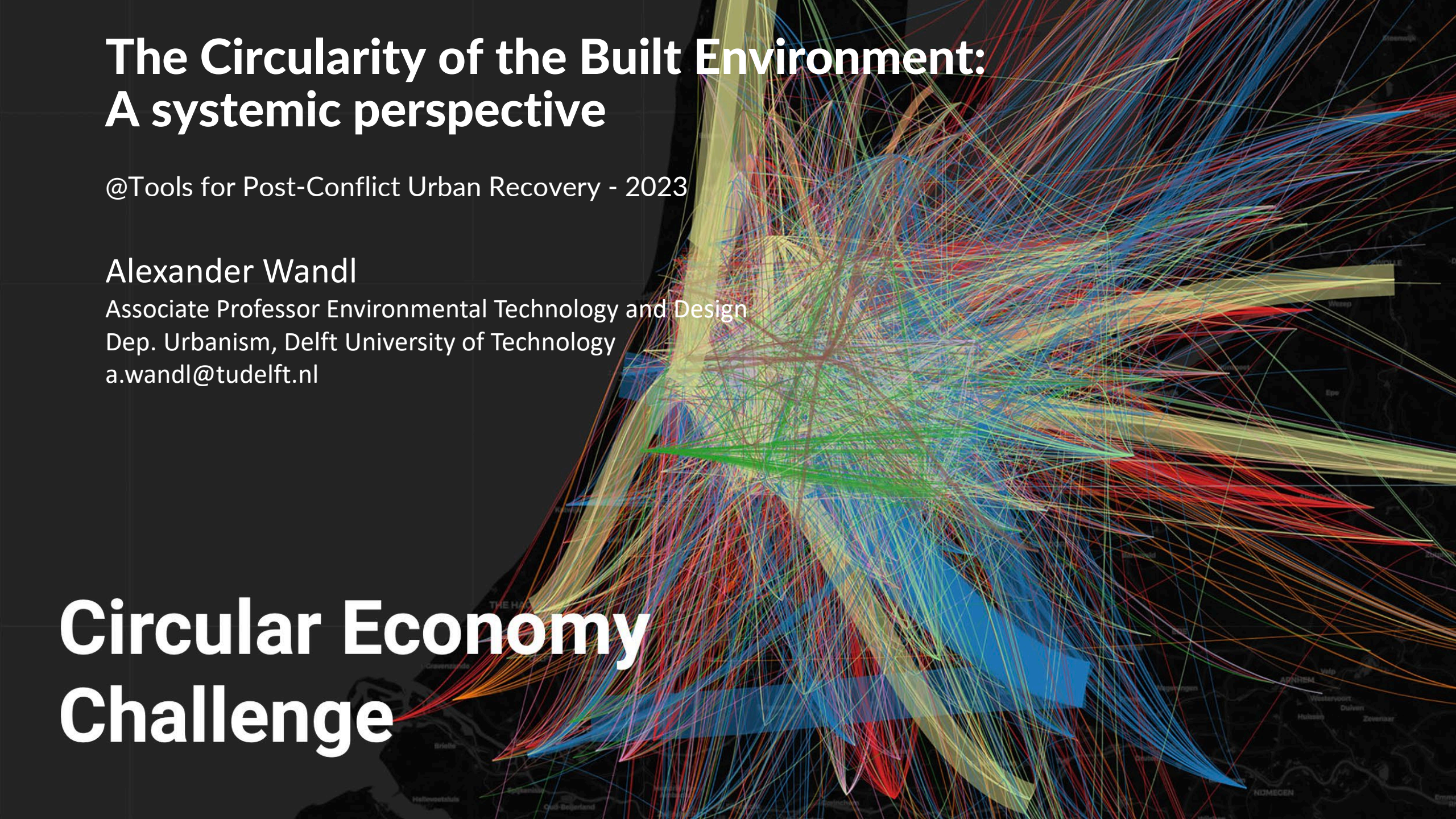
The Circularity of the Built Environment: A systemic perspective

@Tools for Post-Conflict Urban Recovery - 2023

Alexander Wandl
Associate Professor Environmental Technology and Design
Dep. Urbanism, Delft University of Technology
a.wandl@tudelft.nl



Circular Economy Challenge

Alexander Wandl
Urbanist and Landscape Ecologist
Associate Professor Environmental Technology and Design
Dep. Urbanism, Delft University of Technology
a.wandl@tudelft.nl

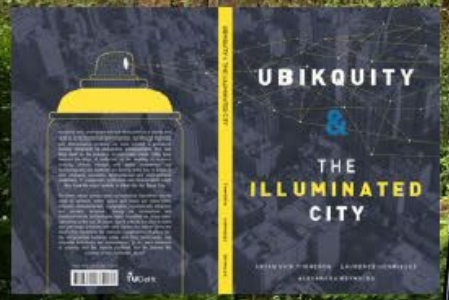
Head of the Section Environmental Technology and Design
Steering Member of the Circular Built Environment Hub

Key Words:
Multiple and Interrelated Sustainability Transitions, Territorial Metabolism, Spatial Dimension of the Circular Economy, Systemic Design, Situated Learning Environments.

Publications - Life Long Learning

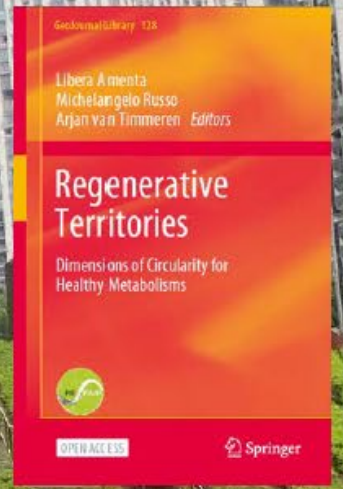
Section Environmental Technology and Design

URBAN CLIMATE



PEOPLE & BEHAVIOR

TERRITORIAL METABOLISM



TUDelft

environmental technology & design

A Systemic Approach

Opening up the Black-Box of Urban Metabolism to facilitate the Transition towards more Circularity

Selected Research Projects

REPAiR –
REsource Management in
Peri-urban Areas

http://h2020repair.eu/

CINDERELA

New Circular Economy Business Model for More Sustainable Urban Construction

2 Start ups: the New Raw / geoFluxus

REPAiR project / TU Delft ETD

TU Delft environmental technology & design

What to Expect

Intro to Circularity (Economy)

A Circular Built Environment

Circularity and Spatial Co-Design

Some mentimeter interaction:

https://www.menti.com/
voting code **3762 8640**

Join at menti.com use code 71 41 71 3

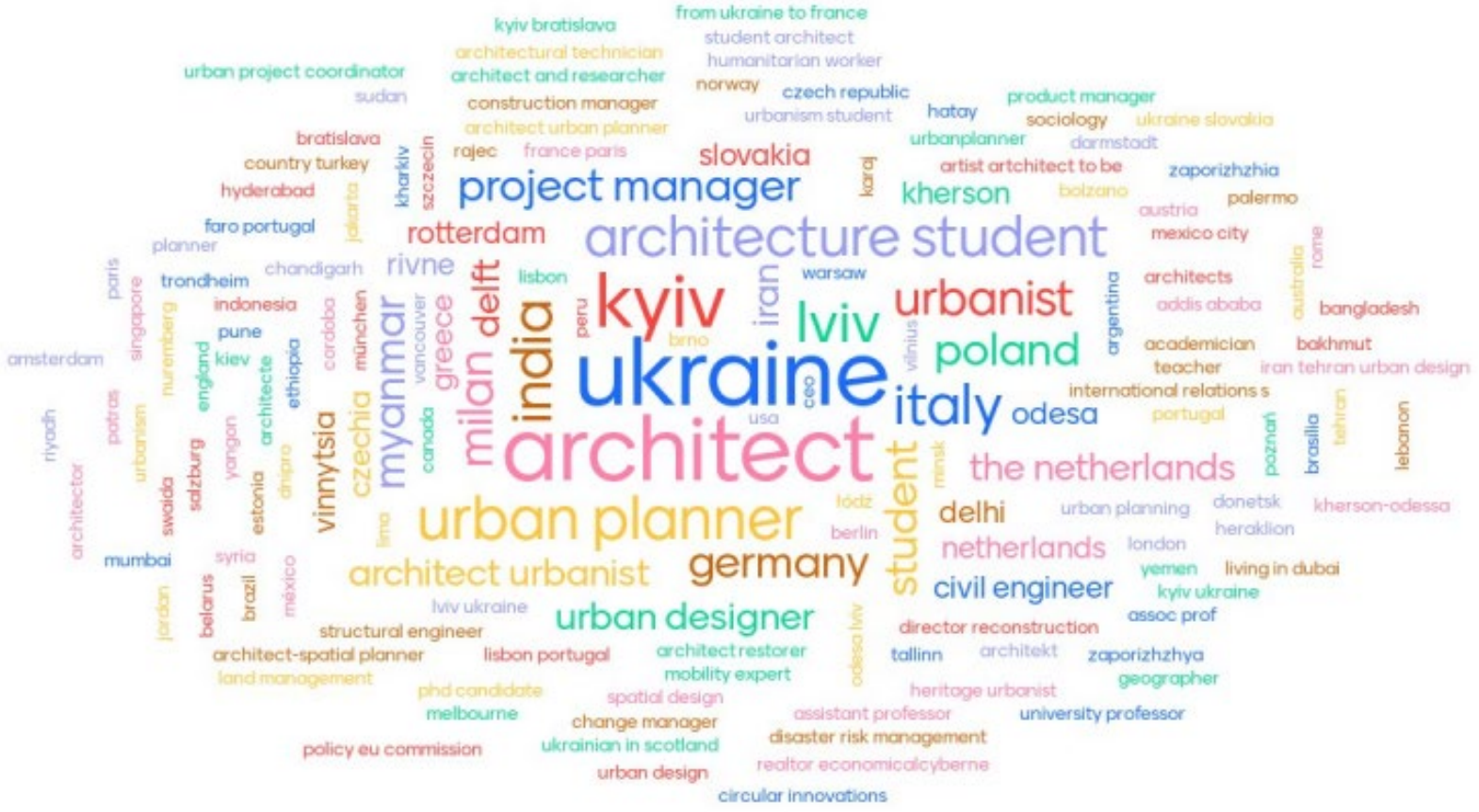
Mentimeter

Where are you from and what 's your profession? Country/City/Profession

Waiting for answers

Results

Where are you from and what 's your profession? Country/City/Profession



Go to www.menti.com and use the code 3762 8640

What are your association with Circular Economy?

Mentimeter

Results

What are your associations with Circular Economy?

A Quick Recap of the Key Concepts of Circular Economy

Towards – A Circular Economy

REGENERATE
- Shift to renewable energy and materials
- Reclaim, retain, and restore health of ecosystems
- Return recovered biological resources to the biosphere

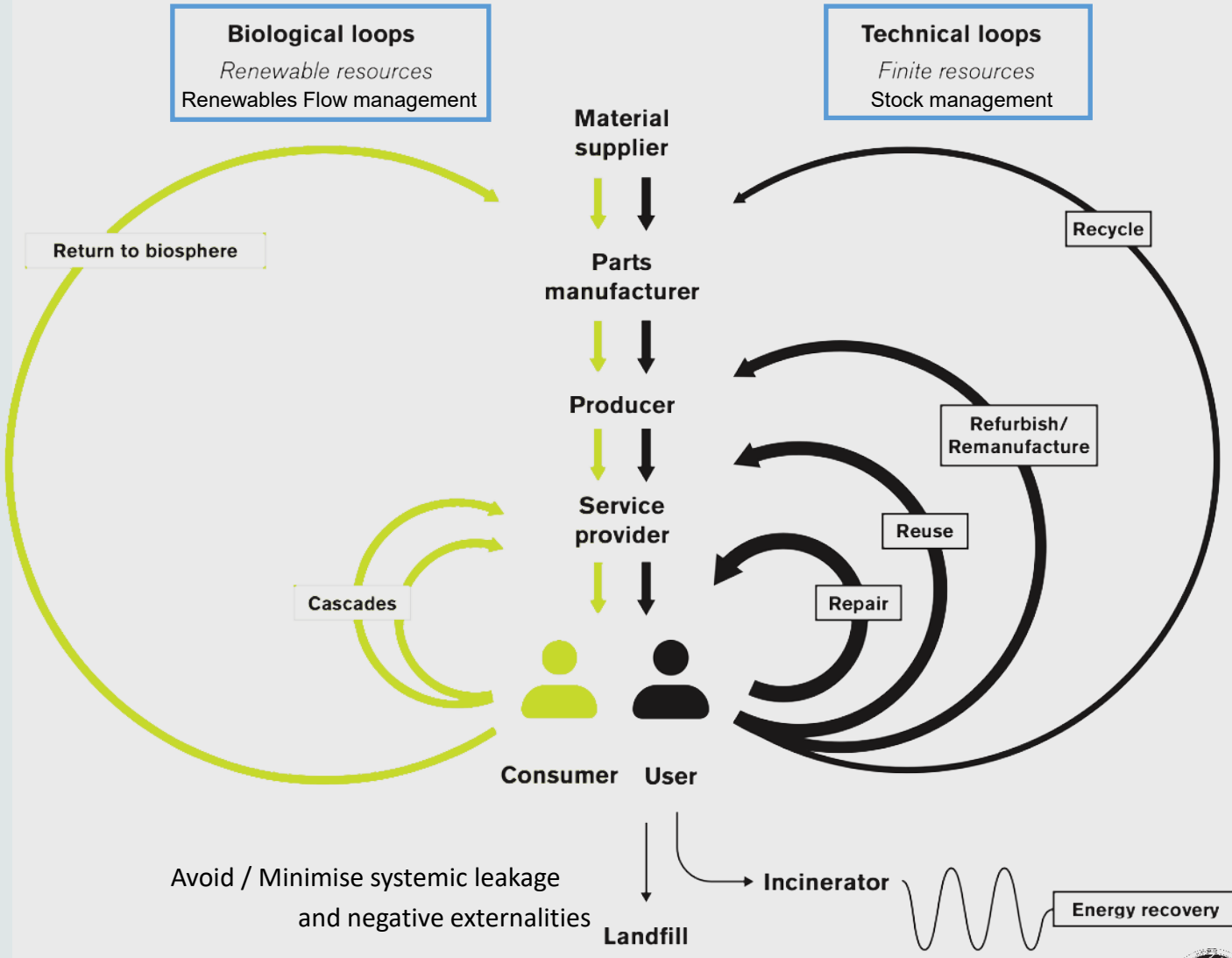
SHARE
- Share assets (e.g. cars, rooms, appliances)
- Reuse/secondhand
- Prolong life through maintenance, design for durability, upgradability, etc.

OPTIMISE
- Increase performance/efficiency of product
- Remove waste in production and supply chain
- Leverage big data, automation, remote sensing and steering

LOOP
- Remanufacture products or components
- Recycle materials
- Digest anaerobically
- Extract biochemicals from organic waste

VIRTUALISE
- Dematerialise directly (e.g. books, CDs, DVDs, travel)
- Dematerialise indirectly (e.g. online shopping)

EXCHANGE
- Replace old with advanced non-renewable materials
- Apply new technologies (e.g. 3D printing)
- Choose new product/service (e.g. multimodal transport)



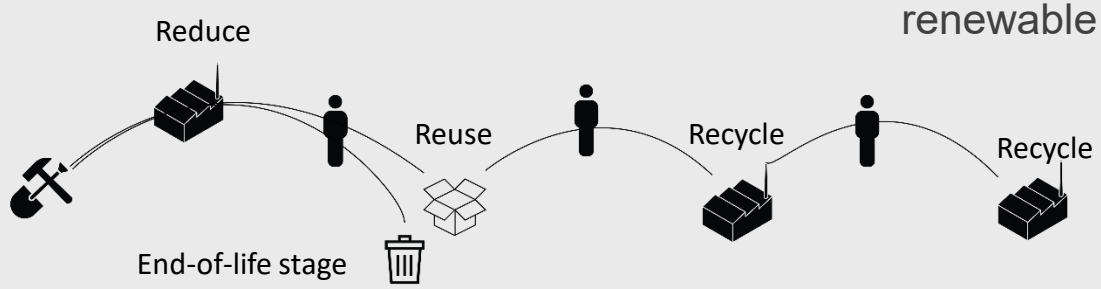
a.wandl@tudelft.nl

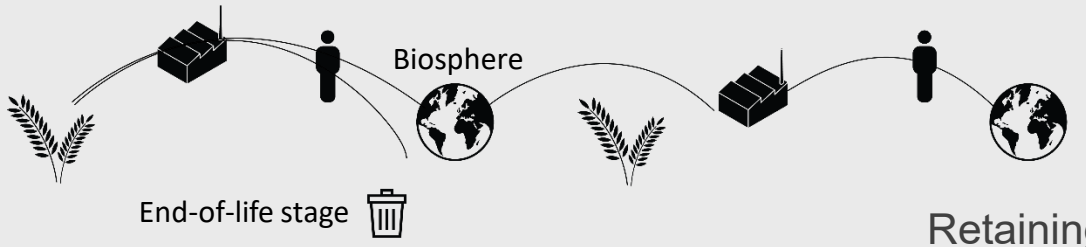
The Circular Built Environment Hub

https://www.ellenmacarthurfoundation.org (2012) / Image by Giliam Dokter (2021)

Circularity & the Two Value Chains

Retaining value in the technical material chain- Starting from non-renewable resources



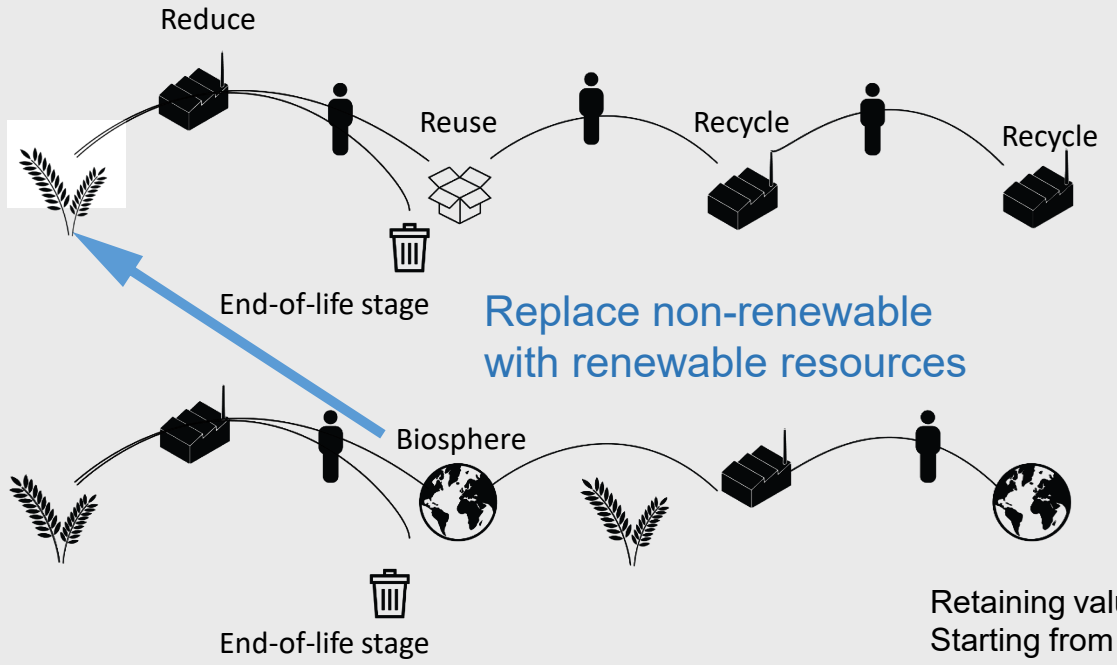


Retaining value in the biological material chain- Starting from renewable resources

Adapted from Graphic: Twan Cortenraede based on Murray et al. 2017

From a linear towards a Circular Economy

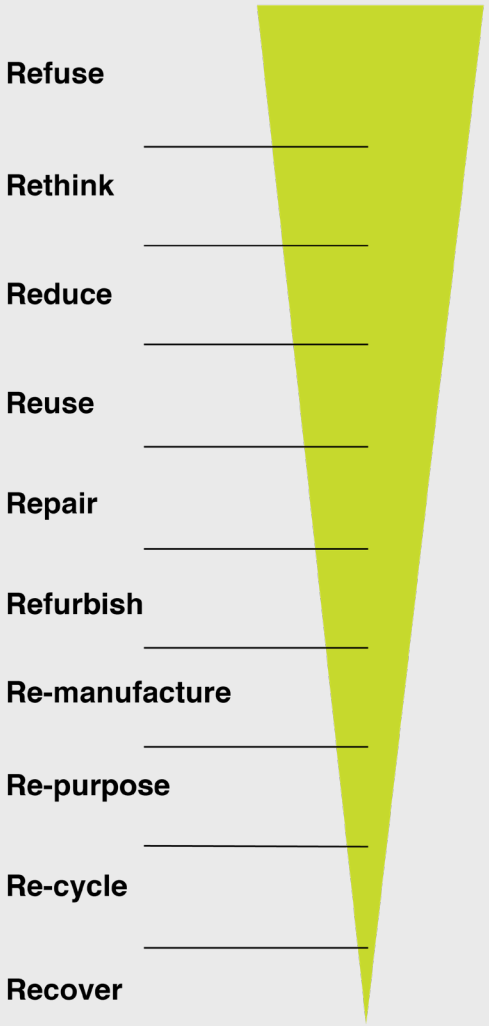
Retaining value in the technical material chain-
Starting from non-renewable resources



Retaining value in the biological material chain-
Starting from renewable resources

Graphic: Twan Cortenraede based on Murray et al, 2017

‘R’-ladder’ with 10 Strategies from Linear to Circular



Make a product redundant by abandoning its function or by providing the same function in a different way.

Make product use more intensive by using(sharing) the product with more people or by giving the product more functions.

Increase the efficiency of the machines in the production process or use fewer raw materials for the same product.

Reuse of discarded, functioning product in the same function by a different user.

Repair defective products so that the original function can be preserved.

Refurbish old products to bring them up to date.

Reuse functioning components of the products to make comparable products.

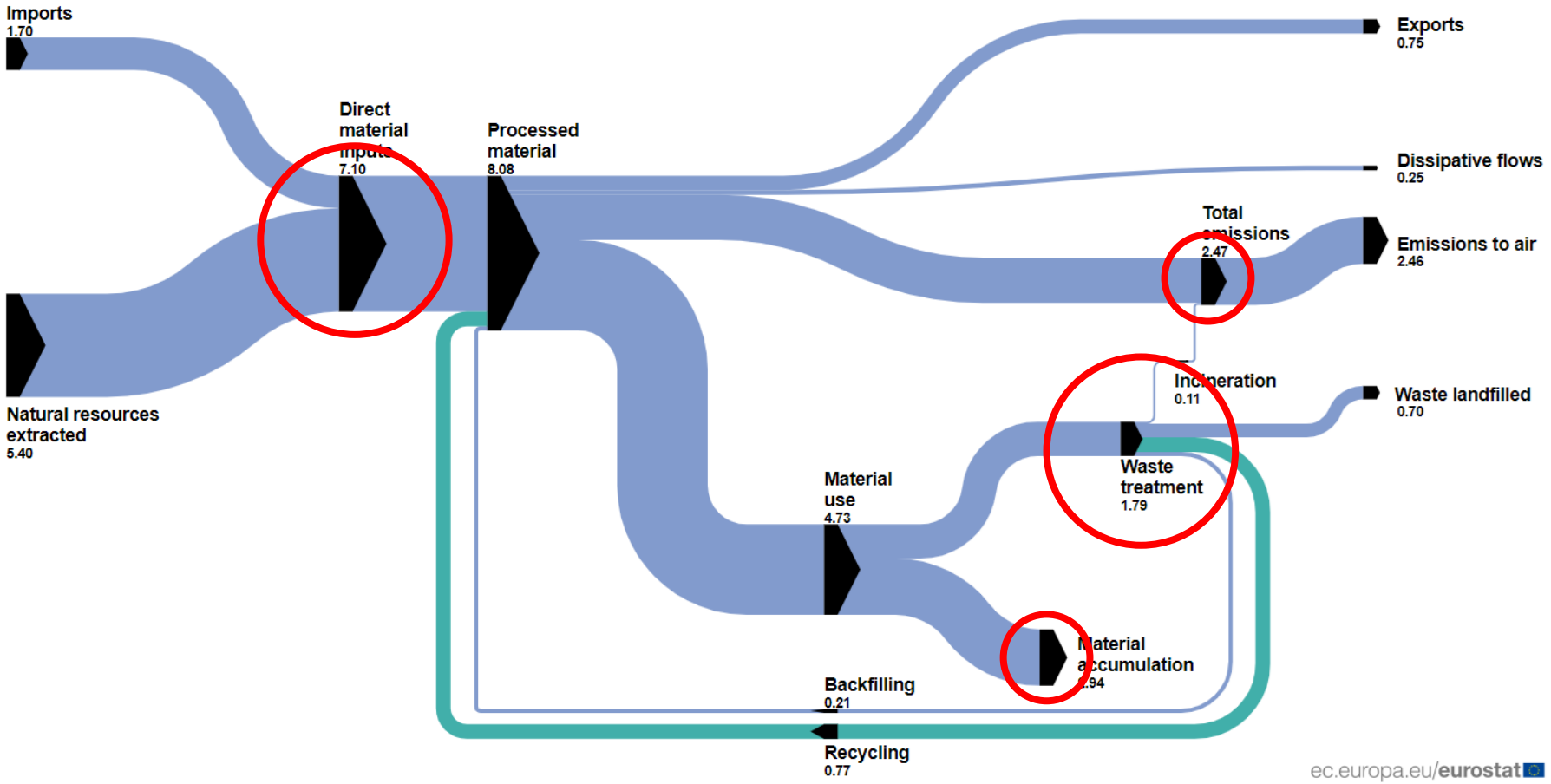
Reuse the product or components thereof in a new product with a different function.

Reuse the materials of the product for application in new products.

Incinerate the materials with energy recovery.

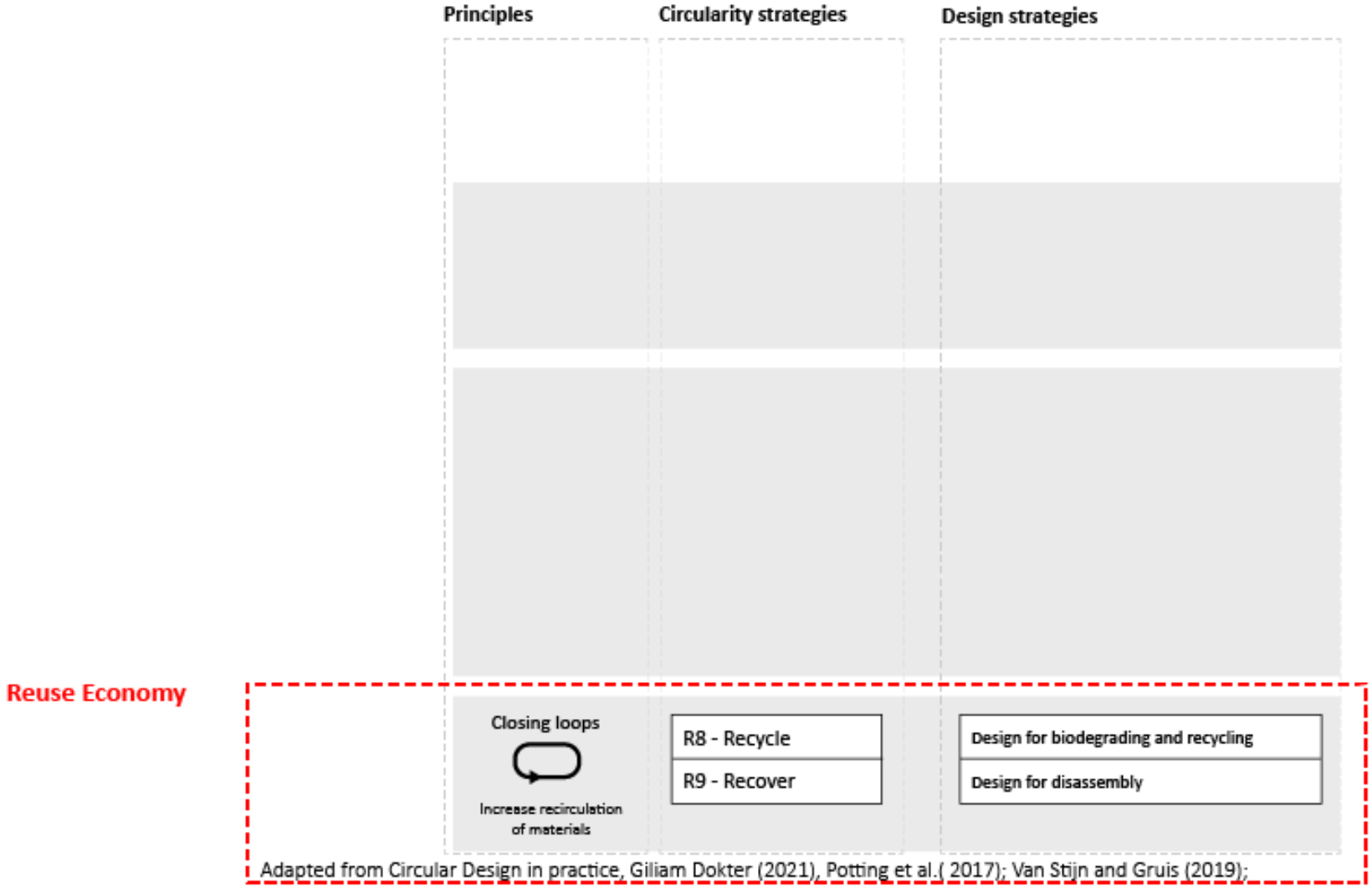
The R-ladder (based on Netherlands Environmental Assessment Agency 2019)

THERE IS NOT ENOUGH WASTE FOR THE CE

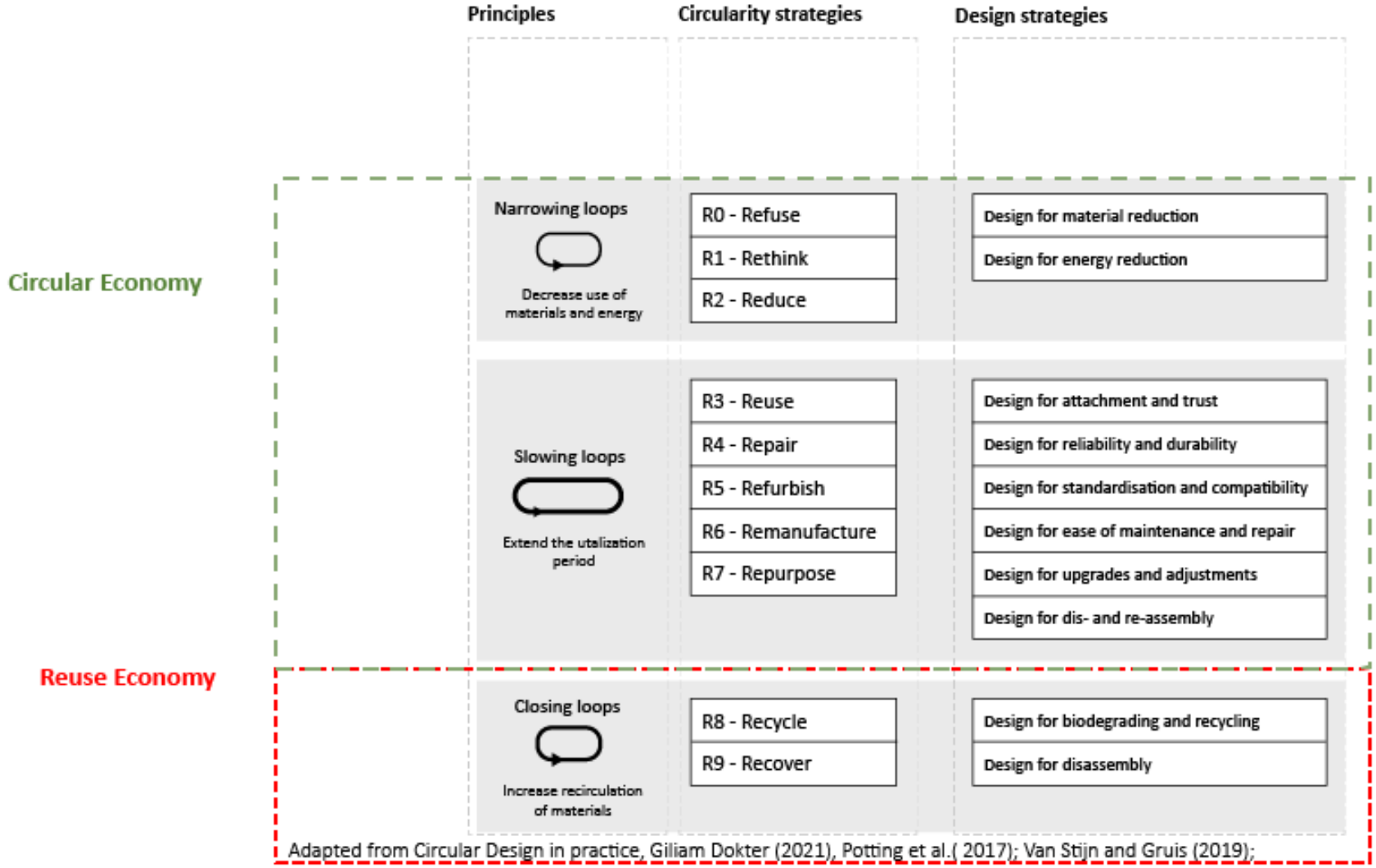


Material flows true scale in Gt/year (billion tonnes per year) in 2019, EU27. Source: Eurostat

FROM PRINCIPLES TO DESIGN



FROM PRINCIPLES TO DESIGN



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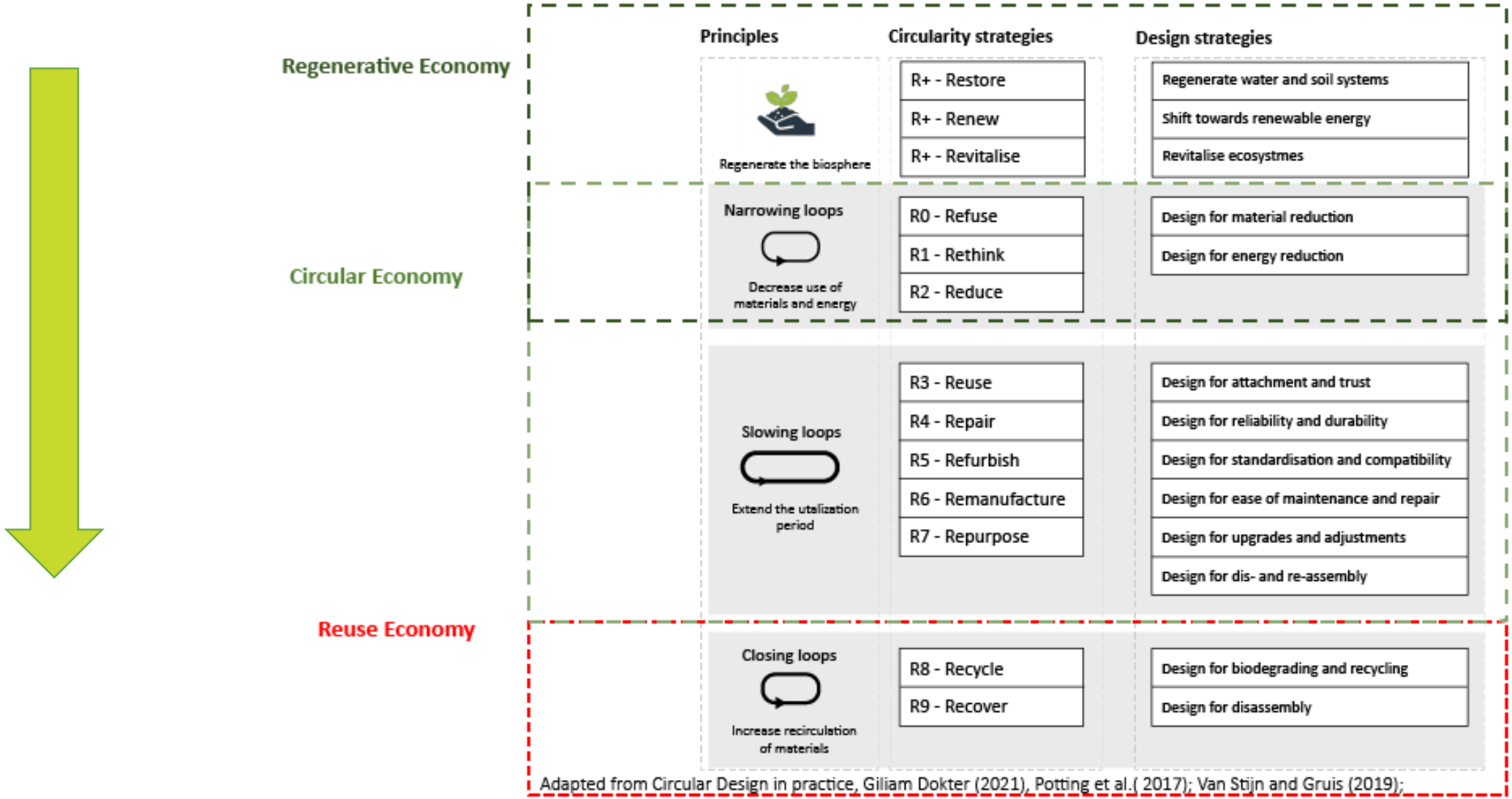
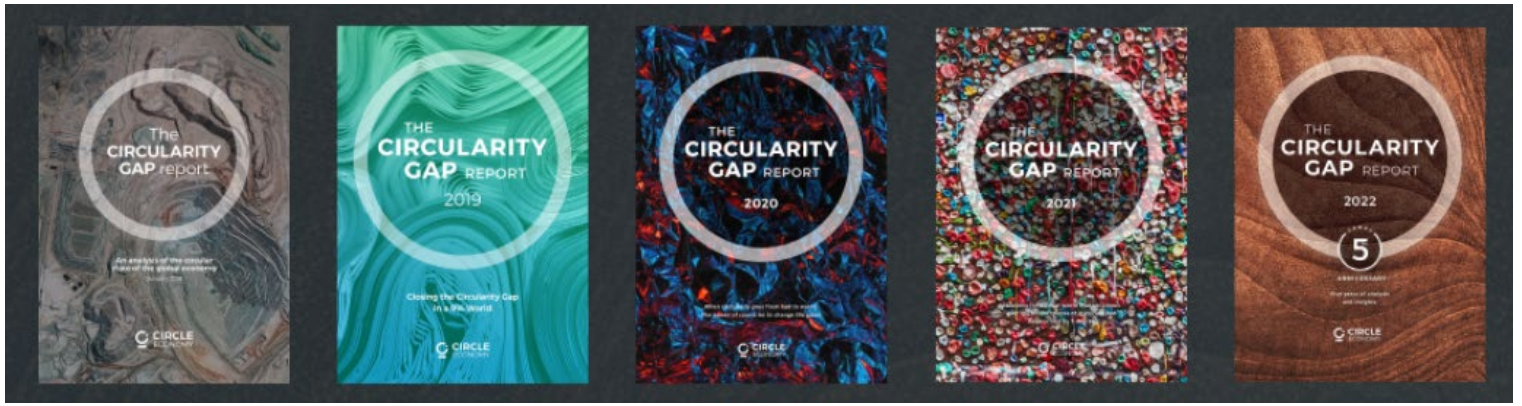


QUESTIONS?

How are we doing in the CE transition?

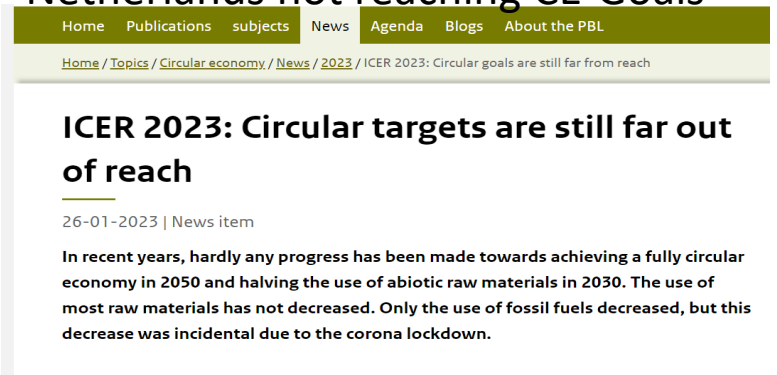
THE CIRCULARITY GAP – HIGH AMBITIONS NO PROGRESS

World -Only 8,7% of mined material per year are cycled in the global economy in 2021 and it reduced from 9% in 2019?



https://www.circularity-gap.world/2023

Netherlands not reaching CE-Goals


Home Publications subjects News Agenda Blogs About the PBL

Home / Topics / Circular economy / News / 2023 / ICER 2023: Circular goals are still far from reach

ICER 2023: Circular targets are still far out of reach

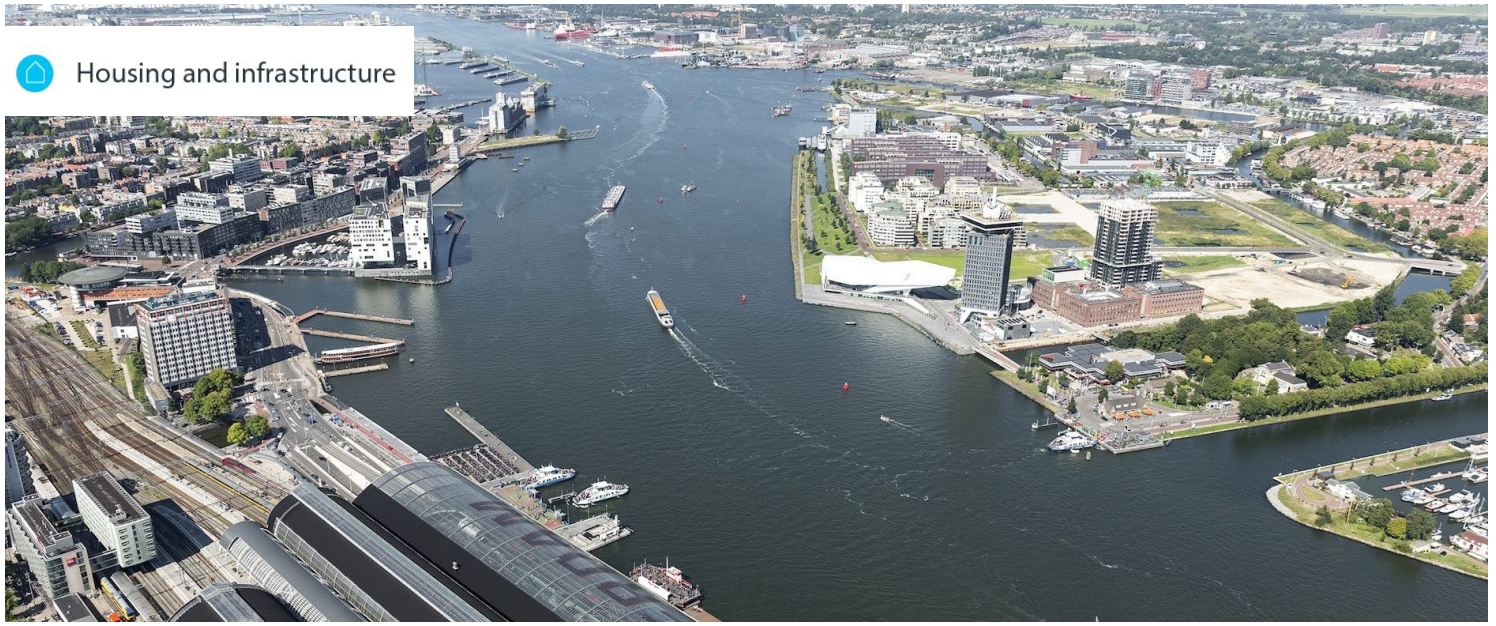
26-01-2023 | News item

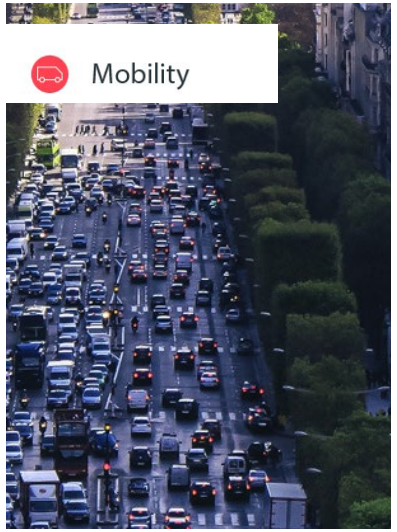
In recent years, hardly any progress has been made towards achieving a fully circular economy in 2050 and halving the use of abiotic raw materials in 2030. The use of most raw materials has not decreased. Only the use of fossil fuels decreased, but this decrease was incidental due to the corona lockdown.

https://www.pbl.nl/nieuws/2023/icer-2023-circulaire-doelen-liggen-nog-ver-buiten-bereik

What has CE to do with the Built Environment

Key societal needs and extracted resources





Consumables

Services

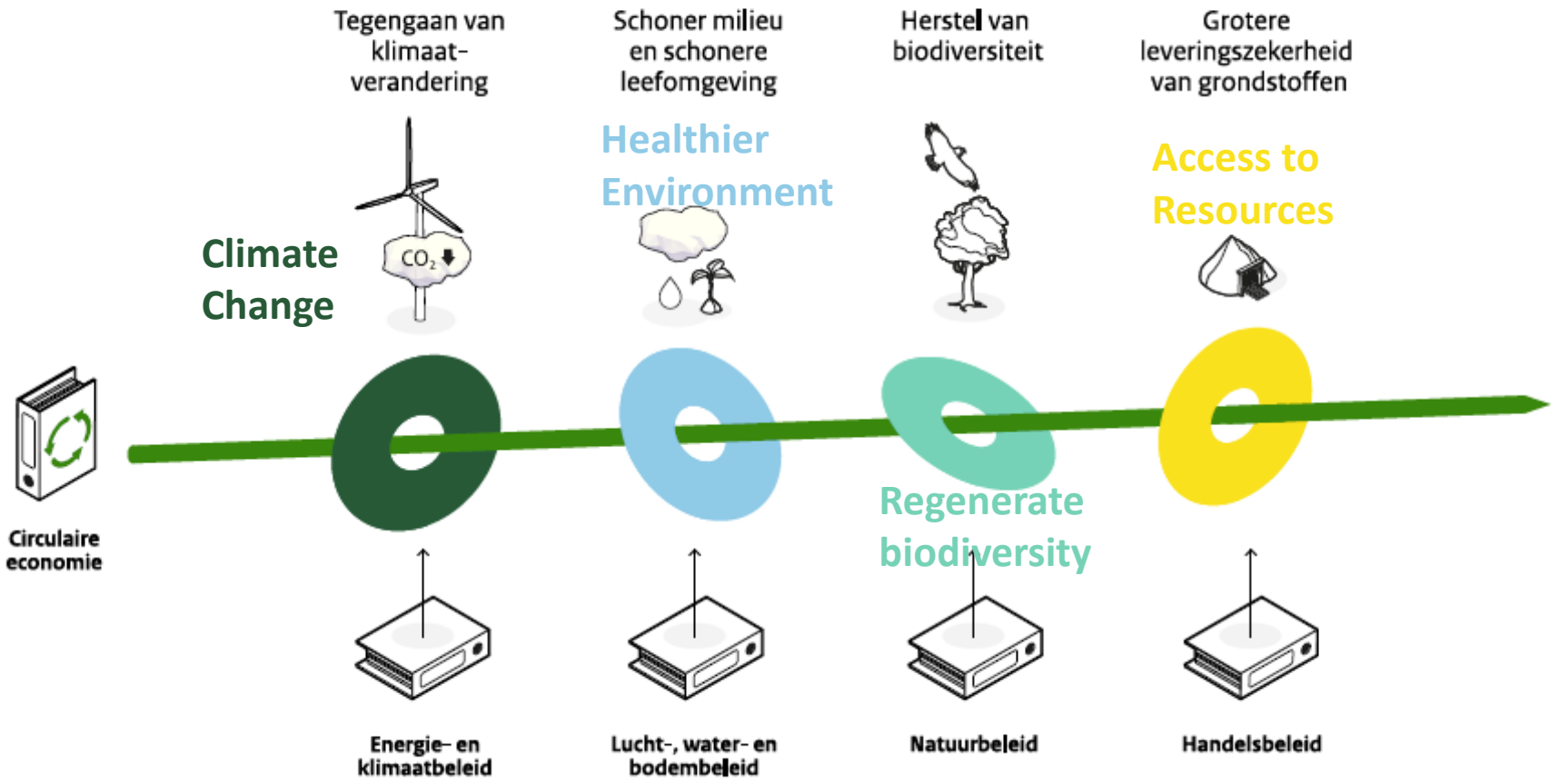
Healthcare

Communication

http://shiftingparadigms.nl/wp-content/uploads/2017/11/the-circularity-gap-report-2018.pdf

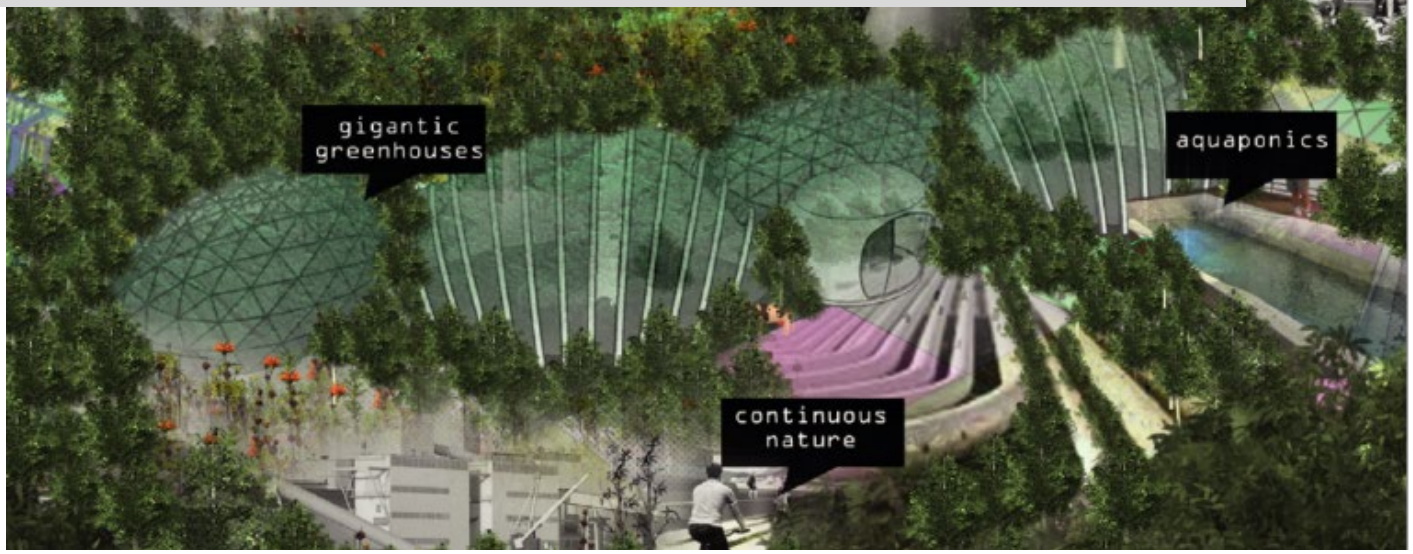
Circularity as “solution” for multiple challenges?

Figuur 2: Positionering circulaire economie ten opzichte van maatschappelijke opgaven en andere beleidsthema’s



Sourece PBL - **Nationaal Programma Circulaire Economie** 2023-2030

In times of uncertainty, we seek a future that people aspire to.



Circular Built Environment – A draft Definition

"The Circular Built Environment (CBE) is a system designed for **narrowing, slowing and closing** resource loops at **different spatial-temporal levels** by **transitioning** cultural, environmental, economic & social **values** towards a sustainable way of living (thus enabling society to live within the planetary boundaries)".

https://www.tudelft.nl/bk/onderzoek/onderzoeksthemas/circular-built-environment/scale-matters

How Can the Built Environment Facilitate the Transition to Circularity?

Four integral starting points

The **physical built environment**

The **flows** in a city/region

The circular **behaviour** of citizens

Economic activities to become circular

Interdisciplinary (student) projects

“Unexpected” scarcities

Critical (raw) materials

Knowledge

Collaboration

Physical Built and Unbuilt Environment

Buildings

Mobility infrastructure

Water infrastructure

Energy facilities

Public spaces

Design strategies

Shift towards Renewable/biobased materials

Regenerate water and soil systems
Design for material reduction
Design for emotional bonding and trust
Design for reliability and durability
Design for resilience and redundancy

Design for disassembly and re-assembly
Design for upgrades and modifications
Design for ease of maintenance and repair
Design for standardisation and compatibility

TU Delft Student Project for Solar Decathlon Europe Competition

The top-up modules are the energy producers of the building.

Photovoltaic envelope and roof. The square shaped building-integrated PV panels use a new technology so they can be produced in a wide colour range.

The wooden facade assembly of the top-up features a bio-based insulation that is produced from paper pulp, achieving a light-weight and carbon neutral facade that reaches passive house standards.

Sources: https://www.delftsolardecathlon.com/en/prototype

Alexander Wandl - a.wandl@tudelft.nl

TU Delft Student Project for Solar Decathlon Europe Competition

Sources: https://www.delftsolardecathlon.com/en/prototype

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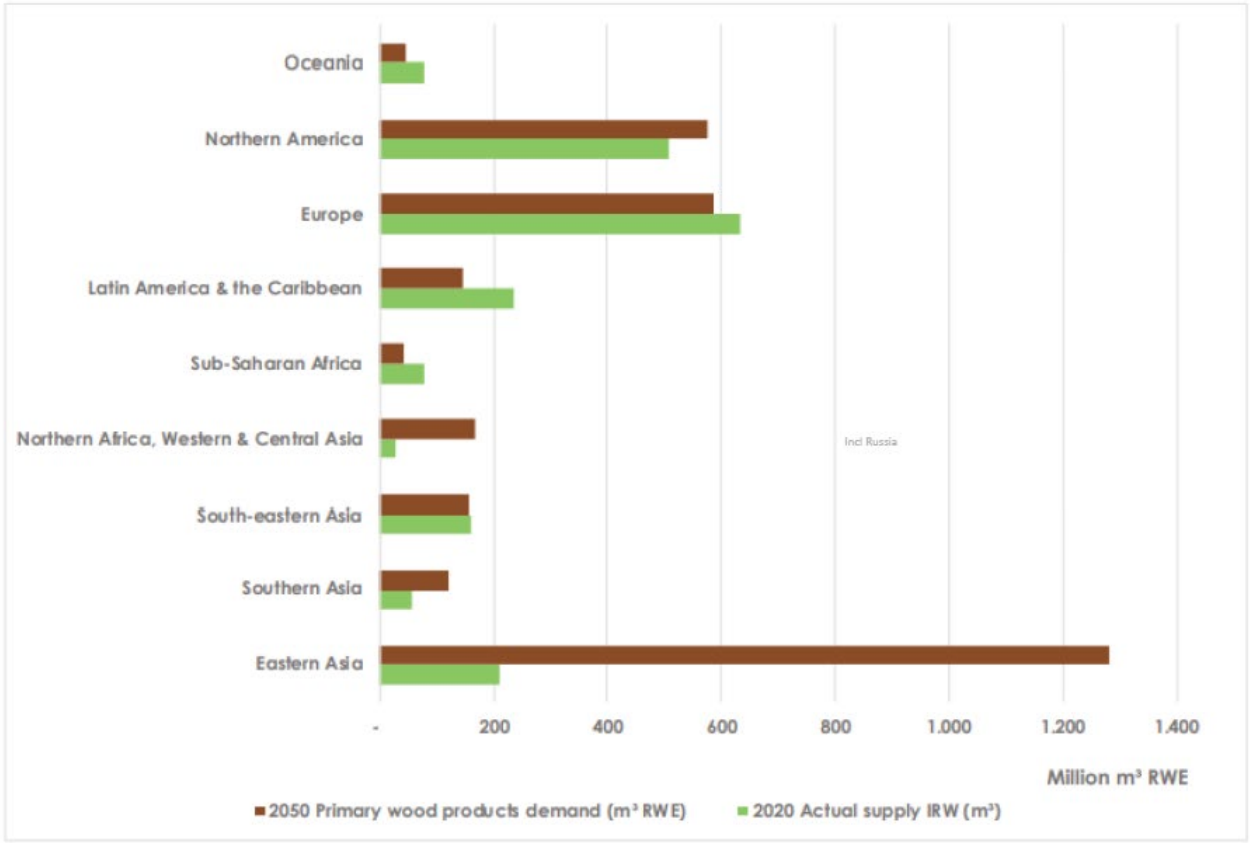
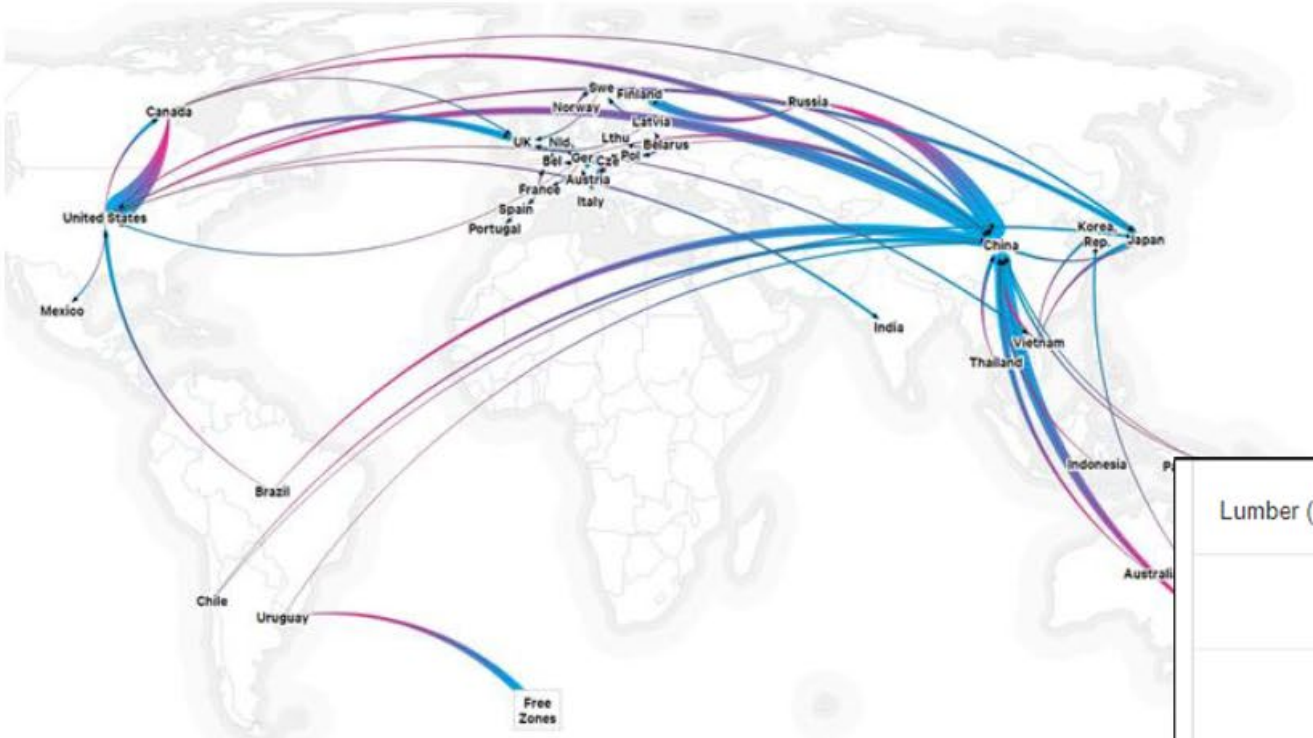
BIO BASE CONSTRUCTION MATERIALS – GEOPOLTICS



Sources: FAOSTAT Forestry for IRW 2020 (Annex 8.7) and GFPM (Annex 8.5).

https://forestdefenders.eu/wp-content/uploads/2022/11/PFPI-Burning-up-the-carbon-sink-Nov-7-2022.pdf

TIMBER AND OTHER FOREST PRODUCTS

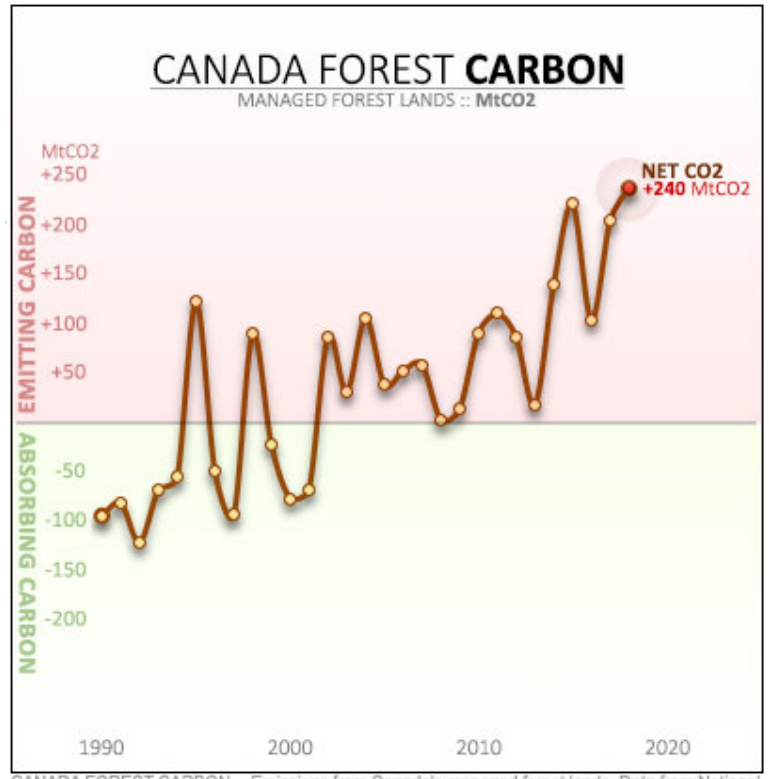


CURRENT TRADE AND PRICE VOLATILITY

Without Sustainable Forestry and Agriculture, there are no Sustainable Biobased Materials.

Canada's managed forests have turned into super-emitters, and 2018 set a record

By Barry Saxifrage | Opinion | June 5th 2020



CANADA FOREST CARBON -- Emissions from Canada's managed forest lands. Data from National Inventory Reports 2019 & 2020, with full time series for some tables provided to author by Environment Canada. Black line is net forest flux (table 6-5). Yellow area is HWP (table 10s1). Brown top line is sum of two. CHART by Barry Saxifrage at VisualCarbon.org & NationalObserver.com. May 2020

Europe rapidly losing its forest carbon sink, study shows

By Frédéric Simon | EURACTIV.com Nov 7, 2022

"There is a clear link between biomass harvesting and land sink loss in some member states," the report said. [Sergey Nemirovsky / Shutterstock]

We are part of the trust project >>>

Supporter

Life Terra

Funded by the LIFE Programme of the European Union

Flows: production, transport, storage and use

Water

Food

Data and information

Energy (electricity, fuels, heat)

Traffic (people and goods, animals)

Waste

New forms of mining

Design strategies

design for reduced energy, water and material consumption

transition to sustainable energy production

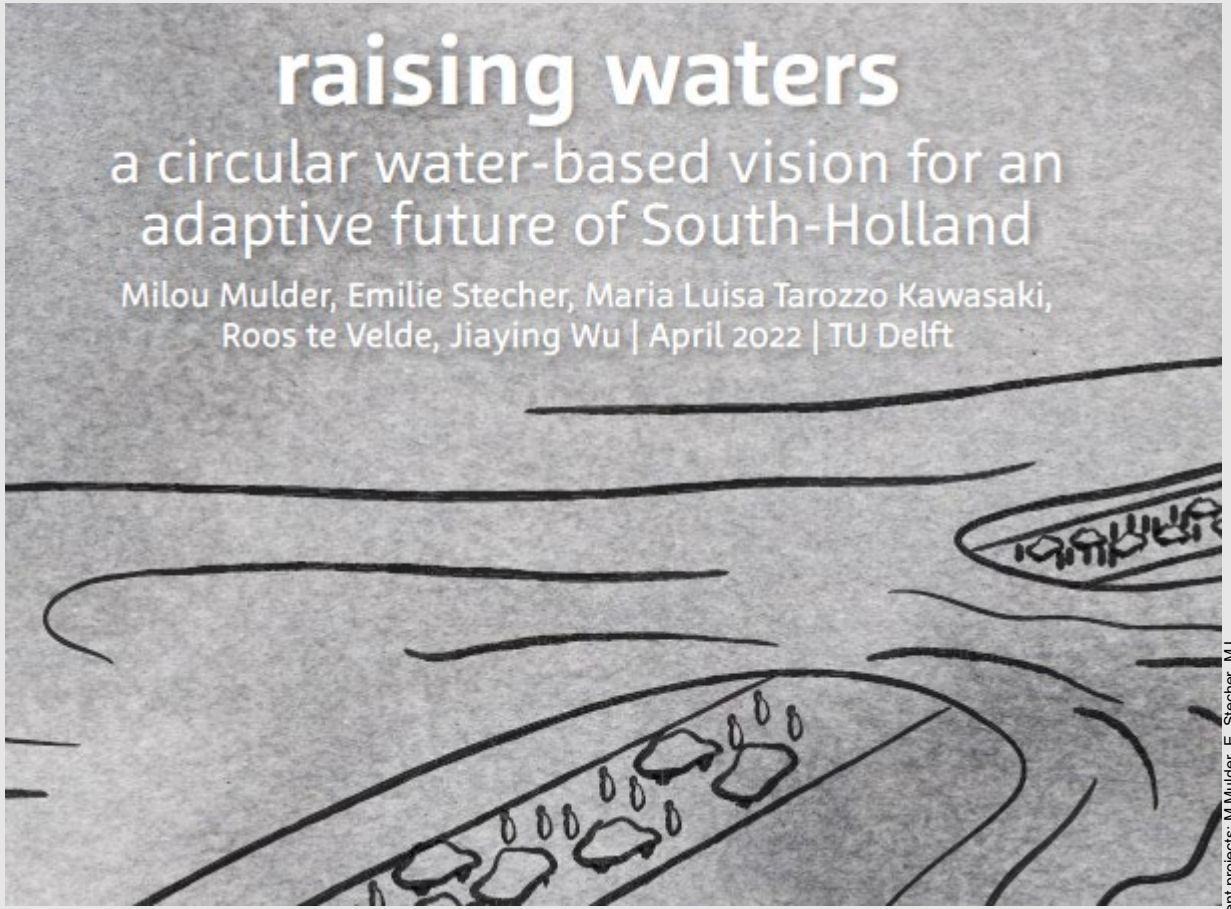
Design for synergies (electricity, heat, cold, materials) between different functions

Cascade flows beyond industrial symbiosis

Regenerate water and soil systems to be part of cascading systems.

Urban and regional design promoting walking, cycling and public transport;

+3m See Level Rise



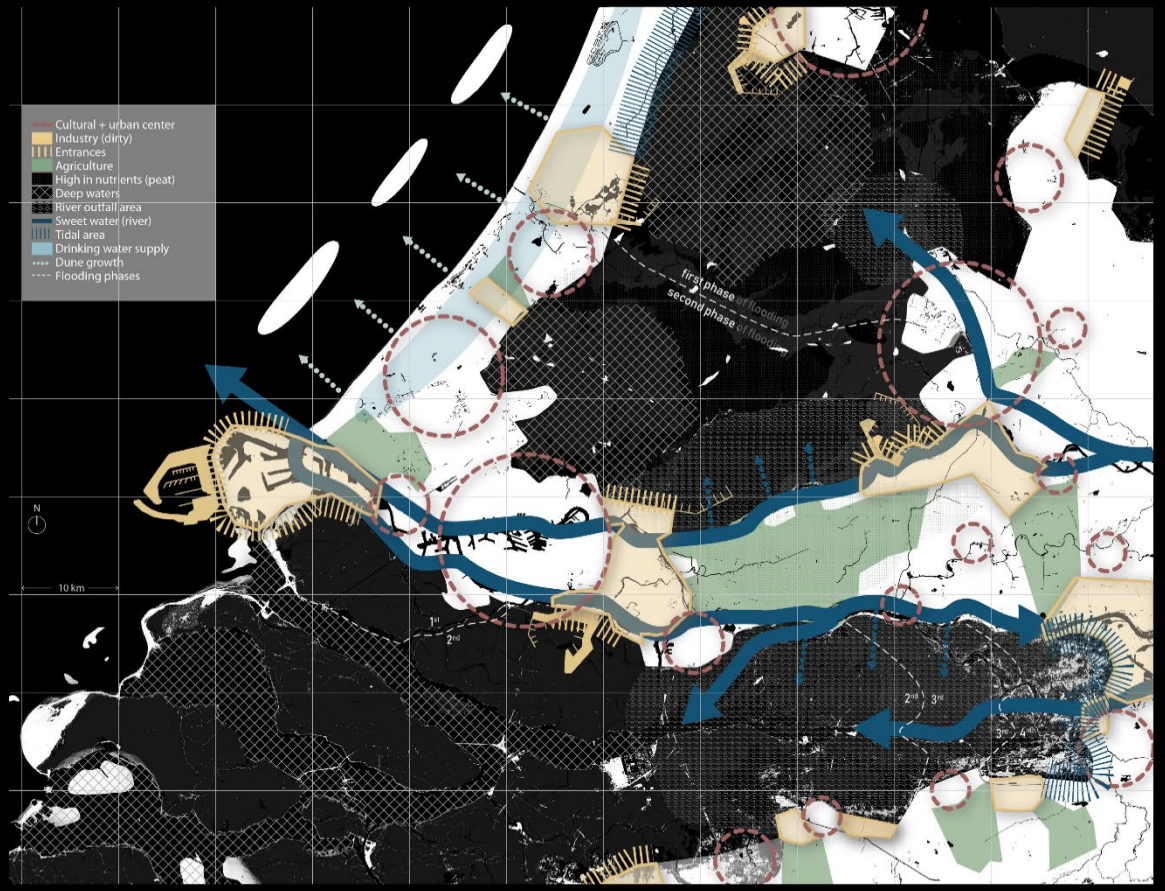
Raising water student projects: M.Mulder, E. Stecher, M.L. Tarozzo Kawasaki, R.te Velde, J. Wu
Mentors: B. Hausleitner, M. Dabrovski

landscape as potential

analysis

vision

strategy



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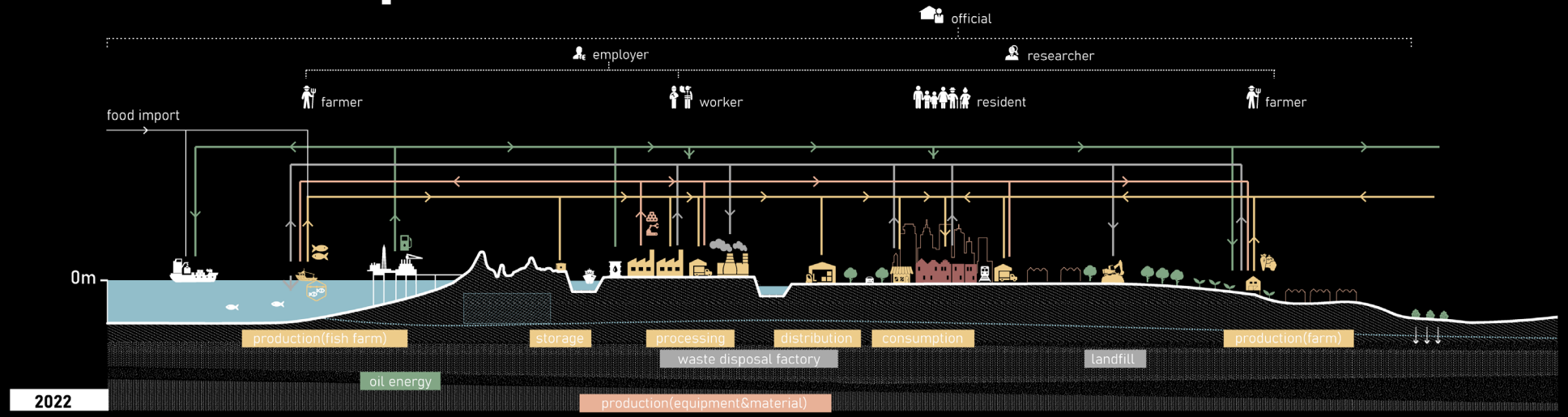
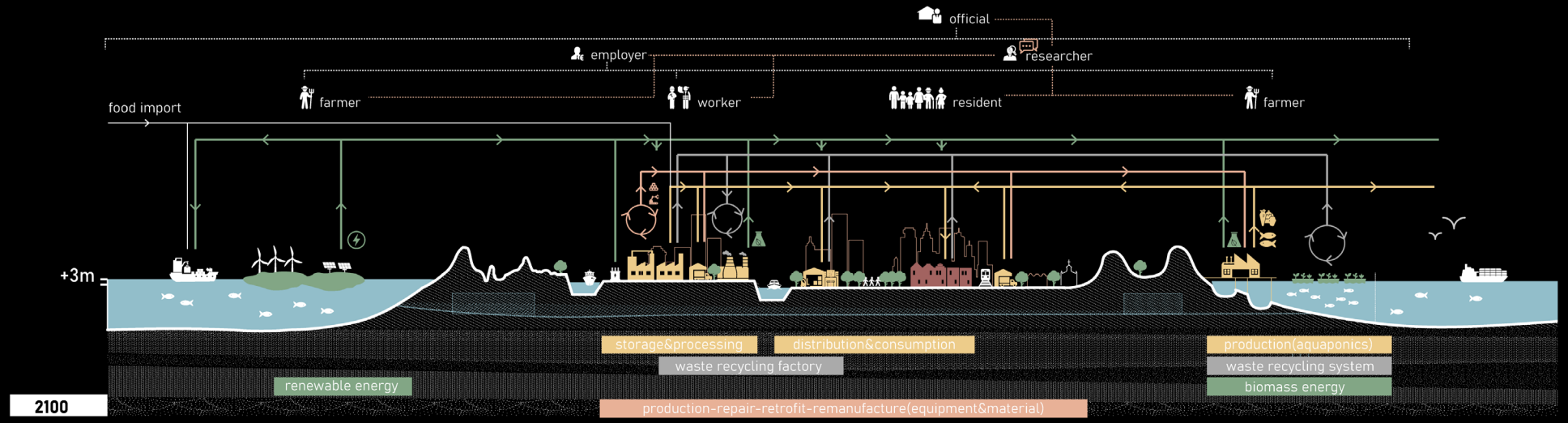
agriculture and aquaculture

analysis

vision

strategy





agricultural/aquacultural products

waste

energy

equipment&material

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retreiving materials

analysis

vision

strategy

High deposit of buildings
Medium deposit of buildings
Steel from rail network
Concrete from road network

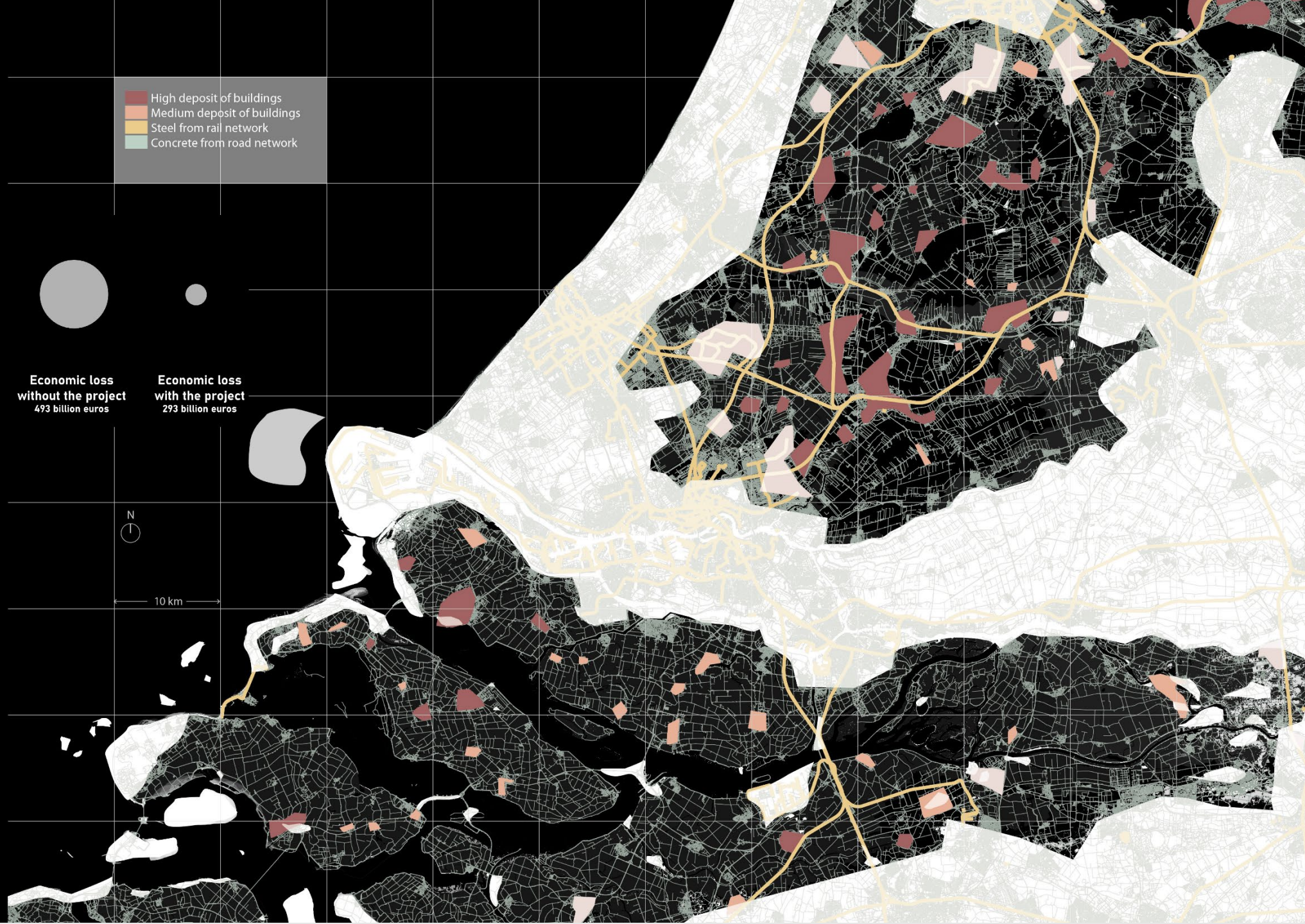
GDP the Netherlands
912 billion euros

Economic loss without the project
493 billion euros

Economic loss with the project
293 billion euros

N

10 km



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analysis

vision

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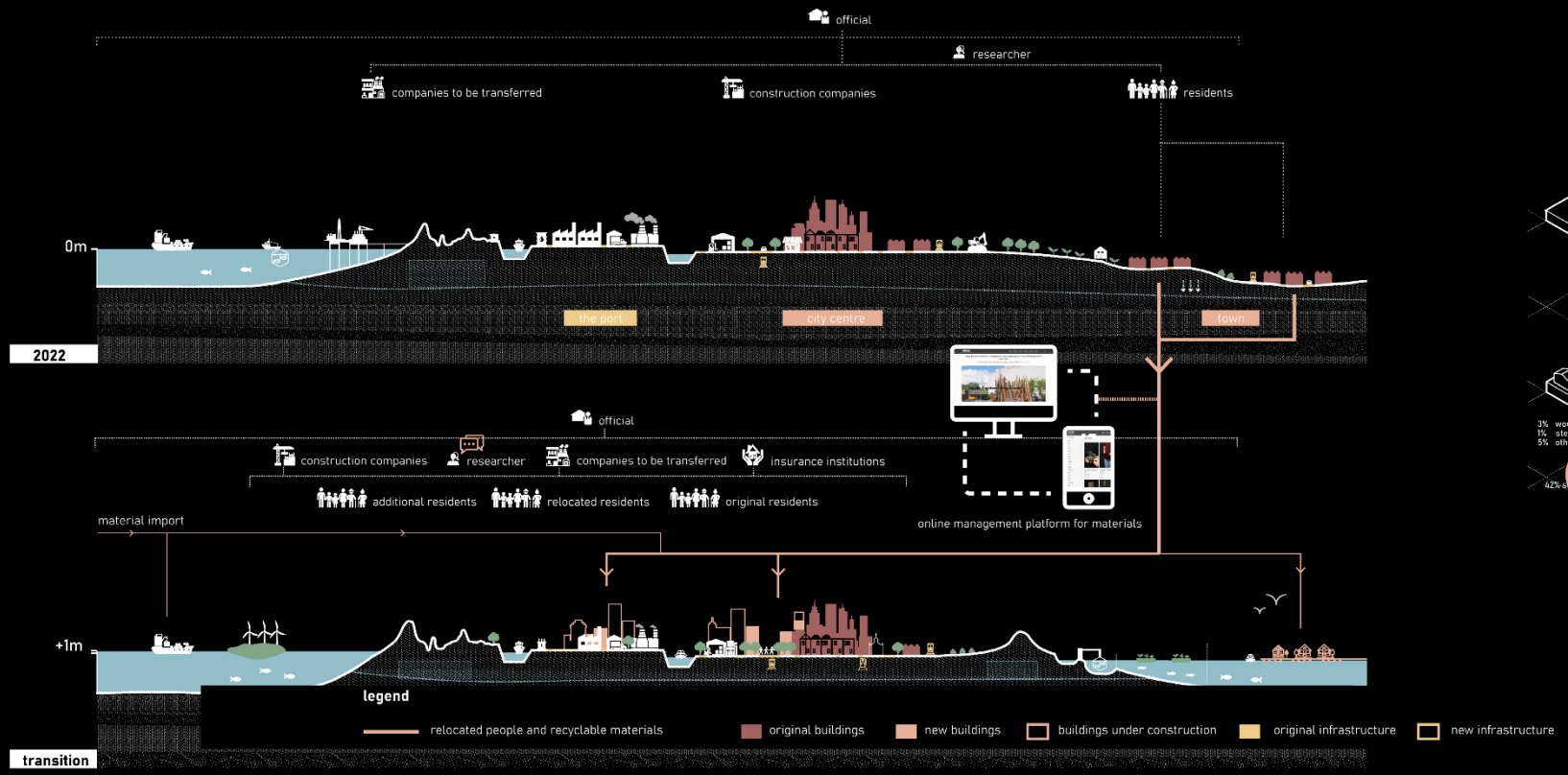

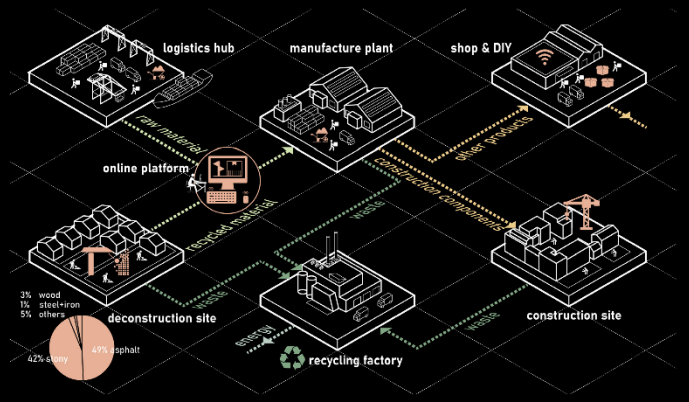

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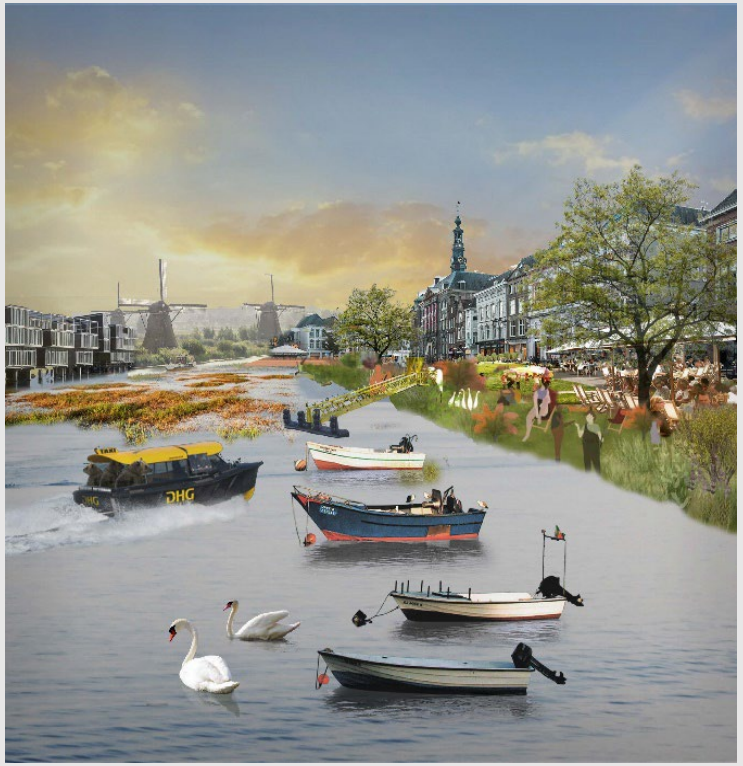
Transition to Circularity => Systemic Changes <=> Different Built Environment



TU Delft
environmental technology & design
Alexander Wandl - a.wandl@tudelft.nl

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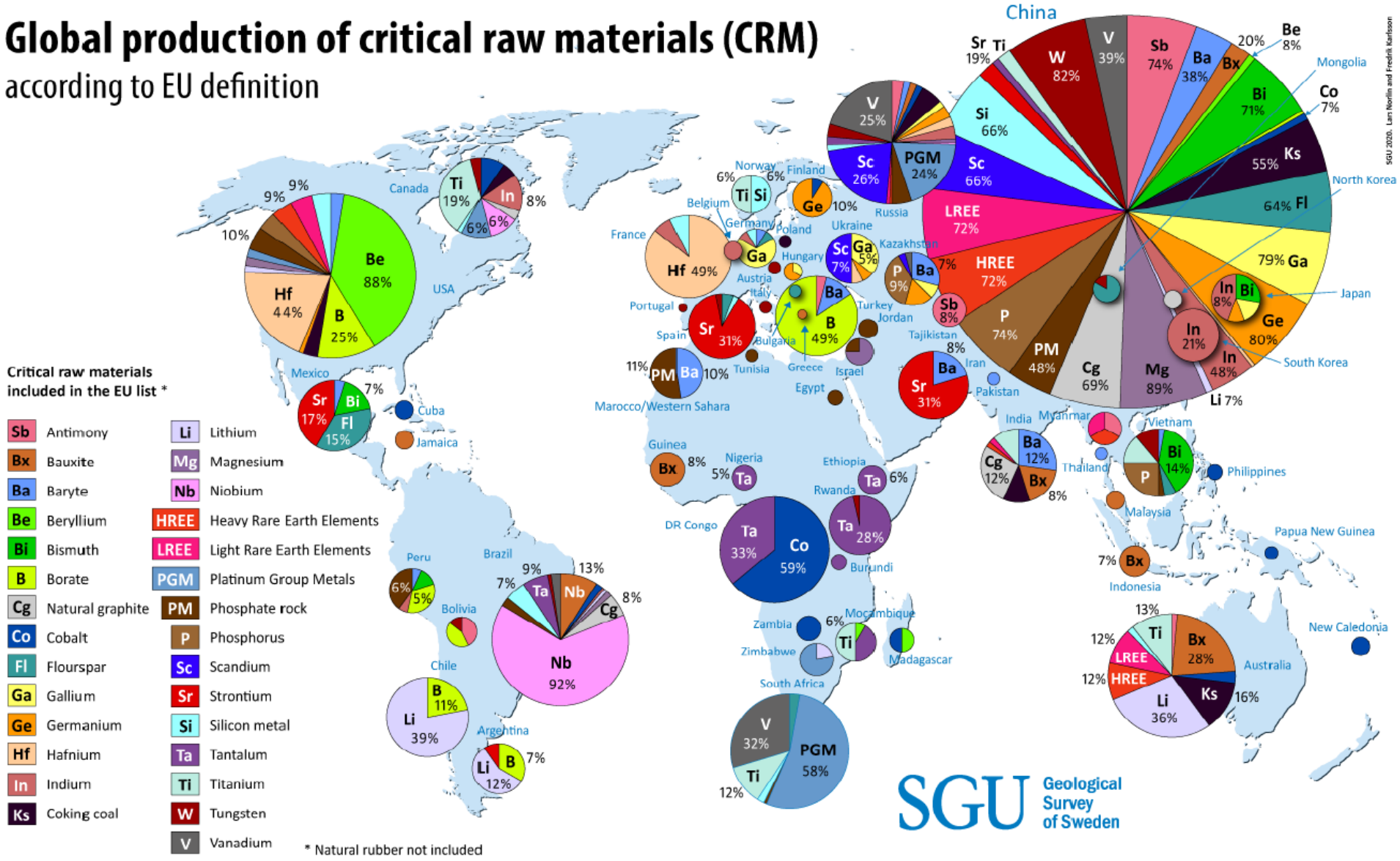
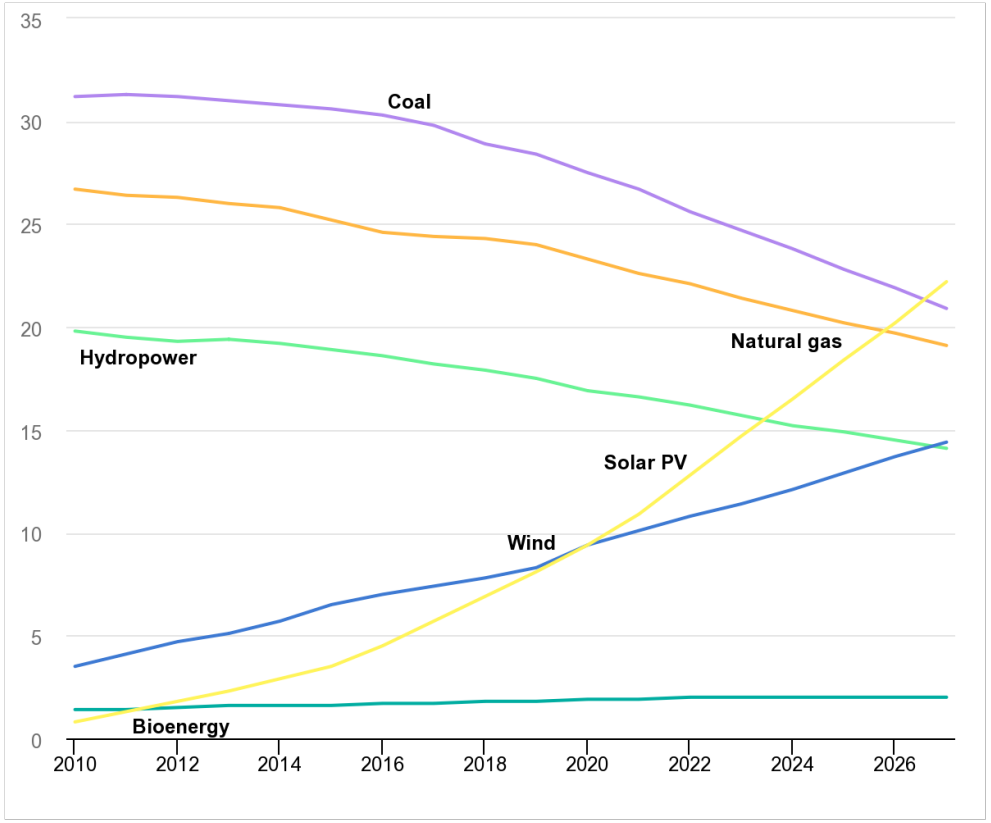
Critical raw materials are often closer than we think



WHERE WILL RENEWABLE ENERGY BE PLACED?



https://www.iea.org/data-and-statistics/charts/share-of-cumulative-power-capacity-by-technology-2010-2027

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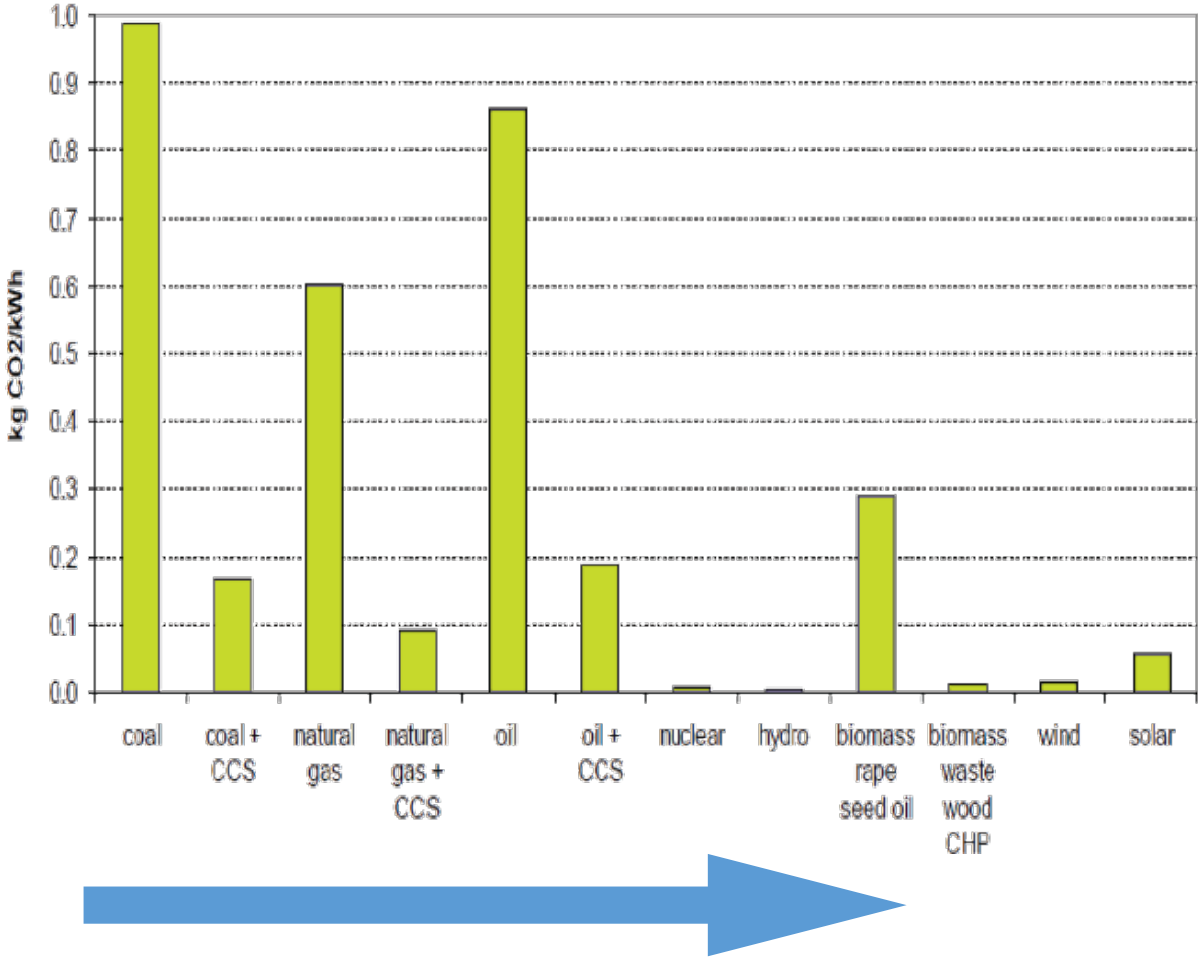
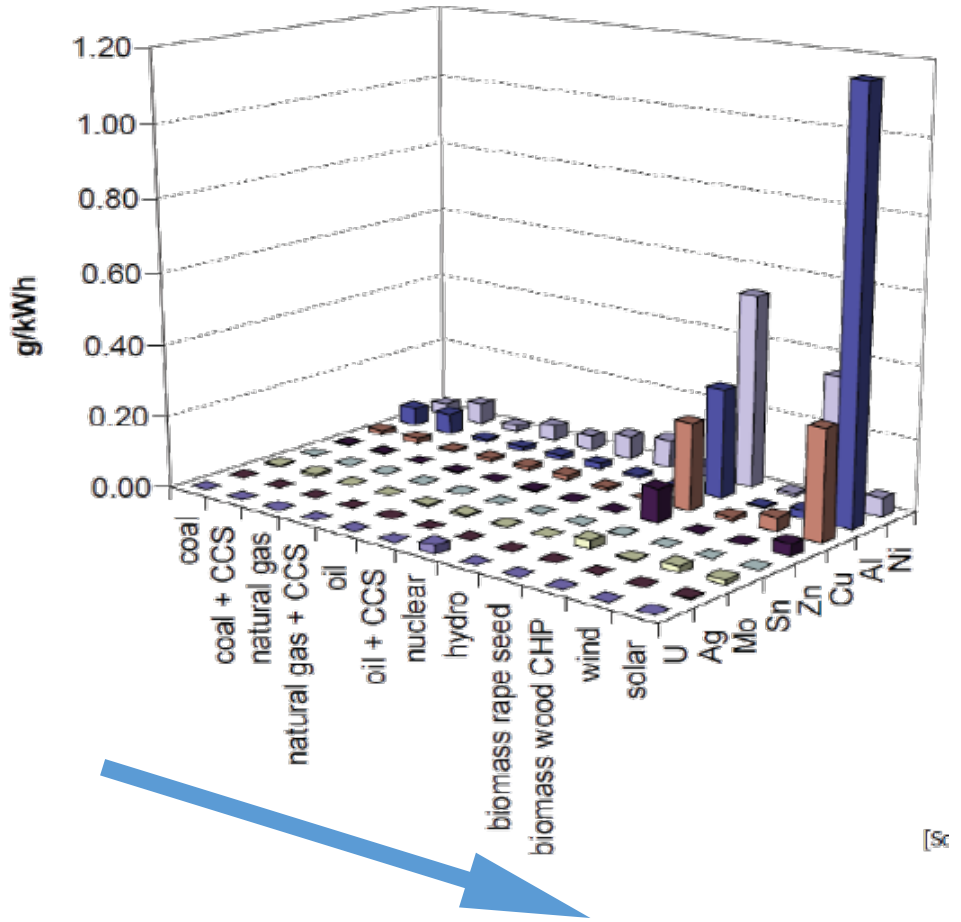
ENERGY TRANSITION – CRITICAL RAW MATERIALS





https://eitrawmaterials.eu/wp-content/uploads/2020/04/rms_for_wind_and_solar_published_v2.pdf

CLIMATE CHANGE - ENERGY TRANSITION – MATERIAL SCARCITY

On EU and global scales there are plans to move towards renewable sources and green energy.

4 factors assessed in high, medium and low demand scenarios

Generation capacity
How much renewable energy will be produced?

Lifetimes
How often do we need to replace the systems?

Market Share
Which sub-technologies will be dominant?

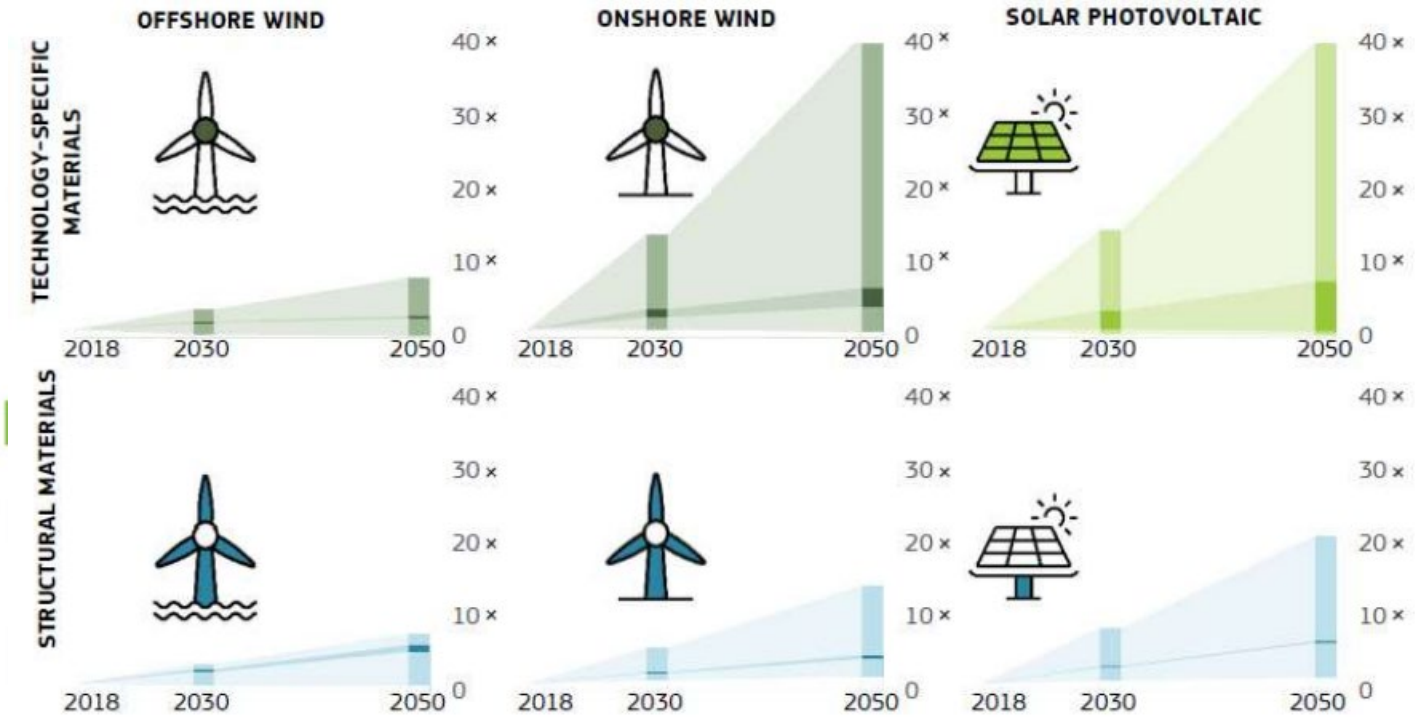
Material intensity
How much will material usage improve?

https://eitrawmaterials.eu/wp-content/uploads/2020/04/rms_for_wind_and_solar_published_v2.pdf

CLIMATE CHANGE - ENERGY TRANSITION – MATERIAL SCARCITY

Raw materials demand forecast for structural and technology-specific materials for offshore wind, onshore wind and solar photovoltaic (relative to 2018)

Materials have been grouped according to the technology (offshore wind, onshore wind, solar) and whether they are structural or technology-specific. The darker area of each vertical bar represents the demand range in a medium demand scenario. The lighter area represents the demand variability considering low demand and high demand scenarios.



Source: JRC analysis.

https://eitrawmaterials.eu/wp-content/uploads/2020/04/rms_for_wind_and_solar_published_v2.pdf

QUESTIONS?

Supporting citizens' circular behaviour

Design for material reduction
Design for emotional bonding and trust
Design for reliability and durability

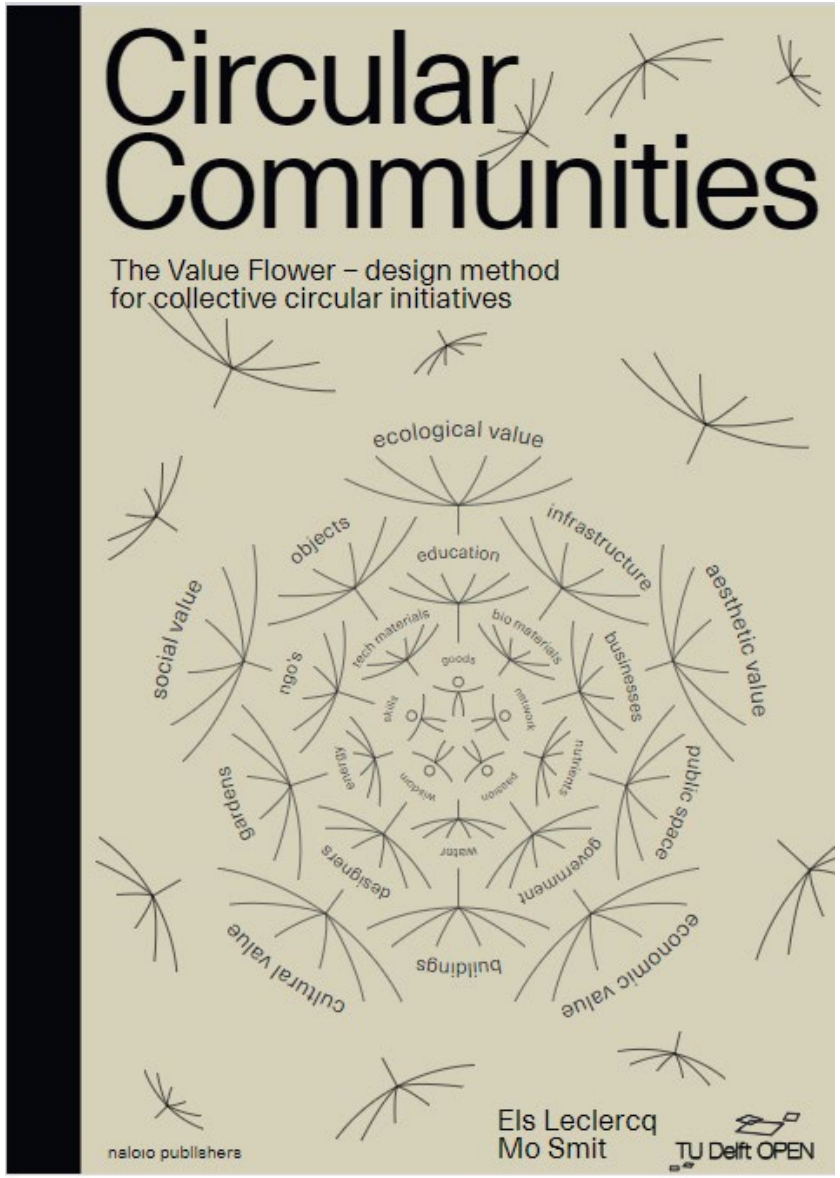
Provide infrastructure for sharing: tools, equipment, vehicles, spaces, and flows.

Facilitate a collaborative production and consumption and sharing economy.

Provide space for reuse and knowledge sharing.

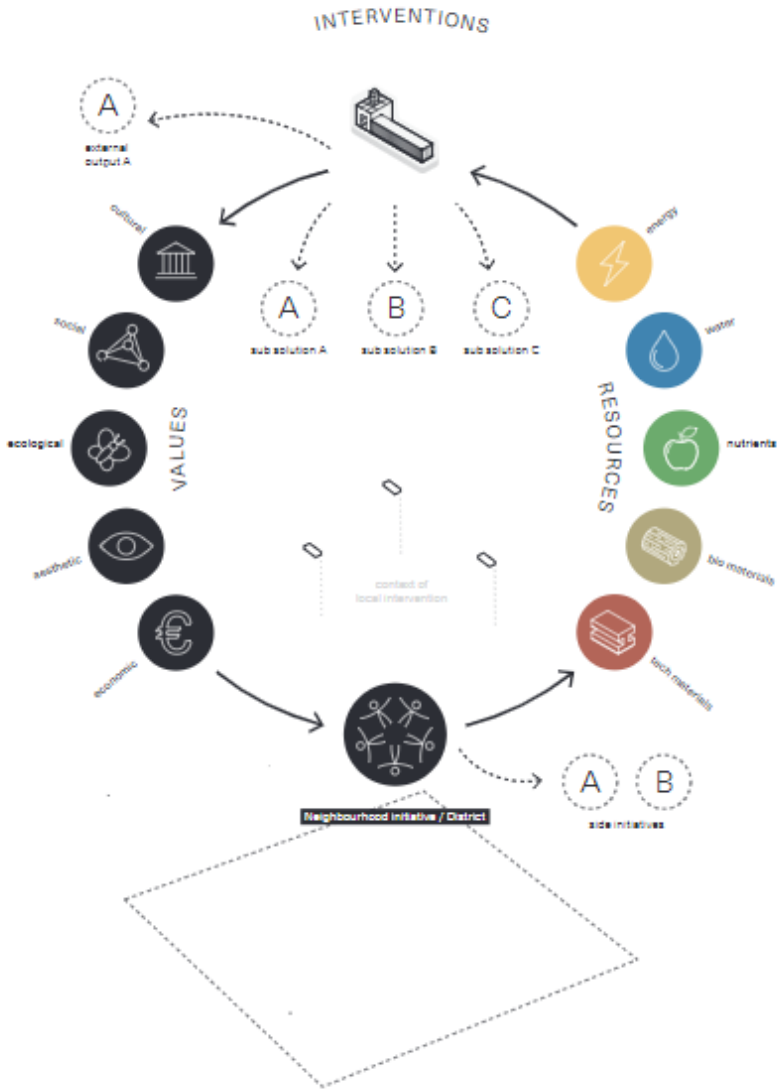
Supporting regenerative practices

urban design, promoting walking and cycling;



• Circular Communities: The circular value flower as a design method for collectively closing resource flows
Authors Els Leclercq, Mo Smit; https://books.open.tudelft.nl/home/catalog/book/62

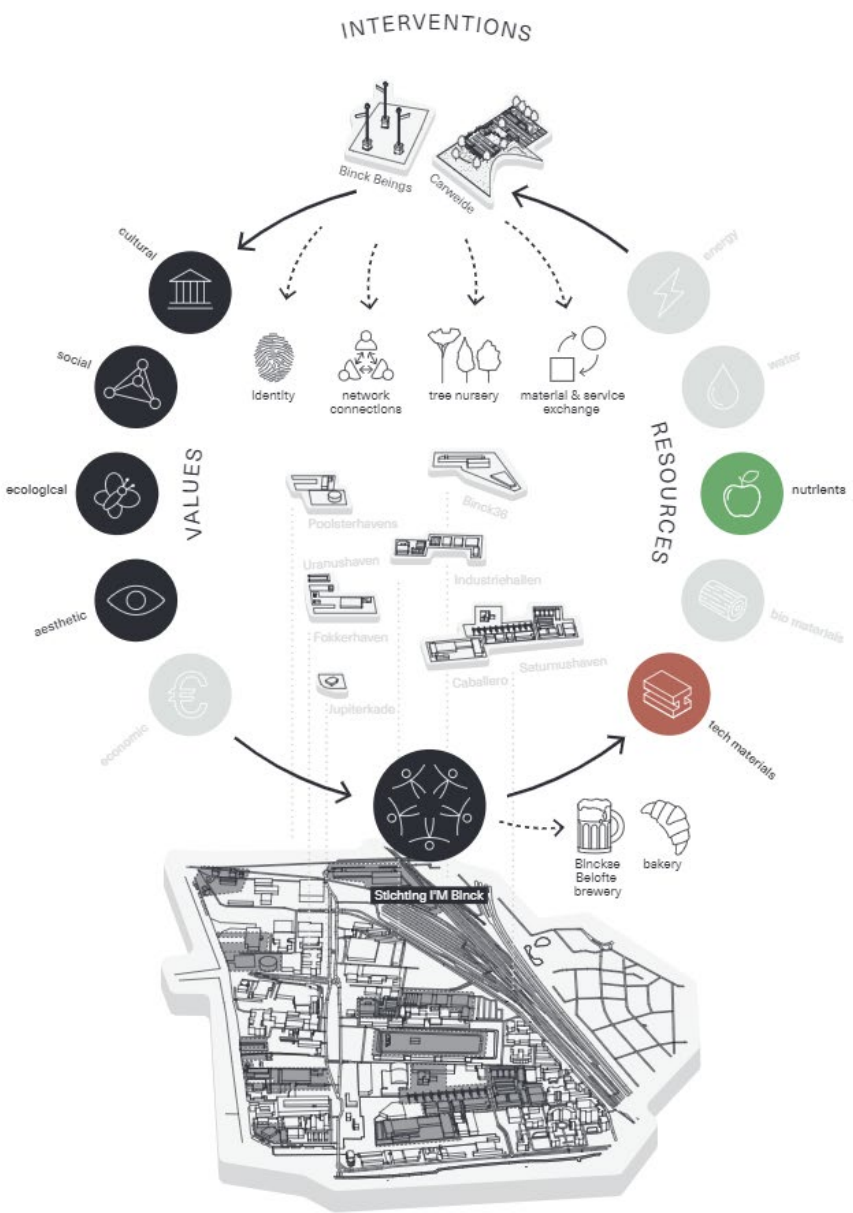
Relating Values, Flows, People, Spaces - Livability



1. Physical and economic security;
2. Basic services (schools, houses et etcetera);
3. Leadership;
4. Openness (tolerance, inclusiveness between different groups of residents); and
5. Aesthetics (physical beauty, culture, and so on).

• Circular Communities: The circular value flower as a design method for collectively closing resource flows
Authors Els Leclercq, Mo Smit; https://books.open.tudelft.nl/home/catalog/book/62

I’M Binck



- Circular Communities: The circular value flower as a design method for collectively closing resource flows Authors Els Leclercq, Mo Smit; https://books.open.tudelft.nl/home/catalog/book/62

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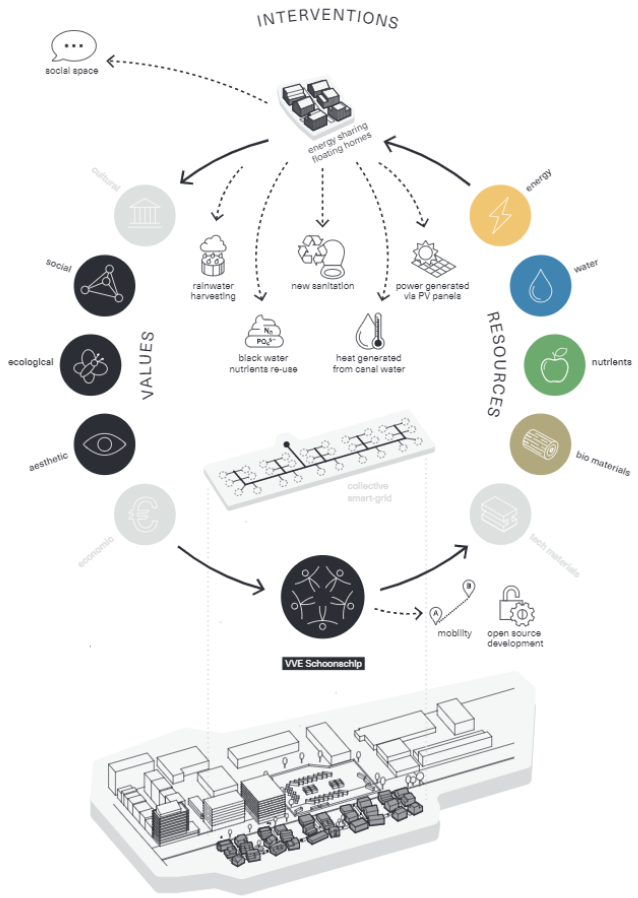
The Circular Built Environment Hub

Schoon Ship



- Affordable for households from diverse backgrounds across five income categories, including social renting
- An urban design that encourages a social living environment
- 100% renewable heating and hot-water supply
- 50-70% reduction in electricity requirements
- 100% renewable electricity
- 100% treatment of waste water and organic waste
- 100% own drinking-water supply
- 60-80% food production (fruits and vegetables) on own plot, using locally obtained nutrients
- Collective facilities such as shared cars, laundries, jetties and floating gardens.

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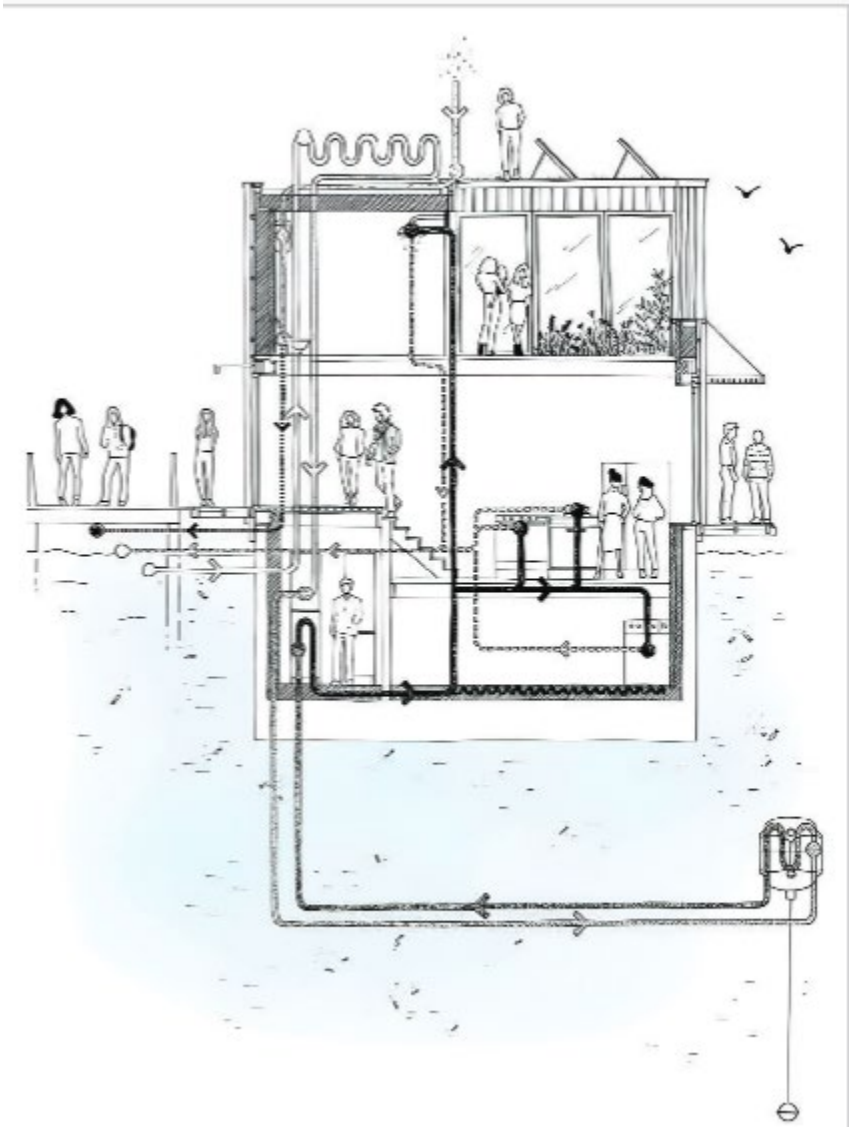
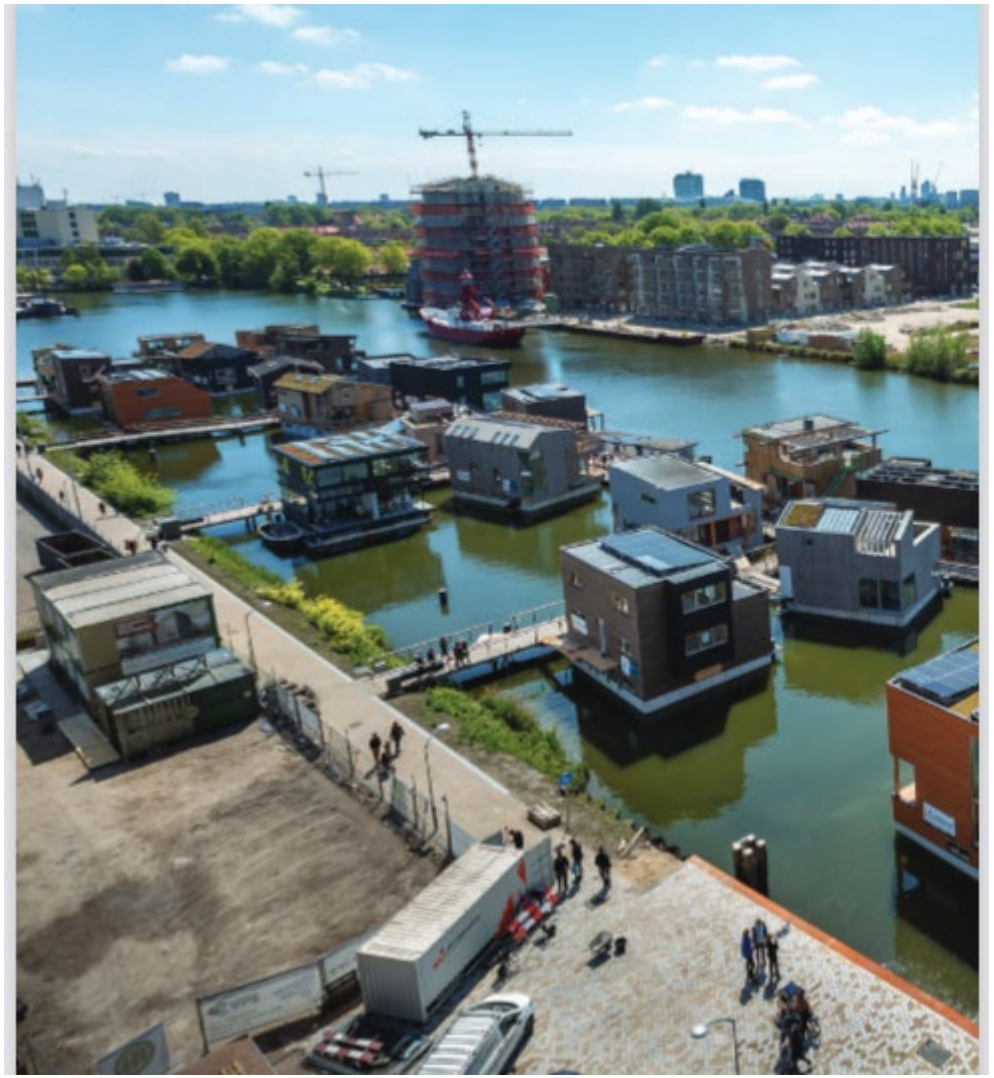
Authors Els Leclercq, Mo Smit; https://books.open.tudelft.nl/home/catalog/book/62

Schoon Ship





- Circular Communities: The circular value flower as a design method for collectively closing resource flows
  Authors Els Leclercq, Mo Smit; https://books.open.tudelft.nl/home/catalog/book/62

Facilitating circular businesses

Space for transport

Scope for re-shoring of production

Space for storage

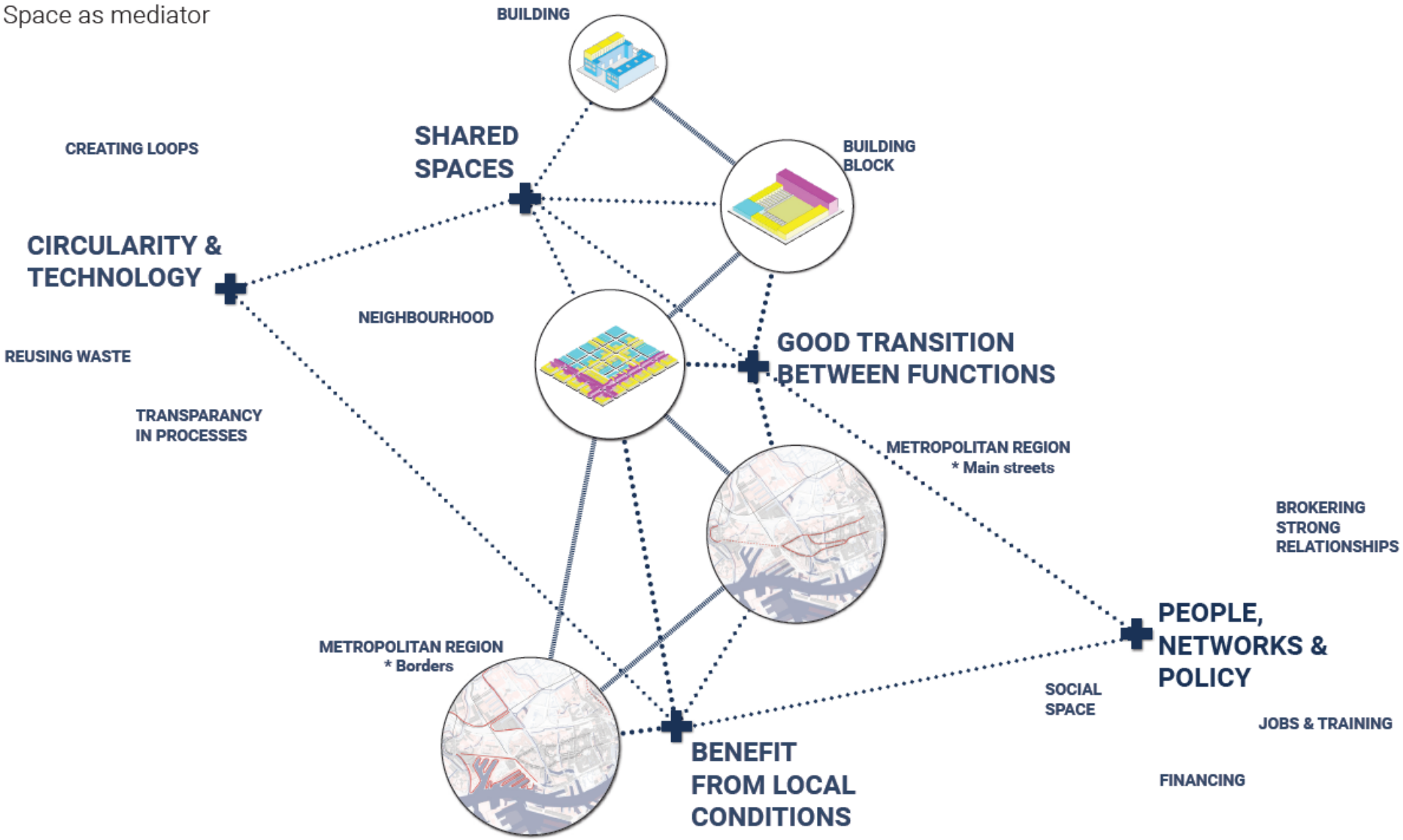
Space for the production of bio-based materials

Space for renewable energy

Facilitate space negotiation

https://citiesofmaking.com/

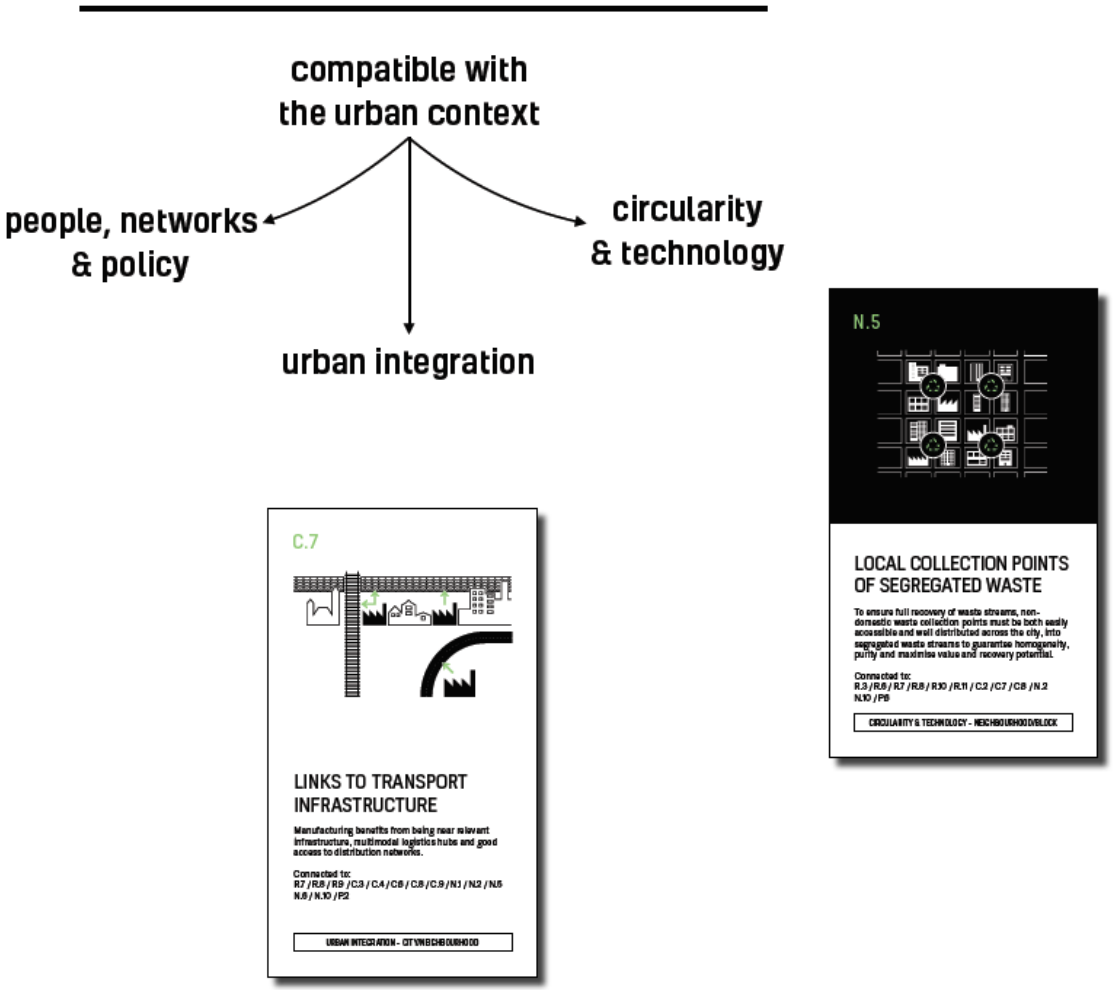
Rethinking urban development
Integrating urban manufacturing
Space as mediator



Source:: Brigit Hausleitner en cities of making project.

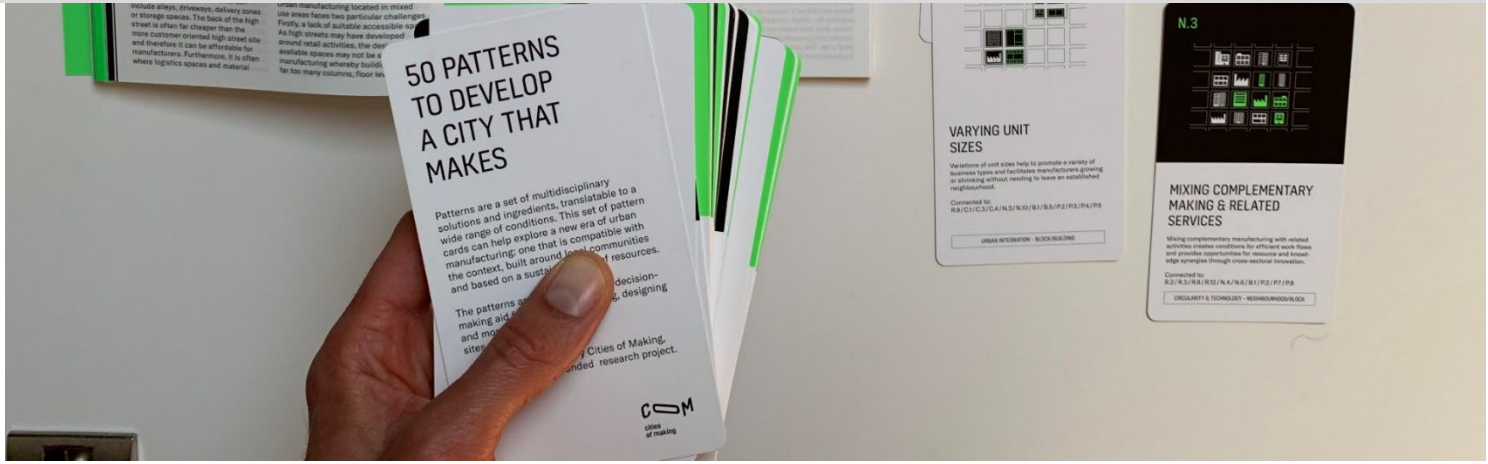
Een patroontaal als ontwerp instrument

CO-CREATION OF THE PATTERN LANGUAGE
Solutions from three different aspects



https://books.bk.tudelft.nl/press/catalog/book/ISBN_9789463662475

https://data.4tu.nl/articles/dataset/Cities_of_Making_pattern_language_cards_testing_set/12721397



50 patronen voor co-creatie

Bron: Brigit Hausleitner en cities of making project.

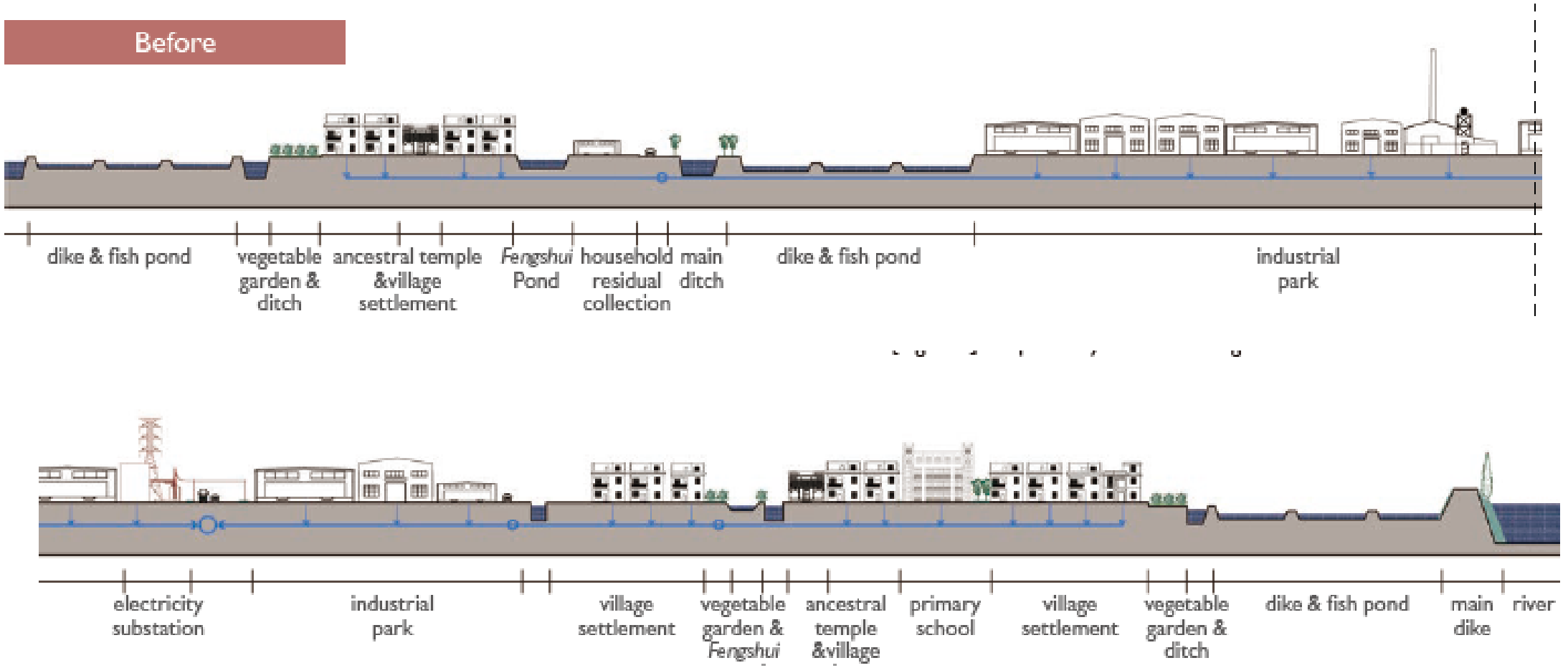
Towards a Sustainable and Livable Desakota:

Designing for sustainable industry transition in the peri-urban territory of the Greater Bay Area

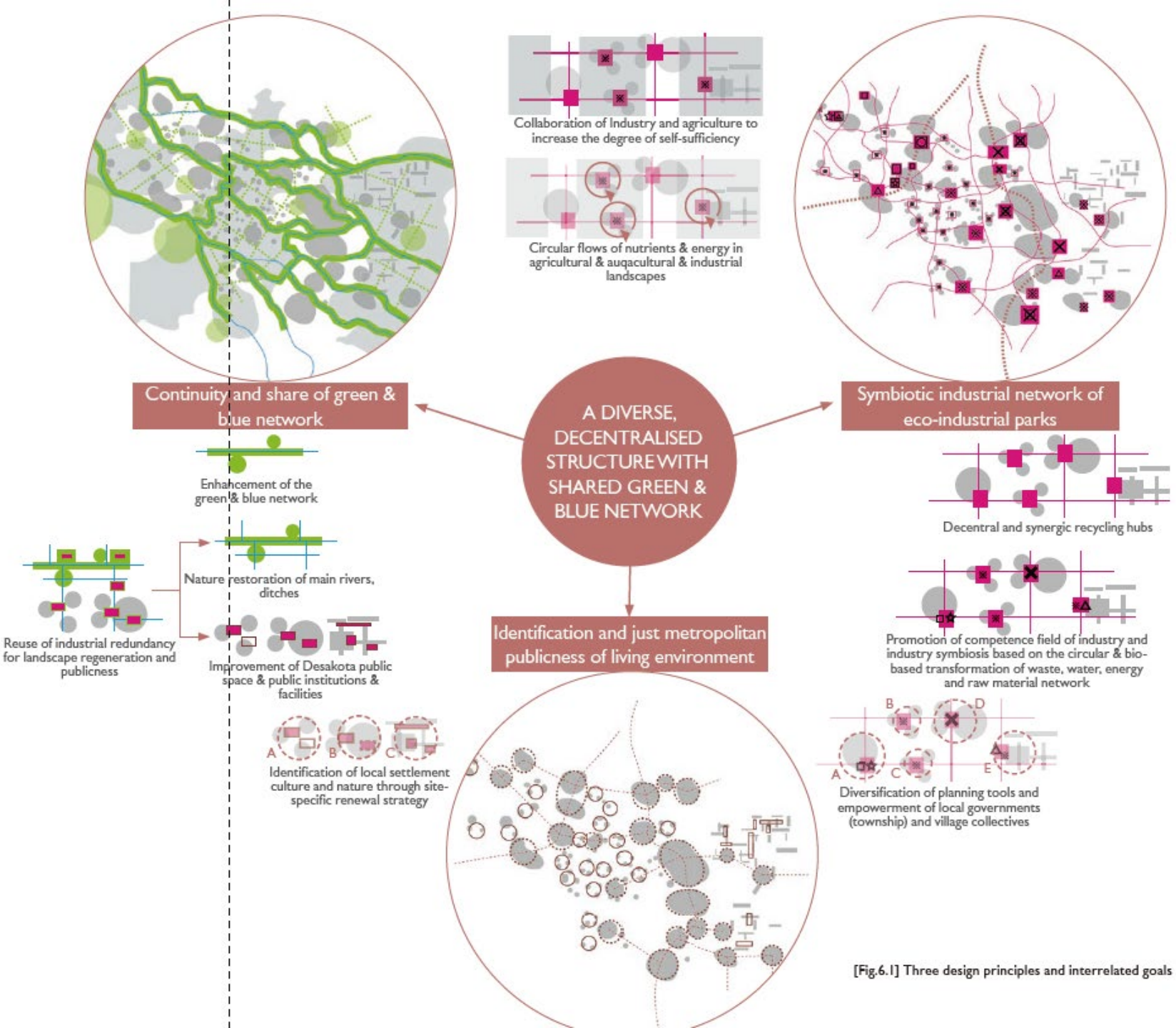
Source: Graduation Project: Shiru Liu

Alexander Wandl - a.wandl@tudelft.nl

Starting from linear Industry and degenerated landscape …

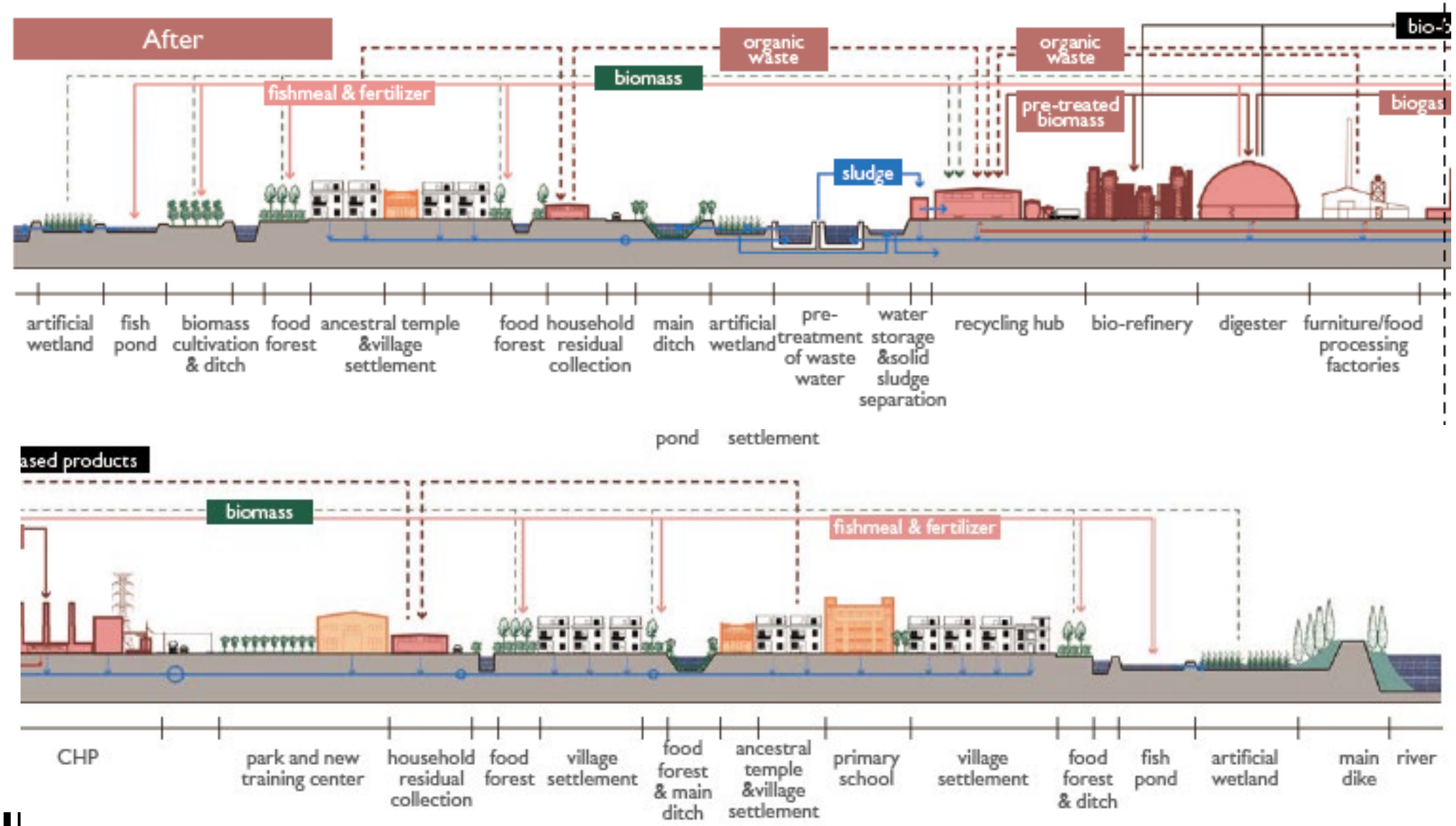


Source: Graduation Project: Shiru Liu



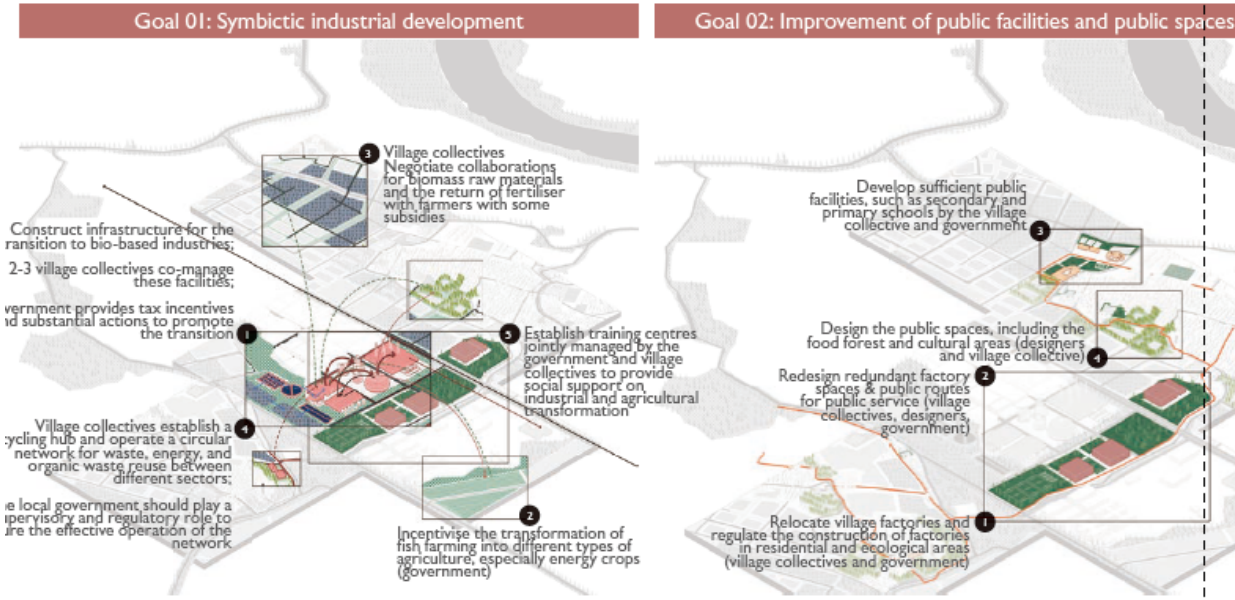
[Fig.6.1] Three design principles and interrelated goals

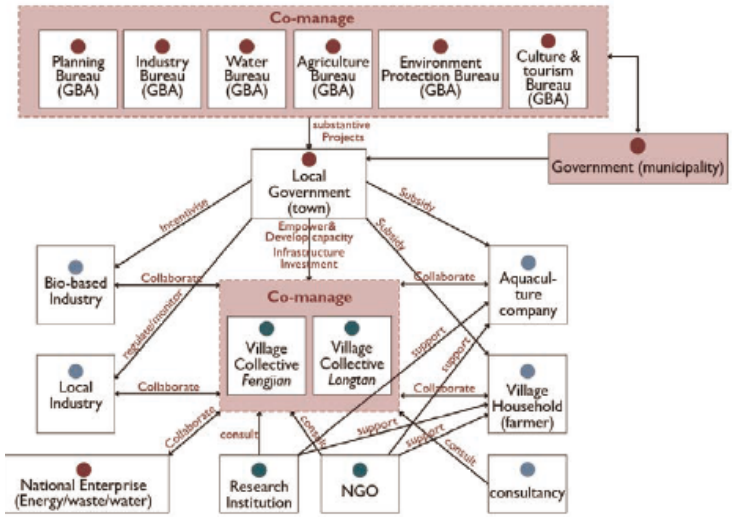
Using Industrial Symbioses and the introduction of bio-based industries as a starter for

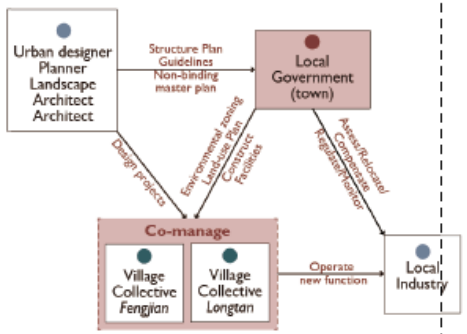


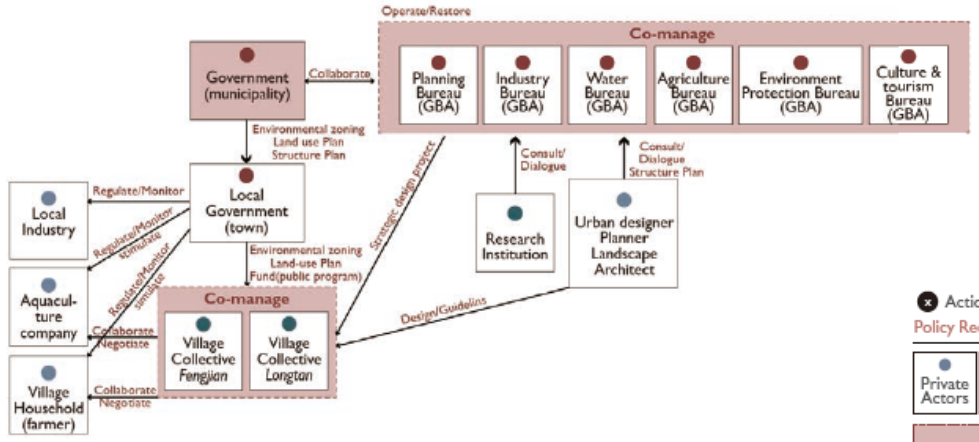
Source: Graduation Project: Shiru Liu

Integrated, systemic but context specific regional design









6.13 Policy Strategies

The specific actions and actors corresponding to each strategy are depicted in the diagram. The core planning strategy to drive these actions includes:

1)Empower village collectives to operate the centralised industrial node and develop their collective management capabilities.

2)Establish circular networks that should be led by village collectives and negotiated in collaboration with residents (farmers). The role of the local government is to assist and regulate, primarily focusing on developing the capabilities of village collectives, such as infrastructure investment, network establishment, and providing training support. Incentive measures can also be implemented to promote agricultural and industrial transformation and regulate unsustainable activities.

3)Localised morphological, physiological, and governance strategic planning can be incorporated into the procedures of the planning system.

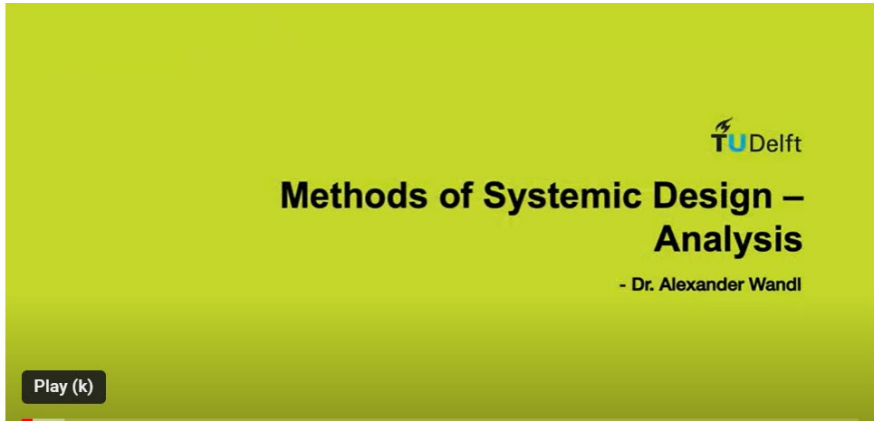
TU Delft
environmental technology & design
Alexander Wandl - a.wandl@tudelft.nl
The Circular Built Environment Hub

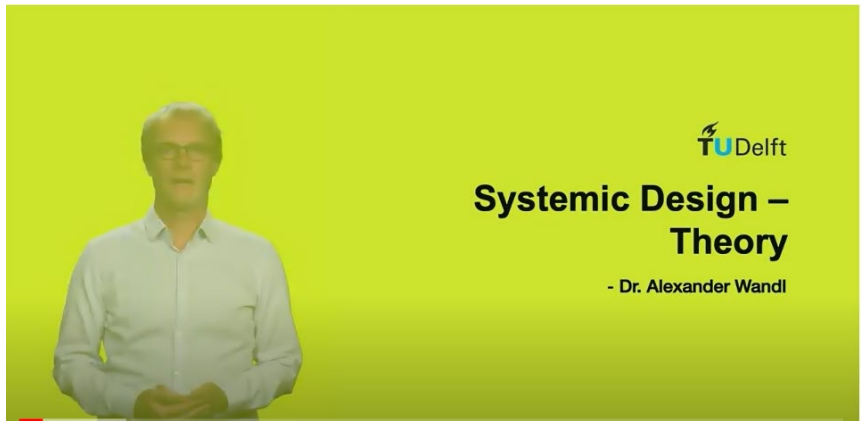
A Circular Built Environment relies on Co-Creation

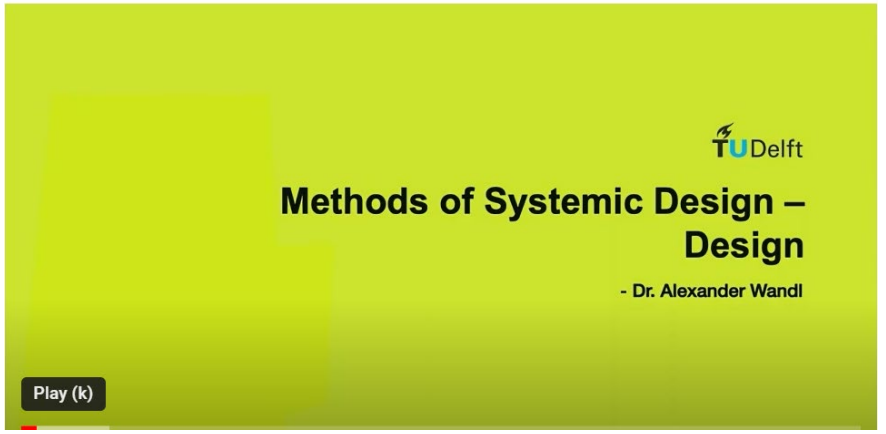
RESOURCE MANAGEMENT IN PERI-URBAN AREAS: GOING BEYOND URBAN

http://h2020repair.eu/virtual-exhibition/

Three Videos to Guide the How







https://online-learning.tudelft.nl/courses/spatial-circularity-strategies-for-sustainable-regional-development/

Circular Economy (CE)

What are your association with CE, now?

Some mentimeter interaction:
https://www.menti.com/zxh8oxzwt3
voting code **3762 8640**

Results

What are your associations with Circular Economy now ?

QUESTIONS?

THE CIRCULAR BUILT ENVIRONMENT HUB

Circular Built Environment Hub

TU Delft

Who we are

Research projects portfolio

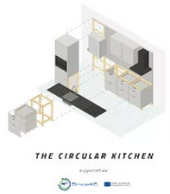
Biobased, Inclusive & Circular

CARED

Catalyse Remanufacturing through Design Bootcamp

CHARM

Circular Housing Asset Renovation & Management - No More Downcycling



CIK: The Circular Kitchen

CINDERELA

New Circular Economy Business Model for More Sustainable Urban Construction

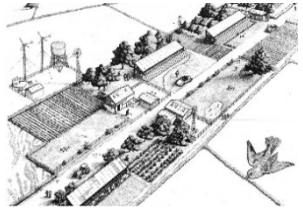
CiRCLETECH

Twinning partnership to develop a European Sustainable Circular Economy Research Hub

Circu-MAT

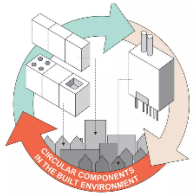
Circular city and Industry park Materials metabolism Learning package and assessment tool

Circular Area Development Binckhorst – The Hague



Circular City

Exploring the roles of contemporary Dutch architects regarding the circular economy in the built environment.



Circular Components in the Built Environment

Circular and Prefabricated High Rise

Doughnut Architecture

The Doughnut Economic approach in Architecture

FacadeReLog

Reverse logistics for the recovery of metals in the facade industry

Façade Leasing

A circular business model based on the use of multifunctional façades.

Research projects portfolio

Intrinsically Circular

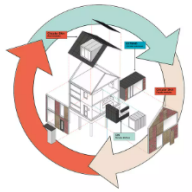
A service for integrated disassembly and design of buildings.

Pop-Machina

Understanding the spatial and social consequences of circular collaborative production in urban areas.

Product Development Test Lab

Testing innovations in an innovative building



REHAB

Developing circular components for housing renovation

REMANPATH

Building Lifelong Education Through Finding Company Path to Remanufacturing

REPAiR

REsource Management in Peri-urban Areas: Going Beyond Urban Metabolism

SeRaMCo

Secondary Raw Materials for Concrete Precast Products

SusCritMat

Sustainable Management of Critical Raw Materials

Trancibo

Changing inter-organizational collaborative behaviour in circular construction projects

Urban Waste

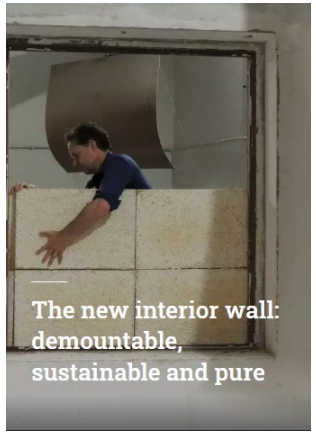
Urban strategies for Waste Management in Tourist Cities

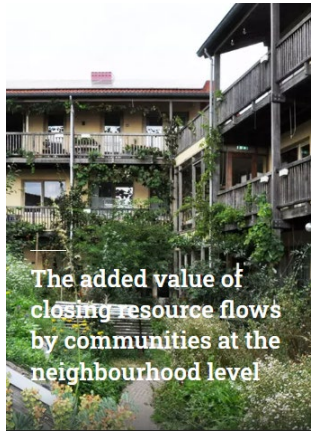
Stories

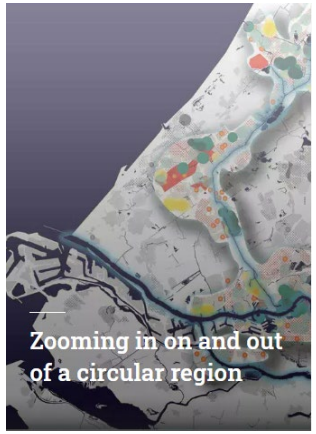

More space for manufacturers please but where?


Resource sharing between vertical farms and the built environment
Source: Signify

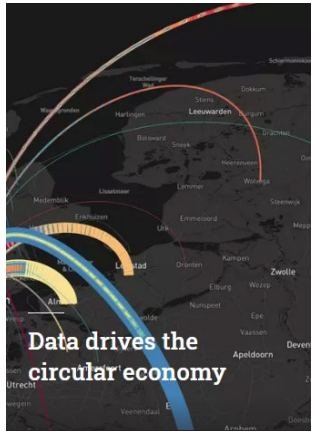

Four graduation projects win circularity award

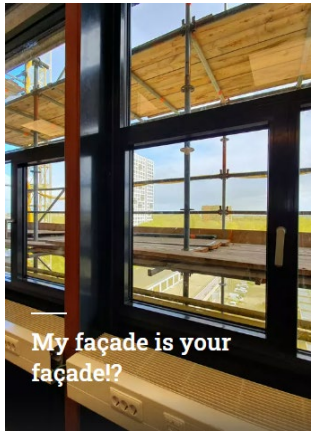

The new interior wall: demountable, sustainable and pure

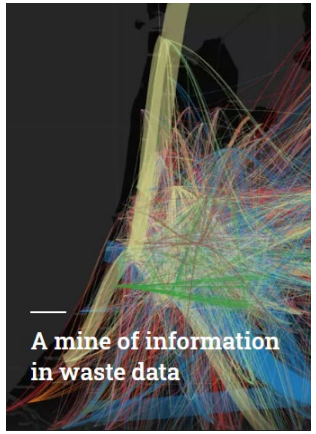

The added value of closing resource flows by communities at the neighbourhood level

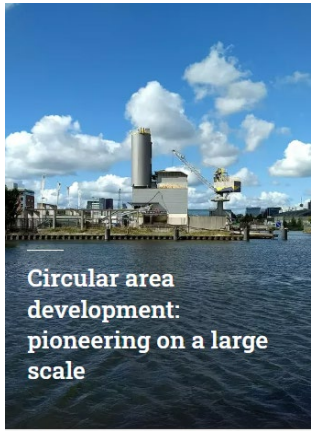

Zooming in on and out of a circular region

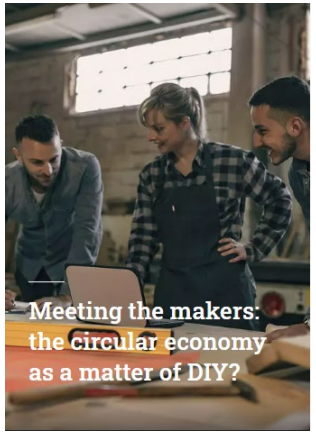

Showcase 'P-lab': urban raw materials in a small-scale circular economy


Data drives the circular economy


My façade is your façade!?


A mine of information in waste data


Circular area development: pioneering on a large scale


Meeting the makers: the circular economy as a matter of DIY?

Summer School on Circularity in the Built Environment

5 - 7 July 2023

From “circuits of capital” to “circuits of value”: addressing the barriers of circularity implementation

The Circular Built Environment Hub of the Faculty of Architecture and the Built Environment will host the second Summer School on Circularity in the Built Environment from 5 to 7 July 2023.

Register now

Summer School on Circularity in the Built Environment

Register here

https://www.tudelft.nl/bk/studeren/summerschools/summer-school-on-circularity-in-the-built-environment

The Circularity of the Built Environment: A systemic perspective

@Tools for Post-Conflict Urban Recovery - 2023

Alexander Wandl
Associate Professor Environmental Technology and Design
Dep. Urbanism, Delft University of Technology
a.wandl@tudelft.nl