

# LOW CARBON URBANISM

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From building to district: steering  
early on embodied CO<sub>2</sub>

**BURA**

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**LOW  
CARBON  
URBANISM**

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# Introduction

The construction sector is shaped by long-established practices and carbon-intensive industries. The existing sector is in urgent need of radical reform. In the realm of buildings and materials, progress is clearly visible — some even speak of a ‘timber construction revolution’. Yet urban design and district development are lagging behind. Urban plans still rely heavily on CO<sub>2</sub>-intensive materials, while the use of an area largely determines which construction methods are feasible in the first place.

Within district development, CO<sub>2</sub> impact must be understood from multiple perspectives. The spatial structure and function of a neighbourhood are closely intertwined with material use and energy demand during construction and infrastructure works. At the same time, emissions are also shaped by the use phase and by different lifestyles — including mobility patterns, energy consumption and everyday consumption.

In this study\*, we focus primarily on the CO<sub>2</sub> impact of the construction and installation phase. We approach urban development in its broadest sense, encompassing soil, infrastructure, public space and buildings — the domains where designers have the most direct influence. This approach does not ignore the crucial interaction between the built environment and patterns of use and lifestyle. On the contrary, these relationships form an essential backdrop to our analysis.

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\* This study is an initiative of BURA, LEVS and Urban Climate Architects, developed between April 2024 and January 2026.

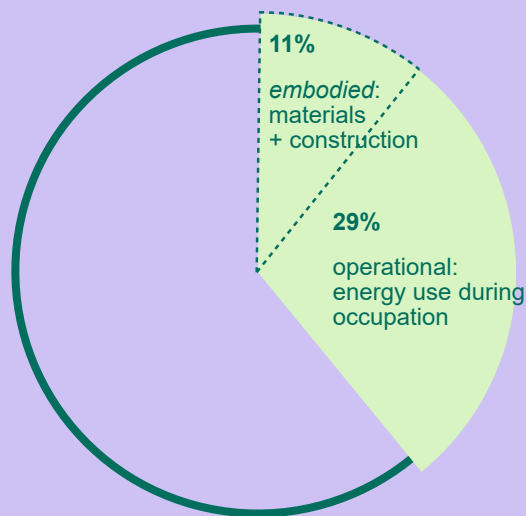
# At a Glance

The built environment accounts for

# 40%

of total CO<sub>2</sub> emissions in the Netherlands.

© DGBC



*Low Carbon Urbanism* represents a **new way of thinking about urban development.**

How do we design not only buildings, but entire neighbourhoods and cities, with the lowest possible CO<sub>2</sub> impact?

The aim of this research is to understand **which design decisions**, and at which moments in the process, have the greatest influence on the material-related CO<sub>2</sub> emissions of urban development.

# Our CO<sub>2</sub> budget is running out — now!

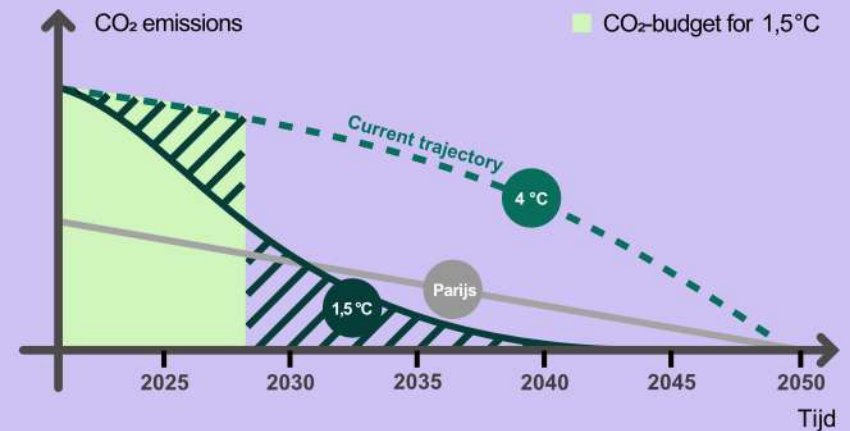
## Focus on embodied emissions

With Low Carbon Urbanism, we explore how to drastically reduce material-related emissions — embodied carbon — by targeting the urban parameters that drive them.

## The Netherlands has until 2030

To remain within the 1.5°C climate goal, the Netherlands has a severely limited CO<sub>2</sub> budget. At the current pace, that budget is likely to be used up by 2030.

Yet construction will continue regardless.



Between 2025 and 2035 alone, the ambition is to add one million new homes. If we keep building as we do today, this decade would generate roughly 120 megatonnes of embodied CO<sub>2</sub> for housing alone. That equates to 15% of the Netherlands' remaining CO<sub>2</sub> budget, spent on residential construction. The choices we make now in urban development determine:

- how much embodied CO<sub>2</sub> we emit immediately (2025–2030)
- how long that impact is locked in (fifty to one hundred years)
- whether we stay within the budget or overshoot it
- 

*Low Carbon Urbanism* makes this hidden impact visible.

# De crux: *embodied carbon*

	Operational (B6–B7)	Embodied (A1–A5)
Timing	Spread over 50 jaar	100% at completion
CO <sub>2</sub> intensity	Falling fast	Remains high
2035 status	80% renewable energy	Still 60% fossil
Impact on the budget	Counts later	Counts in full <b>NOW</b>
Design influence	Indirect (behaviour)	Direct (100%)

This is what we thought — but the balance has tipped.

We now recognise the full impact of embodied CO<sub>2</sub>. The balance has tipped. For years, the assumption was that operational carbon (energy) represented around 70% of the impact, and embodied carbon (materials) 30%. But the Paris Agreement makes one thing painfully clear: the CO<sub>2</sub> budget runs out in 2030. We must cut embodied emissions — and **we must do it now**.

Unlike operational emissions, embodied carbon does not decline automatically due to an obvious transition or market trend. Designers have to **make deliberate choices**.

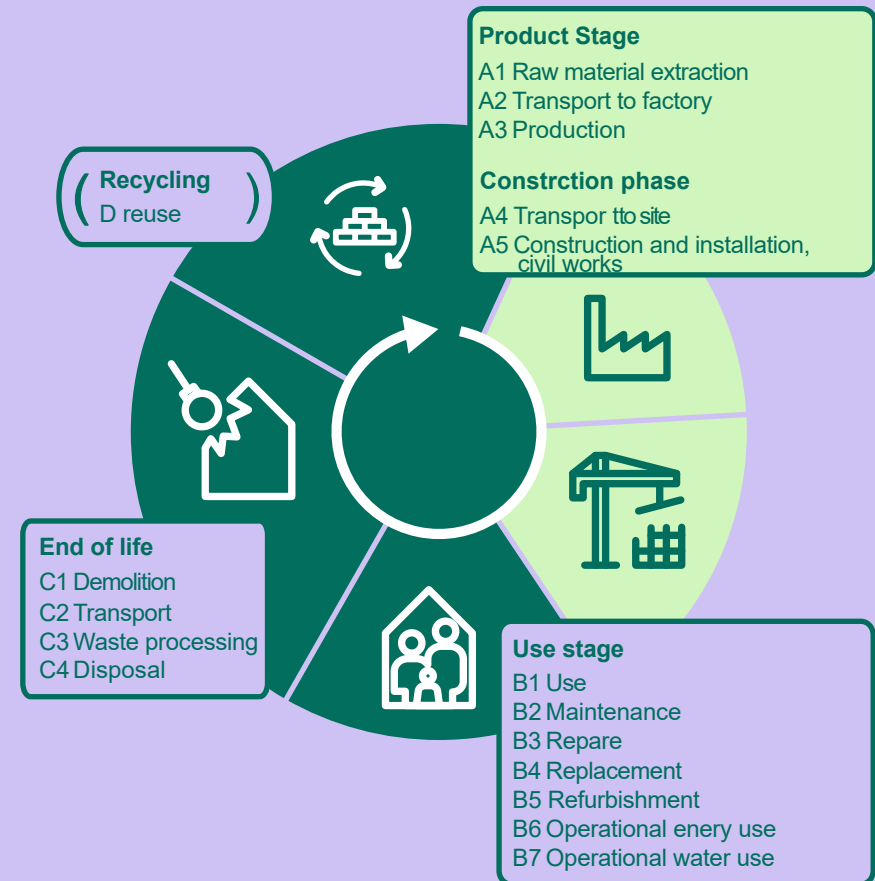
Operational emissions, by contrast, are already decarbonising as part of the energy transition — with the ambition of reaching around 80% renewable electricity by 2030. This transition also requires materials, but designers have less direct influence over it.

Designers determine embodied CO<sub>2</sub> directly through choices about space, materials, structure, mobility infrastructure and dwelling sizes. Human behaviour, on the other hand, is strongly shaped by culture, income and lifestyle — think travel patterns, appliance ownership and food consumption.

# Early choices, lasting impact

The largest CO<sub>2</sub> impact in urban development sits in the **physical creation** of an area and the associated labour, materials and transport — in other words: **phase A1–A5** in the lifecycle diagram. Every spatial choice made in this phase has direct material consequences. This study focuses on early-stage design decisions.

A1–A5 is the game changer.



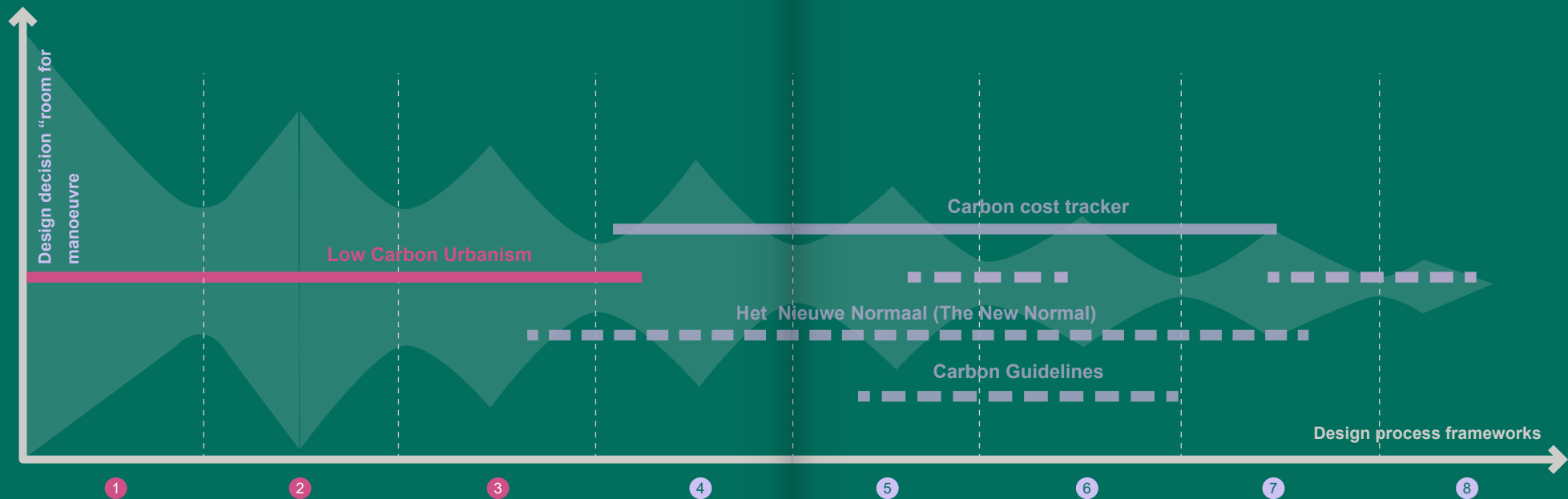
# Where do we stand today?

- 1 **Urban policy (region/city)** — ambitions and strategic choices
- 2 **Urban vision (district/neighbourhood)** — densification, functions
- 3 **Urban plan (neighbourhood level)** — frameworks, rules, structure
- 4 **Urban block / ensemble** — typologies, massing, methodology ←  
Carbon Cost Tracker starts here
- 5 **Building (scheme-detailed design)** — architectural development
- 6 **Building (technical design)** — technical development
- 7 **Delivery** — construction
- 8 **Use phase** — maintenance and occupation

In recent years, our sector has developed a wide range of tools to better understand and reduce the CO<sub>2</sub> emissions of buildings. Think biobased and circular materials, smarter energy use, and innovative construction methods.

At the scale of urban design, however, **an integrated approach is still missing**. It is precisely during the phase of urban policy and the drafting of area visions that much of the eventual spatial layout — and therefore its impact — is already determined. By the time an urban plan is being developed, decisions about where and how much we build are often fixed.

Low Carbon Urbanism fills this gap by making the **impact of urban design choices** visible in early phases — from infrastructure and soil use to density, public space and mobility.



We already integrate many sustainability measures at this stage. ▶

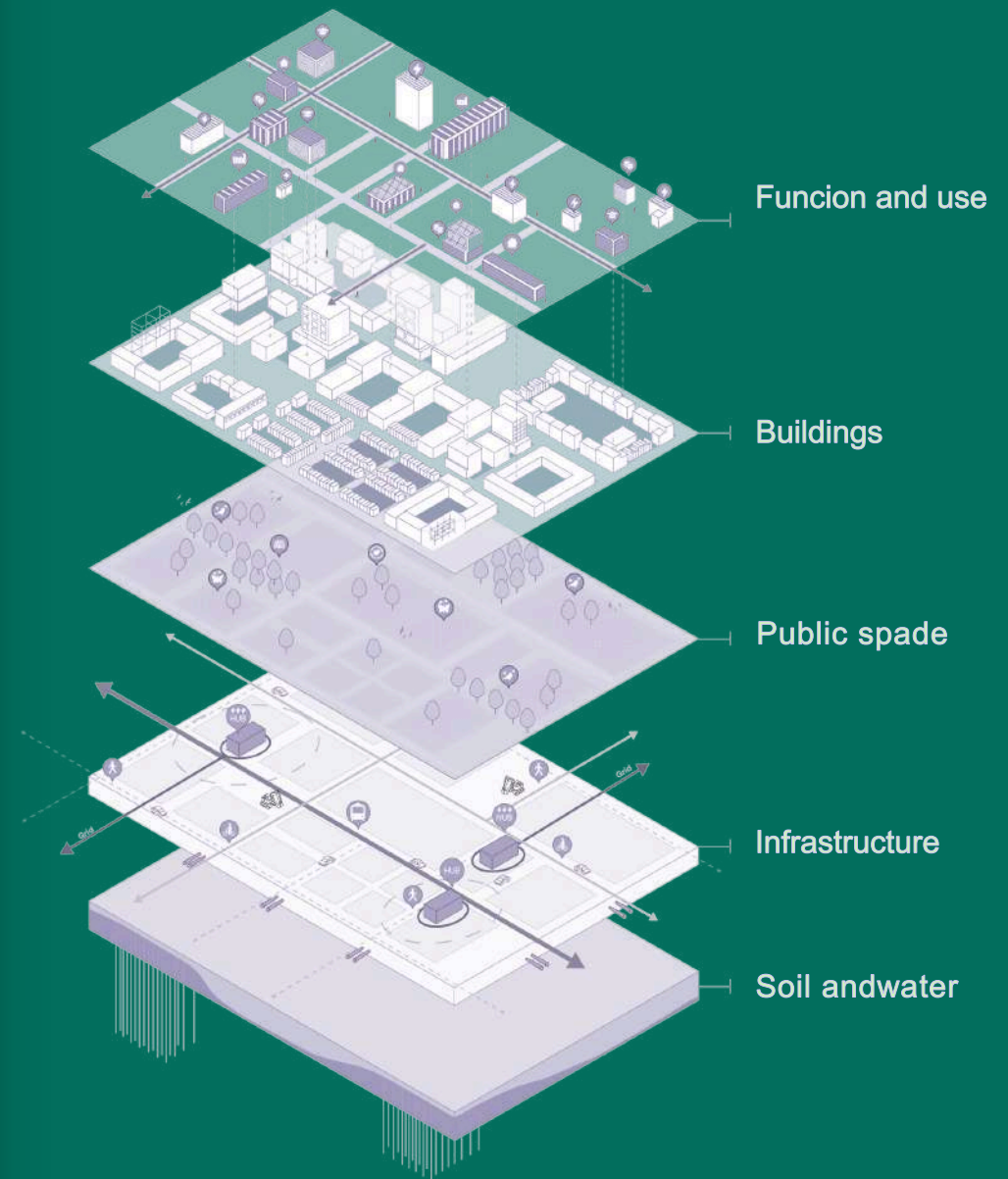
However, this is where the most important spatial decisions are locked in — while a clear, emissions-driven approach is often still missing: ▼

- 1 Urban Policy (district/city)**  
Strategic choices relating to, among other things, densification, development locations, infrastructure, soil and functional mix.
- 2 Urban Vision (district/neighbourhood)**  
Urban ambitions translated into location-specific aims such as spatial quality, density, functions and the character of public space.
- 3 Urban plan (neighbourhood level)**  
Broader ambitions turned into concrete frameworks, rules of play and a definitive spatial structure.

- 4 Urban block**  
Translation of the urban design plan into a block or ensemble: typologies, massing and construction methodologies.
- 5 Building (scheme-detailed design)**  
Architectural development including layouts, materials, structure and appearance.
- 6 Building (Technical design)**  
Technical development and optimisation of materials and detailing.
- 7 Delivery / Construction**
- 8 Use phase**  
Post-completion: maintenance and occupation.

# Layered emissions

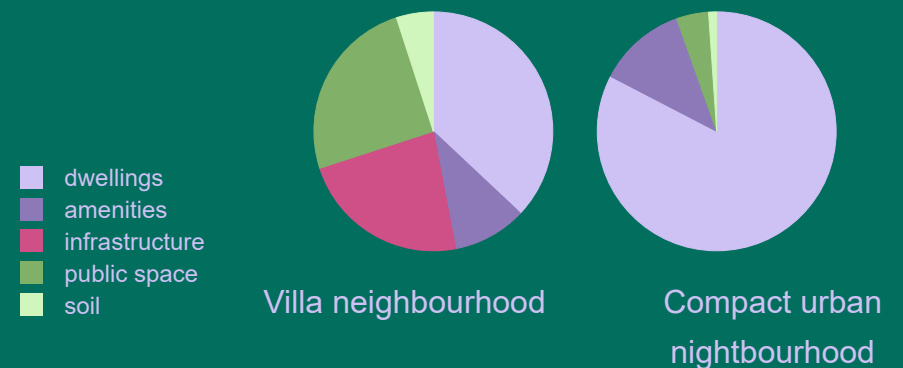
Even in the earliest design phases, the material “base layers” already shape functions and patterns of use. That is why this research explores how to express both dimensions — hard, material-related data and the effects on urban use as predictable CO<sub>2</sub> emissions.



# From window frame to road surface

In urban development, embodied emissions do not come from buildings alone. They also arise from:

- **Buildings**  
Homes, amenities, car parks
- **Public space**  
Hard landscaping (tiles, paving), vegetation (topsoil, sand), street furniture
- **Infrastructure**  
Roads (asphalt, sub-base), cycle tracks, pavements, sewers, cables (electricity, telecoms, water), street lighting
- **Soil and water**  
Earthworks, foundations / piling, drainage, water storage and the balance between these categories can vary dramatically.

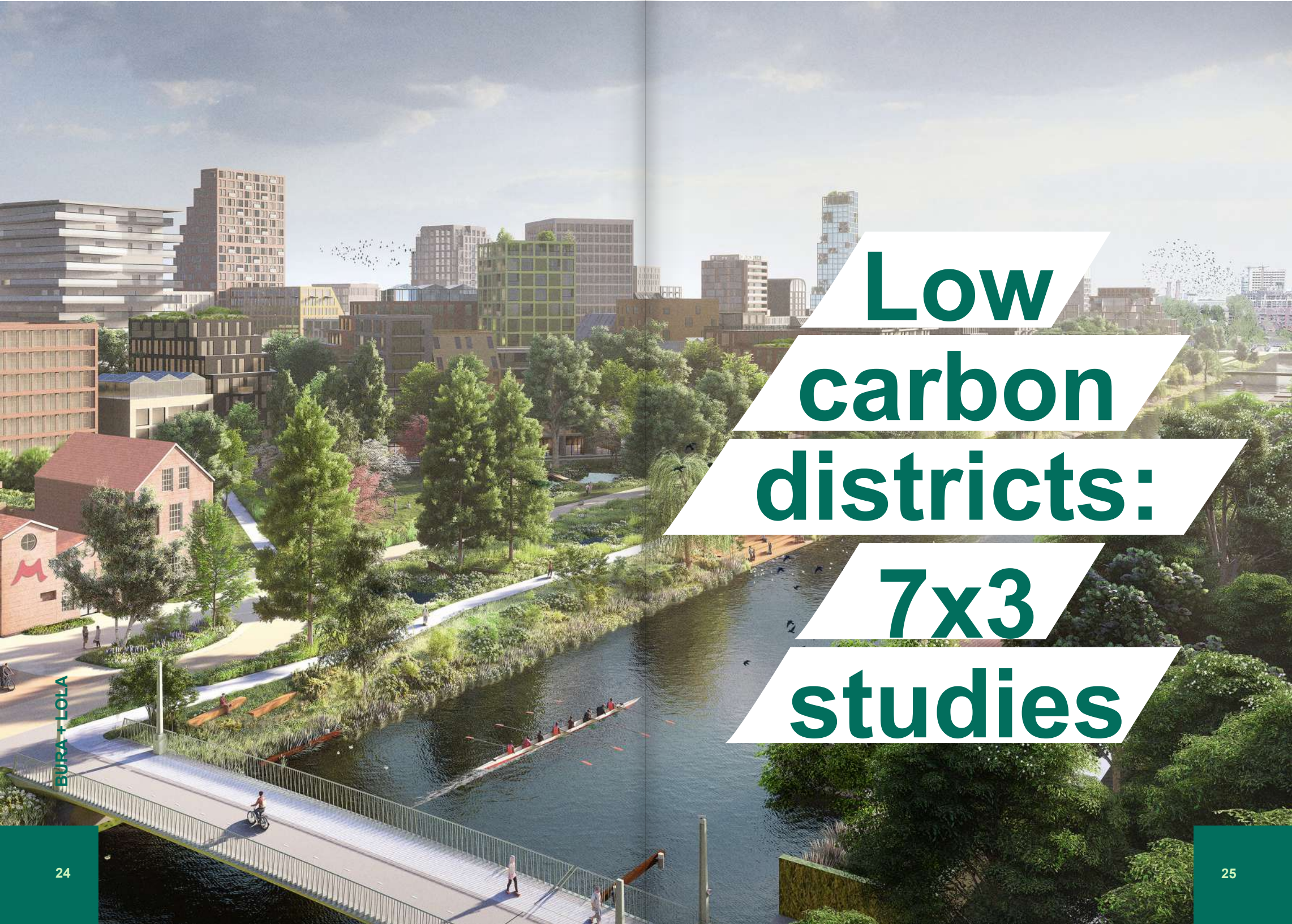


Depending on the urban design choices, one neighbourhood can require twenty times more infrastructure and public space per home than another with major consequences for emissions.

Urban development is therefore about much more than a simple “concrete or timber” debate. It is primarily about:

- **where we build** (new build areas vs existing urban fabric)
- **how densely we build** (infrastructure per home)
- **how large we build** (m<sup>2</sup> per person)

These choices are made in phases 1–3: still partly conceptual, but with decisive implications for the “hard” design decisions later in the process.

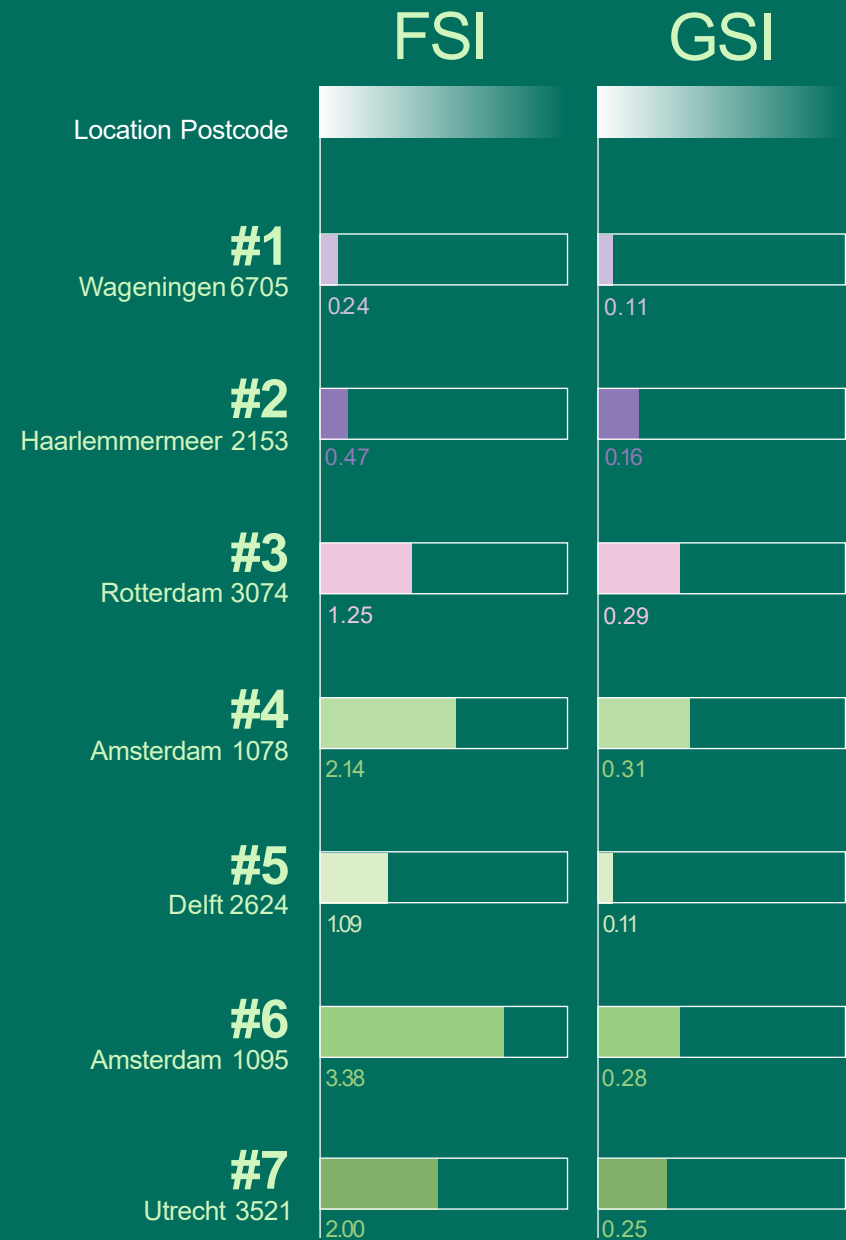


**Low  
carbon  
districts:  
7x3  
studies**

# Our approach

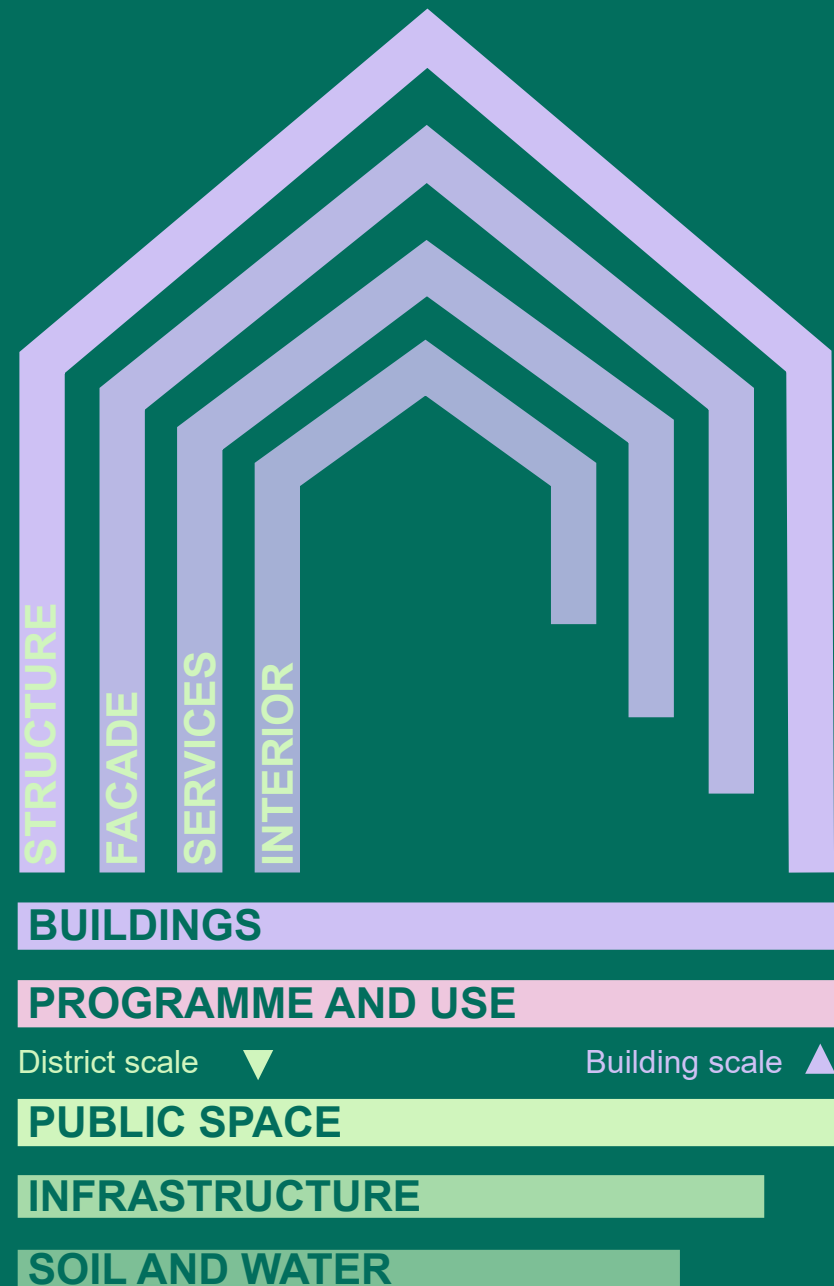
We Analysis seven area typologies, each with a distinct configuration in terms of density, housing profiles, infrastructure and public space.  
Which urban design choices have the greatest impact on total CO<sub>2</sub> emissions?

Seven Analysisd typologies:



# Steward Brand's Layers

The classic model focuses on buildings. For this research, we extend it to the area scale, where public space, infrastructure, soil and water also shape CO<sub>2</sub> impact.



# CO<sub>2</sub> across every layer



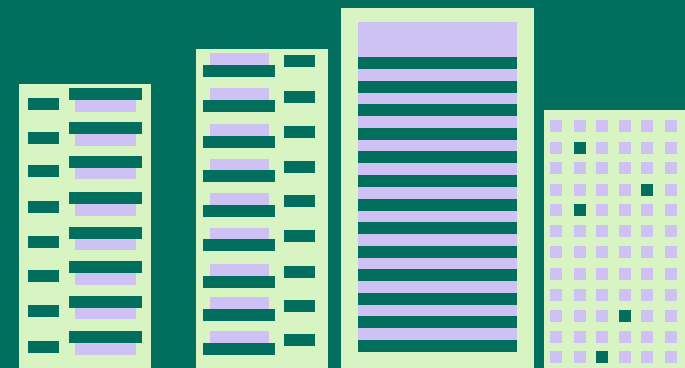
What do these five layers mean in practice? Each layer comprises concrete physical interventions with both **direct and indirect material emissions**.

## **Direct impact** (physical base)

- Buildings: how many m<sup>2</sup> of homes and amenities?
- Infrastructure: how many metres of road or services per home?
- Public space: how many m<sup>2</sup> of hard and vegetated surfaces?
- Soil: how much earthworks and foundation work?

## **Indirect impact** (Function and use)

- Function: density → required infrastructure per home
- Use: car dependence → size and number of parking spaces or garages



# Material scenarios

For each **area typology**, we model three material-use scenarios.

## Traditional

Current mainstream construction practice:

- concrete/calcium-silicate structures, precast slab floors, cavity walls with mineral wool
- public space with concrete paving, standard asphalt and concrete pipes
- minimal reuse

## Hybrid

Conventional structures with more sustainable choices:

- recycled concrete, biobased internal walls, wood-fibre insulation
- public space with geopolymer paving, biobased asphalt where feasible, reused bricks
- stepwise decarbonisation

## Biobased

Maximum renewability and a radical circular approach:

- CLT structures (timber), recycled concrete only for foundations, timber frame façades with bamboo finishes
- public space using recycled materials, biobased binders and local reuse streams



What looks  
like waste  
today  
can be  
tomorrow's  
CO<sub>2</sub> gain



## Research method:

- **three** material scenarios (traditional, hybrid, biobased)
- applied to **seven** existing neighbourhood profiles with different densities and typologies
- **21** case studies in total

We use existing postcode areas, enabling a **broad comparison based on realistic references** and built practice.

### Low density

Villa neighbourhood  
#1 Wageningen 6705



Vinex suburb  
#2 Haarlemmermeer 2153



### Medium density

19<sup>e</sup> century district  
#3 Rotterdam 3074



20<sup>e</sup> century (Plan Zuid)  
#4 Amsterdam 1078



Post-war district  
#5 Delft 2624



### High density

New-build district  
#7 Amsterdam 1095



Regeneration district  
#6 Utrecht 3521



# Spacious or compact?

From low to high density — from high to low CO<sub>2</sub>. To show how density affects carbon impact, we present the seven area typologies using the Floor Space Index (FSI): the ratio between total floor area and plot area.

One thing we can already reveal: **more density is not always better.**

- Low density requires large amounts of infrastructure and public space per home.
- Medium density allows shared infrastructure and efficient public space.
- Very high density goes hand in hand with heavy structures (high-rise) and parking garages.

**There is an optimum.**

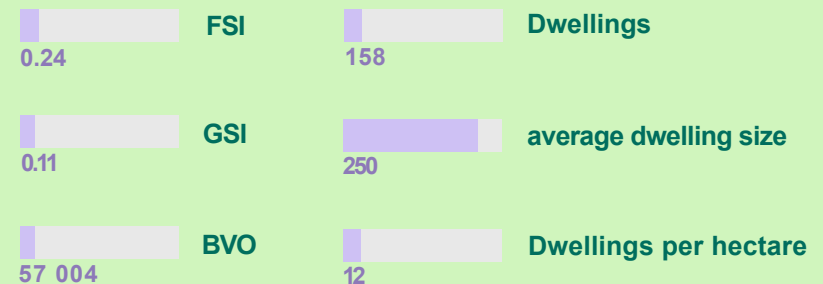
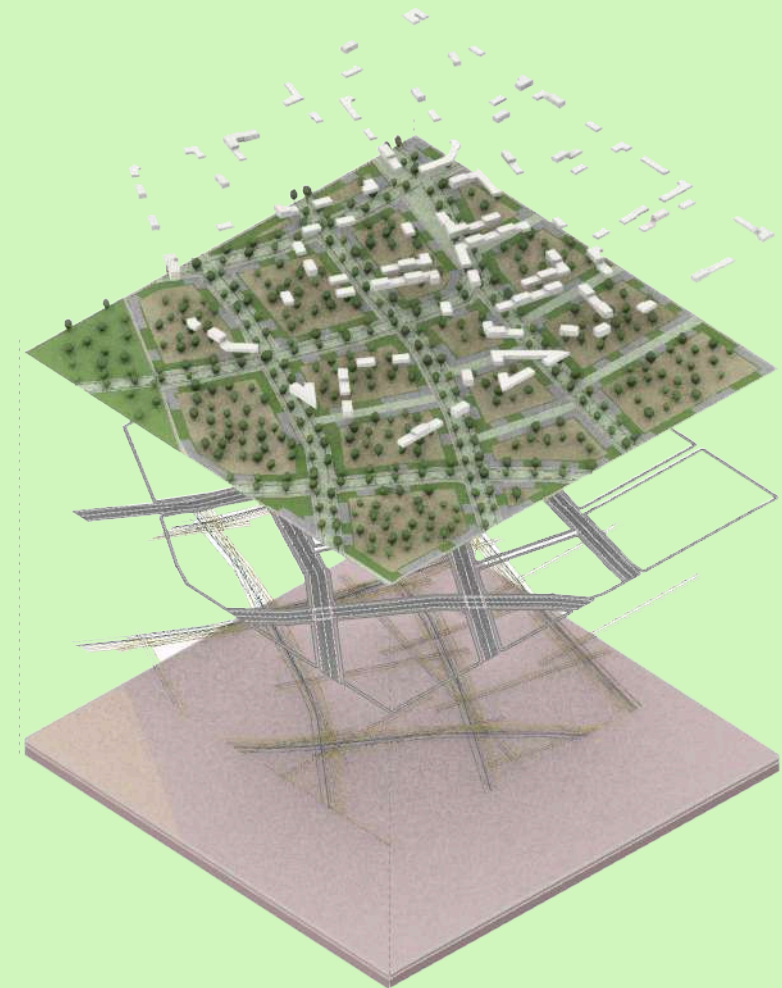
# #1

## Wageningen 6705

A spacious villa neighbourhood with very low density, typical of affluent suburban areas such as Wageningen, Heemstede or Bloemendaal. Large detached dwellings on generous plots with expansive gardens.

### Mobility & infrastructure

- Broad infrastructure with wide streets
- Multiple parking spaces per dwelling
- High car dependency due to low density
- Limited public transport provision
- Little (green) public space



## Analysis

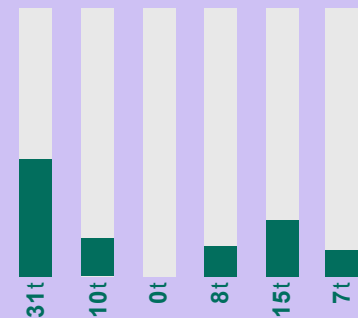
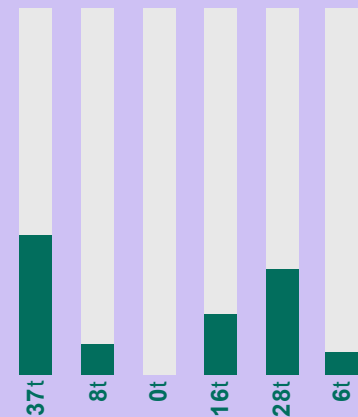
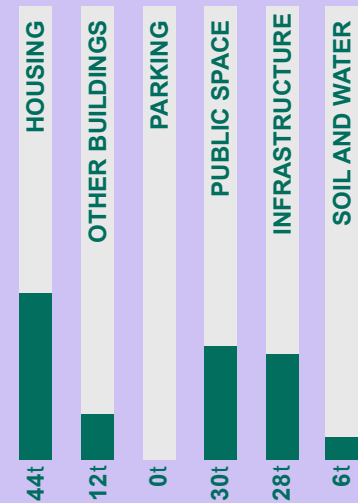
Largest CO<sub>2</sub> contributors (traditional):

- 44 t housing
- 28 t infrastructure
- 30 t public space

Why so high?

- Dwelling size: 250 m<sup>2</sup> = 2.5× the Dutch average
- Low density: 12.5 homes/ha = extensive infrastructure per home
- Extensive public realm: 30 t per dwelling from construction alone
- Biobased construction significantly reduces housing emissions (–40%), but infrastructure and public space remain decisive.

CO<sub>2</sub>  
total impact  
per dwelling



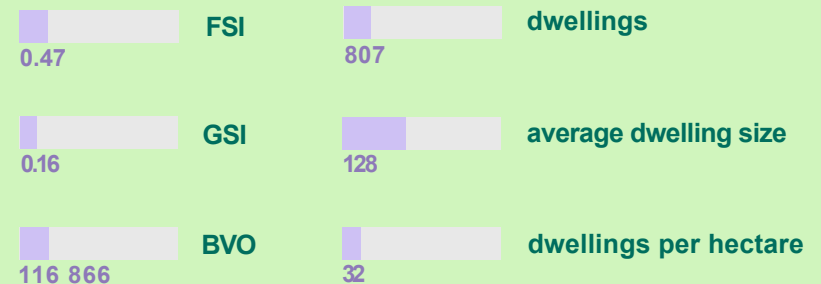
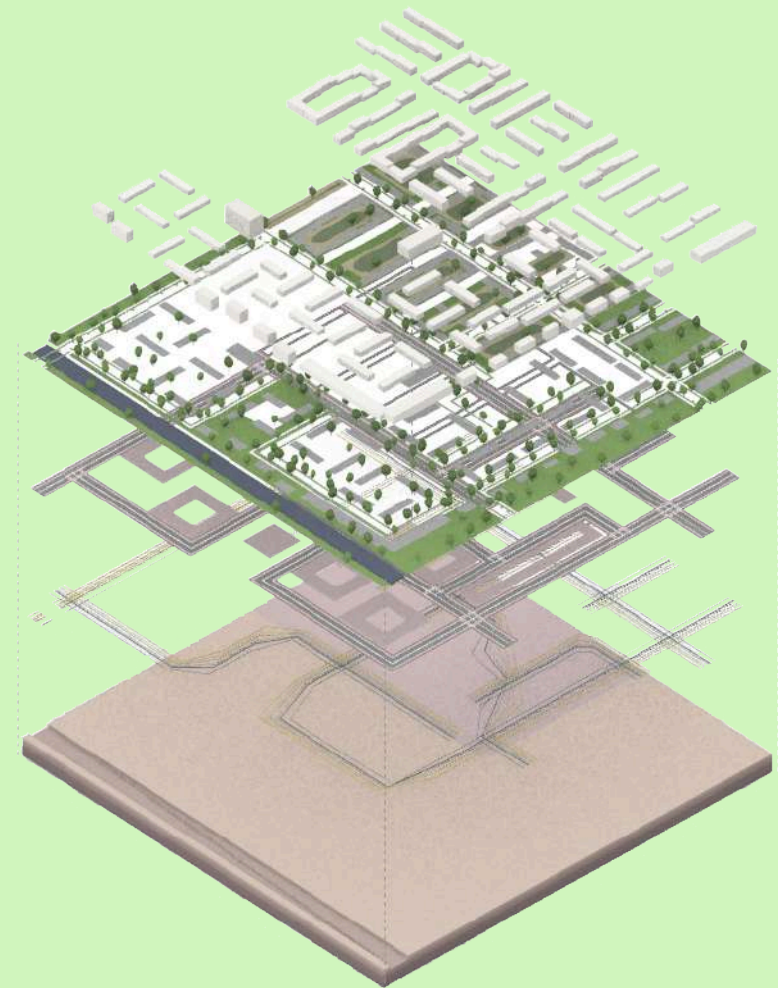
# #2

## Haarlemmermeer 2153

A typical VINEX neighbourhood from the late 1980s–1990s, with low density and a spacious layout. Predominantly single-family homes with front and back gardens, wide streets and generous parking provision.

### Mobility & infrastructure

- Wide residential streets with on-street parking
- Generous green strips and pocket parks
- Car-oriented design
- Reasonable public transport access (bus)
- Moderate cycling use due to distances



## Analysis

Roughly half the emissions of Wageningen 6705.

Why lower?

- Smaller homes (128 m<sup>2</sup> vs 250 m<sup>2</sup>) → ~50% lower building emissions
- Higher density (32 vs 12.5/ha) → ~50% less infrastructure per home
- More green provision

Still relatively high due to:

- Low density → long lengths of roads and services per dwelling
- Wide, car-oriented streets
- Generous public space

Biobased reduction  
49% (from 55t to 28t)

# CO<sub>2</sub>

total impact  
per dwelling

●●●●●●●●  
55 ton

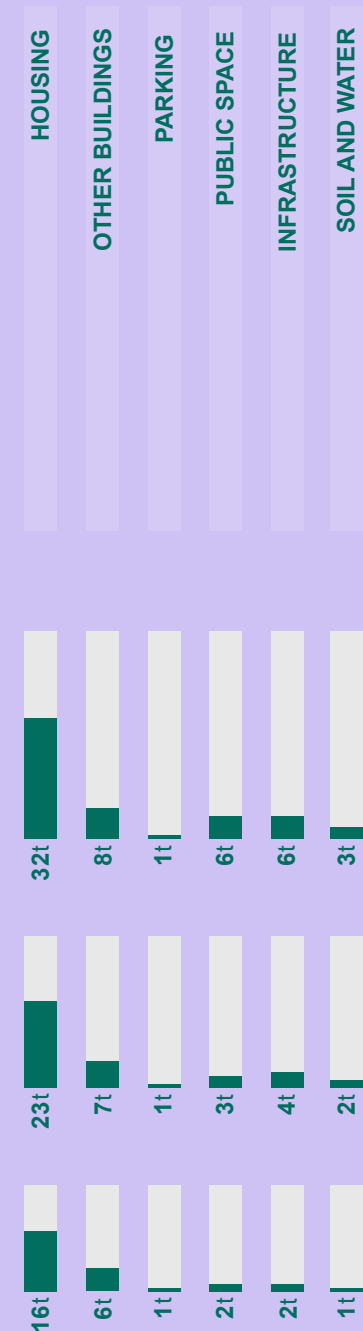
TRADITIONAL

●●●●●  
40 ton

HYBRIDE

●●●●  
28 ton

BIOBASED



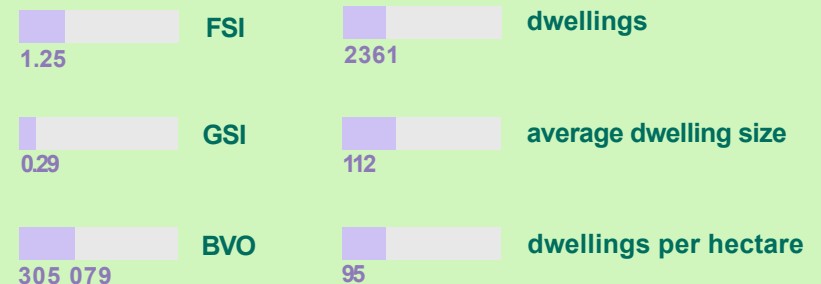
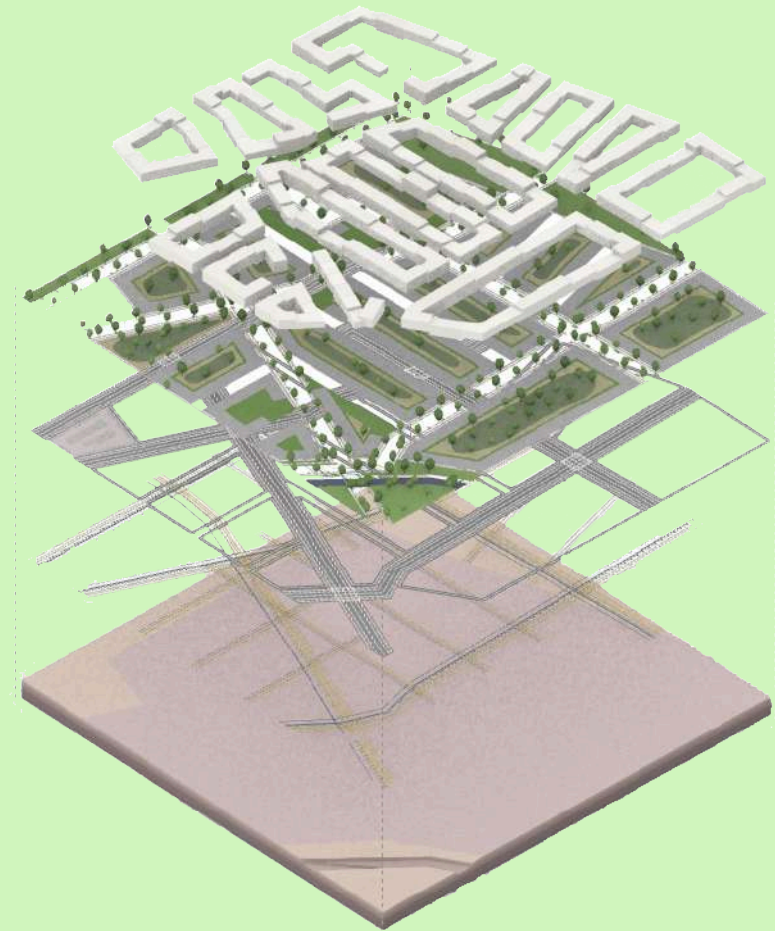
# #3

## Rotterdam 3074

A typical nineteenth-century urban extension, such as Crooswijk in Rotterdam. Comparable to Amsterdam's historic expansion belt and several districts in The Hague. Closed urban blocks with stacked housing and compact inner courtyards.

### Mobility & infrastructure:

- Narrow streets
- Limited parking provision, on-street parking only
- High density with strong public transport accessibility
- Well-developed cycling infrastructure
- Many amenities within walking distance
- Lower car dependency among residents



## Analysis

Why does this perform well?

Compact buildings enables shared infrastructure

- High density (94 homes/ha) minimises roads and services per dwelling
- Smaller-than-average dwellings (112 m<sup>2</sup>)
- Narrow streets require less material

Compared to Delft 2624 — advantages

- Functional mix (housing and retail) supports urban vitality
- Historic urban fabric provides identity

Compared to Delft 2624 — disadvantages

- Slightly lower density (94 vs 119 homes/ha)
- More public space in the form of streets and squares

### Biobased reduction

37% (49t → 31t)

**CO<sub>2</sub>**  
total impact  
per dwelling

●●●●●  
49 ton

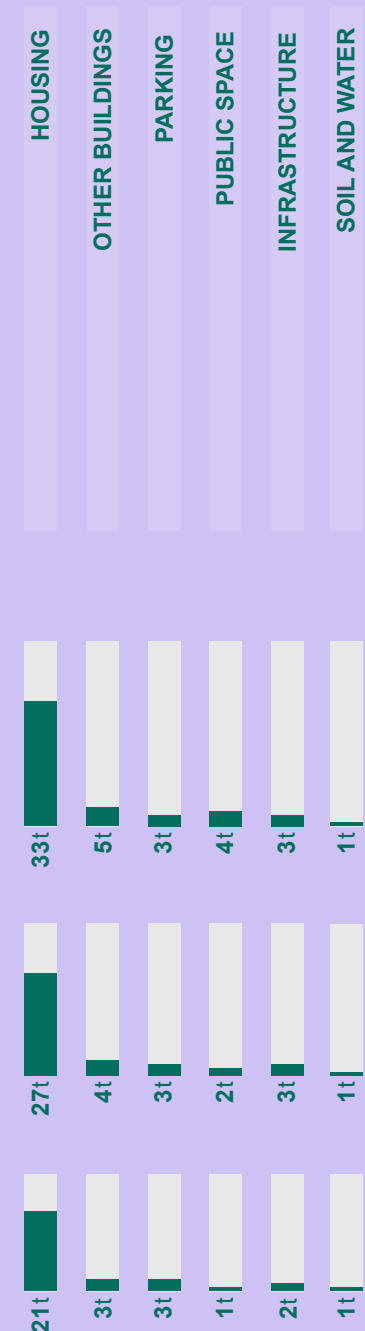
TRADITIONAL

●●●●●  
40 ton

HYBRIDE

●●●●  
31 ton

BIOBASED



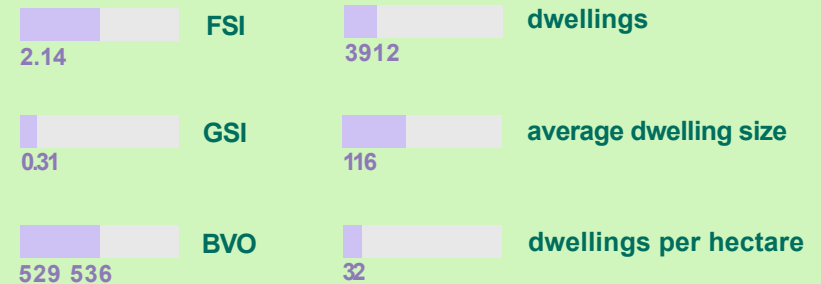
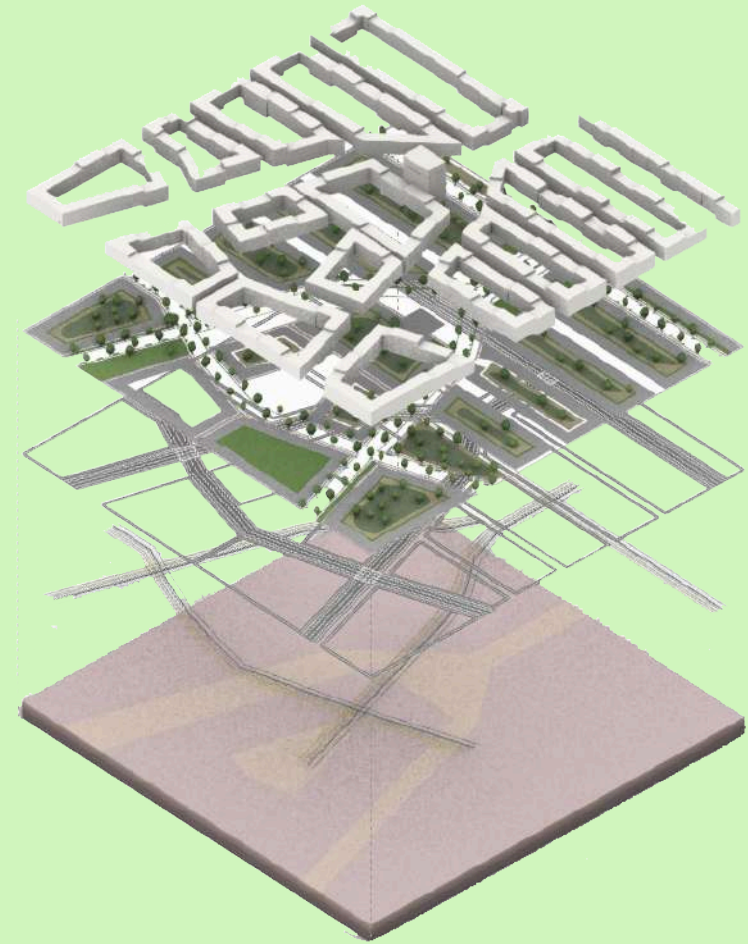
# #4

## Amsterdam 1078

A large-scale urban extension inspired by Berlage's Plan Zuid in Amsterdam. Comparable to districts such as Zuilen in Utrecht and the grand avenues of The Hague. Monumental closed blocks with relatively spacious dwellings.

### Mobility & infrastructure

- Wide, tree-lined avenues
- Limited on-street parking
- Excellent public transport connections close to the city centre
- Extensive cycling infrastructure
- Mixed-use ground floors (housing and retail)
- Lively street life



## Analysis

- Large dwellings (116 m<sup>2</sup>) increase material demand
- Five to seven storeys result in a high FSI
- Relatively few homes per hectare
- Almost identical CO<sub>2</sub> impact to Rotterdam 3074 despite double the FSI
- Larger dwellings require more material per unit
- Lower density per hectare still necessitates substantial infrastructure
- Wide avenues increase construction emissions

Biobased reduction  
42% (48t→25t)

## CO<sub>2</sub> total impact per dwelling

●●●●●  
48 ton

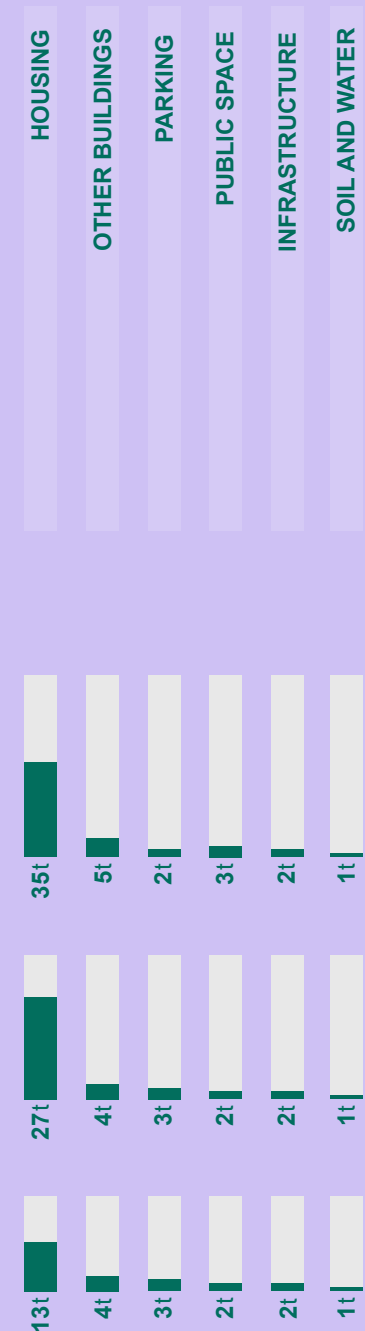
TRADITIONAL

●●●●●  
38 ton

HYBRIDE

●●●●  
25 ton

BIOBASED



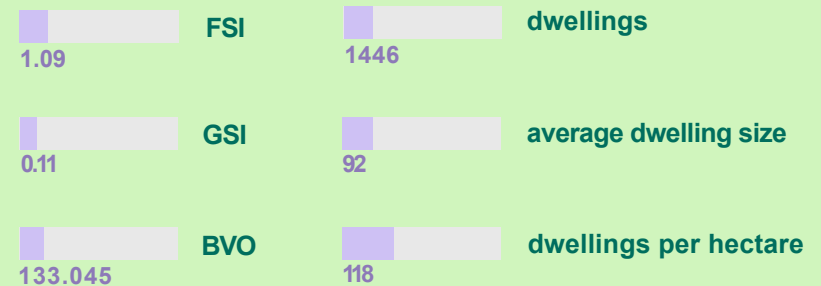
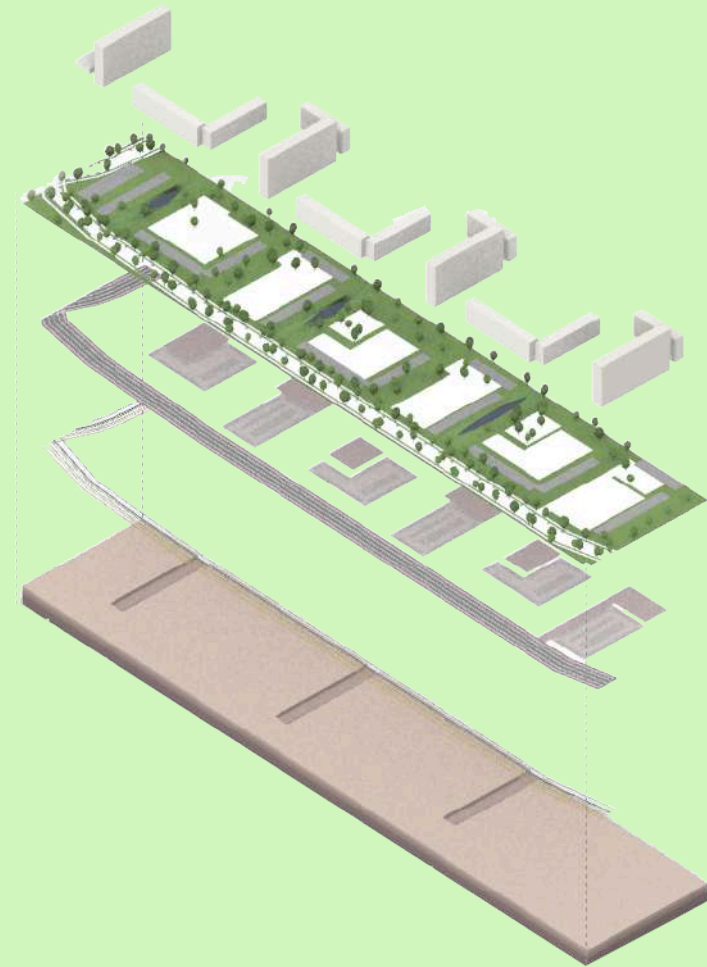
# #5

## Delft 2624

A typical large-scale post-war development such as Delft Zuid, comparable to Buitenveldert in Amsterdam or the AUP. Stacked flats and gallery-access housing characterised by light, air, space and generous greenery.

### Mobility & infrastructure

- Designed during the car-optimistic era of the 1960s
- Extensive surface-level parking
- Parking bays along streets
- Large amounts of public space between buildings
- Reasonable public transport access and cycling infrastructure



## Analysis

- Sharp contrast between built volume and public space
- High density (119 homes/ha) leads to very little infrastructure per dwelling
- Stacked housing supports shared infrastructure
- On-street parking avoids emissions from structured garages

### Paradox:

high density combined with on-street parking results in low overall CO<sub>2</sub> emissions. The building itself remains the dominant contributor. Further densification is possible.

### Conclusion:

building biobased here reduces total emissions by 50% (53 t → 27 t).

## CO<sub>2</sub> total impact per dwelling



53 ton

TRADITIONAL



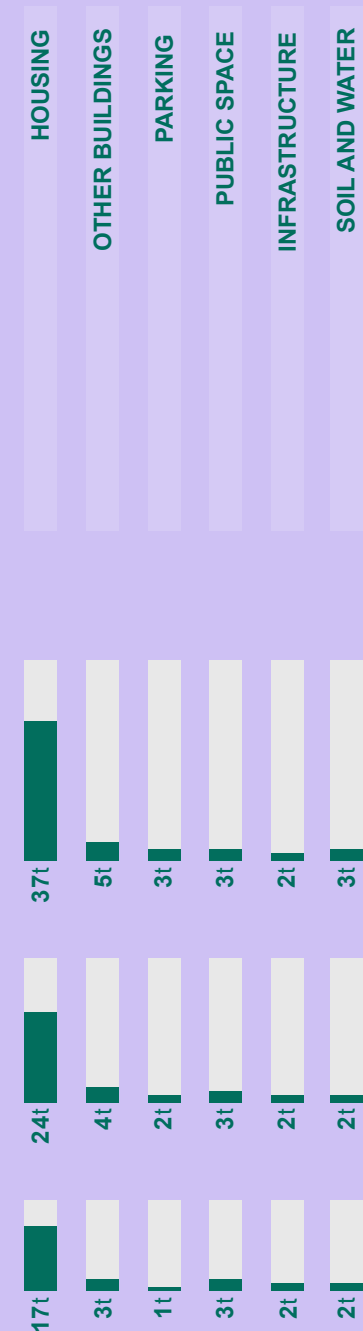
38 ton

HYBRIDE



27 ton

BIOBASED



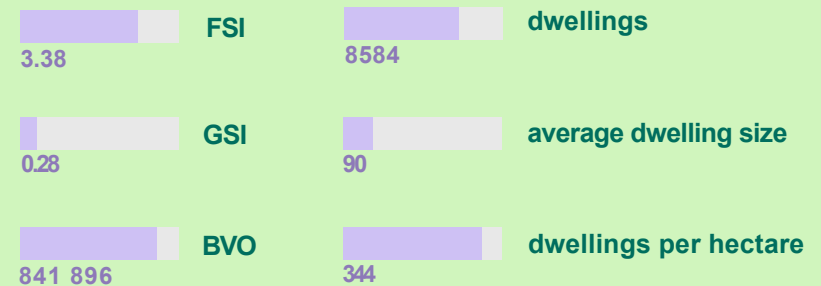
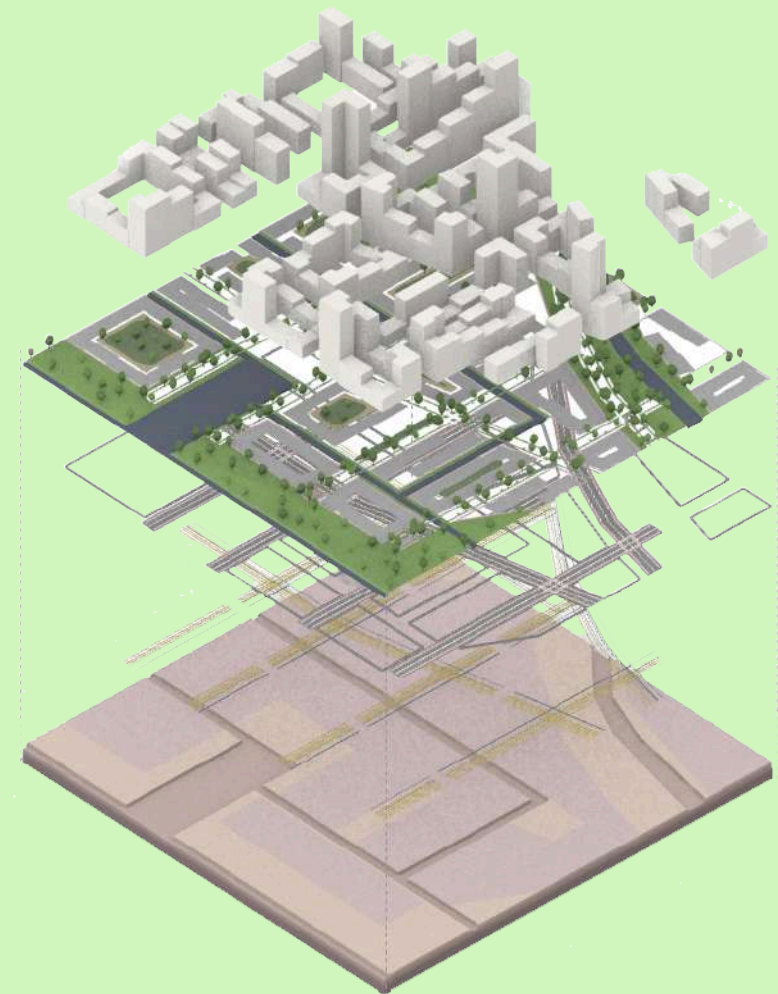
# #6

## Amsterdam 1095

A contemporary high-density urban development such as Sluisbuurt in Amsterdam. Comparable to new waterfront districts in Rotterdam South or around The Hague Central Station. Extremely high density with compact dwellings and vertical stacking ranging from six to thirty storeys.

### Mobility & infrastructure:

- Low parking ratio (0.3), focused on sustainable mobility and parking hubs
- Priority for public transport, cycling and shared mobility
- Strong functional mix: housing, work and amenities
- Transition towards compact, car-light living
- Focus on liveability through shared facilities



## Analysis

Expectation: highest density (343 homes/ha) equals lowest CO<sub>2</sub> impact.

Reality:

- **Traditional:** 49 t vs Utrecht 3521 at 39 t (+25%)
- **Biobased:** 29 t vs Utrecht 3521 at 21 t (+27%)

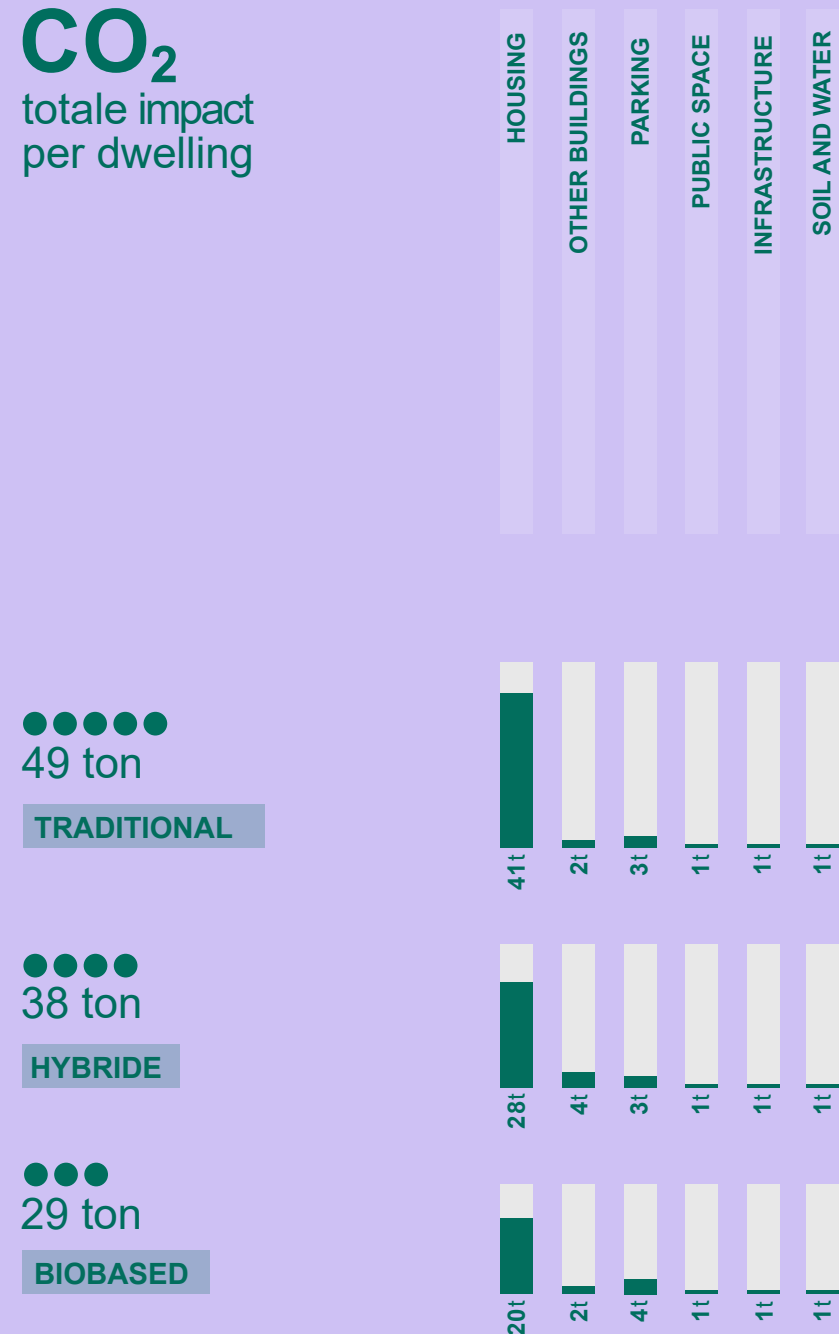
This is independent of the feasibility or affordability of biobased high-rise construction.

Why?

- Heavier structural systems in high-rise buildings
- Complex parking garages
- Small dwellings combined with extensive building services

Conclusion: increasing density through ever taller buildings does not automatically reduce CO<sub>2</sub> emissions.

## CO<sub>2</sub> totale impact per dwelling



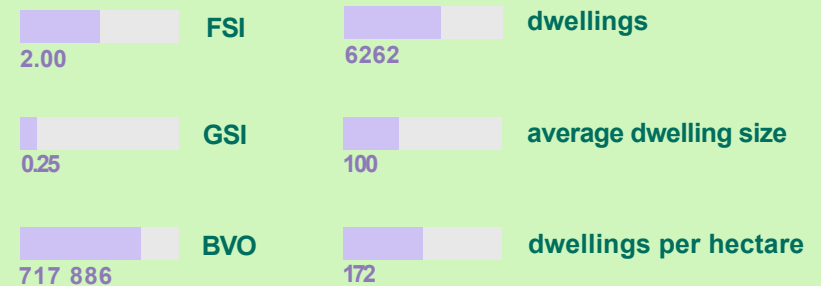
# #7

## Utrecht 3521

Contemporary regeneration districts such as Merwede in Utrecht, comparable to Het Funen in Amsterdam. Car-light neighbourhoods with peripheral parking hubs and car-free public space prioritising greenery, play and social interaction.

### Mobility & infrastructure:

- Car-light design with parking hubs at the edge (0.4 spaces per dwelling)
- Car-free public realm
- Priority for walking, cycling and public transport
- Shared mobility (cars and bicycles)
- 15-minute city: all amenities within walking and cycling distance
- Strong mix of housing, work and services



## Analysis

- Existing infrastructure largely reused
- Compact dwellings (100 m<sup>2</sup>)
- Optimal density (FSI 2.0, 172 homes/ha)
- Parking hubs replace dispersed garages
- Compact but intensively used public space

### Strength of this case

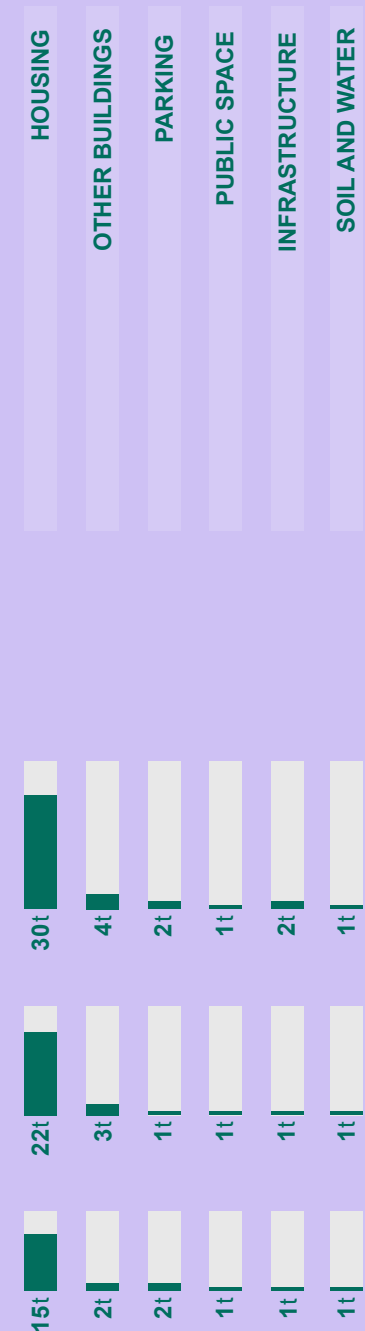
- **Traditional:** 39 t (three times lower than Wageningen 6705 at 120 t)
- **Biobased:** 21 t (3.4 times lower than Wageningen 6705 at 71 t)


## CO<sub>2</sub> total impact per dwelling

●●●●●  
39 ton  
TRADITIONAL

●●●●  
29 ton  
HYBRIDE

●●  
21 ton  
BIOBASED

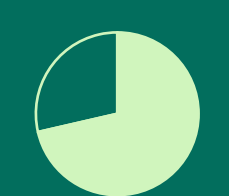
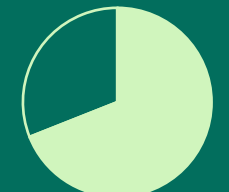
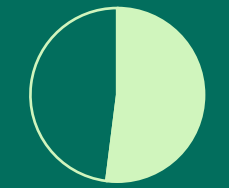
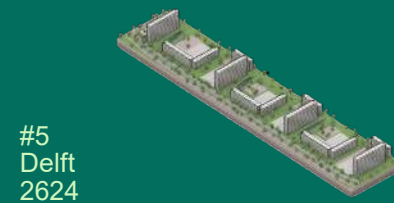
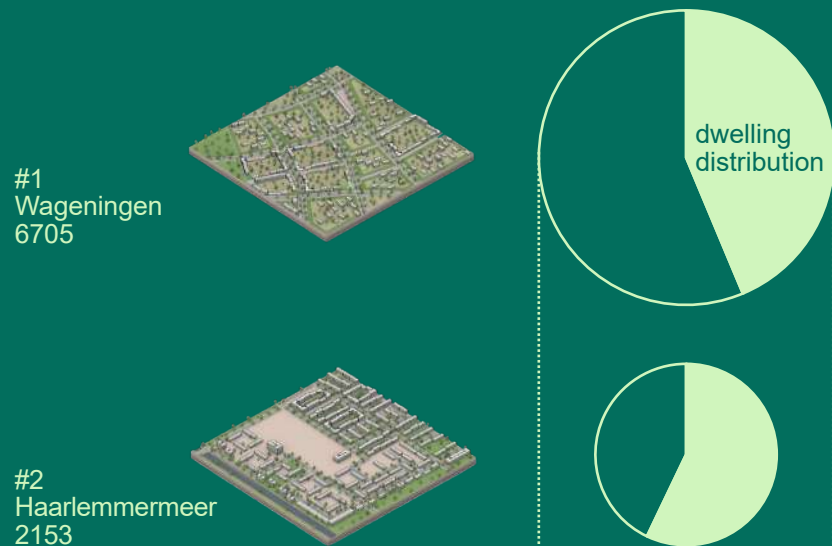




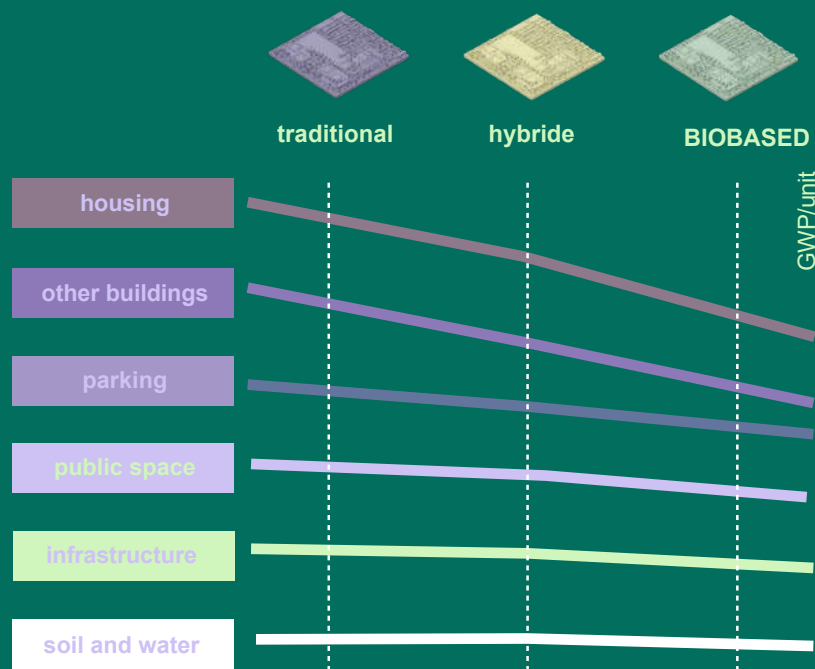
# What does this teach us about CO<sub>2</sub> impact?

# Not too tall, not too spread out

This figure presents the biobased scenario for each case. For optimal CO<sub>2</sub> reduction, there is a clear sweet spot in density: neither too spread out (which increases infrastructure) nor too tall (which increases foundations and structural weight).



# Unequal effects



At building scale, switching to biobased materials reduces CO<sub>2</sub> emissions in every scenario. But this does **not** automatically apply to urban parameters such as infrastructure and soil. Emissions in these layers do not decrease in step with the decarbonisation of buildings.

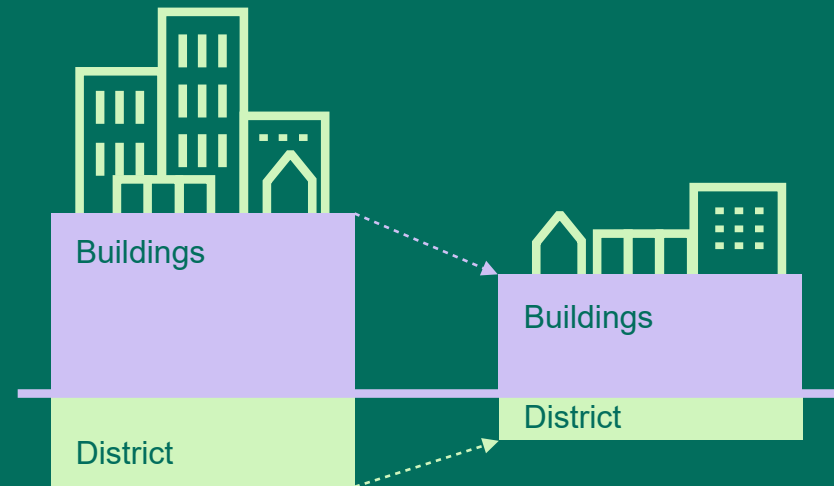
So what is happening here?  
And what do we need to do to achieve results across every urban layer?

## Buildings

A major lever lies in the relationship **between total built volume and average dwelling size**. A typical 250 m<sup>2</sup> dwelling versus a 90 m<sup>2</sup> dwelling creates a **3.5×** difference in CO<sub>2</sub> emissions.

Urban design also determines **how much infrastructure** is required per dwelling (roads, pipes, cables). This can create a **20×** difference in CO<sub>2</sub> emissions per home.

An FSI between 1.5 and 2.5, combined with mid-rise development of **four to twelve storeys**, produces an **optimal density**. It balances efficient land use with limited structural weight. (This is a guideline: in practice, complex spatial requirements—sports facilities, green space, underground infrastructure—may still require additional height.)



A biobased material scenario has major impact at building level (40–50% reduction), but this does not automatically decarbonise the **wider area**. Infrastructure, public space and soil interventions remain largely fossil-based.

The greatest gains come from making smart use of existing **infrastructure**. Building in new urban extensions versus existing urban fabric can make a difference of 5 to 10 tonnes of CO<sub>2</sub> per dwelling.

... and don't forget the impact of embodied CO<sub>2</sub> per person.

For an **average resident** of Haarlemmermeer 2153, **9.3 tonnes** of embodied CO<sub>2</sub> have already been emitted.

**20,3 t**  
Wageningen  
6705

**8,8 t**  
Rotterdam  
3074

**8,3 t**  
Amsterdam  
1078

**8,0 t**  
Delft  
2624

**8,7 t**  
Amsterdam  
1095

**7,0 t**  
Utrecht  
3521

#1

#2

#3

#4

#5

#6

#7

Biobased scenario



# From insights to action

# CO<sub>2</sub> as a designer parameter

A complete plan could be: 50,000 m<sup>2</sup> GFA, 800 homes, 1,200 parking spaces — and 32,000 tonnes of CO<sub>2</sub>.

That allows us to draw a clear line: **32,000 tonnes is too much.**

How do we reduce it to 25,000 tonnes? Smaller floor area per dwelling?

A different location? Biobased materials? Less parking? A combination?

That is the shift we need: treating CO<sub>2</sub> as an **essential design parameter** from the start, and linking it directly to decisions.

Today, we present the first frameworks of an urban plan using familiar parameters. For example: 50,000 m<sup>2</sup> GFA, 800 homes, 1,200 parking spaces.

CO<sub>2</sub> is **missing** from that list.

# Testing at every stage

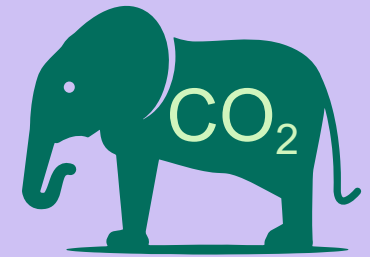
Using CO<sub>2</sub> as a design parameter only works with a measurable budget that is refined throughout the process.

First step: compare urban design options and test each scenario against a CO<sub>2</sub> budget. This makes climate impact as standard as space, mobility or function.

This is what that looks like:

## Phases 1–2: Urban policy & area urban vision

Location choice (new-build or regeneration?), decisions on density and FSI, soil, ownership, defining the programme



**Check:** calculate embodied CO<sub>2</sub> and define the reference date for delivery

## Phases 3–4: Urban plan & block design

Public realm design, infrastructure routing, parking standard and solution, typologies and building heights

**Check:** calculate embodied CO<sub>2</sub>

## Phases 5–7: Architectural design & delivery

Material choice (traditional/hybrid/biobased), structural system, detailing

**Check:** verify results and feed back into Phases 1–2


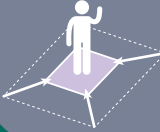

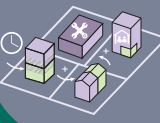

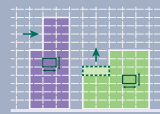

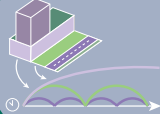





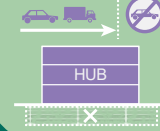








**LCU-  
toolbox:  
What can  
you  
do  
tomorrow?**

# Recommendations by theme

## Design principles at the district scale

## Large-scale framework

<p>1</p>  <p><b>Programme and use</b></p>	<p><b>Less m<sup>2</sup>, more life</b> Compact building and smart sharing deliver higher quality with lower emissions</p>	 <p>Design for fewer m<sup>2</sup> per person</p>	 <p>Aim for an appropriate density</p>	 <p>Create a strong mix of uses (including flexible time-based use)</p>	<ul style="list-style-type: none"> <li>Steer towards smaller homes and larger collective spaces</li> </ul>
<p>2</p>  <p><b>Buildings</b></p>	<p><b>Build less, reuse more—smartly</b> Use what already exists and build only what is needed: considered, efficient, future-ready</p>	 <p>Design volumes with clarity and logic</p>	 <p>Retain existing buildings and structures where possible</p>	 <p>Include Life Cycle Assessment (LCA)</p>	<ul style="list-style-type: none"> <li>Tax materials more, labour less?</li> <li>Establish depots for donor buildings and reclaimed materials</li> </ul>
<p>3</p>  <p><b>Public space</b></p>	<p><b>Make space work</b> The public realm is more than decoration—it is an active climate system. Design to cool, buffer and connect</p>	 <p>Design public space as a climate buffer</p>	 <p>Pave only where necessary</p>	 <p>Integrate energy and climate functions into the public realm</p>	
<p>4</p>  <p><b>Infrastructure</b></p>	<p><b>Think light, move smart</b> Reduce car dependency, bundle networks intelligently, and build flexible, place-based systems</p>	 <p>Limit heavy mobility and infrastructure</p>	 <p>Design for minimal car dependency</p>	 <p>Make infrastructure future-proof, compact and right-scaled</p>	<ul style="list-style-type: none"> <li><b>Large-scale framework:</b> strong public transport and soft mobility</li> </ul>
<p>5</p>  <p><b>Soil and water</b></p>	<p><b>Work the ground intelligently</b> Treat soil as a living system; intervene only where it creates value</p>	 <p>Right soil (ground) in the right place</p>	 <p>Prioritise nature-based solutions</p>	 <p>The right building envelope on the right ground</p>	<ul style="list-style-type: none"> <li><b>Large-scale framework:</b> a municipal/regional “soil depot” approach</li> </ul>

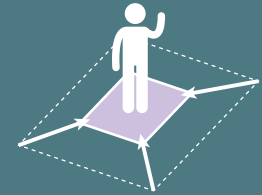


Detailed guidance:

# Programme and use

## Design for fewer m<sup>2</sup> per person

- Guideline: around 50 m<sup>2</sup> GFA per person
- Less private space, more shared space



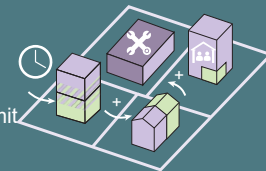
## Aim for the right density

- Density aligned with capacity and context (for example: **soil conditions**)
- Guideline: **FSI 1–3** for residential areas, **>1** for employment areas
- Often this means **mid-rise (6–10 storeys)**, balancing required infrastructure with material use at building level



## Mix smartly, in function and in time

- Combine living, working and amenities at neighbourhood and block scale
- Avoid overly complex mixes at building scale: limit installations and structural complexity
- Encourage shared facilities (laundries, guest rooms, workspaces)



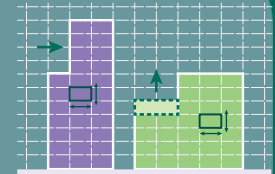


Detailed guidance:

# Buildings

## Design volumes with measure and logic

- Combine living, working and amenities at neighbourhood and block scale
- Avoid overly complex mixes at building scale: limit installations and structural complexity
- Encourage shared facilities (laundries, guest rooms, workspaces)



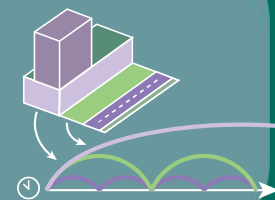
## Keep what you can

- Survey existing buildings, materials and elements at the start of the project | Prioritise reusing foundations, primary structure and the main shell
- Create an early "shopping list" of donor materials from demolition and/or stock
- Limit demolition and enable adaptive reuse
- Reduce unnecessary removal



## Match materials to the time horizon

- Collective, long-term assets: allow more tolerance for higher-CO<sub>2</sub> materials
- Individual, short-term components: strictly biobased, recycled or reusable



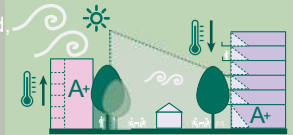


Detailed guidance:

# Public space

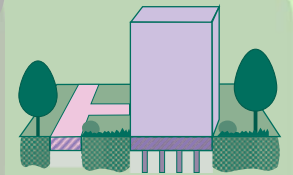
## Design public space as a climate buffer

- Work with microclimate
- Use and strengthen natural conditions (sun, wind, shade, planting)
- Design layered transitions between outside and inside (balconies, arcades, winter gardens)
- Extend the outdoor season and create varied places to stay



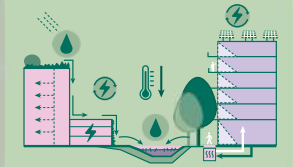
## Pave only where necessary

- Minimise hard surfaces; avoid default asphalt
- Choose circular, modular and relocatable solutions
- Allow for exceptions where paving is a necessary alternative (for example: contaminated soil)



## Integrate energy and climate functions into the public realm

- Combine green-blue structures with water storage and cooling
- Integrate collective systems (energy, heat, PV, mobility hubs) into public space



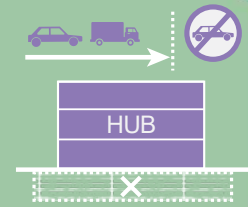


Detailed guidance:

# infrastructure

## Limit heavy mobility and heavy infrastructure

- Fewer heavy access routes and vehicles
- Choose hubs (instead of underground or semi-sunken garages) and lighter modes
- Bundle essential paved routes
- “Green, unless...” and car-light design



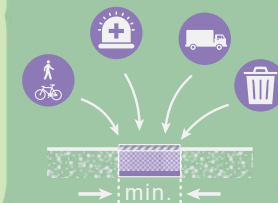
## Design for minimal car dependence

- Negotiate a lower parking standard early in the planning phase
- Support shared mobility, strong public transport, cycling and light vehicles



## Make infrastructure future-proof, compact and right-scaled

- Deliver small-scale energy systems at area level
- Optimise and bundle routes where possible
- Design infrastructure to be modular and adaptable over time





Detailed guidance:

# soil and water

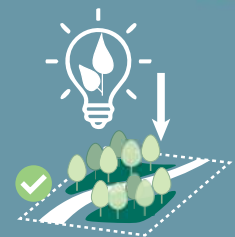
## Right soil in the right place

- Avoid unnecessary basements or crawl spaces
- Optimise routes for underground infrastructure
- Bring soil research into the early planning phase
- Consider a closed soil balance at area or neighbourhood level



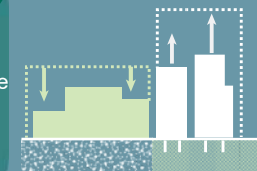
## Prioritise nature-based solutions

- Prioritise vegetation at ground level (not only balconies and roofs)
- Keep green-blue solutions low-carbon: avoid extra foundations/materials where possible, favour low-tech interventions



## Right building envelope on the right ground

- Consider greater building heights on sand, and balance tall and low volumes within the envelope
- Reserve margins in the envelope for passive strategies, heavier façade packages, overhangs and specific zoning



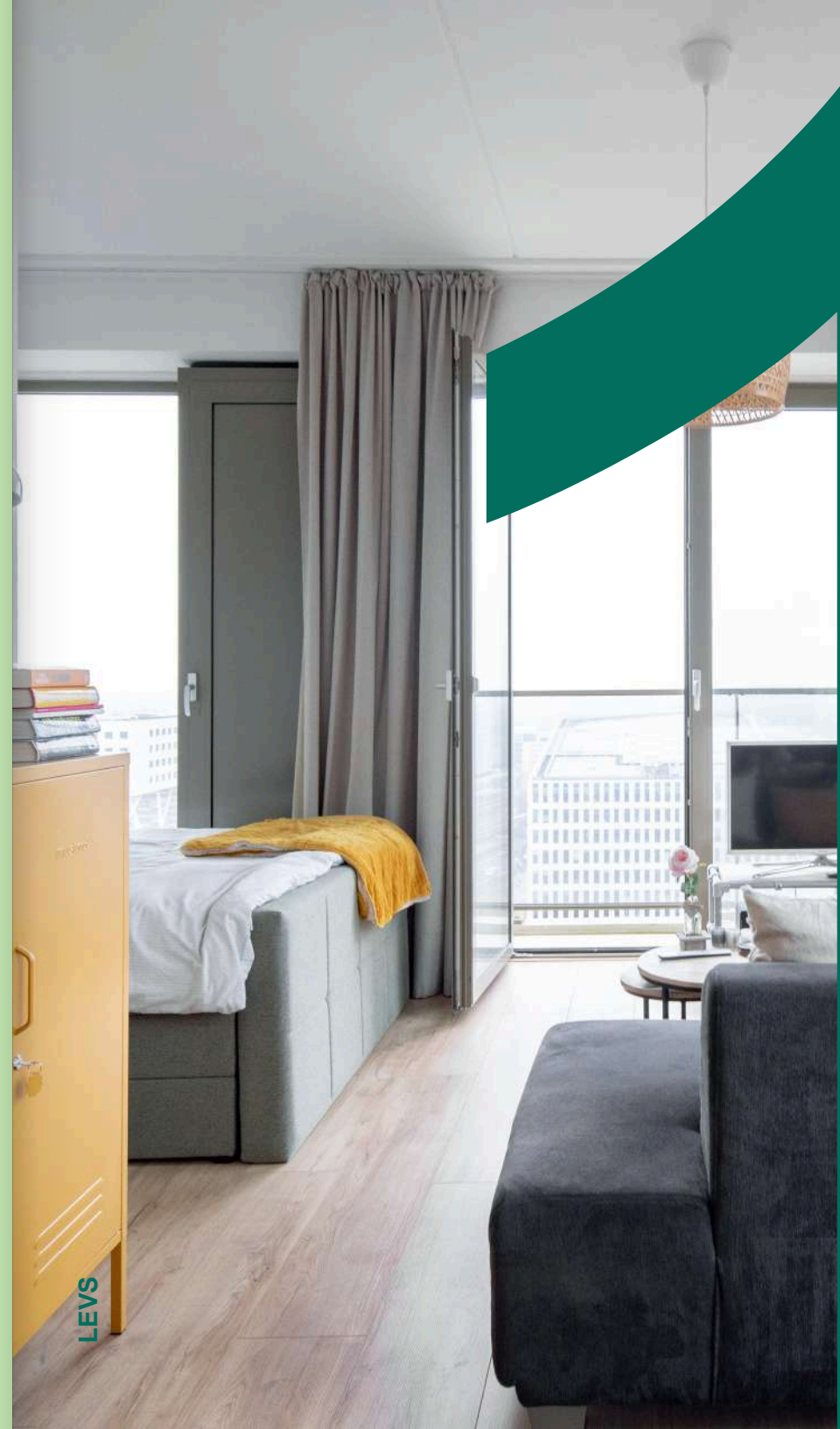


**Choices  
that make  
the  
greatest  
difference**

# Less m<sup>2</sup>, more life

Compact building and smart sharing deliver higher quality with lower emissions.

- Aim for an appropriate density (**FSI 1.5–2.5**)
- Enable shared functions
- Design homes to be flexible and life-cycle adaptable



# Build less, reuse more

Use what already exists and  
build only what is  
necessary.

- Prioritise retention (renovation over new build)
- Apply adaptive reuse (transformation)
- Design smart volumes with efficient dimensions



# Make space work

Public space is more than decoration — it is an active climate system.

- Microclimate (cooling, shelter, sunlight)
- Less hard surfacing (“vegetation, unless...”)
- Integration of energy and water systems (PV, district heating, drainage)



# Think light, move smart

**Reduce car dependency,  
bundle networks and build  
flexible systems.**

- Fewer cars (parking ratio 0.3–0.5)
- Shared mobility (cars, bicycles, scooters)
- Parking hubs (centralised at the edge)



# Anticipate soil and water

**CO<sub>2</sub> reduction is only possible if sites are prepared differently.**

- Choose the right soil (build on suitable ground)
- Integrate nature-based solutions (drainage, greenery)
- Balance building height and soil conditions within the building envelope



# Renovation

What if we didn't build new, but renovated, upgraded and densified?

- Retain load-bearing structure and envelope
  - Renew insulation, building services and façade elements
  - Upgrade with HR++ glazing, heat pumps and PV panels
  -
- Could this deliver an additional 50% CO<sub>2</sub> reduction?





# Use CO<sub>2</sub> as a design parameter

Integrate low carbon thinking into every conversation, every phase and every scale.

Without insight into CO<sub>2</sub> emissions, decisions are driven by intuition, habit and cost. The impact remains invisible until Phase 7 (construction), when steering is no longer possible.

This is why early collaboration is essential — between national government, municipalities, housing associations, developers and designers. We must connect scales: from area to block to building. CO<sub>2</sub> must count from the very first conversation.





**Next  
steps in  
Low  
Carbon  
Urbanism**

Low Carbon Urbanism is a new perspective. This publication is only a first step. Not everything has been explored in full depth. That opens up opportunities and research questions for the next phase.

### **Knowledge sharing**

Many organisations are developing knowledge from different perspectives on this complex puzzle. There is no single blueprint or absolute truth. All studies are relevant — and they need to be far better connected.

We see opportunities for collaboration with peer practices working on comparable tools, including Cityförster, PosadMaxwan, Group A, Merosch, MVRDV, Platform Woonopgave, De Bouwcampus, NRP and others.

### **Practice**

BURA, LEVS and Urban Climate Architects are already applying Low Carbon Urbanism principles in ongoing projects. BURA is working with De Urbanisten, LEVS and Quake on **Schiehaven Noord** in Rotterdam, designated a *Paris Proof testing ground*. Here, new lessons on Paris

Proof principles are prioritised and applied at area level, in both construction and use. BURA is also involved in Almere Pampus (phase 1), Rijnpark Arnhem, and a manifesto for the Post-Growth Marineterrein in Amsterdam.

We call on municipalities, market parties and housing associations to designate test areas — as Rotterdam has done with Schiehaven Noord — at both city and neighbourhood scale. Create space for thinking and acting differently. Allocate time and resources, and allow for the necessary “learning by doing”. Embed design-led research structurally to imagine possible futures alongside day-to-day reality.

### **More precise data, tools and case studies**

Many tools already exist to calculate CO<sub>2</sub>. Do we need a new tool for district development, or should we expand existing ones? Further work is needed on case studies and more precise data, feeding into a prototype calculation methodology.

## Rethinking how we calculate and design: grip on GREX

The success of low-carbon district development depends on how we deal with social and financial interests in projects. The tight coupling between urban development and financial systems makes change difficult.

Returns are linked to pension funds, while demand and revenues are shaped by interest rates. Spatial processes are often driven by non-spatial dynamics and policy. Existing land positions, expected yields and urban ambitions frequently steer decisions on demolition versus new build, density, mobility and programme mix.

Meanwhile, external effects such as CO<sub>2</sub> emissions and environmental damage — here and elsewhere, now and later — are insufficiently accounted for in project economics. This imbalance makes demolition, new build and greenfield expansion financially attractive.



We need a different way of calculating value. The positive effects of Low Carbon Urbanism — on nitrogen, CO<sub>2</sub> and health — must be included. Encouraging initiatives include Samen Slim (Annius Hoornstra), Circular land and property development (Alba Concepts), and the City of Amsterdam's Shared Land Exploration led by Max Smit and Juliana Beekenkamp.

### **A new building culture?**

The transition to low-carbon district development, combined with affordability ambitions, requires a different way of building. Low-carbon building systems are essential. We must deploy the full spectrum of industrial systems: modular (3D), CLT/flat-pack, column-beam structures, and new concepts such as Tim® (LEVS) and specials like SAWA.

These approaches allow us to build more sustainably, intelligently, quickly and affordably.

Urban plans must enable this and anticipate it from the earliest stages. Producers, supply-chain partners and system designers must develop adaptive systems that respond to future-proof neighbourhood challenges: density, mixed use, mobility and spatial efficiency. Initiatives by the Federatie Ruimtelijke Kwaliteit, College van Rijksadviseurs and De Bouwcampus provide strong examples.

Designers stand at the forefront of visualising and realising this new narrative — contributing to a renewed aesthetic and a new relationship with materials, consumption and space.



**A  
new  
building  
culture?**

## DEFINITIONS AND TERMS

### 15-minute city

Urban principle in which all daily amenities (work, shops, school, sports, green space) are reachable within fifteen minutes by walking or cycling. Reduces car dependency and mobility emissions. Example: Utrecht Merwede.

### A1–A5 (Production + construction phase)

**Embodied carbon:** CO<sub>2</sub> emissions from material extraction, production, transport and construction. The focus of this research, as this phase is fully determined by design choices and emitted immediately (within the 2025–2030 CO<sub>2</sub> budget).

### B6–B7 (Operational carbon)

CO<sub>2</sub> emissions during use: heating, cooling and electricity (B6) and water (B7). These emissions are declining rapidly due to the energy transition and are therefore a lower priority in this study.

### Biobased materials

Materials from renewable sources — wood (CLT, timber frame), bamboo, straw, hemp, mycelium — that store CO<sub>2</sub> during growth. In this study: CLT structures, timber-frame façades, bamboo finishes and biobased insulation.

### GFA (Gross Floor Area)

Total floor area of all storeys including walls, measured to the outer face of façades. For example: a 100 m<sup>2</sup> GFA dwelling has approximately 85 m<sup>2</sup> net usable area.

### CO<sub>2</sub> budget

The remaining amount of CO<sub>2</sub> the Netherlands may emit to stay within 1.5°C warming, in line with the Paris Agreement. At current rates this budget will be exhausted around 2030. Construction-related embodied carbon consumes this budget immediately (2025–2030), while operational emissions occur later (2030–2080).

### Embodied carbon

CO<sub>2</sub> embedded in materials and construction processes (A1–A5). Emitted at completion, locked in for 50–100 years and irreversible — unlike operational carbon, which declines with the energy transition.

### FSI (Floor Space Index)

Ratio of total floor area (all storeys) to plot area.

- FSI 1.0: one storey covering the full plot, or two storeys on half the plot
- FSI 2.0: average two storeys across the full plot (e.g. four storeys on 50%)
- FSI 3.0+: high-rise
- **Low-carbon sweet spot:** FSI 1.5–2.5 (mid-rise, four to twelve storeys)

### Greenfield

Undeveloped land requiring new infrastructure, resulting in high embodied carbon due to roads, utilities and surfacing. Opposite of brownfield/regeneration.

### GSI (Ground Space Index)

Percentage of land that is built on (building footprint divided by plot area).

- GSI 0.3: 30% built, 70% open
- GSI 0.1: 10% built, 90% open (post-war “building in green”)
- GSI 0.5: 50% built (dense inner cities)

### GWP (Global Warming Potential)

Greenhouse gas emissions expressed in CO<sub>2</sub> equivalents. All gases (CO<sub>2</sub>, methane, nitrous oxide) converted to CO<sub>2</sub> impact. Example: 1 kg methane = 25 kg CO<sub>2</sub>e.

### Regeneration

Redevelopment of existing urban areas, enabling reuse of infrastructure. Lower embodied carbon than greenfield development. Example: Merwede Utrecht (0% new main infrastructure).

### Hybrid construction

Combination of traditional (concrete/steel) and biobased materials (timber). Example: concrete foundation + CLT floors + timber façades. Midway between traditional and fully biobased. **25–35% CO<sub>2</sub> reduction** versus traditional.

### Mid-rise

Buildings of four to twelve storeys (approx. 15–40 m). Embodied-carbon sweet spot: high enough for shared infrastructure, low enough for lighter structures without high-rise requirements.

### NMD (National Environmental Database)

Database of environmental impacts of construction materials. Basis for MPG calculations and embodied carbon assessments, containing LCA data for concrete, steel, timber, insulation and more.

### Paris Proof

Building approach aligned with the 1.5°C Paris Agreement target. The DGBC guideline defines a maximum allowable embodied carbon per building or area. Goal: all new construction Paris Proof by 2030.

### Sweet spot

Optimal balance between density and CO<sub>2</sub> impact. In this study: FSI 1.5–2.5, mid-rise (four to twelve storeys) and average dwelling size of 90–110 m<sup>2</sup>. Example: Utrecht Merwede (39 t traditional, 21 t biobased).

### Traditional scenario

Conventional construction using concrete/calcium-silicate masonry, standard asphalt and concrete pipes, with the highest embodied carbon (reference: 100%). Baseline for comparison with hybrid and biobased scenarios.

### Whole Life Carbon (WLC)

Total CO<sub>2</sub> emissions across the full life cycle: A1–A5 (embodied) + B1–B7 (operational) + C1–C4 (end-of-life) + D (recycling). This research focuses on A1–A5, as these are decisive for 2025–2030.

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### Research and reports

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2. *Post-Growth City* — BURA and Crimson (2024)
3. *Housing within Planetary Boundaries* — Copper8, Metabolic, W/E Adviseurs (2023)
4. *CO<sub>2</sub> Impact of Housing Locations* — Copper8, LEVS, Metabolic (2025)
5. *Paris Proof Calculation Protocol* — Dutch Green Building Council (2023)
6. *The New Normal: Framework for Circular Construction* — Platform CB'23 (2023)
7. *The 1.5°C Climate Target* — Architecture 2030 (2021)
8. *Global Warming of 1.5°C* — IPCC (2018)

### Tools and databases

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## Low Carbon Urbanism — From building to area: steering early on embodied CO<sub>2</sub>

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At Urban Climate Architects, we envision a future in which everyone can live, learn, work and play in a healthy and safe environment. We aim to create spaces where people of all ages, backgrounds and means can thrive, enhancing quality of life for all.

Our CO<sub>2</sub> budget is running out. Developments such as timber construction are important, but they are not enough on their own to meet the Paris targets.

The greatest material impacts lie in the relationship between building design and urban design. These choices — and the embodied emissions that follow — are fixed long before the first design is drawn, in policy, urban visions and urban plans.

*Low Carbon Urbanism* makes this impact visible. Through the analysis of seven area typologies, it reveals where the greatest gains can be made — from density to mobility, from public space to soil.

This research by BURA, LEVS Architects and Urban Climate Architects offers concrete guidance for designing within the CO<sub>2</sub> budget from **phase one** onwards.

Structural change in how we design and build requires depth, breadth and, above all, action. *Low Carbon Urbanism* takes a decisive step in that direction.