The developer as low-emission supply chain initiator.

A multiple-case study examining the supply-chain configuration and the developer's role in implementing low-emission construction methods for Dutch inner-city high-rise projects.

P5 Jelmar Broekman

Demand for housing production.

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Demand for housing production.

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Demand for housing production.

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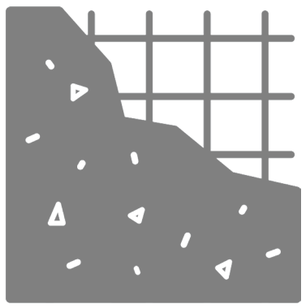
Demand for housing production.

Demand for housing production.

Solution?

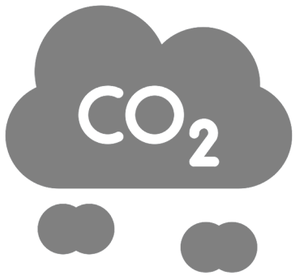
Solution?



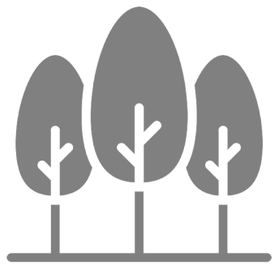
3600 m3

Solution?

3600 m3



1.830.000 kg

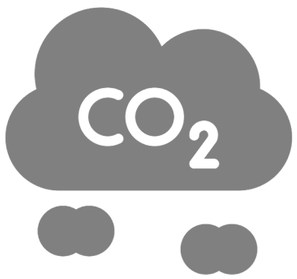


x90.000

1 year CO2 capture

Solution?

3600 m3



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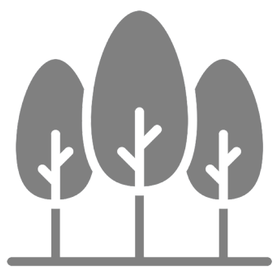
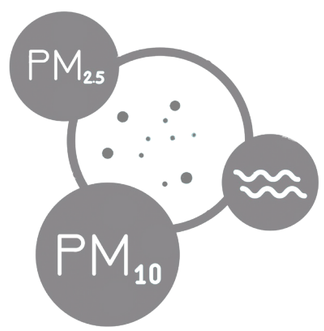


1 year CO2 capture

x90.000

400 trucks



Harmful construction emissions

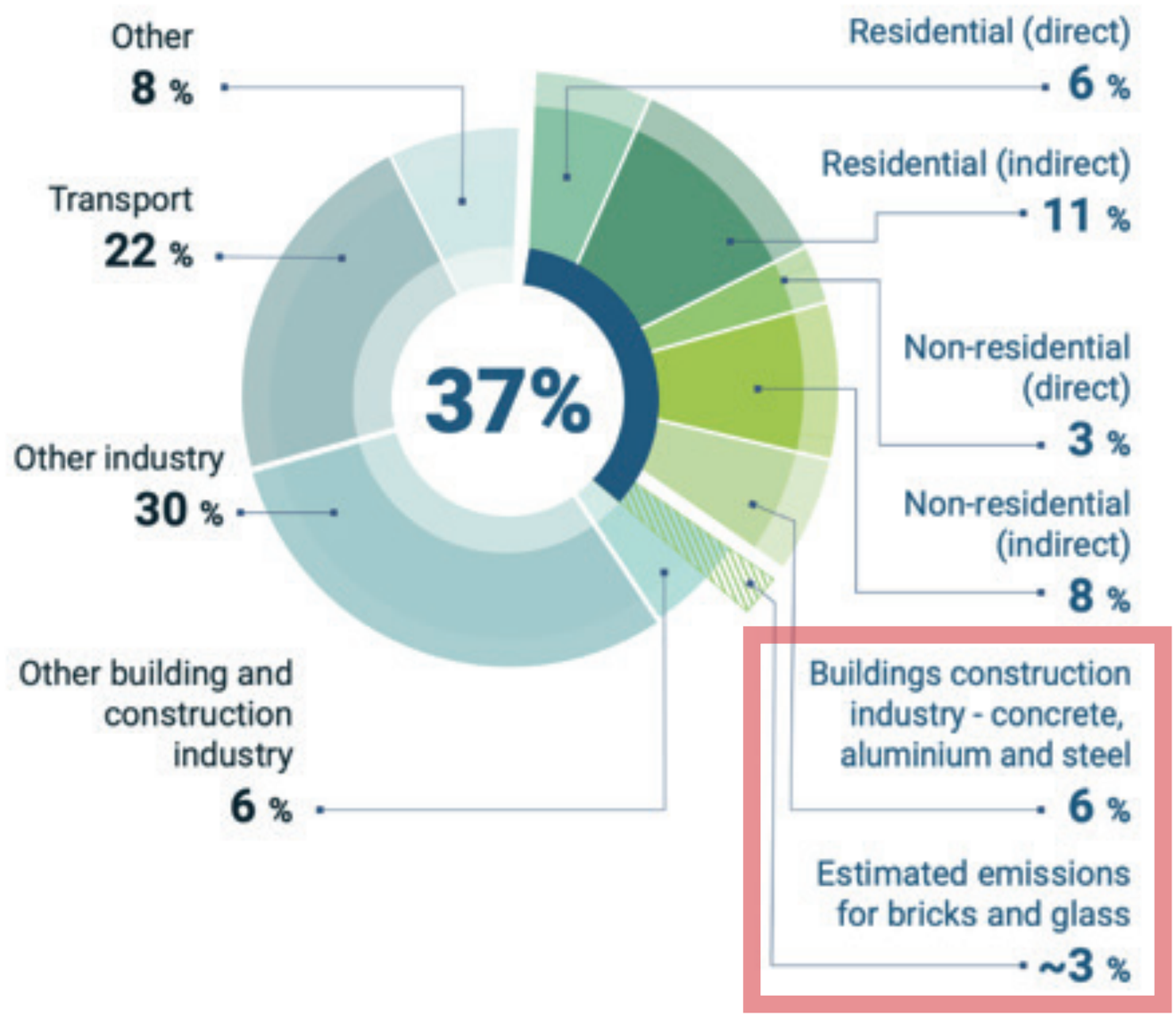


Figure 1: percentage of total global carbo emissions per sector (UNEP, 2022)

Harmful construction emissions

NOS Nieuws • Zaterdag, 15:13 • Aangepast zaterdag, 18:16

Milieuorganisatie stapt naar de rechter om renovatie Binnenhof te stoppen

Political ambitions

Gemeente Amsterdam

Gemeente Rotterdam

Den Haag

Gemeente Utrecht

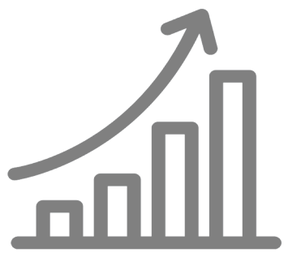
Political ambitions

Gemeente Amsterdam

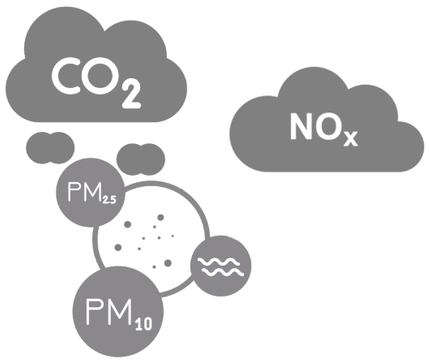
Gemeente Rotterdam

Den Haag

Gemeente Utrecht



&



Increase production

Limit polution

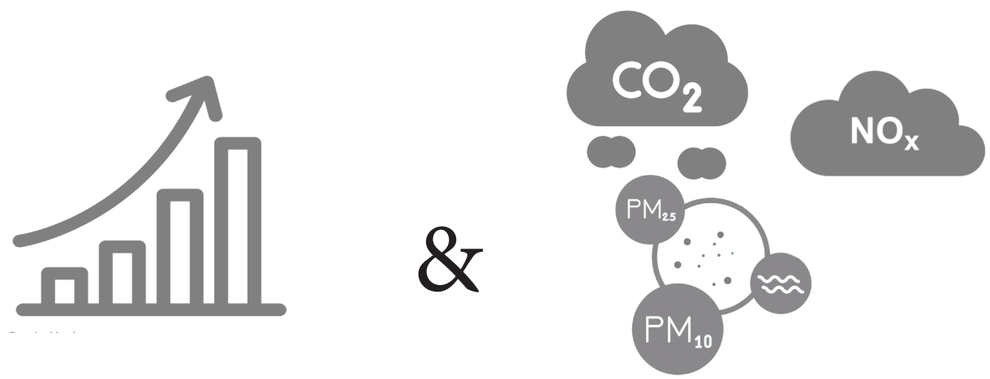
Political ambitions

Gemeente Amsterdam

Gemeente Rotterdam

VREDE EN RECHT
Den Haag

Gemeente Utrecht



Increase production

Limit polution

Low-emission highrise

Construction sector characteristics

Resource scarcity

Construction sector characteristics

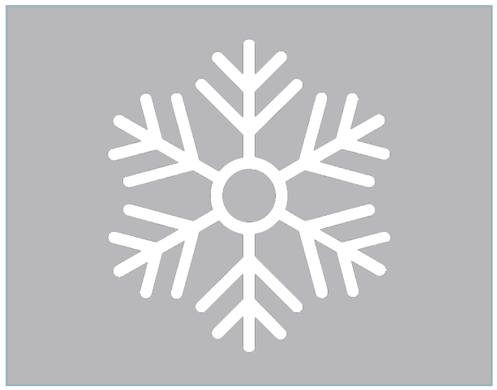
Resource scarcity

Site specific

Construction sector characteristics

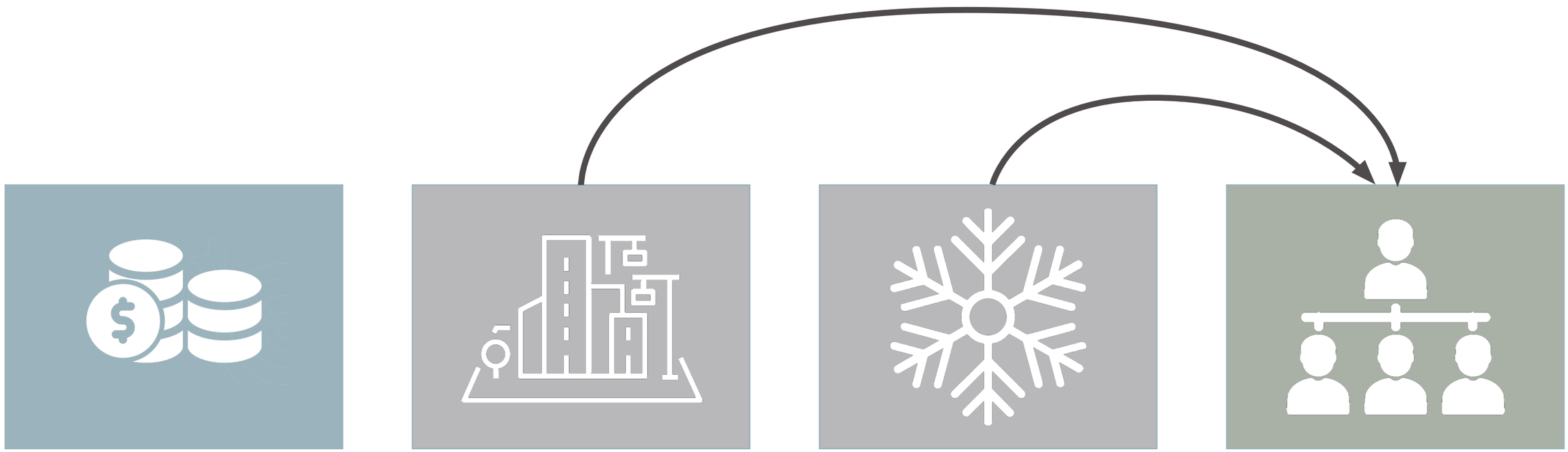
Resource scarcity

Site specific



One-of-a-kind production

Construction sector characteristics



Resource scarcity

Site-specific

One-of-a-kind production

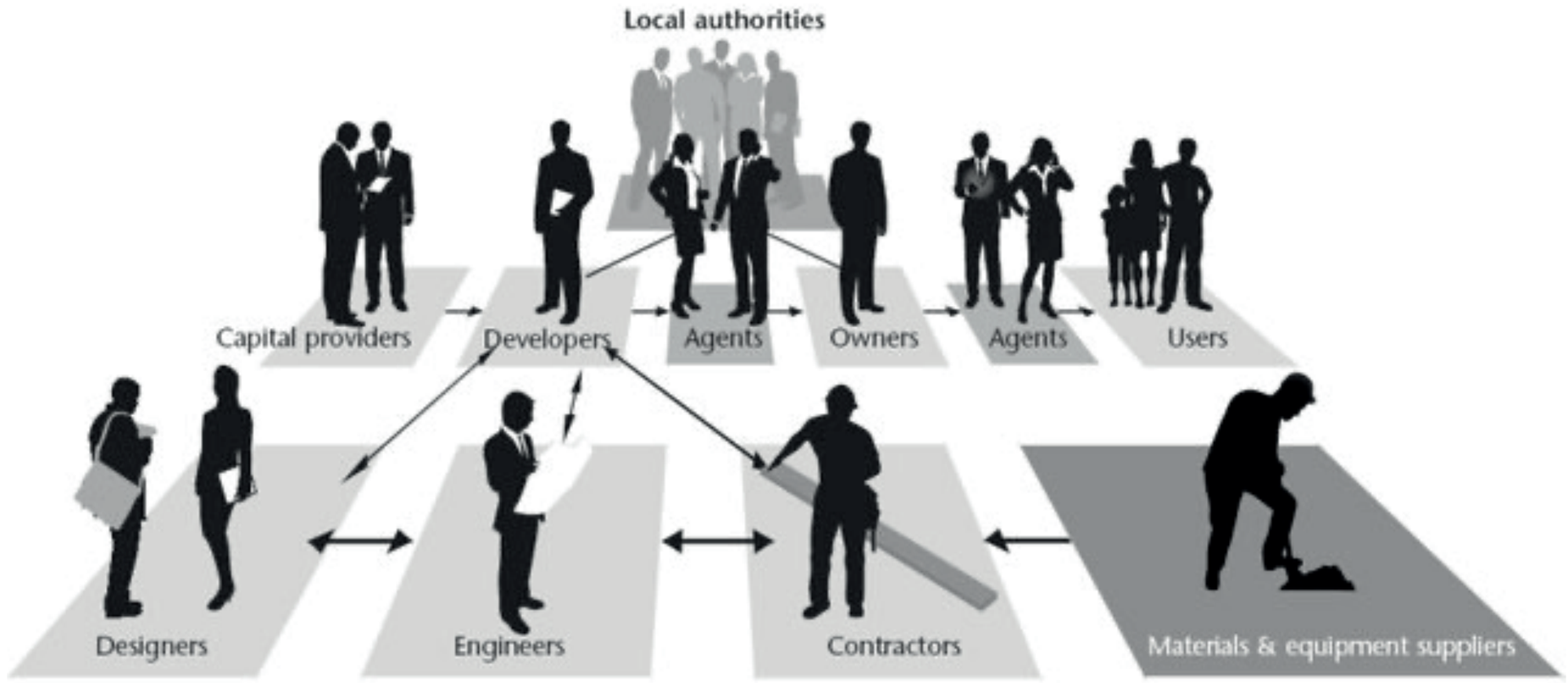
Temporary organizations

Who can steer towards low-emission construction?

Who can steer towards low-emission construction?

Real estate developers?

Position of the real estate developer



The complex value chain (World Business Council for Sustainable Development (WBCSD), 2007)

Main research question:

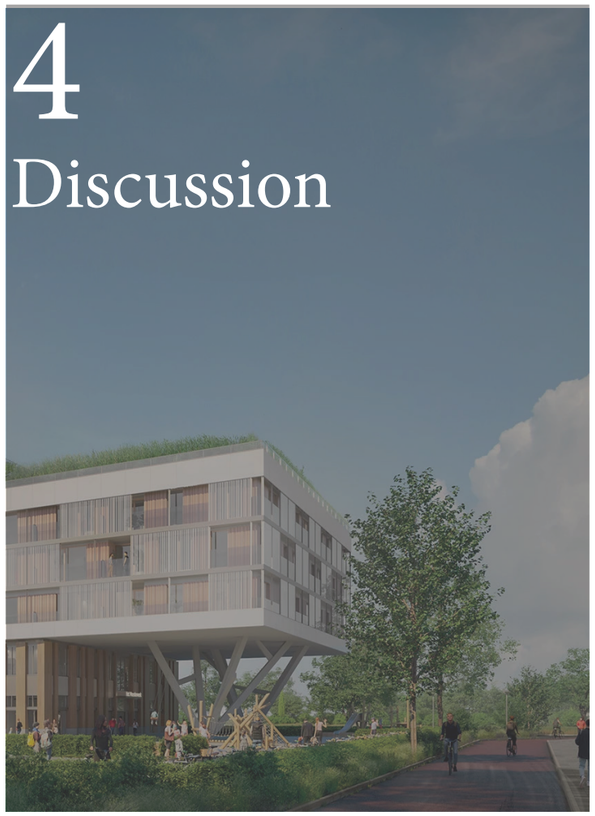
How can real estate developers organize a low-emission supply chain for high-rise construction in Dutch cities?

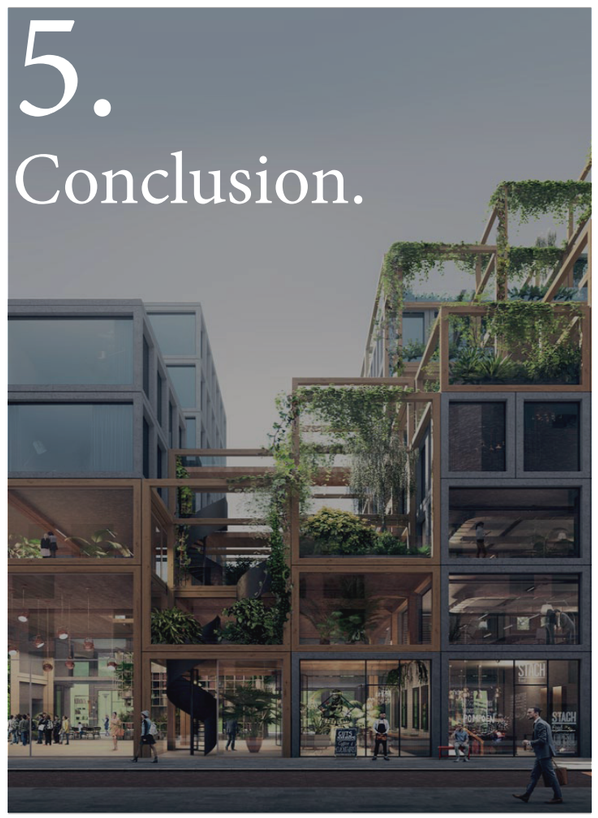
Content.

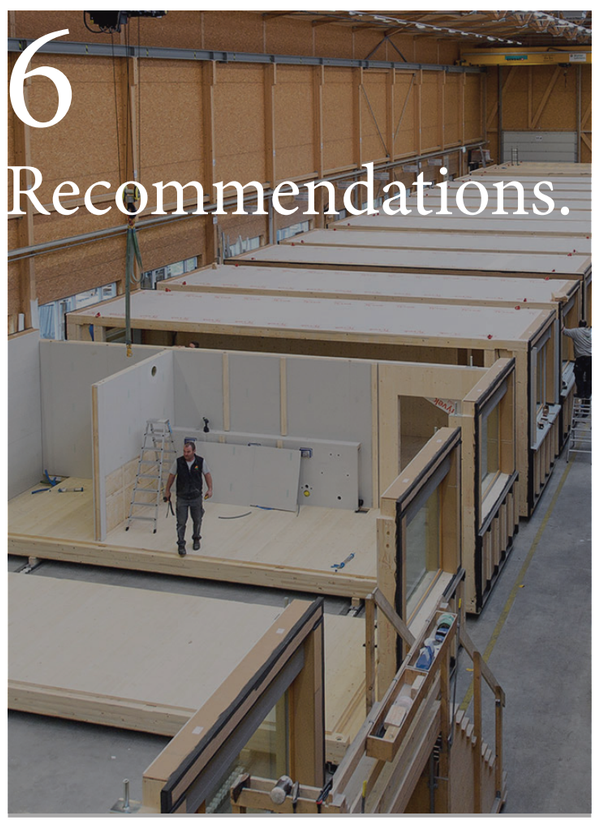

1
Reserch design.


2
Theoratical
research.


3
Emperical research.

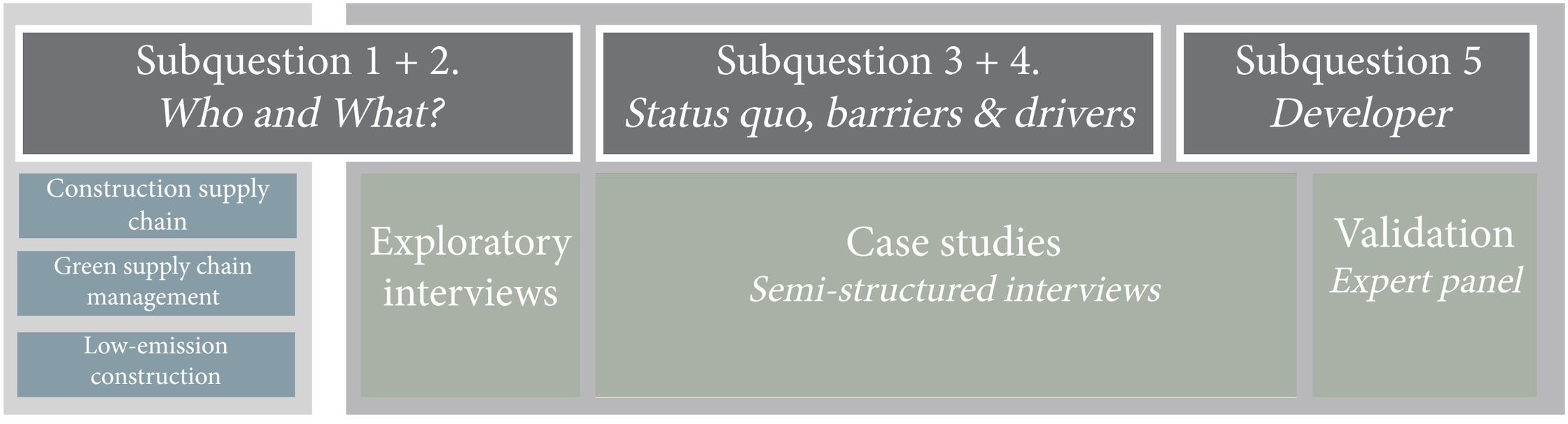

4
Discussion


5.
Conclusion.


6
Recommendations.

1 Research design.
Subquestions & research methods.

Overview & goal.



Supply chain wide practical outcomes

Low-emission steering framework

Research questions.

SQ1 | **How** can **emissions** related to the construction process for high-rise construction in Dutch cities be **minimized** throughout the supply chain?

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SQ5 | What **role** can **developers** take in the implementation of low-emission practices for high-rise construction supply chains in Dutch cities?

2 Theoretical research

Construction emissions & Green supply chain management
What, who & how?

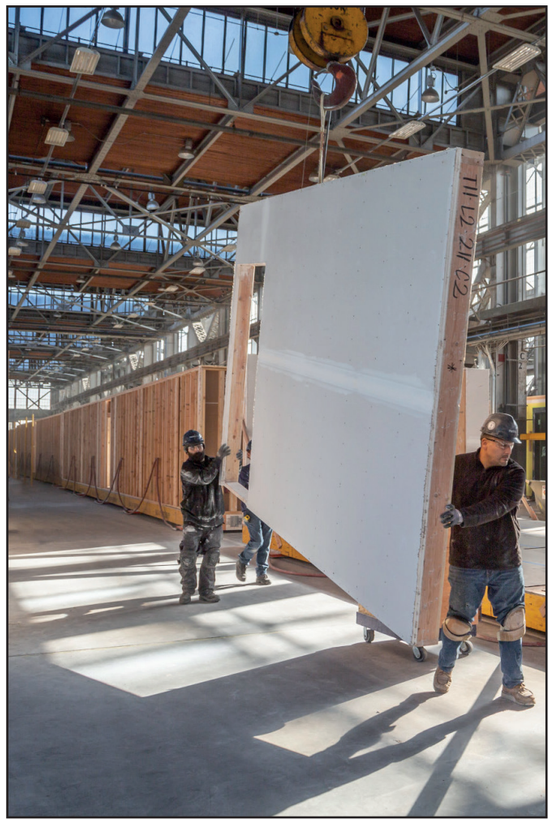
Construction emissions.

Building life cycle																Supplementary information
Product			Construction		Use stage							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw materials supply	Transport	Manufacturing	Transport	Construction	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction Demolition	Transport	Waste processing	Disposal	Re-use-Recovery-Recycling-potential

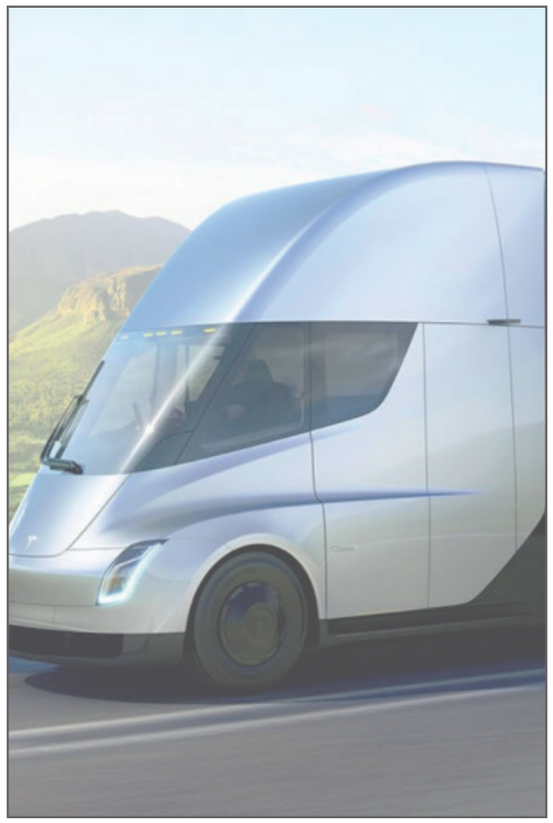
Building life-cycle stages (Nwodo & Anumba, 2019)

Emission reduction.

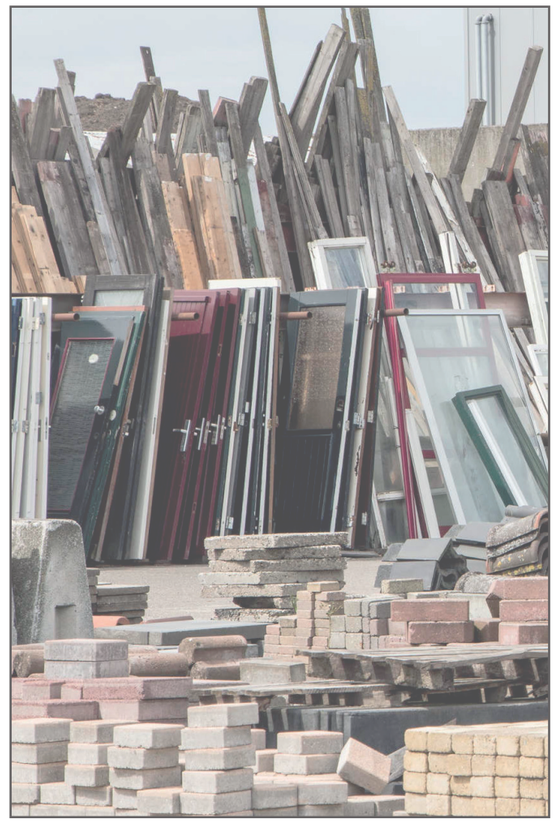
Bio-based construction



Industrialization & modular

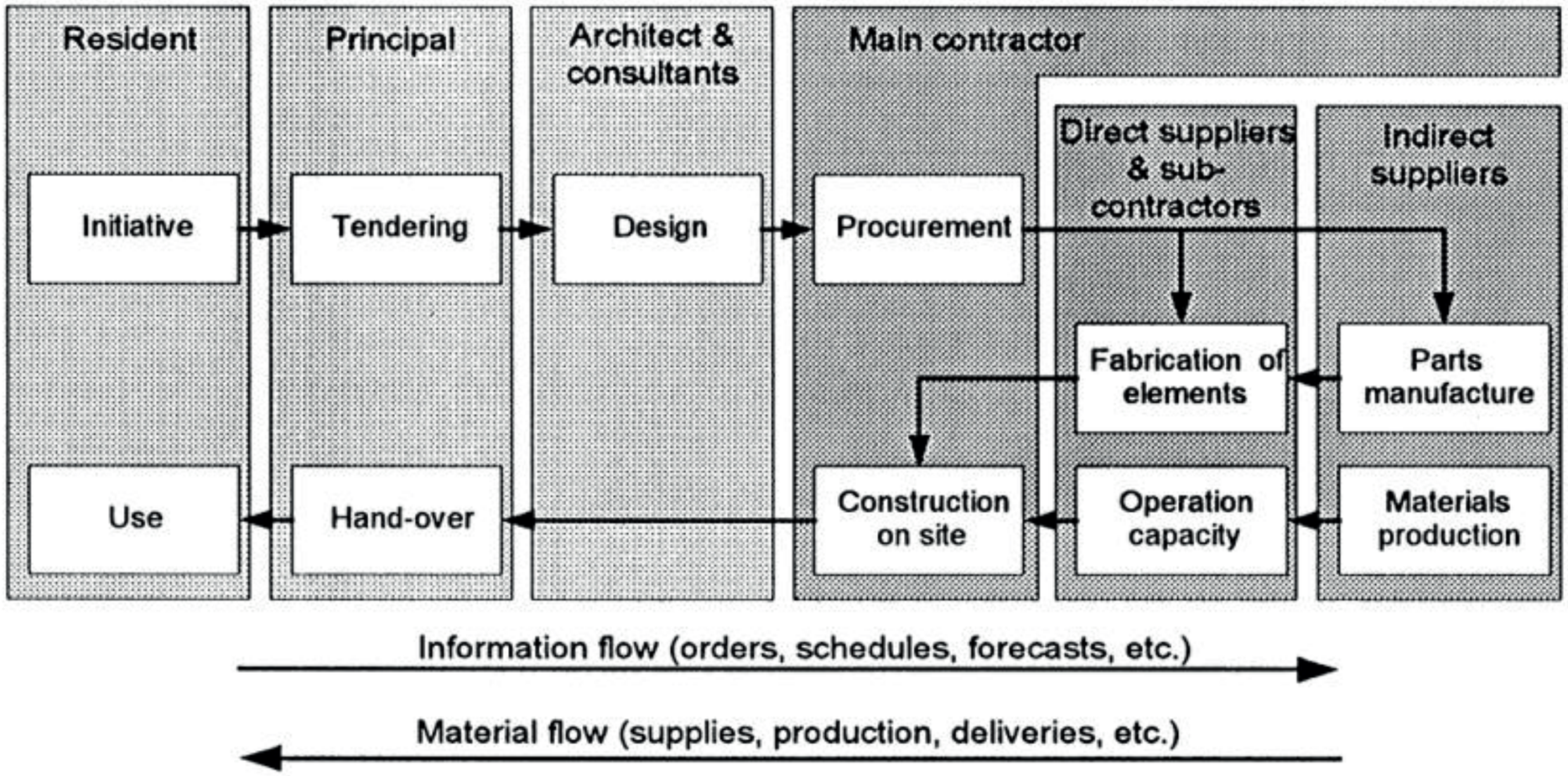


Zero-emission processes.



Circular construction.

Construction supply chain.



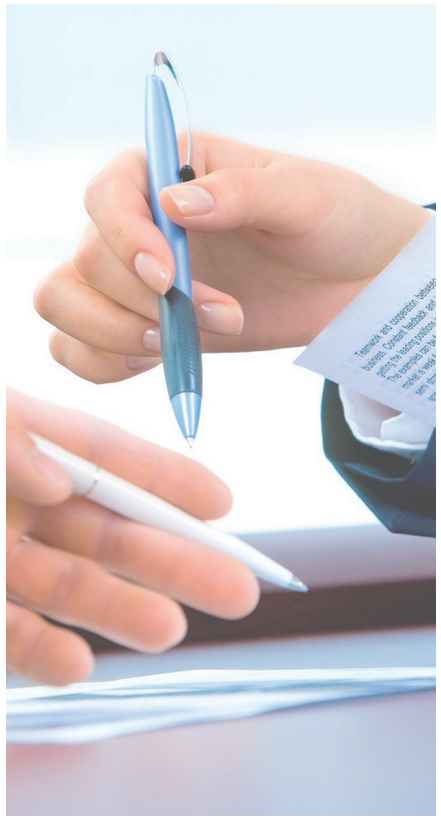
Typical configuration of a construction supply chain (Vrijhoef & Koskela, 2000).

Green supply chain management.

"Green SCM comprises the management of all activities related to minimizing the environmental impact of all its supply chains which contribute to its final products, with the aim of achieving zero net harm to the environment."

(Badi & Murtagh, 2019)

Green supply chain management.



Procurement.

Design.

Transport.

Construction & manufacturing.

End-of-life management.

Low-emission SCM.

Core low emission construction practices
Green design
Environmental impact assessment of design
Provision for the use of prefabricated components
Consideration of materials with high recycled content and low embodied energy
Consideration to reduce the use of hazardous materials
Green procurement
Environmental criteria(s) are included in material purchase decisions
Environmental criteria(s) are included in tendering
Green logistics
Provision of accommodation to employees near project sites
Use of video conferencing
Employees are encouraged to use shared transport and public transport
Materials are transported in full truckload quantities
Materials are transported in fuel efficient vehicles
Green construction/green manufacturing
Use of prefabricated components in projects
Use of materials with high recycled content and low embodied energy
Reducing use of hazardous materials
Comprehensive waste management plan for project/manufacturing sites
Automation is used for onsite construction/manufacturing activities
Fuel efficient equipment/machinery are used at project/manufacturing site
End-of-life management
Environmental impact assessment during end-of-life demolition of projects
Material from the end-of-life demolished projects is recycled

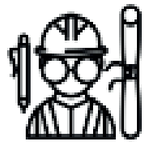
Table 3, low emission construction practices (own table based on Balasubramanian & Shukla, 2017a)

3 Emperical research

Exploratory interviews, In-depth interviews & validation session.

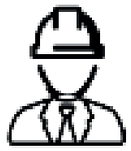
Exploratory interviews | interviewees

Developer



Architect

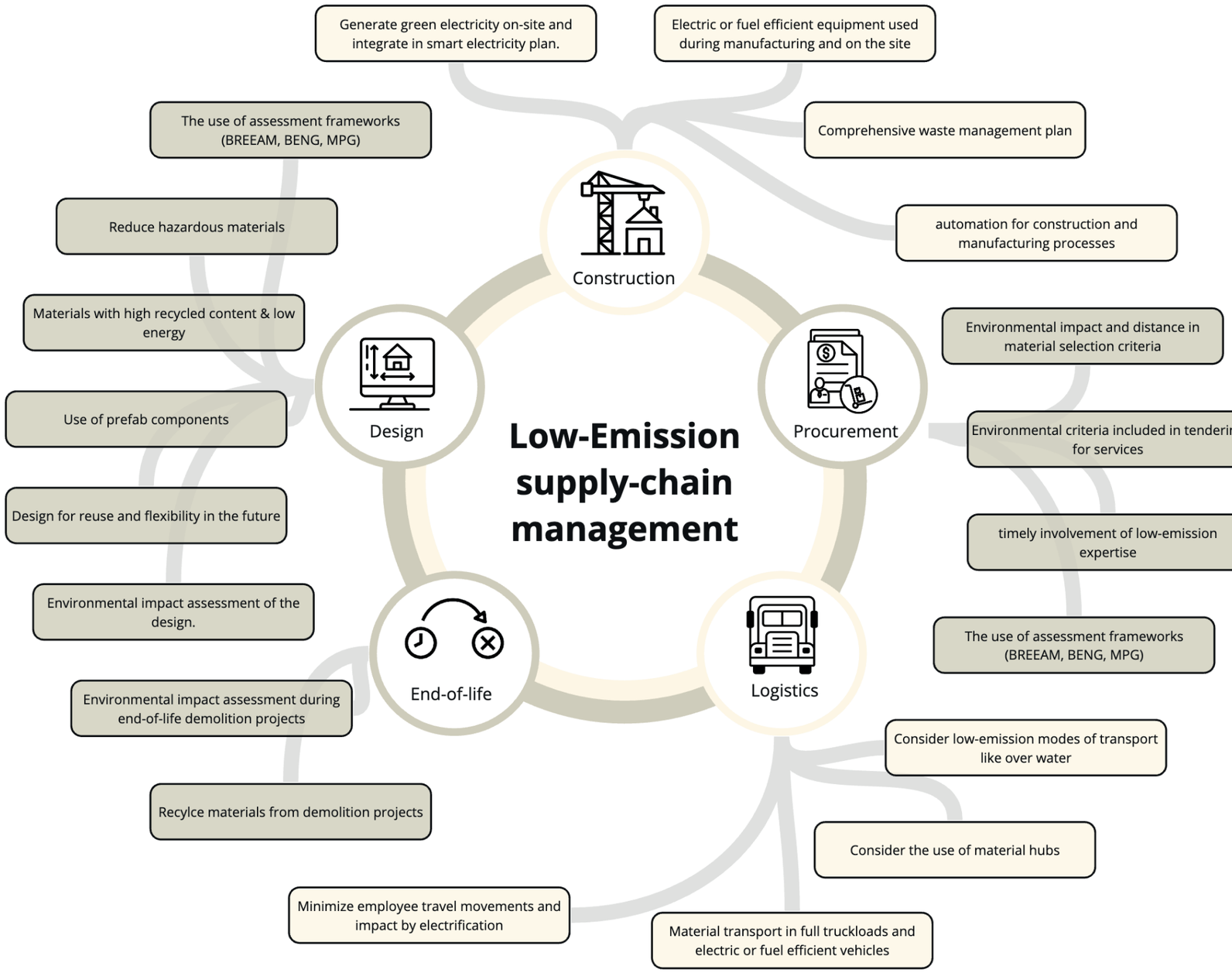
Contractor



Developing contractor

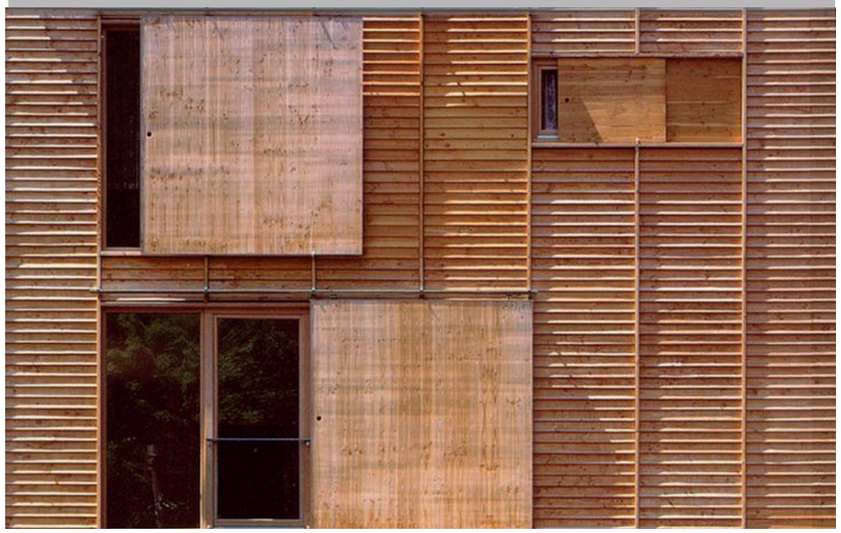
Supplier

Exploratory interviews | what?

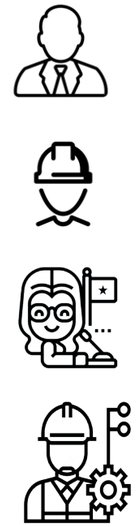


Case studies | Cases & interviewees.

A Circular facade

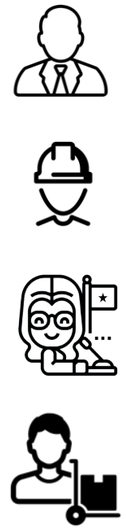


B Tallest in timber



C Emission-free site

D Wooden modules



Case studies | Findings.

Stakeholders point out **strong position of developer** stimulates low-emission construction.

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Shared mindset and ambitions from the start are the most important drivers.

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Early involvement of relevant stakeholders: contractor, subcontractors, suppliers & consultants.

Case studies | Findings.

Stakeholders point out **strong position of developer** stimulates low-emission construction.

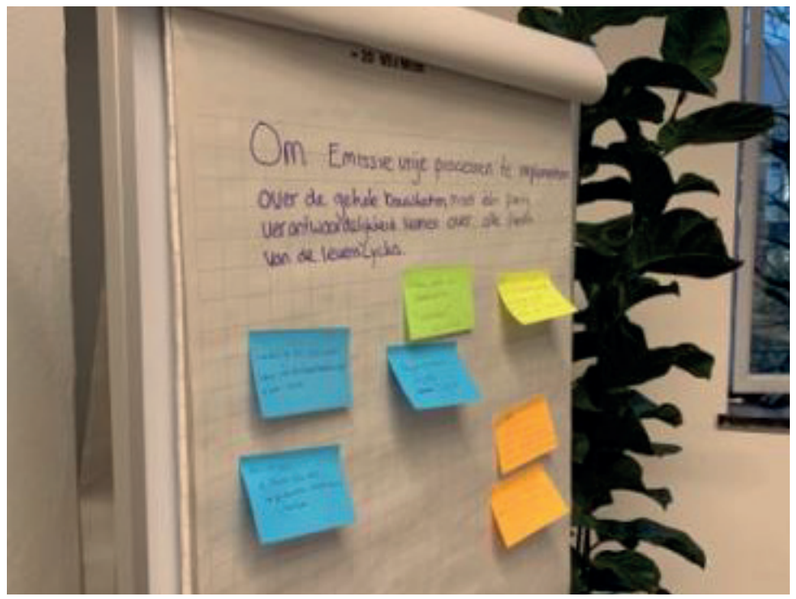
Shared mindset and ambitions from the start are the most important drivers.

Early involvement of relevant stakeholders: contractor, subcontractors, suppliers & consultants.

Institutional drivers more dominant than political drivers in case studies.

Validation.

The developer should have full control

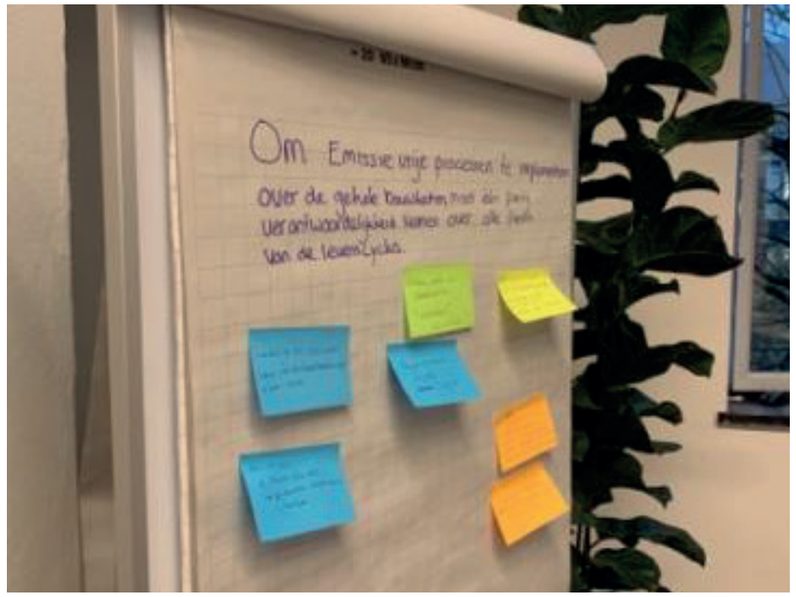


The sector doesn't need the government

Validation.

The developer should have full control

- Difficult for one party, since expertise is spread across the supply chain.
- No clear financial return on low-emission investments yet.
- Some responsibilities even outside supply chain (government)



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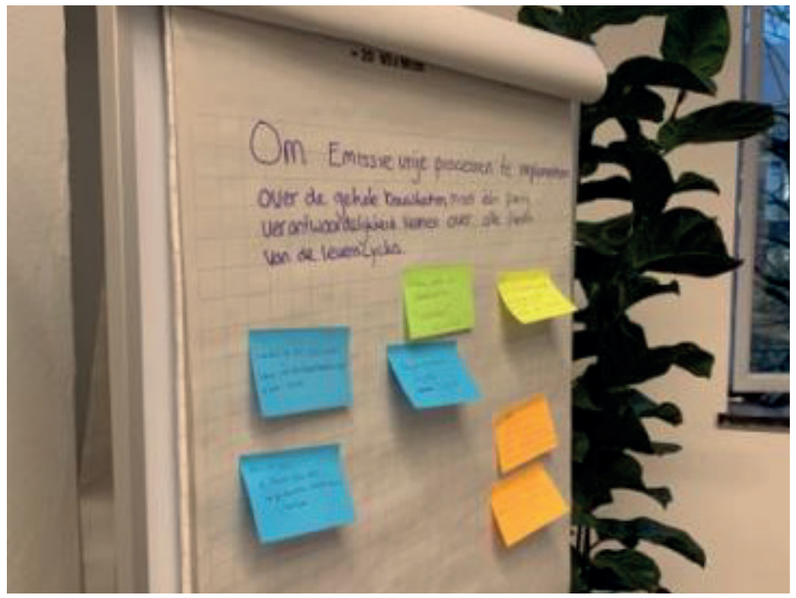


The sector doesn't need the government

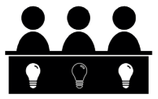
- Disagree.
- Need for new level playing field. (Alternative to MPG)
- Governments can step over (sectoral) boundaries.

4 Discussion.

Discussion

Theoratical findings

Interviews



Validation session

Discussion

Barriers & drivers

Institutional vs political?

Importance political drivers & barriers.

In the past intrinsic motivation as driver.

Focus mainly on political drivers.

Discussion

	Barriers & drivers	Low-emission practices
	Institutional vs political?	Logistics responsibility?
	Importance political drivers & barriers.	Many solutions mentioned in literature
	In the past intrinsic motivation as driver.	Little motivation for implementation.
	Focus mainly on political drivers.	Need for cross-sectoral & regional solutions.

Discussion

	Barriers & drivers	Low-emission practices	Role of the developer
	Institutional vs political?	Logistics responsibility?	Level of responsibility over different phases
	Importance political drivers & barriers.	Many solutions mentioned in literature	Some examples of full responsibility.
	In the past intrinsic motivation as driver.	Little motivation for implementation.	Much attention for influence developer.
	Focus mainly on political drivers.	Need for cross-sectoral & regional solutions.	Responsibility spread according to expertise.

Discussion

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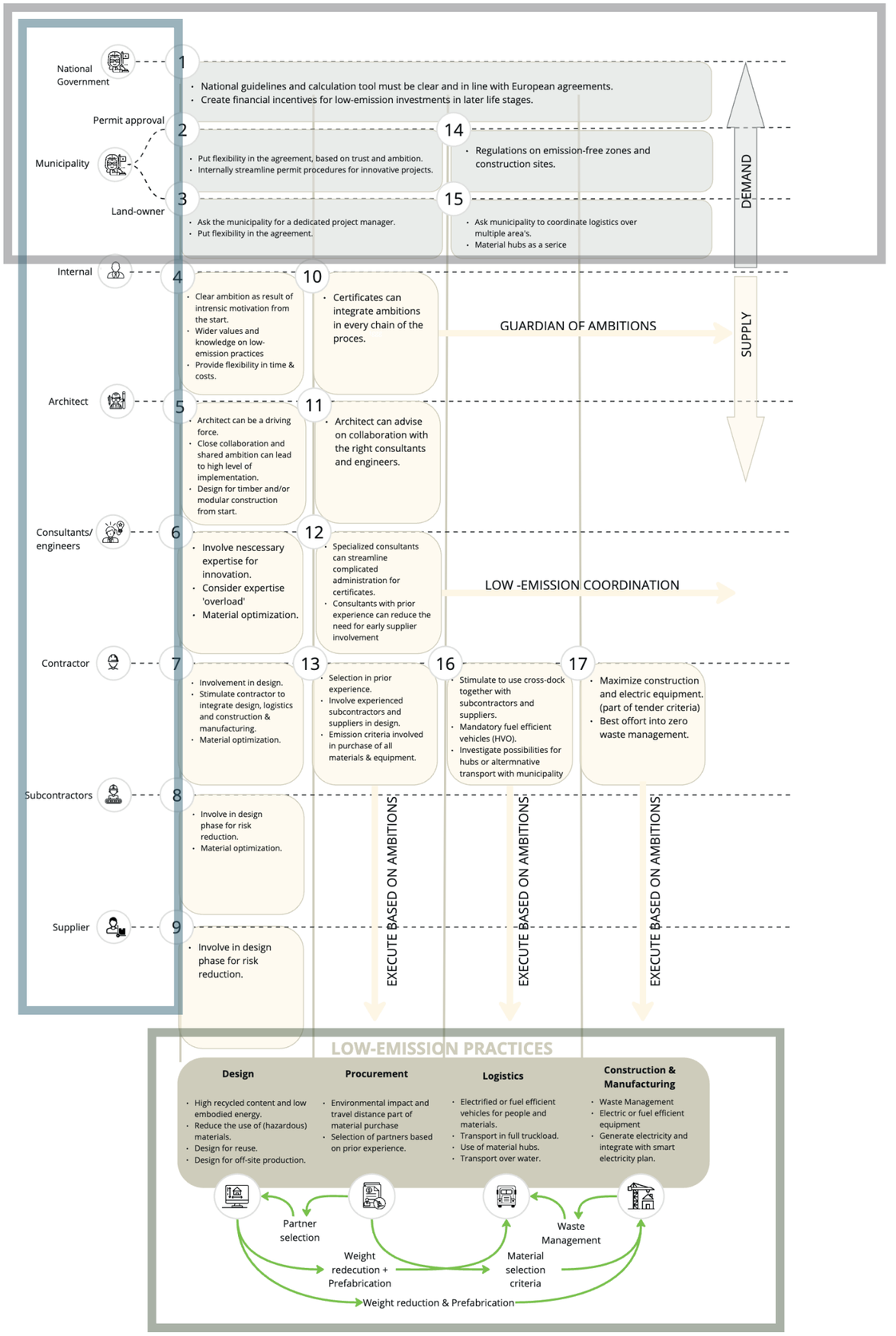
5 Conclusion.

Framework design.

- Important stakeholders
- Low-emission practices
- Government included

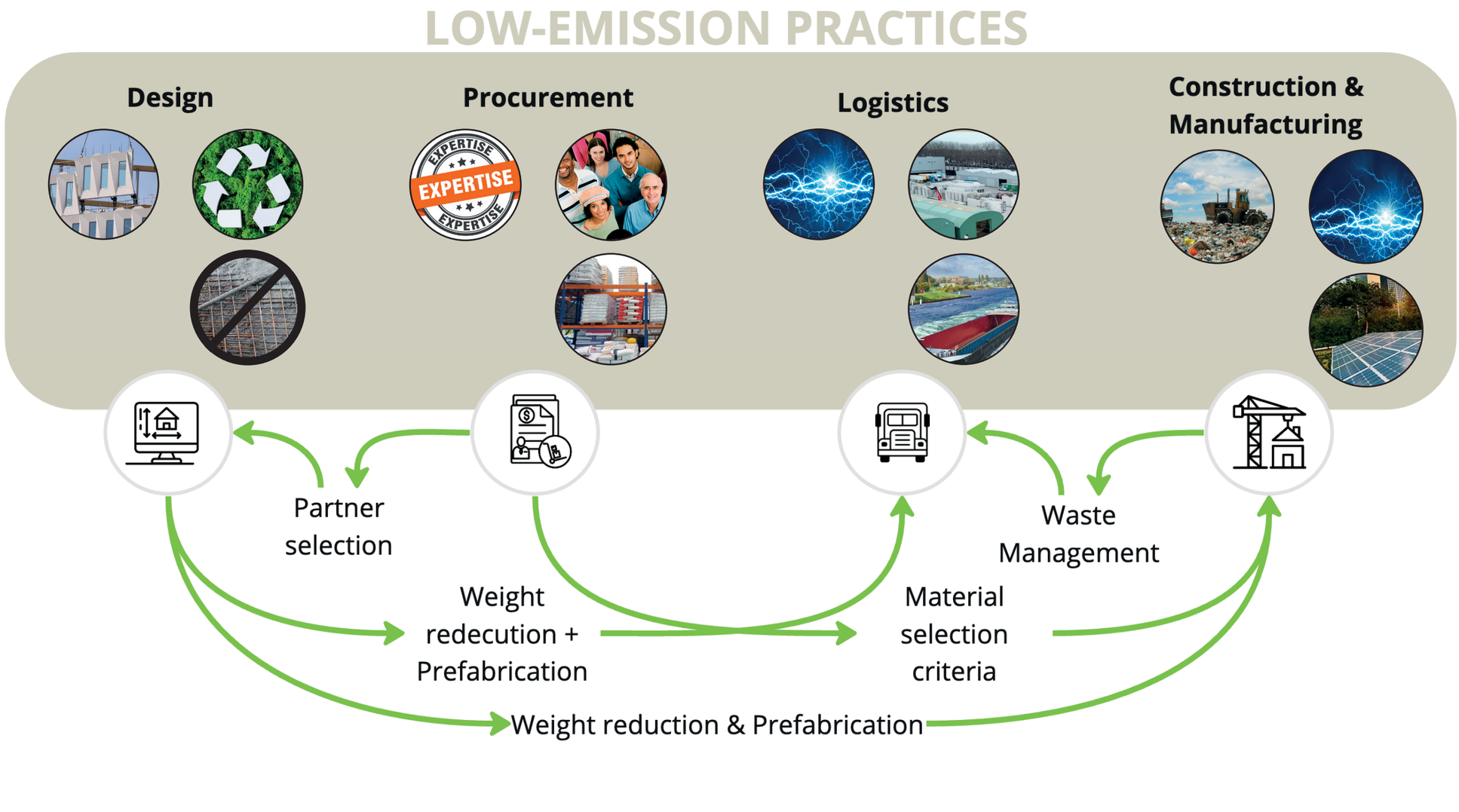


Conclusion

Main question.

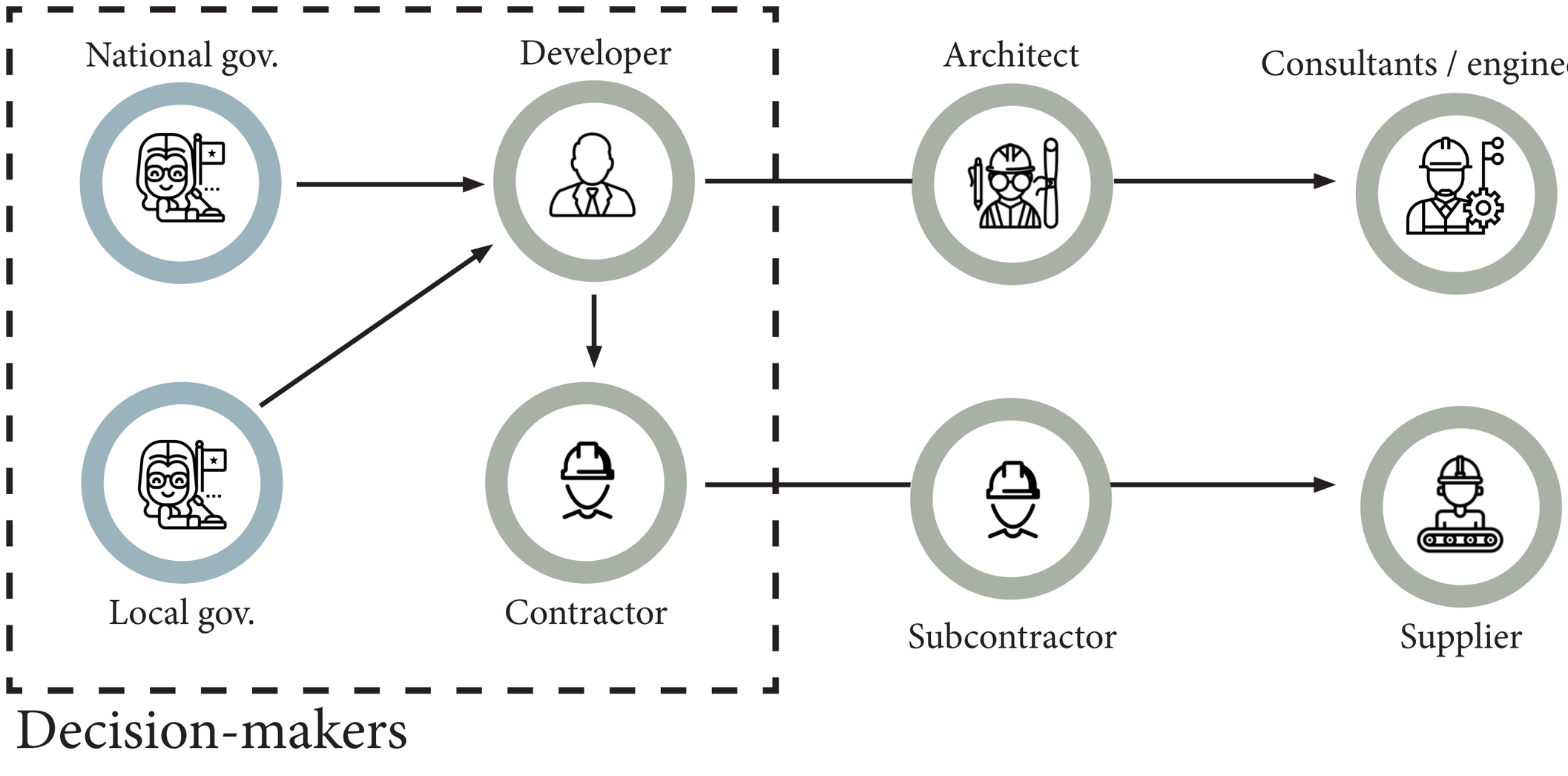
Conclusion

SQ1 | How can emissions related to the construction process for high-rise construction in Dutch cities be minimized throughout the supply chain?



Conclusion

SQ2 | What actors internal and external to the supply-chain influence the implementation of low-emission practices for high-rise construction in Dutch cities?



Conclusion

SQ3 | How are low-emission practices currently implemented in Dutch high-rise construction projects and what is still missing?

LOW-EMISSION PRACTICES

Design

More orchestrated aproach from the initiative in all projects.

Procurement

Logistics

Construction & Manufacturing

Conclusion

SQ3 | How are low-emission practices currently implemented in Dutch high-rise construction projects and what is still missing?

LOW-EMISSION PRACTICES

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More orchestrated aproach from the initiative in all projects.

Procurement

Only in one project both service and material purchasing is emission driven.

Logistics

Construction & Manufacturing

Conclusion

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Construction & Manufacturing

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LOW-EMISSION PRACTICES

Design

More orgestrated aprouch from the initiative in all projects.

Procurement

Only in one project both service and material purchasing is emission driven.

Logistics

Unclear responsibility and no sence of priority.

Construction & Manufacturing

Slow and capital-intensive process & market still immature

Conclusion

SQ4 | What drives or withholds different actors to implement low-emission practices for high-rise construction in Dutch cities?

Drivers

Intitutional
Clear ambitions and project partners with a shared mindset

Political
Incentives, rules and regulations

Barriers

Technological & Economical
Lack of equipment and experience result in high prices.

Political
No level playing field if not all parties must join.

Conclusion

SQ5 | What role can developers take in the implementation of low-emission practices for high-rise construction supply chains in Dutch cities?

Integration and **direct responsibility** over full supply chain will result in **increased risk**.

Conclusion

SQ5 | What role can developers take in the implementation of low-emission practices for high-rise construction supply chains in Dutch cities?

Integration and **direct responsibility** over full supply chain will result in **increased risk**.

Initiation and translation of ambitions in **design & procurement** can reach the full supply chain.

Main conclusion

How can real estate developers organize a low-emission supply chain for high-rise construction in Dutch cities?

1 Set low-emission ambitions and link to steering or calculation method.

Main conclusion

How can real estate developers organize a low-emission supply chain for high-rise construction in Dutch cities?

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2 Select design-team partners based on prior experience and ambition.

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3 Early involvement of contractors and additional expertise in the design team.

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How can real estate developers organize a low-emission supply chain for high-rise construction in Dutch cities?

1 Set low-emission ambitions and link to steering or calculation method.

2 Select design-team partners based on prior experience and ambition.

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4 Influence over construction, manufacturing and transport through procurement.

Main conclusion

How can real estate developers organize a low-emission supply chain for high-rise construction in Dutch cities?

1. Set low-emission ambitions and link to steering or calculation method.
2. Select design-team partners based on prior experience and ambition.
3. Early involvement of contractors and additional expertise in the design team.
4. Influence over construction, manufacturing and transport through procurement.
5. Check and guard execution of ambitions and appoint a specialist for this.

6 Recommendations

Further academic research

Different context

Further academic research

Different context

Procurement tools

Further academic research

Different context

Procurement tools

Governmental instruments

Recommendations for public bodies

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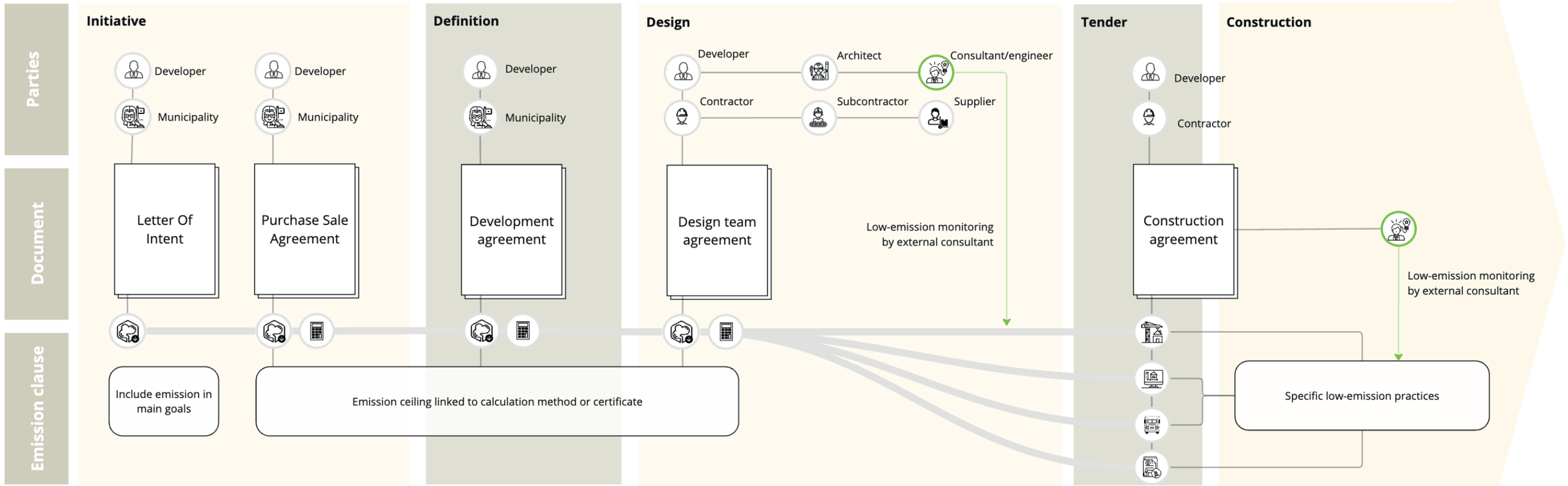
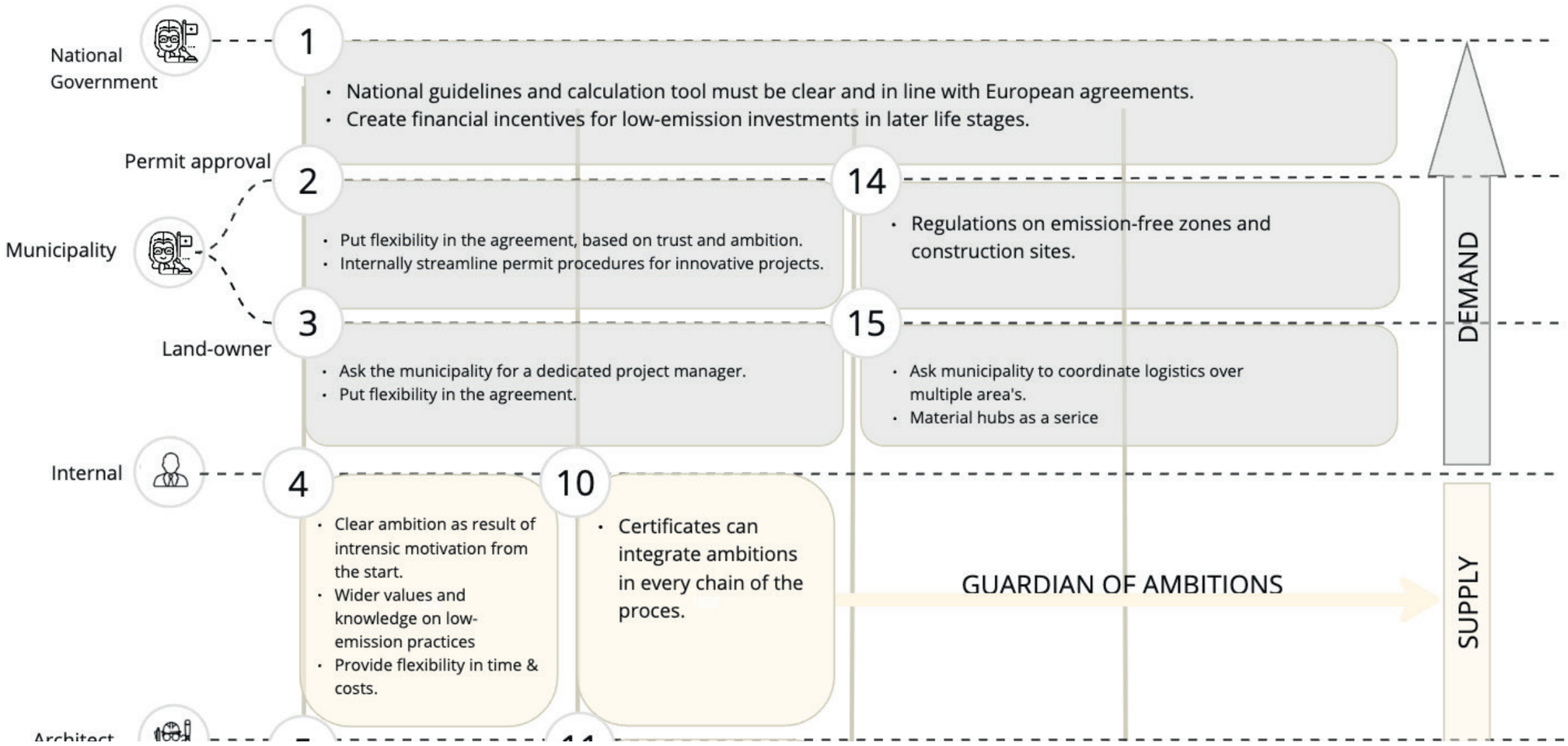
- Set ambitious standards as land-owner.
- Developers can not excel on every aspect of the project.
- Coordinate low-emission logistics between sectors.

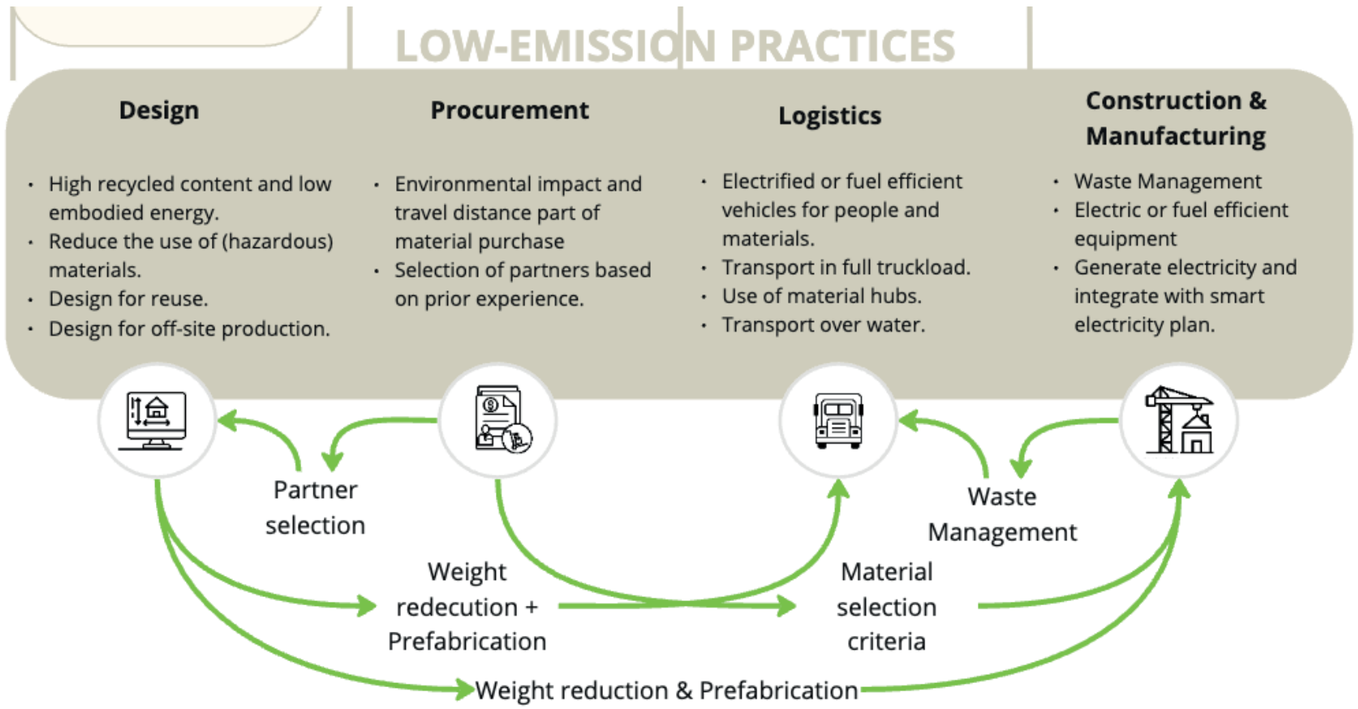
Recommendations for the developer

Low-emission procurement strategy



Any questions?


National Government
1
• National guidelines and calculation tool must be clear and in line with European agreements.
• Create financial incentives for low-emission investments in later life stages.
Permit approval
2
14
Municipality
• Put flexibility in the agreement, based on trust and ambition.
• Internally streamline permit procedures for innovative projects.
• Regulations on emission-free zones and construction sites.
3
15
Land-owner
• Ask the municipality for a dedicated project manager.
• Put flexibility in the agreement.
• Ask municipality to coordinate logistics over multiple area's.
• Material hubs as a serice
DEMAND
Internal
4
10
• Clear ambition as result of intrensic motivation from the start.
• Wider values and knowledge on low-emission practices
• Provide flexibility in time & costs.
• Certificates can integrate ambitions in every chain of the proces.
GUARDIAN OF AMBITIONS
SUPPLY
Architect


LOW-EMISSION PRACTICES
Design
• High recycled content and low embodied energy.
• Reduce the use of (hazardous) materials.
• Design for reuse.
• Design for off-site production.
Procurement
• Environmental impact and travel distance part of material purchase
• Selection of partners based on prior experience.
Logistics
• Electrified or fuel efficient vehicles for people and materials.
• Transport in full truckload.
• Use of material hubs.
• Transport over water.
Construction & Manufacturing
• Waste Management
• Electric or fuel efficient equipment
• Generate electricity and integrate with smart electricity plan.
Partner selection
Weight redecution + Prefabrication
Material selection criteria
Waste Management
Weight reduction & Prefabrication

Architect

5

- Architect can be a driving force.
- Close collaboration and shared ambition can lead to high level of implementation.
- Design for timber and/or modular construction from start.

11

- Architect can advise on collaboration with the right consultants and engineers.

Consultants/ engineers

6

- Involve nescessary expertise for innovation.
- Consider expertise 'overload'
- Material optimization.

12

- Specialized consultants can streamline complicated administration for certificates.
- Consultants with prior experience can reduce the need for early supplier involvement

LOW -EMISSION COORDINATION

Contractor

7

- Involvement in design.
- Stimulate contractor to integrate design, logistics and construction & manufacturing.
- Material optimization.

13

- Selection in prior experience.
- Involve experienced subcontractors and suppliers in design.
- Emission criteria involved in purchase of all materials & equipment.

16

- Stimulate to use cross-dock together with subcontractors and suppliers.
- Mandatory fuel efficient vehicles (HVO).
- Investigate possibilities for hubs or altermnative transport with municipality

17

- Maximize construction and electric equipment. (part of tender criteria)
- Best offort into zero waste management.

LOW-EMISSION PRACTICES

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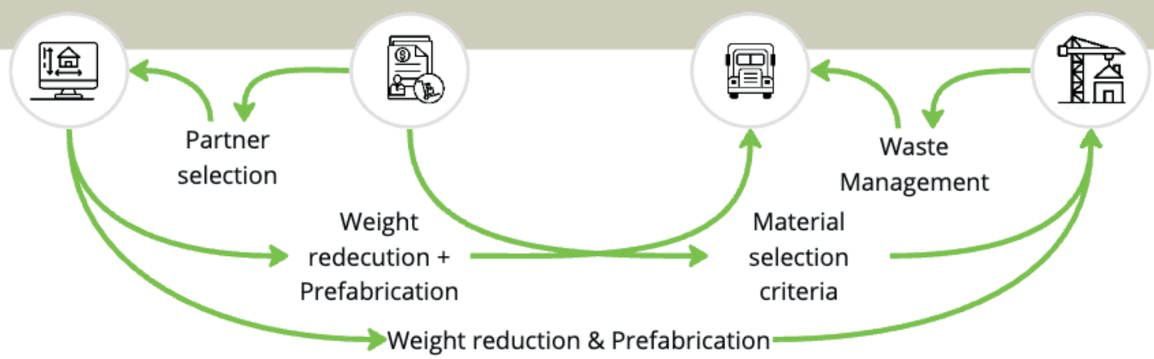

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Subcontractors

8

- Involve in design phase for risk reduction.
- Material optimization.

Supplier

9

- Involve in design phase for risk reduction.

EXECUTE BASED ON AMBITIONS

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