TU Delft Delft University of Technology

Making Sense of Regenerative Development and Design in the Built Environment

P5 Presentation | 30.06.25

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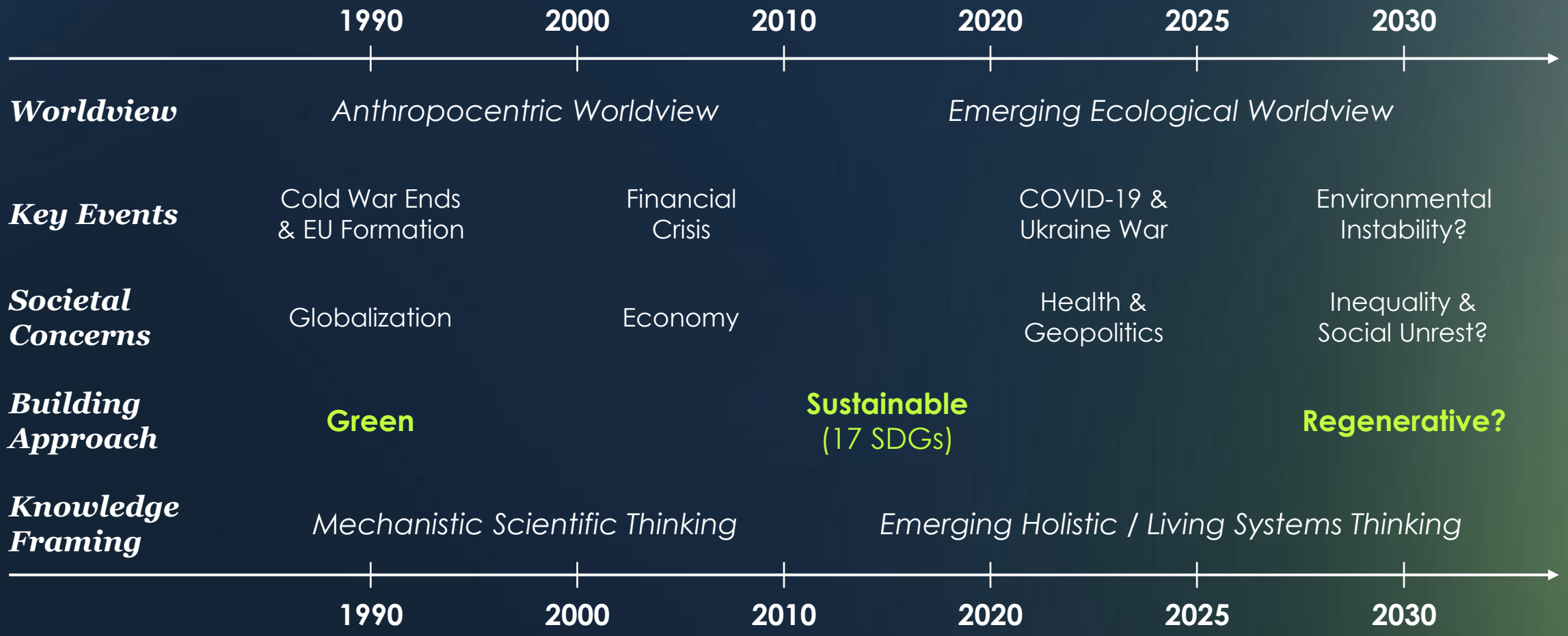
Graduation Organization: Drees & Sommer

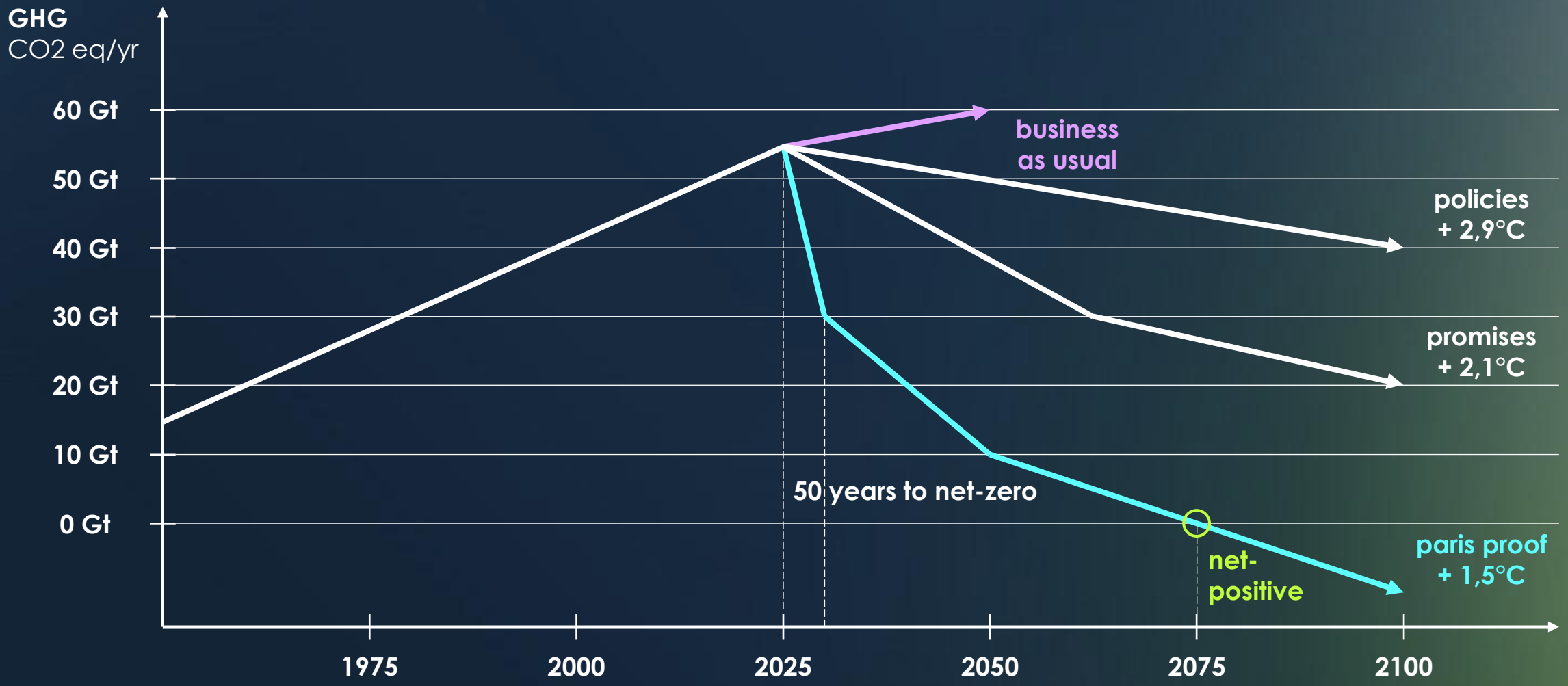
P5 Presentation | Content

1. Introduction | Building Approaches



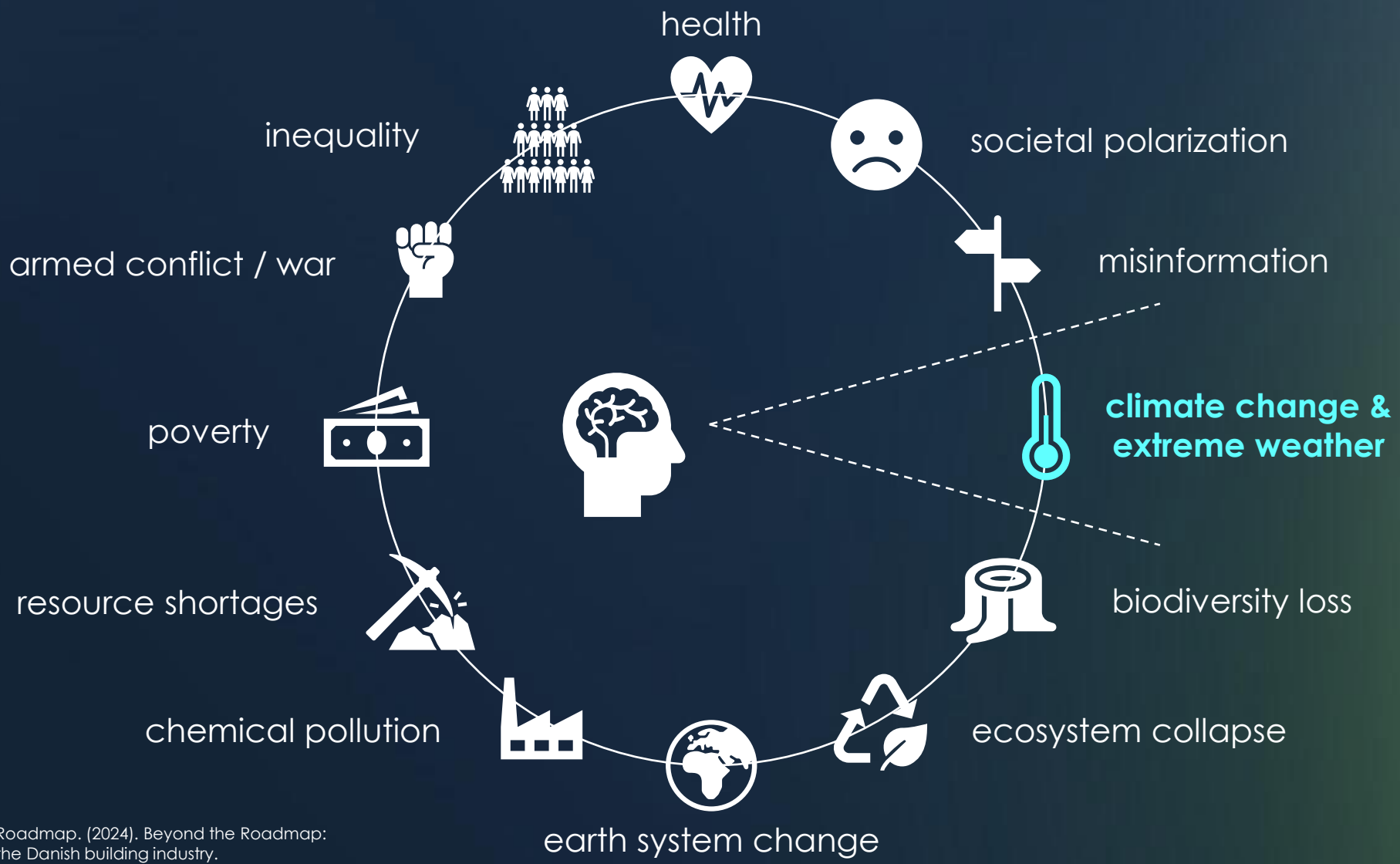
Based on: Cole, R. J. (2020). Navigating climate change: Rethinking the role of buildings. Sustainability (Switzerland), 12(22), 1–25.

1. Introduction | Becoming 'Paris Proof'



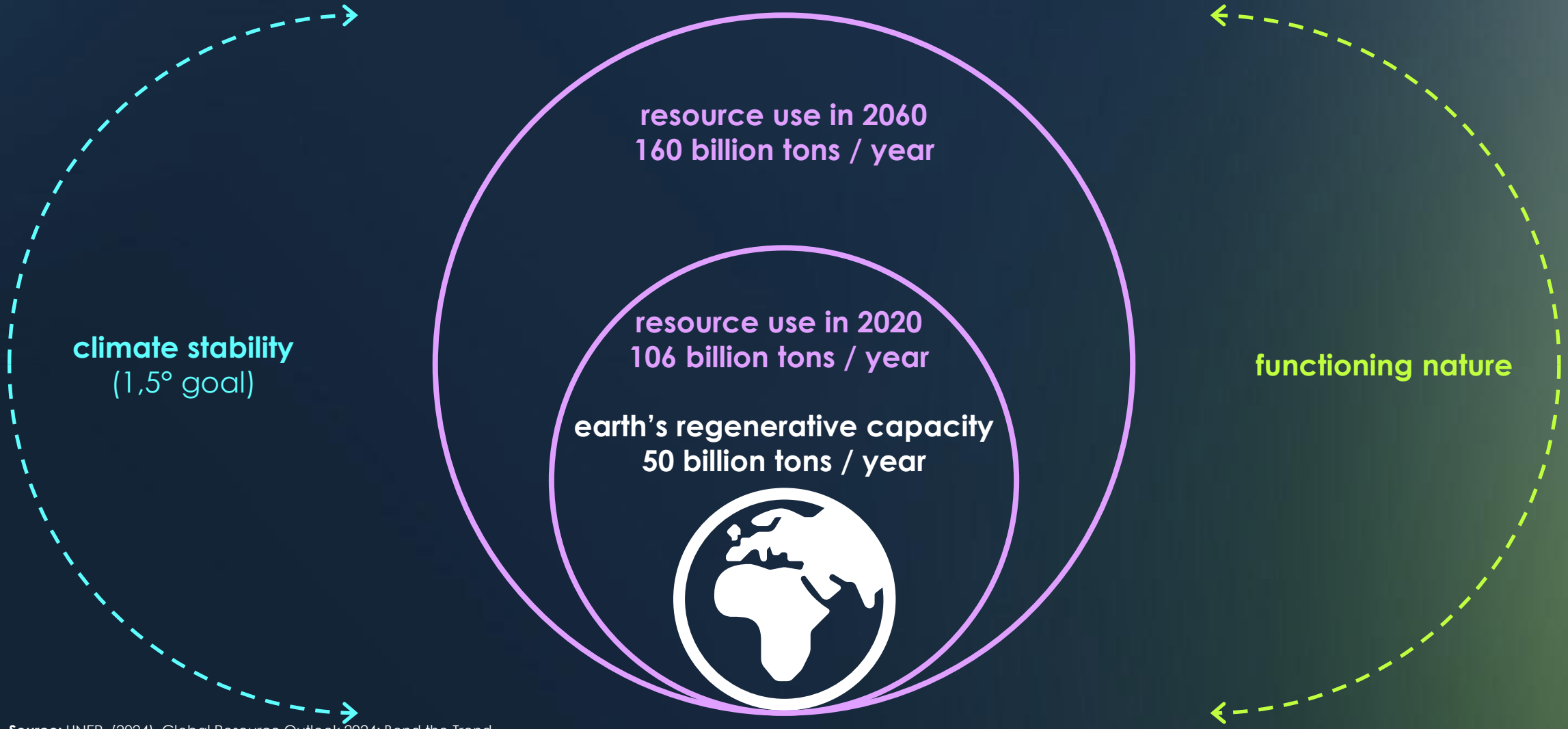
Source: https://climateactiontracker.org/global/emissions-pathways/

1. Introduction | Polycrisis, Global Risks & Tunnel Vision



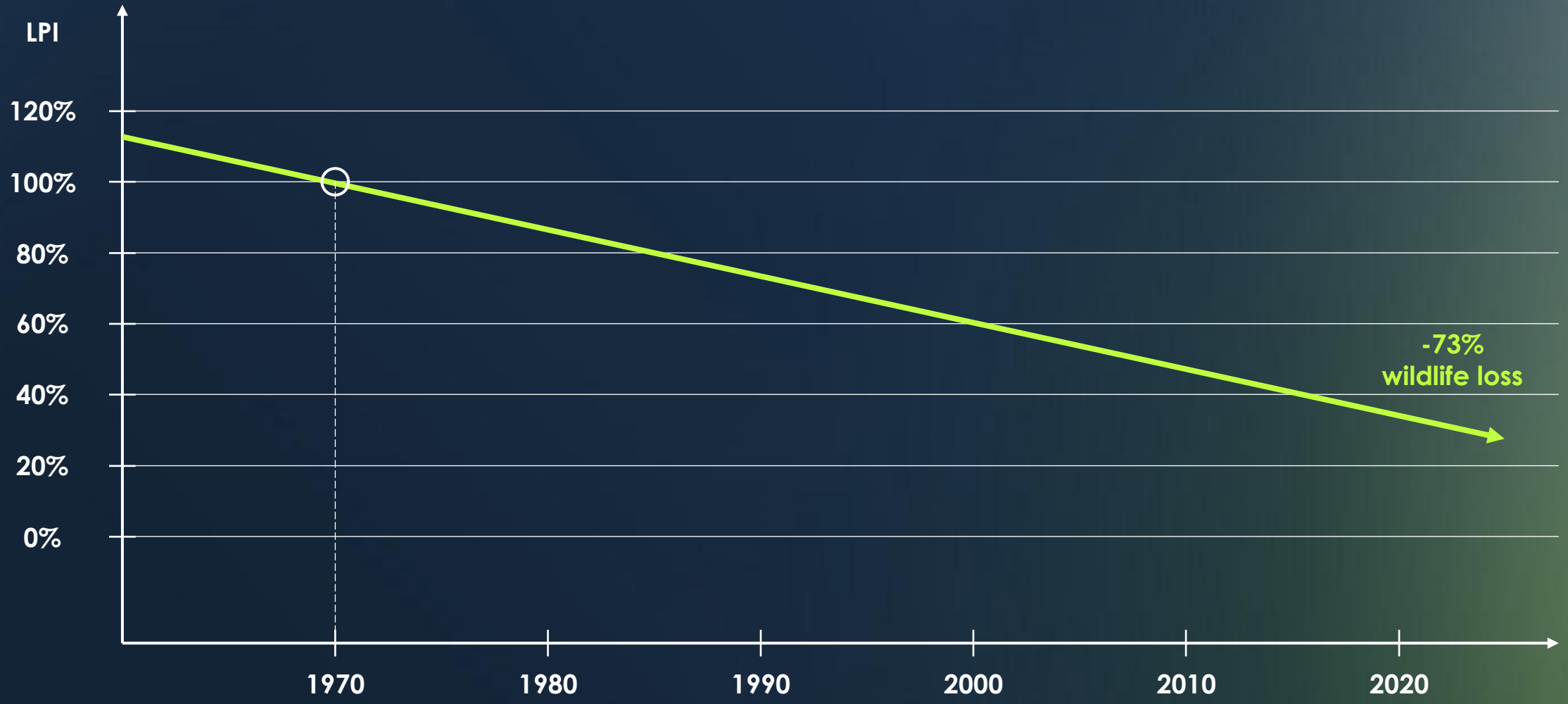
Sources: Reduction Roadmap. (2024). Beyond the Roadmap: A transition plan for the Danish building industry.
WEF. (2024). The Global Risks Report 2024.

1. Introduction | Earth's Resources & Systems



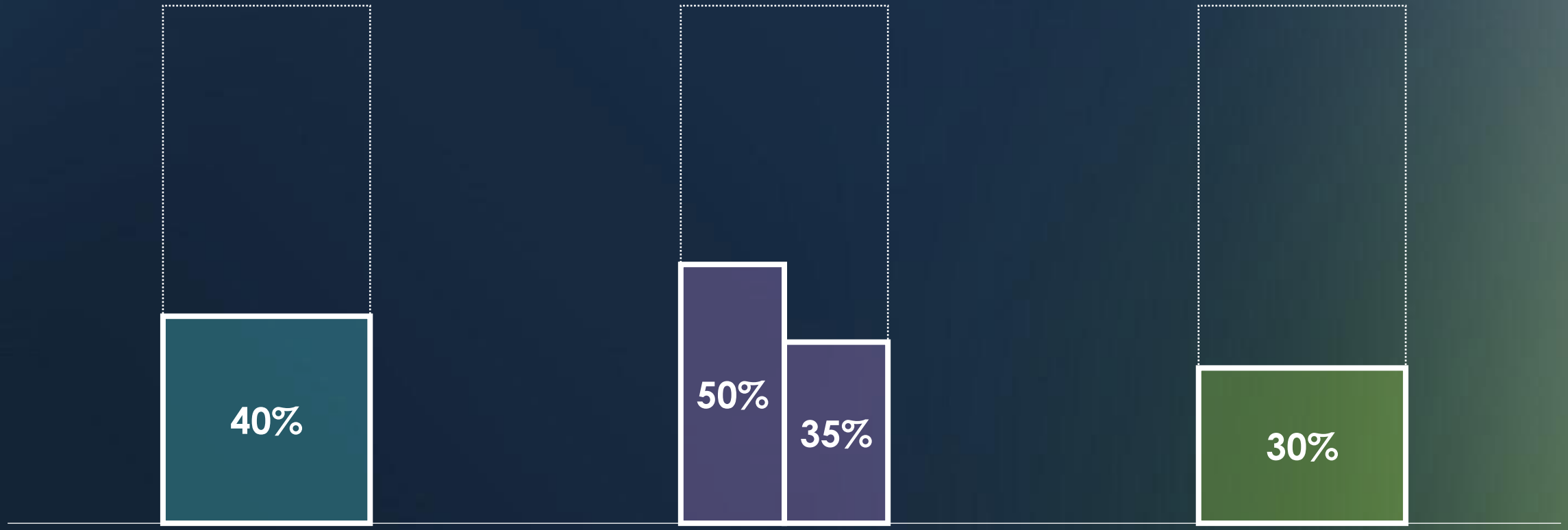
Source: UNEP. (2024). Global Resource Outlook 2024: Bend the Trend – Pathways to a liveable planet as resource use spikes.

1. Introduction | Living Planet Index



Source: WWF. (2024). Living Planet Report 2024.

1. Introduction | Environmental Impacts of the BE



climate impacts

40% of carbon emissions
40% of energy consumption

resource impacts

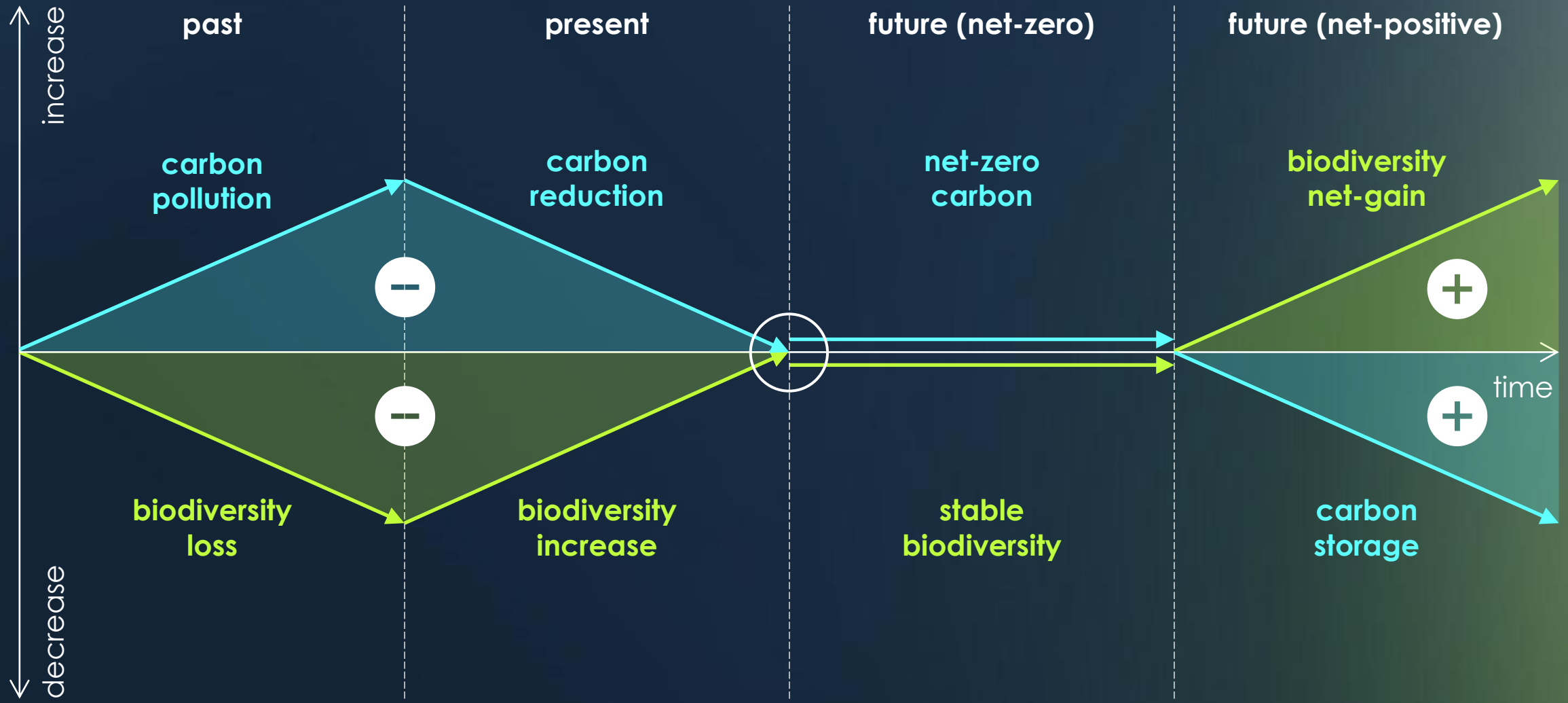
50% of resource consumption
35% of waste generation

nature impacts

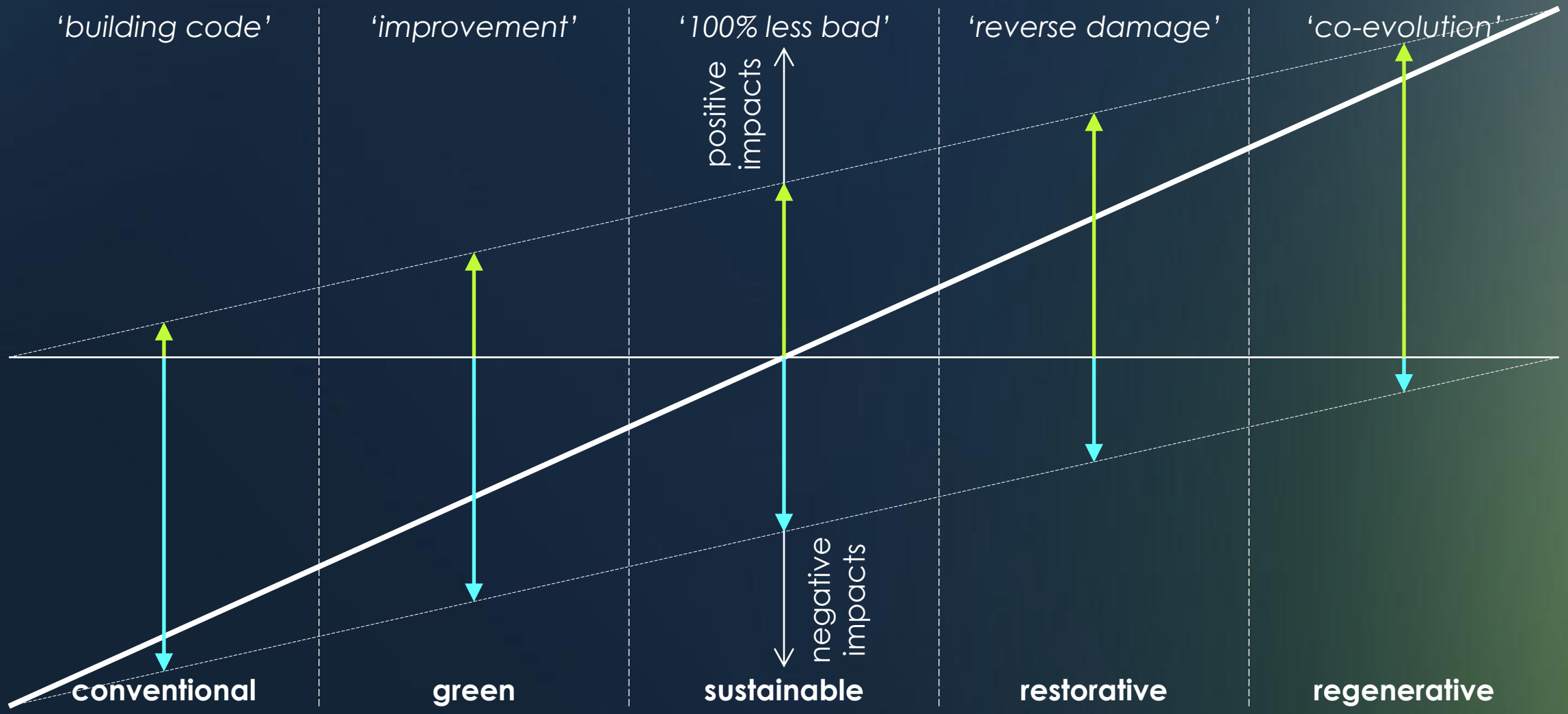
30% of nature loss

Source: European Commission. (2024). Buildings and construction. https://single-market-economy.ec.europa.eu/industry/sustainability/buildings-and-construction_en
WEF. (2020). The Future Of Nature And Business.

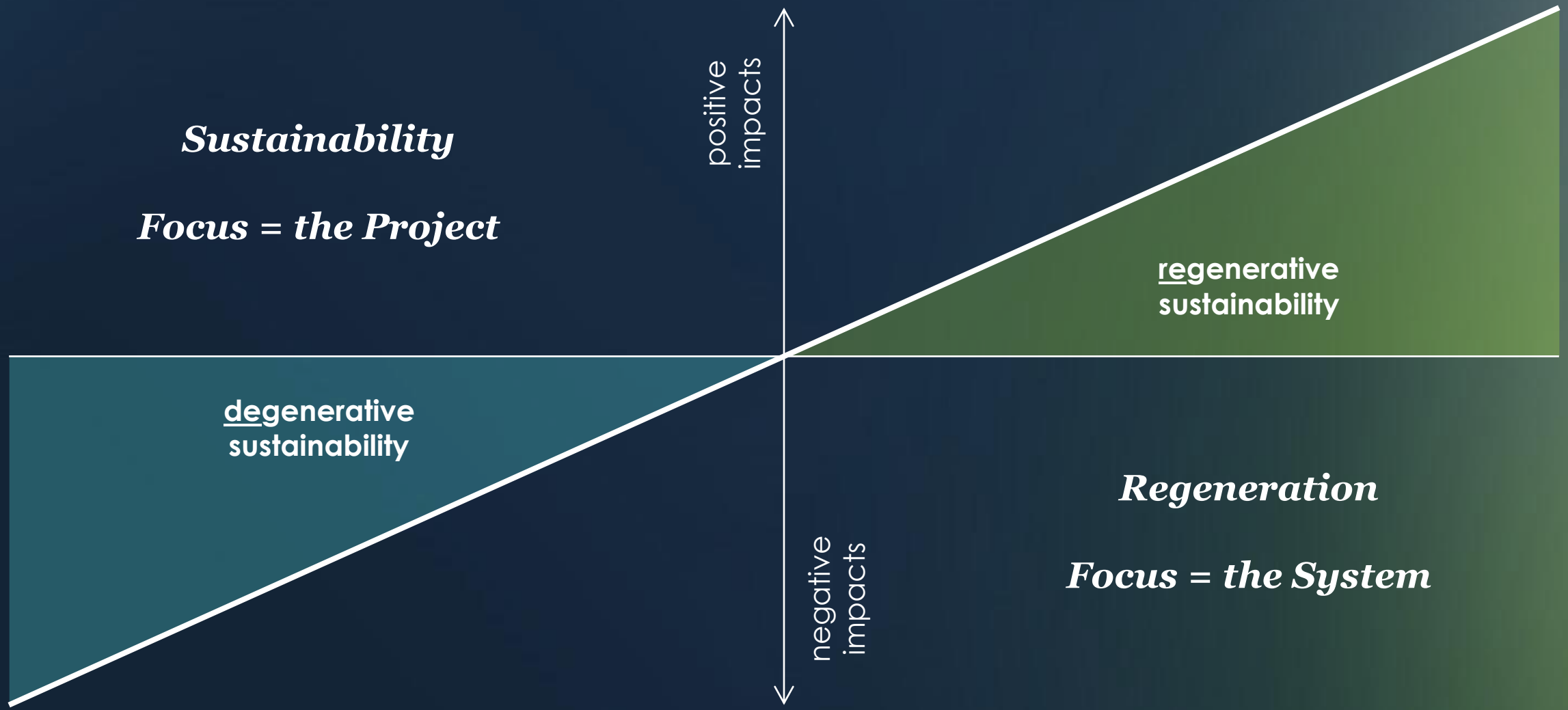
1. Introduction | Environmental Impacts of the BE



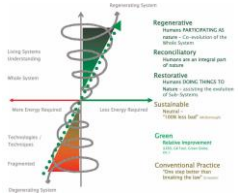
1. Introduction | Regeneration

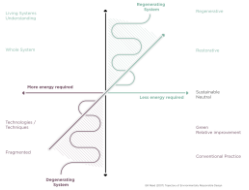


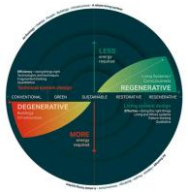
1. Introduction | Regeneration

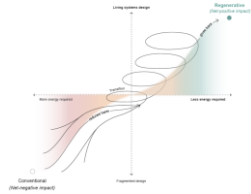


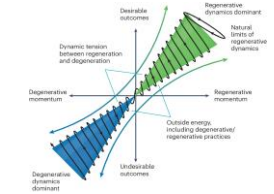
2. Theoretical Background | Definitions & Frameworks

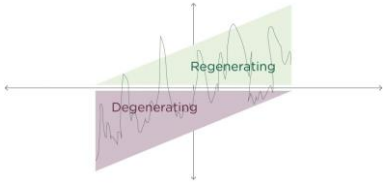


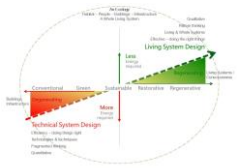


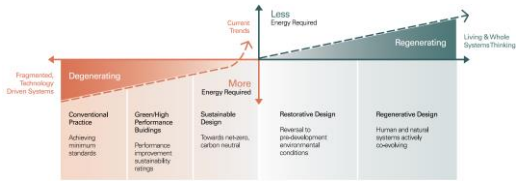


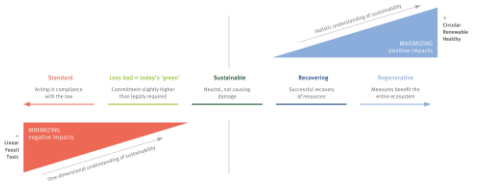


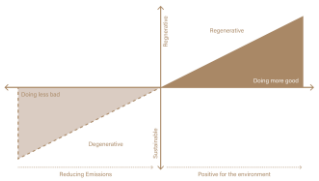


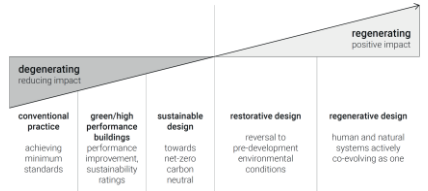


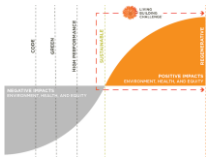


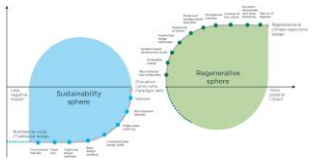


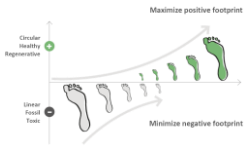


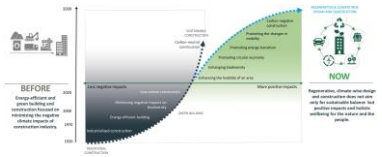


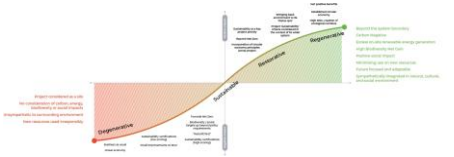




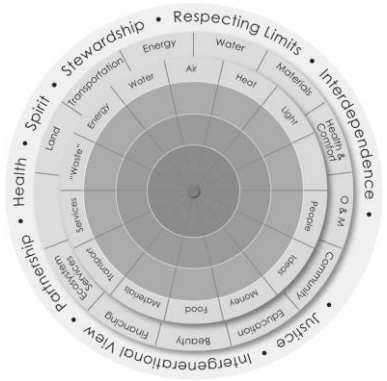


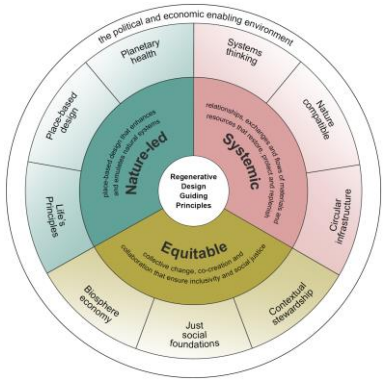


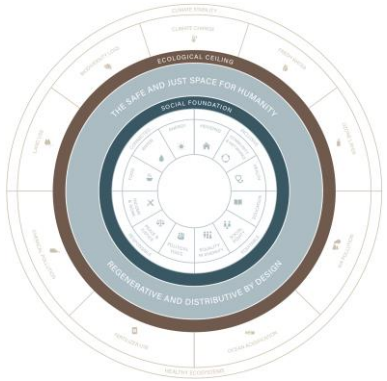


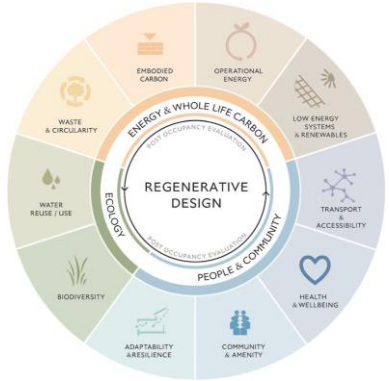


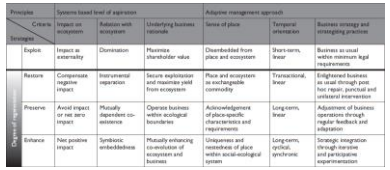
2. Theoretical Background | Principles

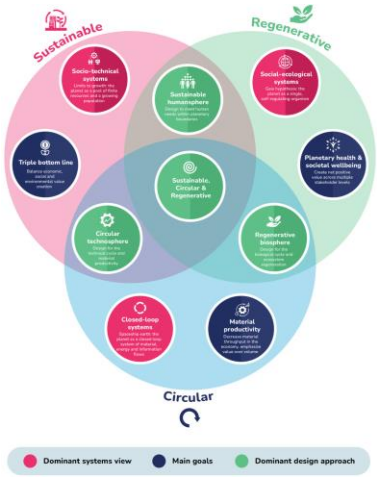


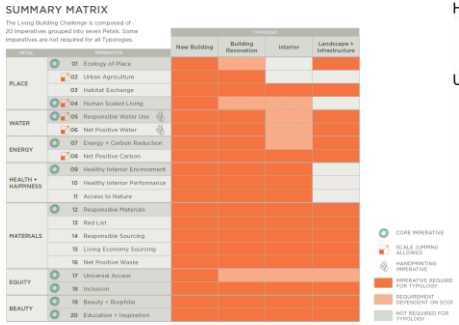


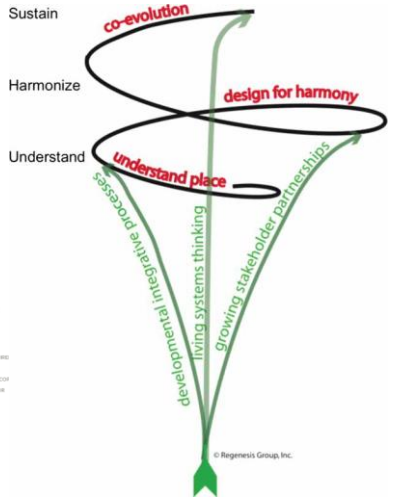








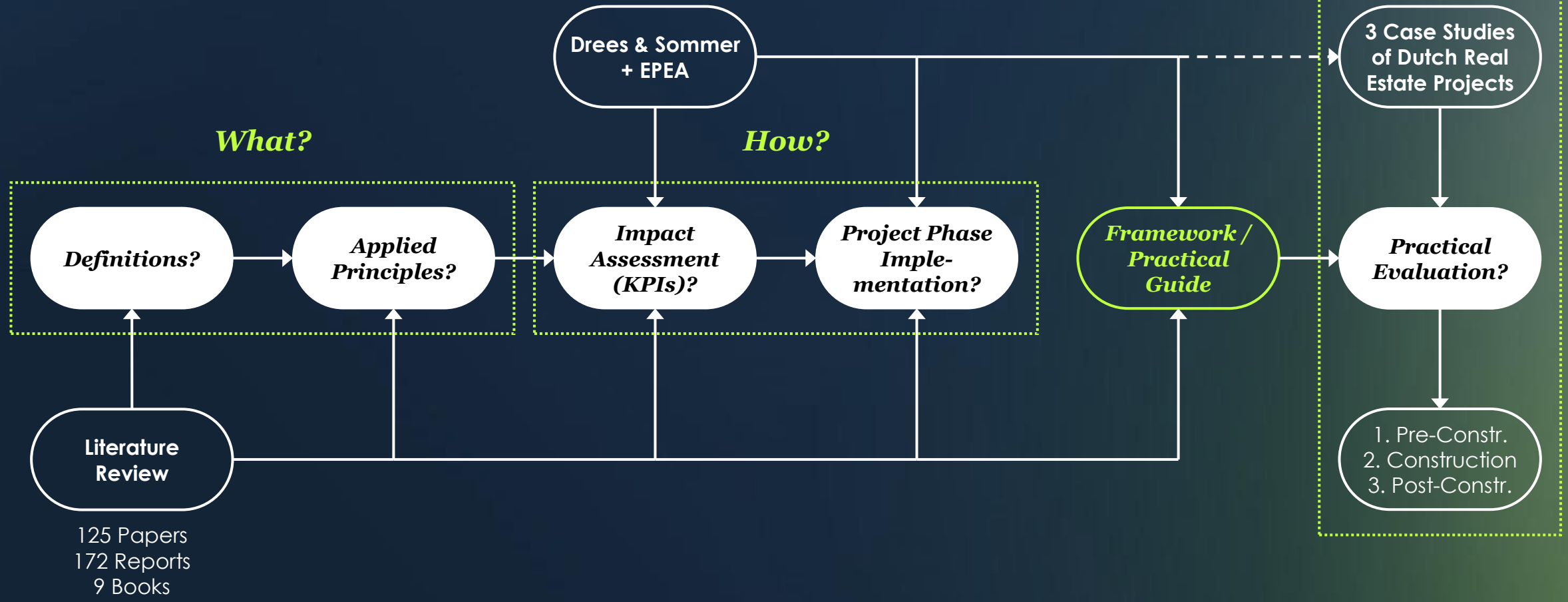




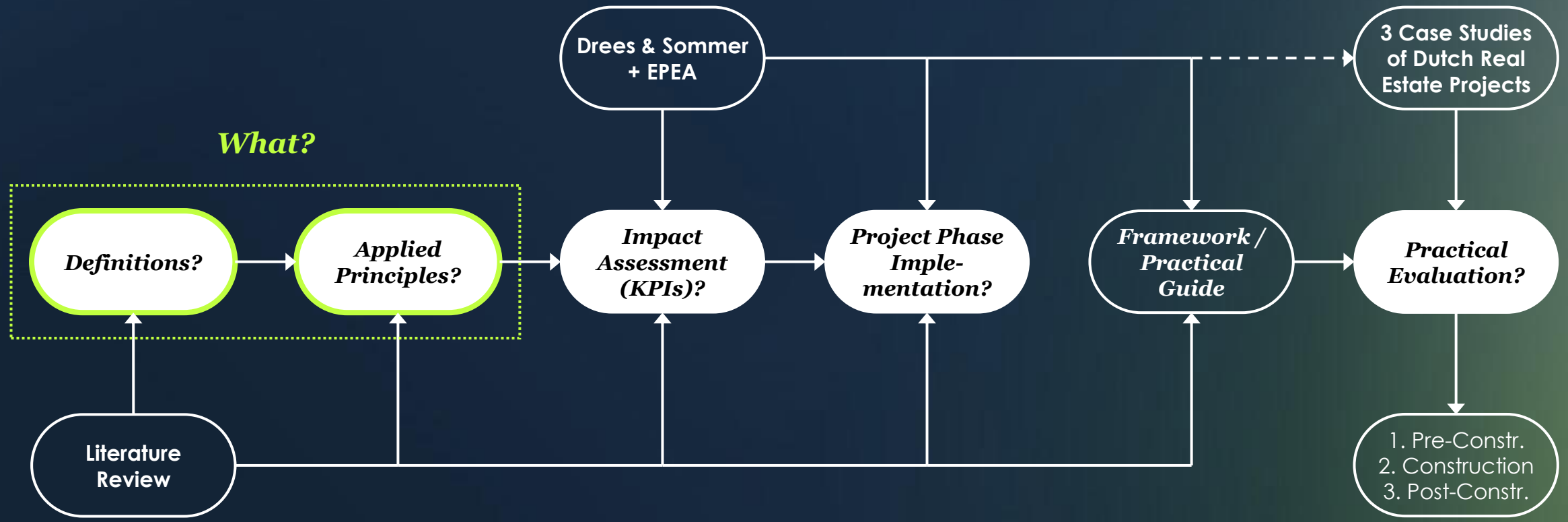
3. Methodology | Main Research Question

"How can a regenerative built environment
be defined, applied, assessed, implemented and evaluated
for real estate projects?"

3. Methodology



4. Results | What?



4. Results | SQ1 | Definitions (Summary)

Regeneration

The **mindset shift**

Regen. Sustainability

The **outcome**

Regen. Principles

The **activities**

Regenerative Design

The **creation**

→ 4 principles

Regen. Development

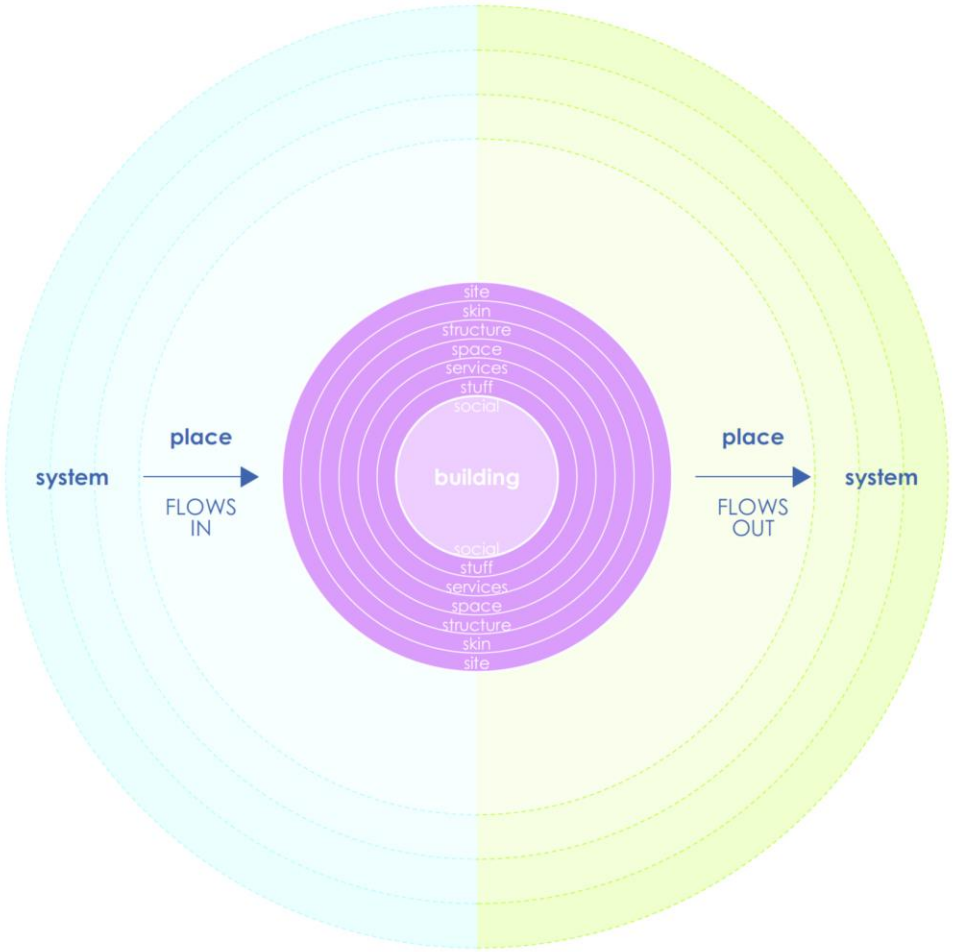
The **support**

→ 6 principles

Net-positive Impacts

The **evaluated outcomes**

Framework Step 1/6



4. Results | SQ2 | Regenerative Development Principles

Place-based

Systemic

Co-creation

Co-evolution

4. Results | SQ2 | Regenerative Development Principles

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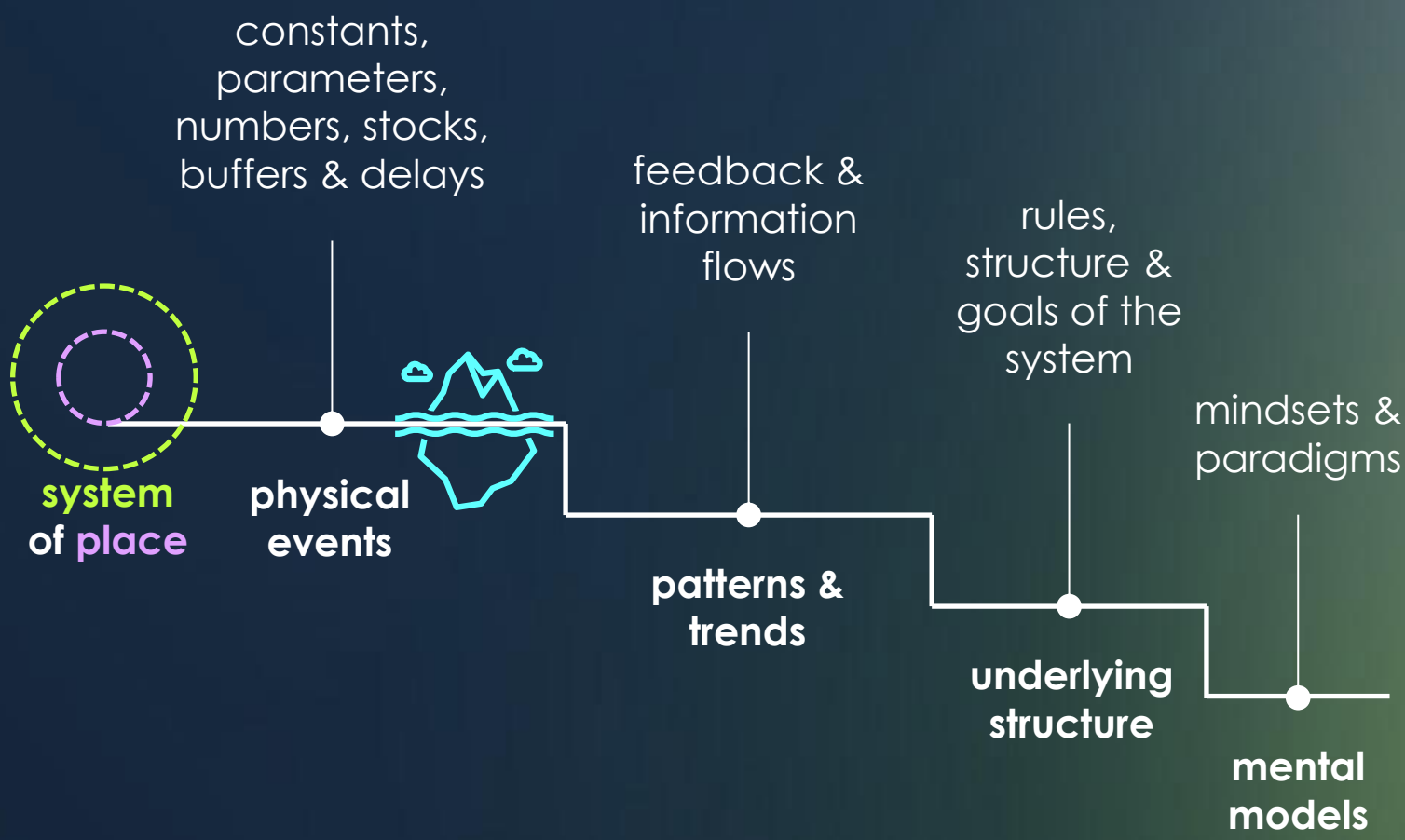
- *Place-based*
- *Systemic*
- *Co-creation*
- *Co-evolution*



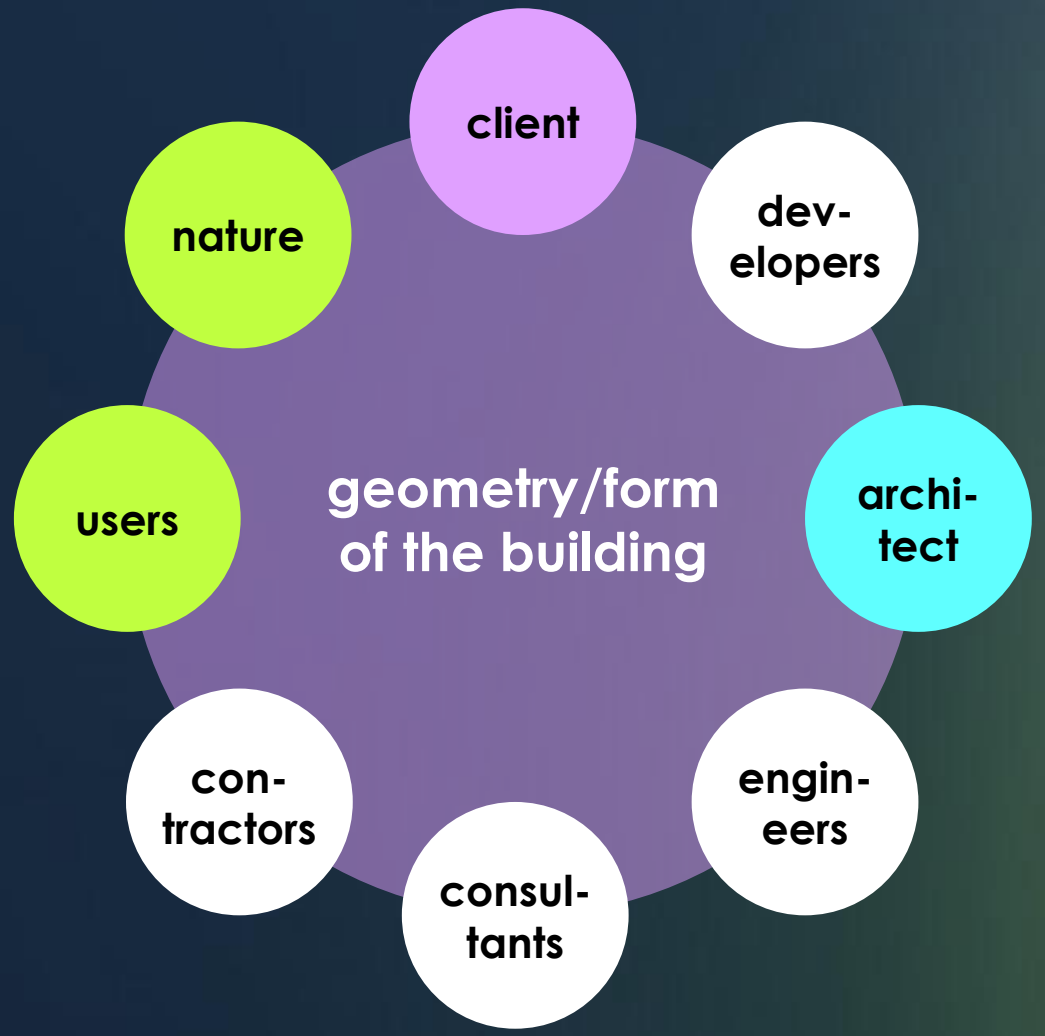
4. Results | SQ2 | Regenerative Development Principles

Place-based

Systemic

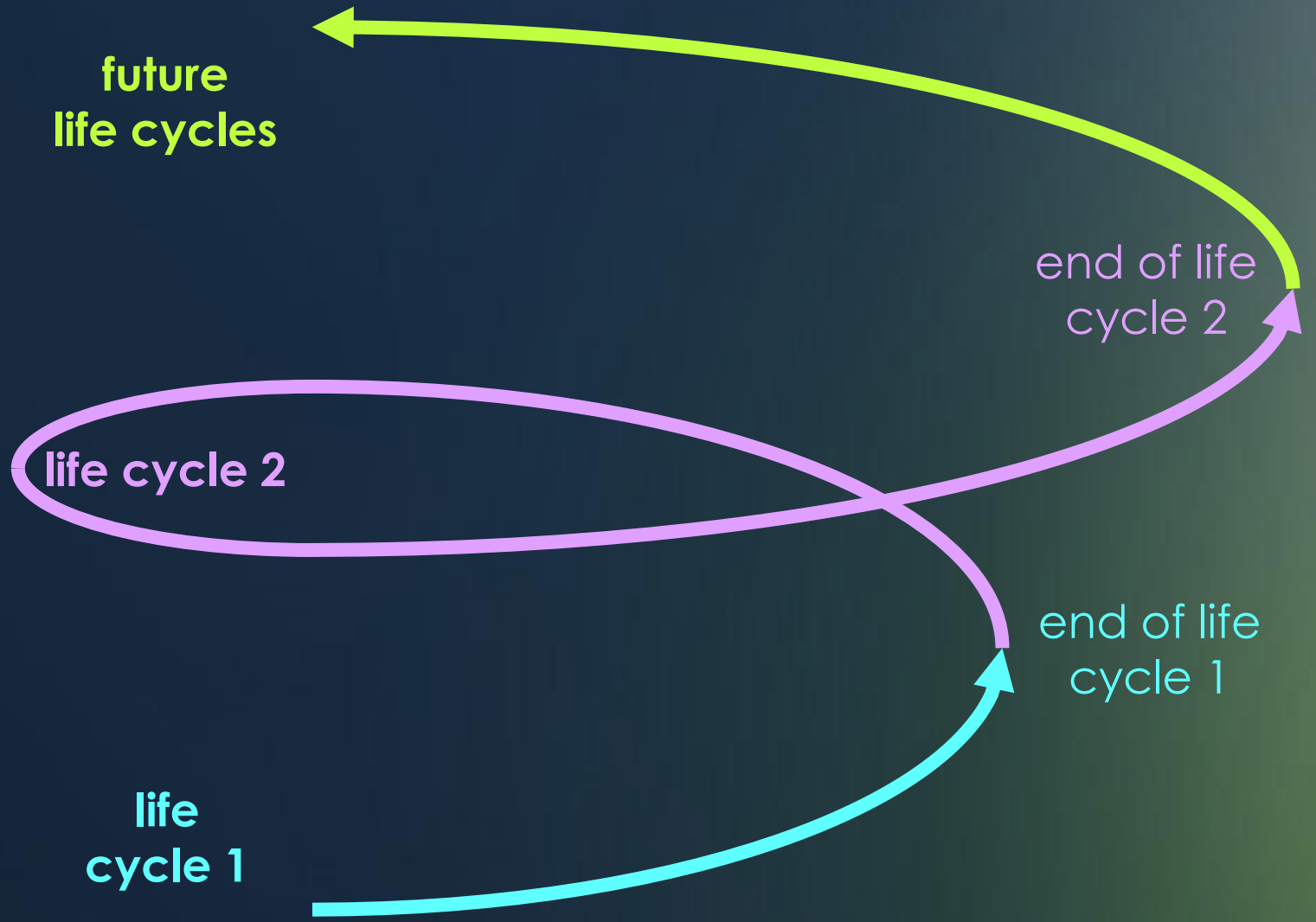
Co-creation

Co-evolution

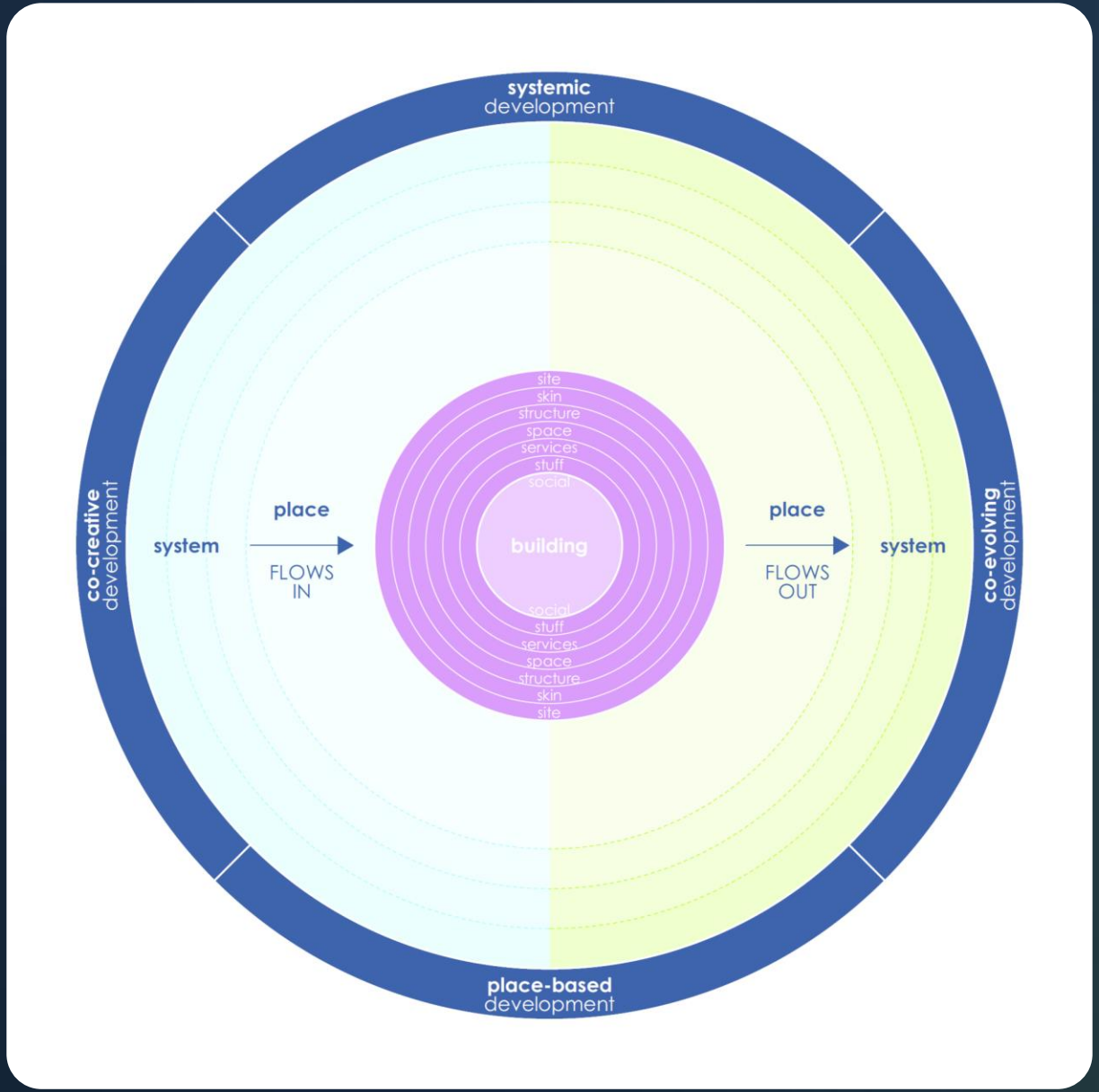


4. Results | SQ2 | Regenerative Development Principles

- *Place-based*
- *Systemic*
- *Co-creation*
- *Co-evolution*



Framework Step 2/6



4. Results | SQ2 | Global Regenerative Design Principles

- **G: Ecosystem Services**
- G: Circularity
- G: Net-positive Flows
- L: Healthy
- L: Bio-inspired
- L: Blue-green

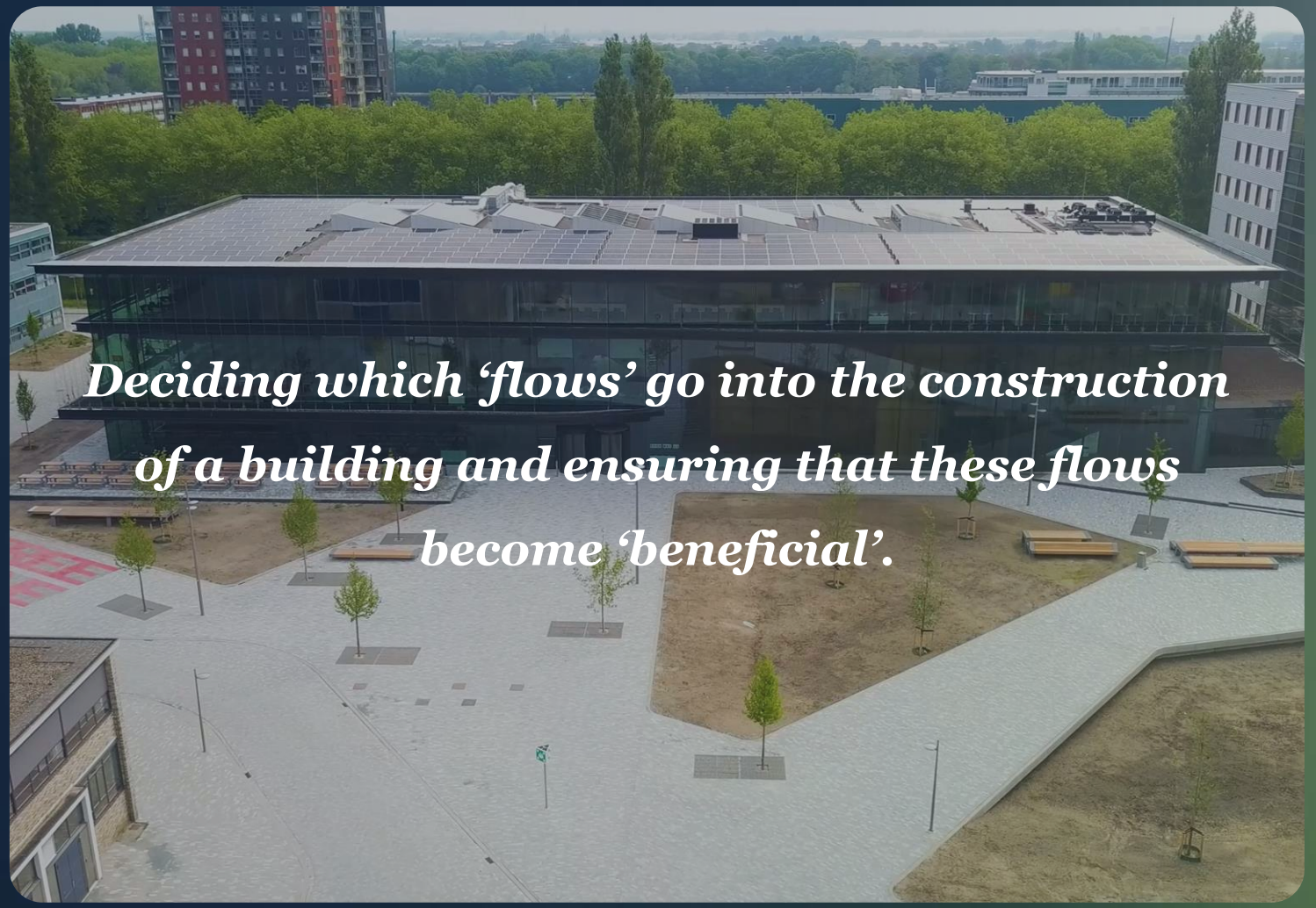
The benefits that humans gain from nature.

4. Results | SQ2 | Global Regenerative Design Principles

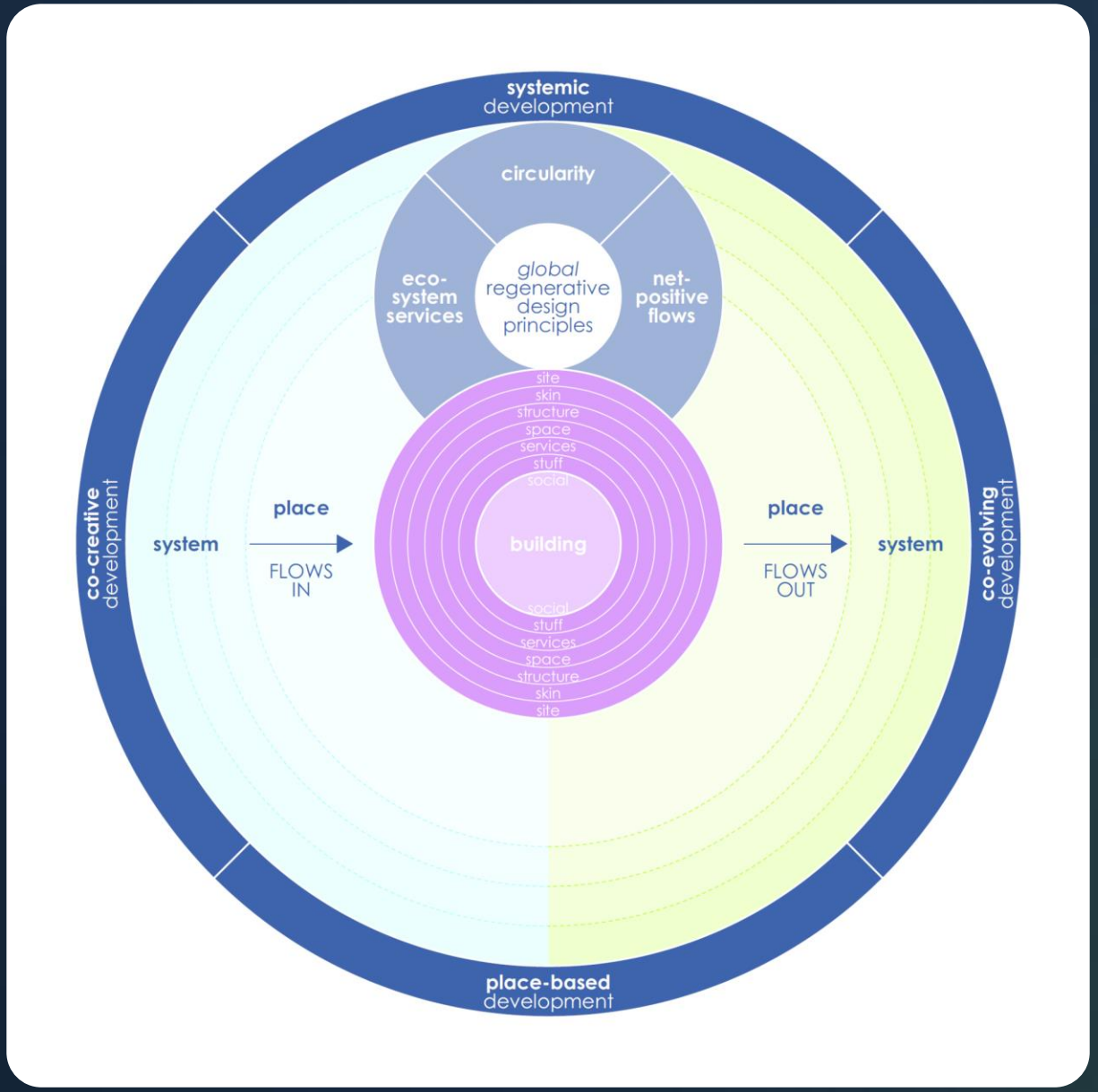
- G: Ecosystem Services
- **G: Circularity**
- G: Net-positive Flows
- L: Healthy
- L: Bio-inspired
- L: Blue-green

4. Results | SQ2 | Global Regenerative Design Principles

- G: Ecosystem Services
- G: Circularity
- **G: Net-positive Flows**
- L: Healthy
- L: Bio-inspired
- L: Blue-green



Framework Step 3/6



4. Results | SQ2 | Local Regenerative Design Principles

- G: Ecosystem Services
- G: Circularity
- G: Net-positive Flows
- **L: Healthy** (Human)
- L: Bio-inspired
- L: Blue-green

4. Results | SQ2 | Local Regenerative Design Principles

- G: Ecosystem Services
- G: Circularity
- G: Net-positive Flows
- L: Healthy
- **L: Bio-inspired** (Building)
- L: Blue-green

4. Results | SQ2 | Local Regenerative Design Principles

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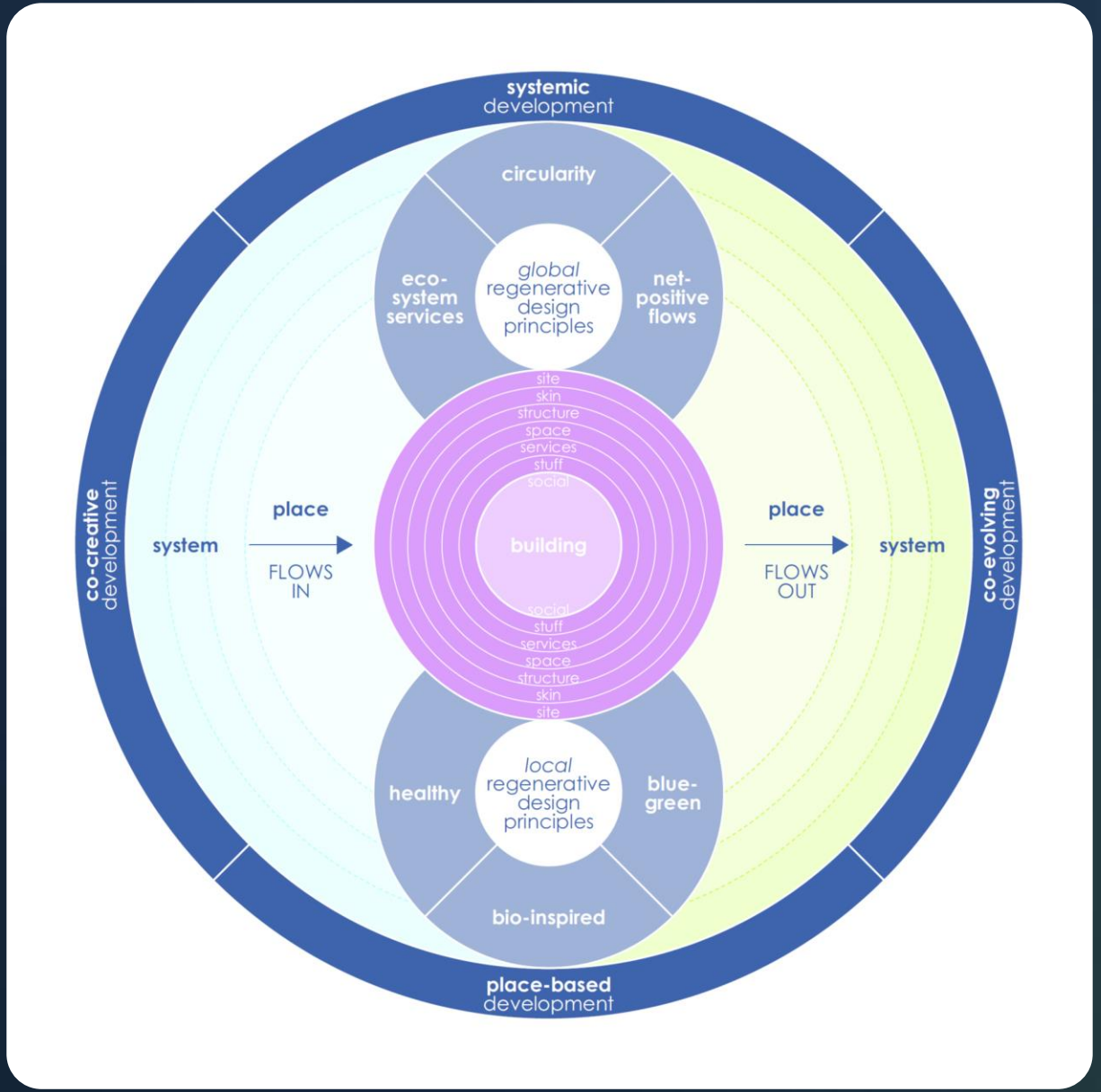
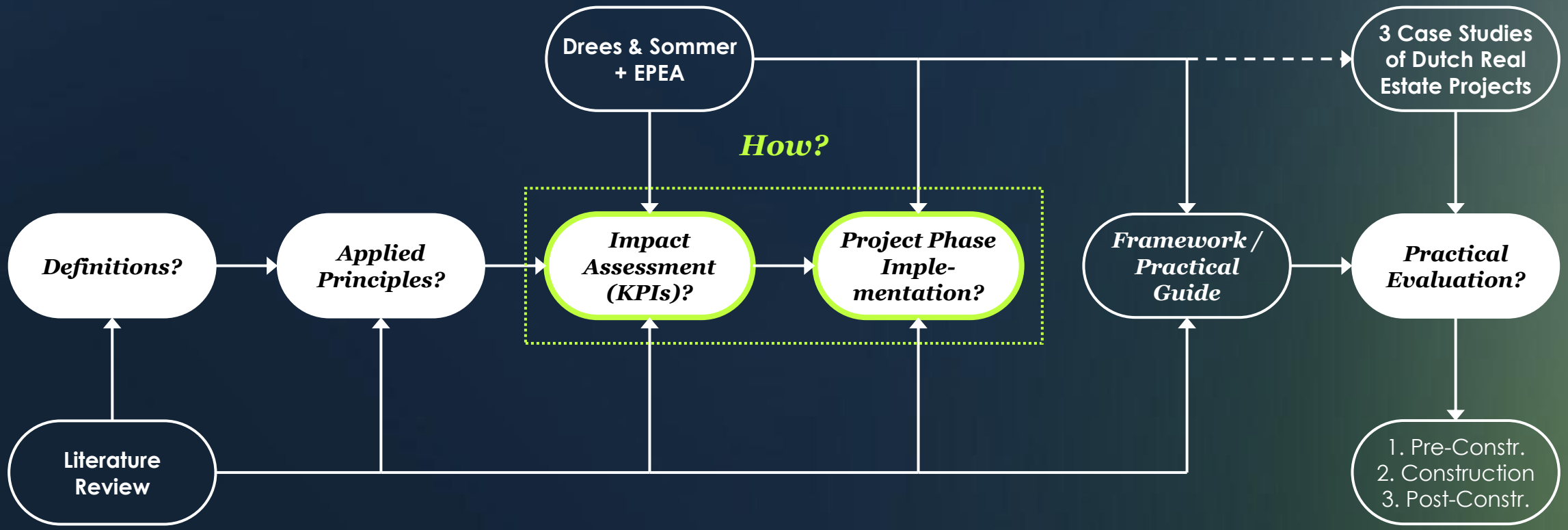
- *G: Ecosystem Services*
- *G: Circularity*
- *G: Net-positive Flows*
- *L: Healthy*
- *L: Bio-inspired*
- ***L: Blue-green*** (Infrastructure)

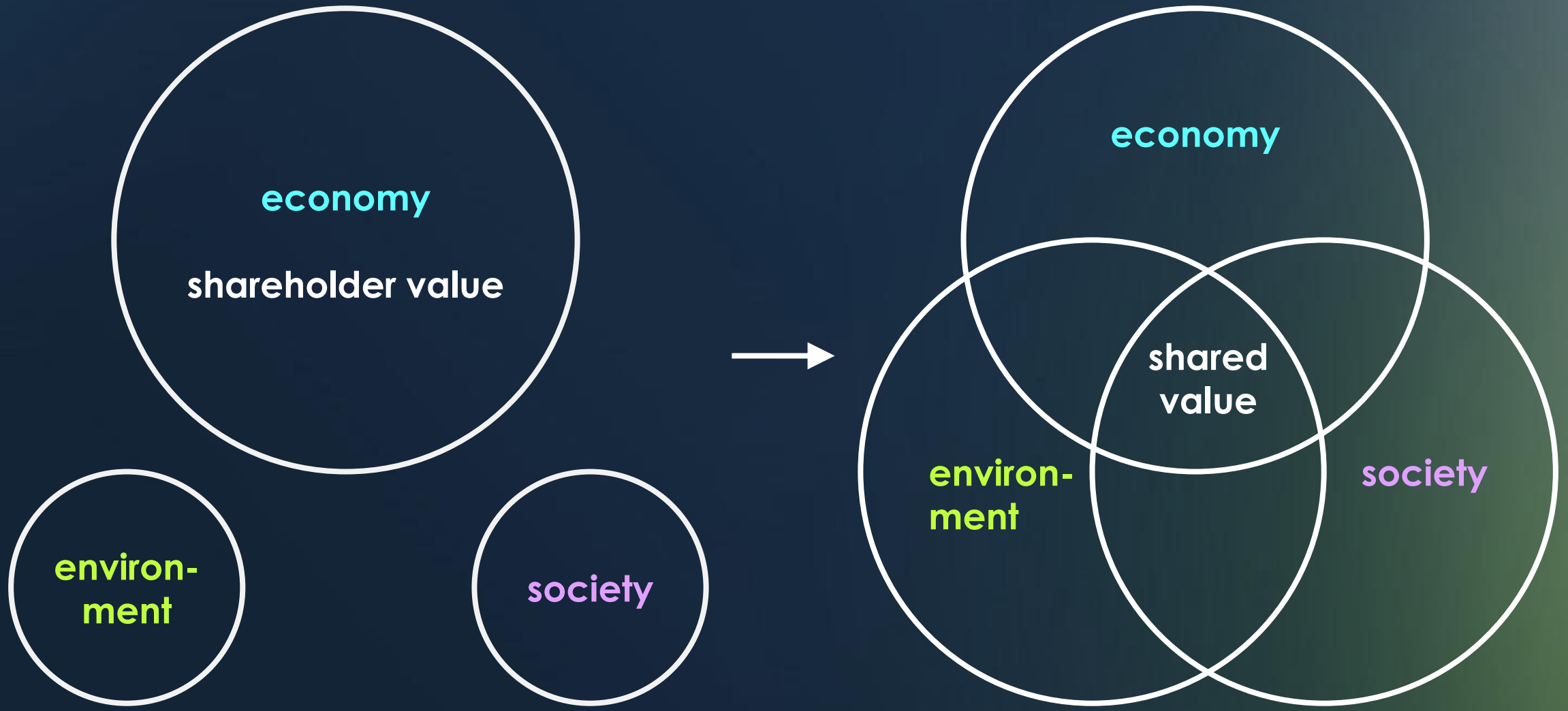
Framework Step 4/6



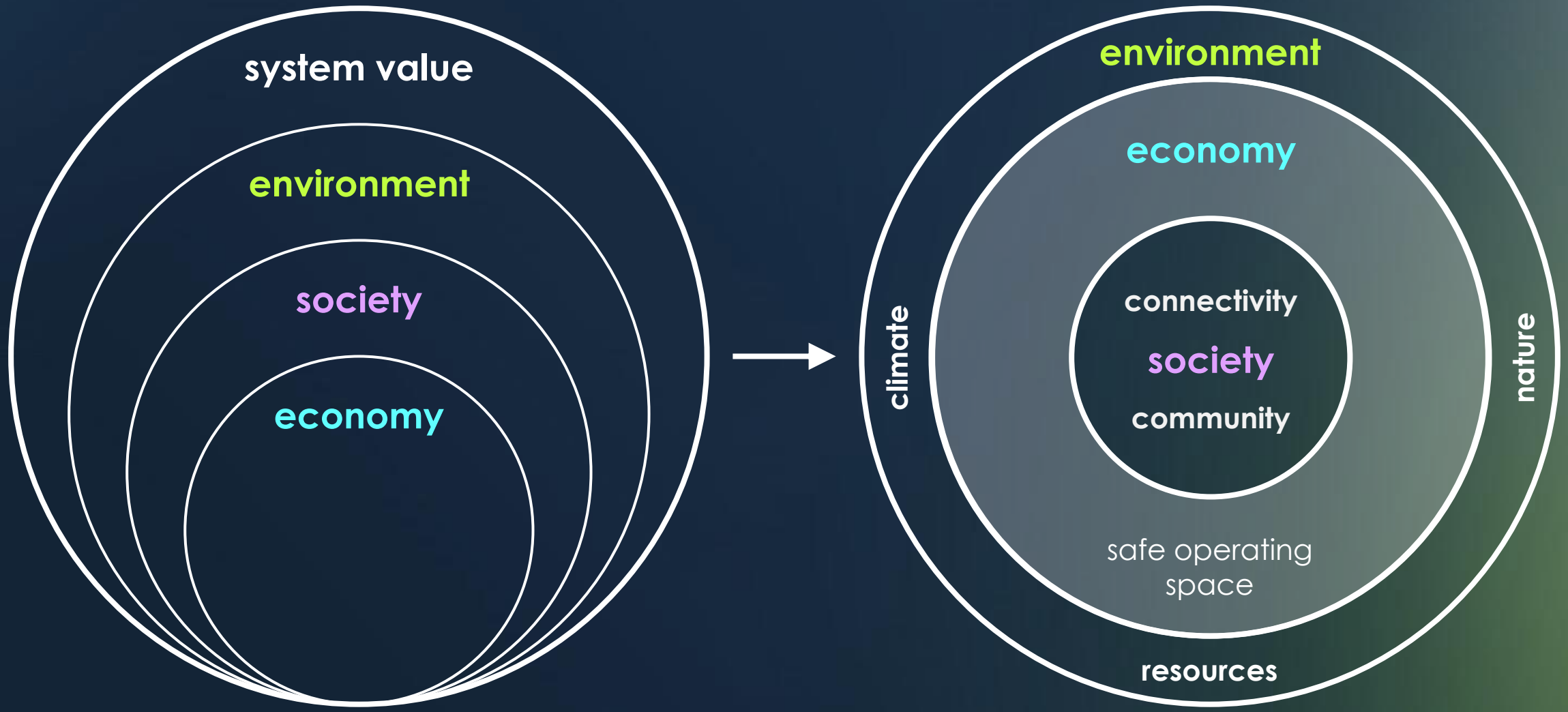
4. Results | How?



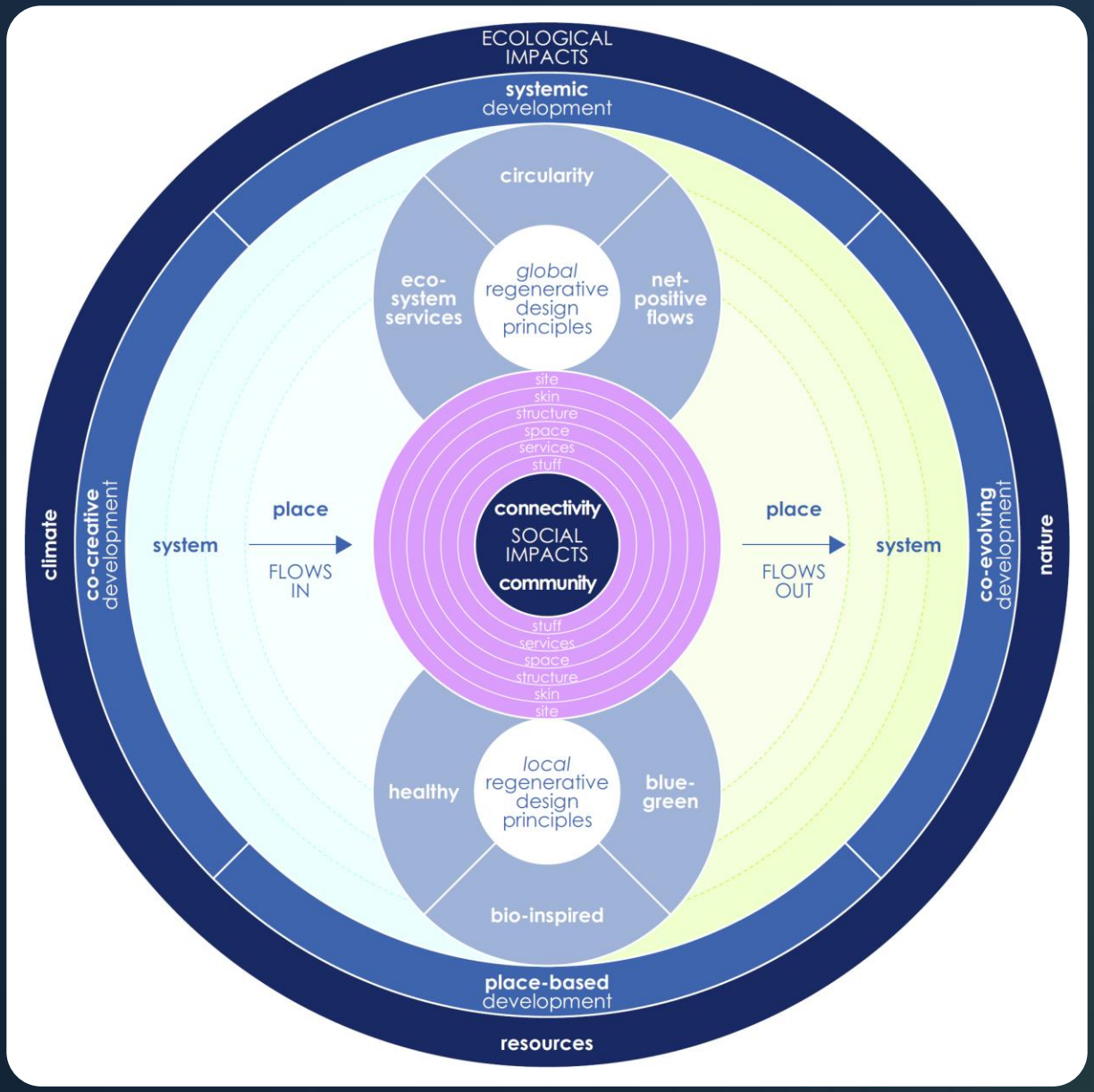
4. Results | SQ 3 | Impact Assessment



4. Results | SQ 3 | Impact Assessment



Framework Step 5/6



4. Results | SQ 4 | Project Phase Implementation

pre-construction phases

(de)**construction phase**

post-construction phases

Results | SQ 3+4 | Assessment and Implementation

investor

"I want to invest for long-term profits. I want to create a regenerative building."

"I need KPIs for the project."

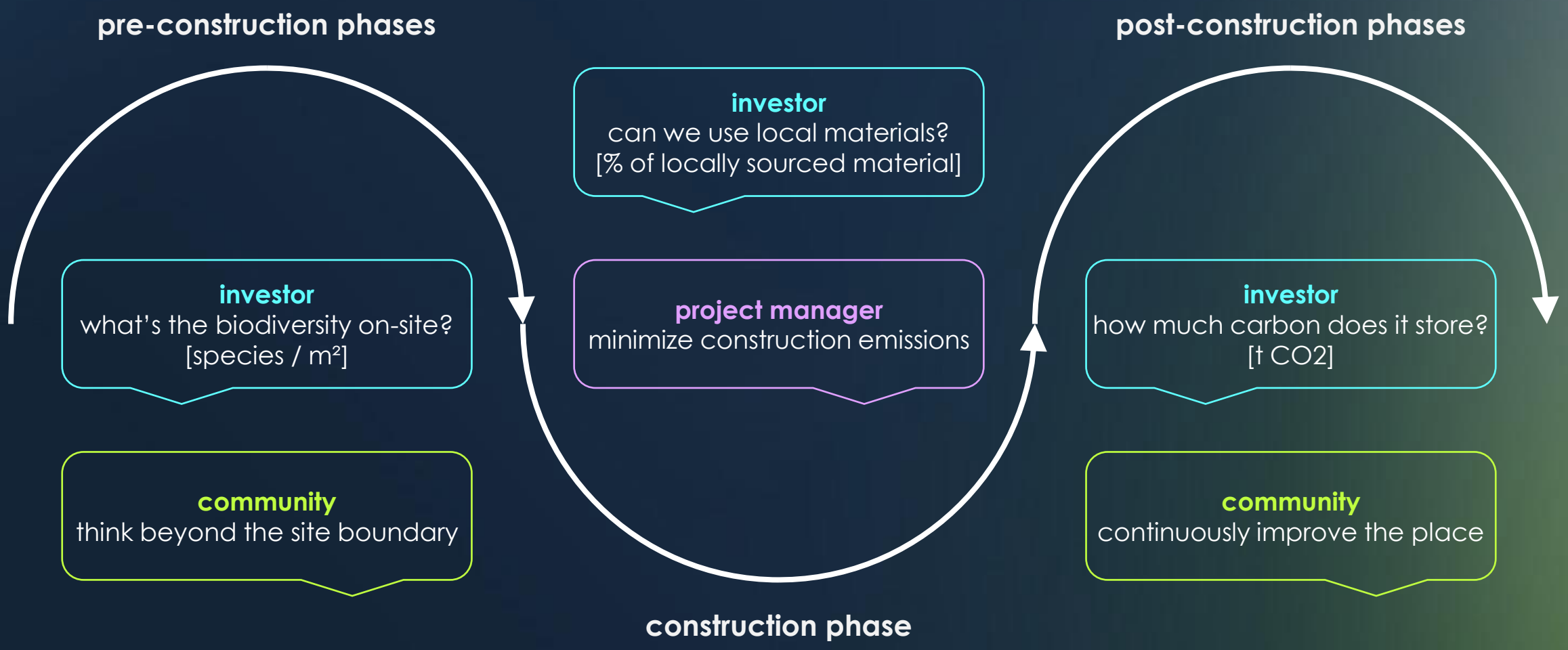
project manager

"I will make sure that your regenerative building gets built, but to do that we need to rethink our conventional practice."

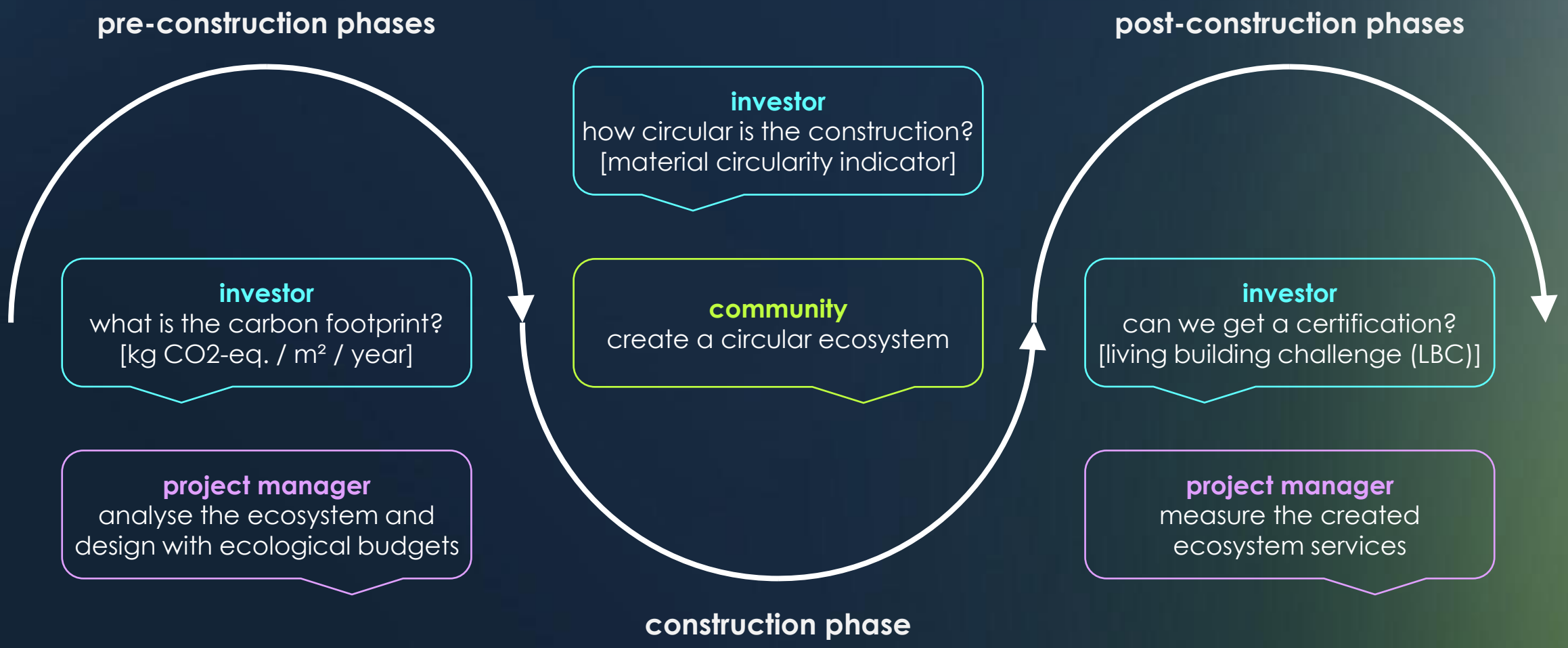
community

"I will be using this building in the future. I want to be involved in the creation of it."

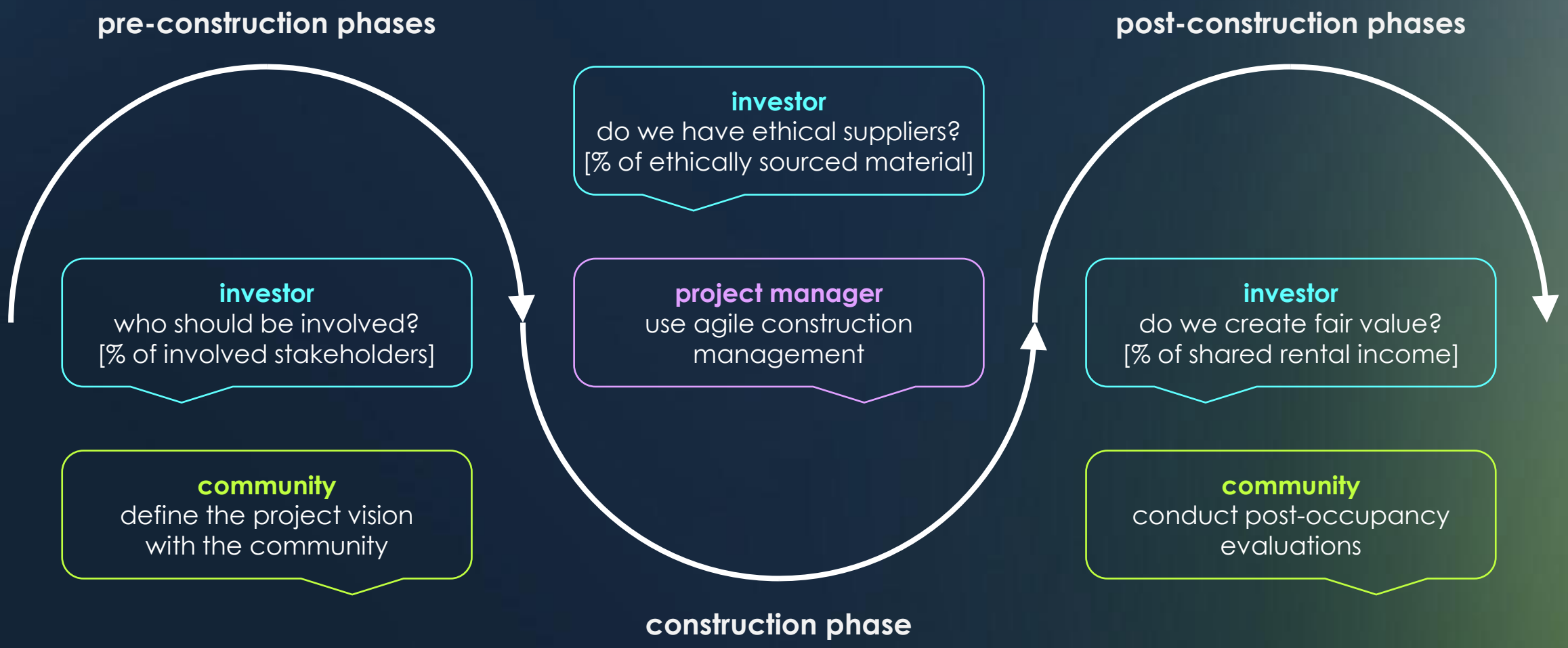
4. Results | SQ 3+4 | Assess & Implement Place-based



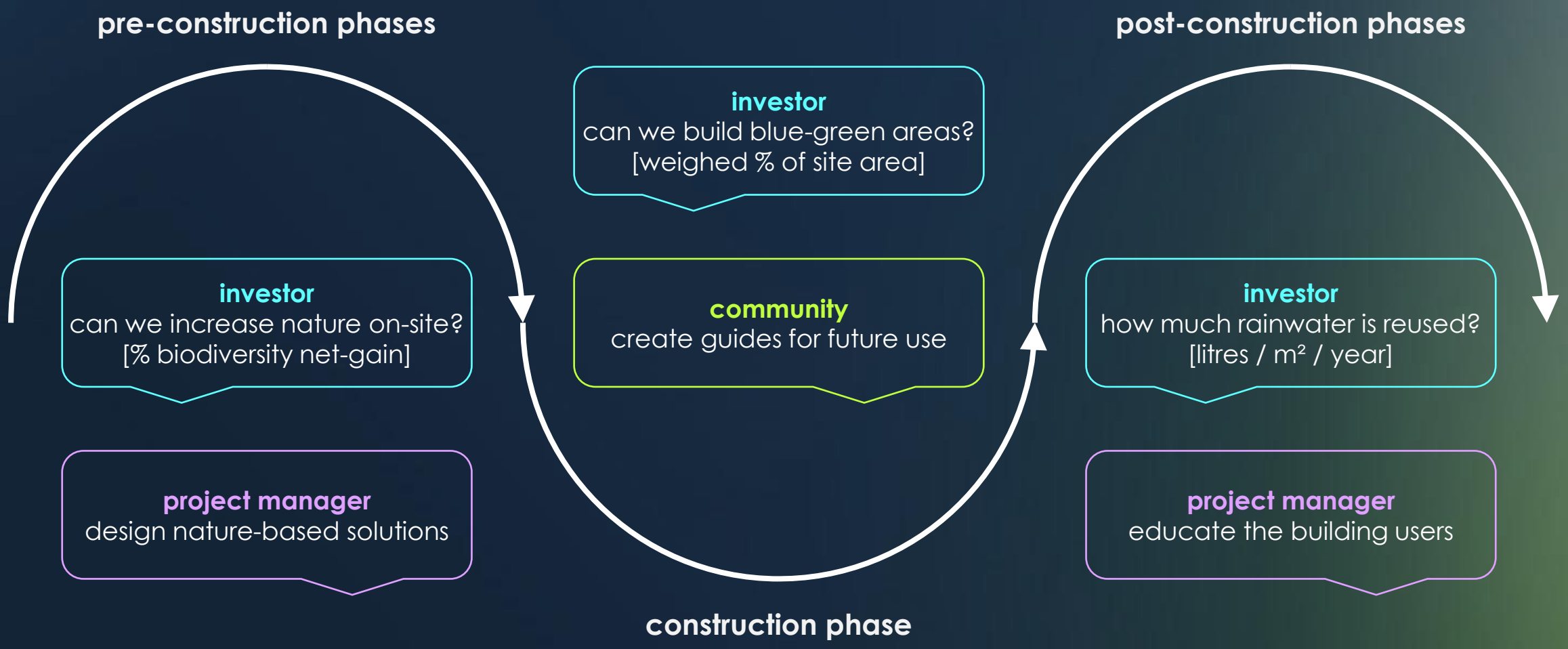
4. Results | SQ 3+4 | Assess & Implement Systemic



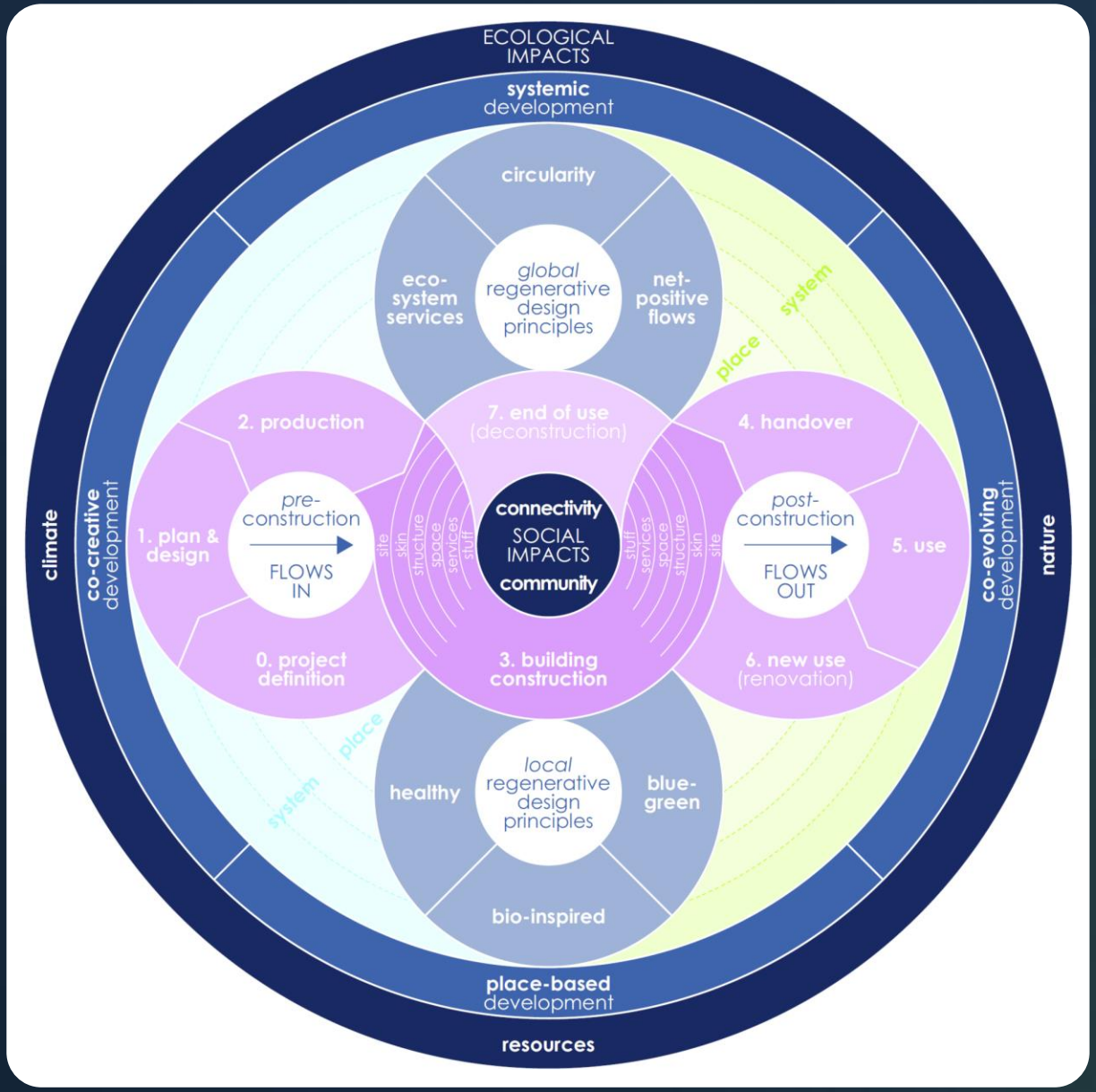
4. Results | SQ 3+4 | Assess & Implement Co-creative



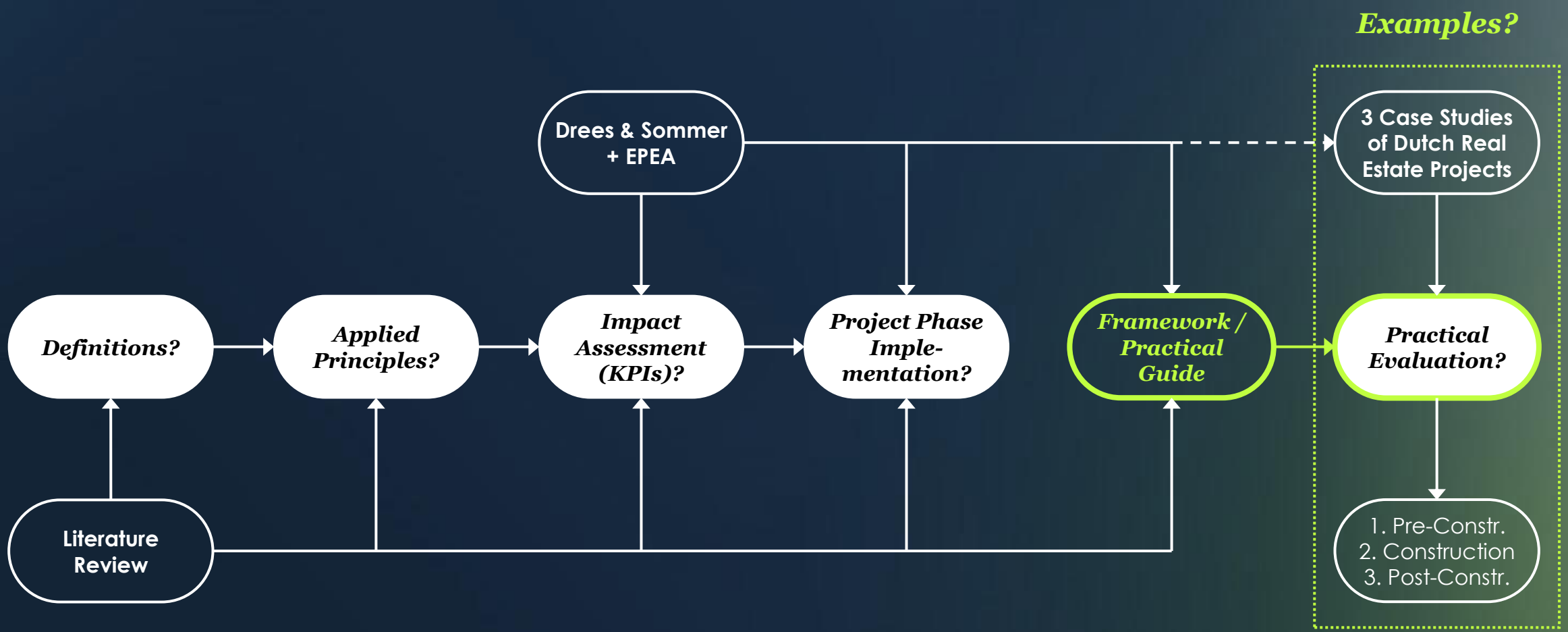
4. Results | SQ 3+4 | Assess & Implement Co-evolving



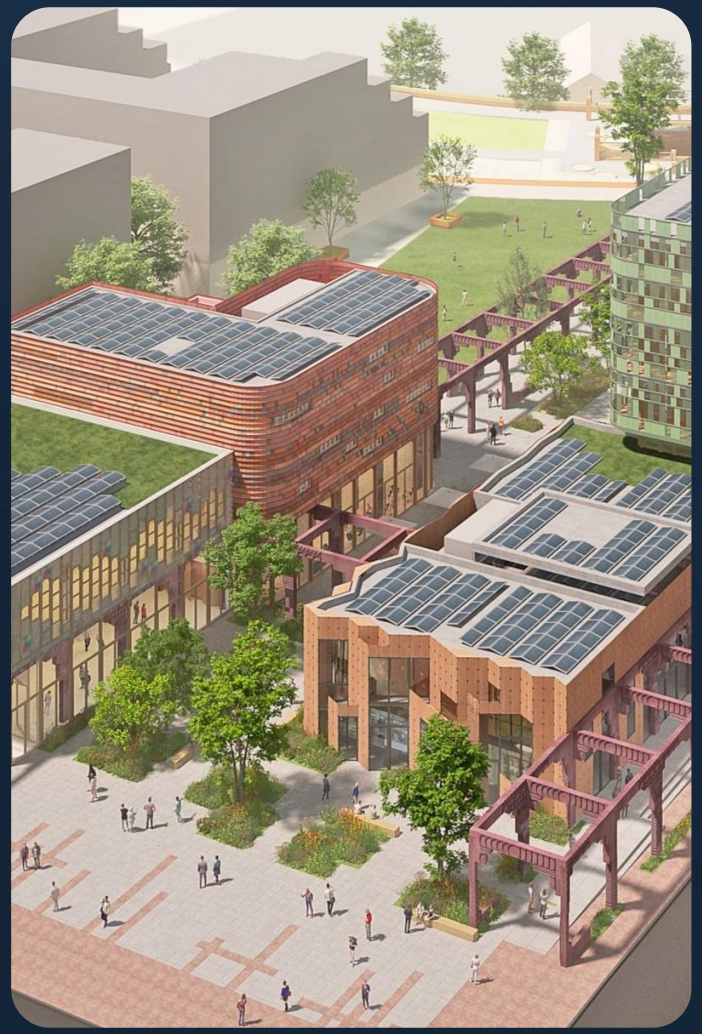
Framework Step 6/6

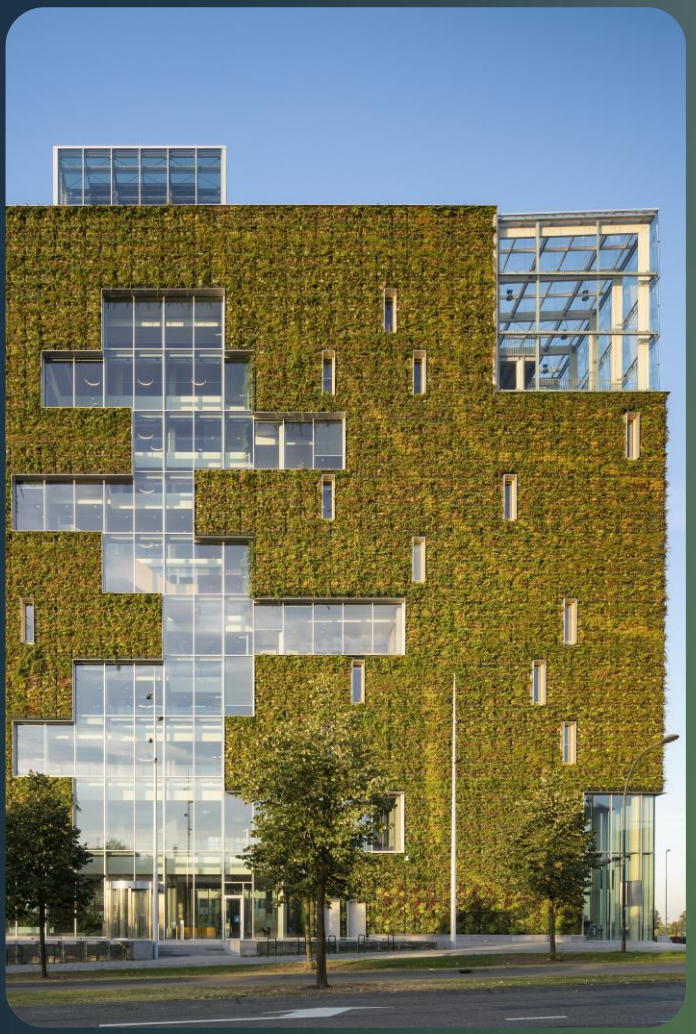


4. Results | Examples?

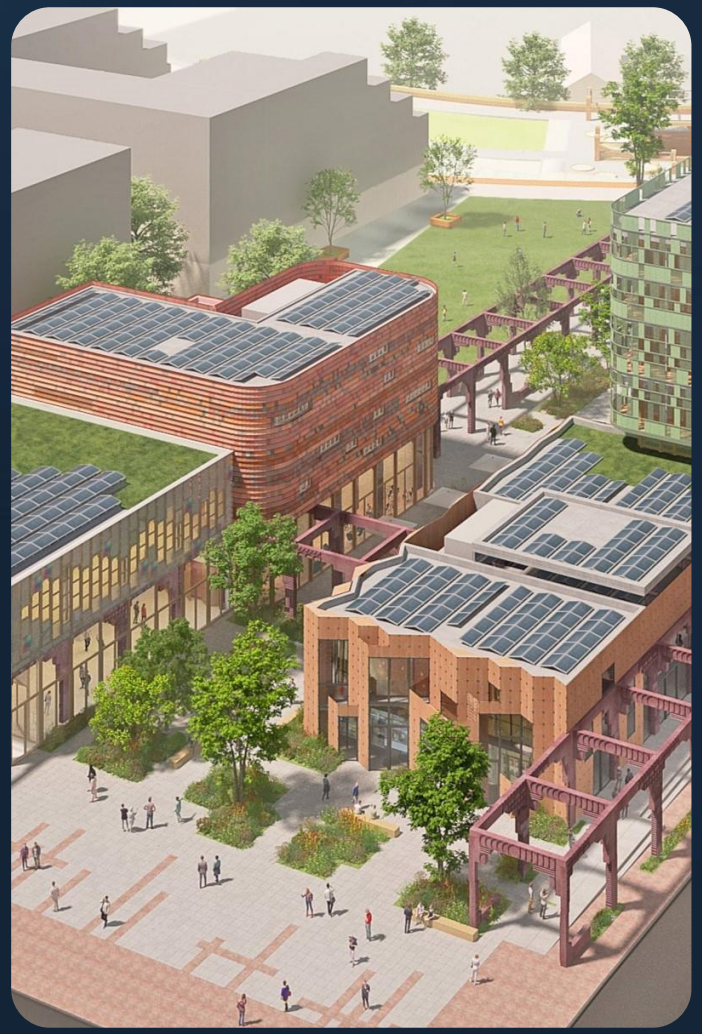


4. Results | Main RQ | Evaluation – Case Studies





4. Results | Main RQ | Evaluation – Berlijnplein



Pre-Construction Phase | Focus on Development Principles

Place-based Development

→ focus on the place's identity | "form follows ambition"

Systemic Development

→ circularity | extending the S-Layers model beyond the building

Co-creative Development

→ co-creation sessions among the "square-mates"

Co-evolving Development

→ enabling transformation over the life cycle

4. Results | Main RQ | Evaluation – Natuurhuis

Construction Phase | Focus on Design Principles

G: Ecosystem Services
→ temp. regulation through passive design | rainwater storage

G: Circularity
→ prefabricated modular building elements | disassembly

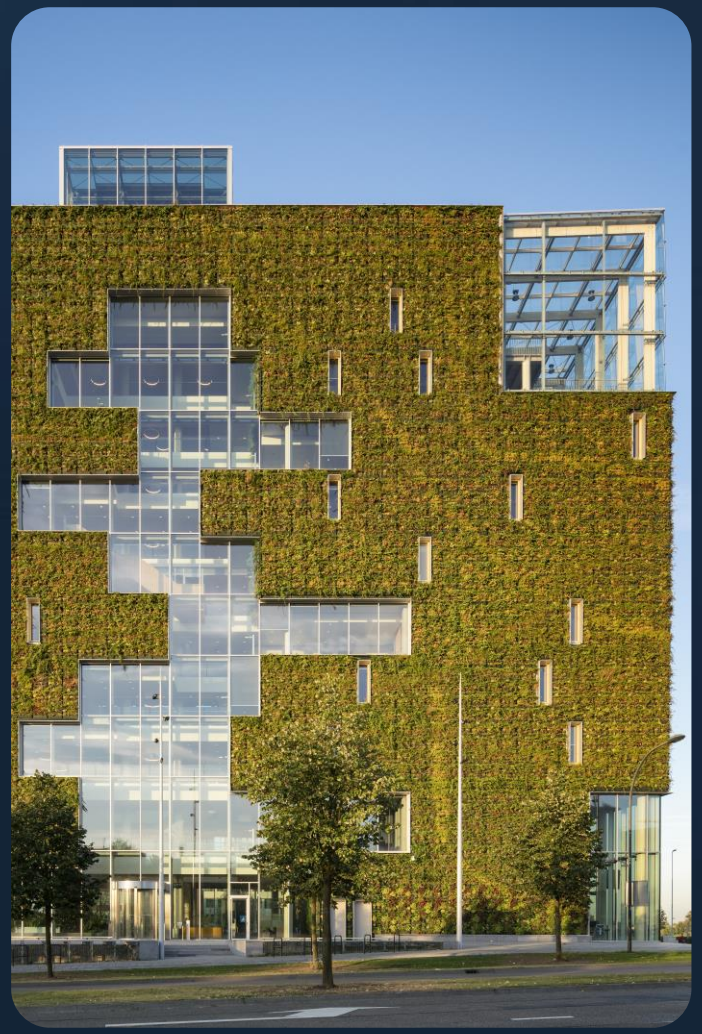
G: Net-positive Flows
→ own energy generation (10% extra) | 90t CO_2 captured

L: Healthy
→ focus on healthy materials | access to nature-inclusive gardens

L: Bio-inspired
→ bio-based materials | human-nature connections

L: Blue-green
→ green roofs & facades

4. Results | Main RQ | Evaluation – Stadskantoor



Post-Construction Phase | Focus on Impacts

Green (less bad impacts)
→ 30% less nitrogen and sulfur oxide emissions
→ 169t CO2 avoided annually
→ 50 – 60 % own energy generation

Sustainable (net-zero impacts)
→ thermal flows without technical ventilation
→ passive shading
→ 80% demountable building

Restorative/Regenerative (net-positive impacts)
→ -1,5°C reduced urban heat island effect
→ purified air within a 500m radius
→ >100 flora and fauna species
→ 42% reduced sick building syndrome and 2% less sick leave
→ extra investment of 3,4M€ saves 17M€ over 40 years

5. Discussion (Part 1/2)

Contributions

Six clear definitions

Ten regenerative principles
- 4 development principles
- 3 global design principles
- 3 local design principles

Five main impact categories
- local/global KPIs

Life cycle implementation
- 4 main project periods

Project evaluation from a regenerative perspective

Interpretations

Buzzword?

Overlaps between principles

Circularity vs. regeneration

Bio-based materials in NL

New vs. historical knowledge

Implications

Strategic relevance

Current economic system

Short-term vs. long-term

Build nothing vs. building as a catalyst of positive change

5. Discussion (Part 2/2)

Limitations

Explorative approach

Sources

Graduation internship

Framework simplification

Generalizing from cases

Lack of existing data

Focus on real estate

Recommendations

Criticise the definitions & FW

Research aspects in detail

Implement the topic into curriculums

Practically apply framework

Challenge industry mindsets

Incentivize regeneration

Be aware that not every-thing can be implemented

Future Research

What does a regenerative building look like?

Beneficial ecosystem of regen. buildings in cities?

Innovative technologies & materials for regeneration?

Barriers and enablers?

Regen. business case?

Knowledge sharing?

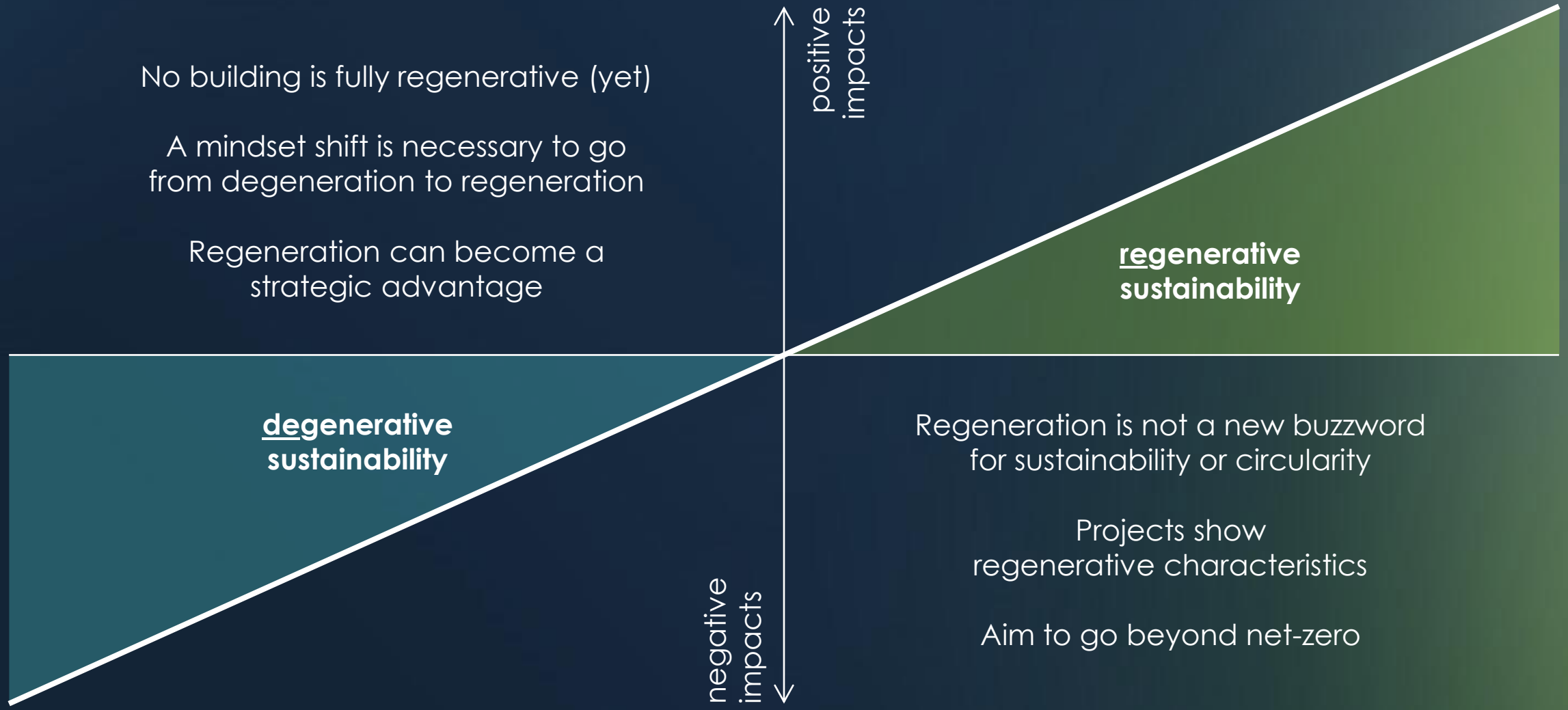
Disciplines beyond the BE?

6. Conclusion

No building is fully regenerative (yet)

A mindset shift is necessary to go from degeneration to regeneration

Regeneration can become a strategic advantage



Regeneration is not a new buzzword for sustainability or circularity

Projects show regenerative characteristics

Aim to go beyond net-zero

Thank You! – Questions?

TU Delft Delft University of Technology

DREES & SOMMER