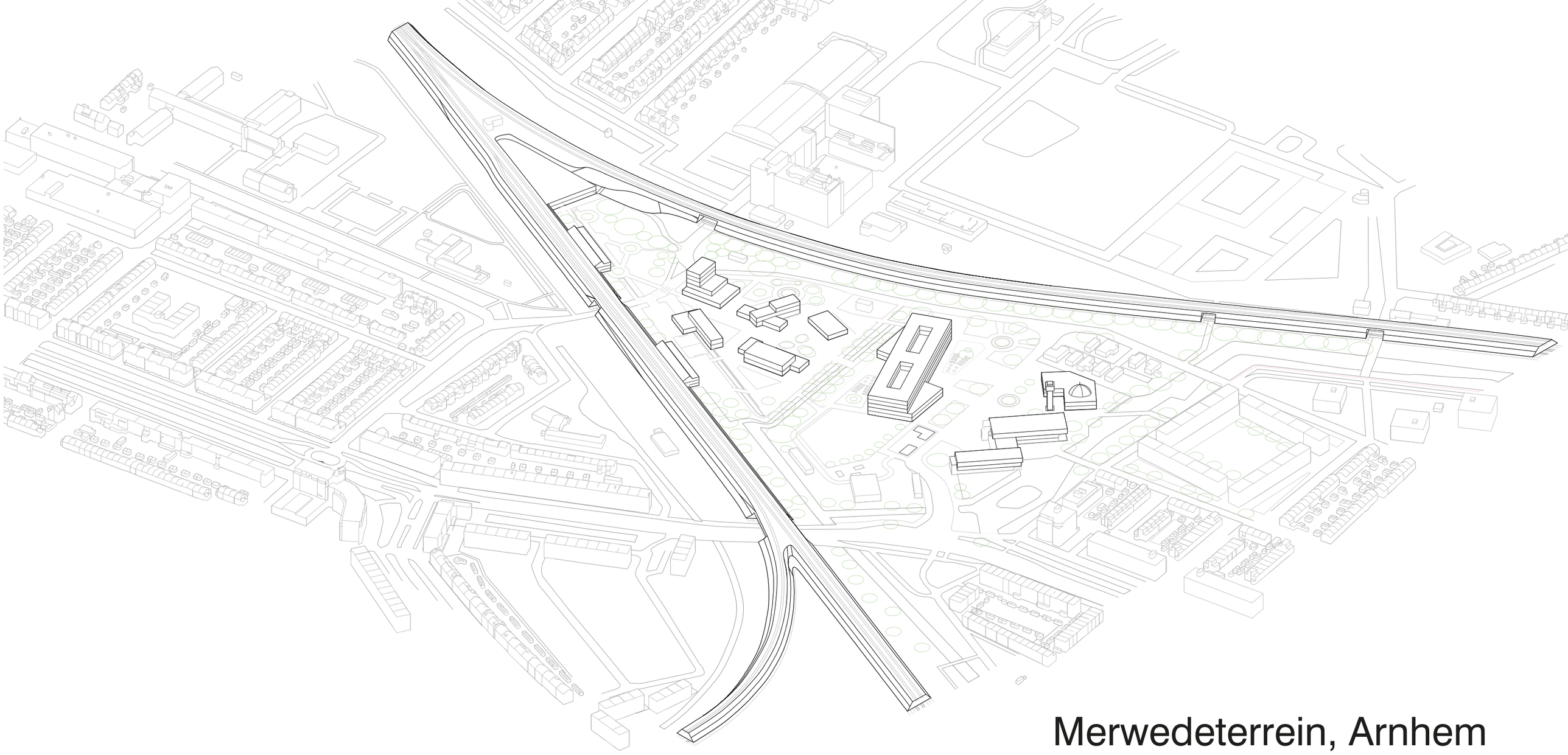


Merwedeterrein, Arnhem

TRANSIT VILLAGE 2.0

Affordable and Sustainable Homes for the Arnhem Middle-Income Group

AR3AE100 Architectural Engineering Graduation Studio
2021/2022 Q2 | P2 Presentation | One Million Homes
David Grünewald | 5397685

Content

Problem Statement
1 Million Homes Missing

Regions with Largest Qualitative Housing Shortage by 2025

0 to 3%

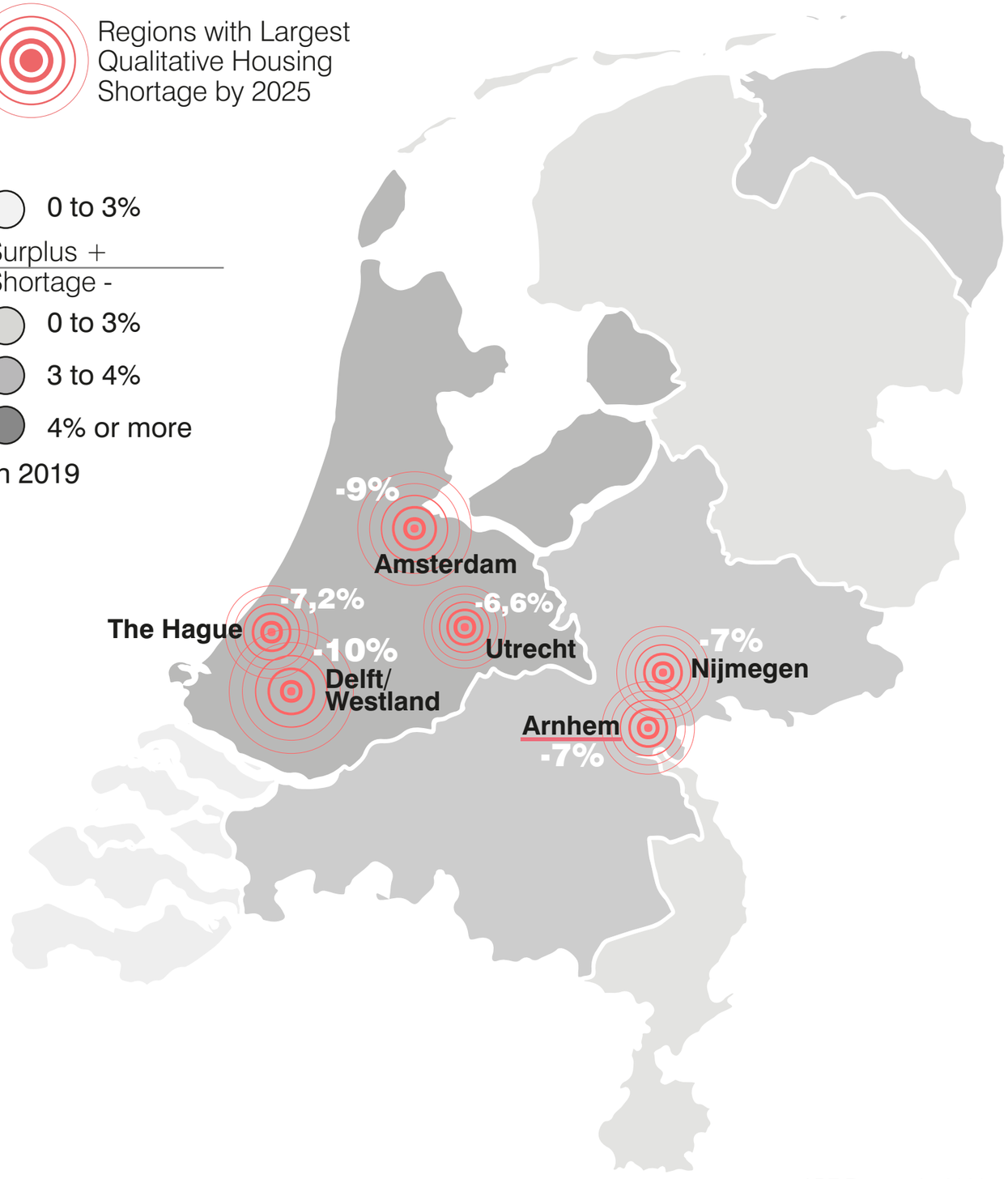
Surplus +
Shortage -

0 to 3%

3 to 4%

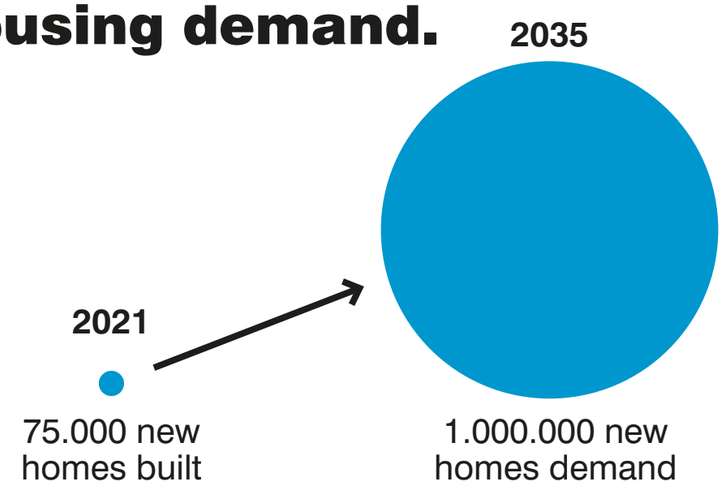
4% or more

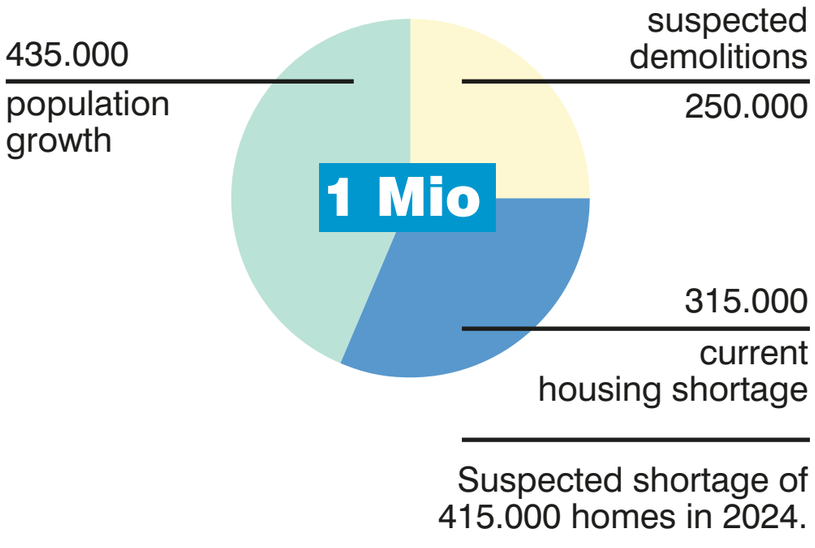
in 2019



ABF Research, 2020

1 million new homes must be added until 2035 to meet housing demand.





Jonkman et al., 2021

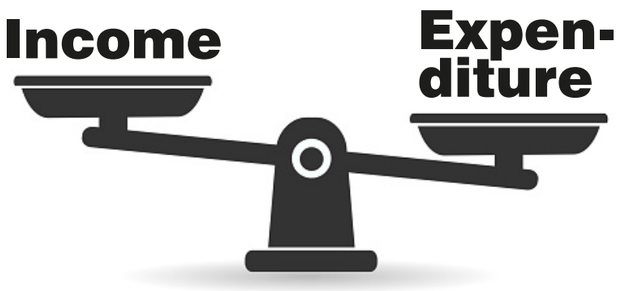
Problem Statement
Skyrocketing Rental Prices

The Dutch housing market recorded a price increase of 18% in 2021.

Statista, 2021

800.000 households are 'financially stuck'.

Most of them: middle-income earners
18.000 - 28.000 € standardized



Metten, 2021

Waiting lists for social housing average 9 years.

Middle-income earners who are eligible for social housing tend to wait longer.

Ø 9 Years

Moeys, 2021

We need more affordable homes for middle-income earners.

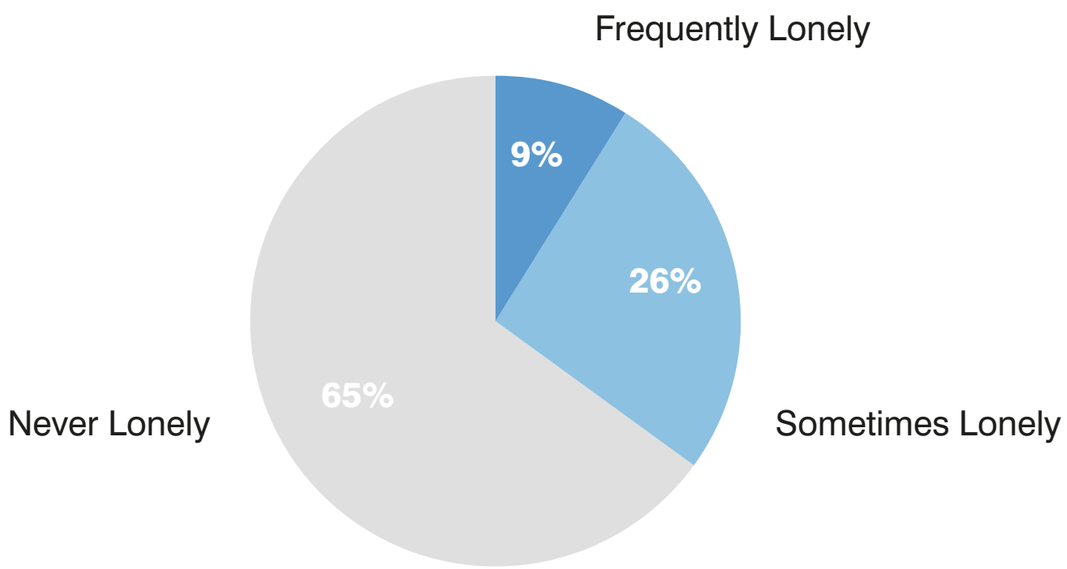
Problem Statement
Social Sustainability

Financial stresses in unaffordable built environments impact the mental health of occupants.

Building quality, noise and air pollution, daylight exposure, ventilation, temperature are equally important.

Hoisington et al., 2019

Loneliness in the Netherlands 2019



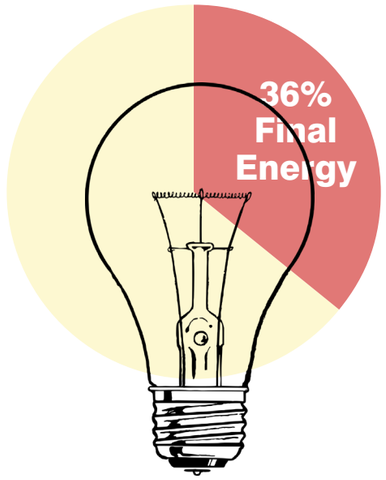
CBS, 2020

Residents of heterogenous land-use mix neighborhoods experience lower levels of loneliness.

Timmermans et al., 2020

Problem Statement
Environmental Sustainability

36% of final energy was used by the global building industry in 2018.



39% of CO2 emmissions worldwide came from the building industry in 2018.

International Energy Agency (IEA), 2020

1,36 tons of CDW per citizen were generated in the EU in 2016.

That is 35% of the total waste generated in the EU.

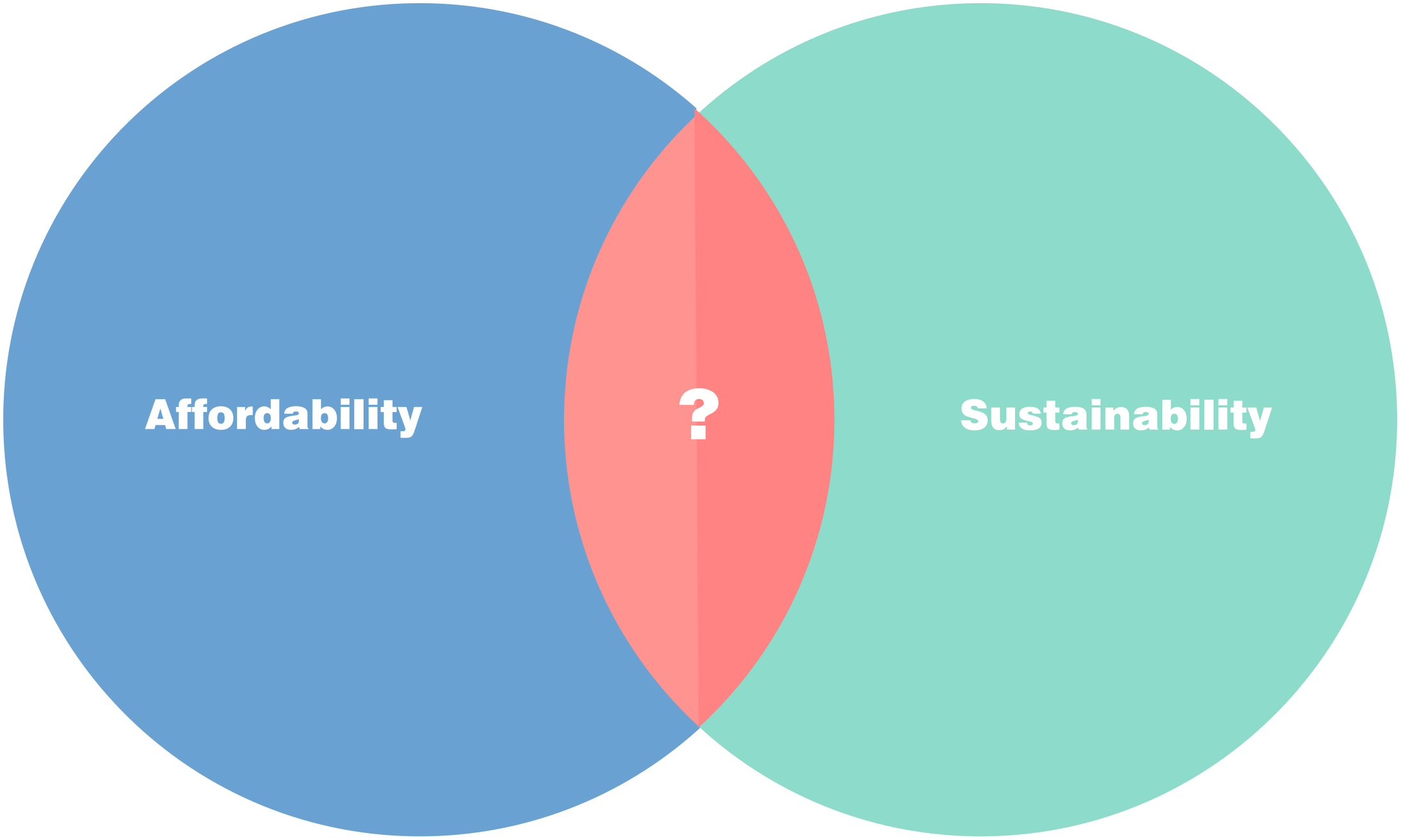
Total Waste EU
2016

Eurostat, 2020

We must find environmentally and socially sustainable solutions.

Research Question

How Can We Integrate Affordability and Sustainability?



Objective
Integrating Affordability and Sustainability

Affordability

Affordable Apartments.
Communitization of Functions, Community Businesses serve as rent support

Low Mobility Costs.
Creating Bicycle-Friendly Infrastructure, Planning Daily-Necessity Mixed-Use

Low Construction Costs.
Integrative Design Approach, Prefabrication, Robotic Manufacturing Processes

Low Life Cycle Costs.
Implementing Open Building Principles, Boosting Energy Performance

Sustainability

Healthy Building.
Bio-based materials, Daylight, Natural Ventilation, Acoustics.

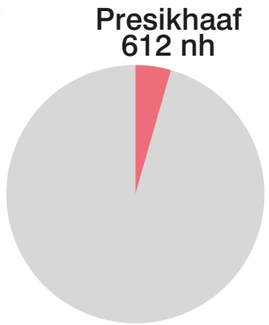
Sustainable Communities.
Cooperative Private Commissioning (CPC), Communicative Zones, Open Ground Level.

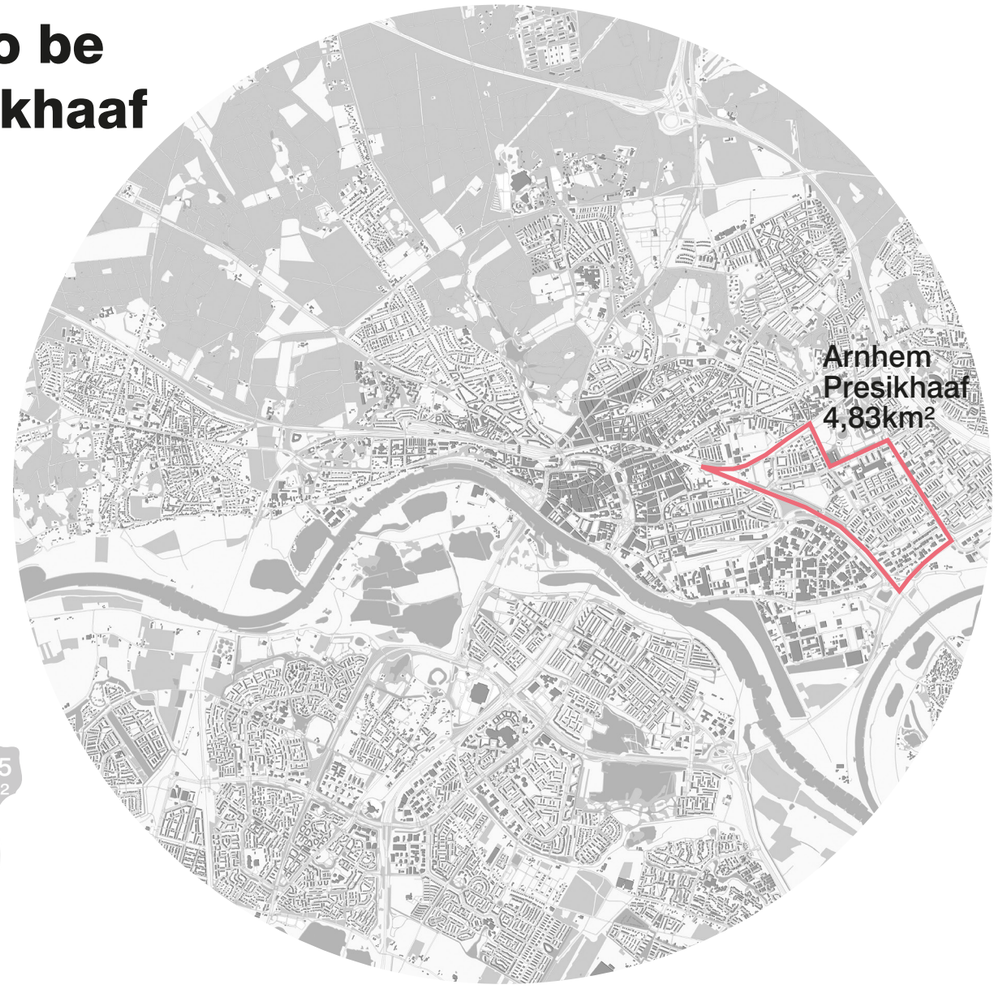
Emmission + Waste Reduction.
Low-Tech Construction, Material Efficiency, Product as a Service (PaaS) Components, Design for Disassembly/ Change/ Reuse.

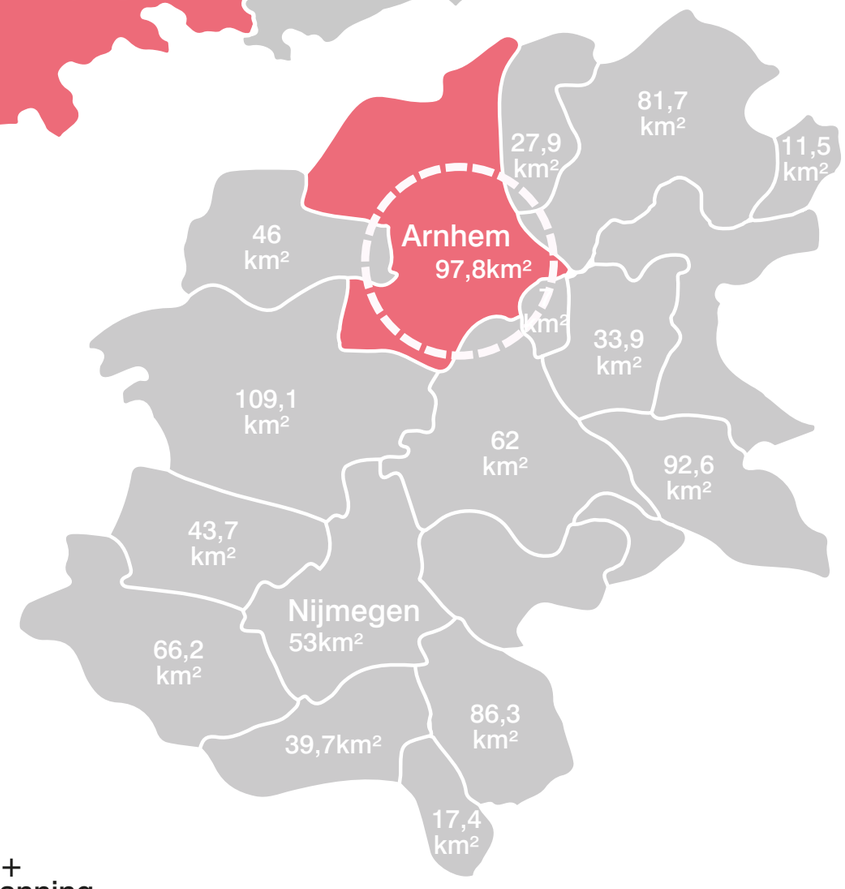
Plus Energy Buildings.
Energetic Optimization, Photovoltaik, Passive Sunshading, Natural Ventilation.

Preliminary Research
Housing Demand in Arnhem

612 new homes are to be built in Arnhem Presikhaaf until 2040.

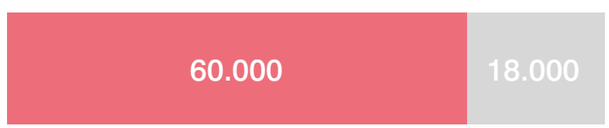






78.000 new homes must be built in the Stadtsregio Arnhem-Nijmegen until 2040.

This was formalized in the 2020 ‘Woondeal‘.



Housing Crisis + Demolition + Impaired Planning

78.000 new homes x 0,0995 relative surface Arnhem
= **7417** new homes

Population Growth

11.652 new inhabitants 2040 / Ø 2.14 P household
= **5445** new homes

= 12.862 Total New Homes Arnhem

12.862 new homes x 0,0476 relative surface Presikhaaf

= 612 Total New Homes Presikhaaf

Preliminary Research

Zoning Plan - Arnhem Presikhaaf

Enkelbestemmingen

- bedrijf
- bedrijventerrein
- bos
- centrum
- cultuur en ontspanning
- detailhandel
- dienstverlening
- gemengd
- groen
- kantoor
- maatschappelijk
- natuur
- overig
- recreatie
- sport
- tuin
- verkeer
- water
- wonen
- woongebied

Dubbelbestemmingen

- waterstaat
- leiding
- waarde

Figuren

- as van de weg
- dwarsprofiel
- gevellijn
- hartlijn leiding
- relatie

Gebiedsgerichte besluiten

- besluitgebied
- besluitvlak
- besluitsubvlak

Bouwvlakken

- bouwvlak

Aanduidingen

- bouwaanduiding
- functieaanduiding
- lettertekenaanduiding
- maatvoering

Structuurvisies

- plangebied

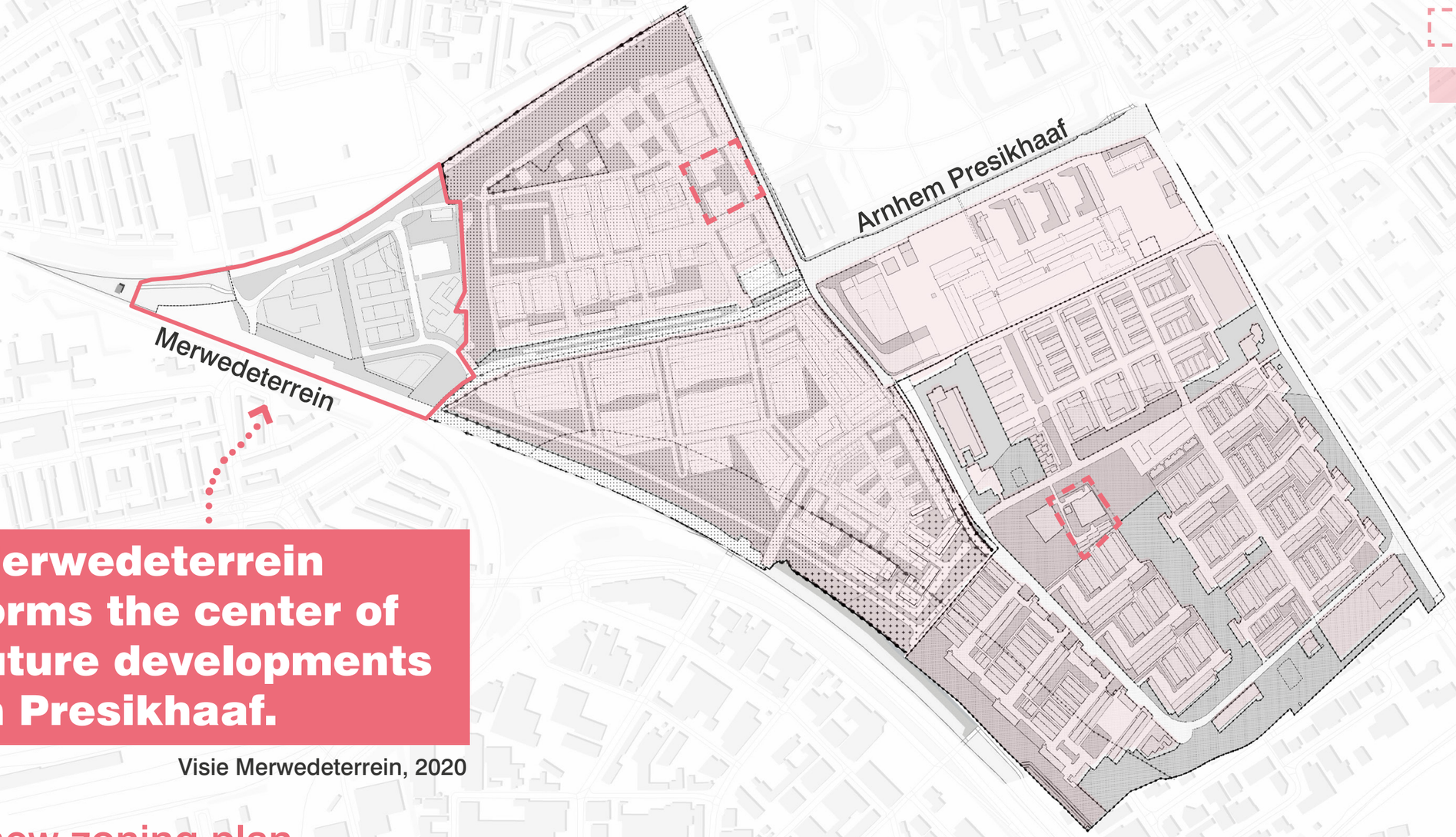
Gescande kaarten

- plangebied

Overige besluiten

- plangebied

Preliminary Research
Development Areas in Presikhaaf

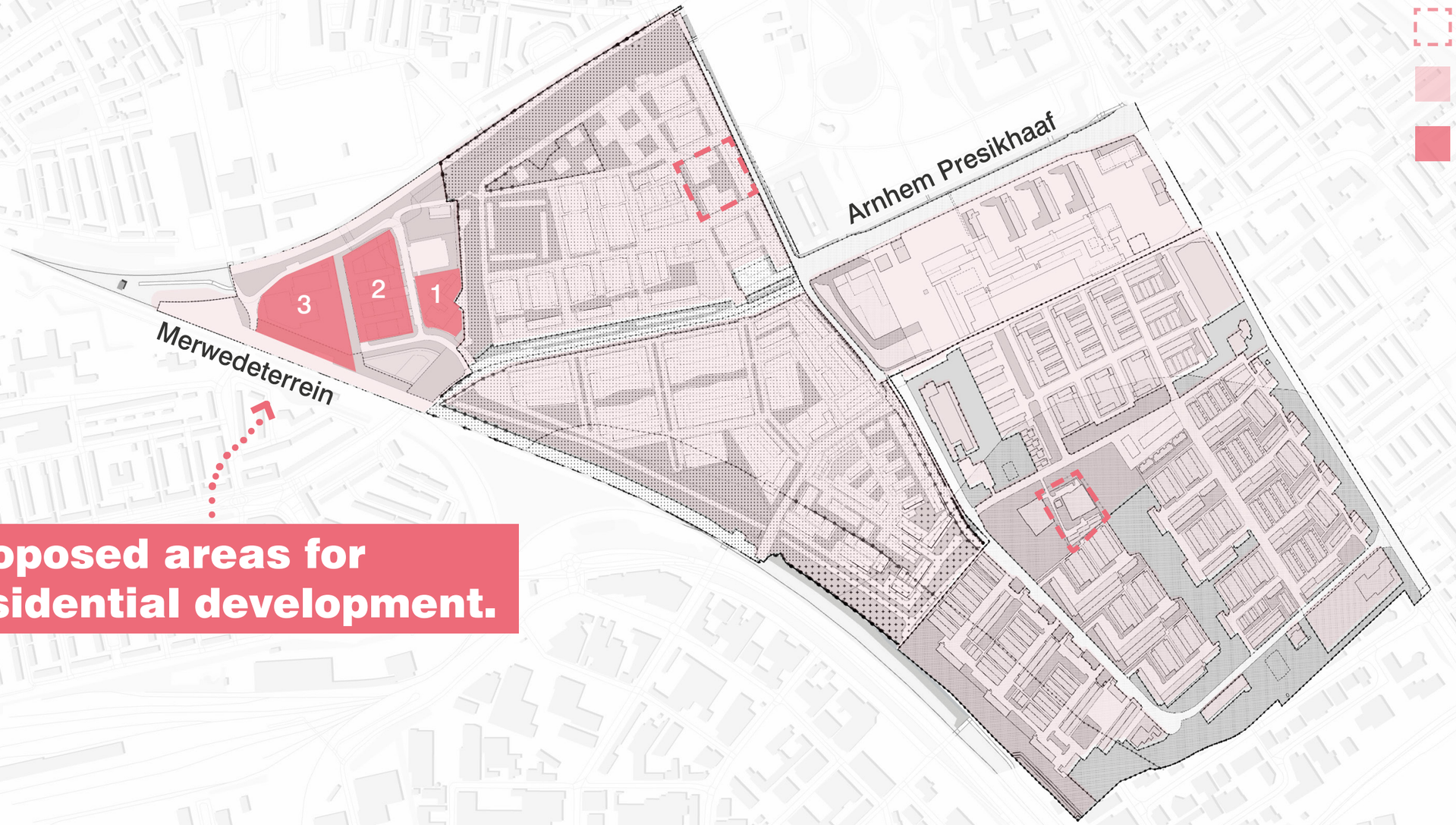


Merwedeterrein forms the center of future developments in Presikhaaf.

Visie Merwedeterrein, 2020

A new zoning plan is currently under investigation.

Preliminary Research
Proposed Residential Development



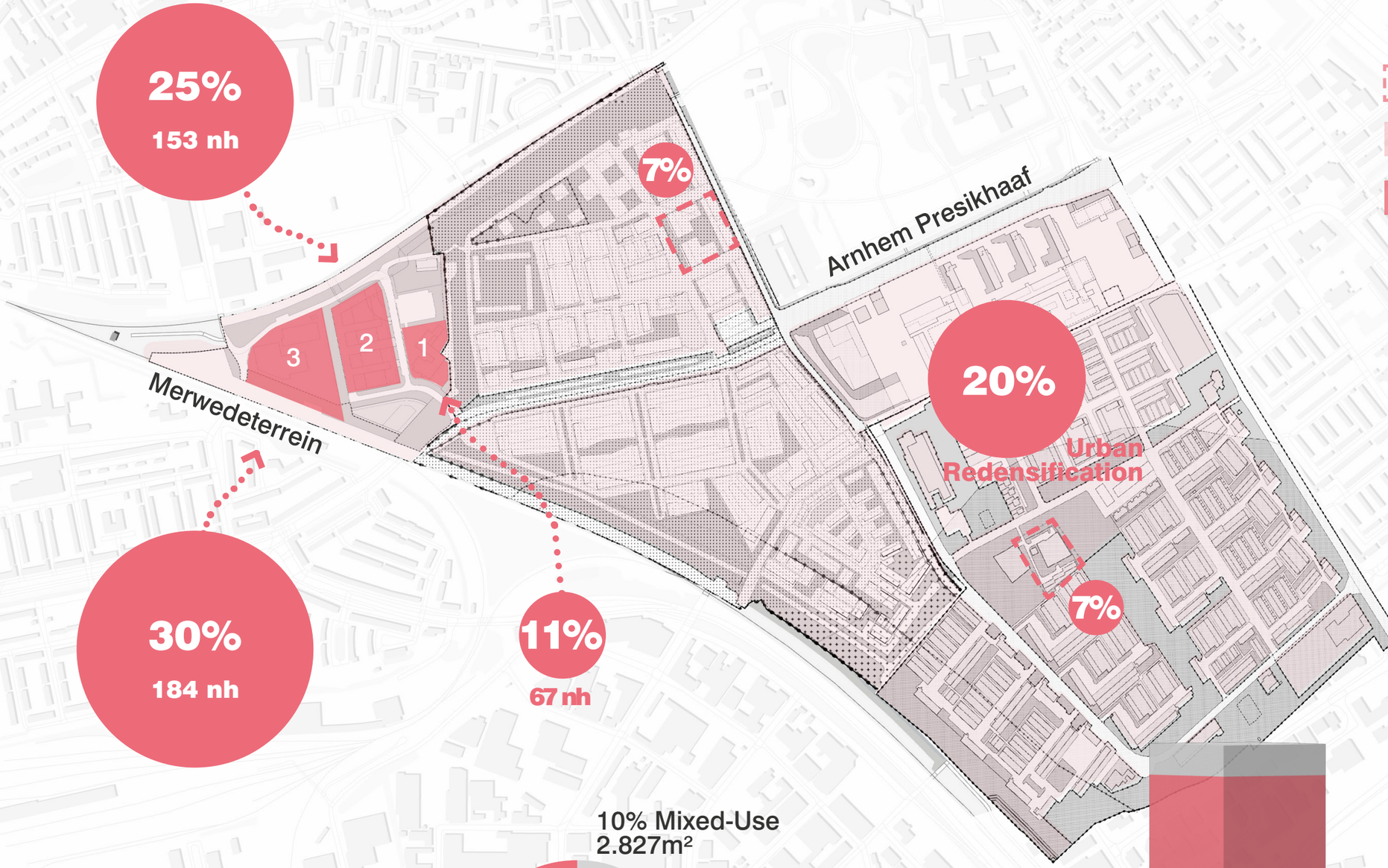
Pending Project

Planning Area

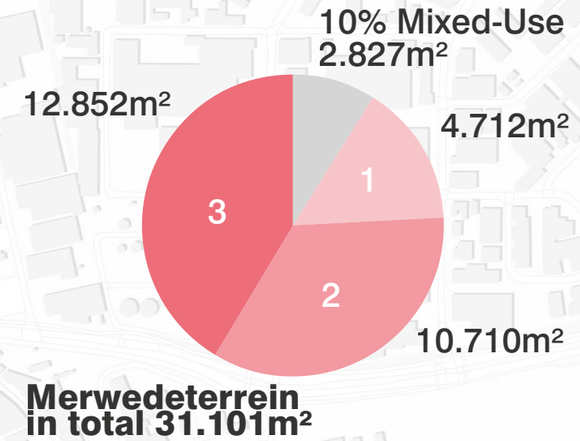
Residential Projects Merwedeterrein

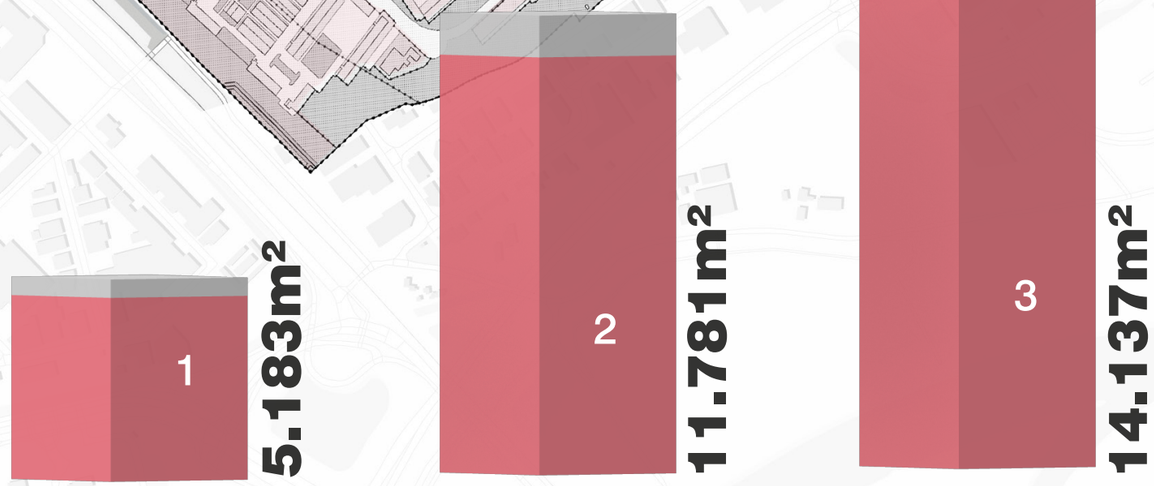
Proposed areas for residential development.

Preliminary Research
Development Distribution



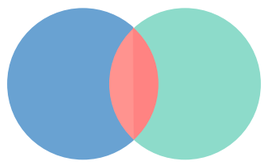
612 new homes in Arnhem Presikhaaf.





Urban Vision
Objectives

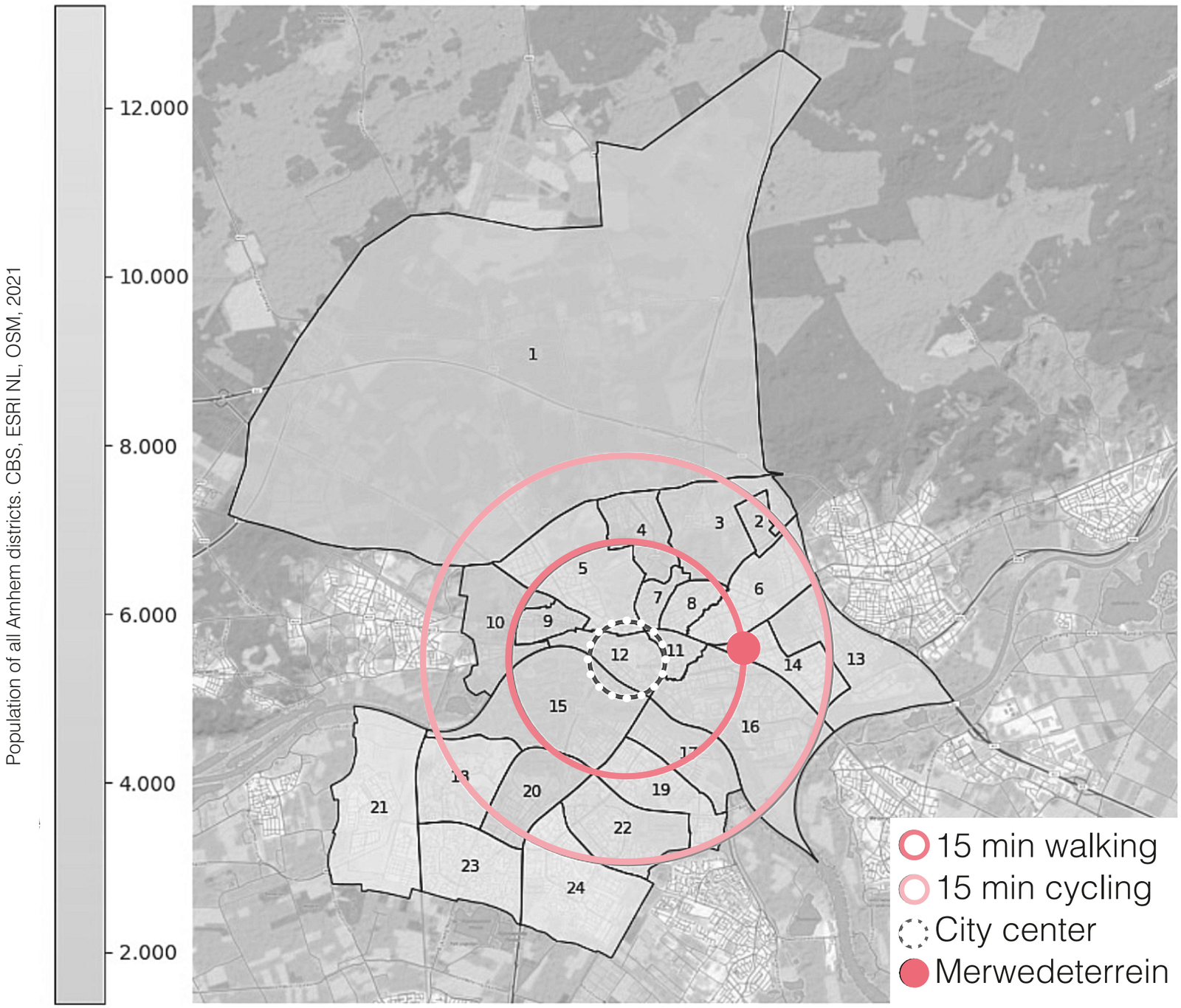
Low Mobility Costs.



Sustainable Communities.

Urban Vision

Implementing 15-Minute-City Principles



New Urban Hubs and Connectors.

Pedestrian and Cyclist Friendly Space Planning.

Proximity to all Utilities.

Participative Spaces that Promote Social Cohesion.

15 Minute Cycling Distance
From Major Residential Areas in Arnhem.

There are still many ‘Holes‘ in the Urban Fabric.

Merwedeterrein is an
Important Connective Element
from the City Center to the
Eastern Residential Districts.

Merwedeterrein takes a Central Position between Residential Districts but is yet Isolated.

Points of Interest

AKZO Terrein

Physical Borders

Thialf

City Center

Het Broek

Presikhaaf I

Presikhaaf II

Much Greenery
at Merwedeterrein.

Current Functions at Merwedeterrein.

Railway Traffic
Playground
Temporary Living
P
Caravan Site
Family Home
Electricity Building
Horse Range
Vegetable Garden
Bar
Kunstwerk-plaats 35
Mosque
Car Dealer
P
P
Signal Box
Railway Traffic
Construction Material Storage
Caravan Site
Art Depot
Ateliers

Land-Ownership at Merwedeterrein.

Vivare

Gemeente Arnhem

Garage Park

Henk Vos Vastgoed

Handels-onderneming Arnhem

Mosque

Rijn en Ijssel

Visie Merwedeterrein
Municipality Arnhem, 2020
Transit Village 1.0

Residential Development AKZO Terrein
50.000 m² floor area
KlokGroup +BPD

Transformation to recreation area

Passage

Bicycle Highway

Connection to Presikhaaf I

Central Connection

Residential Development Merwedeterrein
31.101m² floor area.

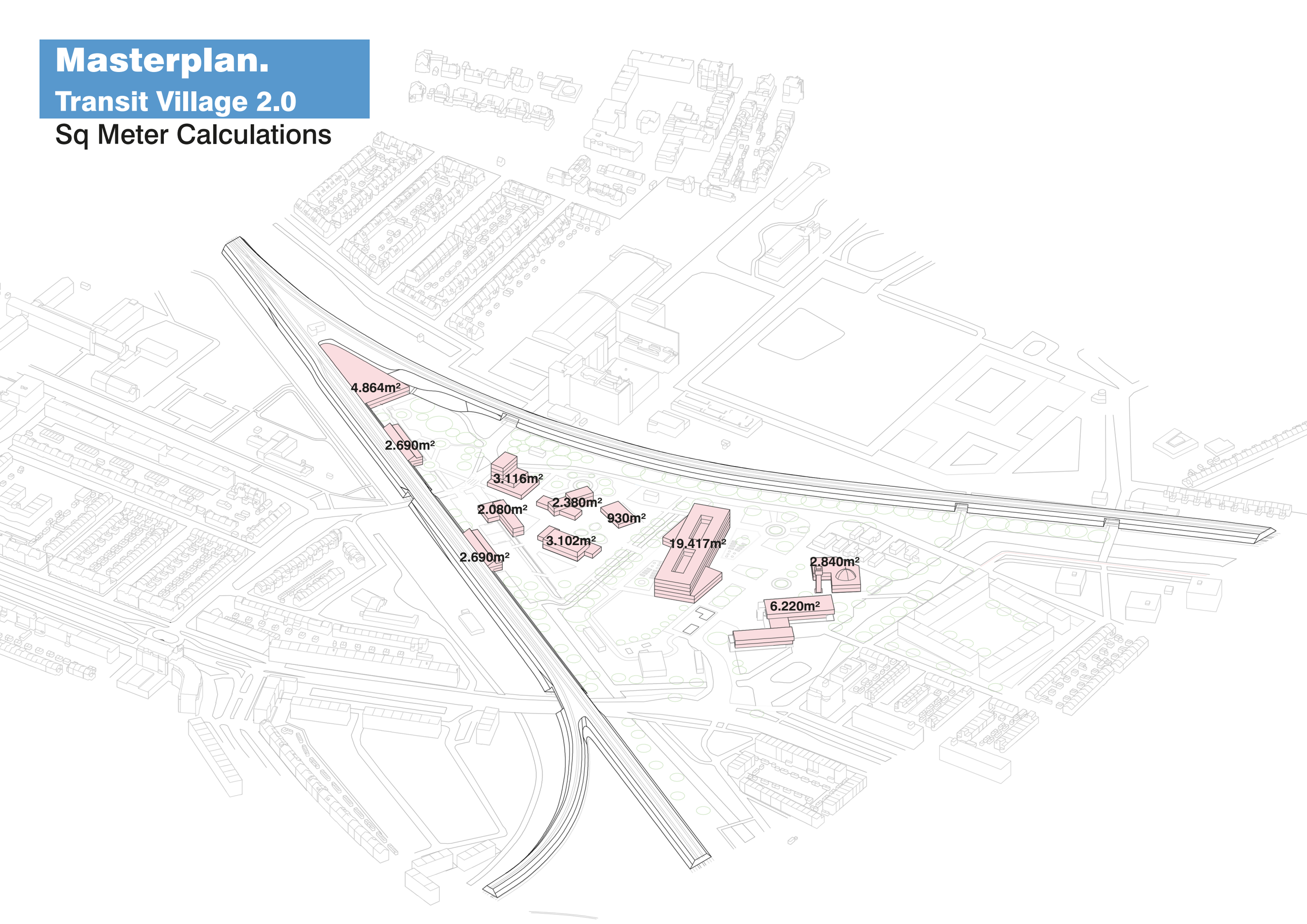
Relocation to New Mosque

Bicycle Highway

Masterplan.

Transit Village 2.0

Sq Meter Calculations



Masterplan.
Transit Village 2.0

P
Parking
Roof: Urban Gardening
+ Mixed-Use

New Park

Connective Axis

Connecting
Parking and Dwellings

Feeling of Security
Through Visibility

New Trees

Sound Deflecting
Roof Shapes

Communicative
Zones

PV

Icon

Connective Axis

Sound Deflecting
Roof Shapes

PV

Densification Trees

Connective Axis

Capturing
Entrance

Green Squares

Mixed-Use
on Ground
Level

New
Urban Hub

Passage

Bridge

Relocation
Artist Workshop

PV

Terrace

Bridge

Relocation
Horse Range

Widening Waterway

Bicycle Highway Allows for Less Cars

P
New Mosque

Bridge

Slow Traffic

Passage

Stallion

Enhancement
Accessibility

New Pathway

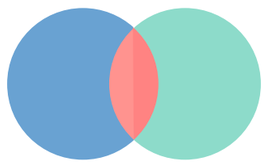
KW35

Main Car Entrance

P

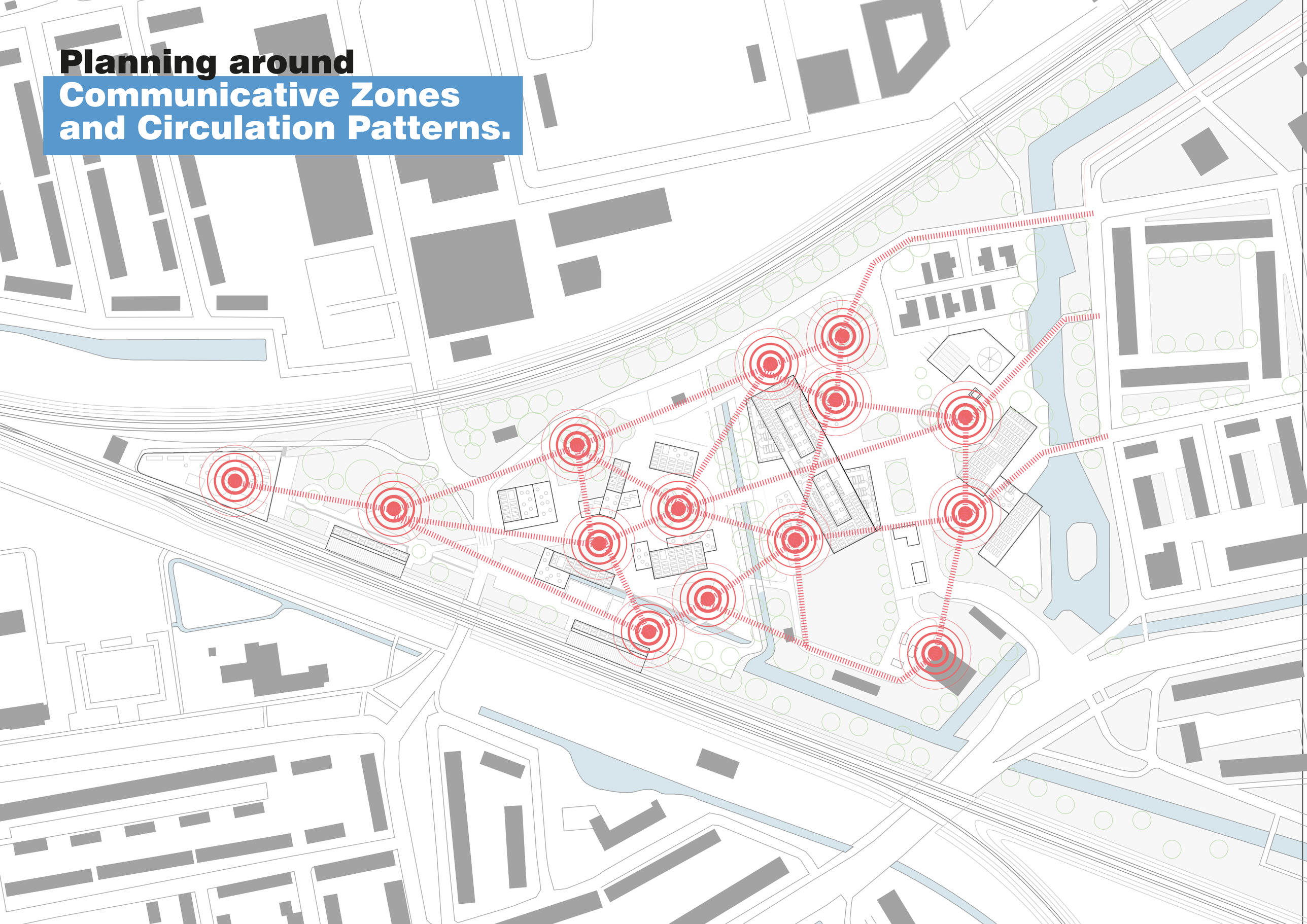
Masterplanning
Objectives and Methodology

Low Life Cycle Costs.



Plus Energy Buildings.

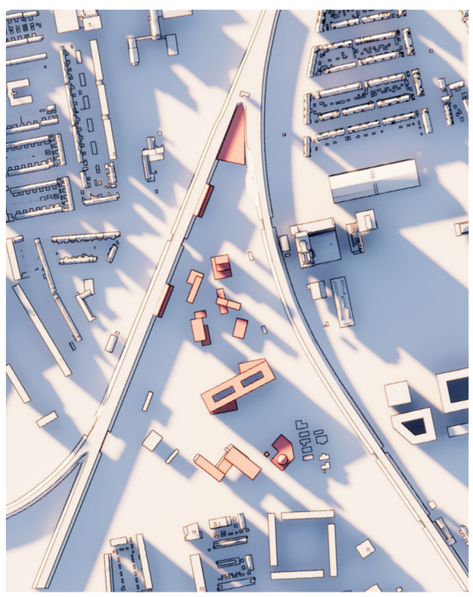
Planning around
Communicative Zones and Circulation Patterns.



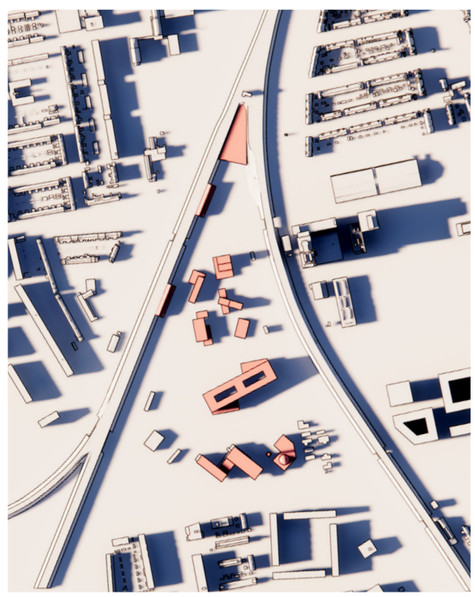
Volume Studies.

Shadow Analysis.

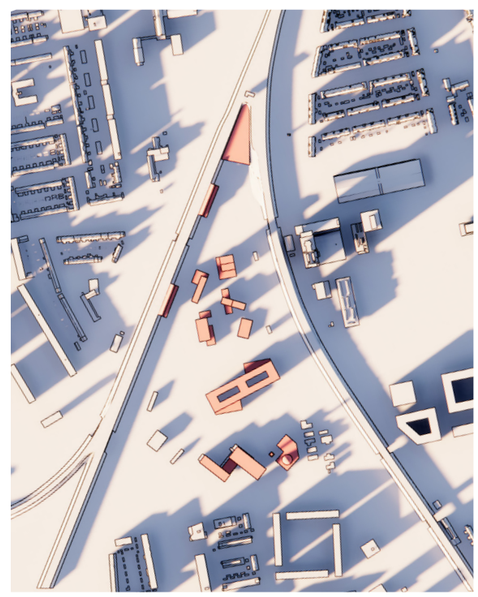
3.30 PM



12.00 PM

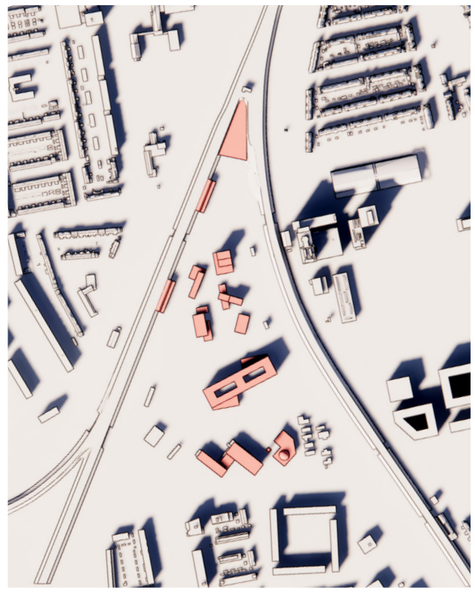


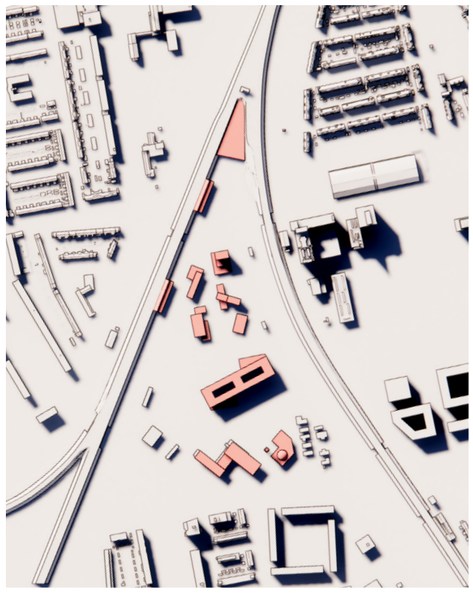
9.30 AM

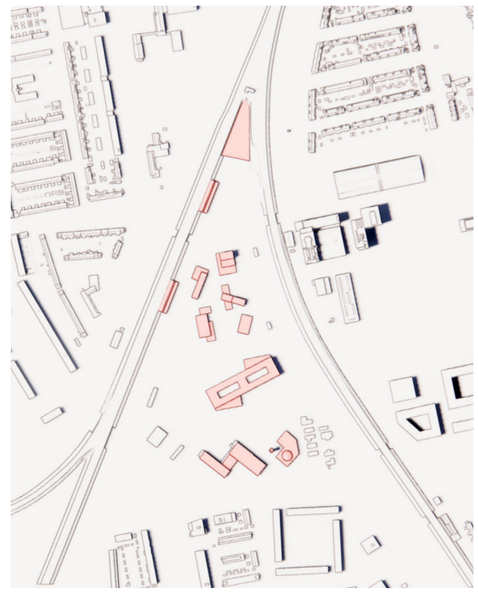


December 21

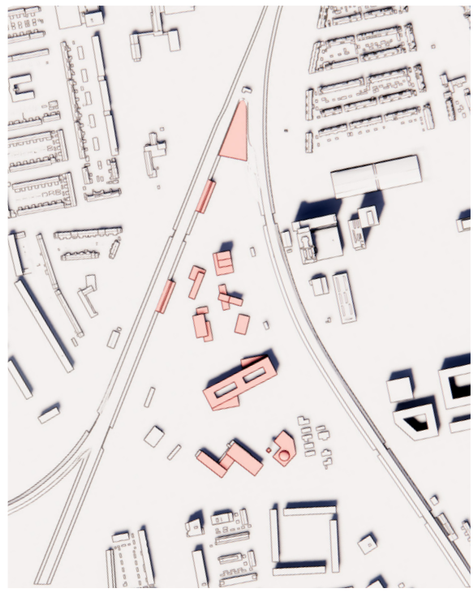
March 21

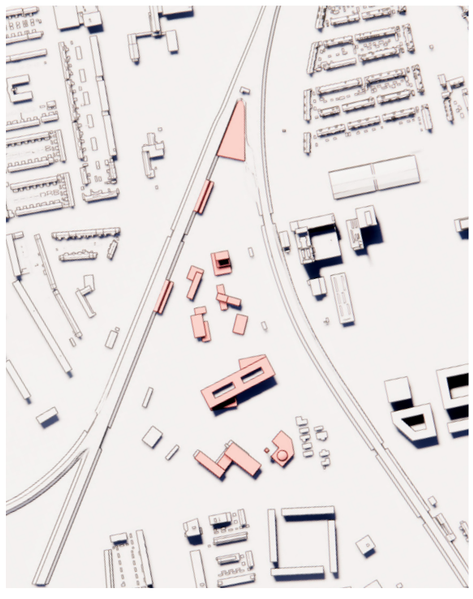




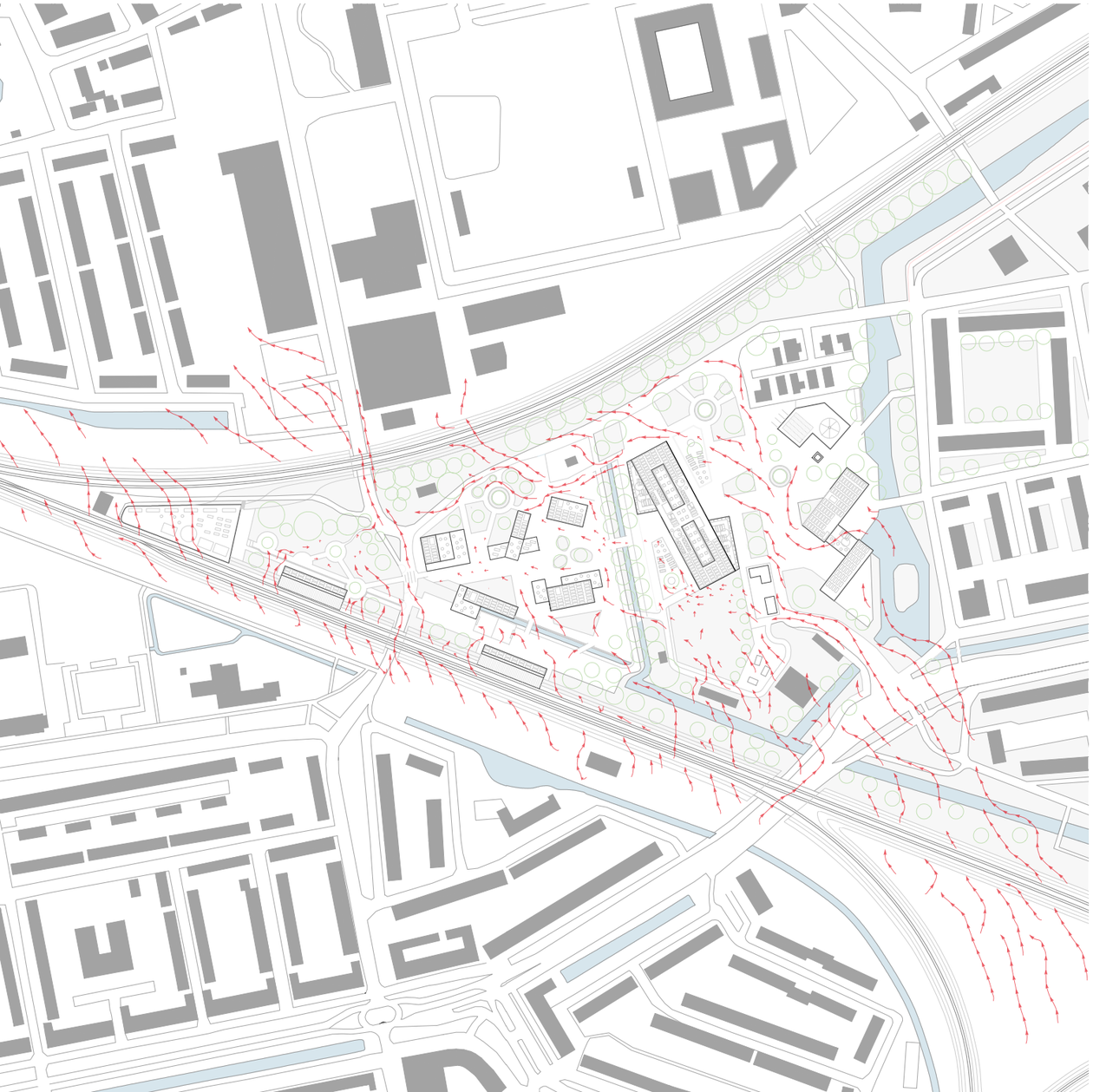


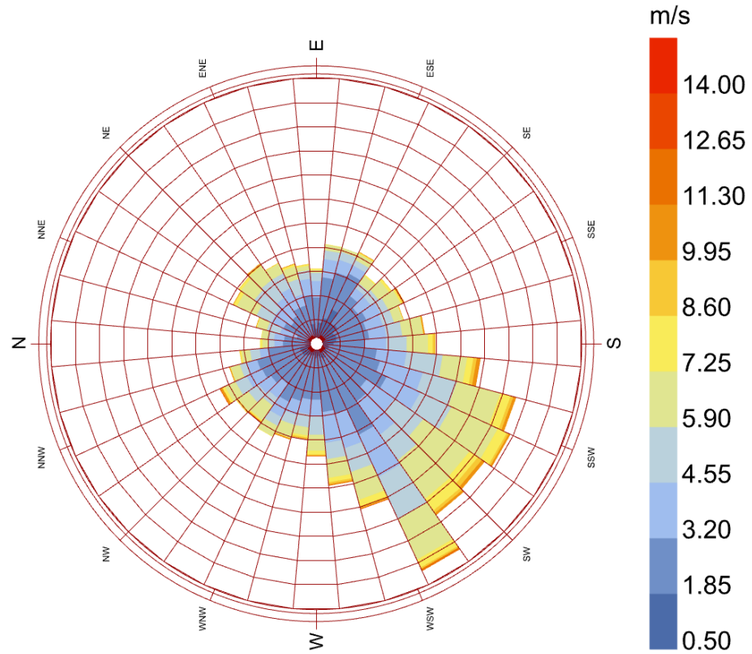
June 21



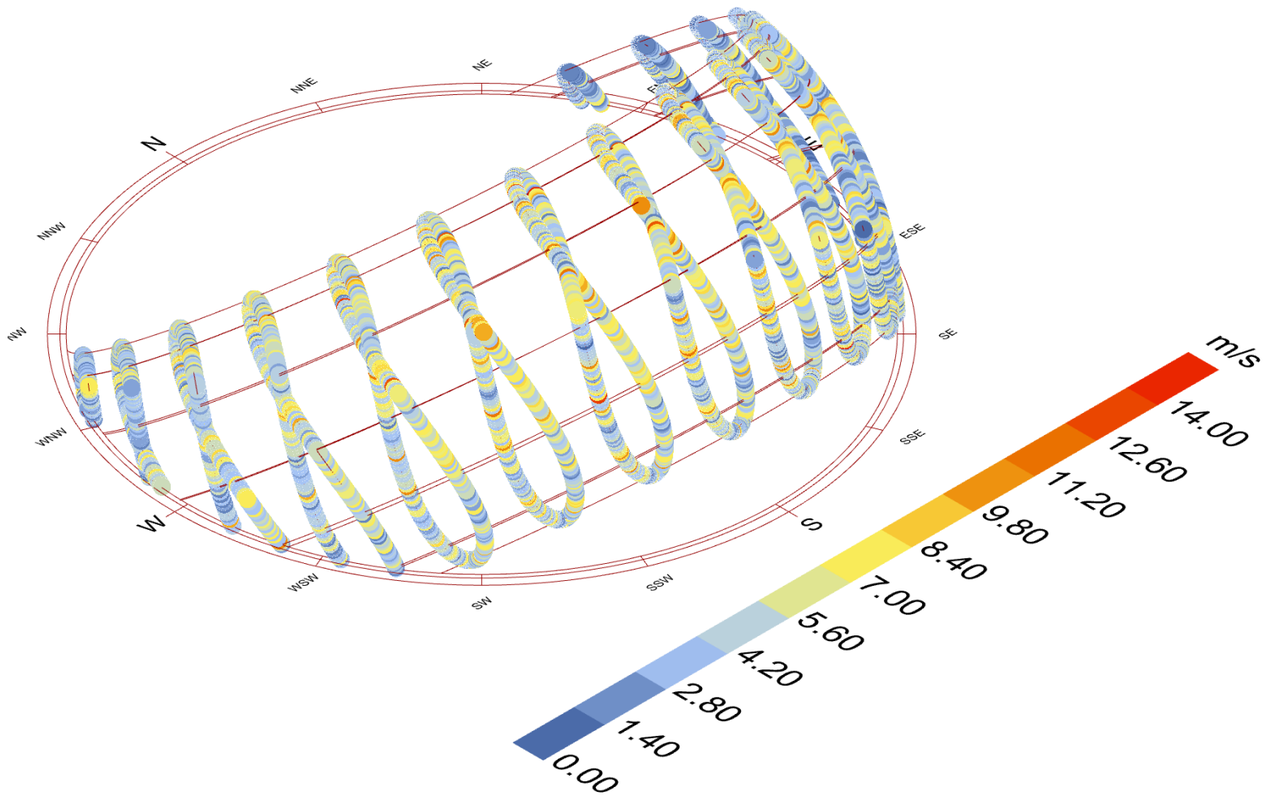


Wind Analysis.

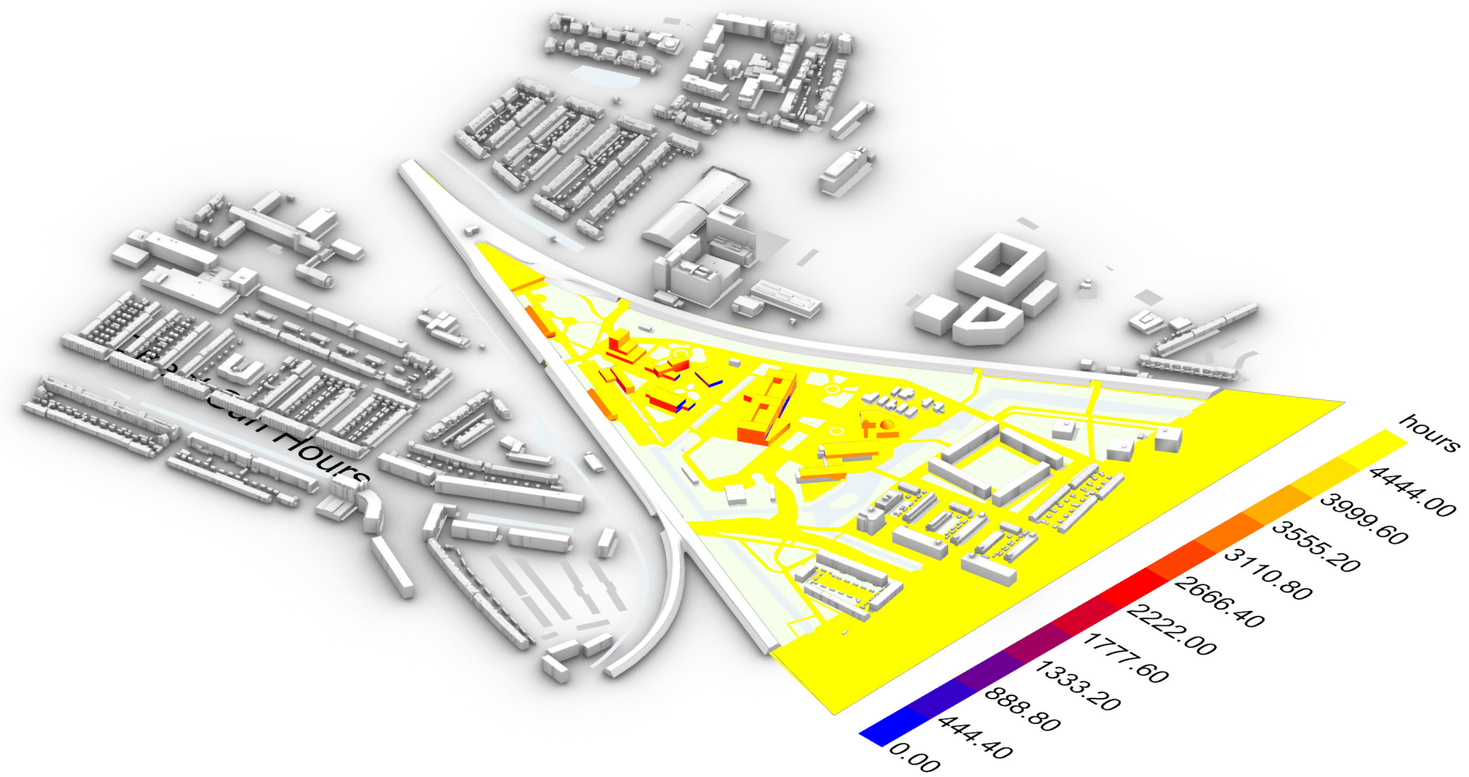


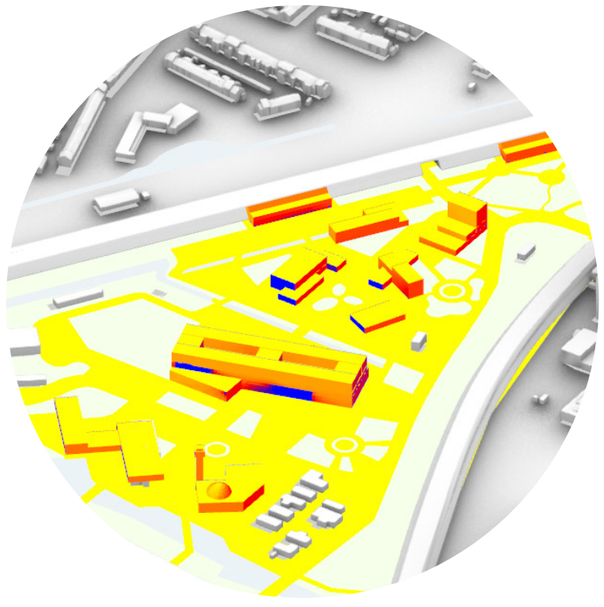


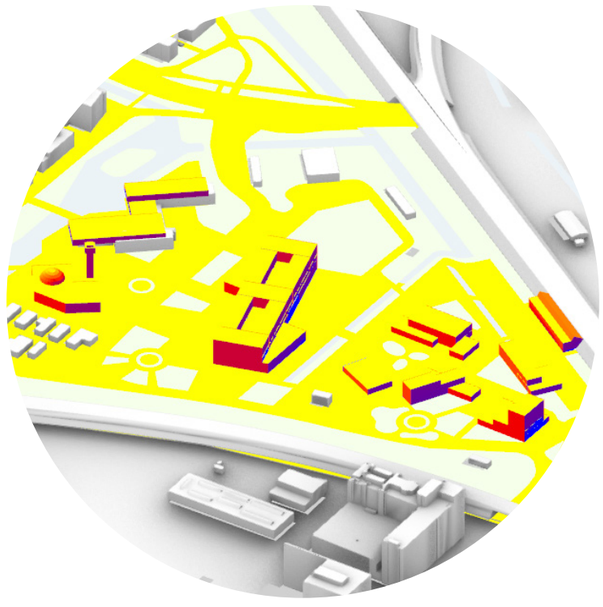
Wind Speed (m/s)
Ciry: Arnhem AB
Source: ISD-TMYx
Period 1/1 to 12/31 between 0 and 23 @1
Each closed polyline shows a frequency of 0.6% = 50 hours.

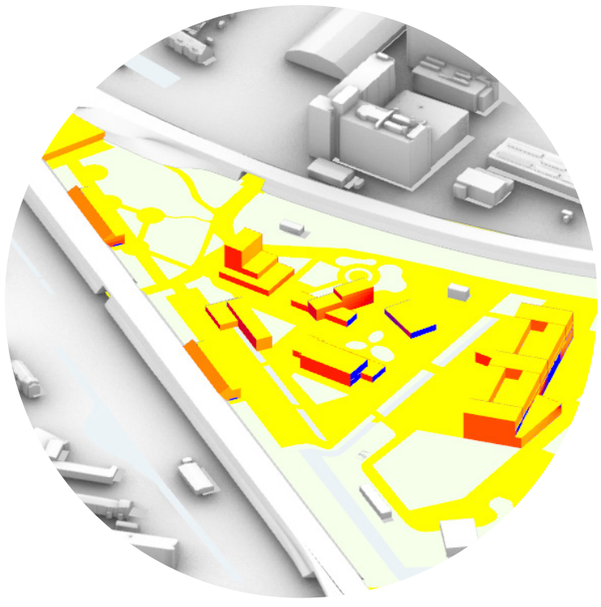


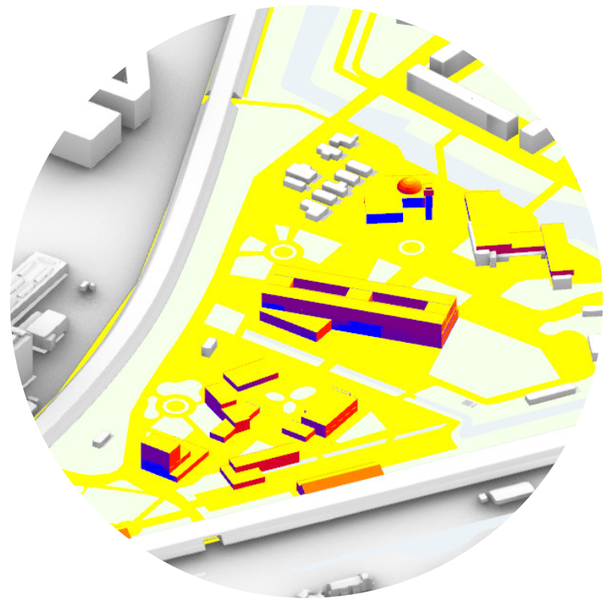
Direct Sunlight Analysis.



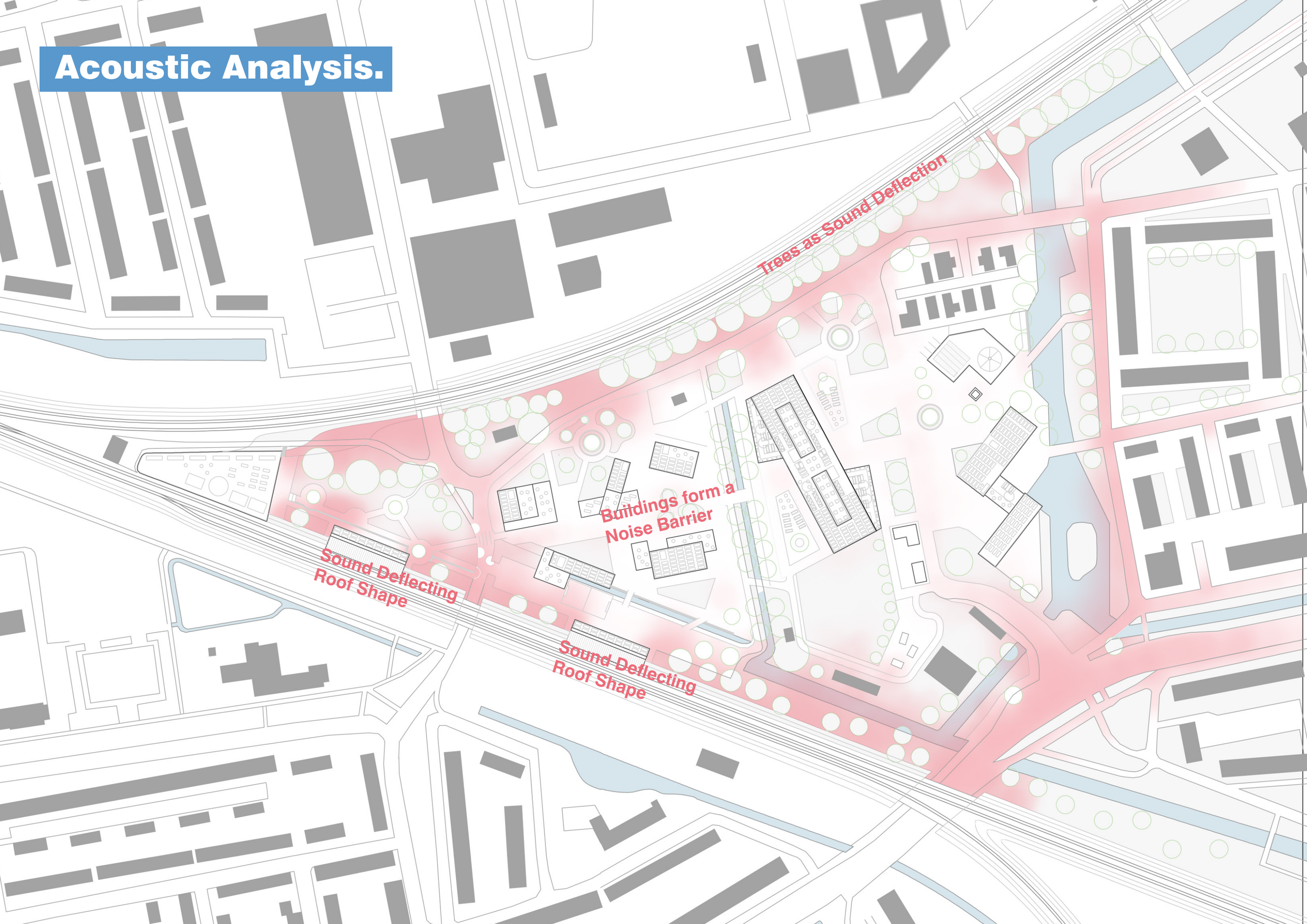




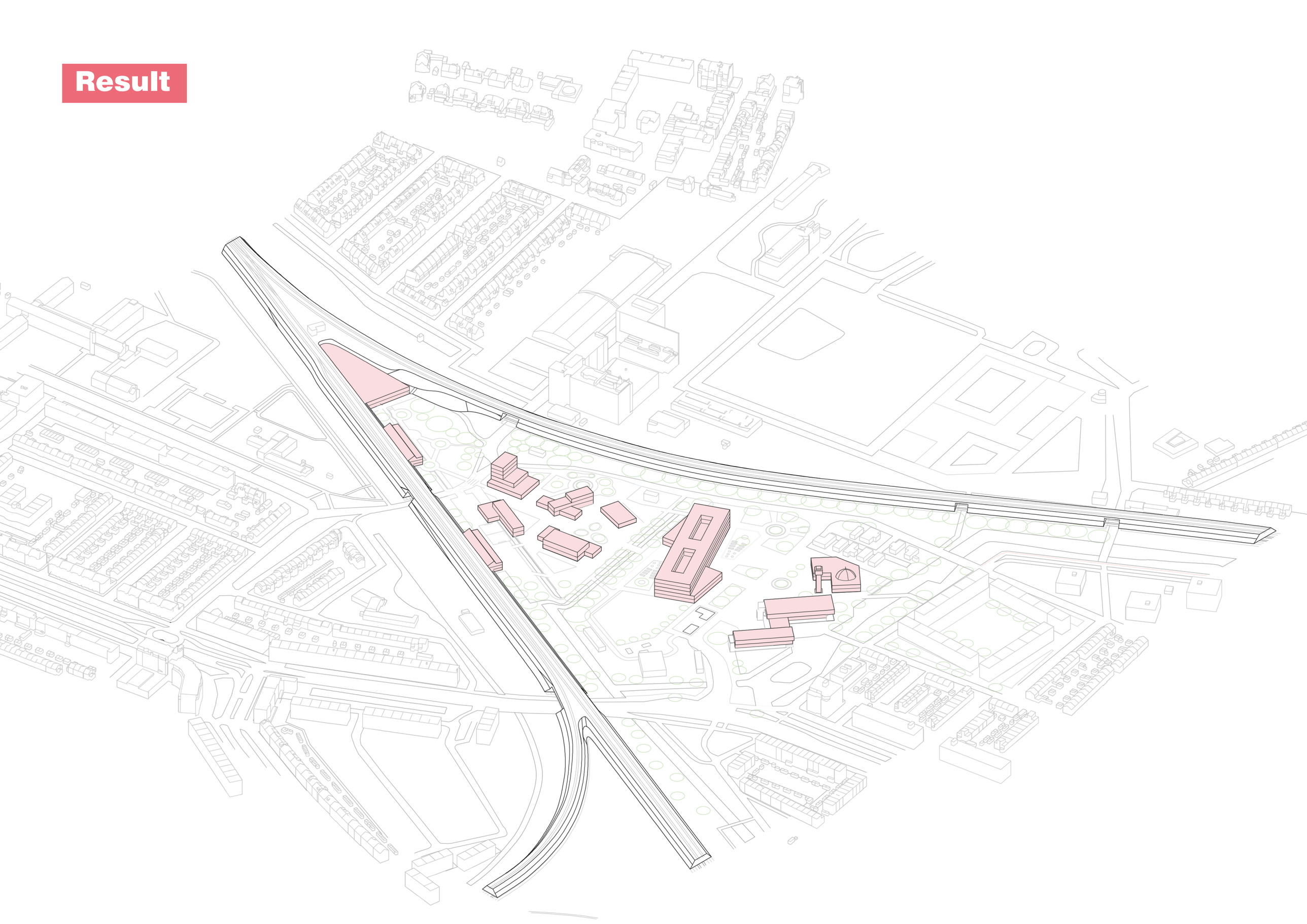




Acoustic Analysis.



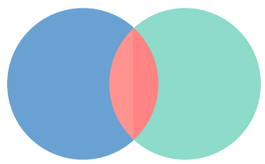
Result



Architectural Concept

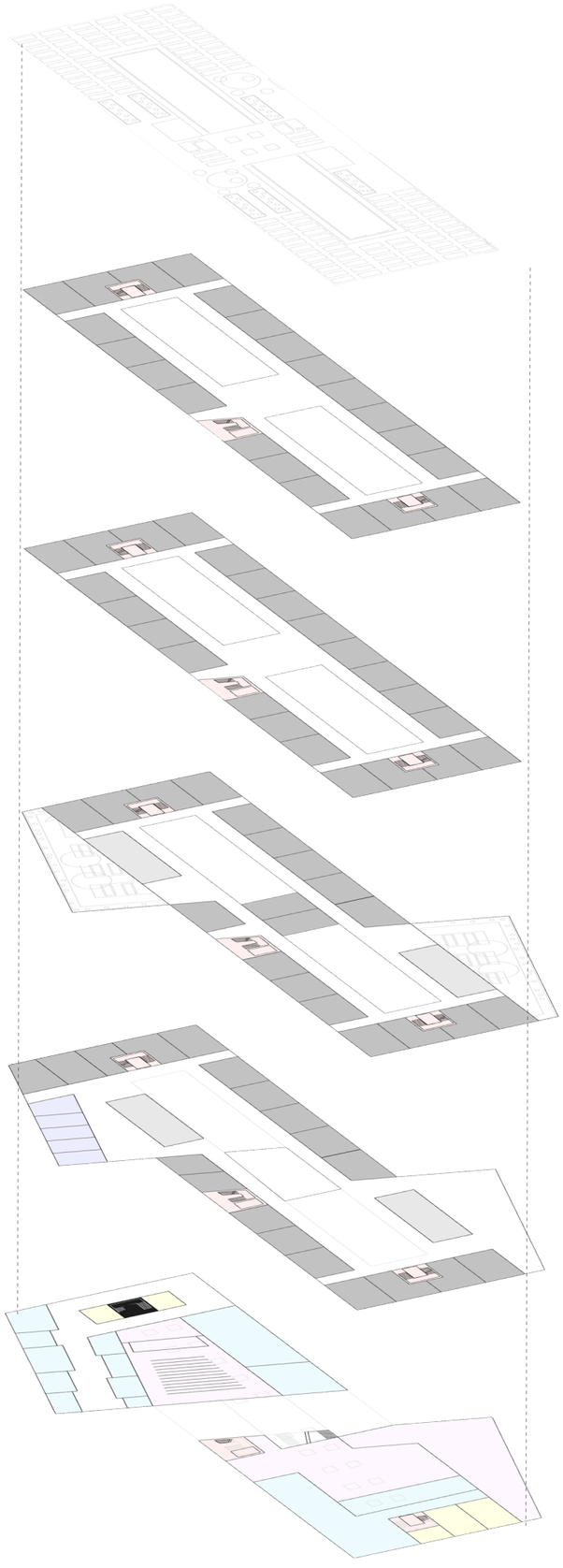
Architectural Concept
Objectives

Affordable Apartments.



Healthy Building.

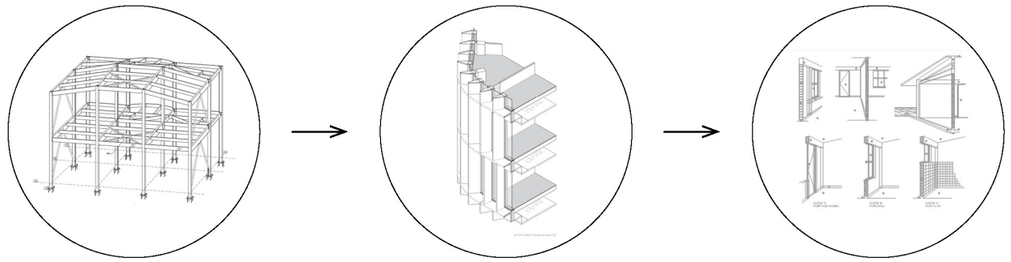
Axonometric



Living Area
Community Area
Business
Rental Office-Space
Culture
Storey Development
Sanitary Facilities

Architectural Concept

Open Building Principles



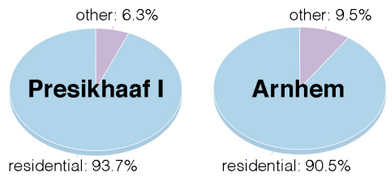
Remountable/
Durable
Structure

Remountable/
Durable
Skin

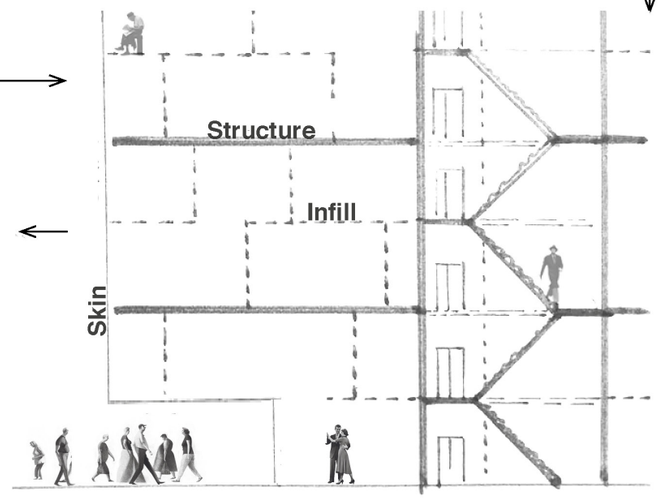
Remountable/
Durable/
Flexible Infill

Open ground level zones

15% mixed-use to enhance
social cohesion + create jobs



Framework



Weekly
Farmers Market

Supermarket

Small
Retail

Impro -
Theater

Rue
Intérieure

Library

Community
Workshop

Café +
Restaurant

Terrace

Ground Floor

Communal
Kitchen

Rental
Workspaces

Communicative
Zones underneath
the Atriums

Ø 70m²
Apartments in
this plan

**Density is flexible
within the
Living Zones.**
Vertically as
Horizontally.

1st Floor

Community
Terrace

Community
Terrace

Billiard,
Table Tennis,
etc.

2nd Floor

Meeting
Point

3rd + 4th Floor

PV

Urban Gardening

Leisure Activities

PV

Roof Terraces

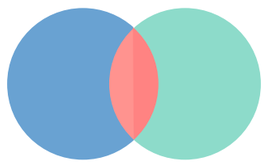
Aesthetic Inspirations

Facade

Open Ground Level Zones

Visualization

Low Construction Costs.



Emmissions + Waste Reduction.

Hypothesis

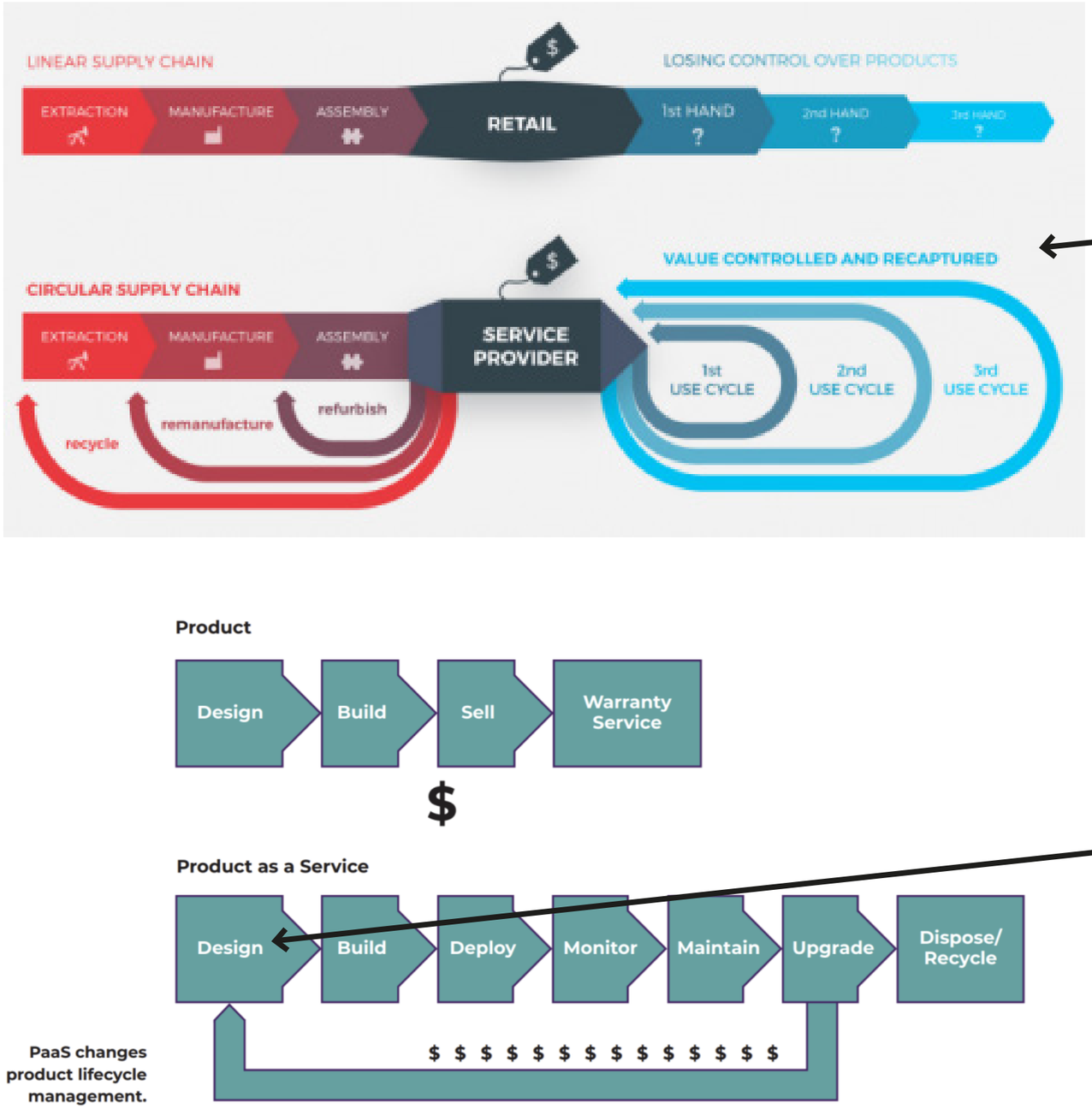
Commercializing Interior Partition Walls ‘as a Service‘ leads to...

Less Waste.

Increased Product Quality.

Financial Benefits for Distributors and Customers.

Product VS Product as a Service (PaaS)



Value Controlled and Recaptured.

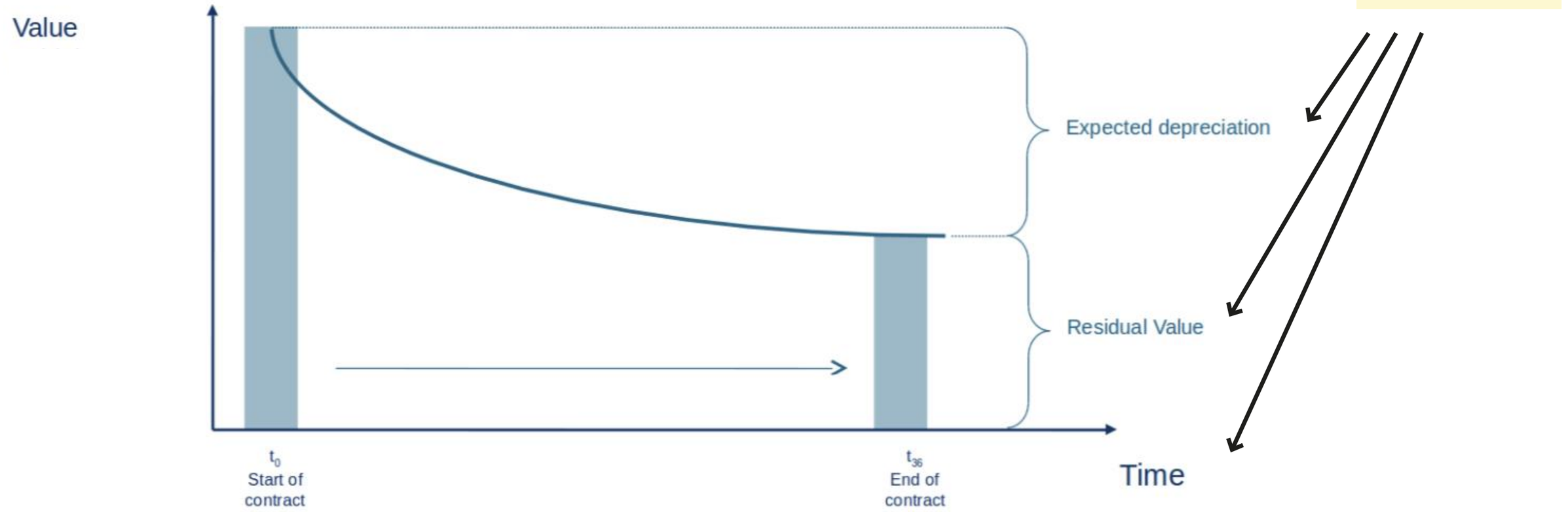
Taking into account Product Life Cycle Management already in the Design Phase.

Appendix D. Comparison between Product and Product as a Service: PaaS changes product life cycle management. (Lombardo, 2019)

Resulting Requirement

Design for Increased Value Retention.

Factors to Consider



Thematic Research Question

What architectural design strategies can be implemented to create circular interior partition walls that retain value?

Research Methodology

Theoretical Framework

Business Model Analysis

> Choosing a business model that induces value retentive design of building producs commercialized through it.

Method 1: Literature research on the workings of the model.

Method 2: Evaluating, if the chosen building product can be commercialized through the model.

Cross Industry Research

> Choosing an industry with expertise in Residual Value Forecasting (RVF).

> Its marketed products optimally have a similar lifespan to the chosen building product.

Method 3: Literature research on how the industry defines and forecasts the residual value of products.

Method 4: Defining causes of value loss and decisive parameters of RVF models.

Case Study Analysis

> Choosing contemporary case studies that apply decisive parameters from the analyzed RVF models to the design of the chosen building products.

Method 5: Categorizing strategies for value retentive design into sub-groups and evaluating the quality of the specific approaches.

Catalog of Design Strategies for Value Retention

Method 6: Performing a Multi-Criteria Decision Analysis (MCDA) or similar evaluation method on the selected case studies.

Case Studies

Figure 1. The FAAY System Wall SP70.

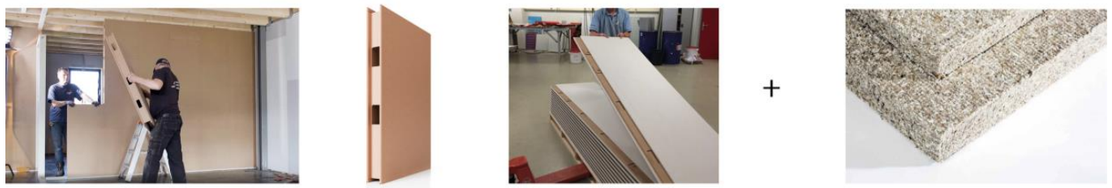


Figure 2. The Quickpanell circular partition wall.

Figure 3. The wooden frame wall with gypsum fiberboard cladding.

Figure 4. The massive wood interior partition wall.

Figure 5. The steel frame wall with plywood panels.

Wall System	Substructure	Connections	Finishing
System 1: FAAY System Wall SP70	Flax Fiber Board 50mm	Floor: aluminum T-profile or wooden guide rail. Wall/ Ceiling: half wooden rails or frame panels.	Chipboard 10 mm on both sides. Eventually paint finish.
System 2: Quickpanell Circular Partition Wall	Foldable cardboard lashes and variable stiff isolation panels. Here: EverUse cellulose mats.	Either frame from aluminum or guide rail from MDF. Plug-in mechanism.	Variable materials. Here: MDF sheet material 14 mm on each side.
System 3: Wooden frame wall with gypsum fiberboard	Prefabricated wooden frame. Flax fiber board.	Screws. Wooden beams on floor and ceiling. No glue.	Gypsum fiberboard . Paint finish.
System 4: Massive wood interior wall	Solid modular wooden beams.	EPDM, L-connectors steel connector bolts. Steel spacers.	Varnish.
System 5: Steel frame wall with wooden panels	Steel frame system. Cellulose mats.	Clamps, hooks, bolts, and screws.	Plywood panels 15mm on each side. Varnish.
Reference: Metal stud drywall system with gypsum board cladding	Metal stud system. Stone wool.	Screws and plaster joining.	Plasterboard cladding 10mm on each side. Paint finish.

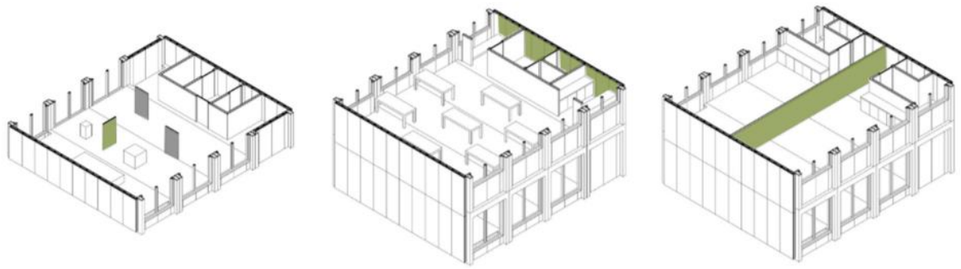
Evaluation Criteria

Appendix G. Qualitative criteria that decrease depreciation and increase the residual value of interior partition walls. These criteria can be regarded as indicators for value retentive design.

	Qualitative Criteria	Positive (1)	Neutral (0,5)	Negative (0)
1	**Durability**			
Technical				
1a	High-quality materials	Low deterioration; hard to damage	Neutral deterioration; damage possible	High deterioration; easily damaged
1b	Durable, functional components that accept movement	Robust connections and dimensioning; Well-engineered	Fair connections and dimensioning; Fair-engineered	Poor quality connections and dimensioning
1c	Resistance against moisture, mold, corrosive substances.	Mold and corrosion resistant materials, vapor-open	Does not mold	Possibly molds
1d	Fire resistance	> EI 90	< EI 60	< EI 30
1e	Acoustic insulation	High (>57 dB) acoustical performance	medium (57 dB > x > 51 dB) acoustical performance	Low (<51 dB) acoustical performance
1f	Thermal insulation	High thermal insulation	Thermal insulation present	No thermal insulation present
Socio-Economic				
1g	Surface qualities and patina	Low deterioration; beautiful patina	Normal deterioration; fair patina	High deterioration; Ages badly
1h	Material texture or paint color	Timeless aesthetic	Good aesthetic	Temporary aesthetic
1i	Acceptance of alterations	Original state can be restored	Some traces of use remain visible	Reuse is limited through alterations
1j	Resistance to applied loads	Shelves or such can be attached without wear	Some wear remains visible	Shelves or such cannot be mounted to the wall
2	**Remountability**			
Technical				
2a	Component independency	Mechanical connectors; no glue; little tools required	Reversible glues allowed; Components can be disassembled	Most components are glued or fixed in ways that prohibit easy disassembly
2b	Component composition and ease of repair	Components can easily be taken apart without wear	Components can be taken apart, however traces are left	Component disassembly leads to wear and tear
2c	Ease of upgrades	Componential logic is well organized	Partial replacement is possible	Upgrades require new components
2d	Speed of assembly and disassembly	Lightweight; mechanical connections; little tools required	More workers required; more tools required	Large complexity; Irreversible connections
2e	Connection reversibility and grade of wear and tear	Reversible and durable connections, no wear and tear	Connections are relatively durable and reversible	Irreversible connections; e.g. glue
2f	Accessibility and adjustability of technical systems	Technical systems are easily accessible and adjustable without wear and tear	Technical systems are accessible and adjustable without wear and tear	Components are damaged or must be replaced after accessing technical systems
Socio-Economic				
2g	Flexibility in case of use-changes	Components are very flexible and can be removed and moved without larger efforts	Components can be removed and moved with little damage	Components are damaged when removed or moved

Wall Type Scenarios

Wall Type Scenario	Turnover Rate (Years)	Description
Scenario 1: quickly changing interior wall	1	Walls and wall segments in the central space of the dissemination room (exhibition walls, presentation walls . . .)
Scenario 2: technical interior wall	10	False walls to cover technical systems (water, heating, electricity and ventilation)
Scenario 3: dwelling-dividing interior wall	15	Central wall or walls to split up the open space into individual housing units



Scenario 1 Scenario 2 Scenario 3

Evaluation Method

Multi Criteria Decision Analysis (MCDA)

1 Assessing the importance of the criteria for each wall type scenario.

Appendix I. Assessment of the importance of the qualitative criteria for the wall type scenarios. Each of the criteria is assigned a weight. The weight is expressed as a relative percentage of the criteria's importance for a specific wall type scenario.

	Qualitative Criteria	**Wall Type Scenario 1** Quickly changing interior walls	**Wall Type Scenario 2** Technical interior walls	**Wall Type Scenario 3** Dwelling-dividing interior walls
1	**Durability**			
Technical				
1a	High-quality materials	8,8%	5,9%	8,7%
1b	Durable, functional components that accept movement	9,8%	2,2%	3,8%
1c	Resistance against moisture, mold, corrosive substances.	2,9%	7,4%	5,8%
1d	Fire resistance	4,9%	5,9%	7,7%
1e	Acoustic insulation	2,9%	7,4%	8,7%
1f	Thermal insulation	0%	5,9%	6,7%
Socio-Economic				
1g	Surface qualities and patina	4,9%	6,7%	8,7%
1h	Material texture or paint color	7,8%	4,4%	6,7%
1i	Acceptance of alterations	8,8%	5,9%	7,7%
1j	Resistance to applied loads	0%	5,2%	6,7%
2	**Remountability**			
Technical				
2a	Component independency	9,8%	5,2%	5,8%
2b	Component composition and ease of repair	7,8%	5,9%	3,8%
2c	Ease of upgrades	7,8%	5,2%	4,8%
2d	Speed of assembly and disassembly	9,8%	4,4%	5,8%
2e	Connection reversibility and grade of wear	3,9%	7,4%	9,6%
2f	Accessibility and adjustability of technical systems	0%	7,4%	4,8%
Socio-Economic				
2g	Flexibility in case of use-changes	9,8%	7,4%	9,6%
		Total: 100%	Total: 100%	Total: 100%

2 Assessing the case studies performance in each criterion.

Appendix J. A rating of the case studies regarding their performance in the criteria. The scoring is based on a positive (1), neutral (0,5), and negative (0) evaluation.

	Qualitative Criteria	**System 1**	**System 2**	**System 3**	**System 4**	**System 5**	**Reference**
1	**Durability**						
Technical							
1a	High-quality materials	1	0	0,5	1	1	0,5
1b	Durable, functional components that accept movement	1	0,5	0,5	1	1	0
1c	Resistance against moisture, mold, corrosive substances.	0,5	0	1	1	0,5	1
1d	Fire resistance	0	0	1	0,5	0	1
1e	Acoustic insulation	0,5	0	0,5	0,5	0,5	0,5
1f	Thermal insulation	1	0,5	1	0,5	1	1
Socio-Economic							
1g	Surface qualities and patina	0,5	1	0	1	1	0
1h	Material texture or paint color	0,5	1	0	1	1	0
1i	Acceptance of alterations	0,5	0,5	0	0	0,5	0,5
1j	Resistance to applied loads	0,5	0	1	1	1	1
2	**Remountability**						
Technical							
2a	Component independency	0	1	1	1	1	0
2b	Component composition and ease of repair	0	1	1	1	1	0,5
2c	Ease of upgrades	1	1	0,5	1	0	0
2d	Speed of assembly and disassembly	1	1	0,5	1	1	0,5
2e	Connection reversibility and grade of wear and tear	0,5	1	0	1	1	0
2f	Accessibility and adjustability of technical systems	0	1	0,5	0,5	1	0,5
Socio-Economic							
2g	Flexibility in case of use-changes	1	1	0,5	1	0,5	0,5

3 Multiplying Performance and Importance.

Appendix M. A ranking of the systems using the weight for wall type scenario 3 – dwelling-dividing interior walls.

	Qualitative Criteria	System 1	System 2	System 3	System 4	System 5	Reference
1	**Durability**						
Technical							
1a	High-quality materials	8,7%	0%	4,4%	8,7%	8,7%	4,4%
1b	Durable, functional components that accept movement	3,8%	1,9%	1,9%	3,8%	3,8%	0%
1c	Resistance against moisture, mold, corrosive substances.	2,9%	0%	5,8%	5,8%	2,9%	5,8%
1d	Fire resistance	0%	0%	7,7%	3,9%	0%	7,7%
1e	Acoustic insulation	4,4%	0%	4,4%	4,4%	4,4%	4,4%
1f	Thermal insulation	6,7%	3,4%	6,7%	3,4%	6,7%	6,7%
Socio-Economic							
1g	Surface qualities and patina	4,4%	8,7%	0%	8,7%	8,7%	0%
1h	Material texture or paint color	3,4%	6,7%	0%	6,7%	6,7%	0%
1i	Acceptance of alterations	3,9%	3,9%	0%	0%	3,9%	3,9%
1j	Resistance to applied loads	3,4%	0	6,7%	6,7%	6,7%	6,7%
2	**Remountability**						
Technical							
2a	Component independency	0%	5,8%	5,8%	5,8%	5,8%	0%
2b	Component composition and ease of repair	0%	3,8%	3,8%	3,8%	3,8%	1,9%
2c	Ease of upgrades	4,8%	4,8%	2,4%	4,8%	0%	0%
2d	Speed of assembly and disassembly	5,8%	5,8%	2,9%	5,8%	5,8%	2,9%
2e	Connection reversibility and grade of wear and tear	4,8%	9,6%	0%	9,6%	9,6%	0%
2f	Accessibility and adjustability of technical systems	0%	4,8%	2,4%	2,4%	4,8%	2,4%
Socio-Economic							
2g	Flexibility in case of use-changes	9,6%	9,6%	4,8%	9,6%	4,8%	4,8%
	Value Retention Ranking	**66,6%**	**68,6%**	**59,7%**	**93,9%**	**87,1%**	**51,6%**

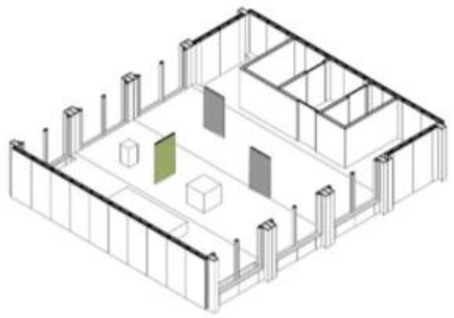
Appendix L. A ranking of the systems using the weight for wall type scenario 2 – technical interior walls.

	Qualitative Criteria	System 1	System 2	System 3	System 4	System 5	Reference
1	**Durability**						
Technical							
1a	High-quality materials	5,9%	0%	3%	5,9%	5,9%	3%
1b	Durable, functional components that accept movement	2,2%	1,1%	1,1%	2,2%	2,2%	0%
1c	Resistance against moisture, mold, corrosive substances.	3,7%	0%	7,4%	7,4%	3,7%	7,4%
1d	Fire resistance	0%	0%	5,9%	3%	0%	5,9%
1e	Acoustic insulation	3,7%	0%	3,7%	3,7%	3,7%	3,7%
1f	Thermal insulation	5,9%	3%	5,9%	3%	5,9%	5,9%
Socio-Economic							
1g	Surface qualities and patina	3,4%	6,7%	0%	3,4%	6,7%	0%
1h	Material texture or paint color	2,2%	4,4%	0%	4,4%	4,4%	0%
1i	Acceptance of alterations	3%	3%	0%	0%	3%	3%
1j	Resistance to applied loads	2,6%	0%	5,2%	5,2%	5,2%	5,2%
2	**Remountability**						
Technical							
2a	Component independency	0%	5,2%	5,2%	5,2%	5,2%	0%
2b	Component composition and ease of repair	0%	5,9%	5,9%	5,9%	5,9%	3%
2c	Ease of upgrades	5,2%	5,2%	2,6%	5,2%	0%	0%
2d	Speed of assembly and disassembly	4,4%	4,4%	2,2%	4,4%	4,4%	2,2%
2e	Connection reversibility and grade of wear and tear	3,7%	7,4%	0%	7,4%	7,4%	0%
2f	Accessibility and adjustability of technical systems	0%	7,4%	3,7%	3,7%	7,4%	3,7%
Socio-Economic							
2g	Flexibility in case of use-changes	7,4%	7,4%	3,7%	7,4%	3,7%	3,7%
	Value Retention Ranking	**53,3%**	**61,1%**	**55,5%**	**77,4%**	**74,7%**	**46,7%**

Appendix K. A ranking of the systems using the weight for wall type scenario 1 – quickly changing interior walls.

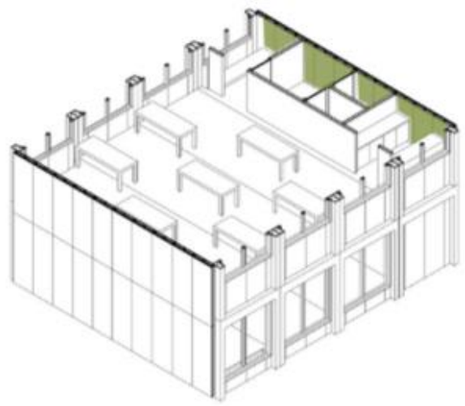
	Qualitative Criteria	System 1	System 2	System 3	System 4	System 5	Reference
1	**Durability**						
Technical							
1a	High-quality materials	8,8%	0%	4,4%	8,8%	8,8%	4,4%
1b	Durable, functional components that accept movement	9,8%	4,9%	4,9%	9,8%	9,8%	0%
1c	Resistance against moisture, mold, corrosive substances.	1,5%	0%	2,9%	2,9%	1,5%	2,9%
1d	Fire resistance	0%	0%	4,9%	2,5%	0%	4,9%
1e	Acoustic insulation	1,5%	0%	1,5%	1,5%	1,5%	1,5%
1f	Thermal insulation	0%	0%	0%	0%	0%	0%
Socio-Economic							
1g	Surface qualities and patina	2,5%	4,9%	0%	4,9%	4,9%	0%
1h	Material texture or paint color	3,9%	7,8%	0%	7,8%	7,8%	0%
1i	Acceptance of alterations	4,4%	4,4%	0%	0%	4,4%	4,4%
1j	Resistance to applied loads	0%	0%	0%	0%	0%	0%
2	**Remountability**						
Technical							
2a	Component independency	0%	9,8%	9,8%	9,8%	9,8%	0%
2b	Component composition and ease of repair	0%	7,8%	7,8%	7,8%	7,8%	3,9%
2c	Ease of upgrades	7,8%	7,8%	3,9%	7,8%	0%	0%
2d	Speed of assembly and disassembly	9,8%	9,8%	4,9%	9,8%	9,8%	4,9%
2e	Connection reversibility and grade of wear and tear	2%	3,9%	2%	3,9%	3,9%	0%
2f	Accessibility and adjustability of technical systems	0%	0%	0%	0%	0%	0%
Socio-Economic							
2g	Flexibility in case of use-changes	9,8%	9,8%	4,9%	9,8%	4,9%	4,9%
	Value Retention Ranking	**61,8%**	**70,9%**	**51,9%**	**79,3%**	**74,9%**	**31,8%**

4 Result - Value Retention Ranking per Wall Type Scenario



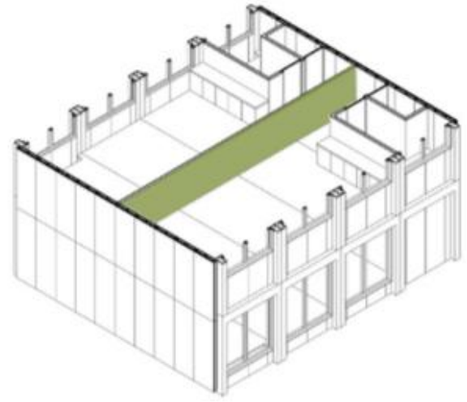
Scenario 1

	Qualitative Criteria	System 1	System 2	System 3	System 4	System 5	Reference
1	Durability						
	Value Retention Ranking	**66,6%**	**68,6%**	**59,7%**	**93,9%**	**87,1%**	**51,6%**



Scenario 2

	Qualitative Criteria	System 1	System 2	System 3	System 4	System 5	Reference
	Value Retention Ranking	**53,3%**	**61,1%**	**55,5%**	**77,4%**	**74,7%**	**46,7%**



Scenario 3

	Qualitative Criteria	System 1	System 2	System 3	System 4	System 5	Reference
	Value Retention Ranking	**61,8%**	**70,9%**	**51,9%**	**79,3%**	**74,9%**	**31,8%**

Note: MCDA is also a useful tool to evaluate new designs.

Outlook
Planning the Next Steps

Towards P3
> Refining the Design
> Refining the Architectural Concept
> Integrating Thematic Research and Design

Meso Scale

Towards P4
> Finishing the Design
> Designing a Value Retentive Interior Partition Wall
> Building a 1:1 Prototype

Towards P5
> Correct Last Inconsistencies
> Finalizing Drawings and Visualizations

Micro Scale