research project (2023)

BIMZEC!

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

A modelling approach

TU Delft

Hogeschool van Amsterdam

AMS
AMSTERDAM INSTITUTE FOR ADVANCED METROPOLITAN SOLUTIONS

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“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

‘Bouwstop’ in North Brabant I Omroep Brabant 2023

Research Problem

Emissions CO_2, NO_x, PM...

Construction Materials I Haut I
ARUP

(Highrise) Construction

Haut Building I 73 meter I Amsterdam I
ARUP

Process Solutions > Logistics

for low-emission construction

Biobased **Modular** **Circular** **Zero-emission**

solutions

BIMZEC!

#**B**iobased #**I**ndustrialized #**M**odular #**Z**ero-**E**mission #**C**ircular
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

1

Micro Hub
local inner city

from two 2D to 3D
modular construction
Assembly Hub

e-charging
hydrogen tanking
from fossil to clean
Clean Energy Hub

circular economy
material flows from the city
Circular Hub

Introduction and use of construction hubs

Amsterdam Logistic Cityhub (ALC) I CTP

Construction Hubs I Macrohub

BIMZEC I Logitics Fllows

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**

logistics

output: **emissions, materials, transport movements**

70.000

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

agents I contruction sites

agents **I suppliers**

agents **I 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

	Hub Network	Logistics Network	Trucks Type	Materials Type	Modularity	Circularity
BAU						
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....

Assendelft
Westzaan
Koog aan de Zaan
Ilpendam
Monnickendam
Marken
Zaandam
Wateringen
Landsmeer
Zuiderwoude
Uitdam
Holysloot
Zunderdorp
Santpoort-Noord
Velserbroek
Spaarndam
WESTPOORT
HAARLEM
Haarlemmerliede
Halfweg
Zwanenburg
Schellingwoude
Durgerdam
IJmeer
AMSTERDAM
WEST
NIEUW-WEST
OOST
Lijnden
Vijfhuizen
Badhoevedorp
Diemen
Muiden
Muiderberg
ALMERE PAMPUS
ALMERE POORT
Weesp
Hoofddorp
Amstelveen
Ouderkerk aan de Amstel
Naarden
Bussum
Aalsmeerderbrug

Highrise Construction
Suppliers
Demolition Sites
Construction Hubs
Agents
Assendelft
Westzaan
Koog aan de Zaan
Ilpendam
Monnickendam
Marken
Zaandam
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Naarden
Bussum
Hoofddorp
Aalsmeerderbrug
Santpoort-Noord
Velserbroek
Spaarndam

Road network
Waterways
Zero-emission zone
Environment
Assendelft
Westzaan
Koog aan de Zaan
Ilpendam
Gouwzee
Marken
Zaandam
Oostzaan
Wateringen
Landsmeer
Zuiderwoude
Uitdam
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Naarden
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Aalsmeerderbrug

Emissions – quantities per km/vehicle/weight
Construction Sites – locations, size, year
Suppliers – locations of closest source
Demolition Sites – Locations, amounts of material
Building types – material composition of conventional, biobased, modular buildings
Logistics – vehicle types, load percentage, capacity
Hubs functions/locations
Data landscape
AMSTERDAM
Zaandam
Ilpendam
Monnickendam
Marken
Zuiderwoude
Uitdam
Holysloot
Zunderdorp
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Assendelft
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Wateringen
Ijmeer
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Naarden
Bussum
Hoofddorp
Aalsmeerderbrug
Nigtevecht

total

CO2

NOx

PM 2.5 & PM 10

emissions per scenario

+ transport kilometers
+ materials amounts

results

Figure 1: Impacts (CO2, NOX, 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

DERIX Modular Solutions

findings

Zero-emissions transport does not significantly lower overall emissions

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

Zero-emission charging at ALC hub

findings

- Data quality – e.g. materials compositon
- Simplification – e.g. no multi-stop deliveries
- Validation – e.g. testings 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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