All of the above = SCE?



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Recycling “circular” economy

Production and consumption patterns largely unchanged

Reformative

Technology will save us

Resource efficiency

Progress = Green growth

Weak sustainability

Sustainable circularity

Average material use per person halved

Transformative

Behaviour change

Resource efficiency + sufficiency

Progress = Well-being and environmental quality, with economic prosperity

Strong sustainability

Recycling ≠ Circular economy

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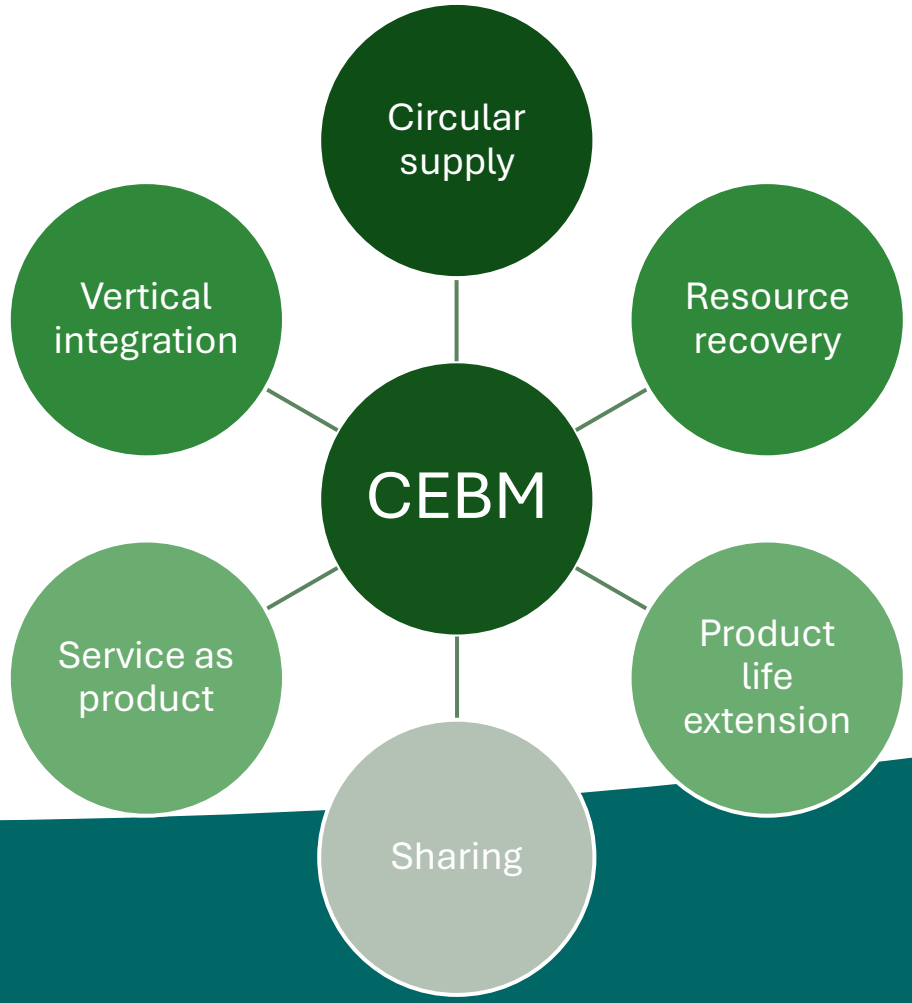

3. Future of circular business models

Example business models

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✓ Winnow – reducing food waste (UK)

- One-third all food produced is wasted; 20% primary wastage in commercial kitchens.
- Decomposition = 5% of CO_2 emissions.

- AI system that identifies and weighs food waste as it is “binned”.
- Analytics identifies major wastes/sales and causes of waste.
- Reports generated to suggest process changes to eliminate waste (e.g. portion sizes, minimum supplier orders, preparation routes).
- Reduction in waste 40% – 70%.
- Decreased emissions, water use and increased margins.

Sources: EMF, Winnow

Example business models

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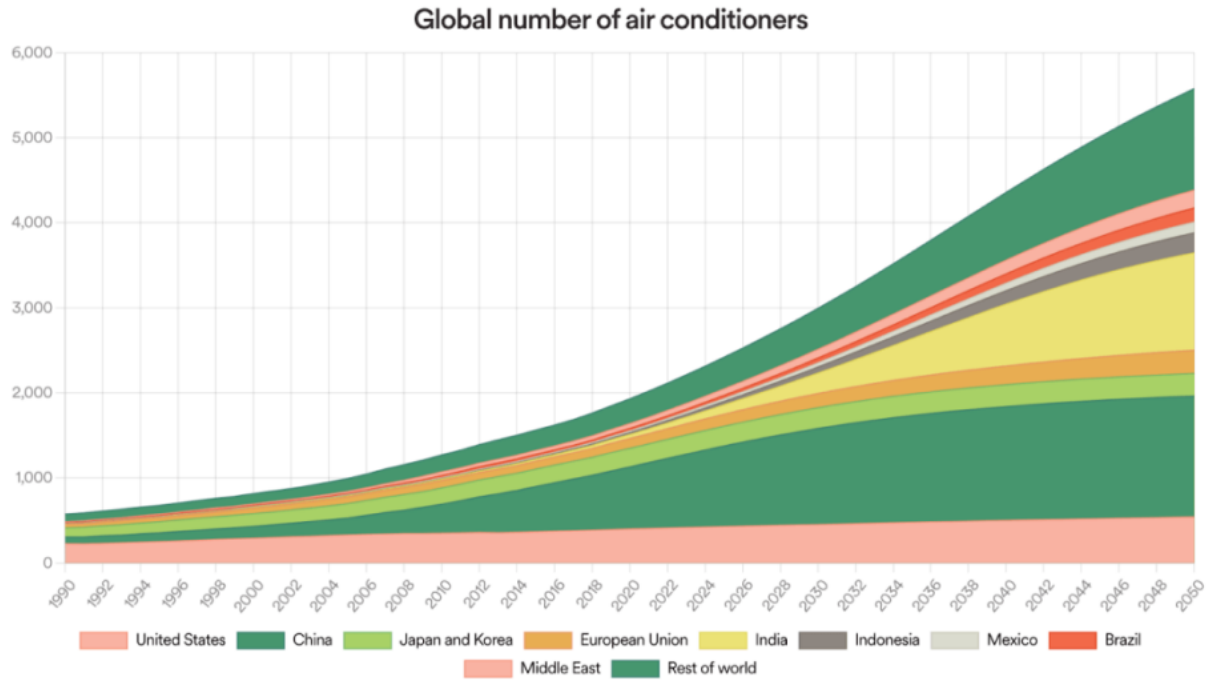
✓ ACaaS: Kaer Air (Singapore)



Sources: IEA; Ellen MacArthur Foundation

- By 2050, AC will be 13% of electricity use.
- Up to 40% performance gap (under-spec) and 50% of air con units never operated (over-spec) – poor design of systems.

- Sell temperature, not air-con: capex replaced by “pay as you use”.
- Highly-efficient, modular design approach by experts.
- Energy savings of up to 70%.
- Reduced churn of AC units.
- Incentive: Kaer increases margin if energy use per unit of cooling is decreased.
- Now trialling centralised, solar-powered chiller stations.

Example business models

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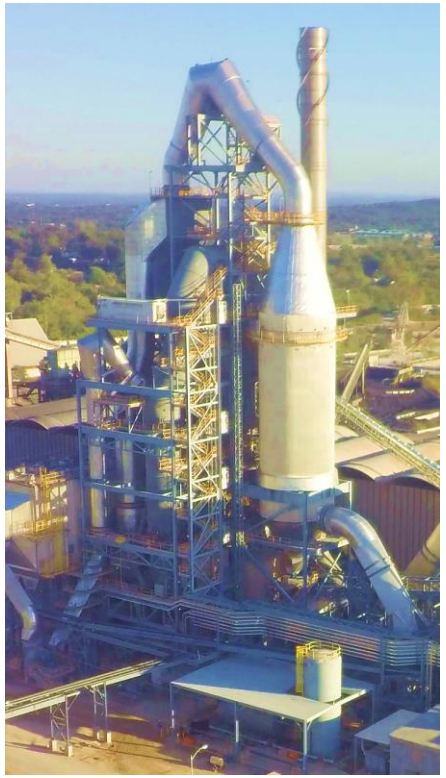
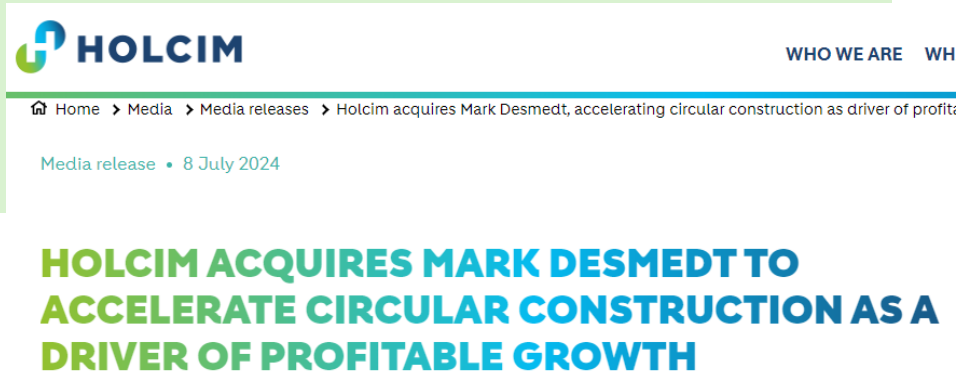
✓ Vertical integration (Foundation industries)



Sources: Holcim

- Metals, cement, chemicals, paper, ceramics…
- High energy/temperature and inherent process emissions
- High-volume, low margin, high sunk costs
- Difficult to innovate and pass innovation along supply chain

- Most value is generated by products (e.g. structures, not cement)
- Moves to integrate with sections of the supply chain where value is generated
- Routes for innovative materials
- Opportunity for value capture to drive innovation
- E.g. Lafarge-Holcim



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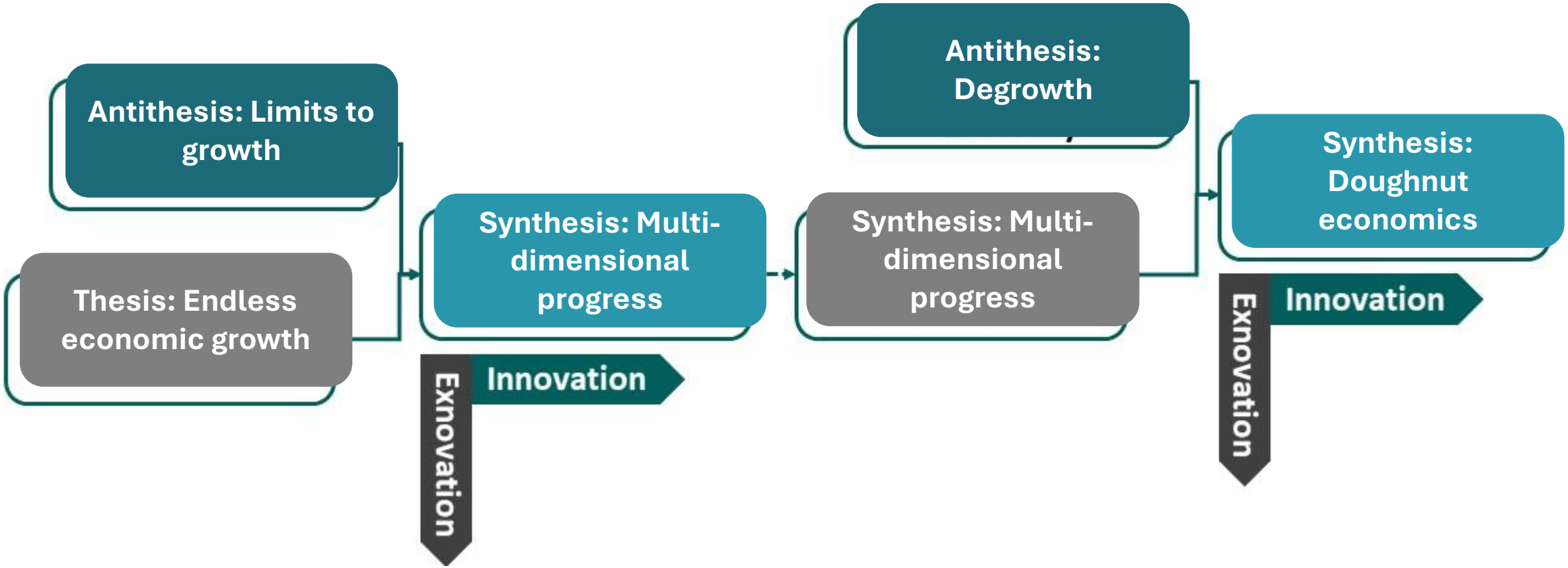
Societal transitions



Velenturf and Purnell (2021) Principles for a Sustainable Circular Economy

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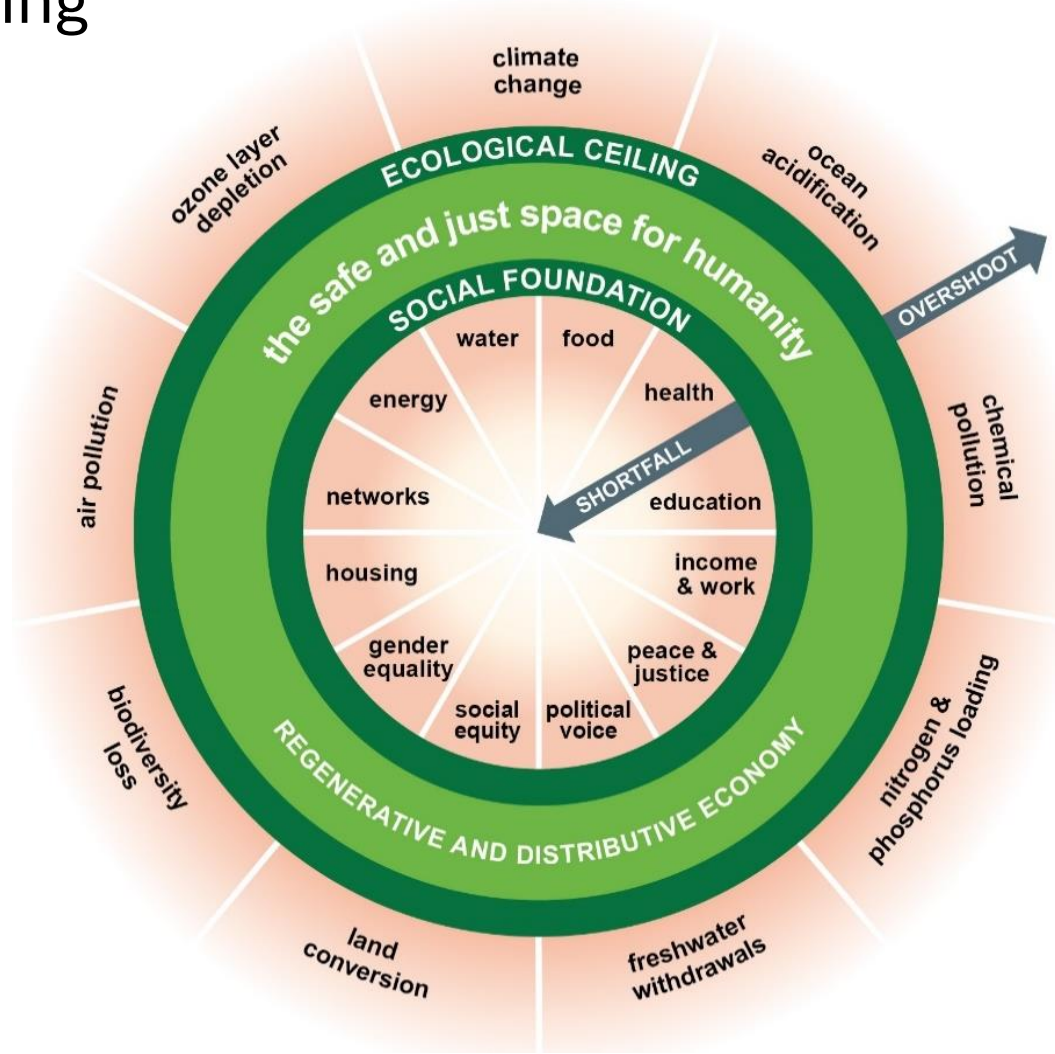
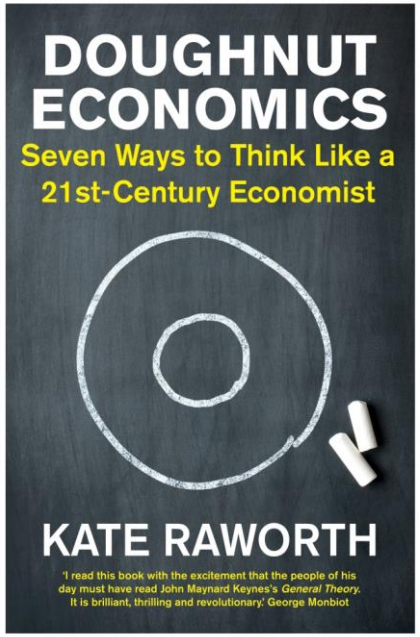
Doughnut economics

Further reading





Raworth (2017) Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist

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4. Facilitating transition processes that work

Evidence-based changes


Image credit: rawpixel.com

All changes facilitated for sustainability transitions by academia must be based on scientific evidence!

Participation process management

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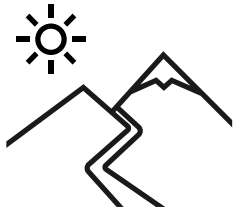
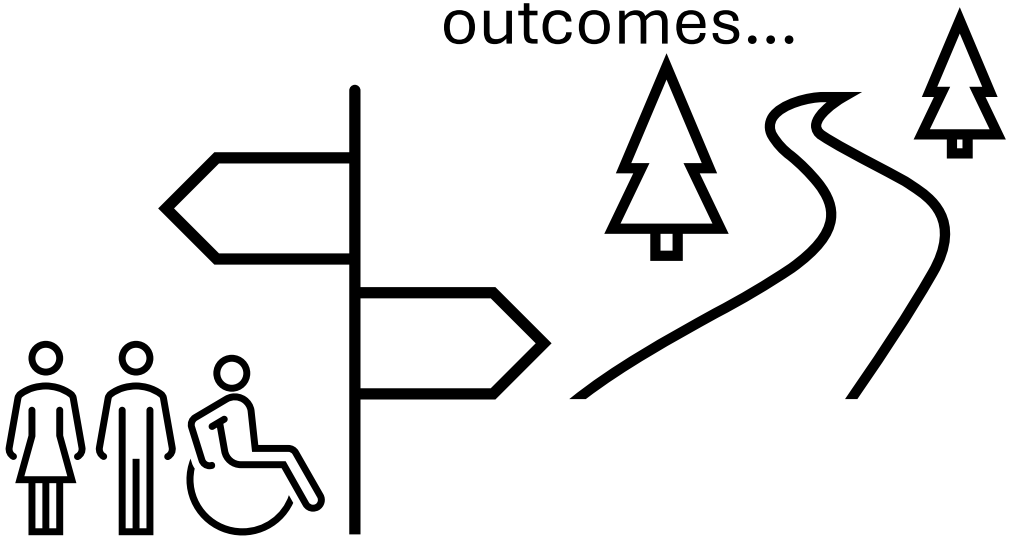
Steer towards strategic outcomes...





...that typically require actions from diverse people.

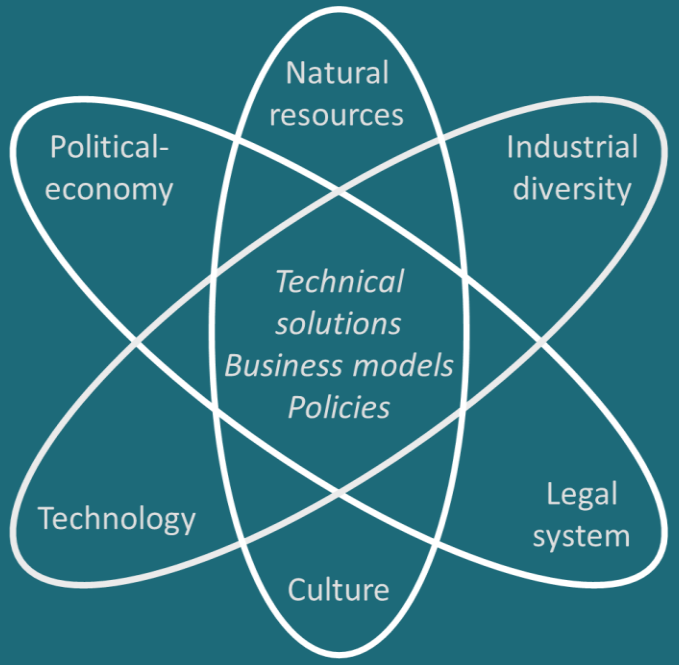
Why use participation processes? Some reasons:

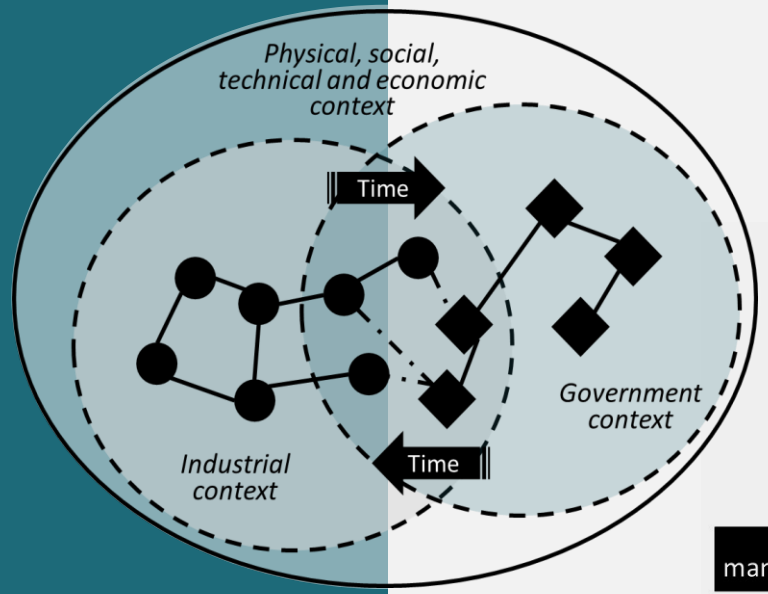
- Better relation government-society. Democracy.
- Improve organisation's image.
- Enable achievement of higher ambitions.
- Higher quality solutions, combining local knowledge with regional, national or global perspectives.
- Raise support for implementing change.
- Access to the means and resources to realise a change (e.g. land, people, relations, money).

Breman et al (2008) Participatie in waterbeheer: een vak apart. WaterTekens project.

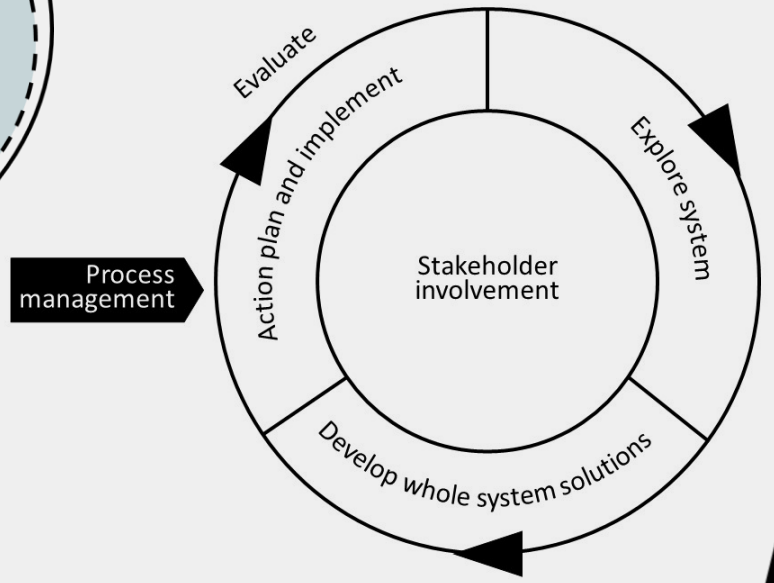
Facilitating sustainability transitions: a people-centred network approach

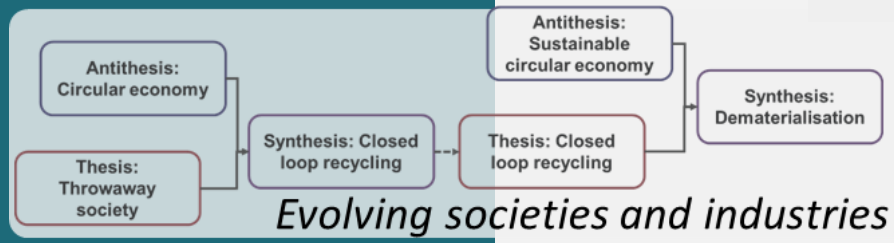
External: adaptations to changing context

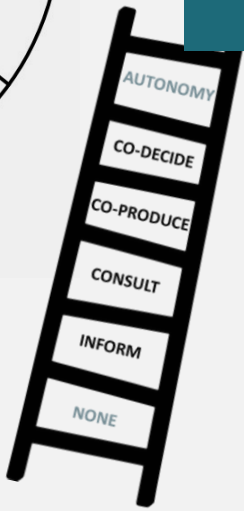




Internal: through creation and transmission of ideas between people







Resources sector

(RRfW 2016-2019)

Starting situation:

- Dispersed network with divided stakeholders
- Openness for circular economy and to build relations between RRfW and stakeholders
- Necessity to innovate beyond energy-from-waste and waste exports
- From exploitation to exploration

Strategy:

- Worked from within the sector
- Identified what drove the various stakeholders
- Channelled diverse views into creative solutions
- Influenced individual (groups of) stakeholders to start moving in the same direction, create “window of opportunity”
- Brought stakeholders together in controlled arenas for radical change, making use of a sufficiently shared vision on the direction of travel
- Anchored the change in policy, making use of processes that were already underway

Offshore wind

(Various projects 2017-2021 and on-going)

Starting situation:

- A largely united industry in coopetition
- Unfamiliar with circular economy and low openness to understand its necessity
- Rapid growth
- Highly innovative with focus on reducing costs
- In process of moving from exploration to exploitation

Strategy:

- Drove change from outside of the industry
- Identified what drove the industry
- Influenced via reputation/licence to operate, and;
- Activated policy based on poor financial securities for decommissioning, with oil and gas fresh on our mind
- Built strategic relations to reach wind audiences with coproduced view on circular economy for wind
- Articulated business cases for policy and industry change
- Circular economy became a more fixed part of the wind agenda via regular events, innovation and public funds

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Thank you!

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