

research project (2023)

BIMZEC!

Low-emission construction logistics for bio-based modular high-rise in Amsterdam:

A modelling approach

“ Excessive nitrogen deposition in the Netherlands has been a problem for many years. It is harmful for both nature and public health. The Dutch government is introducing measures for industry, agriculture, transport and the construction sector in order to reduce nitrogen deposition and improve the quality of nature areas.

Government of the Netherlands

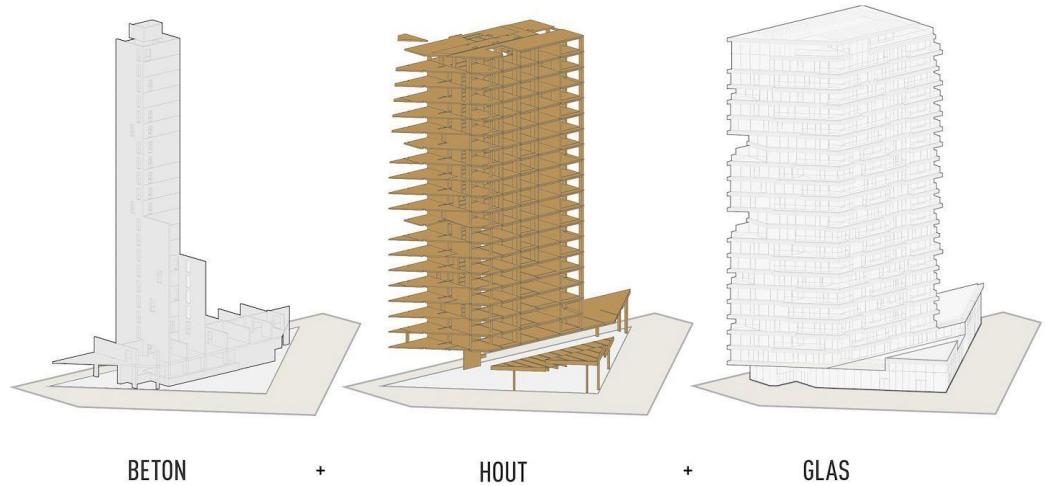
Research Problem



‘Bouwstop’ in North Brabant | Omroep Brabant 2023

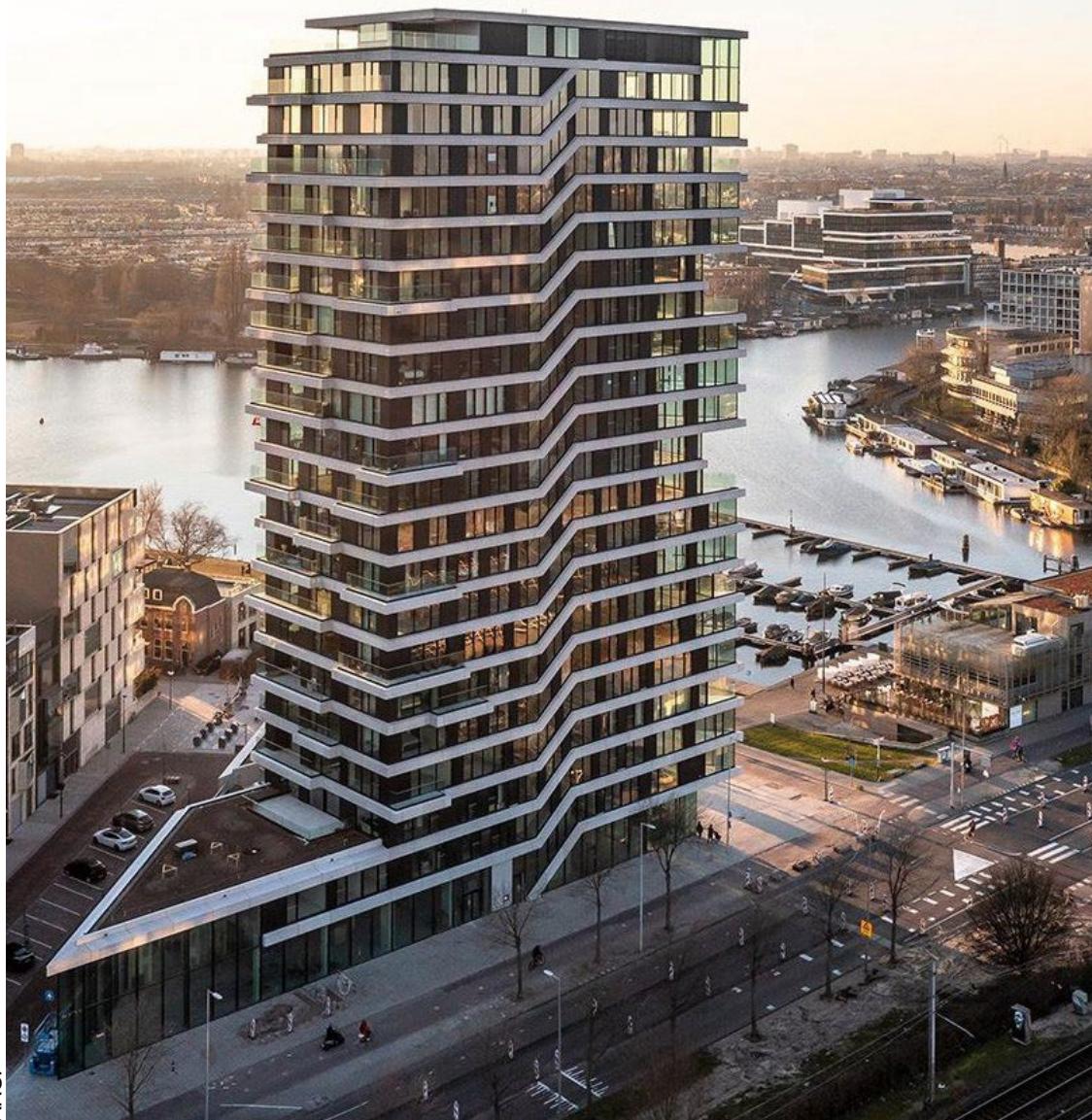
Emissions CO₂, NOx, PM...

Construction Materials | Haut |
ARUP



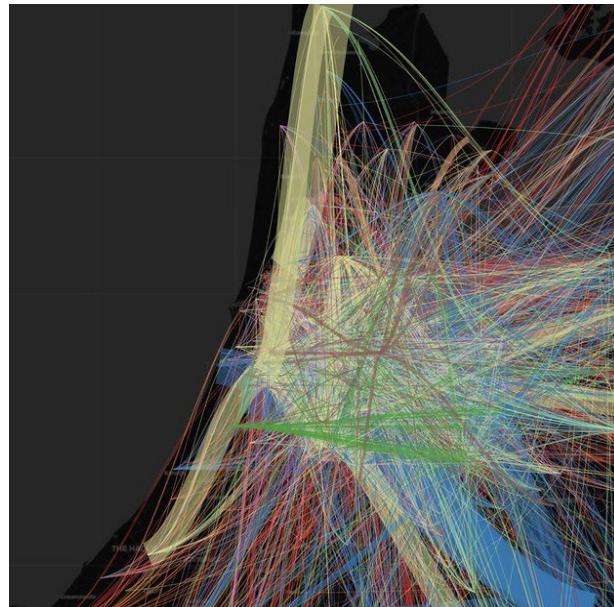
(Highrise) Construction

Haut Building | 73 meter | Amsterdam |



Process Solutions > Logistics

for low-emission construction



Biobased

Modular

Circular

Zero-emission



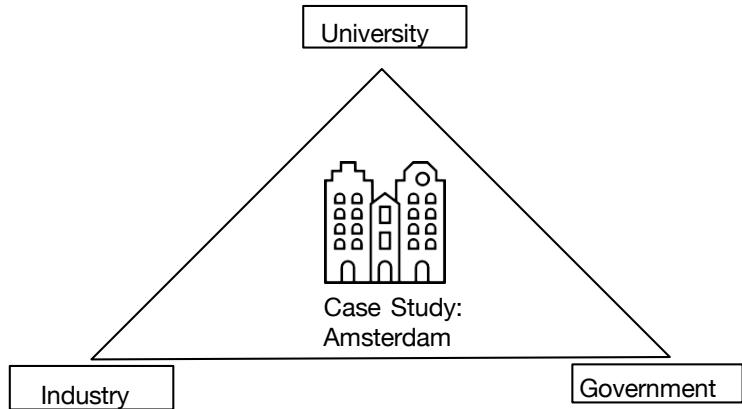
solutions

BIMZEC!

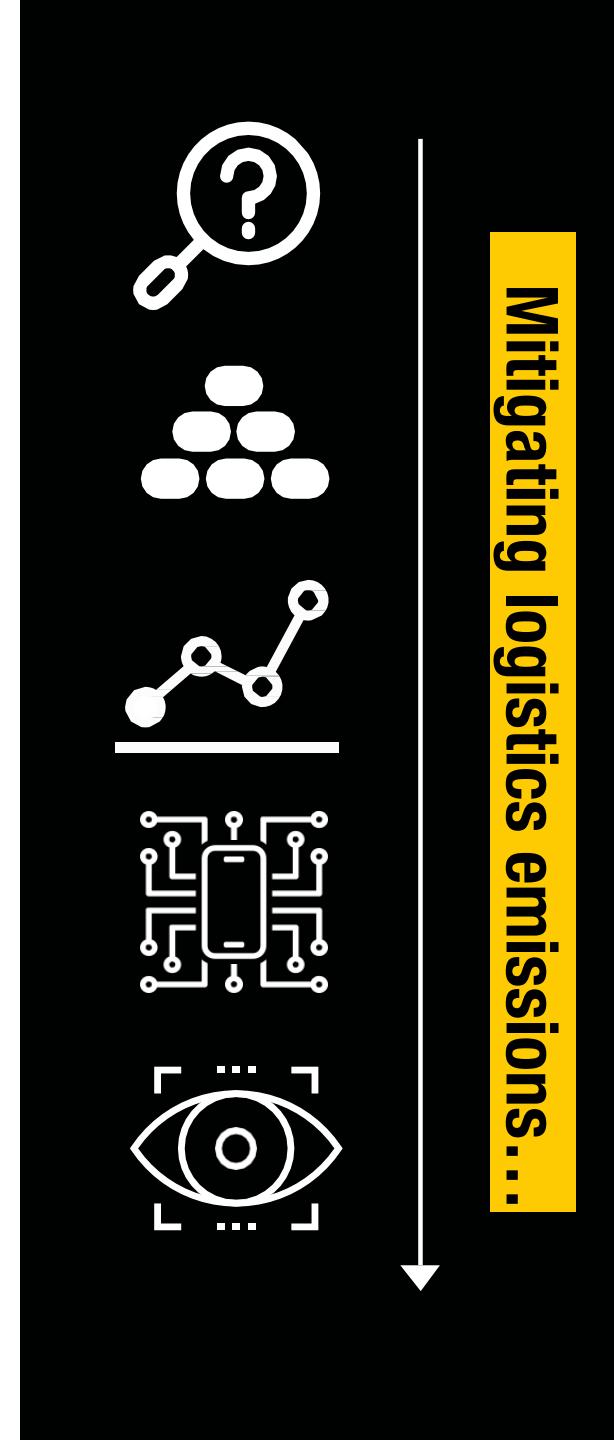
#Biobased #Industrialized #Modular #Zero-Emission #Circular
turn in construction methods and processes

“
The triple helix model of innovation refers to a set of interactions between academia (the university), industry and government, to foster economic and social development.”

Loet Leydesdorff (2012)

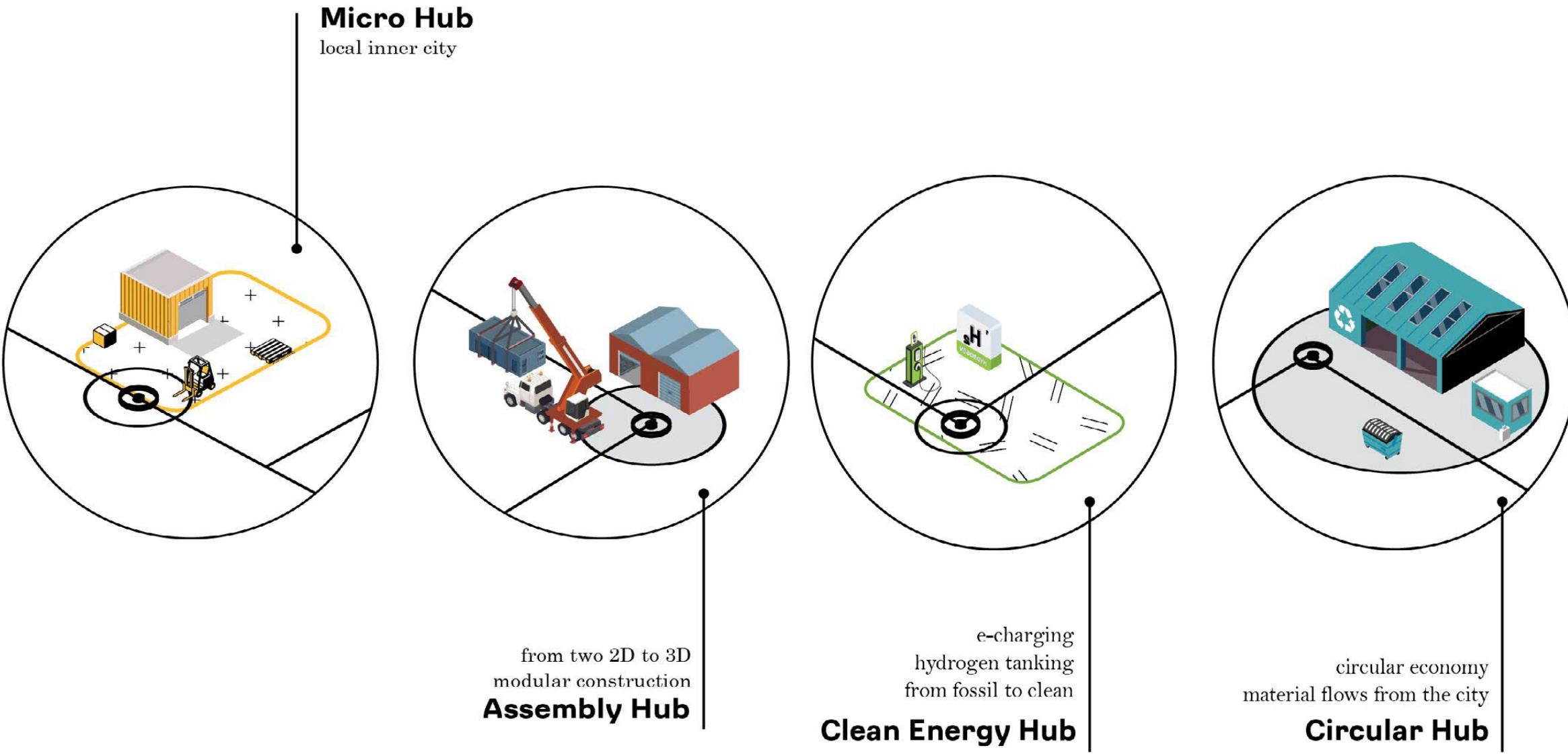


Research Methods

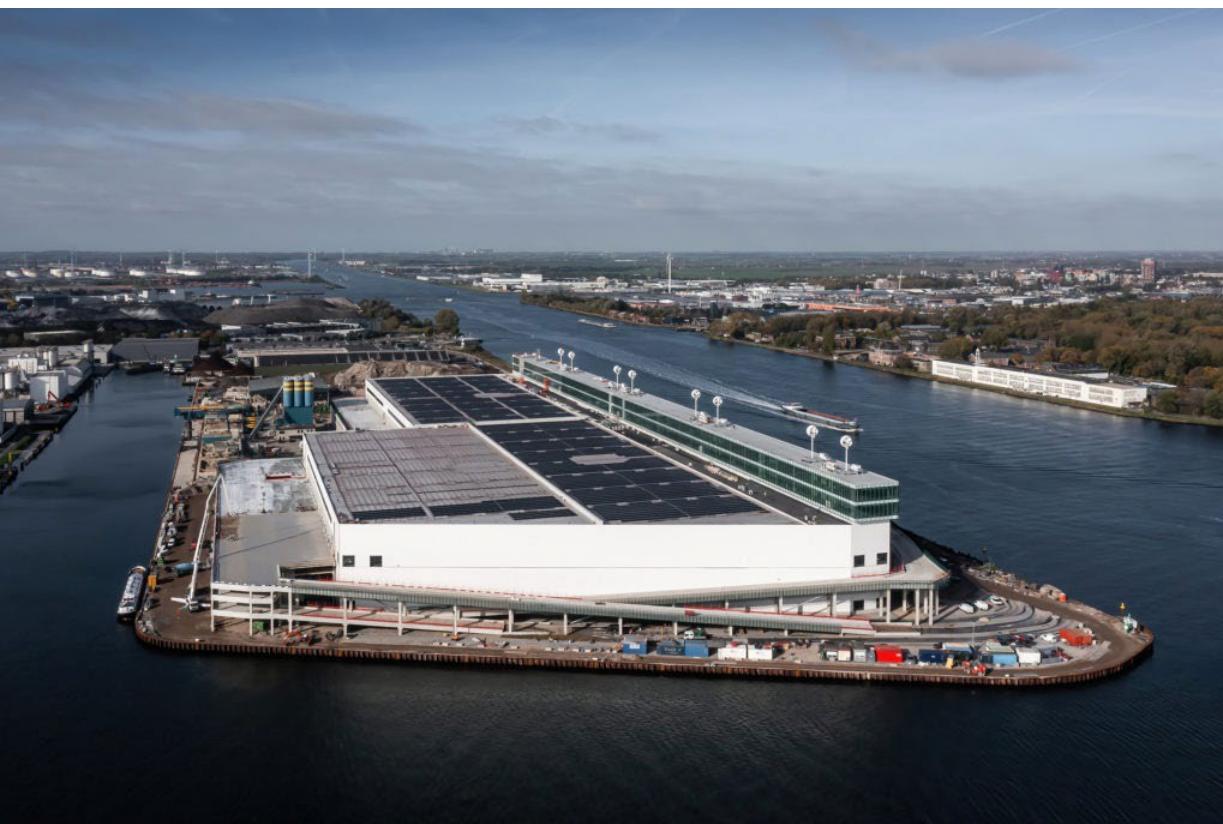


Construction Hubs Typologies and Functions

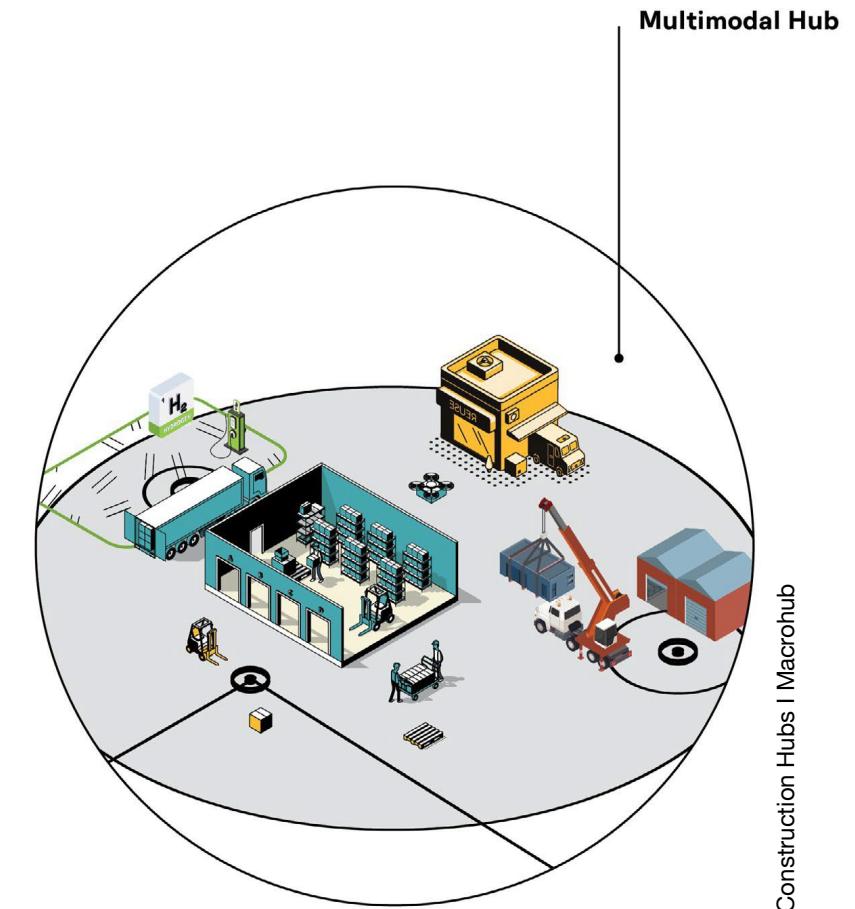
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Introduction and use of **construction hubs**



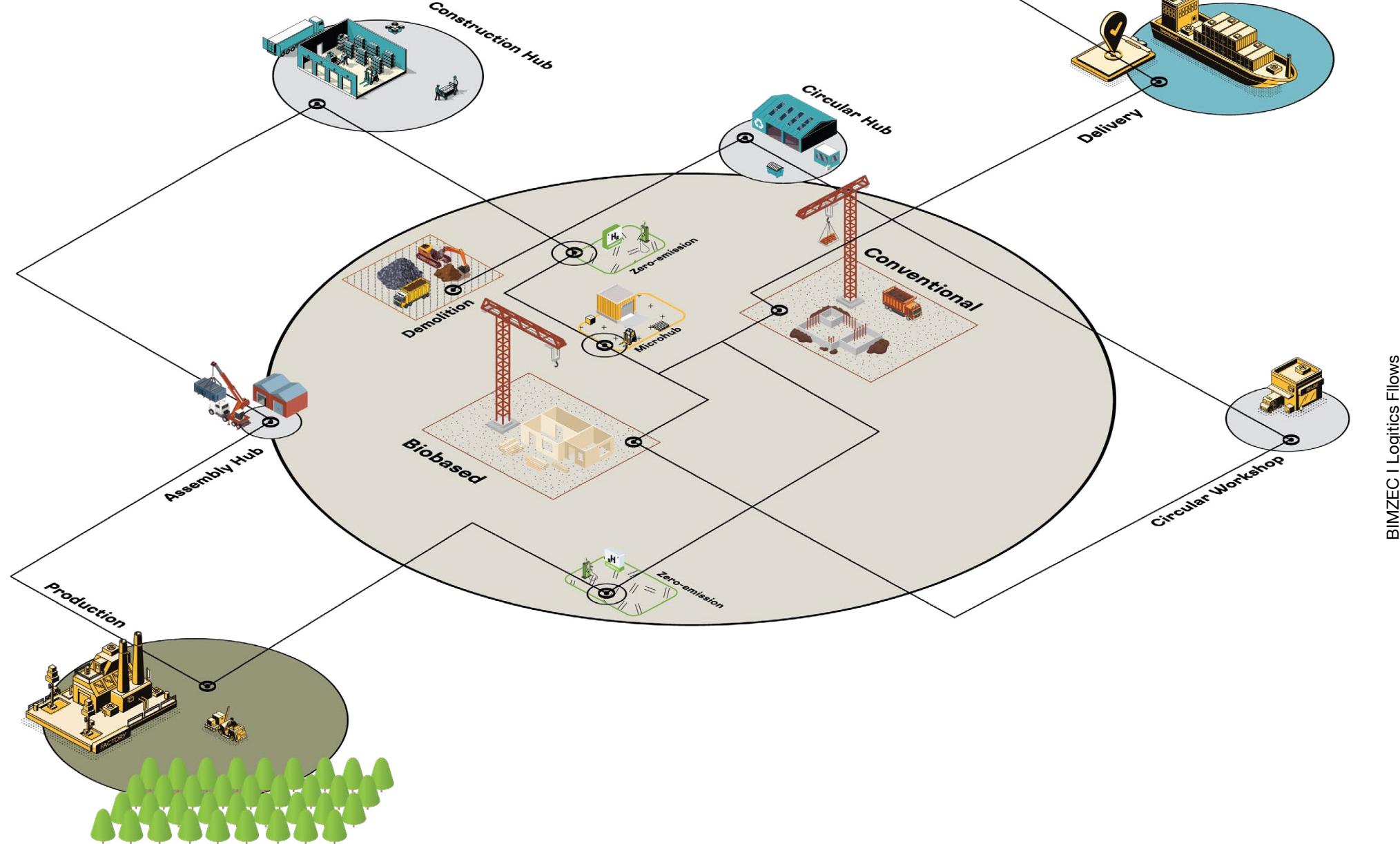
Amsterdam Logistic Cityhub (ALC) I CTP

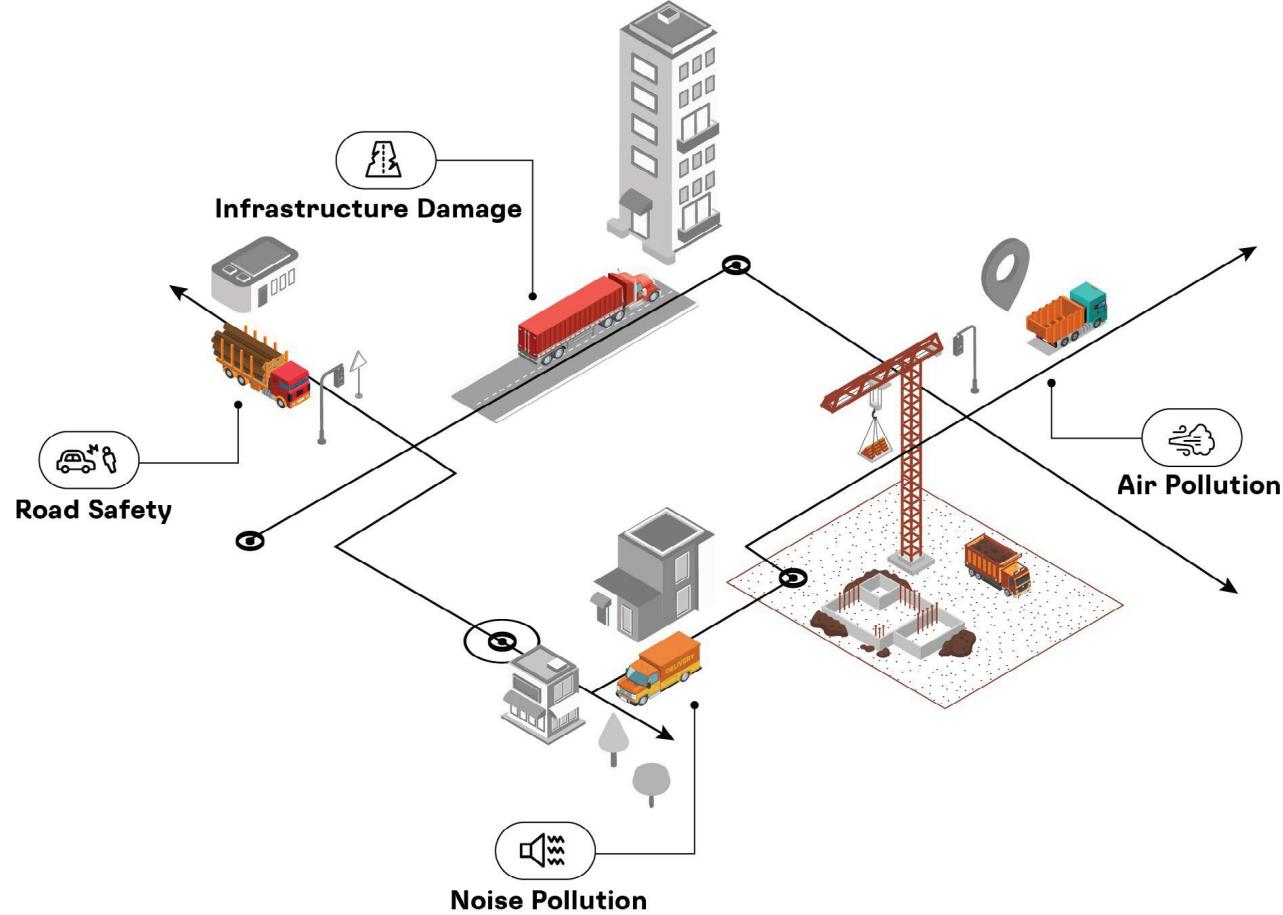


Construction Hubs | Macrohub

2

Strategies for efficient low-emission construction logistics





BIMZEC I 4 Urban Effects

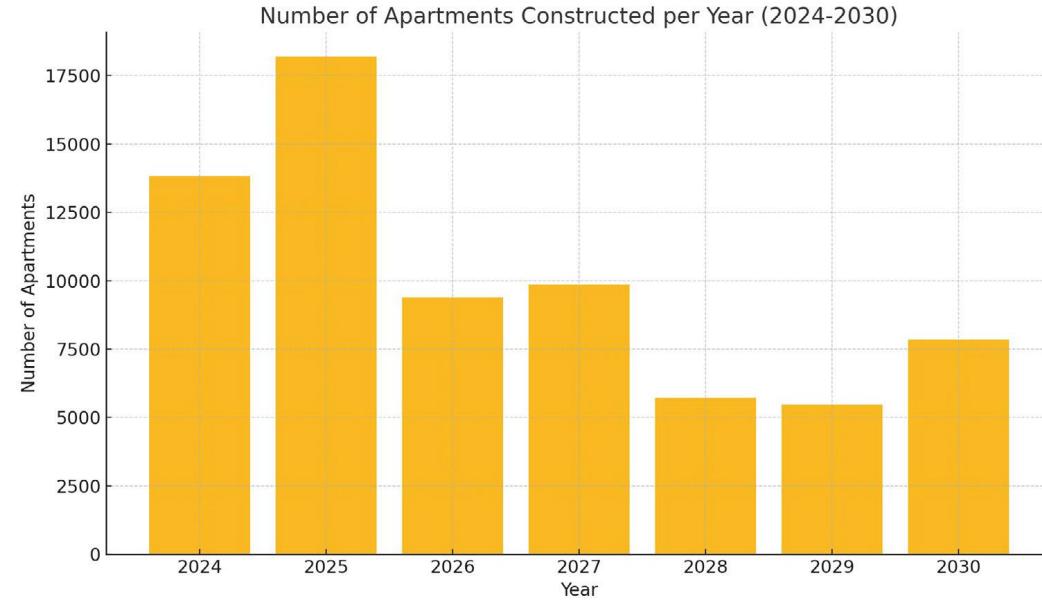
3

Urban effects of these strategies

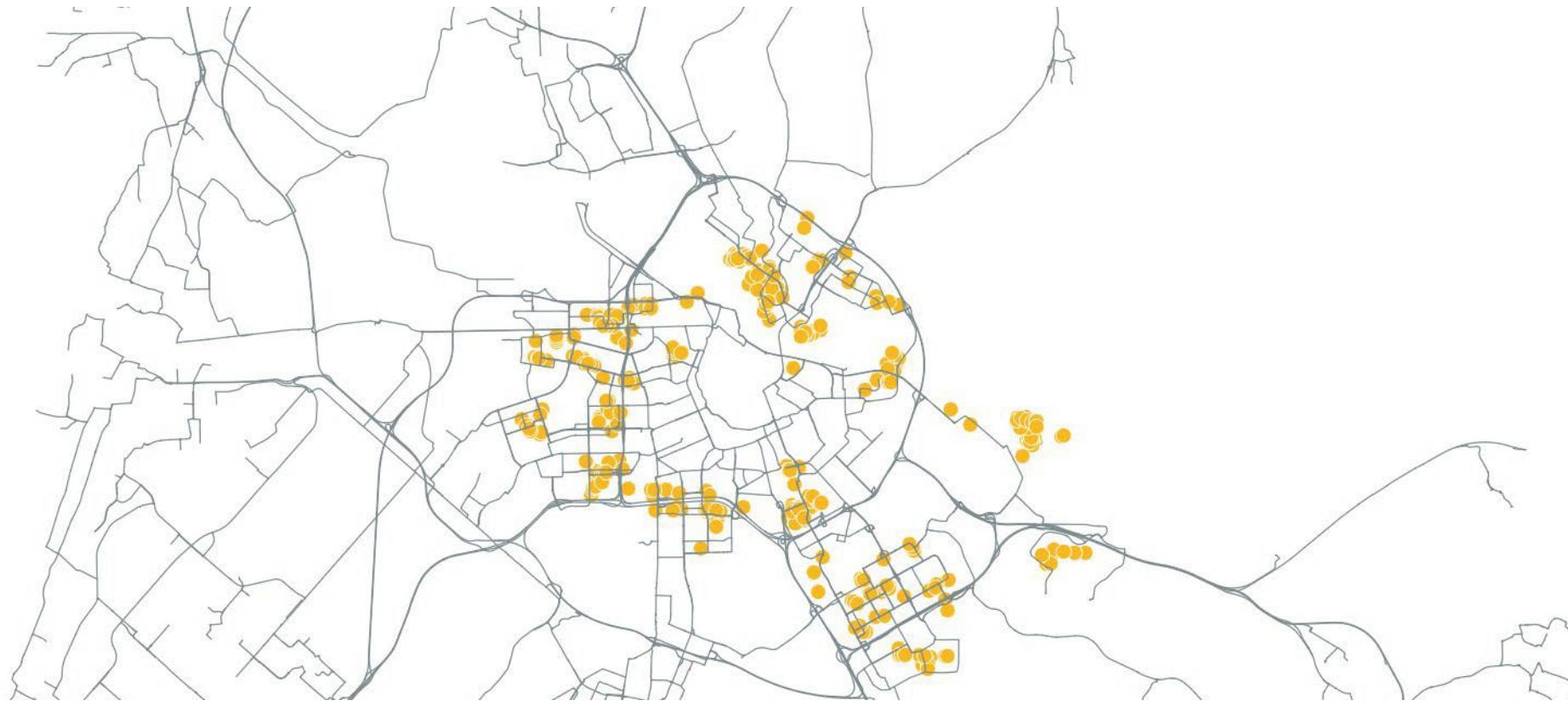
input: highrise construction for the coming 10 years in Amsterdam



output: emissions, materials, transport movements



70.000
number of housing units to be built in next 10 yrs in AMS



agents | construction sites



agents | suppliers



agents | demolition sites



agents | construction hubs

Hub network - no hub, centralized, decentralized

Transportation type - road, water, rail

Fuel type - diesel, semi, electric

Biobased type - conventional, biobased

Modularity type - conventional, modular

Circularity type - none, semi, full

six parameters



Scenarios 2023 - 2033

BAU

- 1
- 2
- 3
- 4
- 5
- 6

	Hub Network	Logistics Network	Trucks Type	Materials Type	Modularity	Circularity
1	none	road	diesel	conventional	conventional	conventional
2	centralized	road + water	diesel	conventional	conventional	conventional
3	centralized	road + water	semi	conventional	conventional	conventional
4	centralized	road + water	semi	biobased	conventional	conventional
5	centralized	road + water	electric	biobased	modular	conventional
6	centralized	road + water	electric	biobased	modular	fully circular

BIMZEC

six scenarios

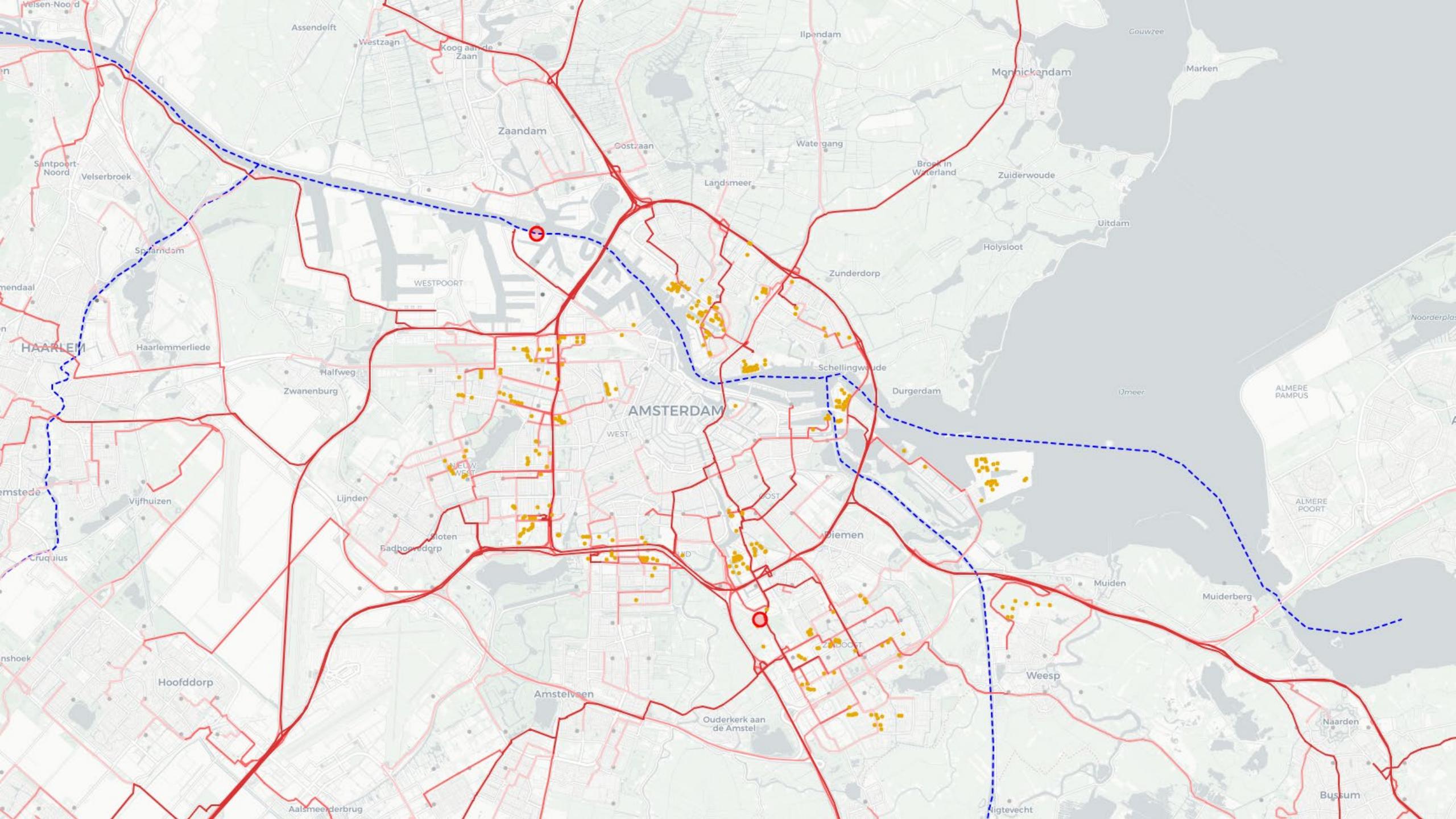
from current to future state

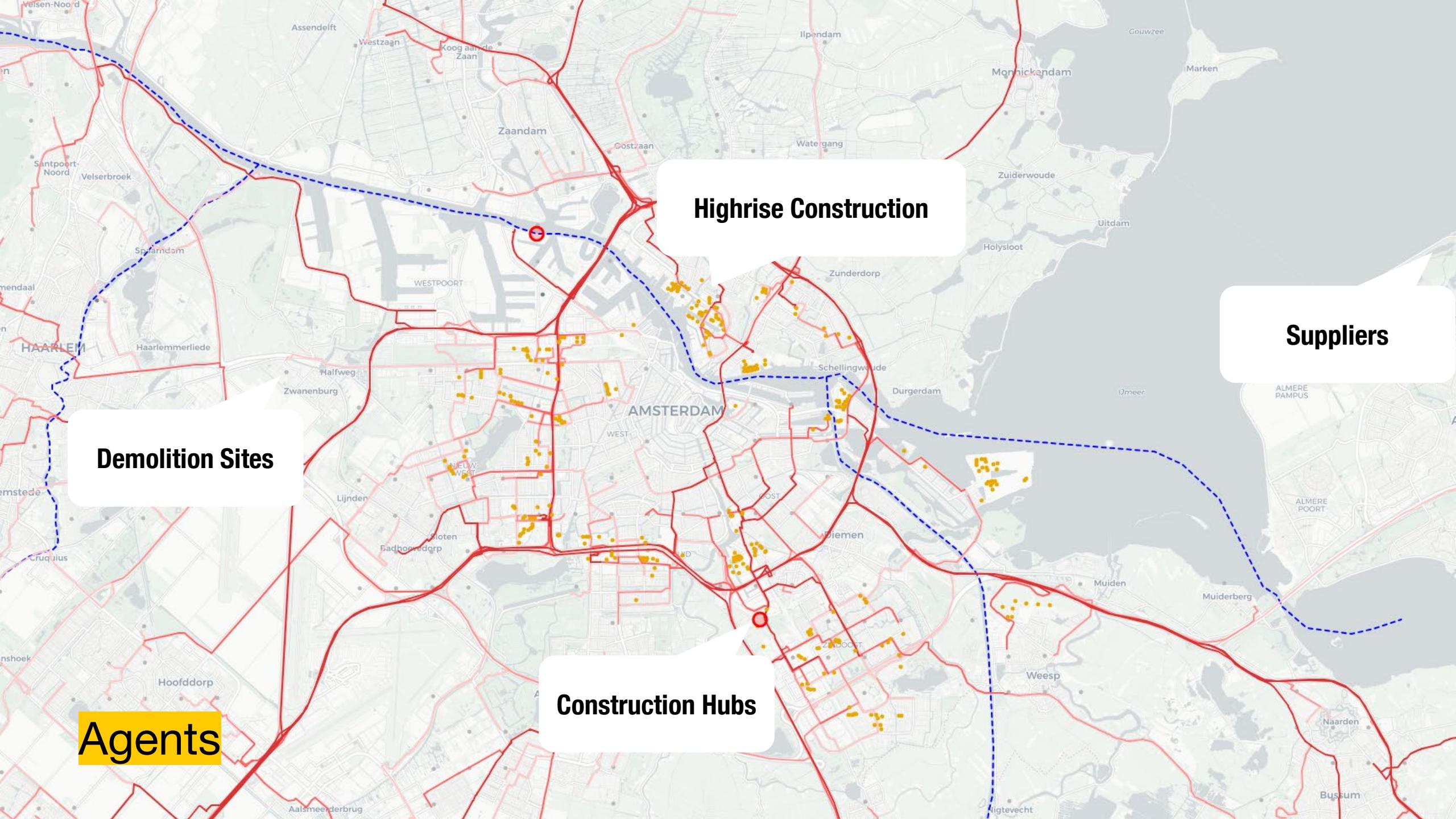
We created an agent-based*
spatial model
to test BIMZEC strategies

*Agent-based model (ABM) is a computational model for simulating the **actions and interactions** of autonomous **agents** in order **to understand the behavior** of a **system**.

- 
- 1) **Material flow:** suppliers (or demolition sites) ► hubs► construction sites
 - 2) **Closest** hubs / suppliers / demolition sites are chosen
 - 3) **Transport emissions** only

model running....





Agents

Demolition Sites

Hightrise Construction

Suppliers

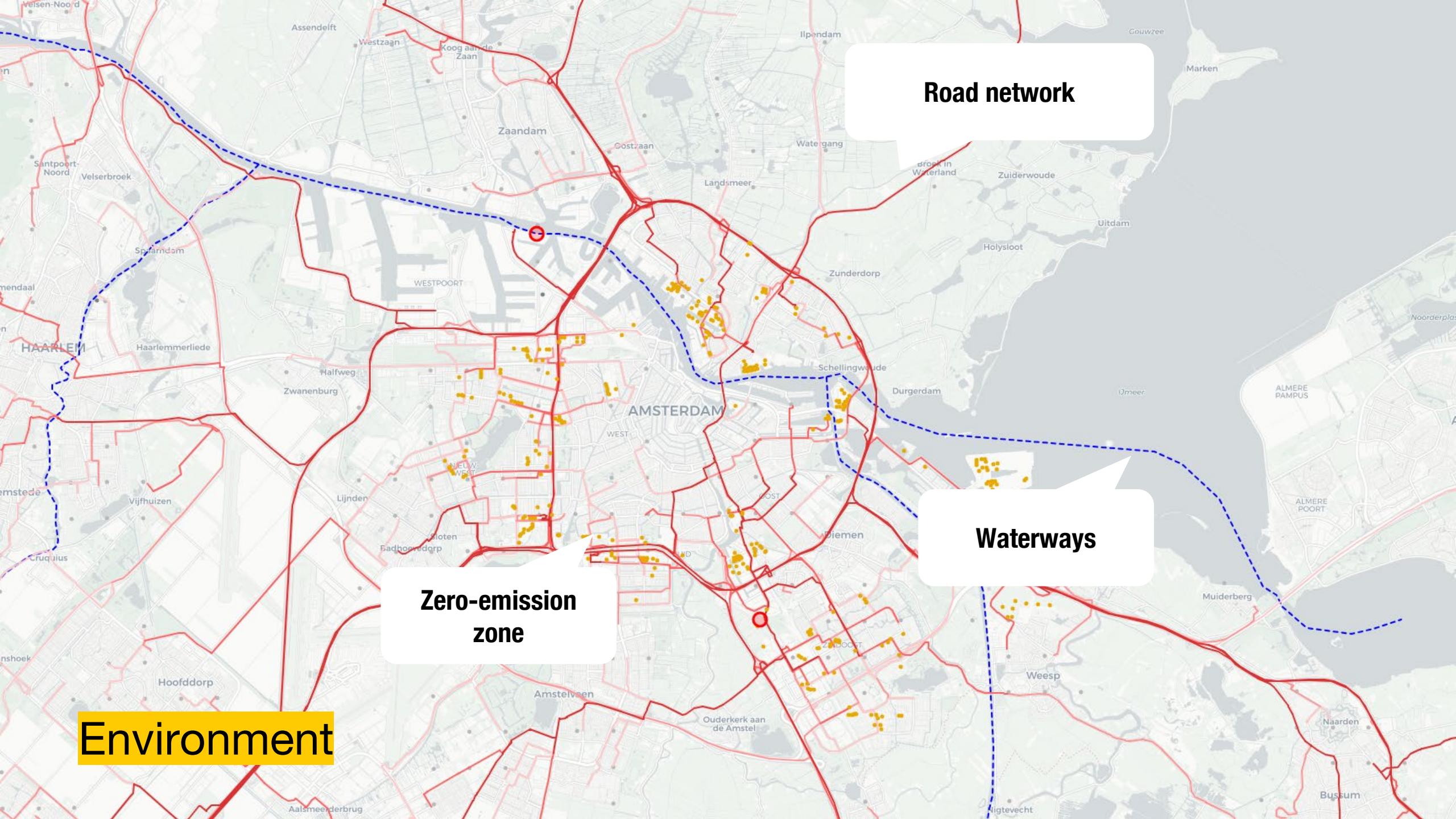
Construction Hubs

Environment

**Zero-emission
zone**

Road network

Waterways



Data landscape

**Demolition Sites –
Locations, amounts of
material**

**Logistics – vehicle
types, load
percentage, capacity**

**Emissions – quantities per
km/vehicle/weight**

**Construction Sites –
locations, size, year**

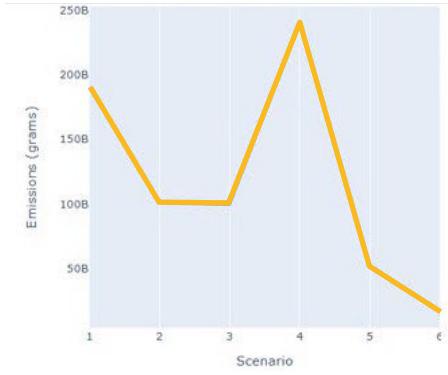
**Hubs
functions/locations**

**Building types – material
composition of
conventional, biobased,
modular buildings**

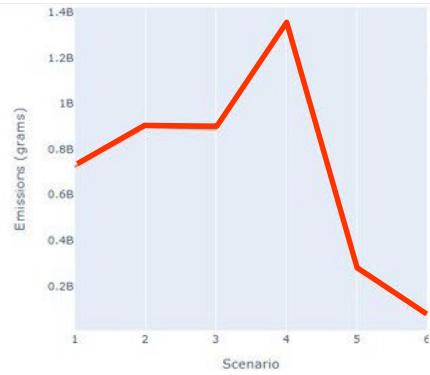
**Suppliers – locations
of closest source**

results

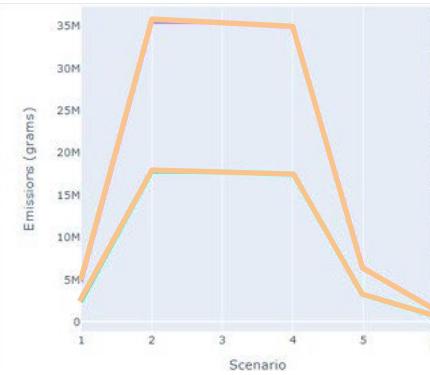
total



CO2



NOx



PM 2.5 & PM 10

emissions per scenario

- + transport kilometers
- + materials amounts

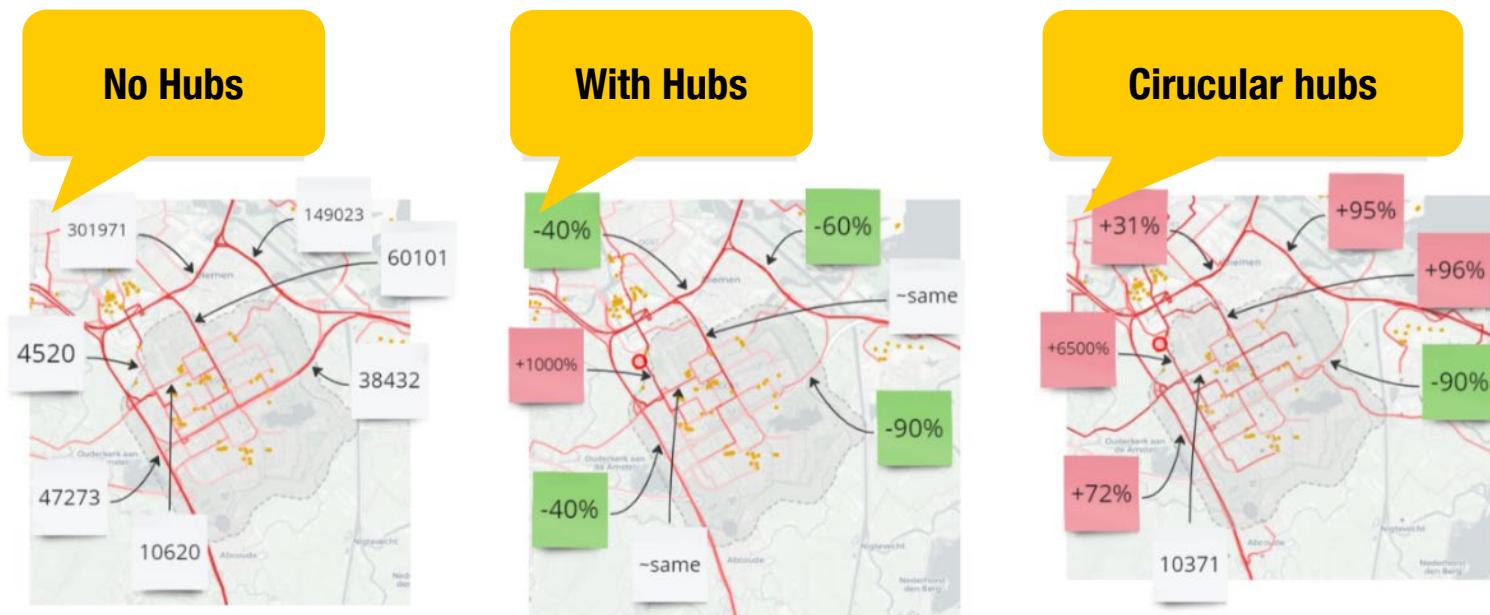
Figure 1: Impacts (CO₂, NO_x, PM emissions) for the whole model



All emissions

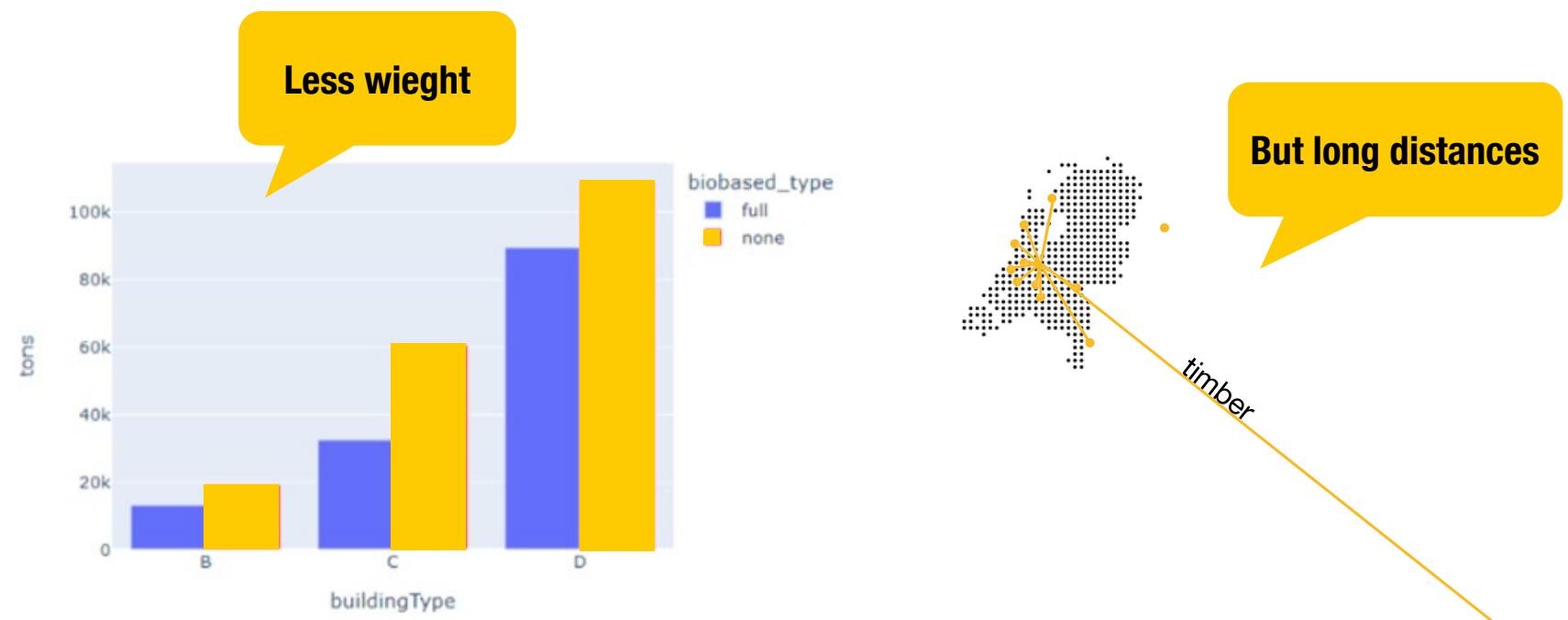


Circular economy leads to lower emissions overall, but increases local impact



findings

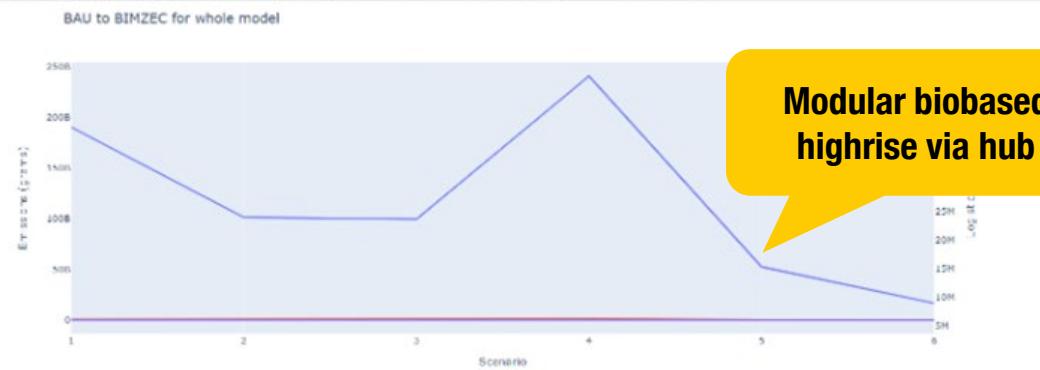
Biobased buildings lead to higher emissions, unless circular



findings

Modular buildings result in 50% lower emissions

Figure 1: Impacts (CO₂, NOx, PM emissions) for the whole model



findings



DERIX Modular Solutions

Zero-emissions transport does not significantly lower overall emissions

Figure 1: Impacts (CO₂, NOx, PM emissions) for the whole model



ZE Vehicles for ZE zone deliveries

findings

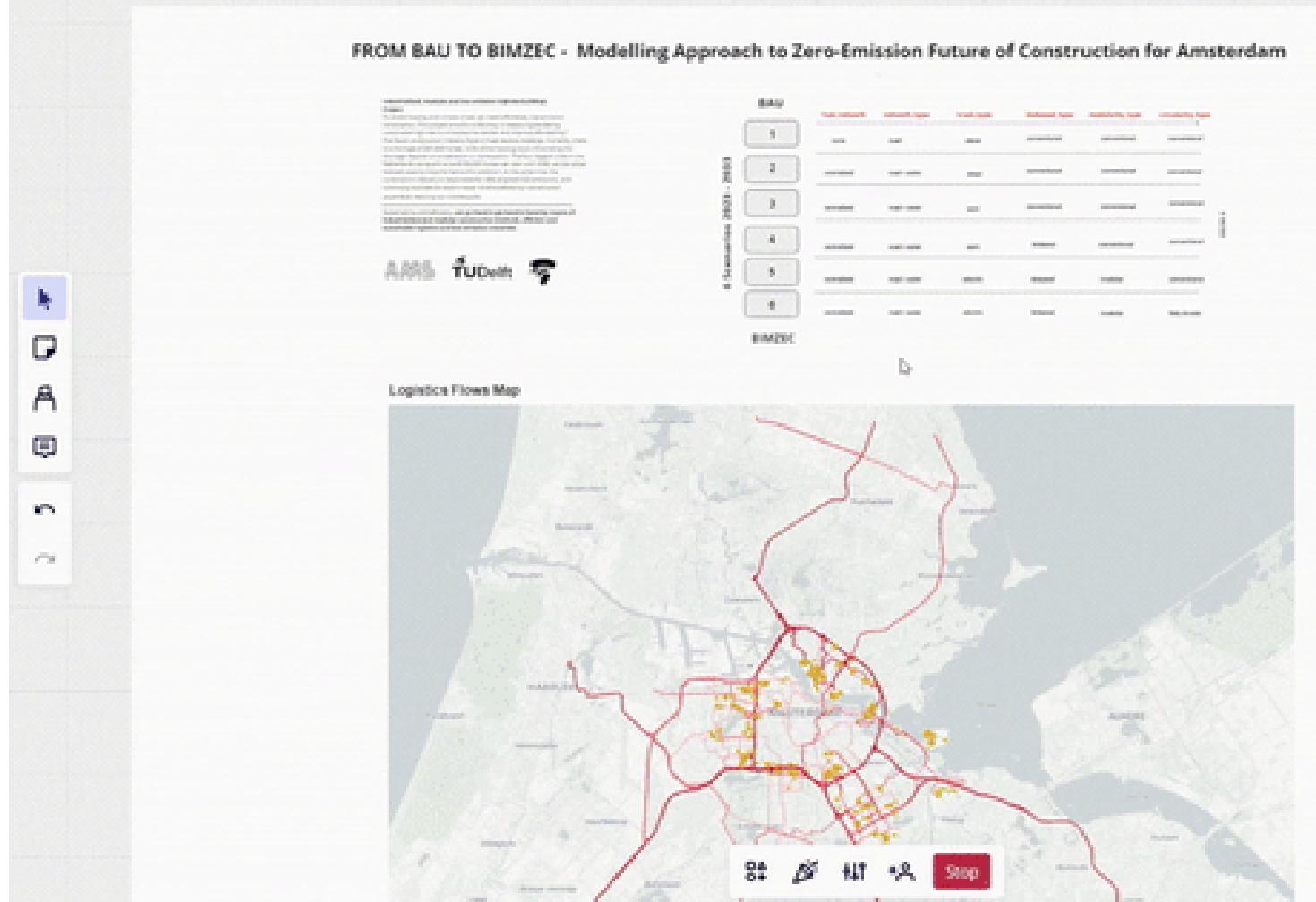


Zero-emission charging at ALC hub

- Data quality – e.g. materials composition
- Simplification – e.g. no multi-stop deliveries
- Validation – e.g. tests with experts
- Indirect effects – e.g. impact on the city

model limitations

BIMZEC solutions in real-world **living labs**
Involving public and private **stakeholders**
Impact on **urban environment**
Potential of **hubs** development



BIMZEC next?



Thank you

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Presentation content

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