

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE STUDENT HOUSING

PROBLEM STATEMENT



STUDENT

03/02/2023

Waiting times for student housing getting longer

The housing shortage is making itself felt. Students are spending a longer time on the waiting lists of student housing providers such as DUWO and SSH: an average of more than three years, according to a survey.

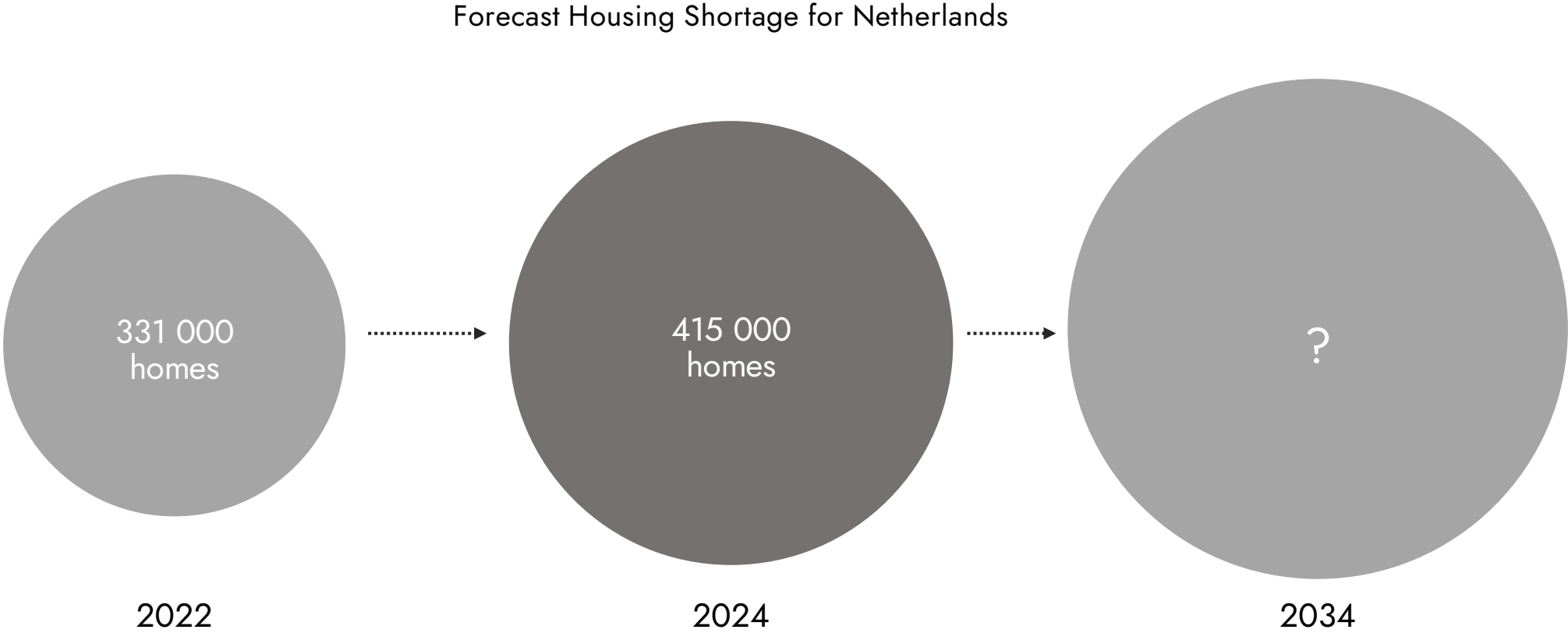
BY HOGER ONDERWIJS PERSBUREAU PHOTO GEMENACOM / ISTOCK



Source:

<https://www.cursor.tue.nl/en/news/2023/februari/week-1/waiting-times-for-student-housing-getting-longer/>

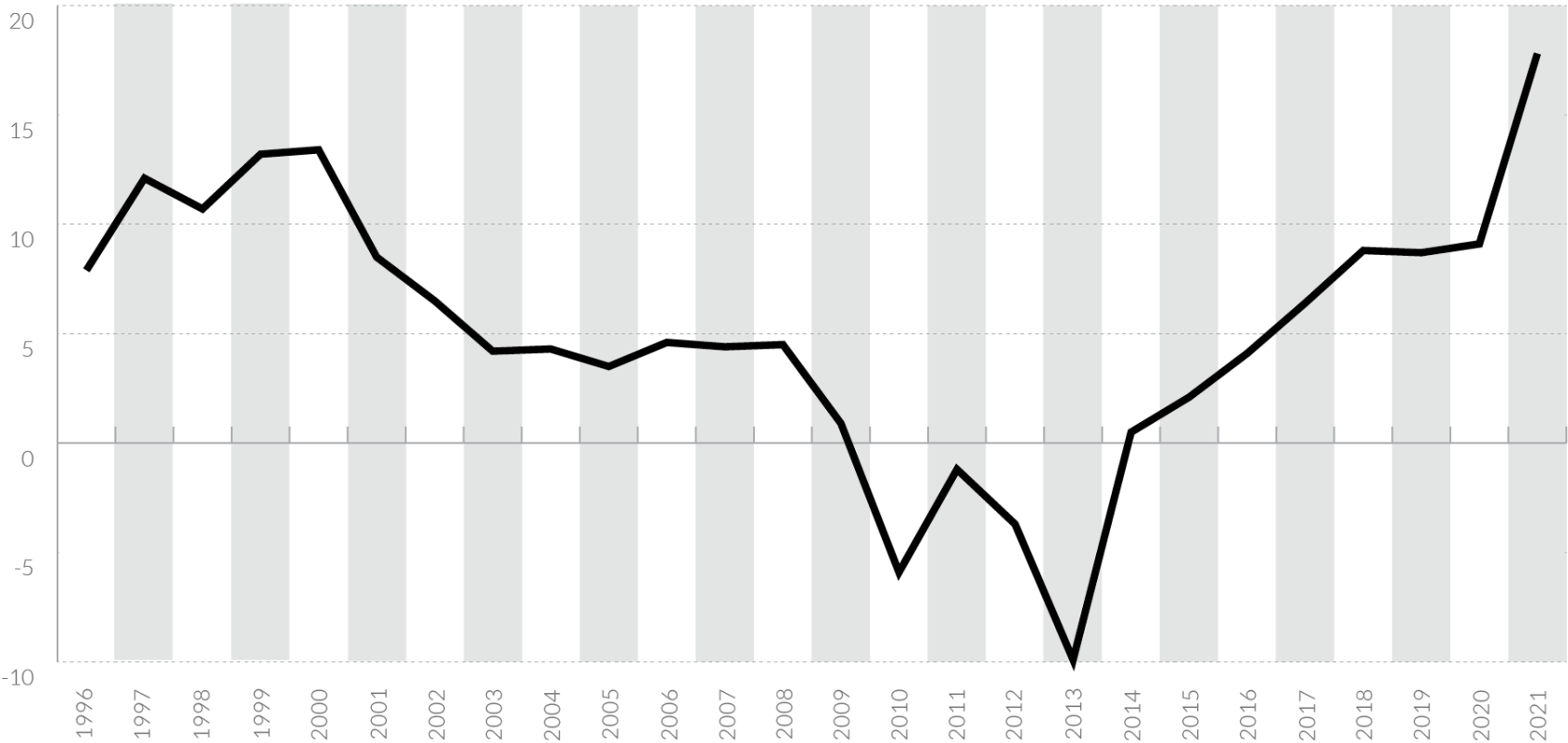
PROBLEM STATEMENT | HOUSING SHORTAGE



Capital Value. (2022).
Housing and residential investment market in the Netherlands 2022.

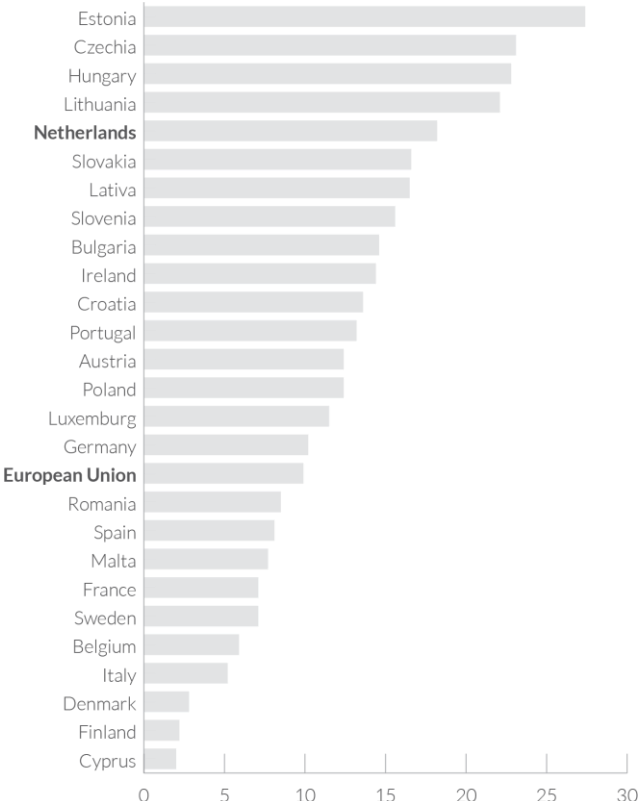
PROBLEM STATEMENT | AFFORDABILITY

Percentage change on previous year of housing prices in the Netherlands from January 1996 to August 2021



CBS. (2022).
New construction homes.

EU house price index, Q2 2022



CBS. (2022).
Dutch house price increase among EU top five.

TU DELFT

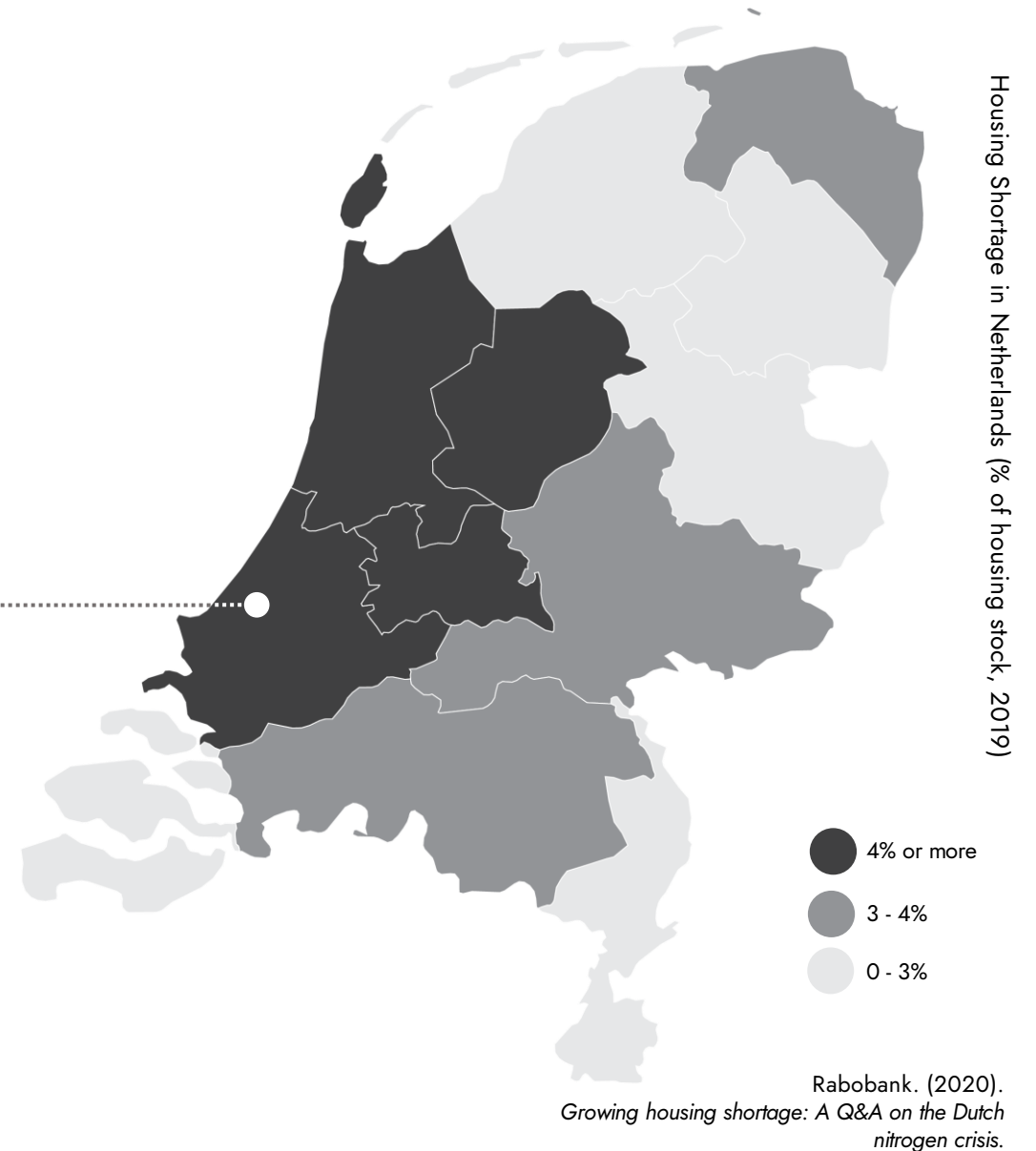
- In 2019/2020 student housing shortage was estimated at 9%
- It is expected that in 2026/2027 it will be as much as 24%
- By 2030 the shortage of student rooms will be around 5 260 - 6 111 units
- In 2021 the rent for a student apartment was 15% higher than in 2020

Rijksoverheid. (2022).

Landelijk Actieplan Studentenhuisvesting 2022 tot 2030.

Savills. (2021).

Spotlight Student Housing 2021 - Housing Shortages.



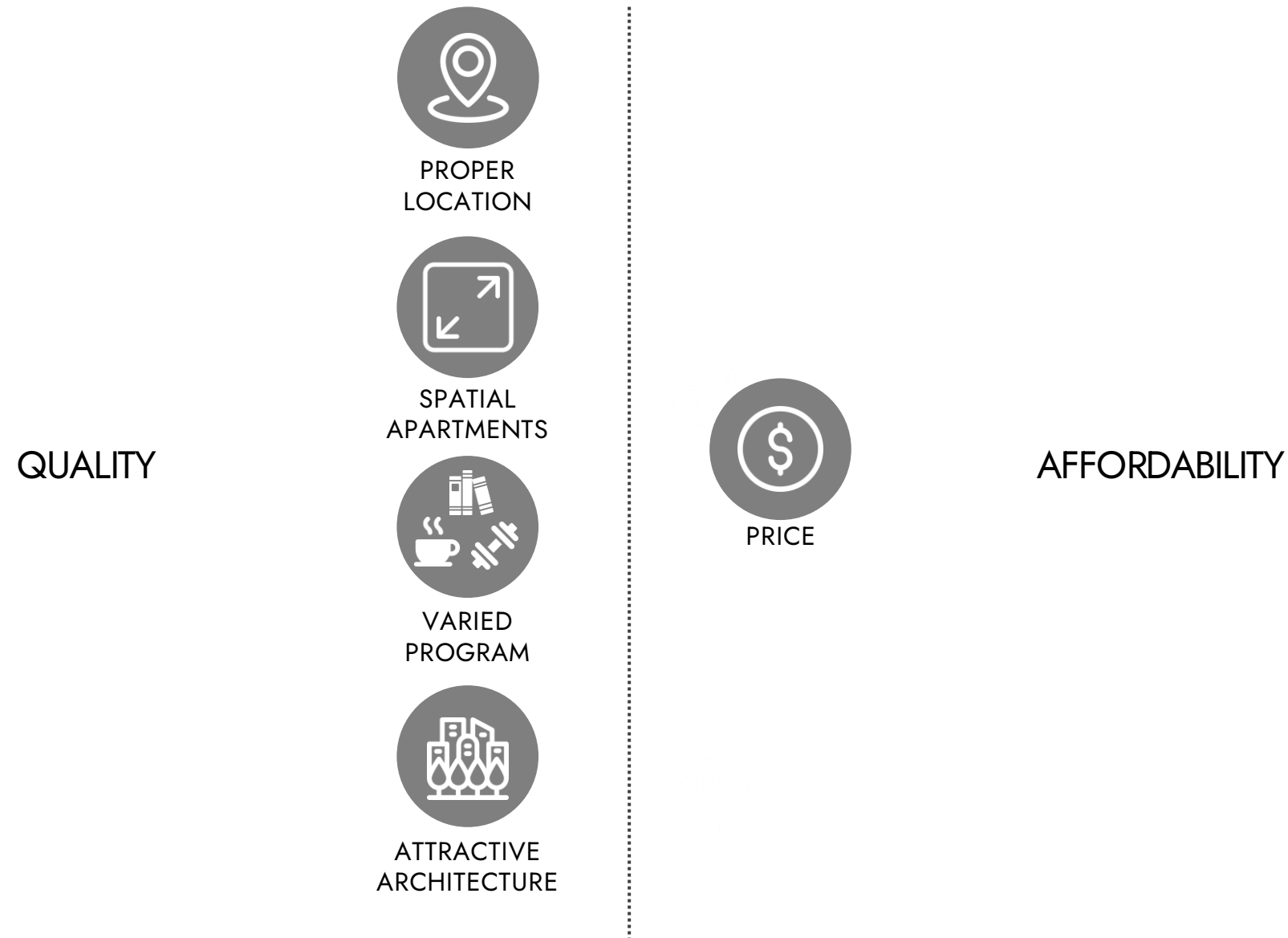
“Instead then, of thinking of places as areas with boundaries around, they can be imagined as articulated moments in networks of social relations and understandings [...]”

Doreen Massey, (1991).
A Global Sense Of Place. In Marxism Today (p. 27).

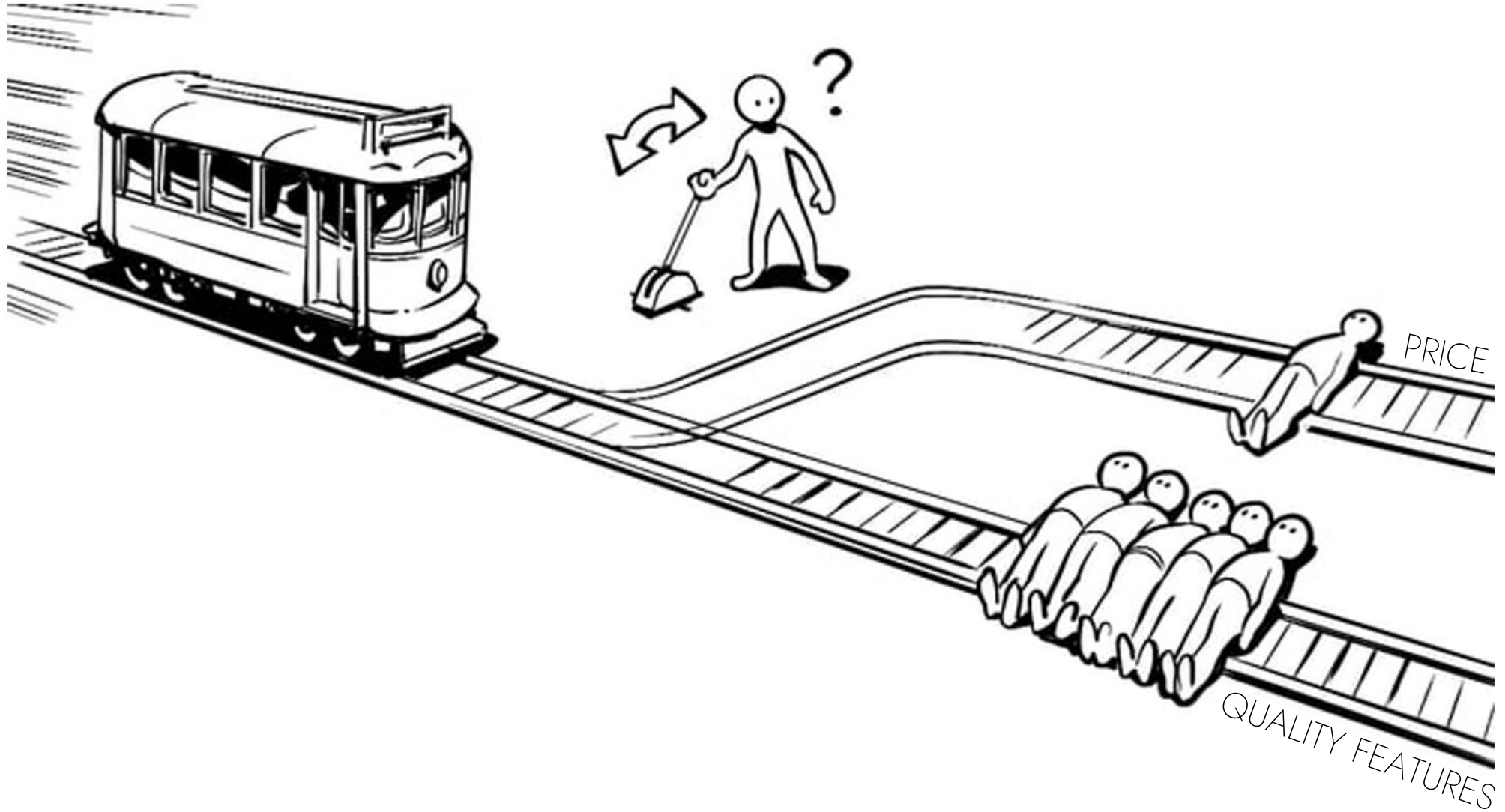
“Architecture is about the people”

Francis Kere.

PROBLEM STATEMENT | QUALITY vs AFFORDABILITY



PROBLEM STATEMENT | QUALITY vs AFFORDABILITY

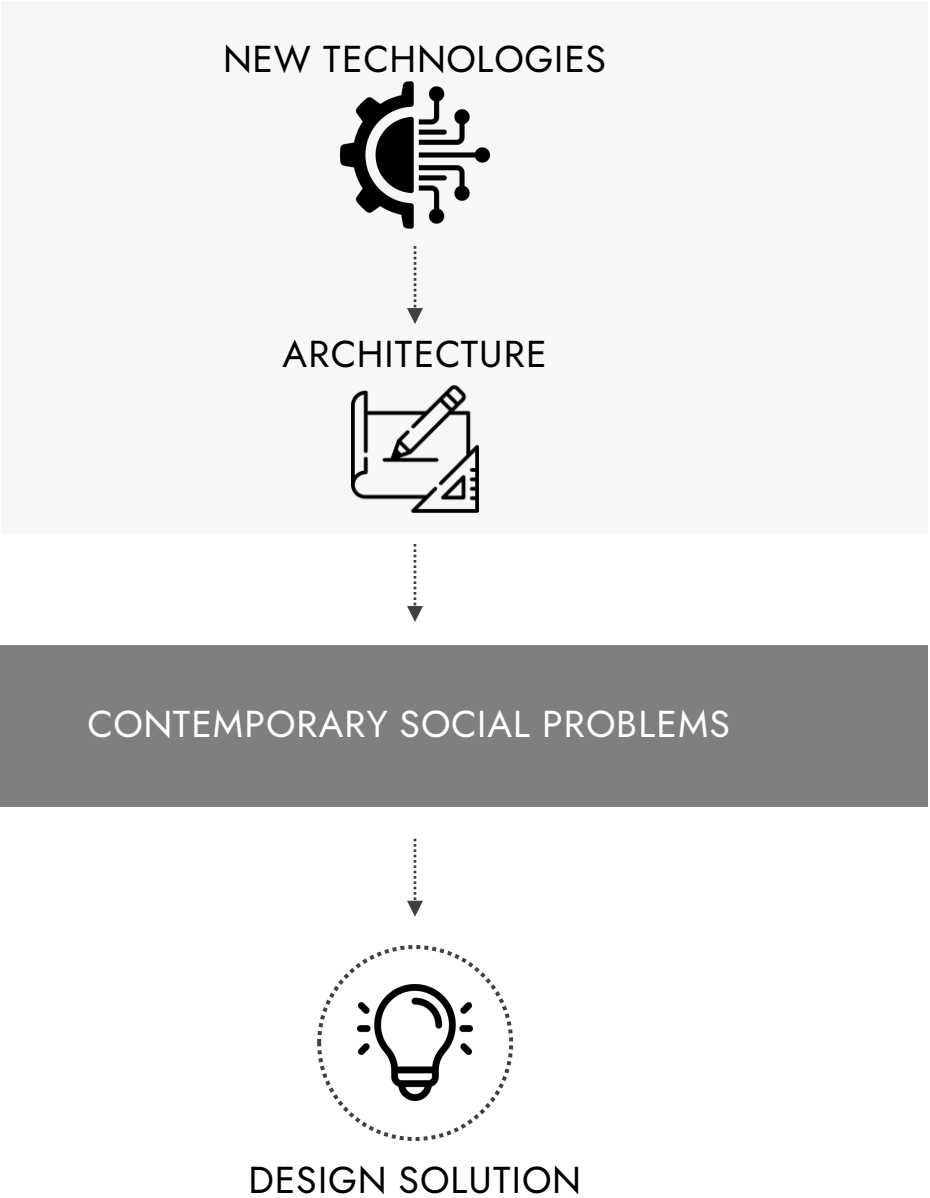


PROBLEM STATEMENT:

Lack of sufficient number of affordable and qualitative student housing

POTENTIAL SOLUTION

EXPERIMENT



POTENTIAL SOLUTION | DEFINING REASONS

CONSTRUCTION COSTS



Materials



Transport



Personnel &
Equipment

DENSITY



Dwindling
land



Low-density
housing

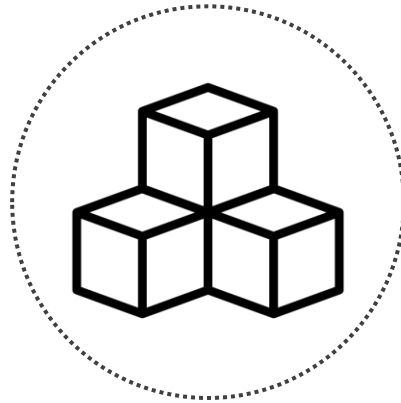
ENVIRONMENTAL IMPACT



Adaptation to
new conditions

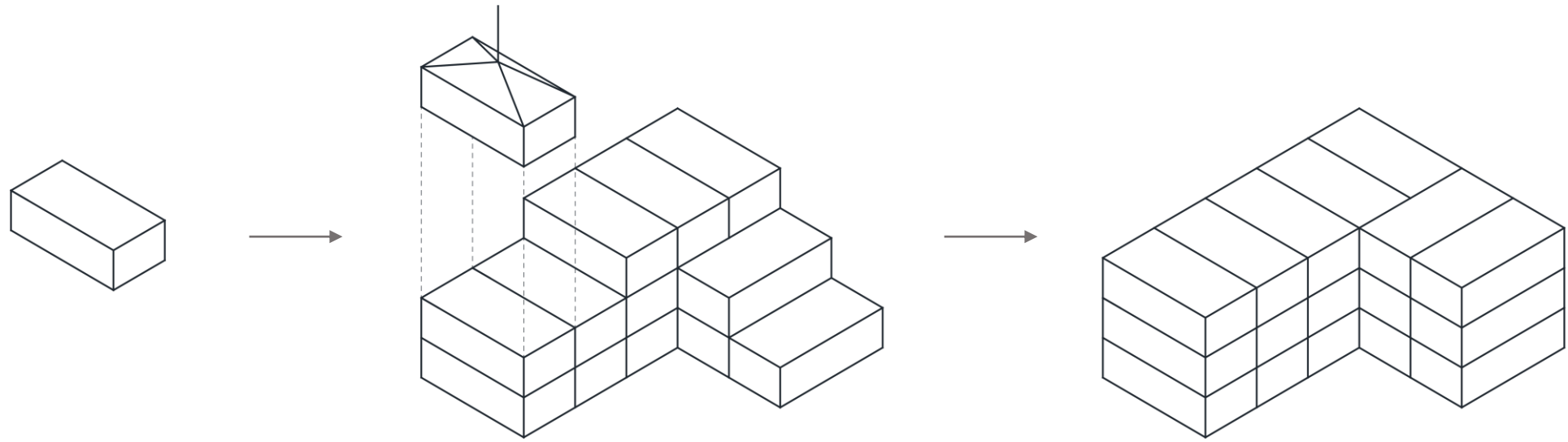


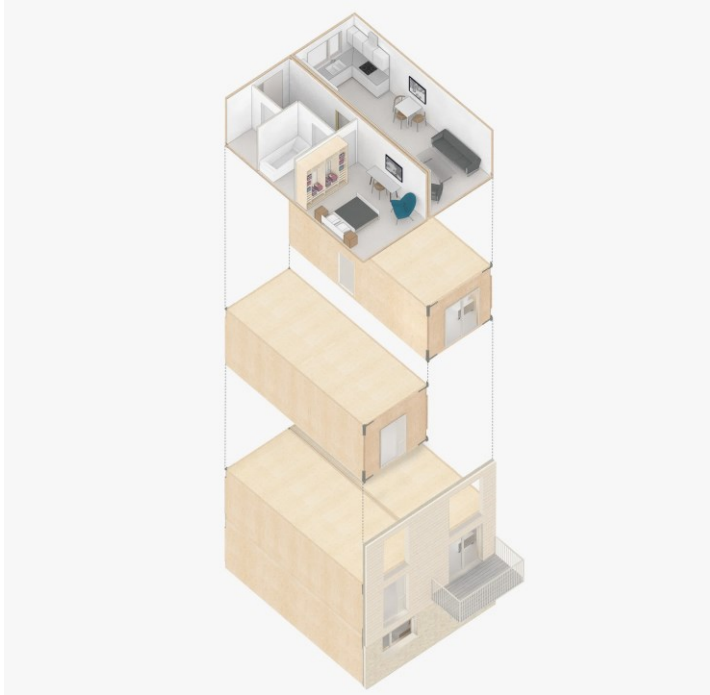
Migrations



TIMBER MODULAR
ARCHITECTURE

POTENTIAL SOLUTION | TIMBER MODULAR ARCHITECTURE

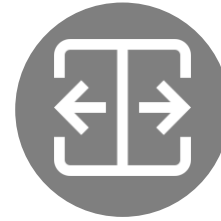




TIMBER MODULAR ARCHITECTURE



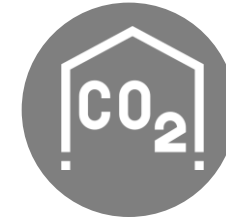
Construction
Costs



Applicable in student
housing



Construction
Time



Carbon
Footprint

POTENTIAL SOLUTION | TIMBER MODULAR ARCHITECTURE

Student Hostel Woodie, Hamburg (DE)

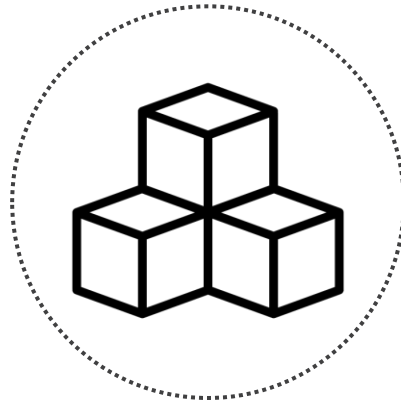
Year of completion: 2017
Architects: Sauerbruch Hutton
Construction costs: €1,450 per m²
Construction period: 10 months
Number of modules: 371
Module area: 20m²
Rent: €525 / month (incl. utilities)

Average construction period
(traditional): 17 months
Average rent in Hamburg (2017):
€530 / month (excl. utilities)

Statista. (2023).
*Prime rent for office real estate in Hamburg
from 2013 to 2022.*

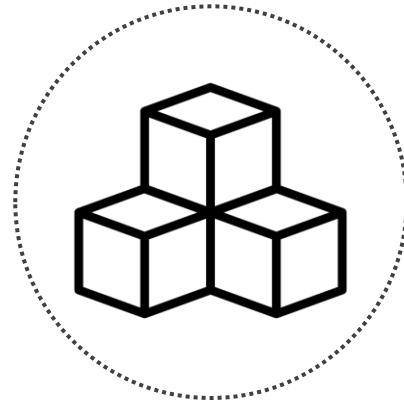
Swiftlane. (2022).
*Time is money: How long it takes to build an
apartment.*



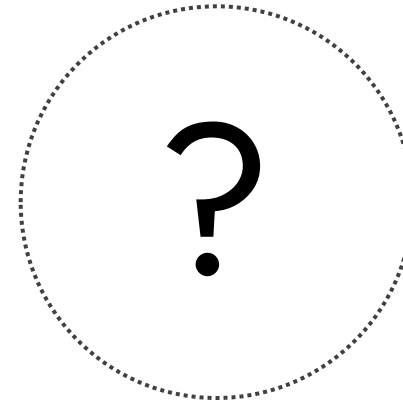


TIMBER MODULAR
ARCHITECTURE

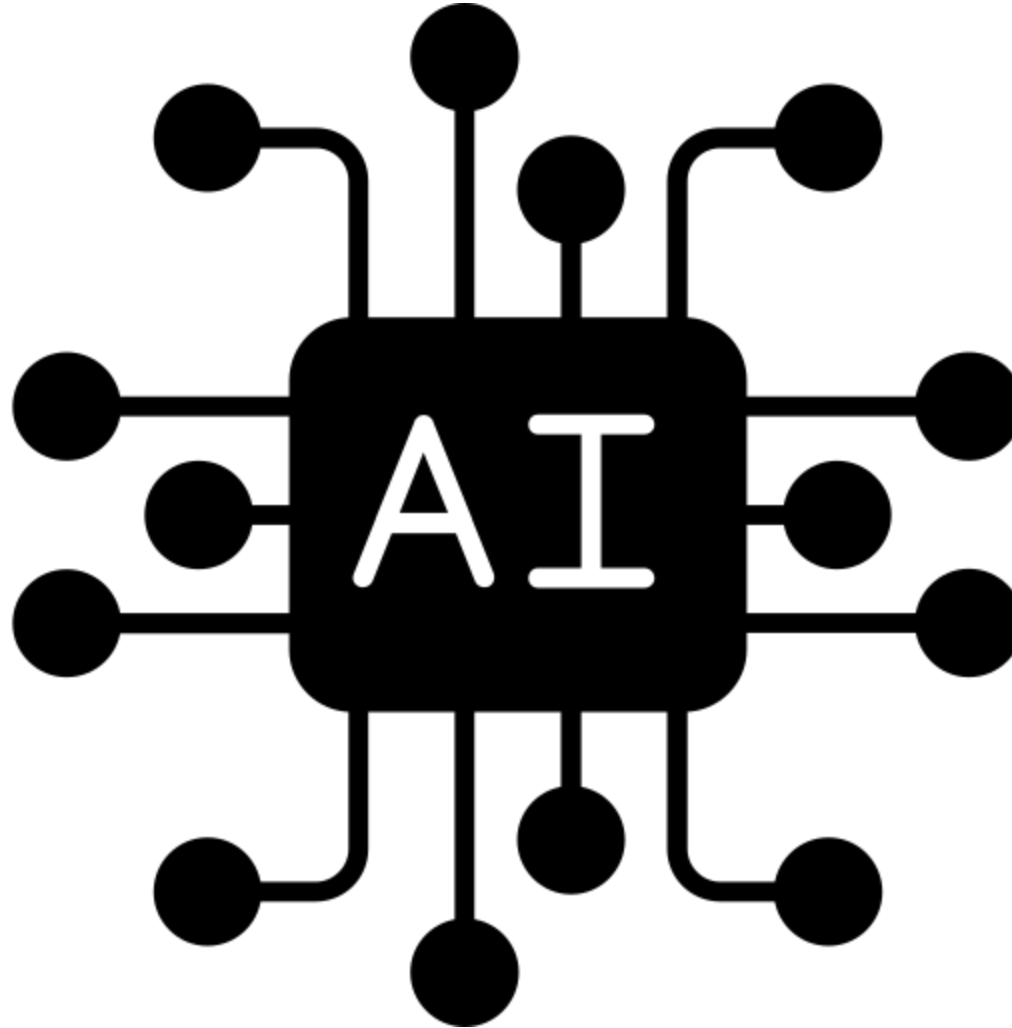
POTENTIAL SOLUTION | TIMBER MODULAR ARCHITECTURE



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TIMBER MODULAR
ARCHITECTURE



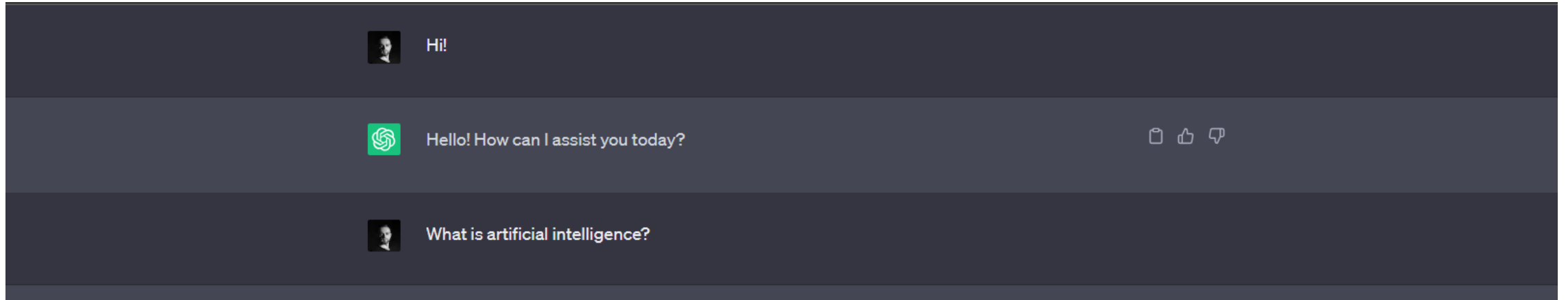
What is Artificial Intelligence (AI)?

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE



Hi!

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE



POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE



What is the potential application of AI in the field of architecture?

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE

sketches or 3D models and generate detailed drawings, sections, or plans automatically.

This saves architects time and allows them to focus on higher-level design decisions.

4. **Simulation and Analysis:** AI can facilitate simulations and analyses of architectural designs. By running simulations, AI algorithms can evaluate factors such as structural integrity, acoustics, lighting, and thermal performance. This helps architects identify potential design flaws, optimize building performance, and make informed decisions.
5. **Smart Buildings:** AI can enable the development of intelligent, responsive buildings. AI systems can monitor and analyze data from sensors embedded in the building infrastructure to optimize energy usage, enhance occupant comfort, and improve security. For example, AI can adjust lighting and HVAC systems based on occupancy patterns or weather conditions.
6. **Construction Optimization:** AI can assist in optimizing construction processes. By analyzing construction schedules, resource allocation, and historical project data, AI algorithms can identify potential bottlenecks, predict project delays, and suggest strategies for improving efficiency and reducing costs.

These are just a few examples of how AI can be applied in architecture. As technology continues to advance, the integration of AI has the potential to enhance creativity, efficiency, and sustainability in architectural design and construction.

🔄 Regenerate response

Send a message



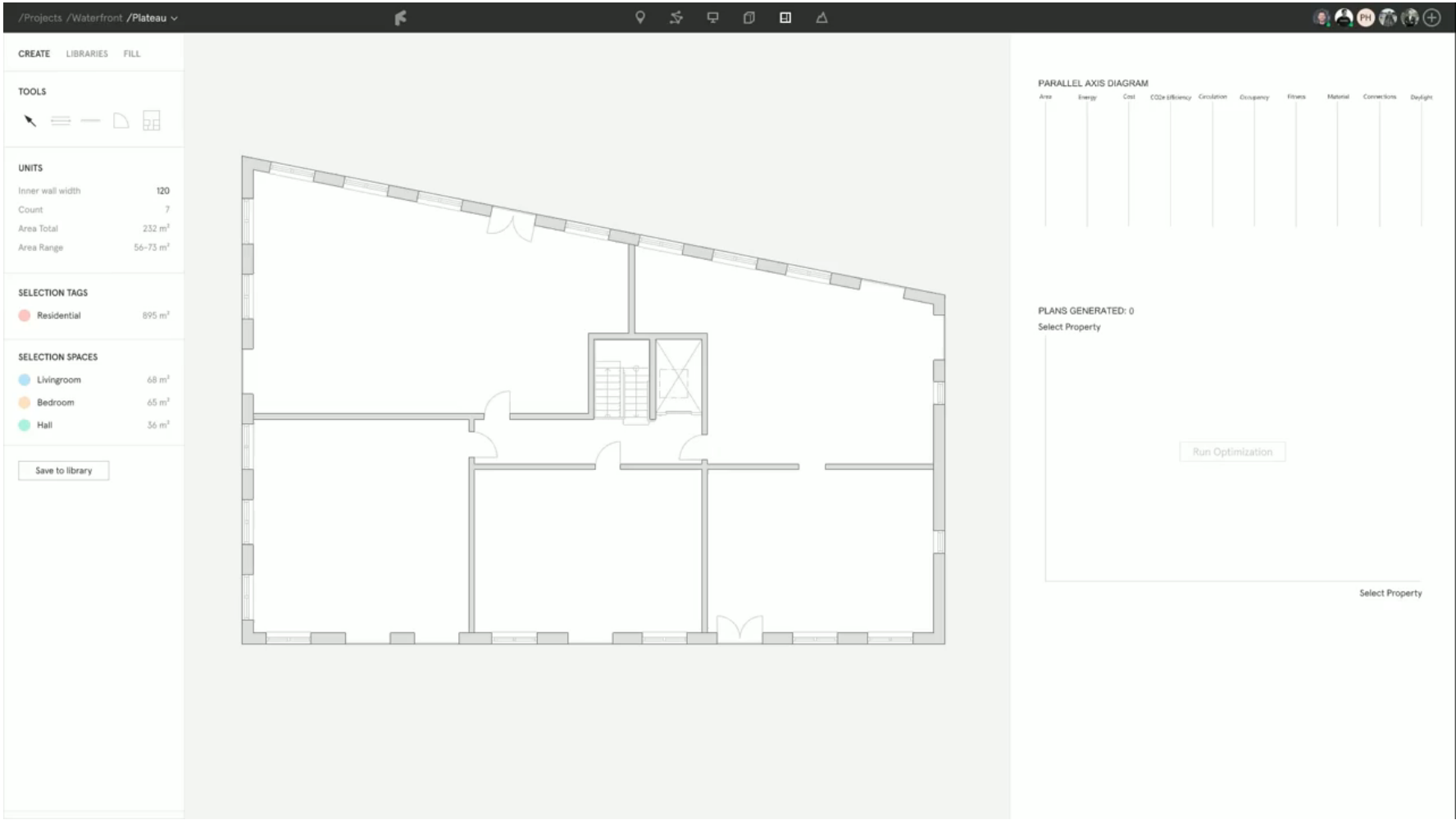
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POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE IN ARCHITECTURE



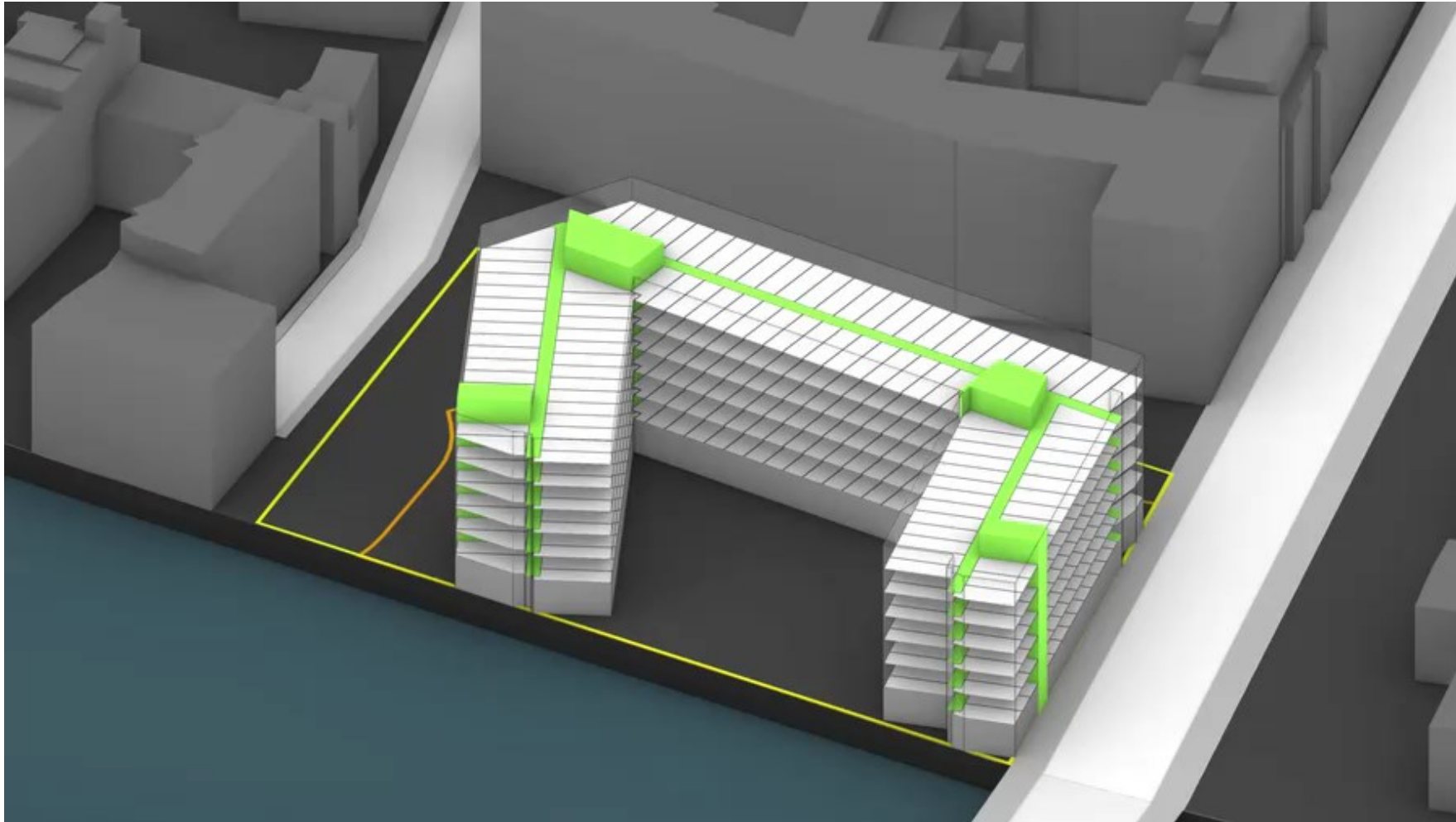
Midjourney

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE IN ARCHITECTURE



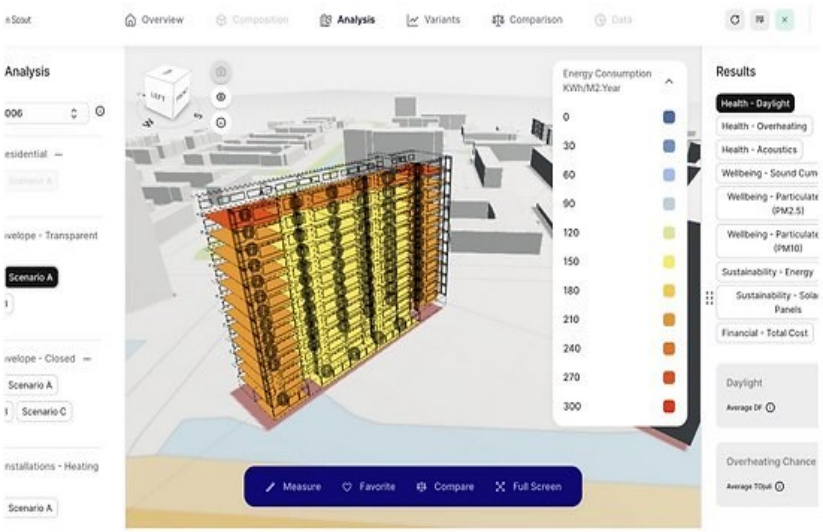
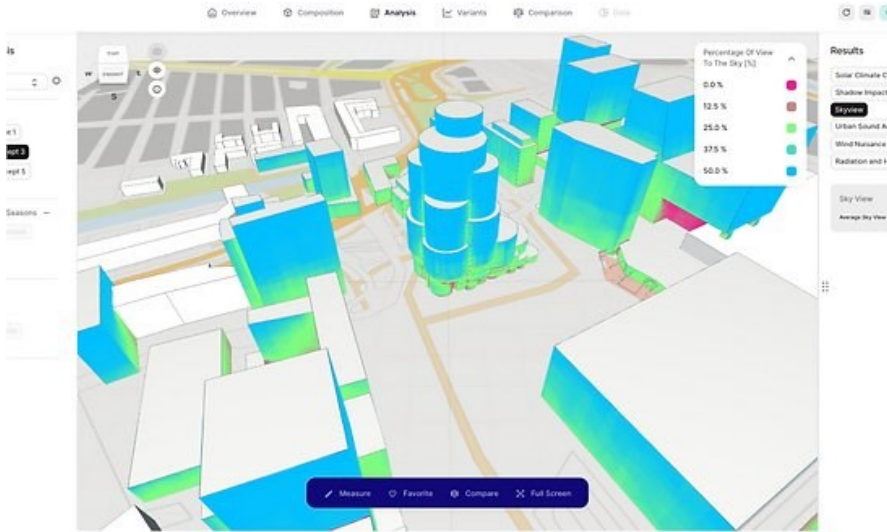
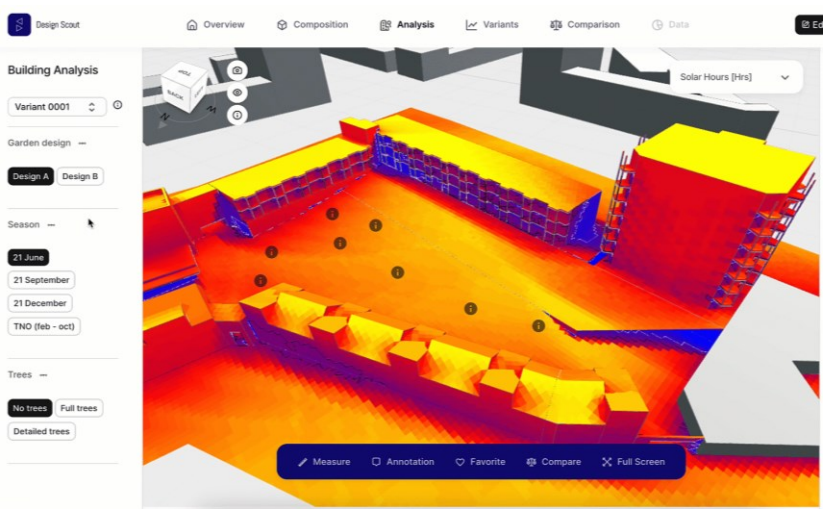
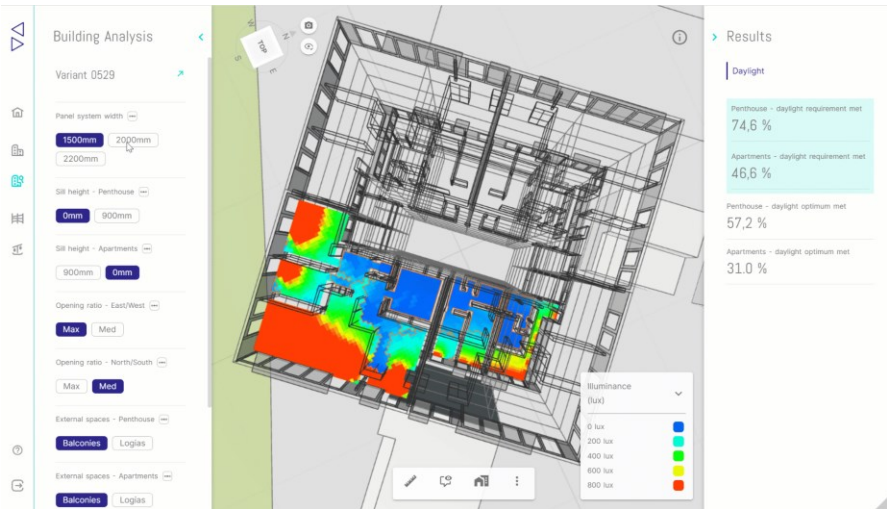
Source:
<https://www.finch3d.com/>

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE IN ARCHITECTURE



Source:
<https://www.outlineai.com/>

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE IN ARCHITECTURE



Source:
<https://www.omrt.tech/product>

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE



Can AI replace the architect?

POTENTIAL SOLUTION | ARTIFICIAL INTELLIGENCE

empathy, and collaboration are vital skills that architects bring to the table, which are not easily replaceable by AI systems.

4. **Ethics and Judgment:** Architects must consider ethical, social, and cultural implications when designing buildings. They need to balance functional requirements, aesthetics, sustainability, and the well-being of users. These value judgments and ethical considerations involve subjective decision-making, which is challenging for AI algorithms that rely on data-driven or rule-based approaches.
5. **Adaptability and Innovation:** Architecture evolves over time due to changing societal needs, advancements in technology, and emerging design philosophies. Architects play a crucial role in adapting to these changes and pushing the boundaries of innovation in design. While AI can assist in generating design options, it may struggle to envision radical departures from existing architectural paradigms without human guidance and creative input.

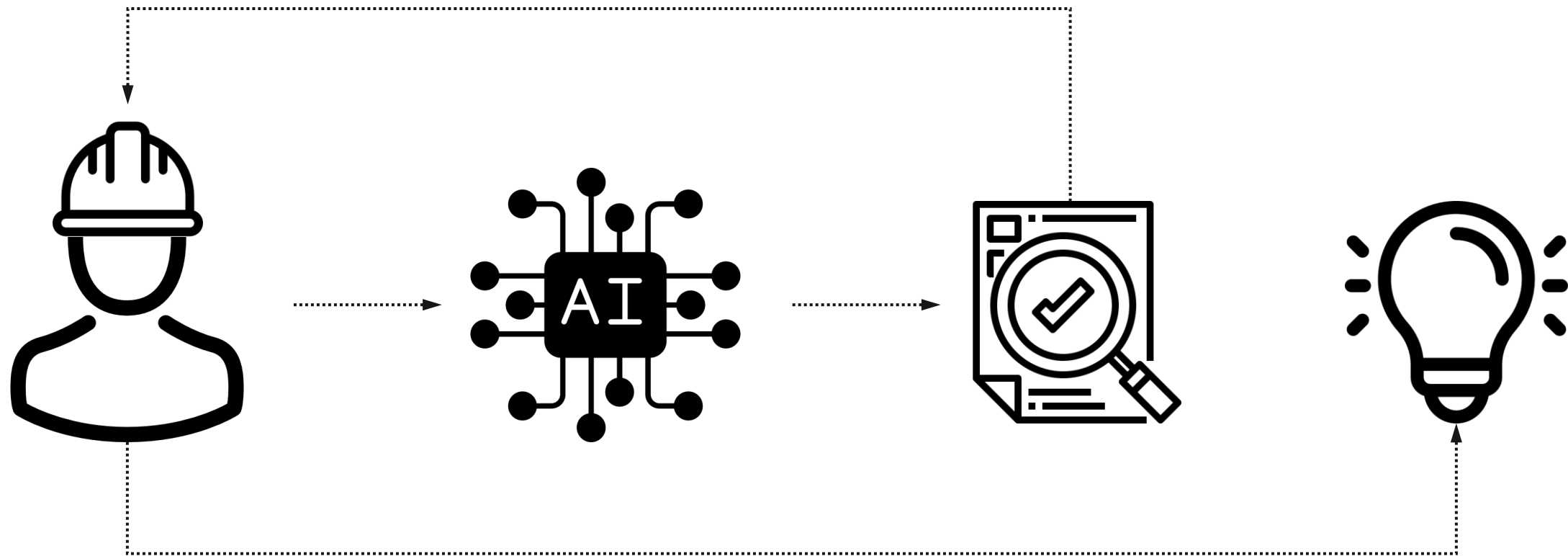
Instead of replacing architects, AI is more likely to augment their capabilities, streamline processes, and help them make more informed decisions. AI can automate repetitive tasks, provide design recommendations, assist with data analysis, and offer insights during the design process. This allows architects to focus on higher-level design thinking, problem-solving, and the human-centric aspects of architecture.

🔄 Regenerate response

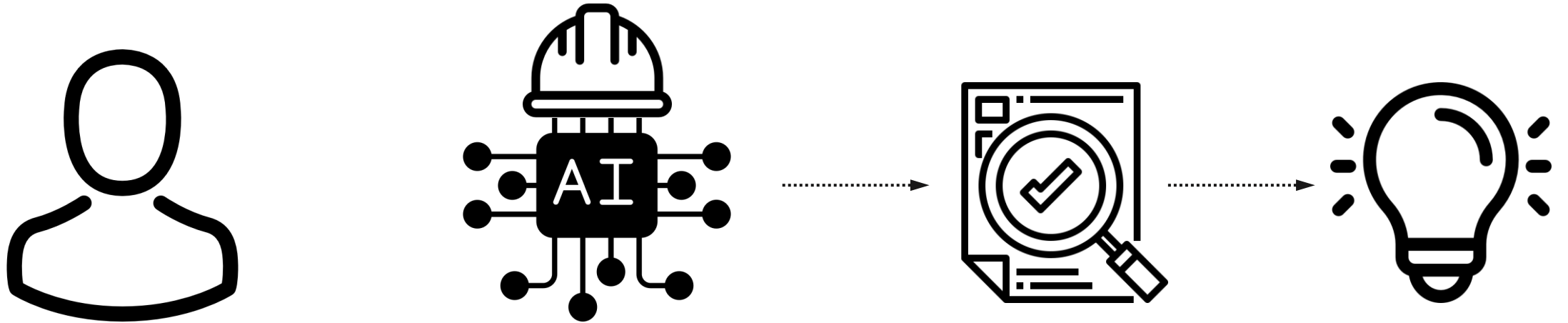
Send a message



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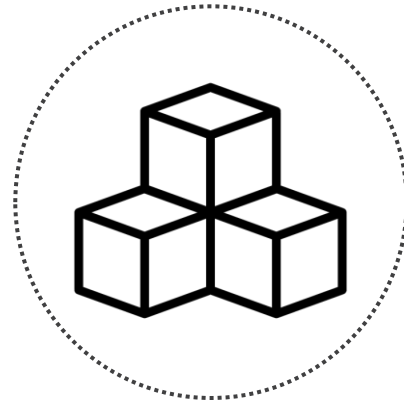


AI AS A TOOL FOR THE DESIGNER



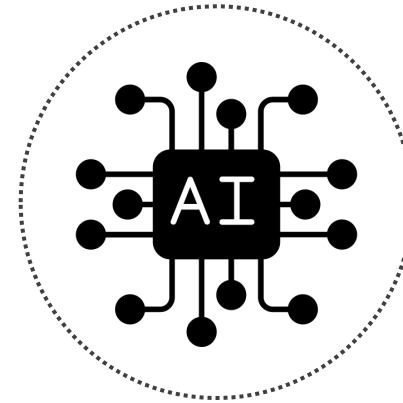
AI AS THE DESIGNER

POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



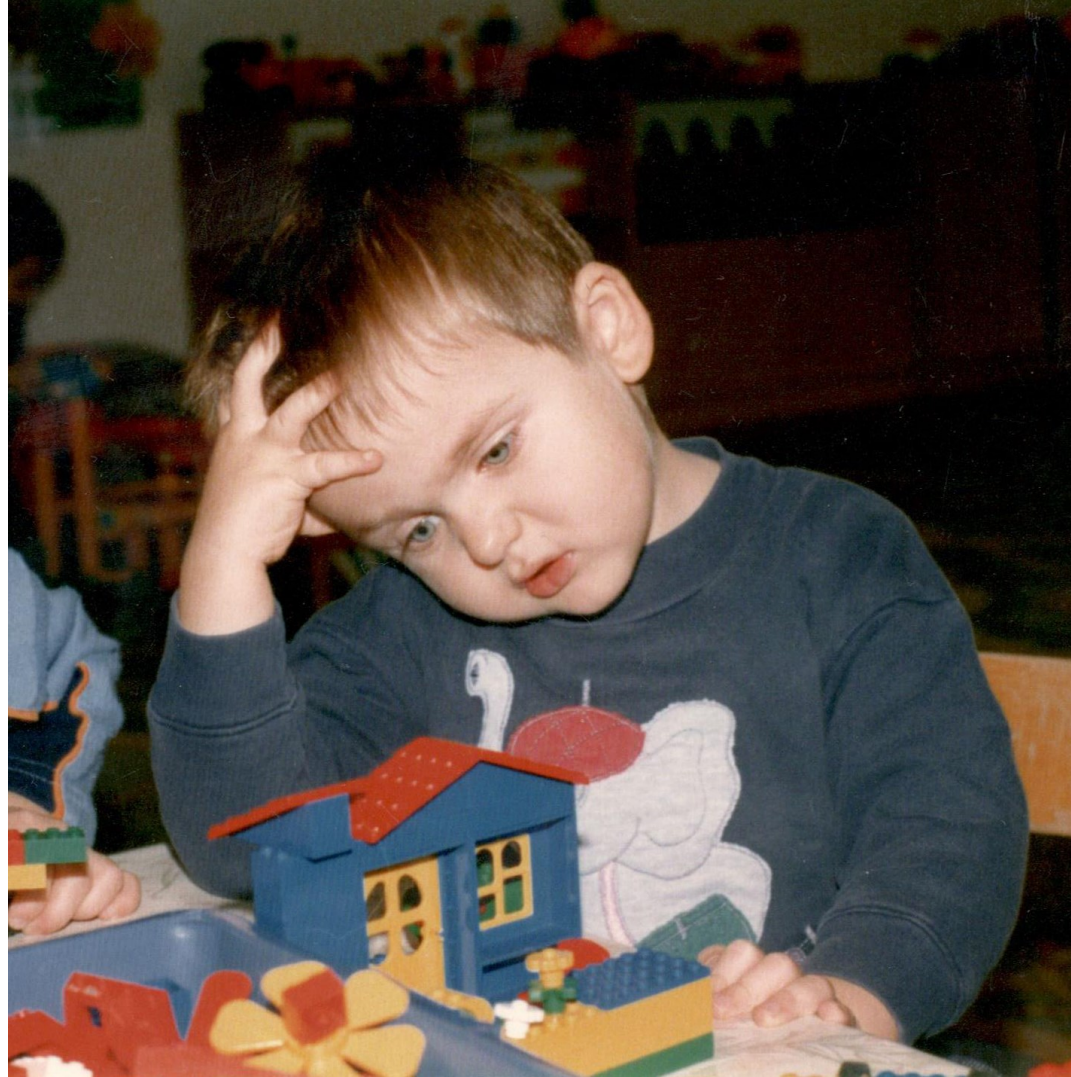
TIMBER MODULAR
ARCHITECTURE

HOW?

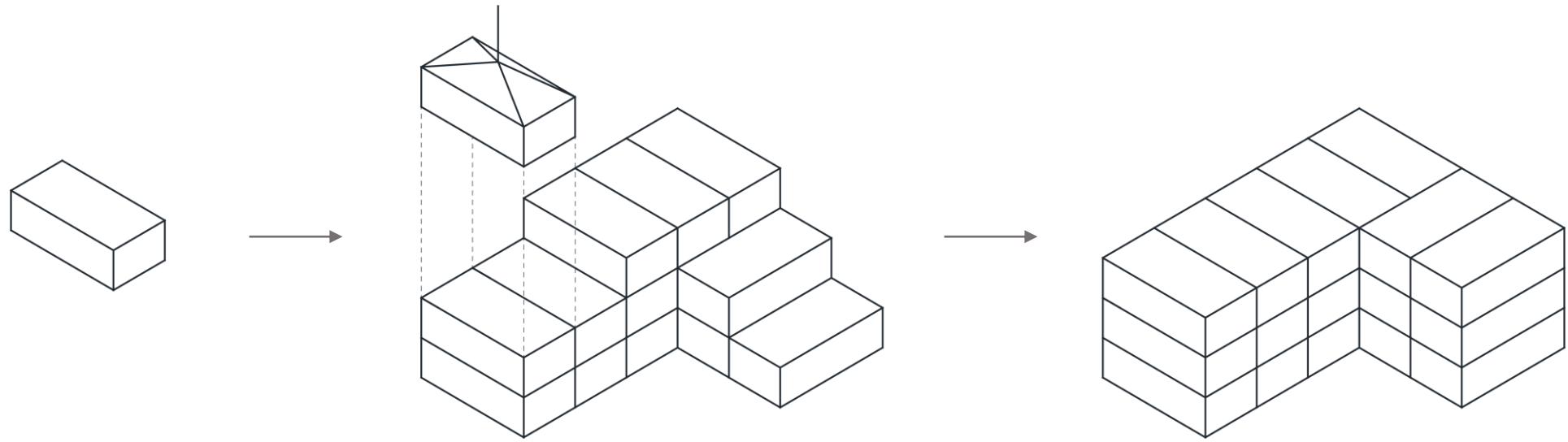


ARTIFICIAL
INTELLIGENCE

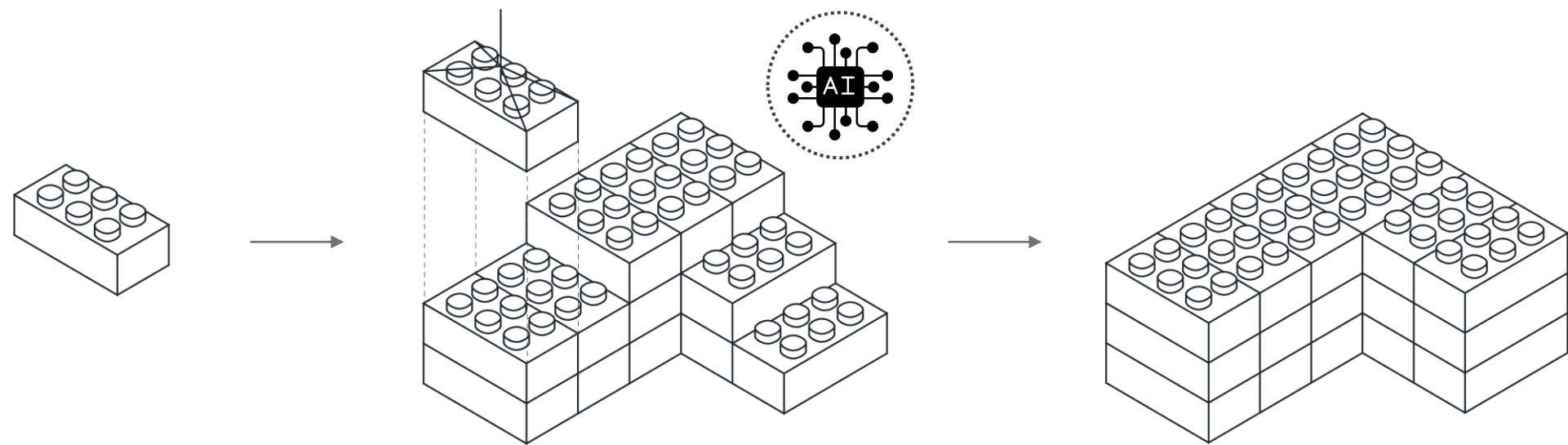
POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



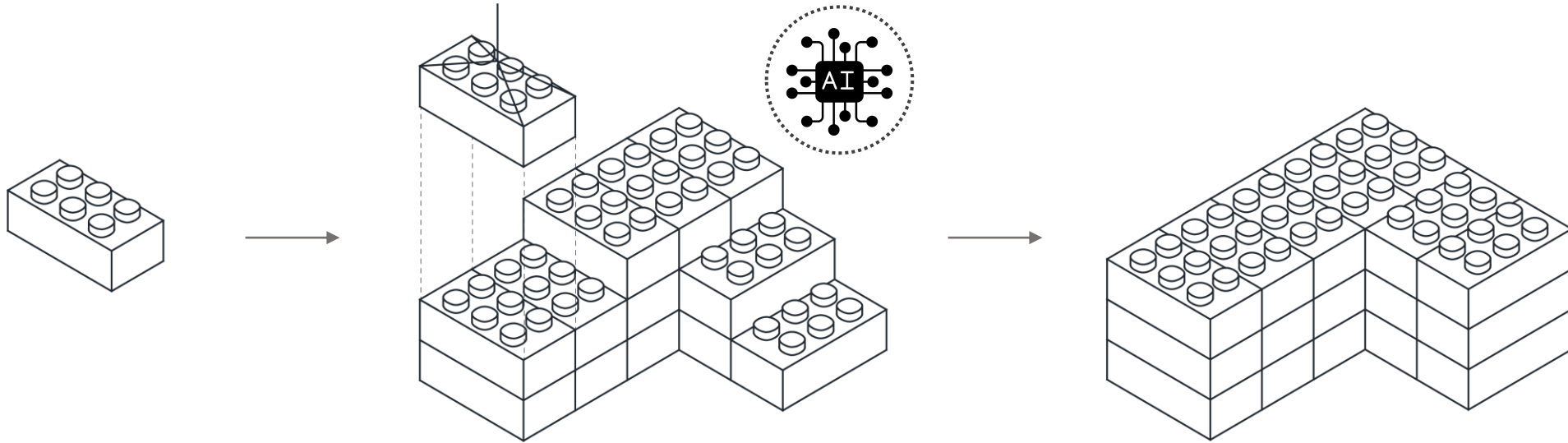
POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



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POTENTIAL SOLUTION | COMBINING TECHNOLOGIES

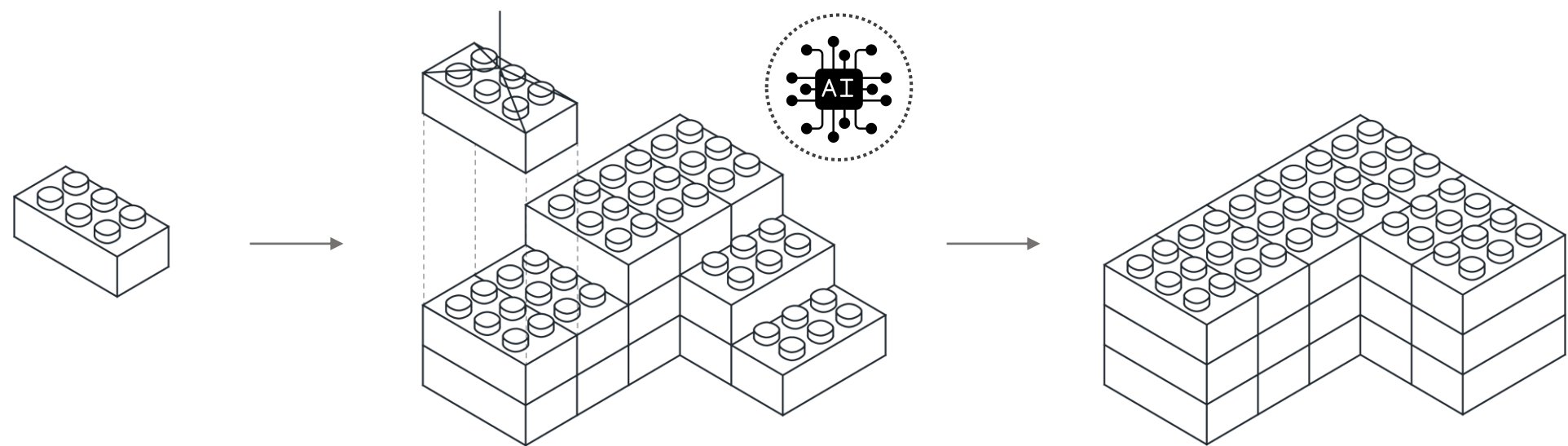


Artificial intelligence has the potential to revolutionize the field of architecture in several ways. Here are some potential applications of AI in architecture:

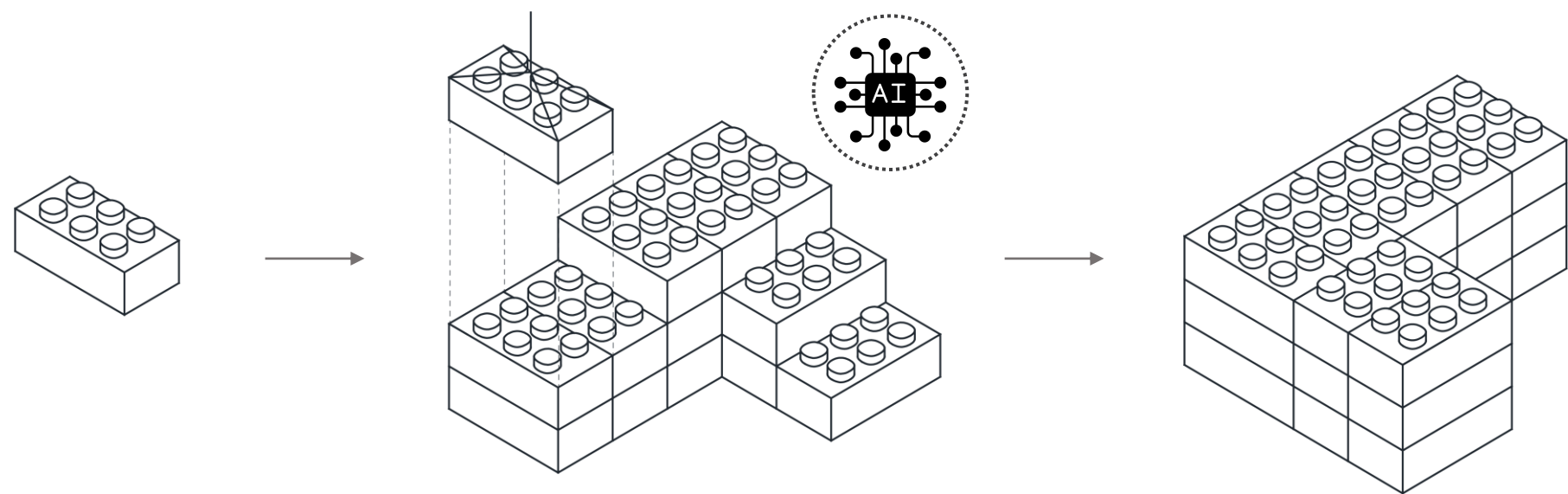


1. **Generative Design:** AI can be used to generate and optimize architectural designs based on specified parameters and constraints. By leveraging machine learning algorithms, architects can explore a vast number of design possibilities and receive automated recommendations. This can help speed up the design process, improve creativity, and generate innovative solutions.

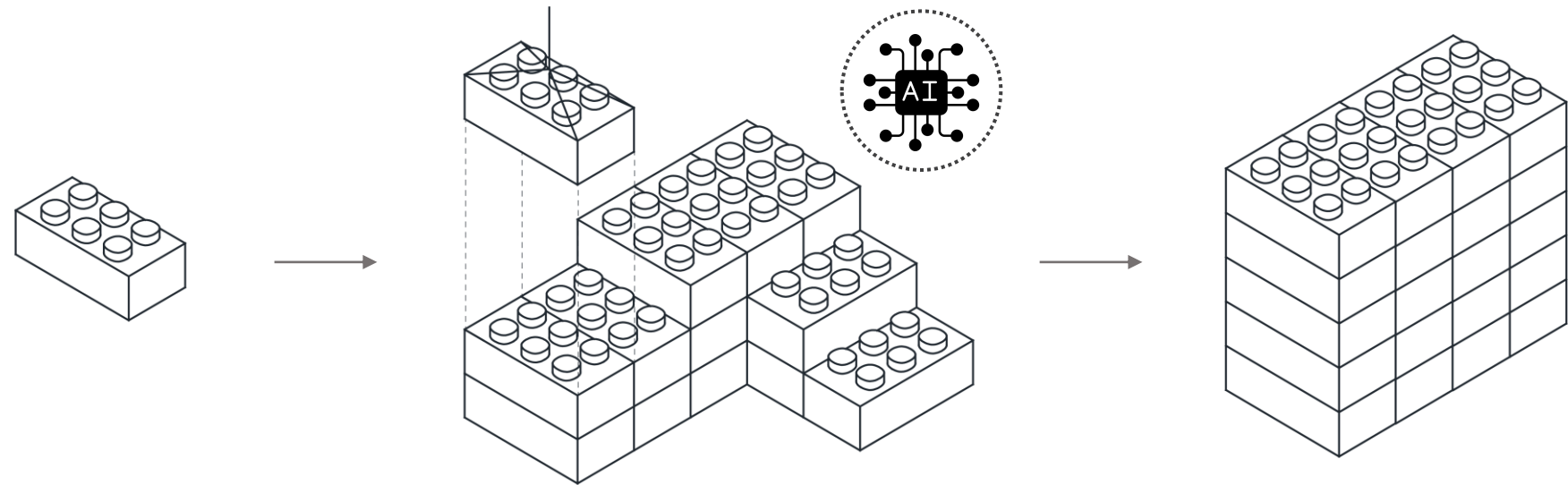
POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



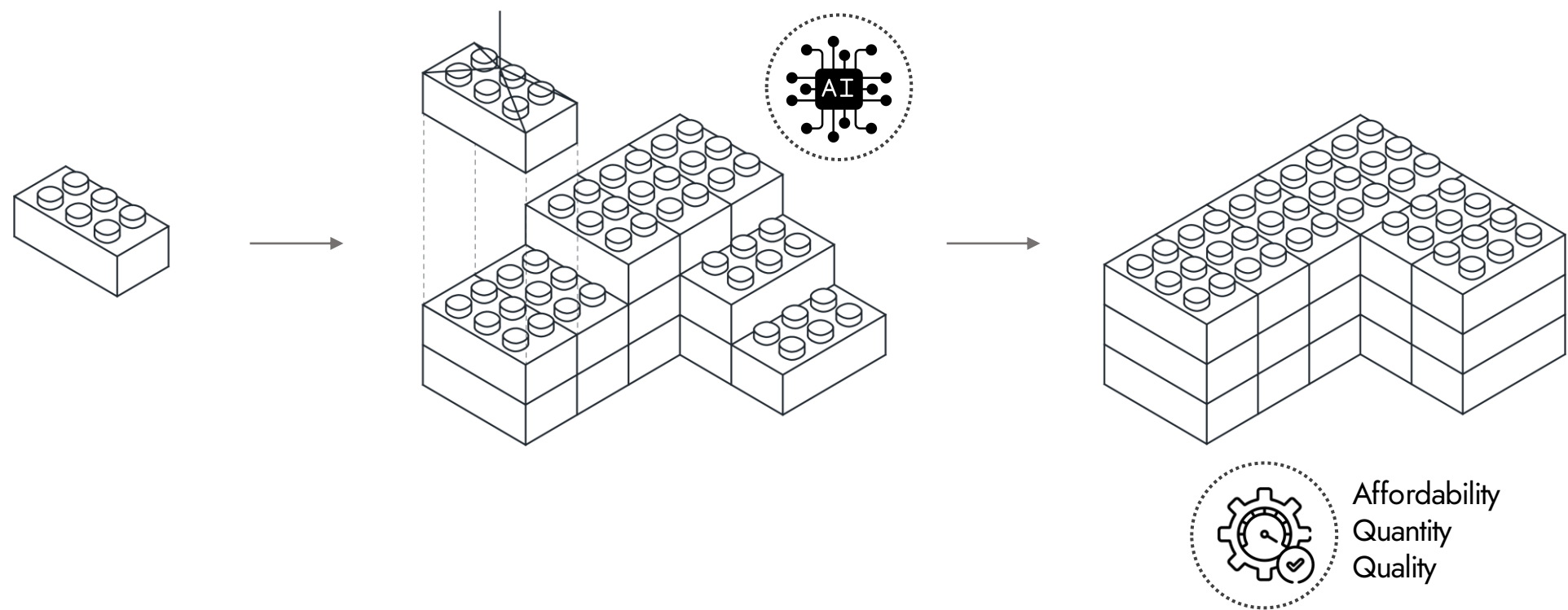
POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



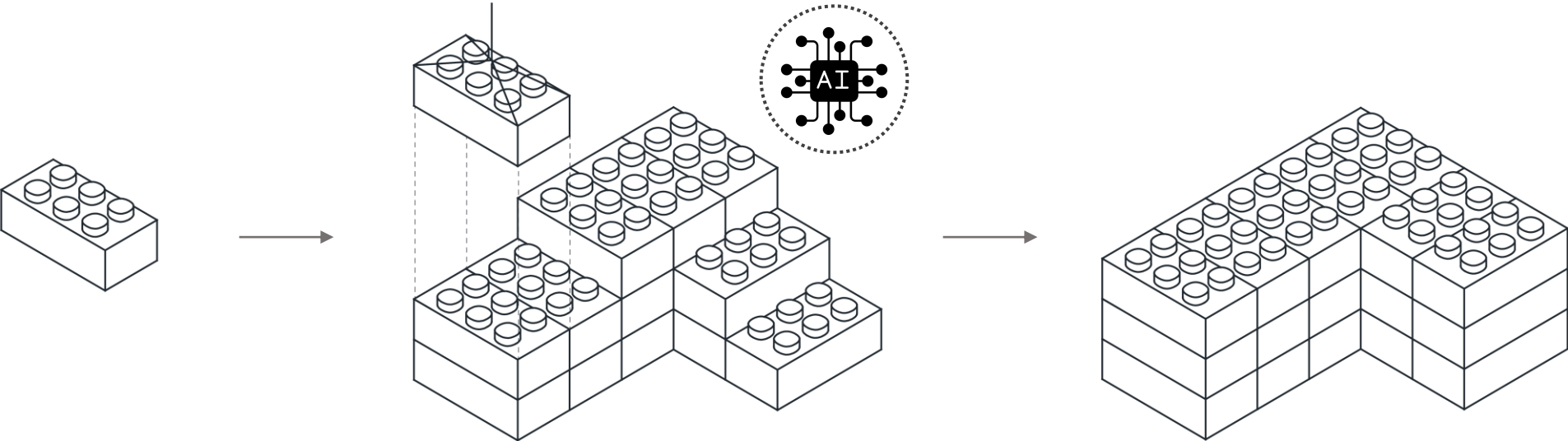
POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



POTENTIAL SOLUTION | COMBINING TECHNOLOGIES



Speed up designing
process



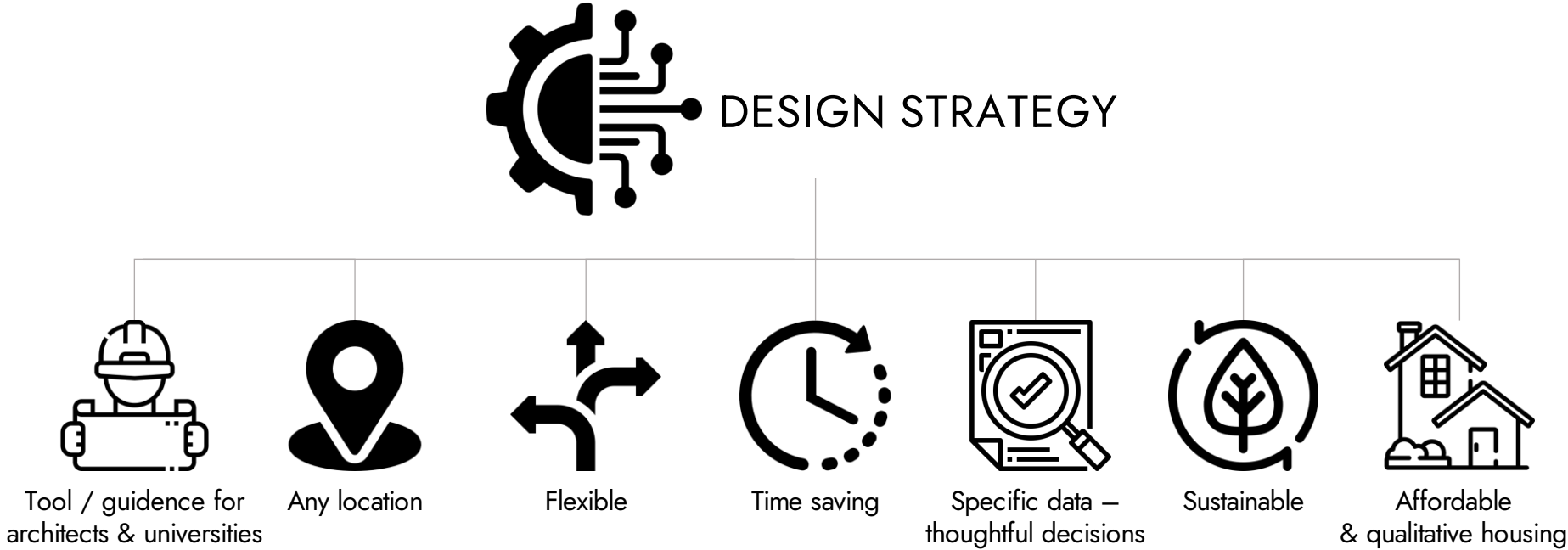
Multi-objective
optimization



Specific data —
thoughtful decisions



Combining into
System



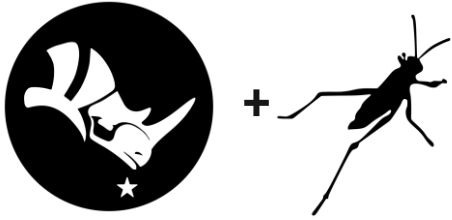
RESEARCH

RESEARCH QUESTION

How could generative system based on engineered timber modules optimize the functional layout of student housing, by finding the balance between the maximum living units and the minimal material use?

Sub-questions:

- Q1. What are the currently available generative design tools and how do they work?*
- Q2. What conditions regarding functional program of student housing and construction system needs to be included in the algorithm in order to generate proper functional layouts?*
- Q3. What are the material consumption parameters in a typical TVE module for student housing?*
- Q4. How could the solutions generated by the algorithm be ranked?*
- Q5. How could the algorithm generate functional layouts and rank them according to the balance between the maximum living units and the minimal material use?*



GRASSHOPPER

- Popular architecture modelling software
- Visual programming method
- Lot of additional plugins for optimization algorithms



DYNAMO

- Open source visual programming language
- Cooperation with Revit
- Built-in generative functions



OUTLINEAI

- Service providing optimization algorithm-based solutions
- 92% of effectiveness
- Generating and ranking solutions based on specific factors



DESIGN SCOUT

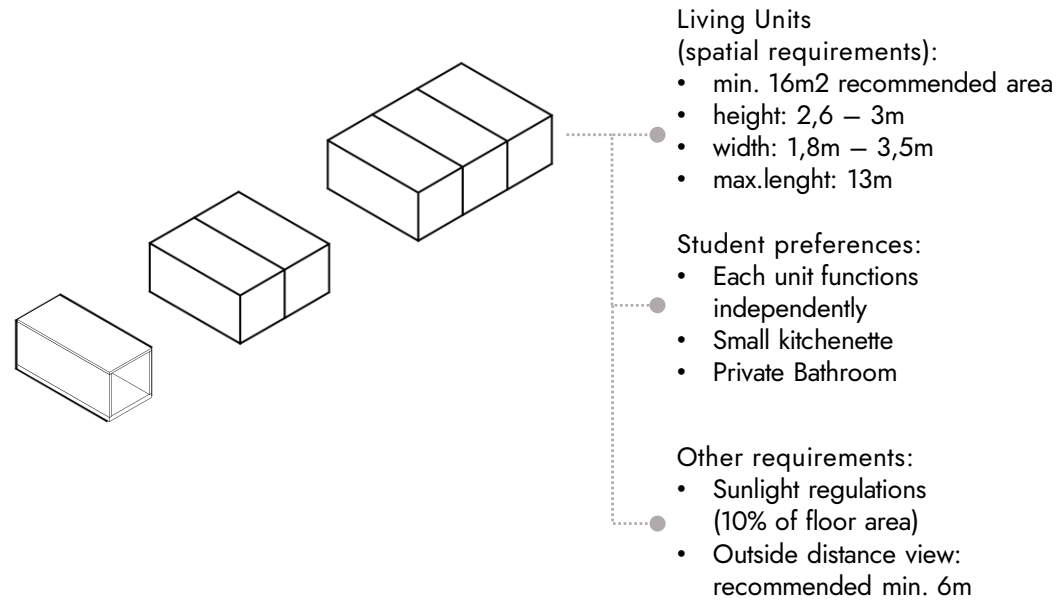
- Independent design program
- Generating solutions on both architectural and urban scale
- Allows for performing solar path, daylight, energy&CO2 analyses



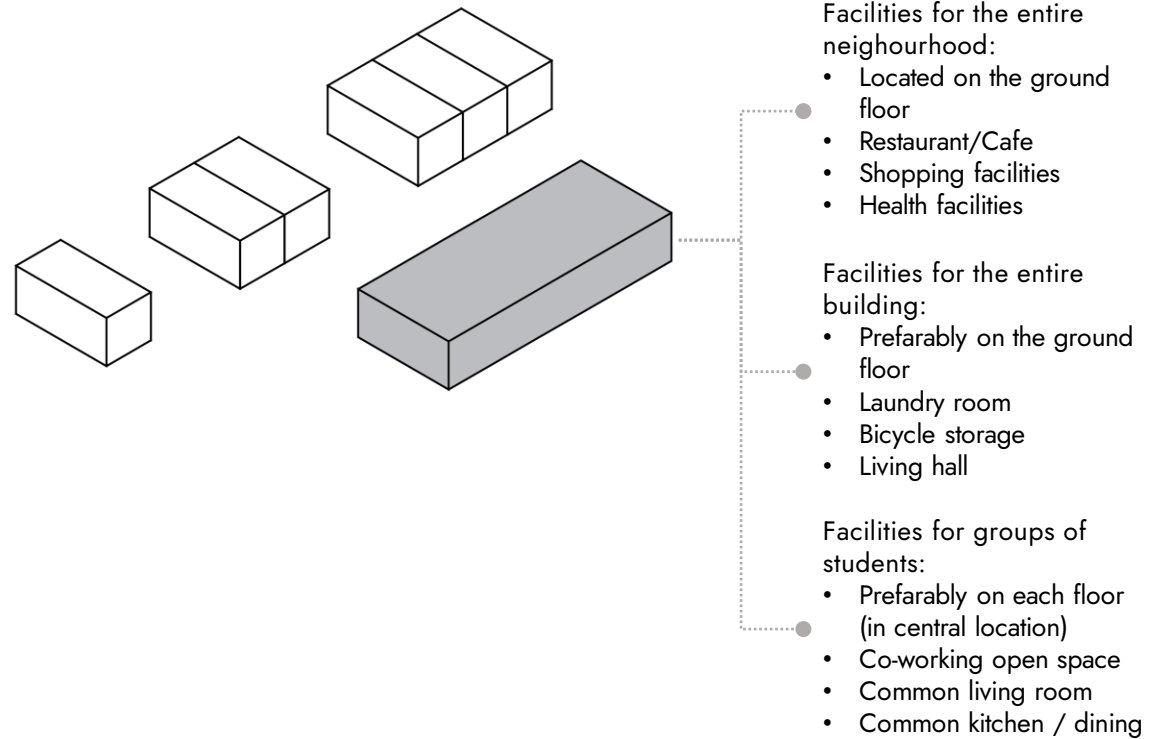
DIGITAL BLUE FOAM

- Online platform for optimization
- Transforms generative design process through AI
- Allows for creating instant parametric site plans, generate volumetric solutions, conducting analyses

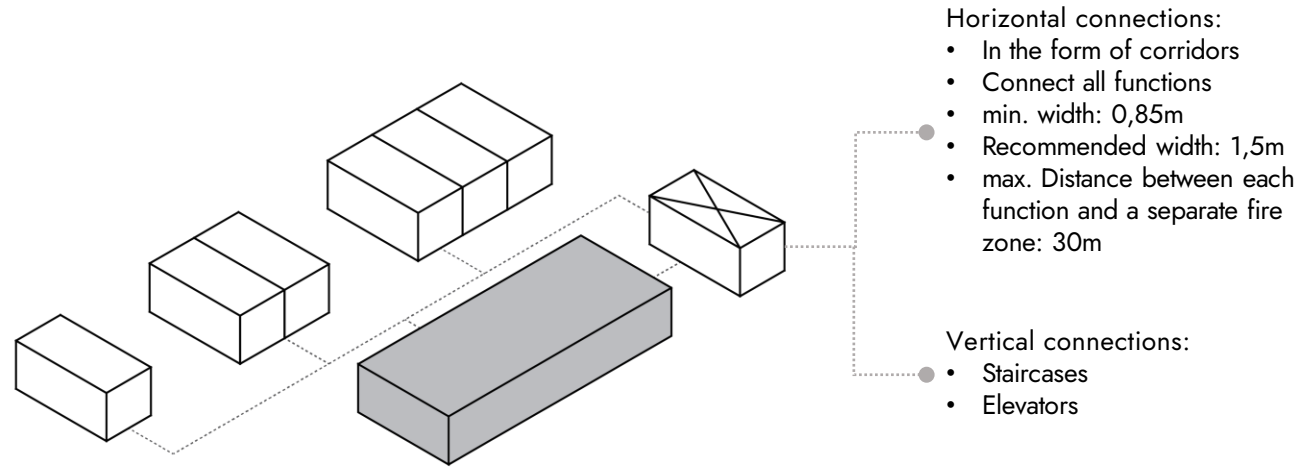
RESEARCH CONCLUSIONS | FUNCTIONAL PROGRAM & CONSTRUCTION SYSTEM - CONDITIONS



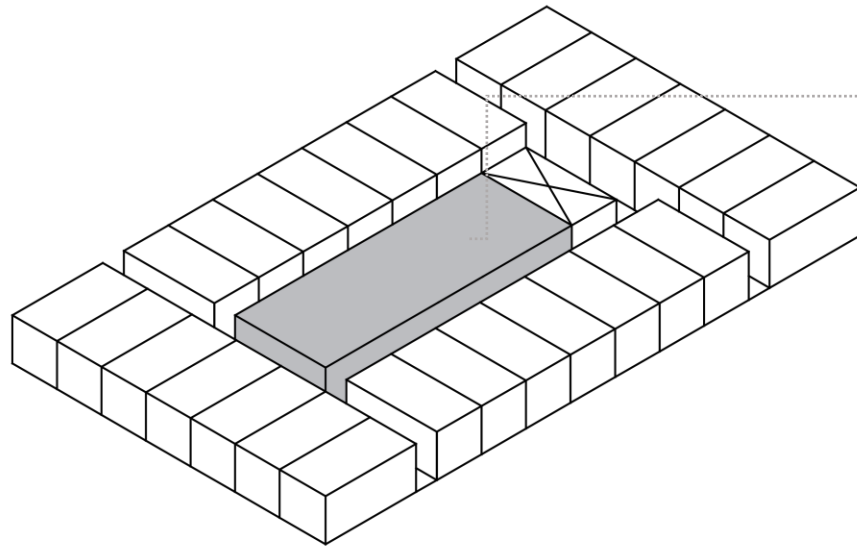
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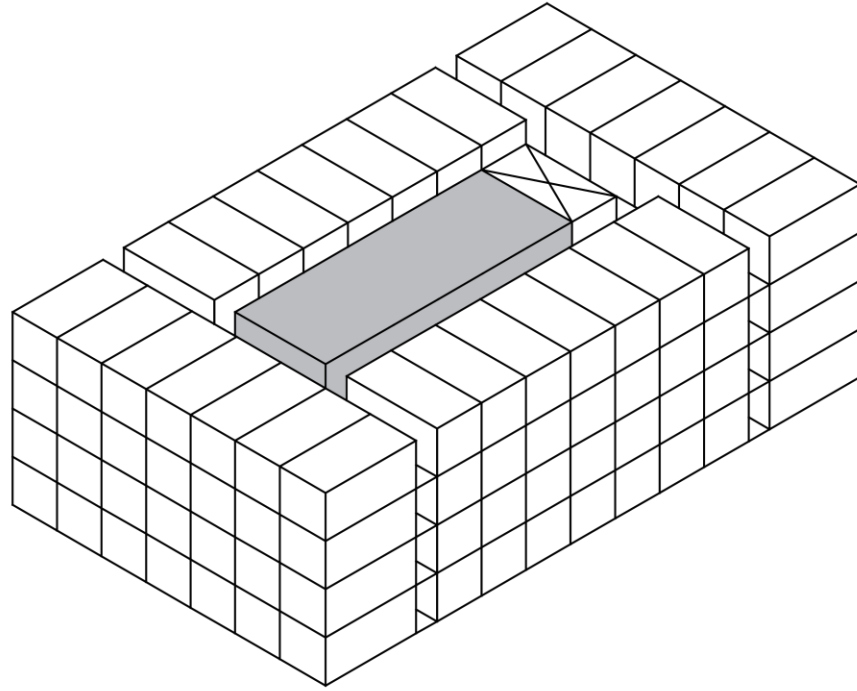
RESEARCH CONCLUSIONS | FUNCTIONAL PROGRAM & CONSTRUCTION SYSTEM - CONDITIONS



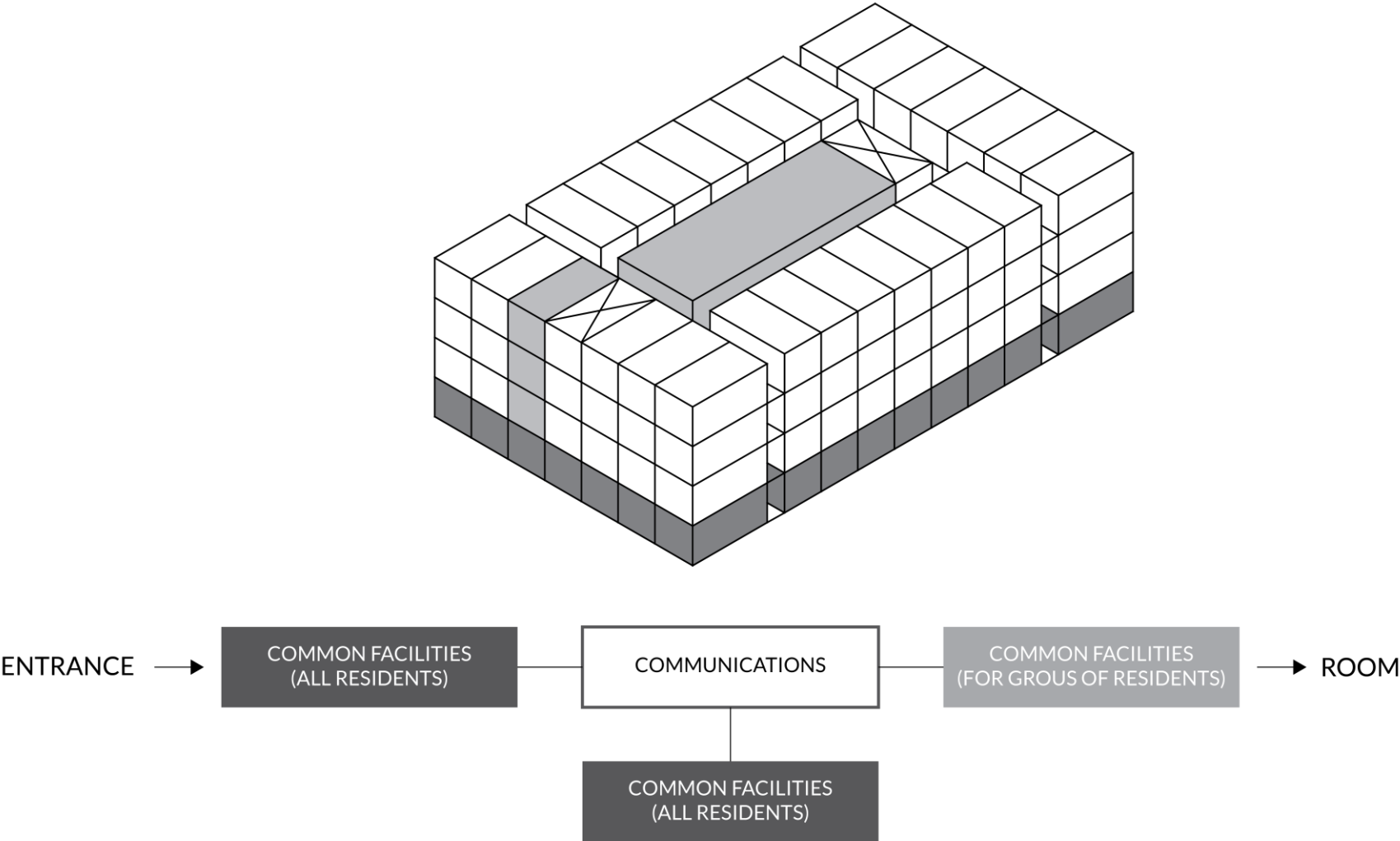
Building core:

- Located preferably in the center
- Provide stiffness
- Open plan — it is effective to arrange there common facilities
- Connected to vertical connections (evacuation staircase, elevators)

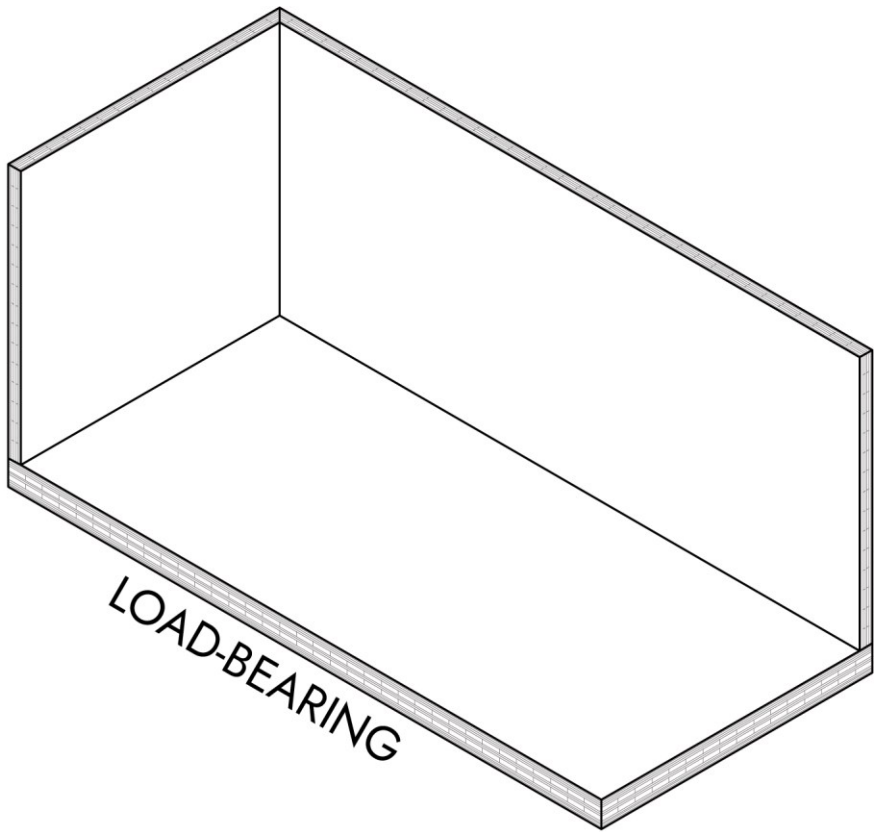
RESEARCH CONCLUSIONS | FUNCTIONAL PROGRAM & CONSTRUCTION SYSTEM - CONDITIONS



RESEARCH CONCLUSIONS | FUNCTIONAL PROGRAM & CONSTRUCTION SYSTEM - CONDITIONS



RESEARCH CONCLUSIONS | MODULE – MATERIAL PARAMETERS



| CLT FLOOR | | |
|-----------|--------|----------|
| Thickness | Layers | Span (m) |
| 51 | 3 | 1,55 |
| 61 | 3 | 2,05 |
| 71 | 3 | 2,20 |
| 81 | 3 | 2,80 |
| 85 | 5 | 2,75 |
| 93 | 3 | 3,25 |
| 95 | 5 | 3,05 |
| 99 | 3 | 3,45 |
| 105 | 5 | 3,55 |
| 115 | 5 | 3,85 |
| 125 | 5 | 4,10 |
| 135 | 5 | 4,40 |
| 147 | 5 | 4,85 |
| 153 | 5 | 5,05 |
| 165 | 5 | 5,35 |
| 174 | 6 | 5,65 |
| 186 | 6 | 6,00 |
| 189 | 7 | 6,50 |
| 201 | 7 | 6,90 |
| 207 | 7 | 7,10 |
| 219 | 7 | 7,55 |
| 231 | 7 | 7,90 |
| 240 | 8 | 8,15 |
| 252 | 8 | 8,60 |
| 264 | 8 | 8,90 |
| 273 | 9 | 9,15 |
| 285 | 9 | 9,45 |
| 297 | 9 | 9,75 |

| CLT WALL | | | |
|-------------|------------|-----|----|
| Load (kN/m) | Height (m) | | |
| | D.L. + L.L | 2,5 | 3 |
| 75 | 61 | 71 | 81 |
| 100 | 61 | 71 | 93 |
| 125 | 71 | 81 | 93 |
| 150 | 71 | 93 | 99 |
| 175 | 81 | 99 | 99 |

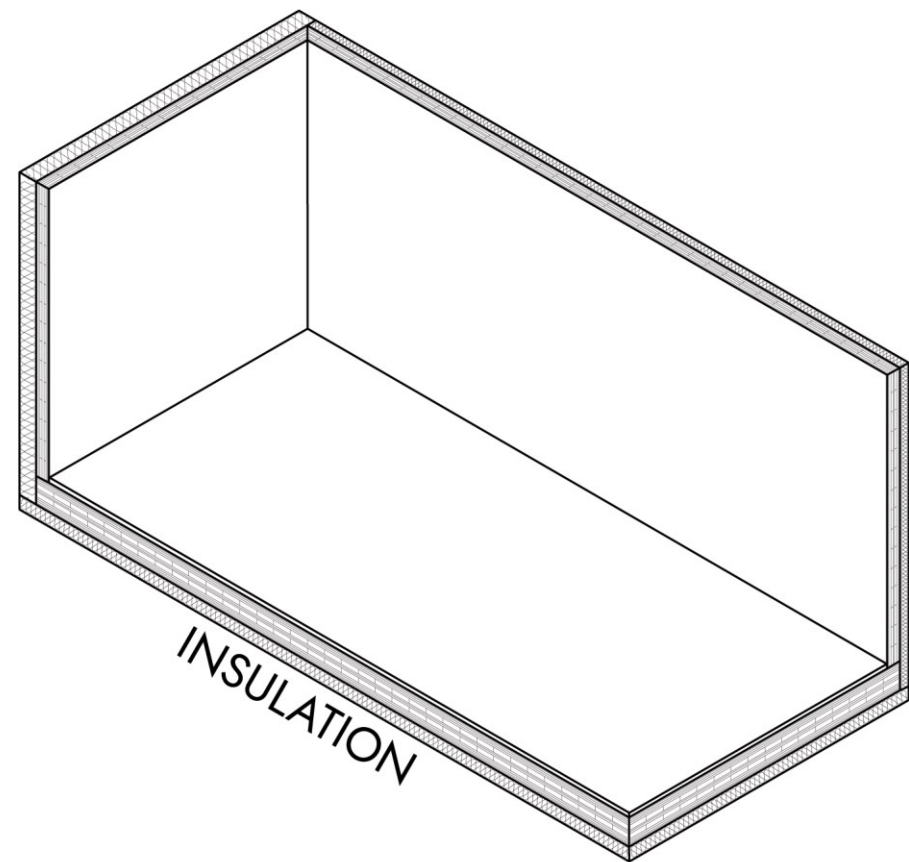
| GYPSUM BOARD | | | | |
|-----------------------|---------------|--------------------------|----|-----|
| CLT Covering | CLT Thickness | Fire Exposure Time (min) | | |
| | | 60 | 90 | 120 |
| Wall structures | | | | |
| No covering | 80 | - | - | - |
| | 100 | + | - | - |
| | 120 | + | - | - |
| 12,5mm gypsum board | 80 | + | - | - |
| | 100 | + | + | - |
| | 120 | + | + | - |
| 2 x 15mm gypsum board | 80 | + | + | - |
| | 100 | + | + | - |
| | 120 | + | + | + |
| Floor structures | | | | |
| No covering | 100 | - | - | - |
| | 140 | + | - | - |
| | 160 | + | + | - |
| 12,5mm gypsum board | 100 | + | + | - |
| | 140 | + | + | - |
| | 160 | + | + | - |

| INSULATION | | |
|------------|----------|-------------------------|
| Internal | External | Floor: sound insultaion |
| 50mm | 120mm | 30mm |

| FLOOR FINISH | |
|----------------|--------|
| Leveling layer | Finish |
| 50mm | 15mm |

| ELEVATION |
|-------------------------------|
| 20mm + 40mm ventilated cavity |
| WINDOWS |
| 10% of the floor area |

RESEARCH CONCLUSIONS | MODULE – MATERIAL PARAMETERS



CLT FLOOR

| Thickness | Layers | Span (m) |
|-----------|--------|----------|
| 51 | 3 | 1,55 |
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| 174 | 6 | 5,65 |
| 186 | 6 | 6,00 |
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| 201 | 7 | 6,90 |
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| 273 | 9 | 9,15 |
| 285 | 9 | 9,45 |
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INSULATION

| Internal | External | Floor: sound insultaion |
|----------|----------|-------------------------|
| 50mm | 120mm | 30mm |

CLT WALL

| Load (kN/m) | Height (m) | | |
|-------------|------------|----|-----|
| D.L. + L.L | 2,5 | 3 | 3,5 |
| 75 | 61 | 71 | 81 |
| 100 | 61 | 71 | 93 |
| 125 | 71 | 81 | 93 |
| 150 | 71 | 93 | 99 |
| 175 | 81 | 99 | 99 |

GYPSUM BOARD

| CLT Covering | CLT Thickness | Fire Exposure Time (min) | | |
|-----------------------|---------------|--------------------------|----|-----|
| | | 60 | 90 | 120 |
| Wall structures | | | | |
| No covering | 80 | - | - | - |
| | 100 | + | - | - |
| | 120 | + | - | - |
| 12,5mm gypsum board | 80 | + | - | - |
| | 100 | + | + | - |
| | 120 | + | + | - |
| 2 x 15mm gypsum board | 80 | + | + | - |
| | 100 | + | + | - |
| | 120 | + | + | + |
| Floor structures | | | | |
| No covering | 100 | - | - | - |
| | 140 | + | - | - |
| | 160 | + | + | - |
| 12,5mm gypsum board | 100 | + | + | - |
| | 140 | + | + | - |
| | 160 | + | + | - |

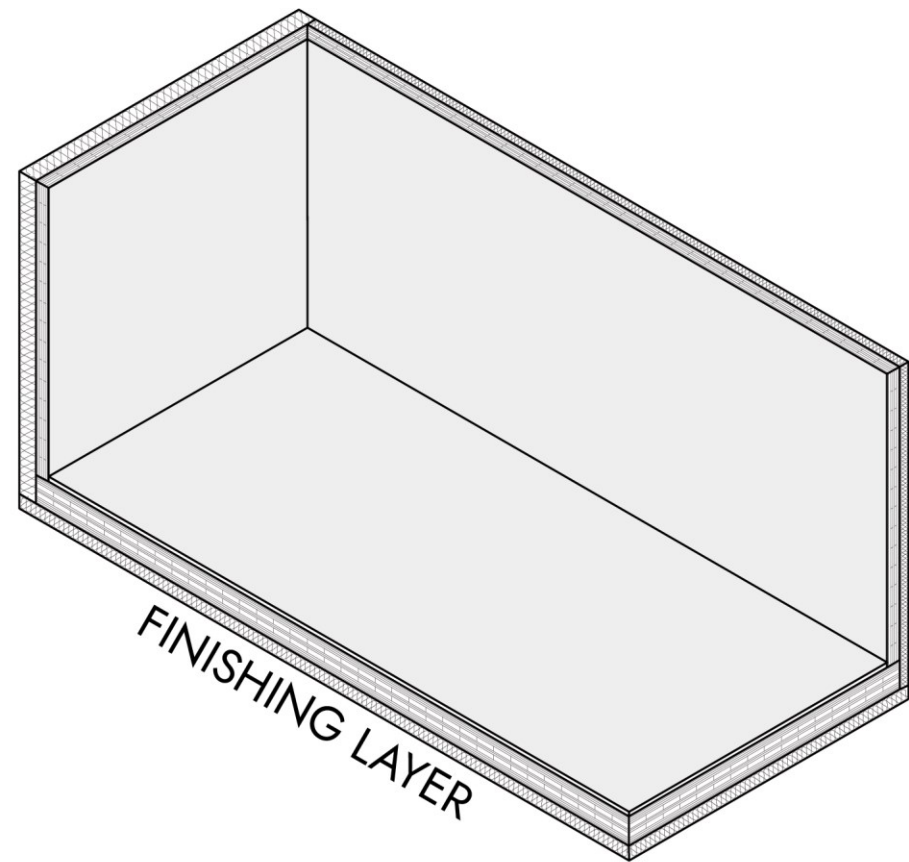
FLOOR FINISH

| Leveling layer | Finish |
|----------------|--------|
| 50mm | 15mm |

ELEVATION

| |
|-------------------------------|
| 20mm + 40mm ventilated cavity |
| WINDOWS |
| 10% of the floor area |

RESEARCH CONCLUSIONS | MODULE – MATERIAL PARAMETERS



CLT FLOOR

| Thickness | Layers | Span (m) |
|-----------|--------|----------|
| 51 | 3 | 1,55 |
| 61 | 3 | 2,05 |
| 71 | 3 | 2,20 |
| 81 | 3 | 2,80 |
| 85 | 5 | 2,75 |
| 93 | 3 | 3,25 |
| 95 | 5 | 3,05 |
| 99 | 3 | 3,45 |
| 105 | 5 | 3,55 |
| 115 | 5 | 3,85 |
| 125 | 5 | 4,10 |
| 135 | 5 | 4,40 |
| 147 | 5 | 4,85 |
| 153 | 5 | 5,05 |
| 165 | 5 | 5,35 |
| 174 | 6 | 5,65 |
| 186 | 6 | 6,00 |
| 189 | 7 | 6,50 |
| 201 | 7 | 6,90 |
| 207 | 7 | 7,10 |
| 219 | 7 | 7,55 |
| 231 | 7 | 7,90 |
| 240 | 8 | 8,15 |
| 252 | 8 | 8,60 |
| 264 | 8 | 8,90 |
| 273 | 9 | 9,15 |
| 285 | 9 | 9,45 |
| 297 | 9 | 9,75 |

INSULATION

| Internal | External | Floor: sound insultaion |
|----------|----------|-------------------------|
| 50mm | 120mm | 30mm |

CLT WALL

| Load (kN/m) | Height (m) | | |
|-------------|------------|----|-----|
| D.L. + L.L | 2,5 | 3 | 3,5 |
| 75 | 61 | 71 | 81 |
| 100 | 61 | 71 | 93 |
| 125 | 71 | 81 | 93 |
| 150 | 71 | 93 | 99 |
| 175 | 81 | 99 | 99 |

GYPSUM BOARD

| CLT Covering | CLT Thickness | Fire Exposure Time (min) | | |
|--------------------------|------------------|--------------------------|----|-----|
| | | 60 | 90 | 120 |
| Wall structures | | | | |
| No covering | 80 | - | - | - |
| | 100 | + | - | - |
| | 120 | + | - | - |
| 12.5mm gypsum board | 80 | + | - | - |
| | 100 | + | + | - |
| | 120 | + | + | - |
| 2 x 15mm gypsum board | 80 | + | + | - |
| | 100 | + | + | - |
| | 120 | + | + | + |
| Floor structures | | | | |
| No covering | 100 | - | - | - |
| | 140 | + | - | - |
| | 160 | + | + | - |
| 12.5mm gypsum board | 100 | + | + | - |
| | 140 | + | + | - |
| | 160 | + | + | - |

FLOOR FINISH

| Leveling layer | Finish |
|----------------|--------|
| 50mm | 15mm |

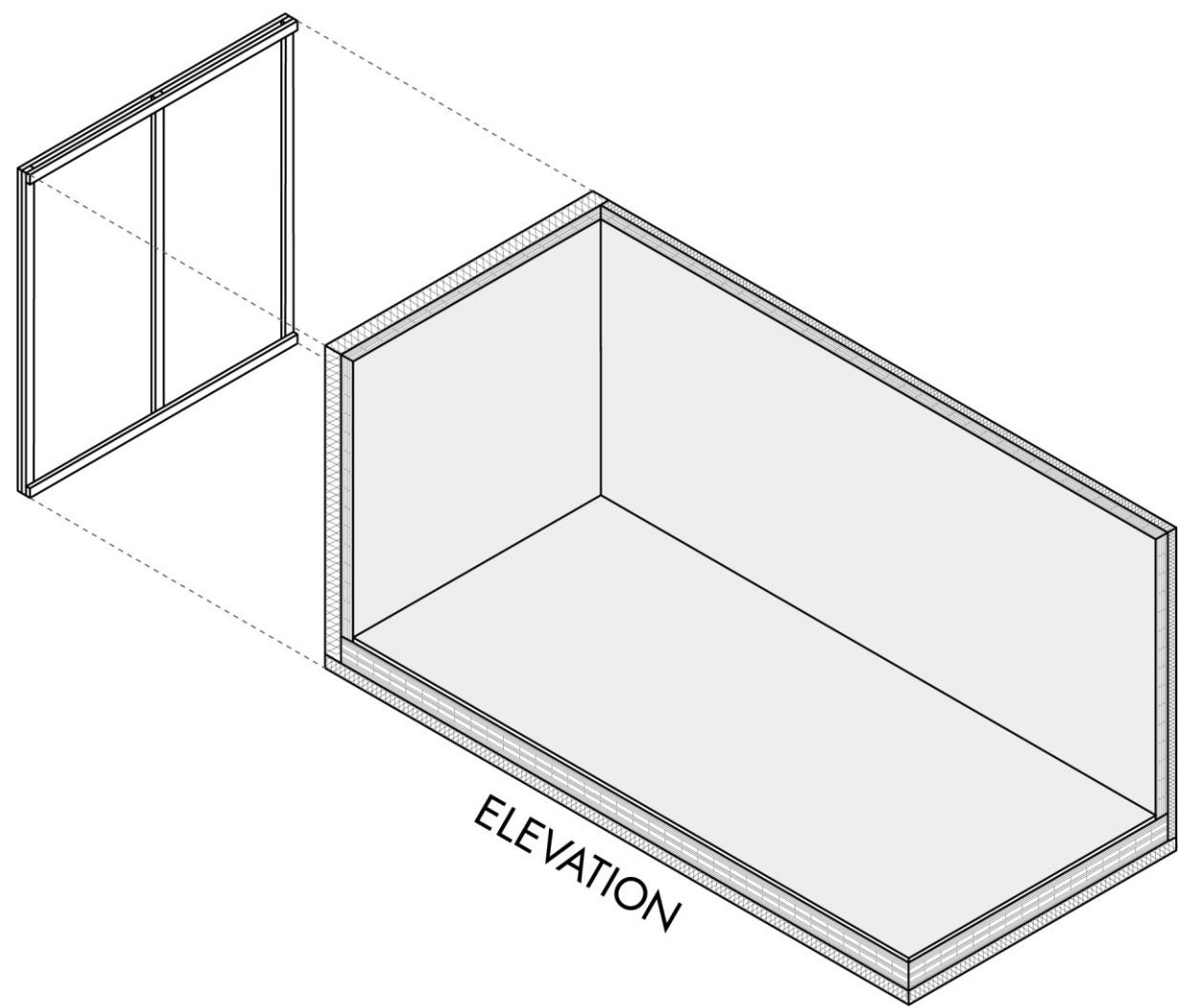
ELEVATION

| |
|-------------------------------|
| 20mm + 40mm ventilated cavity |
|-------------------------------|

WINDOWS

| |
|-----------------------|
| 10% of the floor area |
|-----------------------|

RESEARCH CONCLUSIONS | MODULE – MATERIAL PARAMETERS



CLT FLOOR

| Thickness | Layers | Span (m) |
|-----------|--------|----------|
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| 105 | 5 | 3,55 |
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| 135 | 5 | 4,40 |
| 147 | 5 | 4,85 |
| 153 | 5 | 5,05 |
| 165 | 5 | 5,35 |
| 174 | 6 | 5,65 |
| 186 | 6 | 6,00 |
| 189 | 7 | 6,50 |
| 201 | 7 | 6,90 |
| 207 | 7 | 7,10 |
| 219 | 7 | 7,55 |
| 231 | 7 | 7,90 |
| 240 | 8 | 8,15 |
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| 264 | 8 | 8,90 |
| 273 | 9 | 9,15 |
| 285 | 9 | 9,45 |
| 297 | 9 | 9,75 |

INSULATION

| Internal | External | Floor: sound insultaion |
|----------|----------|-------------------------|
| 50mm | 120mm | 30mm |

CLT WALL

| Load (kN/m) | Height (m) | | |
|-------------|------------|----|-----|
| D.L. + L.L | 2,5 | 3 | 3,5 |
| 75 | 61 | 71 | 81 |
| 100 | 61 | 71 | 93 |
| 125 | 71 | 81 | 93 |
| 150 | 71 | 93 | 99 |
| 175 | 81 | 99 | 99 |

GYPSUM BOARD

| CLT Covering | CLT Thickness | Fire Exposure Time (min) | | |
|-----------------------|---------------|--------------------------|----|-----|
| | | 60 | 90 | 120 |
| Wall structures | | | | |
| No covering | 80 | - | - | - |
| | 100 | + | - | - |
| | 120 | + | - | - |
| 12.5mm gypsum board | 80 | + | - | - |
| | 100 | + | + | - |
| | 120 | + | + | - |
| 2 x 15mm gypsum board | 80 | + | + | - |
| | 100 | + | + | - |
| | 120 | + | + | + |
| Floor structures | | | | |
| No covering | 100 | - | - | - |
| | 140 | + | - | - |
| | 160 | + | + | - |
| 12.5mm gypsum board | 100 | + | + | - |
| | 140 | + | + | - |
| | 160 | + | + | - |

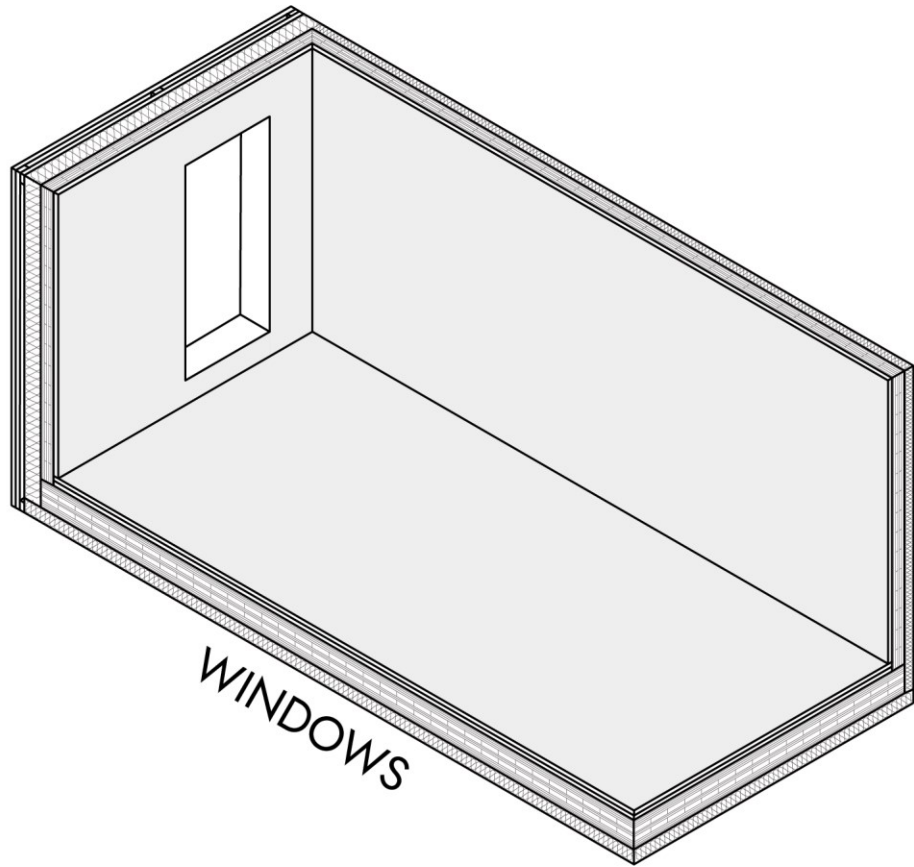
FLOOR FINISH

| Leveling layer | Finish |
|----------------|--------|
| 50mm | 15mm |

ELEVATION

| |
|-------------------------------|
| 20mm + 40mm ventilated cavity |
| WINDOWS |
| 10% of the floor area |

RESEARCH CONCLUSIONS | MODULE – MATERIAL PARAMETERS



CLT FLOOR

| Thickness | Layers | Span (m) |
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| 51 | 3 | 1,55 |
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| 135 | 5 | 4,40 |
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| 153 | 5 | 5,05 |
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| 264 | 8 | 8,90 |
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INSULATION

| Internal | External | Floor: sound insultaion |
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| 50mm | 120mm | 30mm |

CLT WALL

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| D.L. + L.L | 2,5 | 3 | 3,5 |
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| 100 | 61 | 71 | 93 |
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| 150 | 71 | 93 | 99 |
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GYPSUM BOARD

| CLT Covering | CLT Thickness | Fire Exposure Time (min) | | |
|-----------------------|---------------|--------------------------|----|-----|
| | | 60 | 90 | 120 |
| Wall structures | | | | |
| No covering | 80 | - | - | - |
| | 100 | + | - | - |
| | 120 | + | - | - |
| 12.5mm gypsum board | 80 | + | - | - |
| | 100 | + | + | - |
| | 120 | + | + | - |
| 2 x 15mm gypsum board | 80 | + | + | - |
| | 100 | + | + | - |
| | 120 | + | + | + |
| Floor structures | | | | |
| No covering | 100 | - | - | - |
| | 140 | + | - | - |
| | 160 | + | + | - |
| 12.5mm gypsum board | 100 | + | + | - |
| | 140 | + | + | - |
| | 160 | + | + | - |

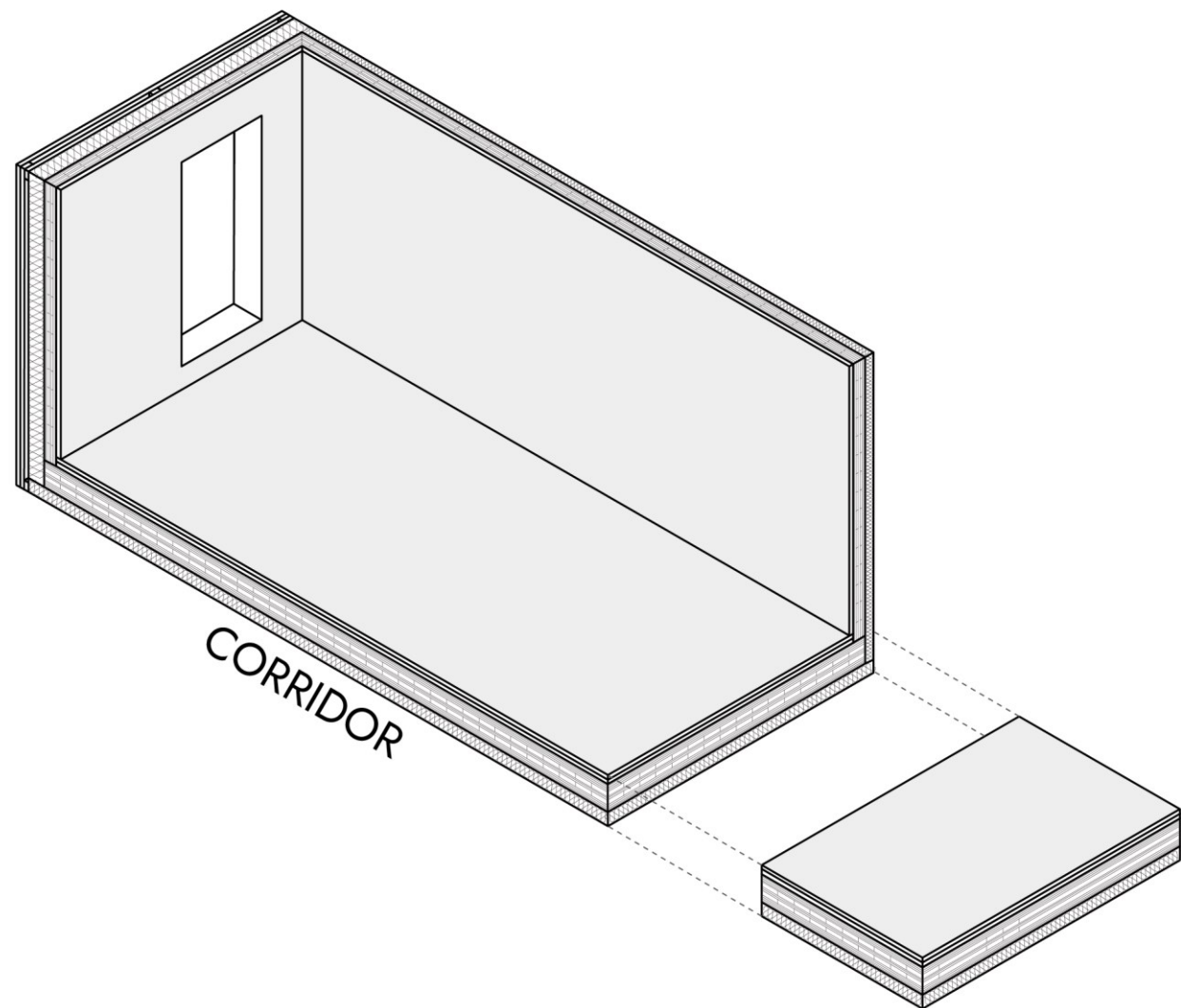
FLOOR FINISH

| Leveling layer | Finish |
|----------------|--------|
| 50mm | 15mm |

ELEVATION

| |
|-------------------------------|
| 20mm + 40mm ventilated cavity |
| WINDOWS |
| 10% of the floor area |

RESEARCH CONCLUSIONS | MODULE – MATERIAL PARAMETERS



| CLT FLOOR | | |
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| Thickness | Layers | Span (m) |
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| 252 | 8 | 8,60 |
| 264 | 8 | 8,90 |
| 273 | 9 | 9,15 |
| 285 | 9 | 9,45 |
| 297 | 9 | 9,75 |

| INSULATION | | |
|------------|----------|-------------------------|
| Internal | External | Floor: sound insultaion |
| 50mm | 120mm | 30mm |

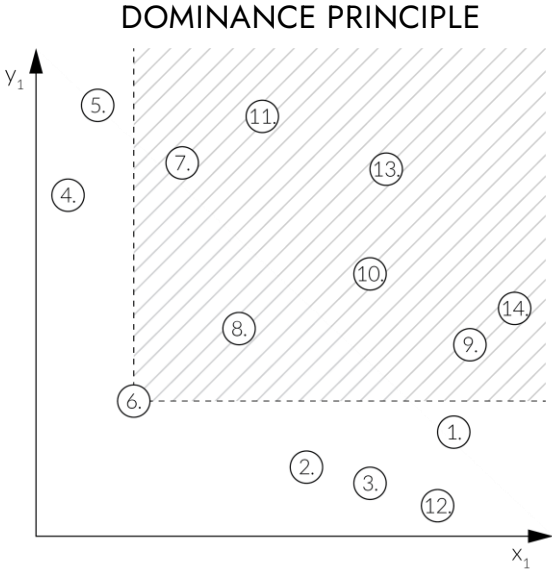
| CLT WALL | | | |
|-------------|------------|-----|----|
| Load (kN/m) | Height (m) | | |
| | D.L. + L.L | 2.5 | 3 |
| 75 | 61 | 71 | 81 |
| 100 | 61 | 71 | 93 |
| 125 | 71 | 81 | 93 |
| 150 | 71 | 93 | 99 |
| 175 | 81 | 99 | 99 |

| GYPSUM BOARD | | | | |
|-----------------------|---------------|--------------------------|----|-----|
| CLT Covering | CLT Thickness | Fire Exposure Time (min) | | |
| | | 60 | 90 | 120 |
| Wall structures | | | | |
| No covering | 80 | - | - | - |
| | 100 | + | - | - |
| | 120 | + | - | - |
| 12,5mm gypsum board | 80 | + | - | - |
| | 100 | + | + | - |
| | 120 | + | + | - |
| 2 x 15mm gypsum board | 80 | + | + | - |
| | 100 | + | + | - |
| | 120 | + | + | + |
| Floor structures | | | | |
| No covering | 100 | - | - | - |
| | 140 | + | - | - |
| | 160 | + | + | - |
| 12,5mm gypsum board | 100 | + | + | - |
| | 140 | + | + | - |
| | 160 | + | + | - |

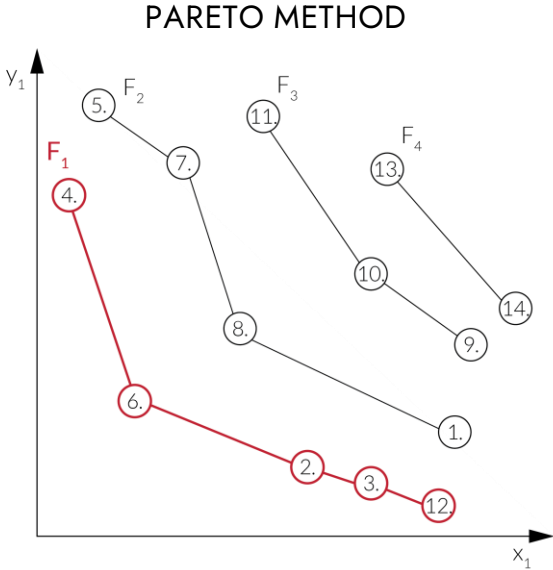
| FLOOR FINISH | |
|----------------|--------|
| Leveling layer | Finish |
| 50mm | 15mm |

| ELEVATION |
|-------------------------------|
| 20mm + 40mm ventilated cavity |
| WINDOWS |
| 10% of the floor area |

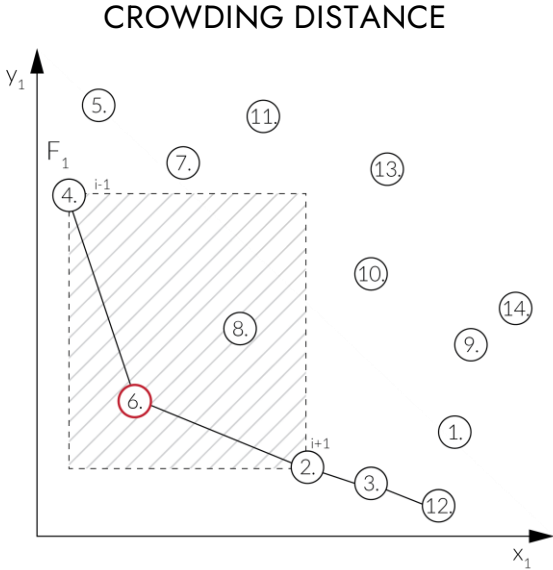
RESEARCH CONCLUSIONS | RANKING RESULTS – MULTI-OBJECTIVE OPTIMIZATION



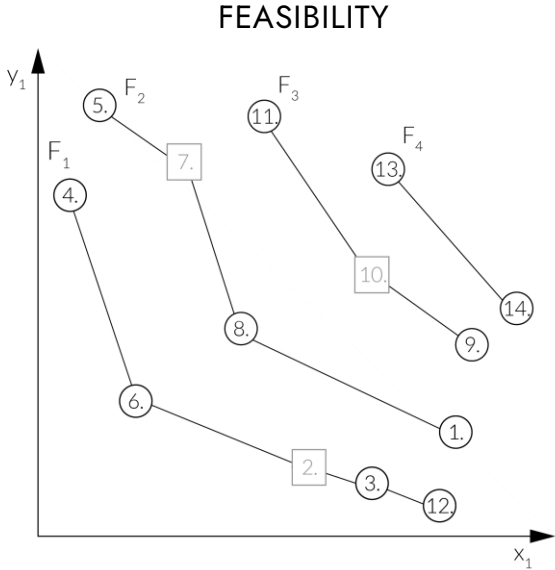
In presented scenario optimal solution sought would have minimal x_1 value and minimal y_1 value



In presented scenario optimal solution sought would have minimal x_1 value and minimal y_1 value



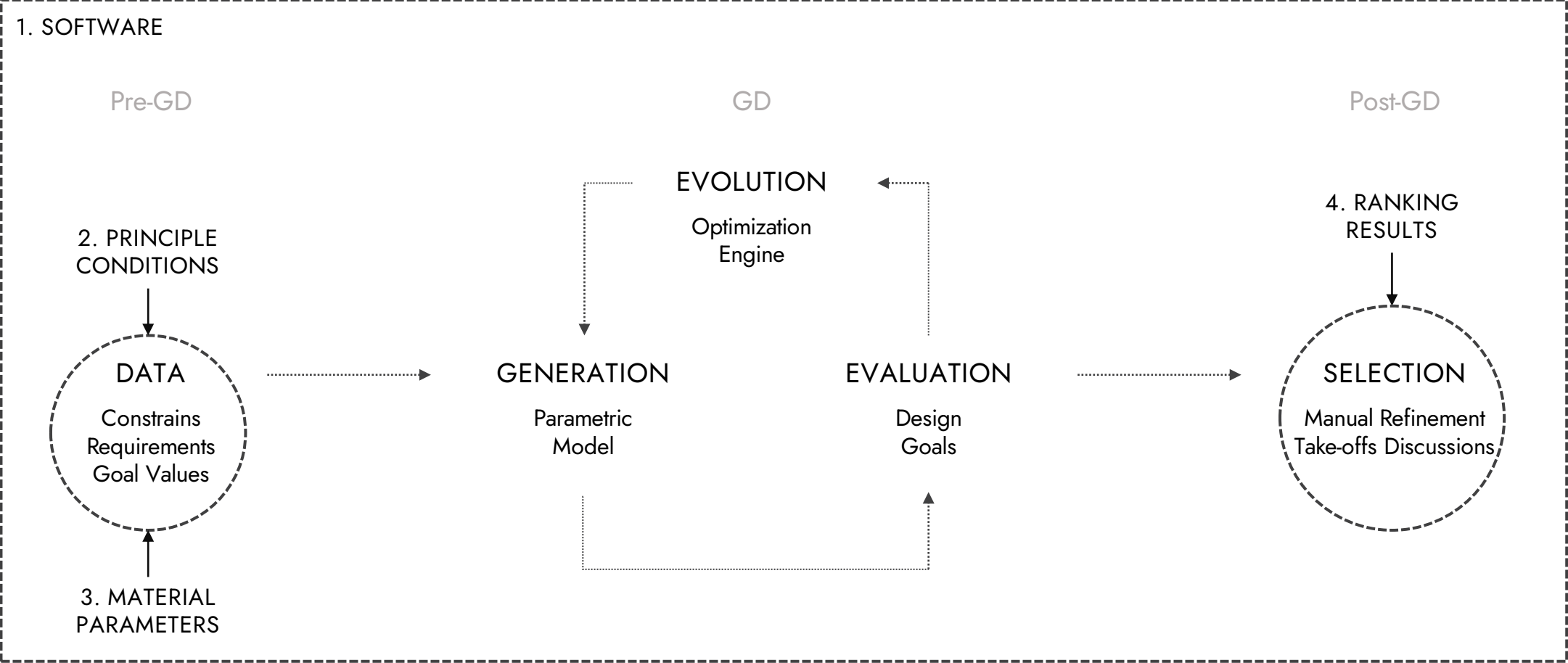
In presented scenario optimal solution sought would have minimal x_1 value and minimal y_1 value



In presented scenario optimal solution sought would have minimal x_1 value and minimal y_1 value

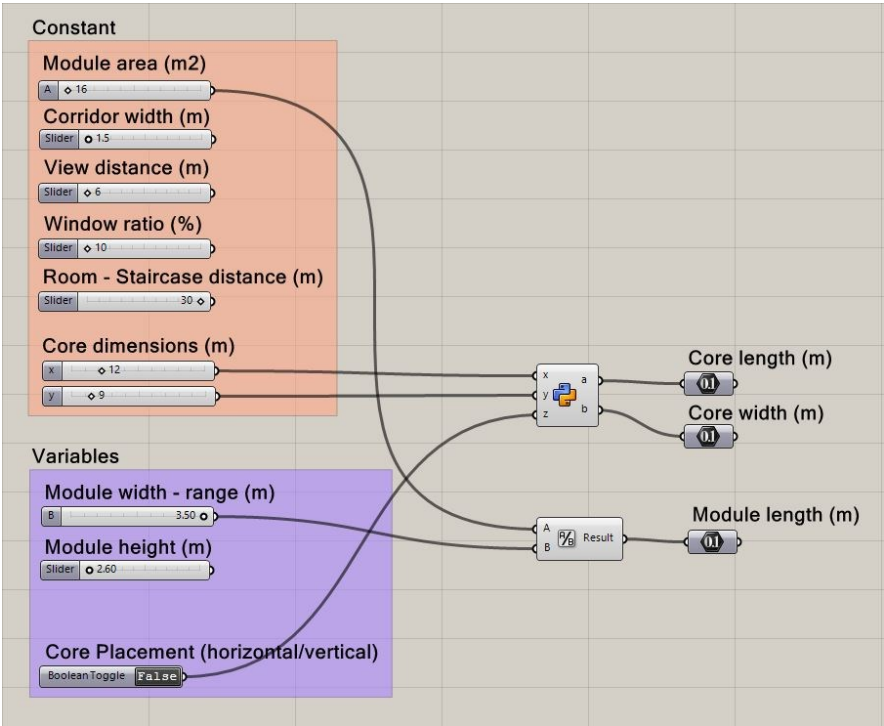
MULTI-STAGED DECISION PROCESS

RESEARCH CONCLUSIONS | CREATING THE SYSTEM

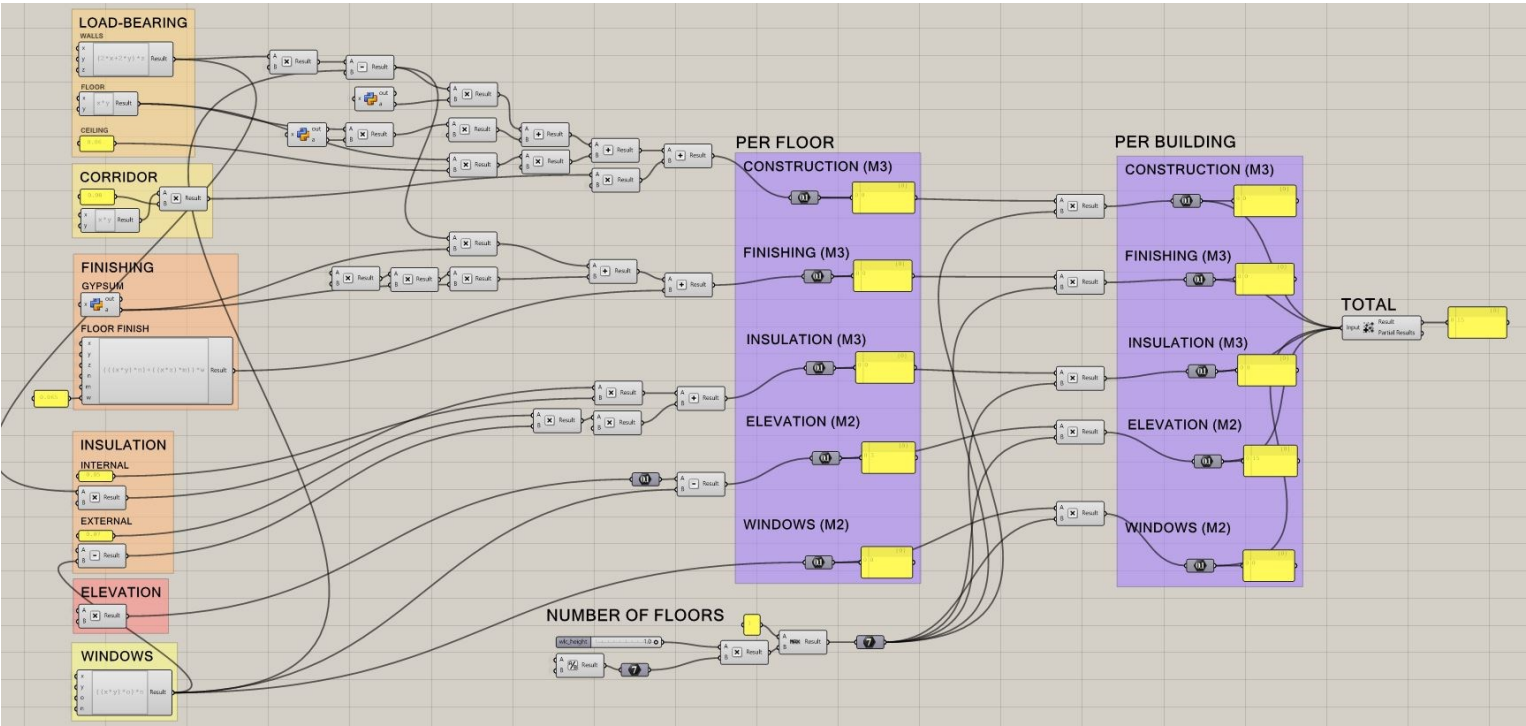


RESEARCH CONCLUSIONS | CREATING THE SYSTEM

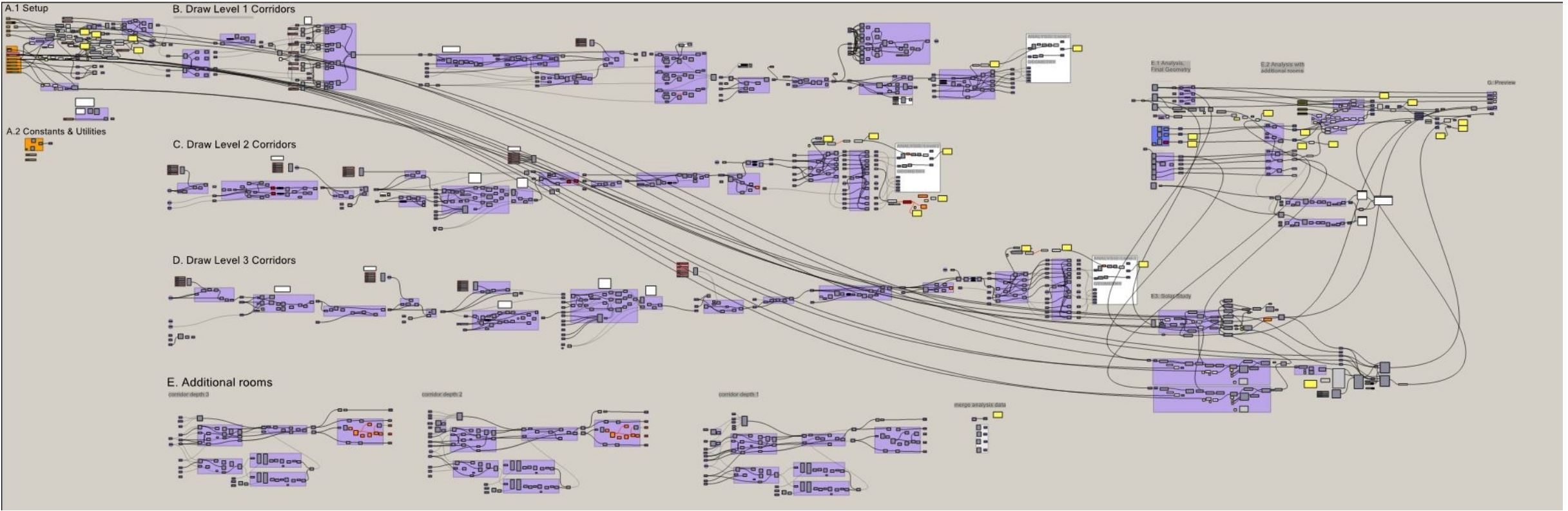
INITIAL DATA



METHOD OF CALCULATION THE MATERIAL USE



RESEARCH CONCLUSIONS | CREATING THE SYSTEM



RESEARCH CONCLUSIONS | CREATING THE SYSTEM

Constant

Module area (m2)

Slider 16

Corridor width (m)

Slider 1.5

View distance (m)

Slider 6

Window ratio (%)

Slider 10

Room - Staircase distance (m)

Slider 30

Core dimensions (m)

x 12

y 9

Variables

Module width - range (m)

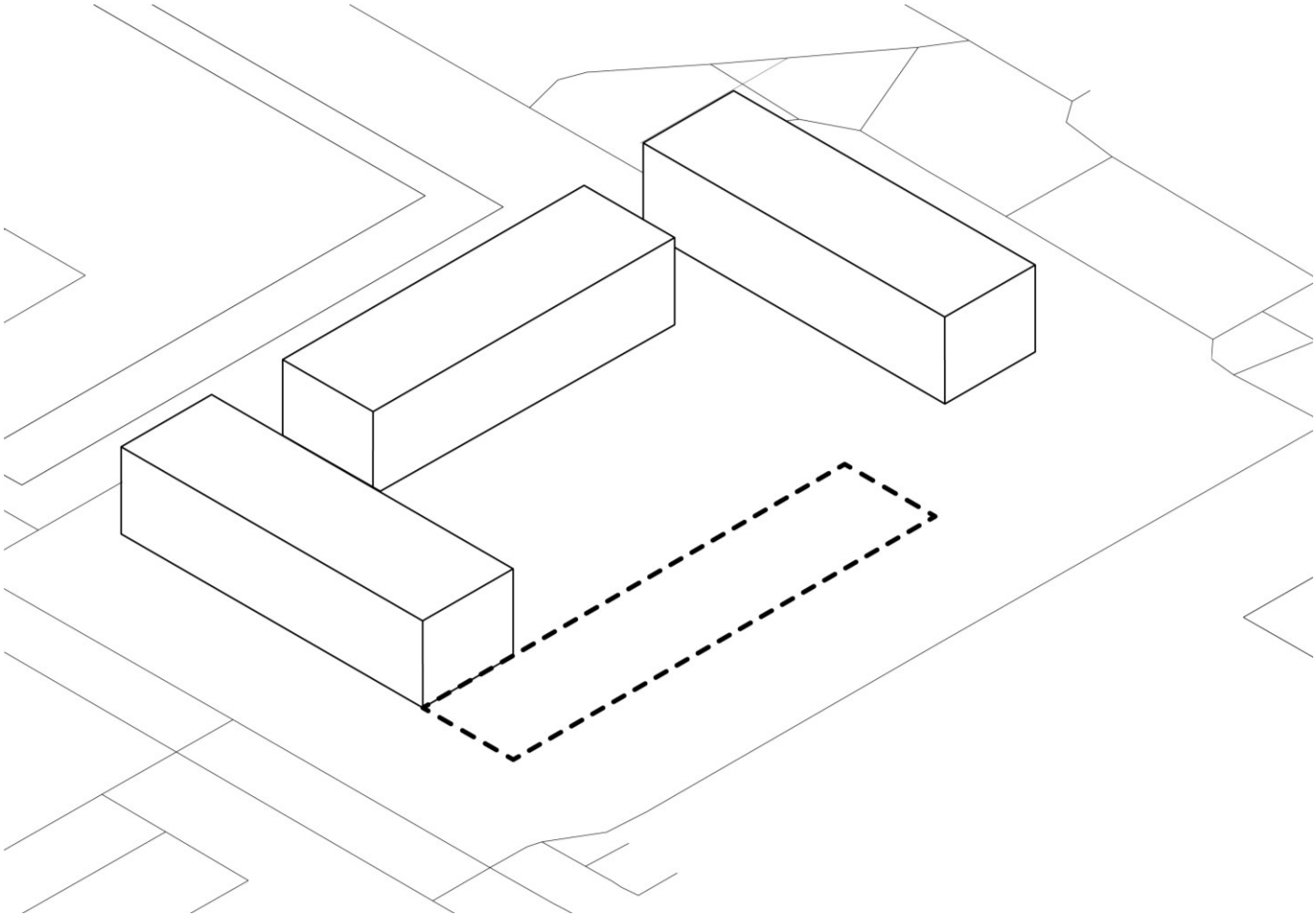
Slider 3.50

Module height (m)

Slider 2.60

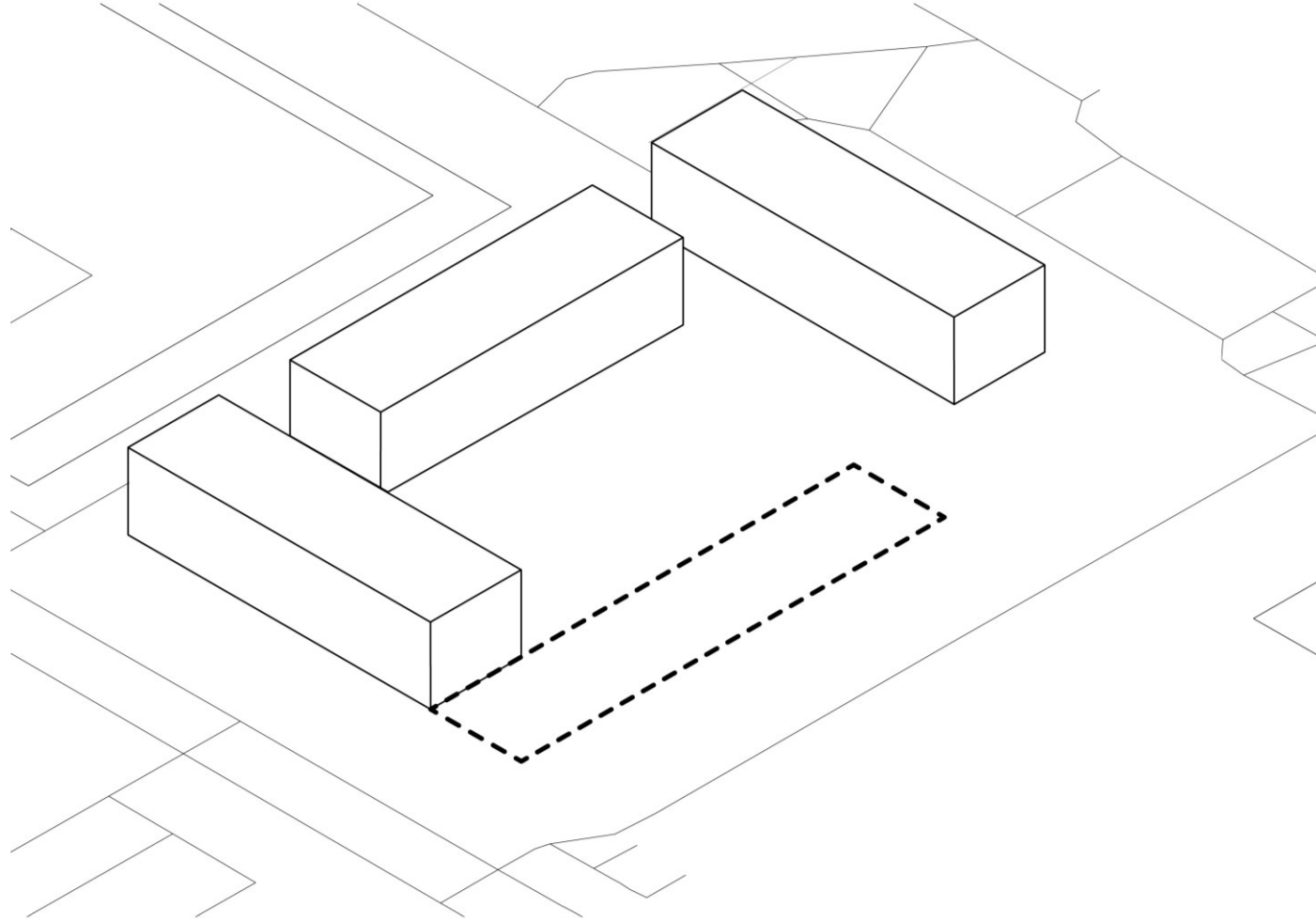
Core Placement (horizontal/vertical)

BooleanToggle False



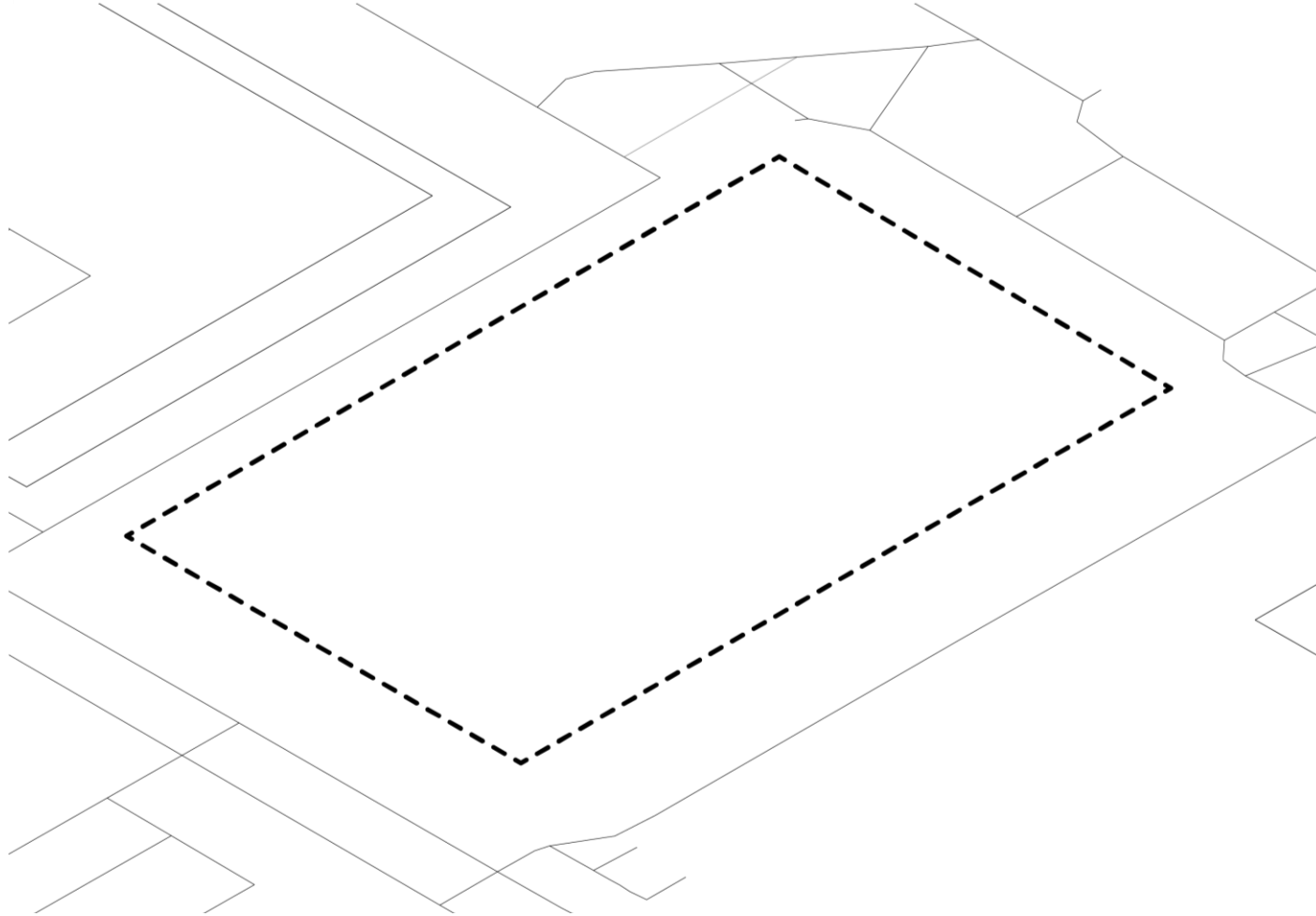
RESEARCH CONCLUSIONS | CREATING THE SYSTEM

PRE-DESIGN



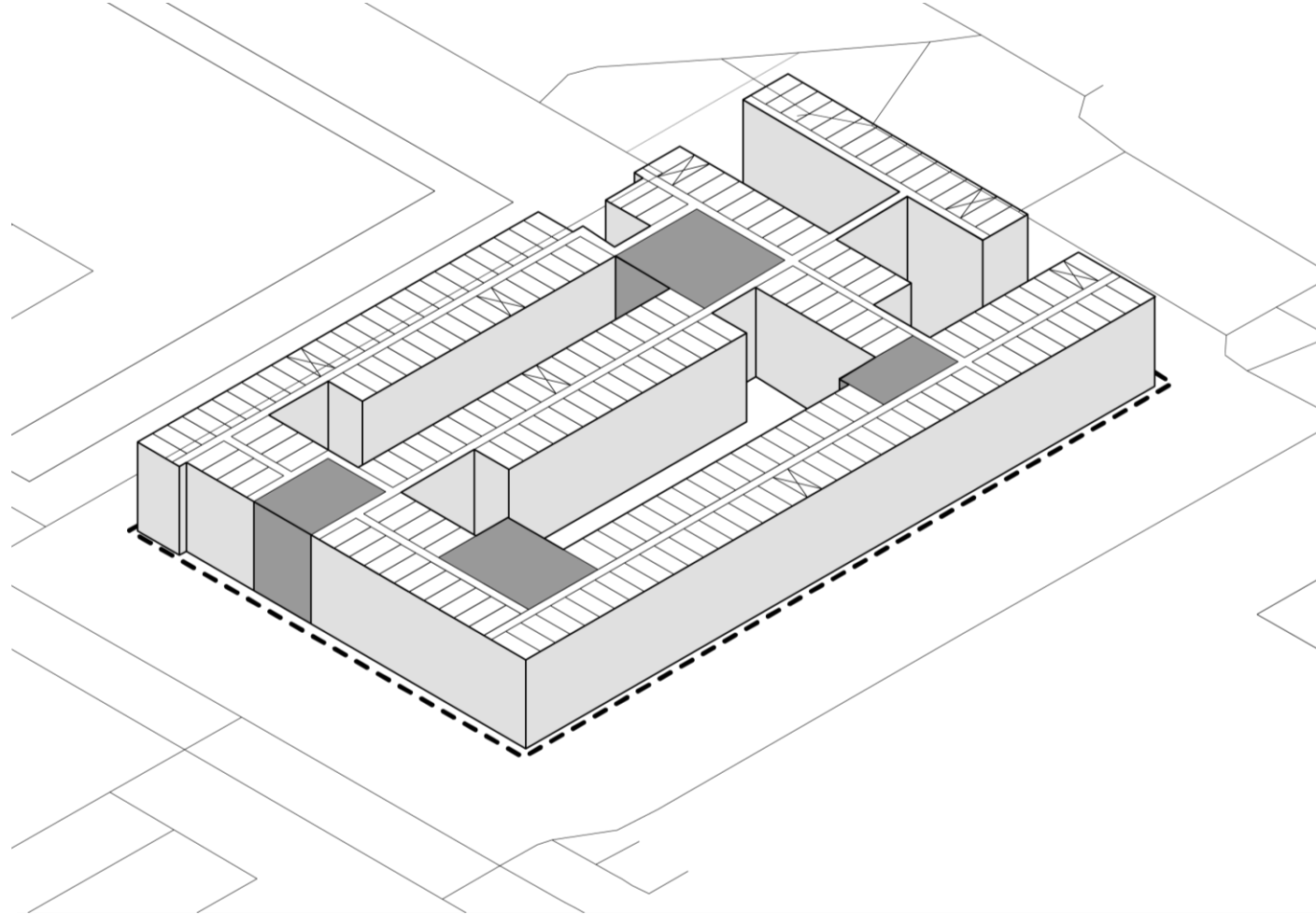
RESEARCH CONCLUSIONS | CREATING THE SYSTEM

~~PRE-DESIGN~~

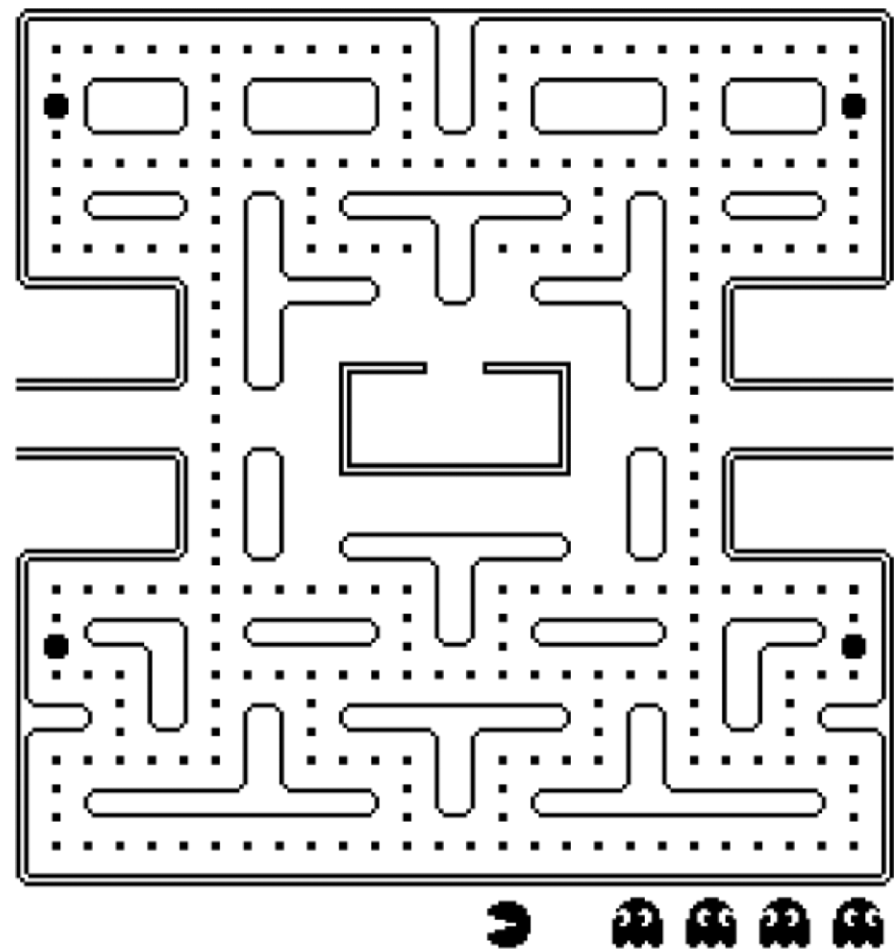


RESEARCH CONCLUSIONS | CREATING THE SYSTEM

~~PRE-DESIGN~~

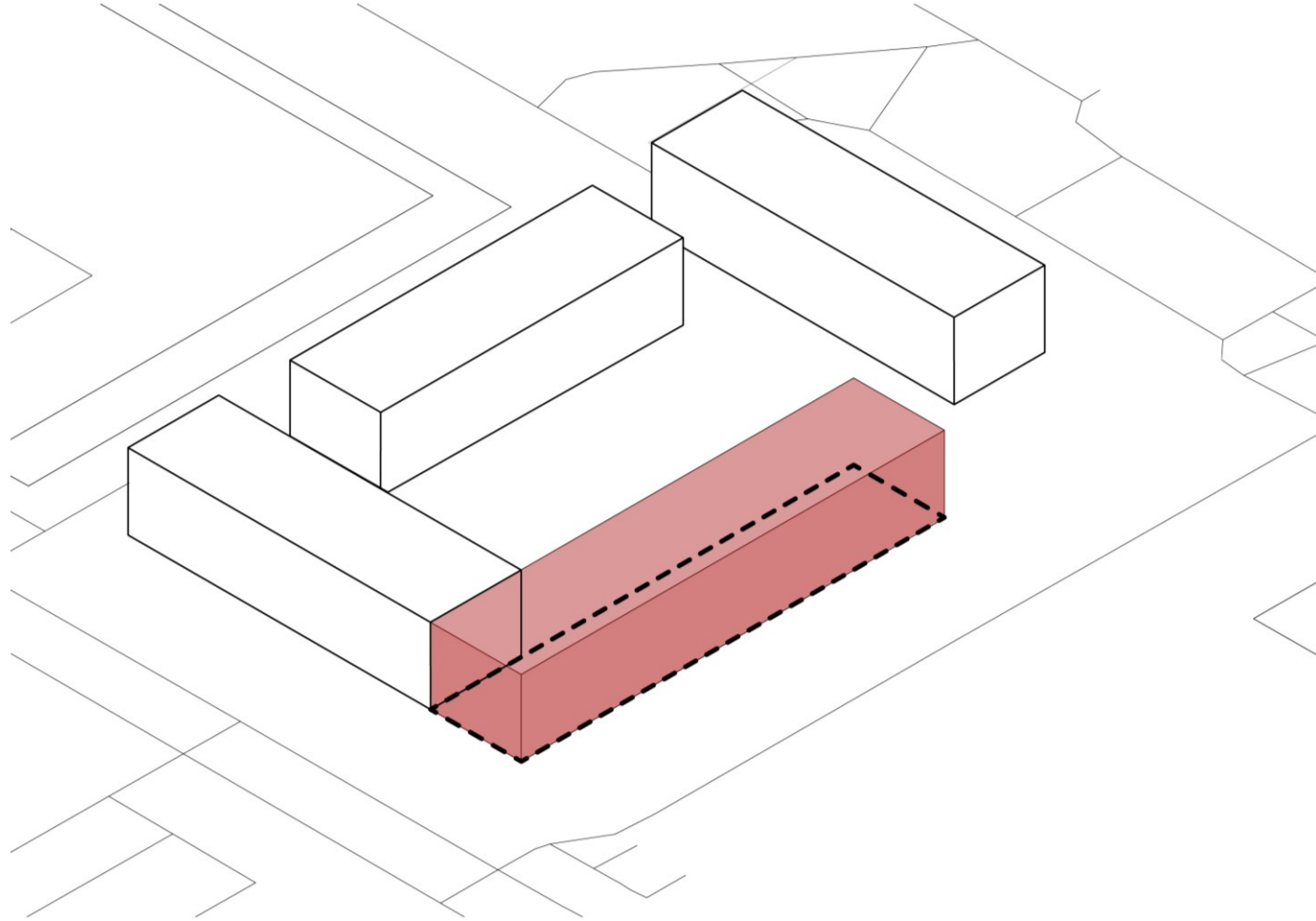


~~PRE-DESIGN~~ →

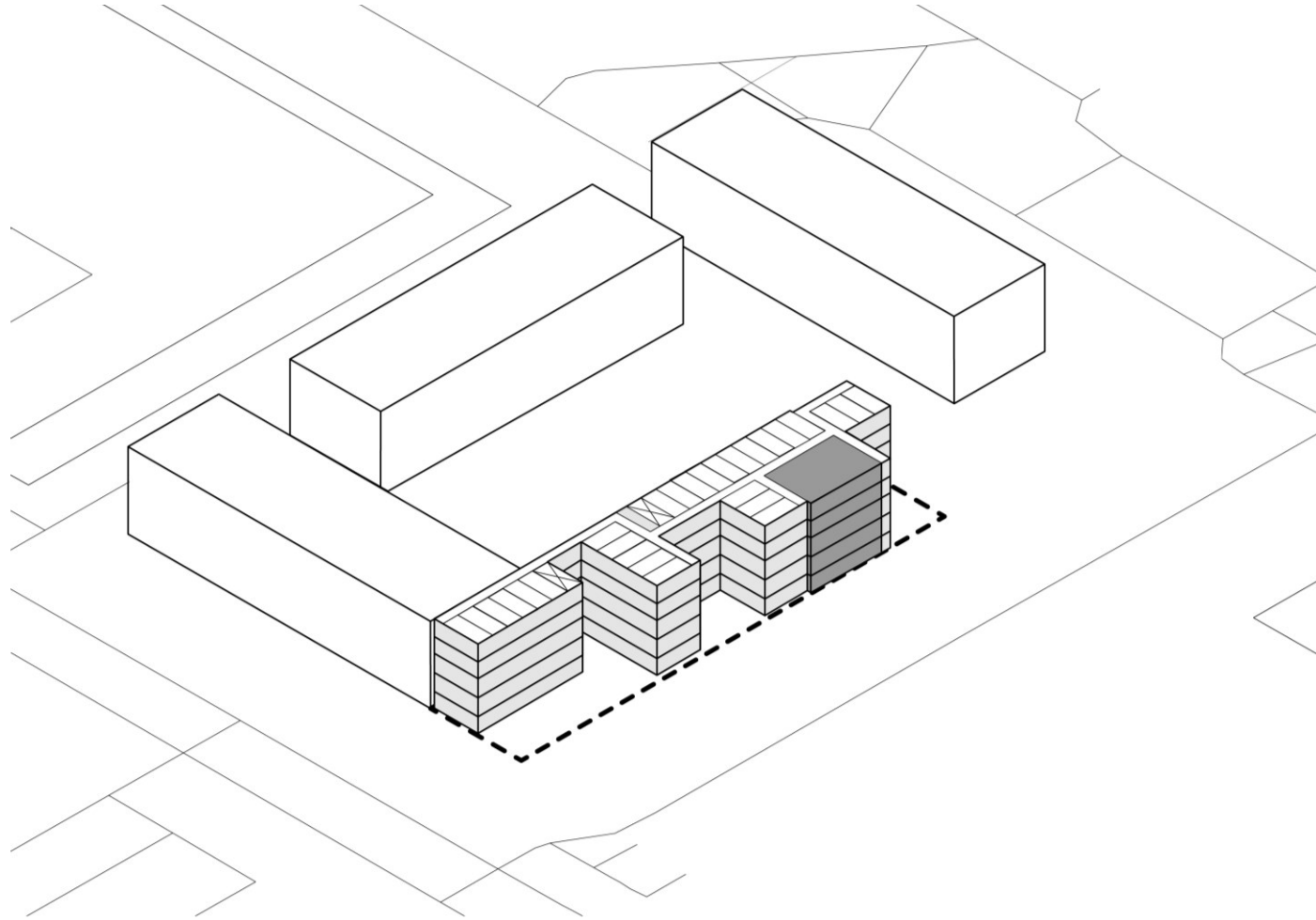


RESEARCH CONCLUSIONS | CREATING THE SYSTEM

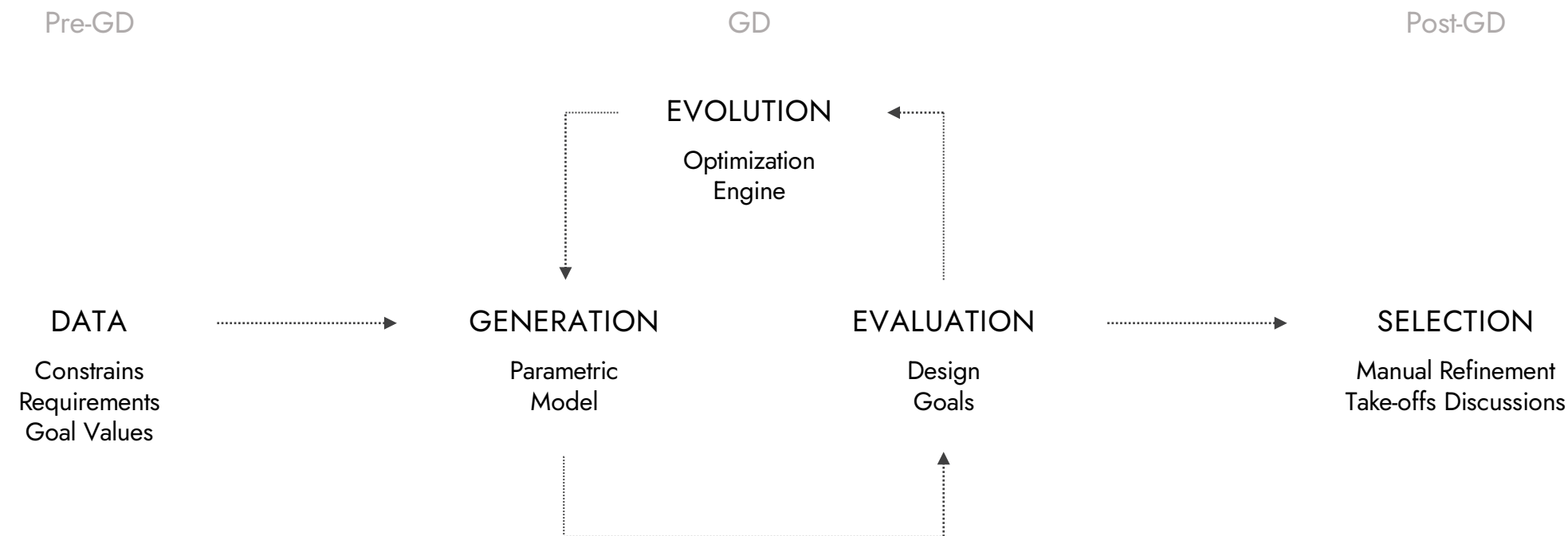
PRE-DESIGN



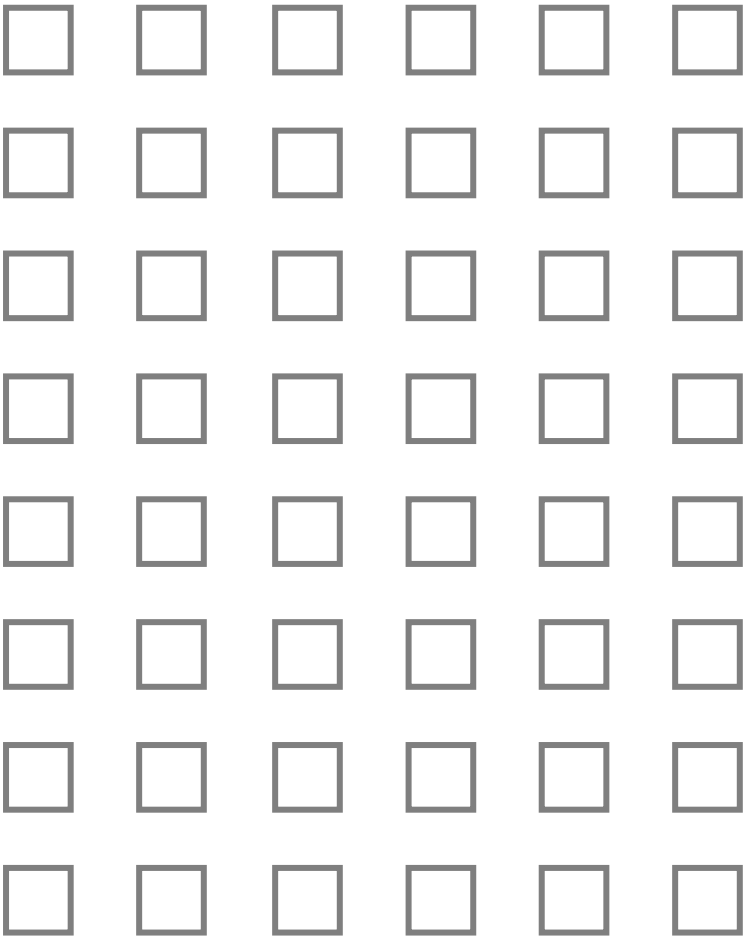
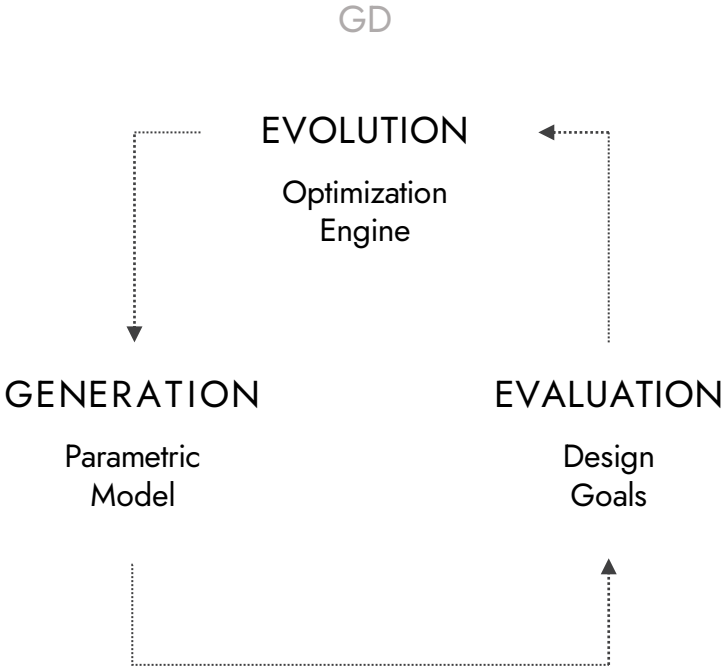
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



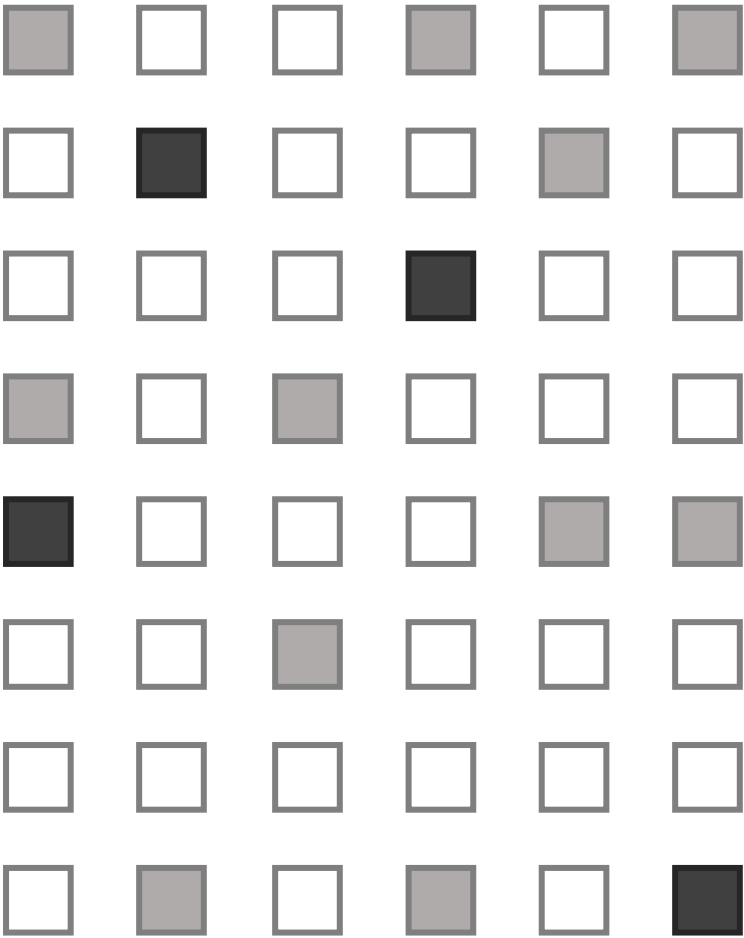
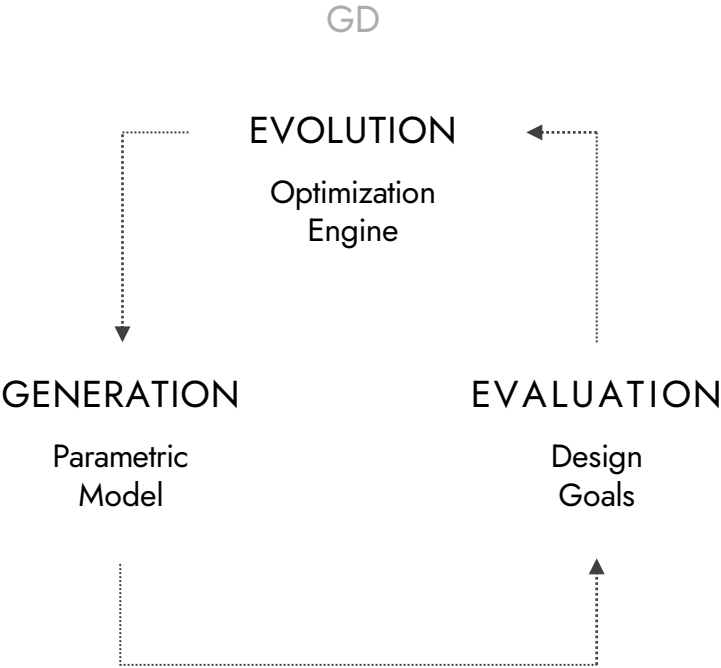
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



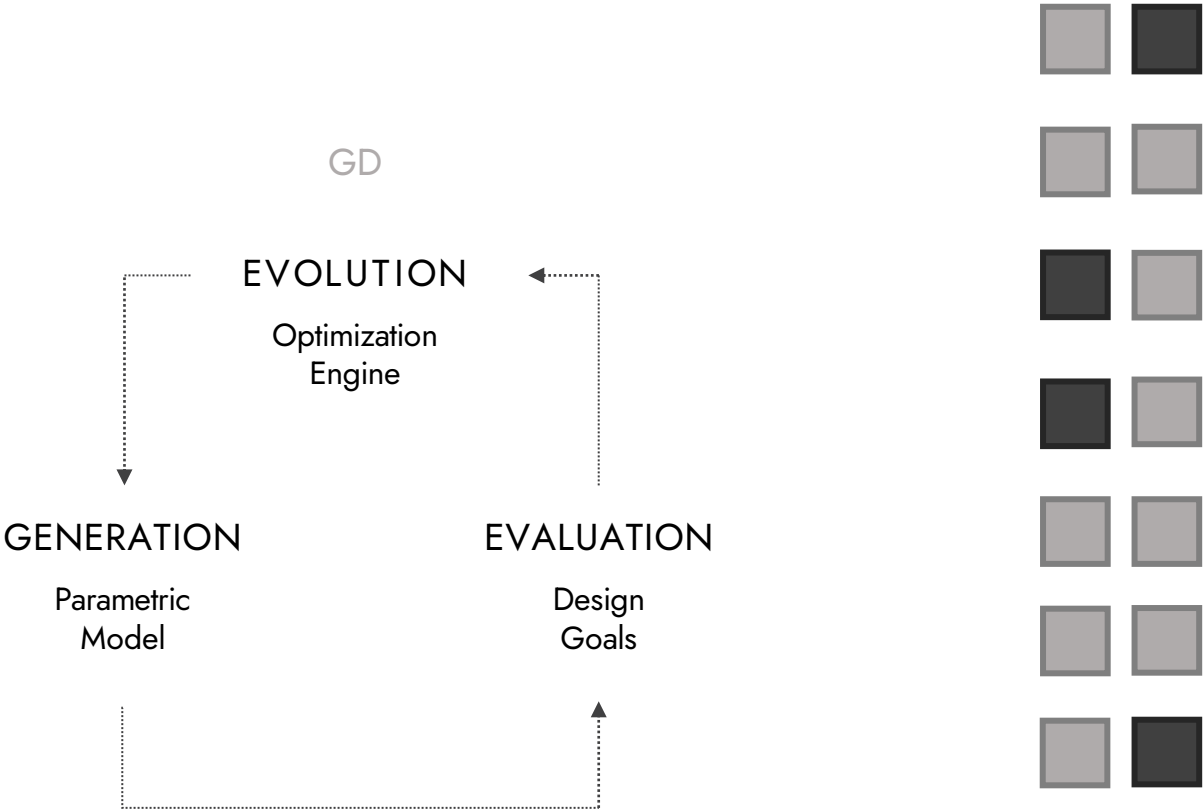
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



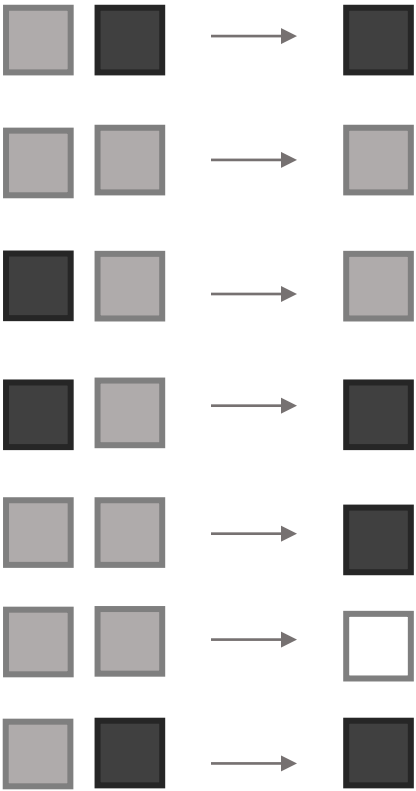
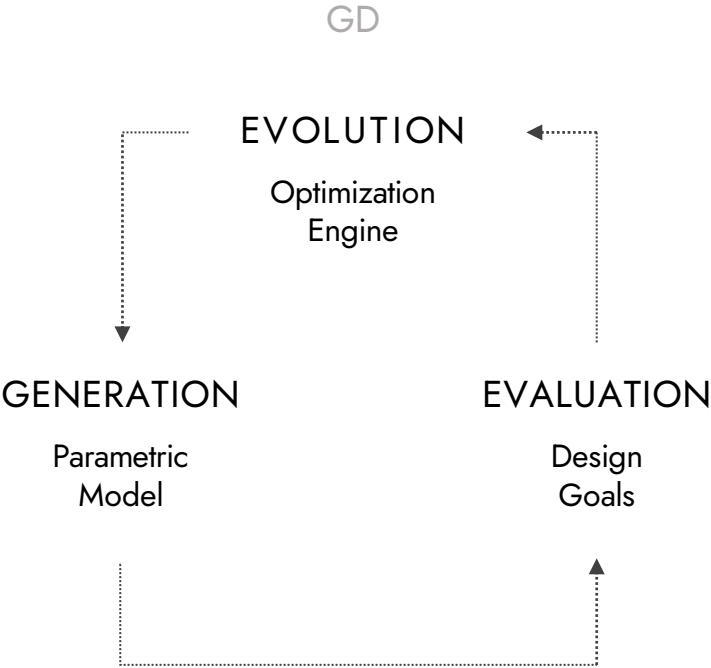
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



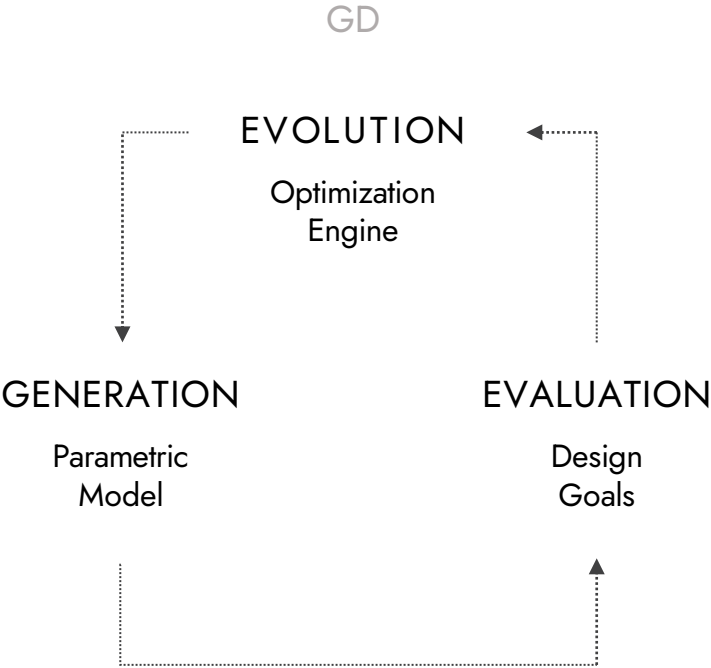
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



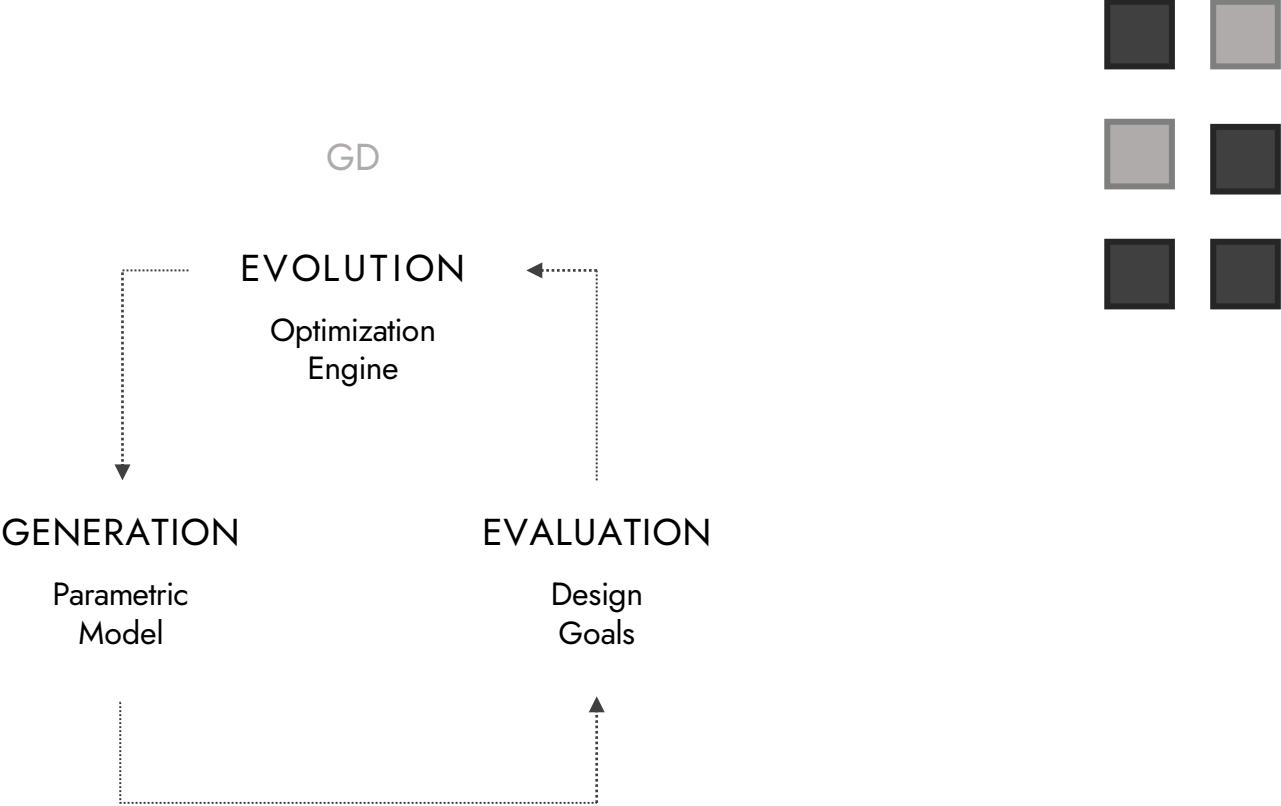
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



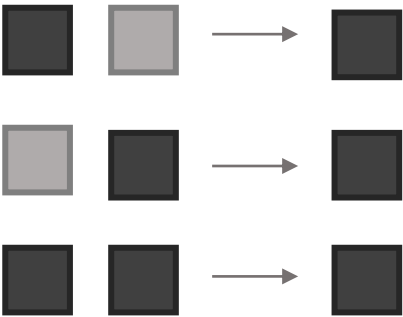
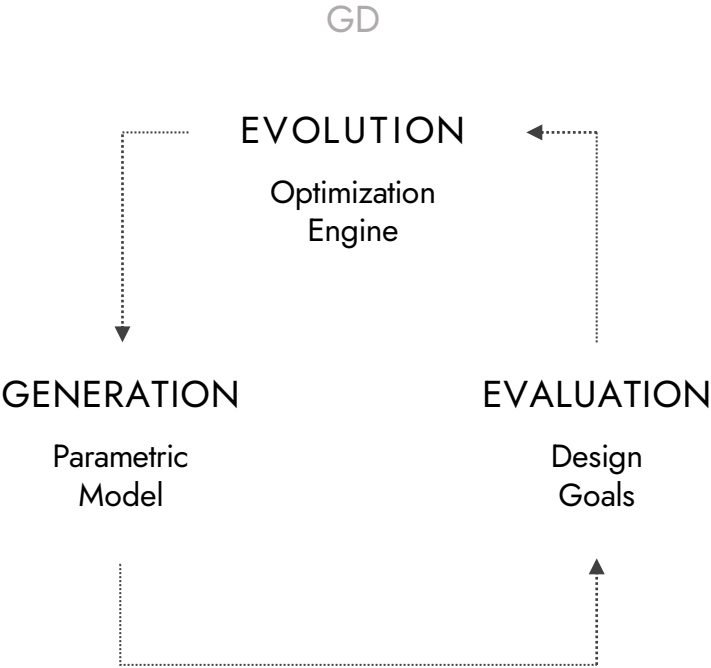
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



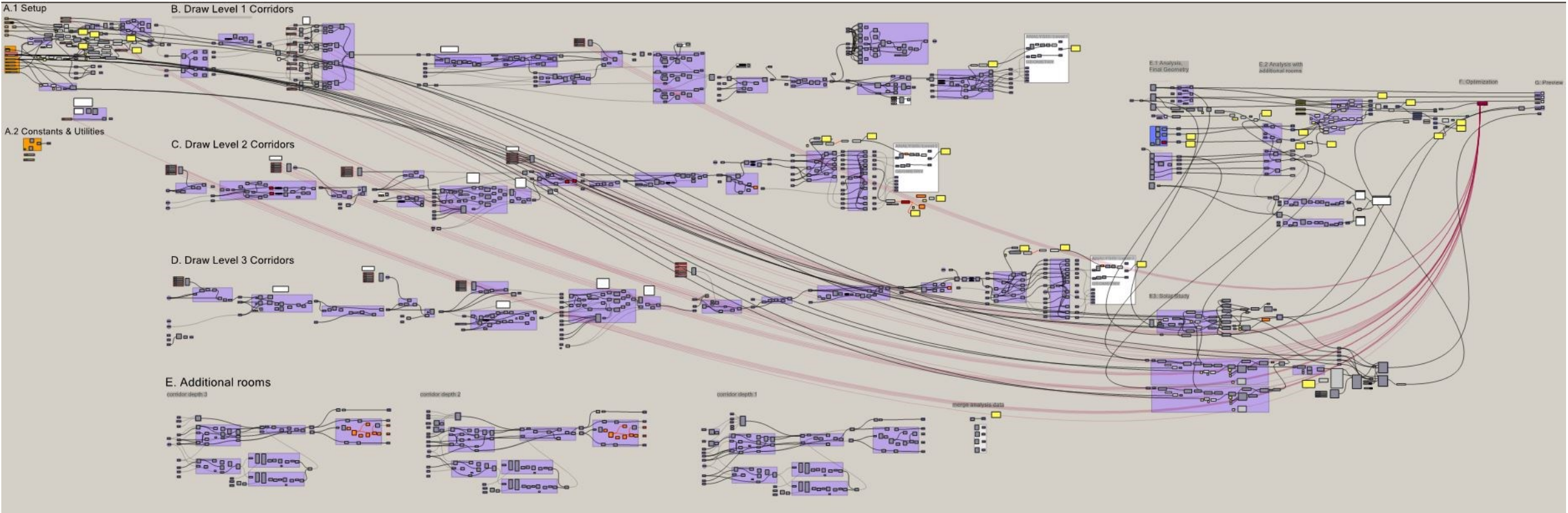
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



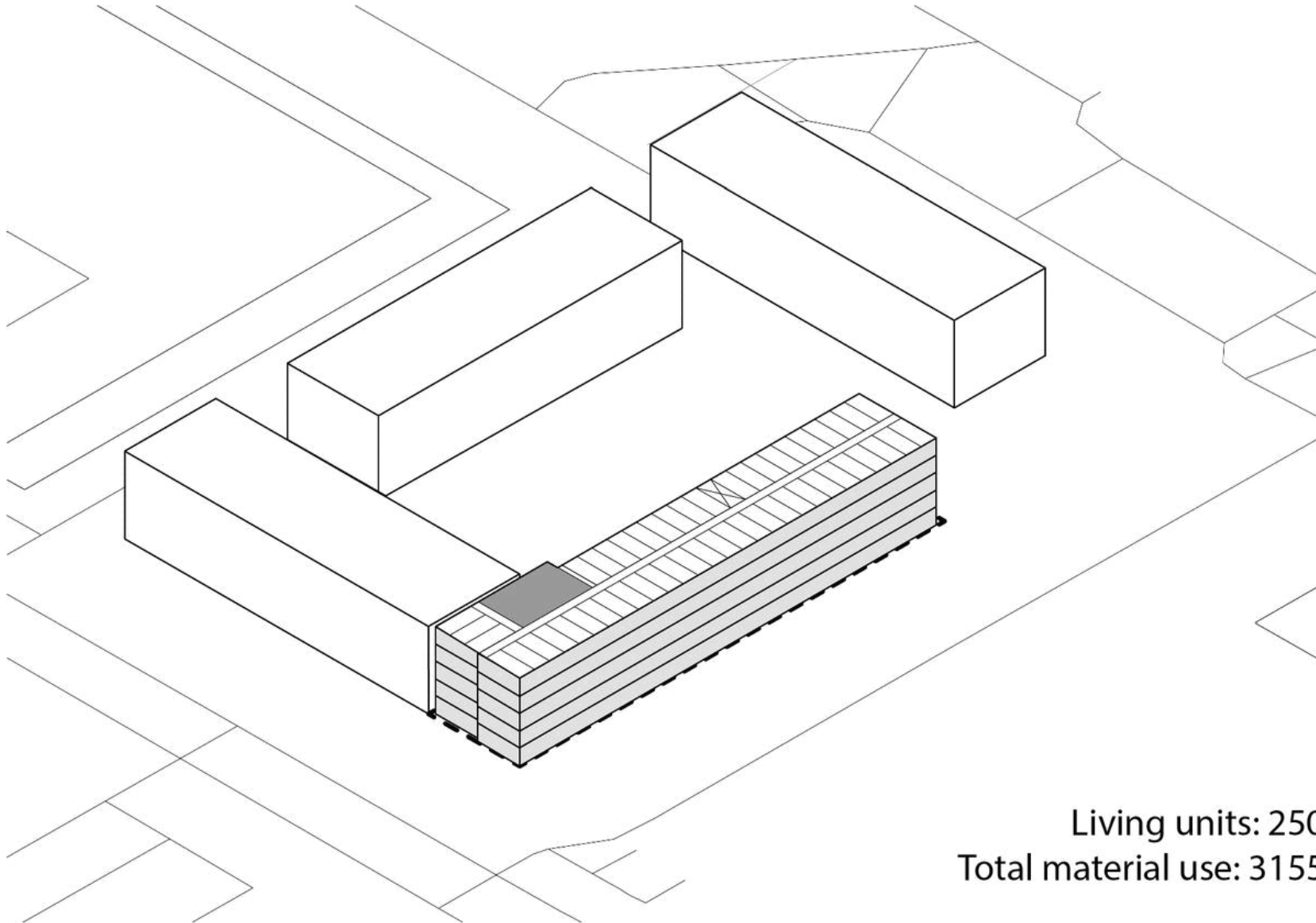
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



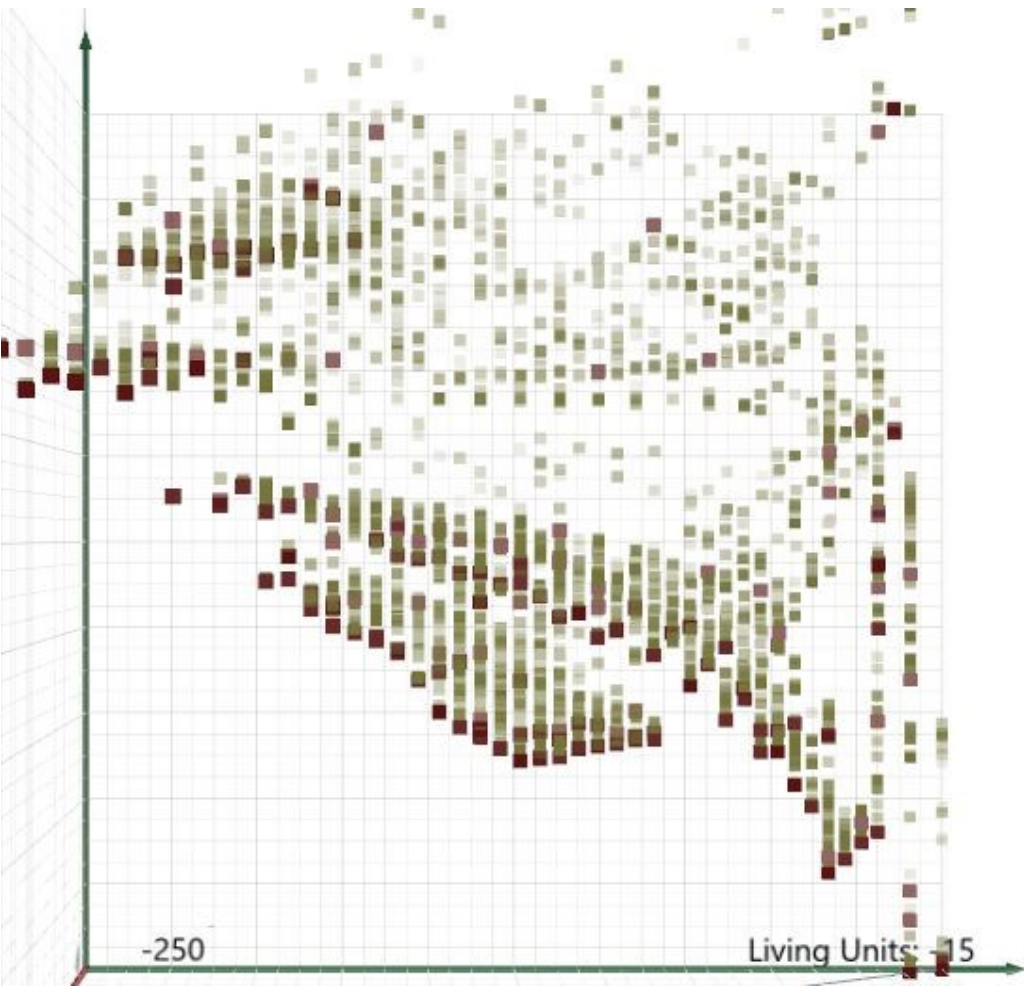
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



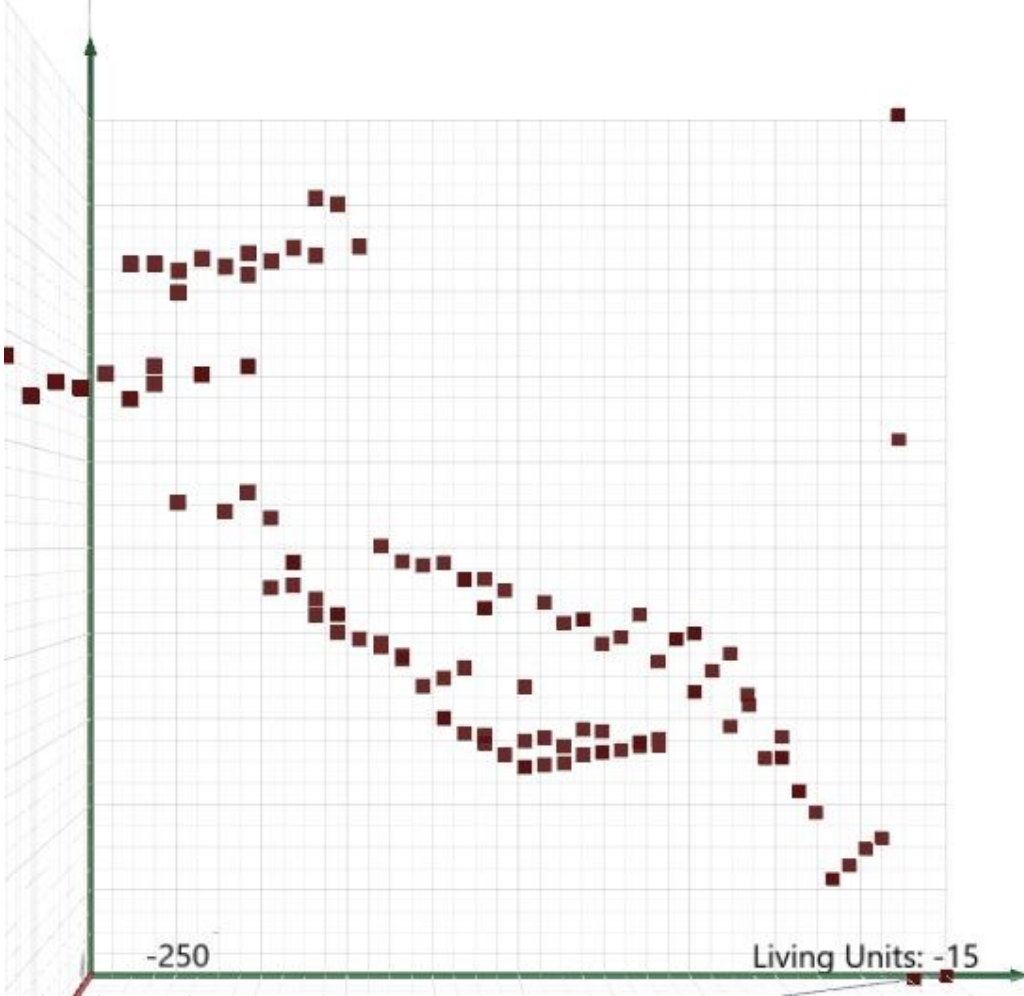
RESEARCH CONCLUSIONS | CREATING THE SYSTEM



RESEARCH CONCLUSIONS | CREATING THE SYSTEM



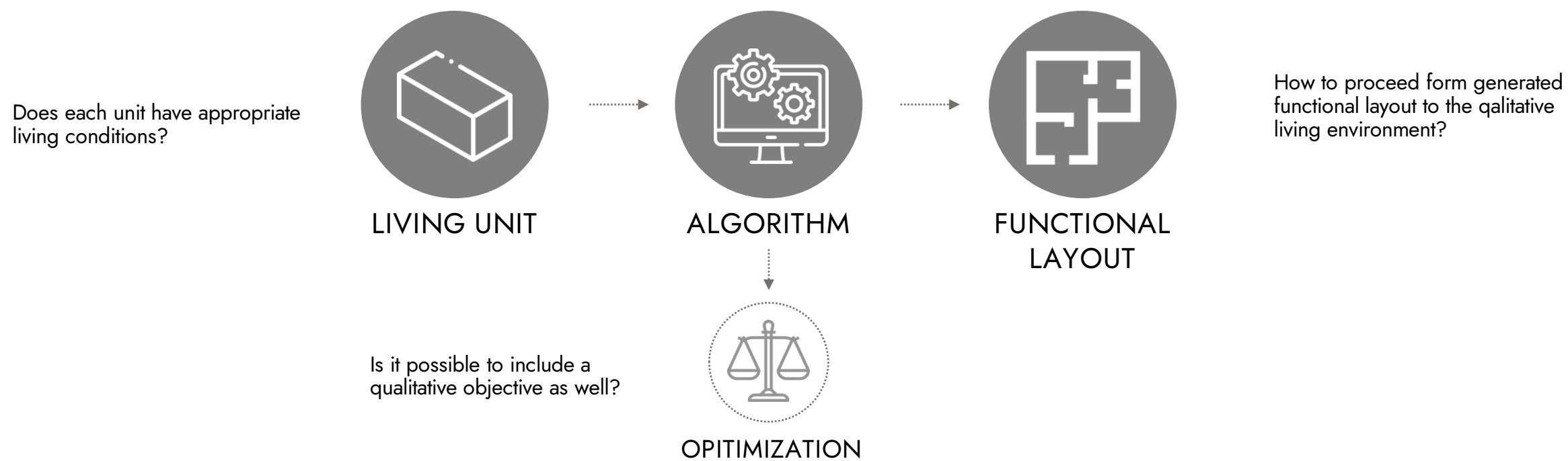
ALGORITHM RESULTS – COORDINATE SYSTEM



PARETO METHOD – SOLUTION SELECTION

RESEARCH/DESIGN

WHAT ABOUT THE QUALITY?



What is the quality of the living environment?

POST-RESEARCH | DEFINING QUALITY

"Everyone has the right to a standard of living adequate for the **health and well-being** of himself and of his family, including food, clothing, **housing** [...]"

United Nations.
(1948). *Universal Declaration of Human Rights*. New York.

"Besides being non-hazardous, the salient features of the healthy building include **thermal comfort, pleasant air quality, illumination and acoustical characteristics, support of social needs and productivity, and distinguished aesthetic qualities**"

Boschi, N., & Pagliughi, L. M.
(2002). *Quality of life: meditations on people and architecture*.

"Home has a dual significance, both **internal** and **external**, what we might call its **psycho-social and socio-spatial relevances**. It has symbolic and latent meanings internal to the occupant and important for satisfying human needs"

Rapoport, A.
(1995). *A critical look at the concept 'home'*.

POST-RESEARCH | DEFINING QUALITY



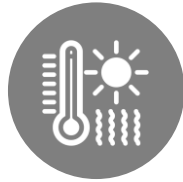
LOCATION

Site conditions, neighbourhood, safety, access to facilities, green spaces



SOCIAL WELL-BEING

Providing places for social interactions, accessibility, notion of community



PHYSICAL COMFORT

Thermal comfort, air quality, insolation, noise protection, proper spatial conditions



ECONOMY

Availability, affordability



MENTAL HEALTH

Providing space for intellectual, spiritual, emotional development, safety, accessibility



VISUAL QUALITY

Visual appearance of a building, well-kept surrounding, view from apartment

Boschi, N., & Pagliughi, L. M.
(2002). *Quality of life: meditations on people and architecture*.

Homes and Communities Agency.
(2011). *Housing quality indicators*.

Tibesigwa, B., Hao, L., & Karumuna, B. L.
(2017). The concept of spatial quality and its challenges on exercised affordable housing design typology in Dar es Salaam – Tanzania. *Habitat International*. <https://doi.org/10.1016/j.habitatint.2016.11.010>

POST-RESEARCH | DEFINING QUALITY

UNIT

- Layout
- Privacy
- Accessibility
- Safety
- Physical comfort
- Psychological comfort
- Sun exposure
- View quality
- Affordability

BUILDING

- Accessibility
- Safety
- Public / Semi-public / Private
- Circulation
- Place of social interactions
- Place to live / study / work
- Qualitative materials
- Sustainability
- Flexibility
- Visual quality
- Diverse program
- Building form

SURROUNDING

- Green areas
- Identity & connection with neighbourhood
- Connections within buildings
- Safety
- Public / Private – clean margin
- Distance to most important and basic amenities
- Visual quality, well-kept surrounding

POST-RESEARCH | DEFINING QUALITY

| UNIT | BUILDING | SURROUNDING |
|--|---|---|
| <ul style="list-style-type: none">• Layout• Privacy• Accessibility• Safety• Physical comfort• Psychological comfort• Sun exposure• View quality• Affordability | <ul style="list-style-type: none">• Accessibility• Safety• Public / Semi-public / Private• Circulation• Place of social interactions• Place to live / study / work• Qualitative materials• Sustainability• Flexibility• Visual quality• Diverse program• Building form | <ul style="list-style-type: none">• Green areas• Identity & connection with neighbourhood• Connections within buildings• Safety• Public / Private – clean margin• Distance to most important and basic amenities• Visual quality, well-kept surrounding |

Included as an input for the system

POST-RESEARCH | DEFINING QUALITY

| UNIT | BUILDING | SURROUNDING |
|--|---|---|
| <ul style="list-style-type: none">• Layout• Privacy• Accessibility• Safety• Physical comfort• Psychological comfort• Sun exposure• View quality• Affordability | <ul style="list-style-type: none">• Accessibility• Safety• Public / Semi-public / Private• Circulation• Place of social interactions• Place to live / study / work• Qualitative materials• Sustainability (CO2)• Flexibility• Visual quality• Diverse program• Building form | <ul style="list-style-type: none">• Green areas• Identity & connection with neighbourhood• Connections within buildings• Safety• Public / Private – clean margin• Distance to most important and basic amenities• Visual quality, well-kept surrounding |

Included in the algorithm

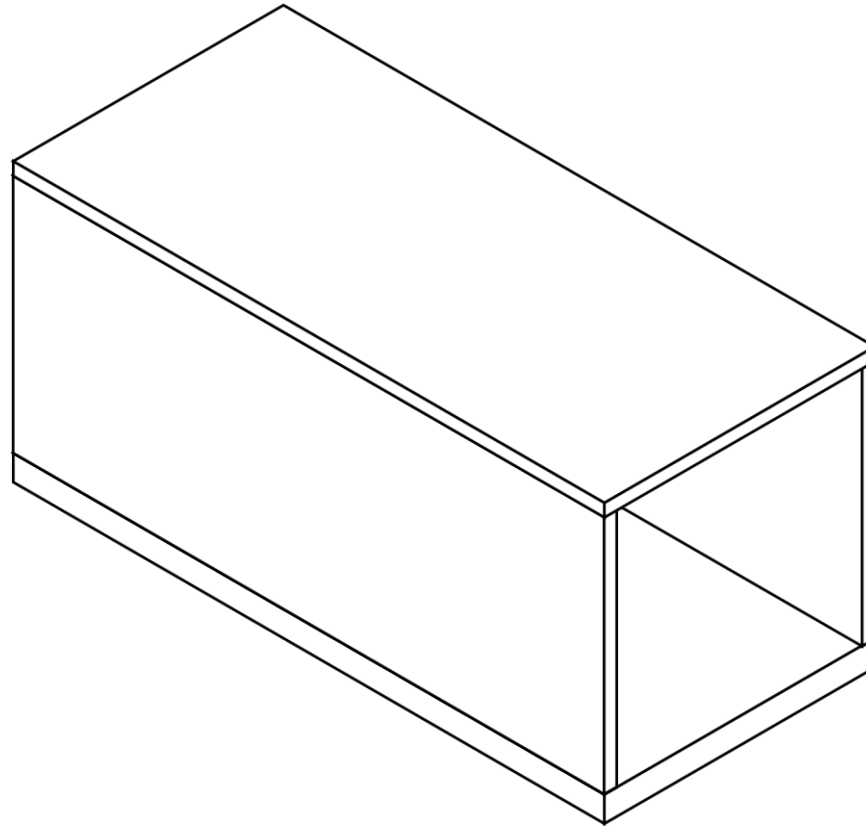
POST-RESEARCH | DEFINING QUALITY

| UNIT | BUILDING | SURROUNDING |
|--|---|---|
| <ul style="list-style-type: none">• Layout• Privacy• Accessibility• Safety• Physical comfort• Psychological comfort• Sun exposure• View quality• Affordability | <ul style="list-style-type: none">• Accessibility• Safety• Public / Semi-public / Private• Circulation• Place of social interactions• Place to live / study / work• Qualitative materials• Sustainability• Flexibility• Visual quality• Diverse program• Building form | <ul style="list-style-type: none">• Green areas• Identity & connection with neighbourhood• Connections within buildings• Safety• Public / Private – clean margin• Distance to most important and basic amenities• Visual quality, well-kept surrounding |

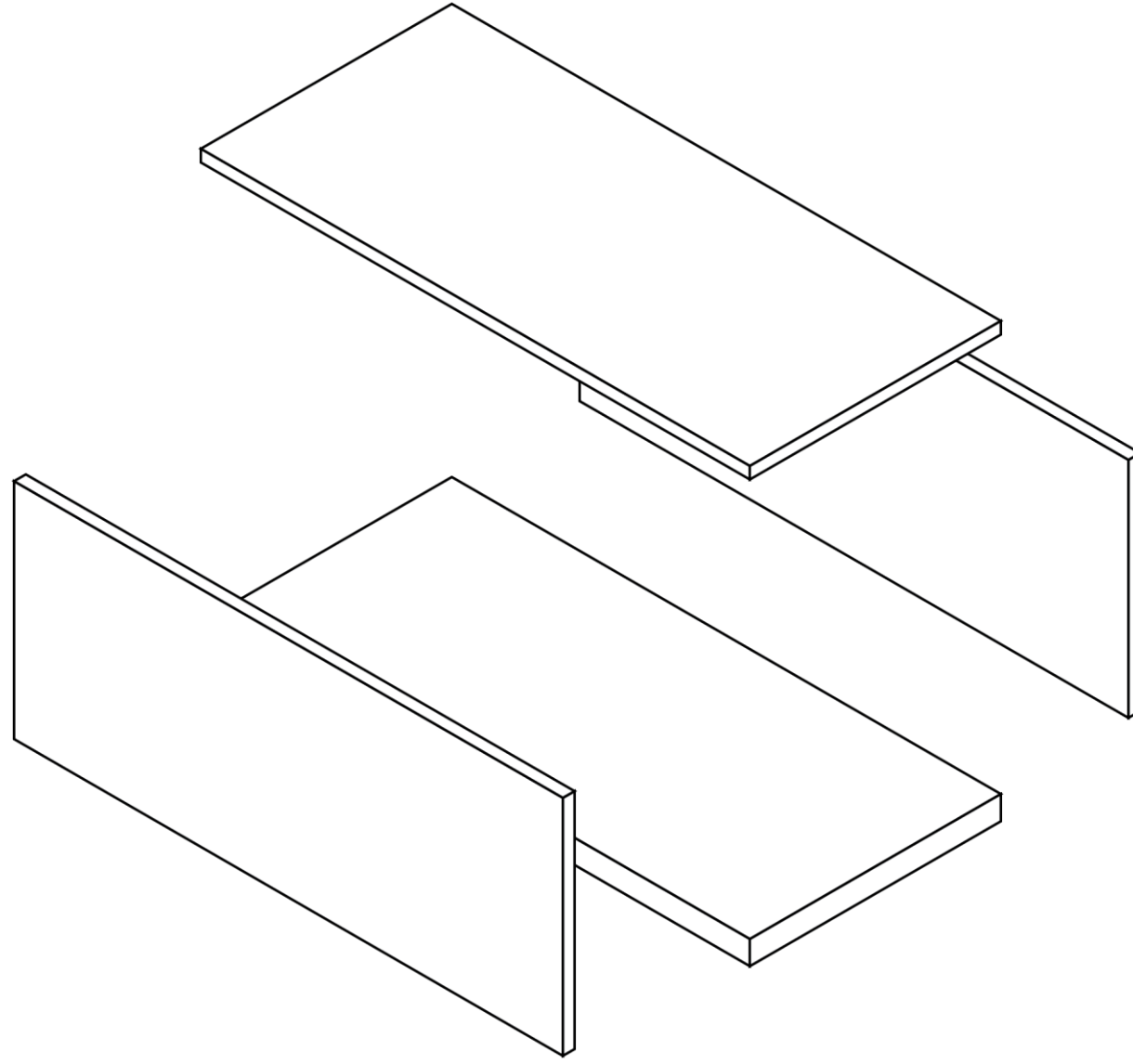
Included in the post-generation phase

MODULE

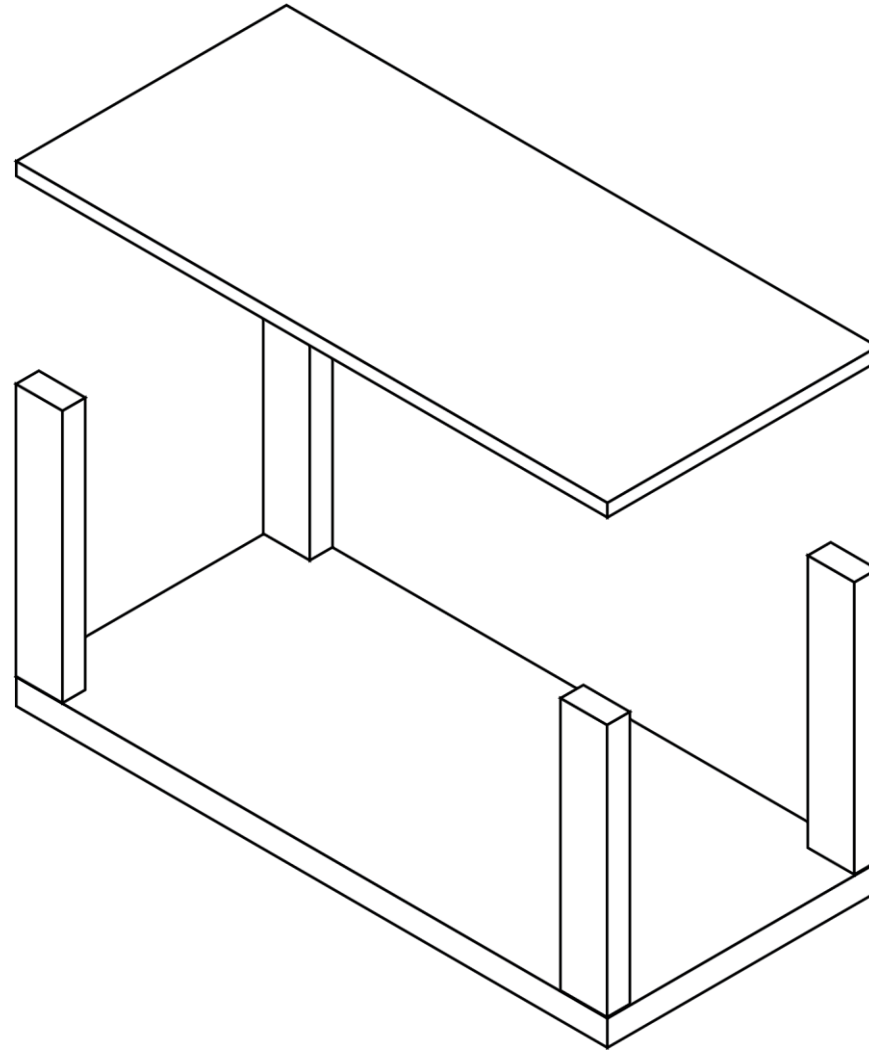
LIVING UNIT | FROM CLOSED TO OPEN



LIVING UNIT | FROM CLOSED TO OPEN



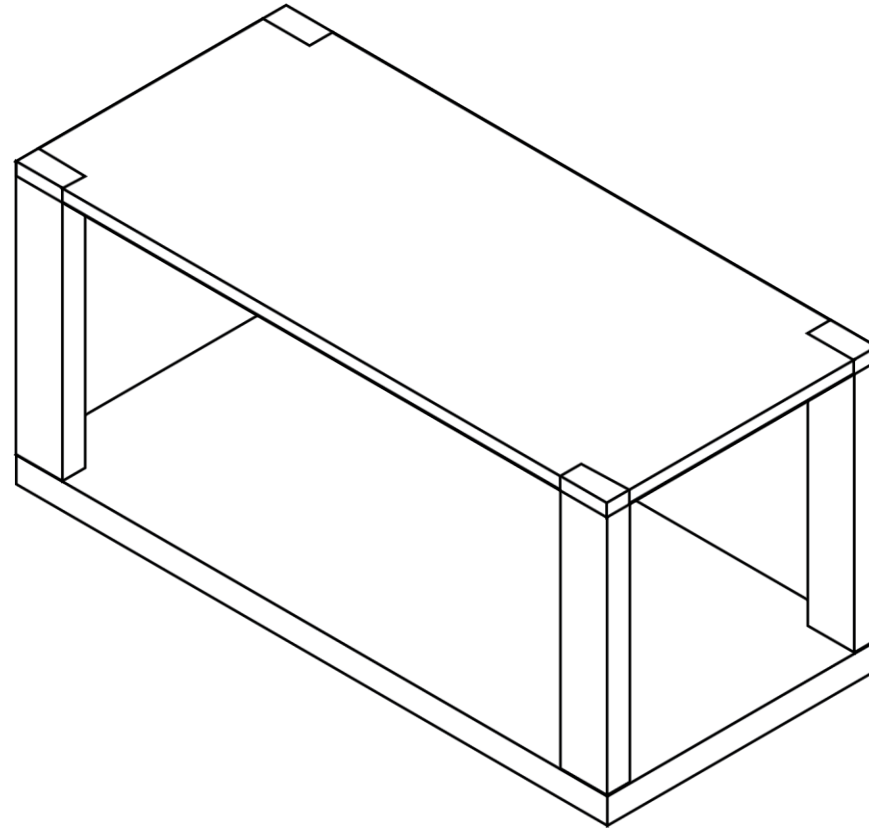
LIVING UNIT | FROM CLOSED TO OPEN



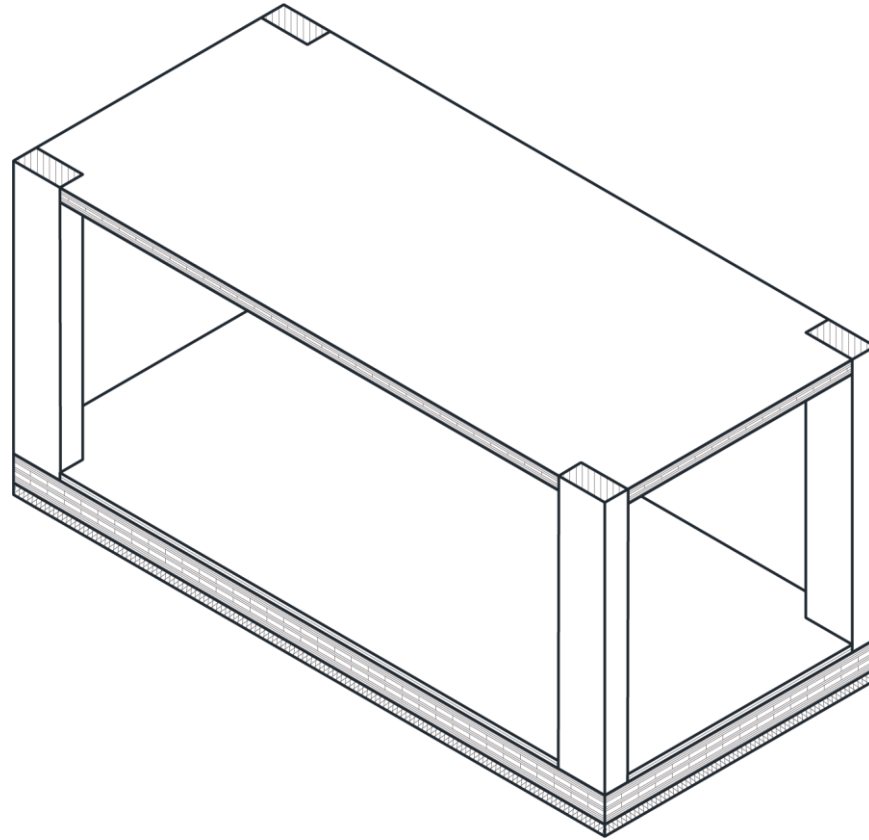
LIVING UNIT | FROM CLOSED TO OPEN



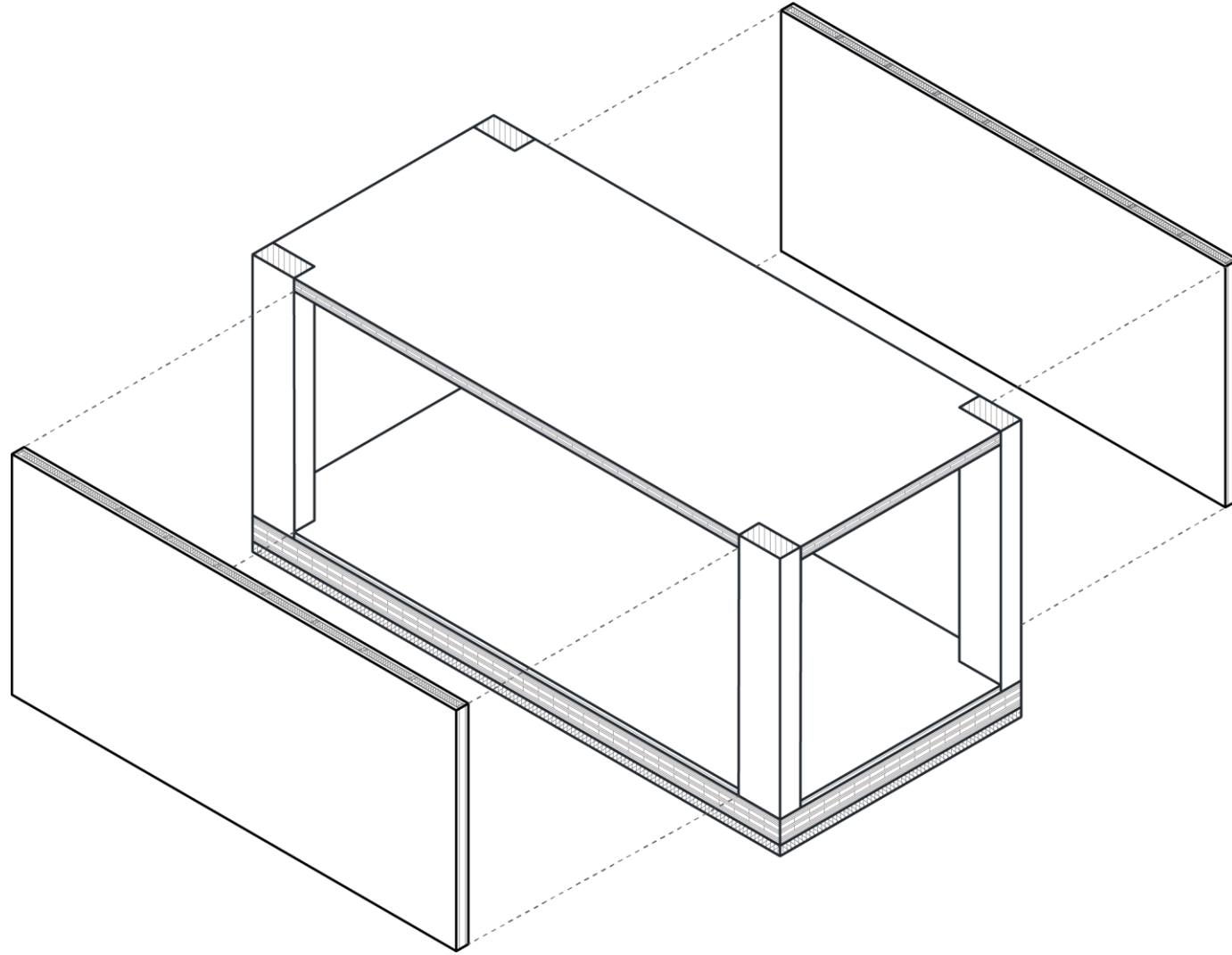
CIRCLEWOOD



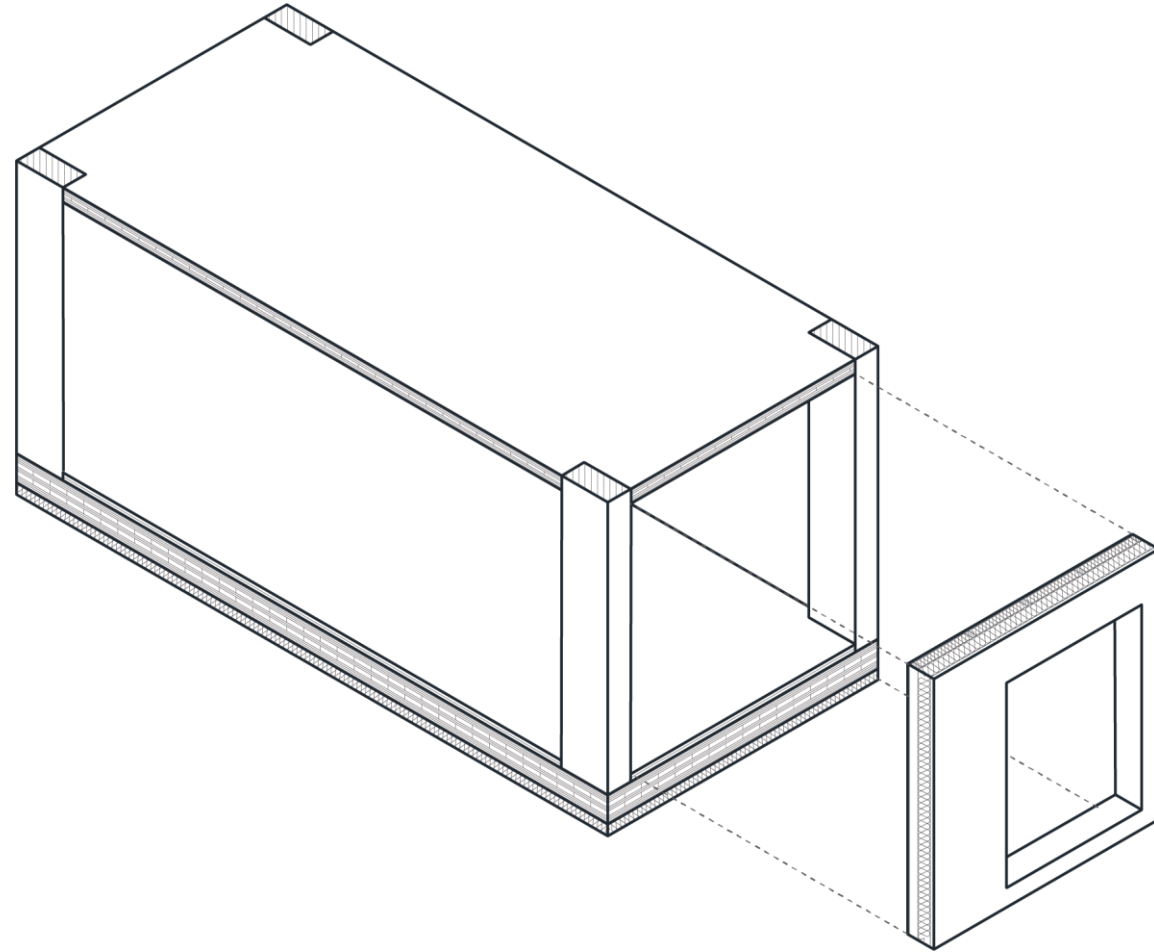
LIVING UNIT | FROM CLOSED TO OPEN



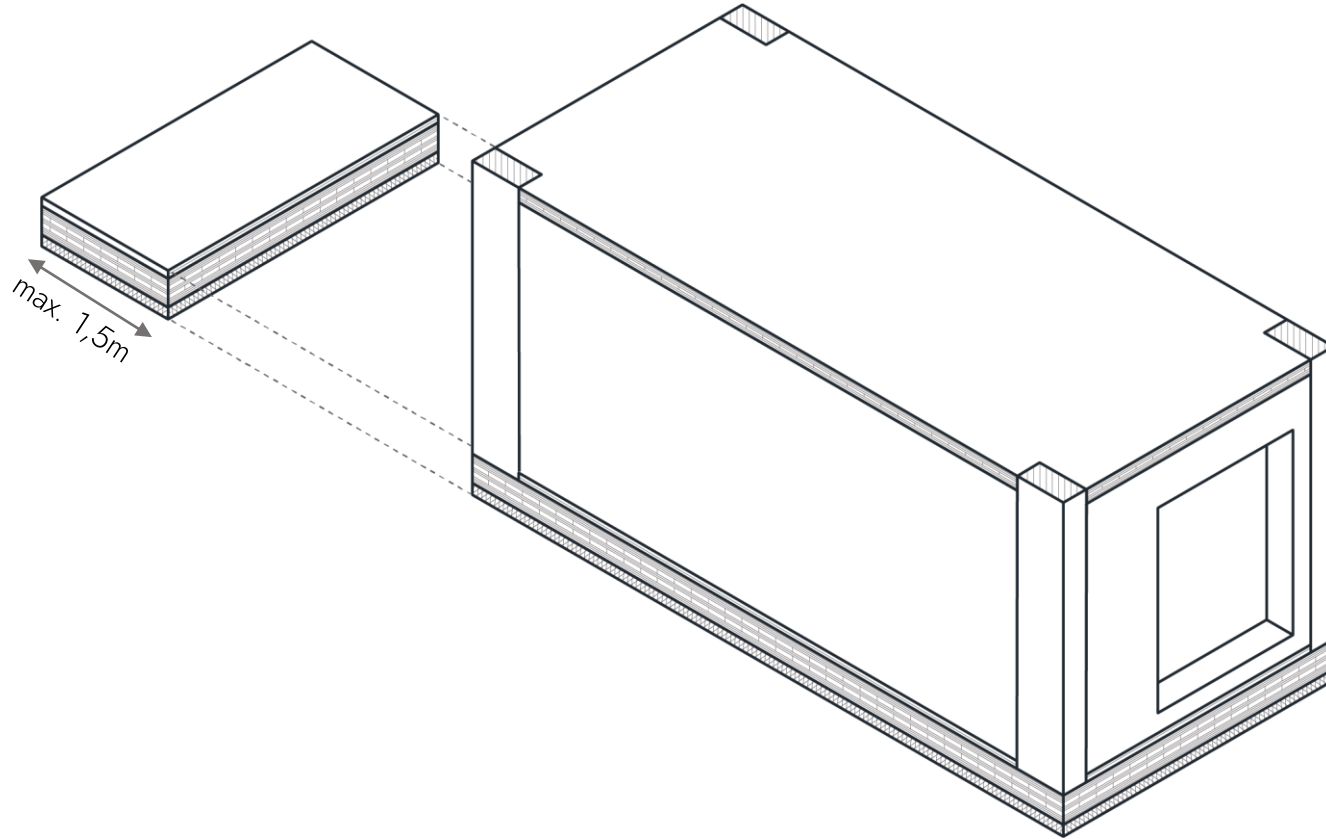
LIVING UNIT | FROM CLOSED TO OPEN



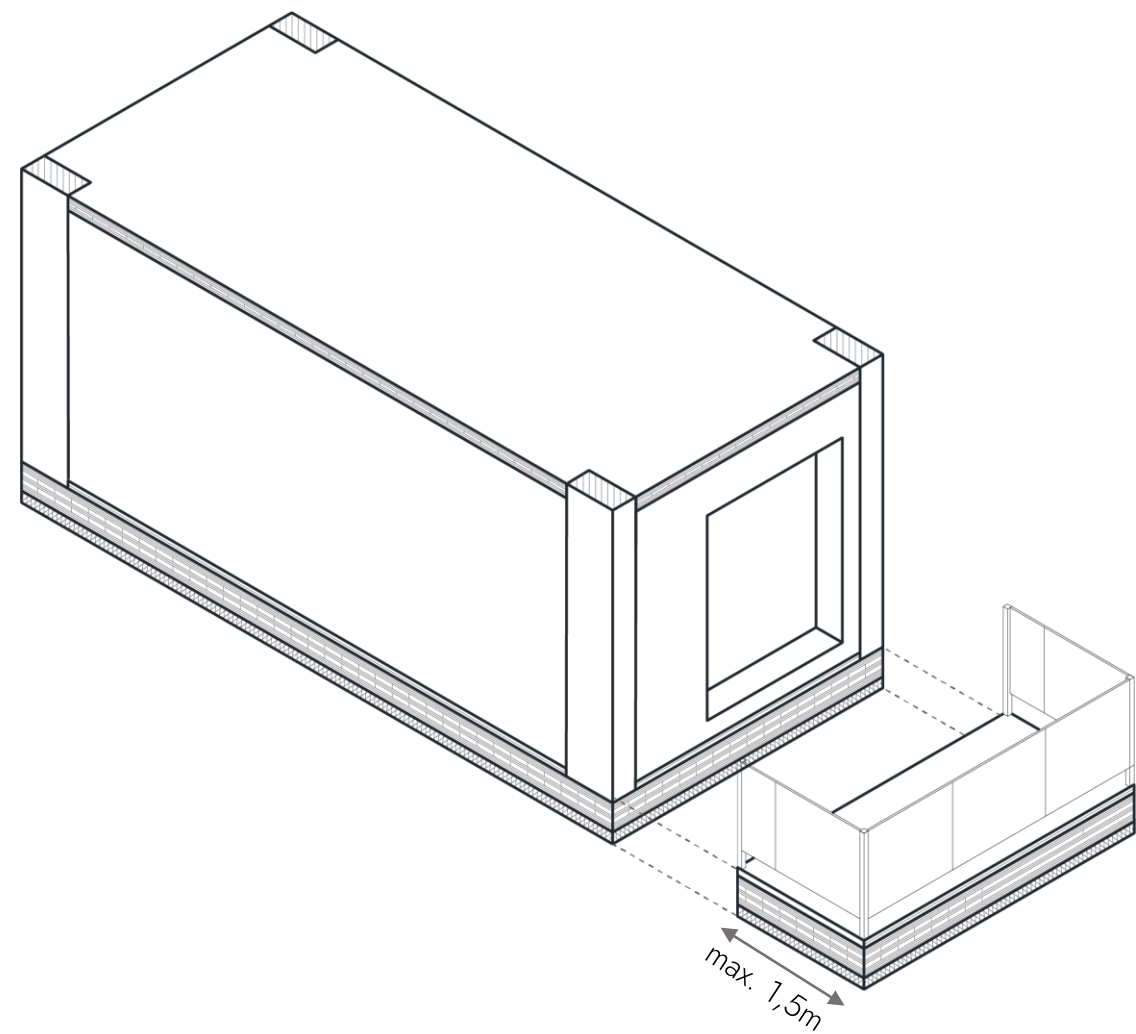
LIVING UNIT | FROM CLOSED TO OPEN



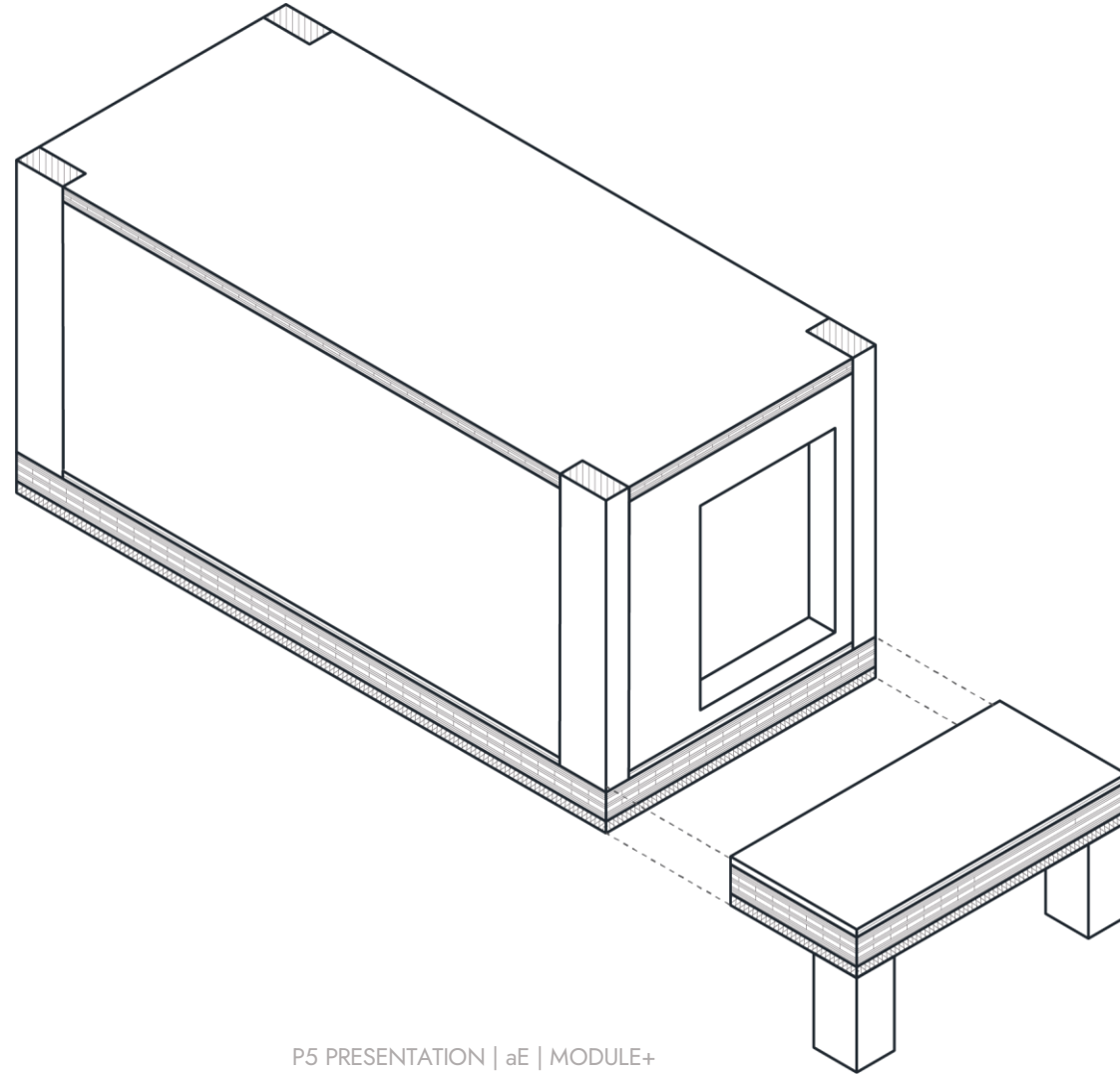
LIVING UNIT | FROM CLOSED TO OPEN



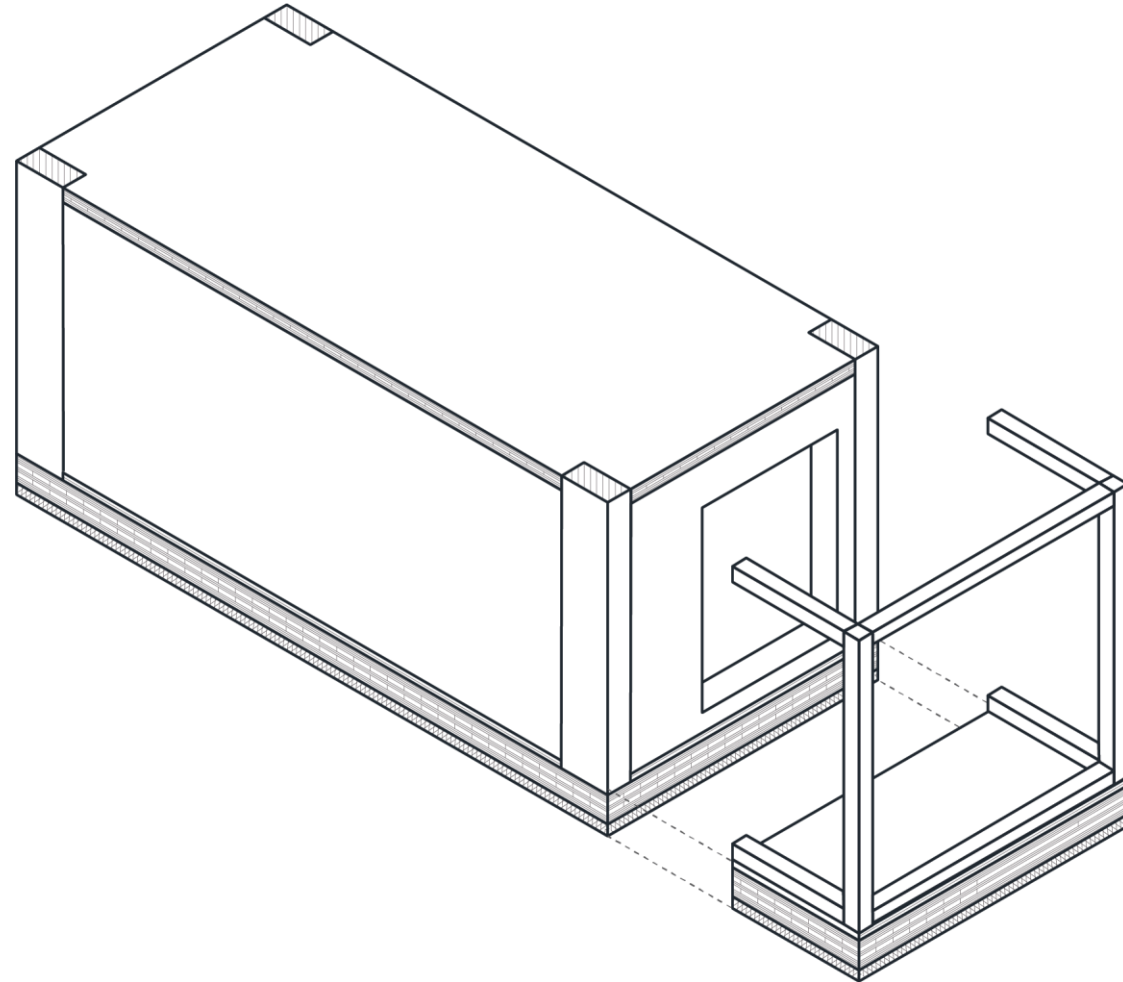
LIVING UNIT | FROM CLOSED TO OPEN



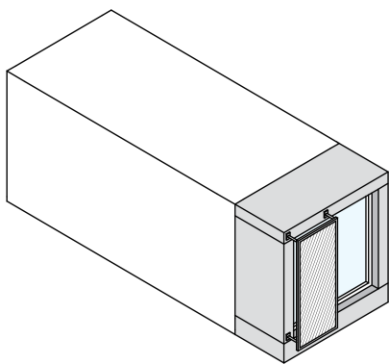
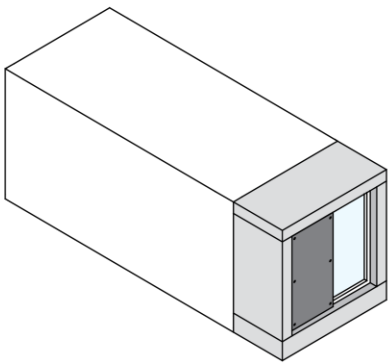
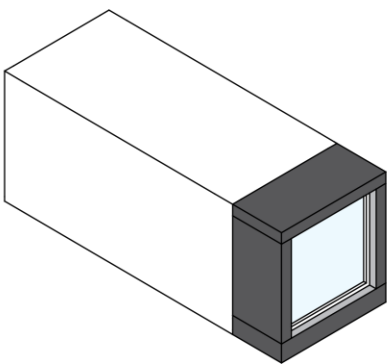
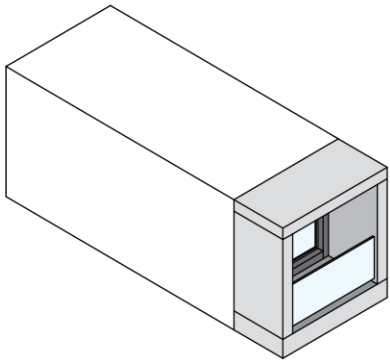
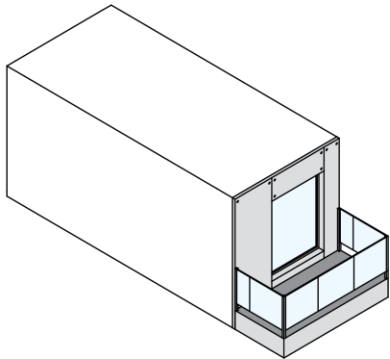
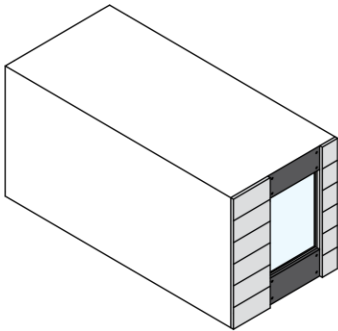
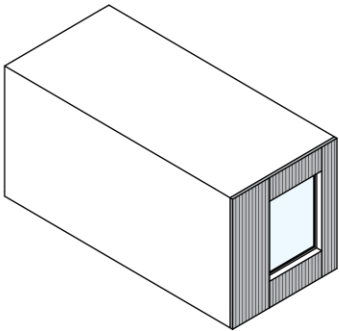
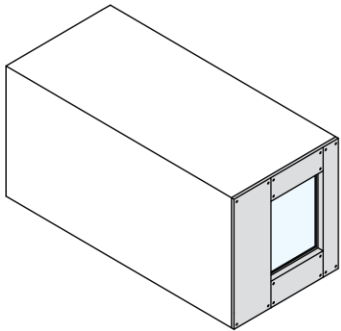
LIVING UNIT | FROM CLOSED TO OPEN



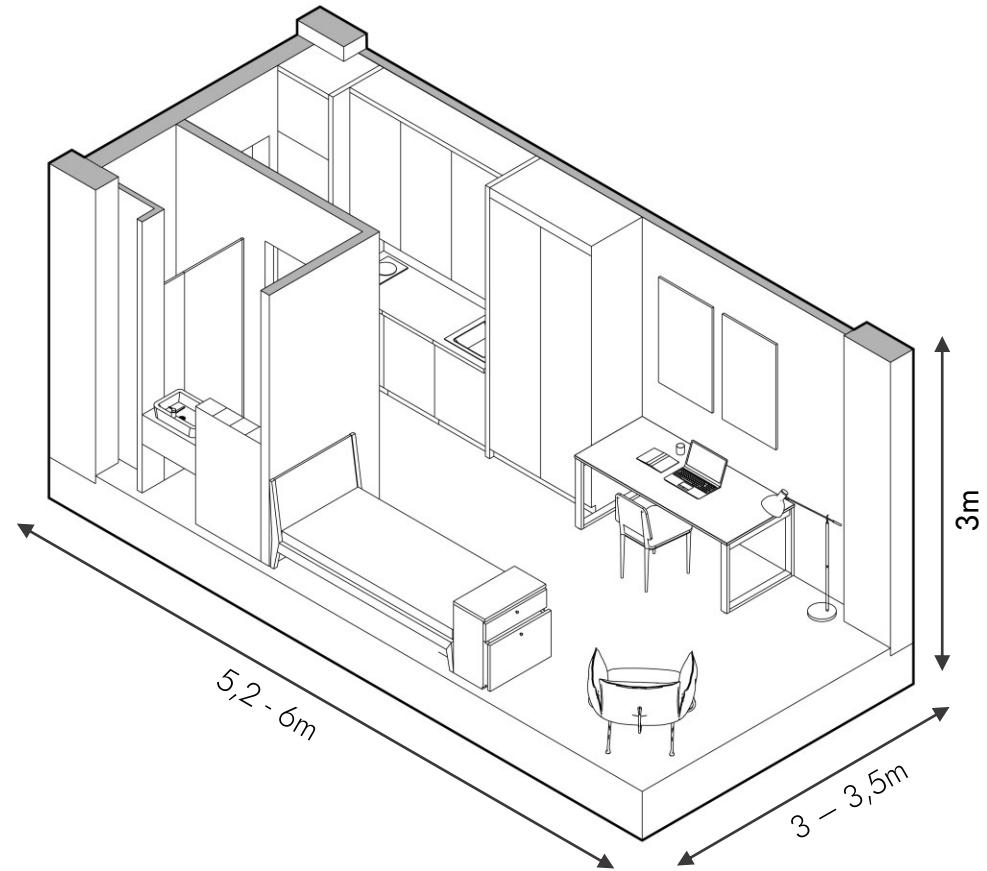
LIVING UNIT | FROM CLOSED TO OPEN



LIVING UNIT | ELEVATION

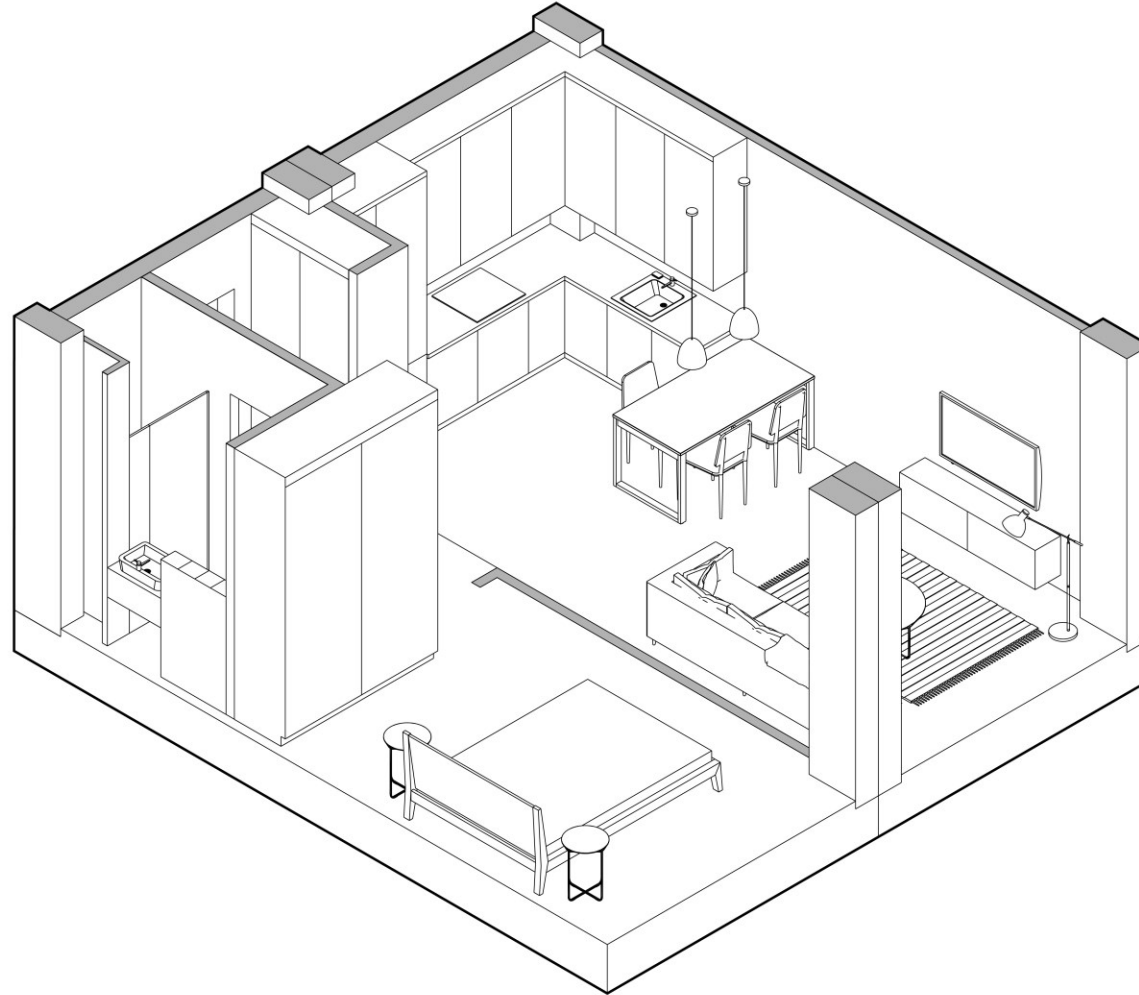


LIVING UNIT | SINGLE STUDIO

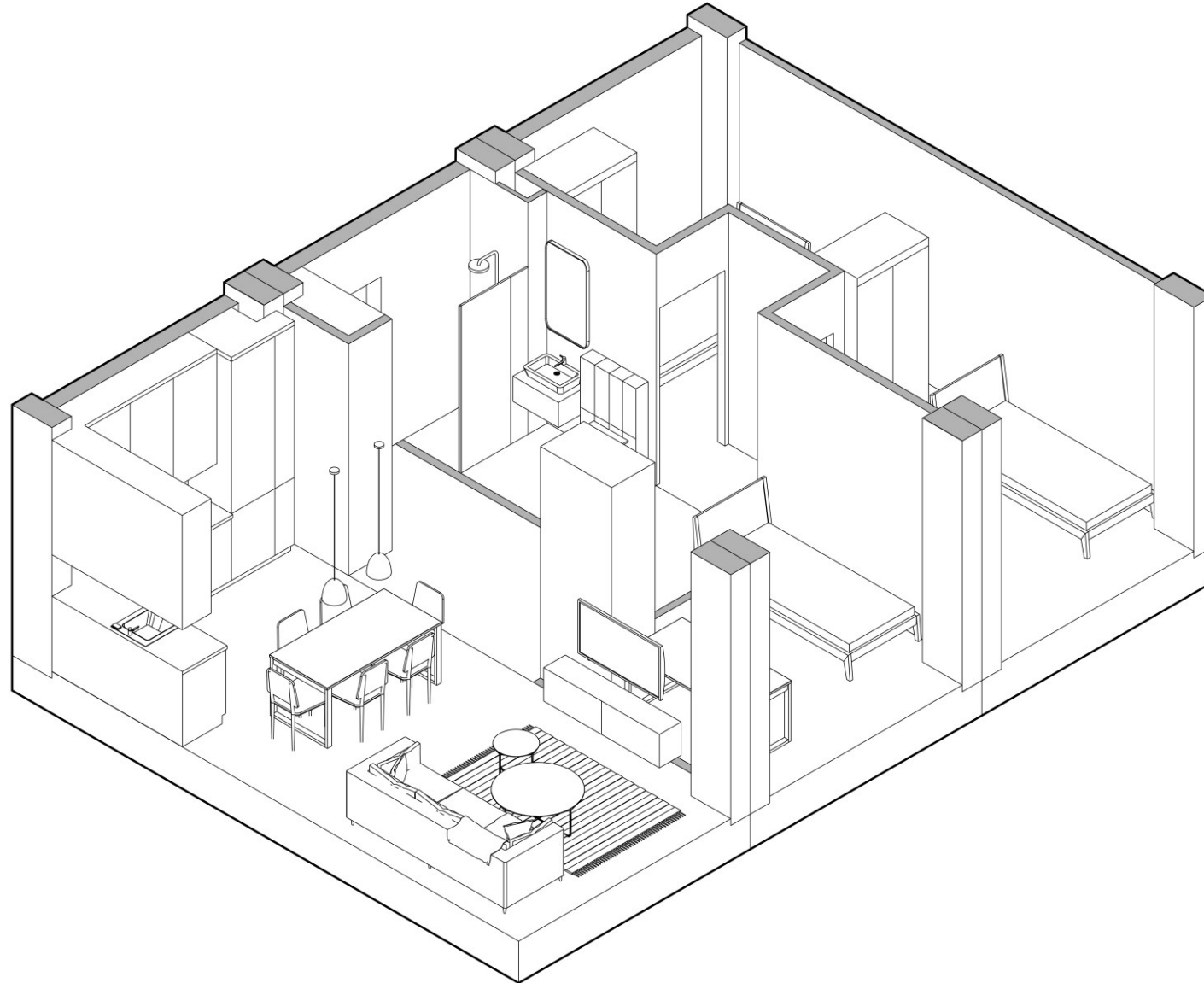


Area: 18m²

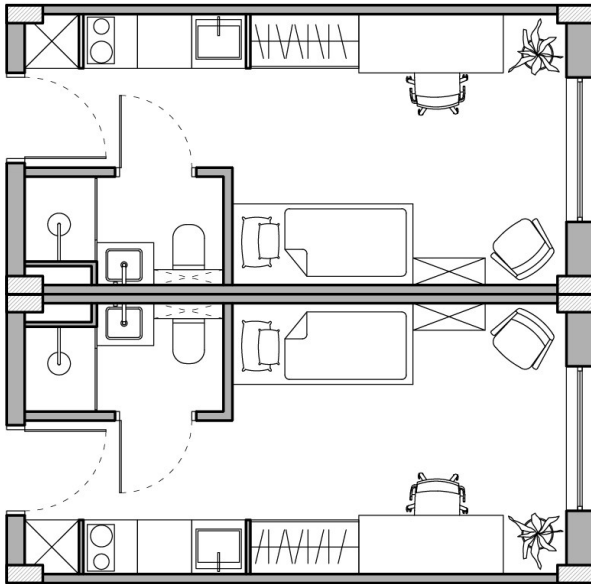
LIVING UNIT | DOUBLE APARTMENT



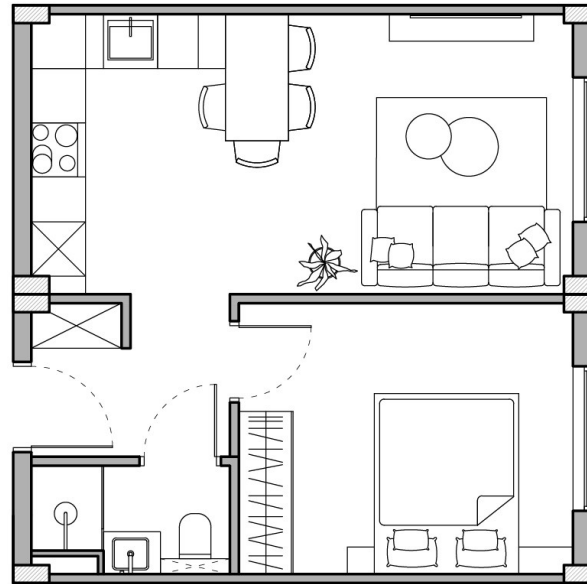
LIVING UNIT | CO-HOUSING APARTMENT



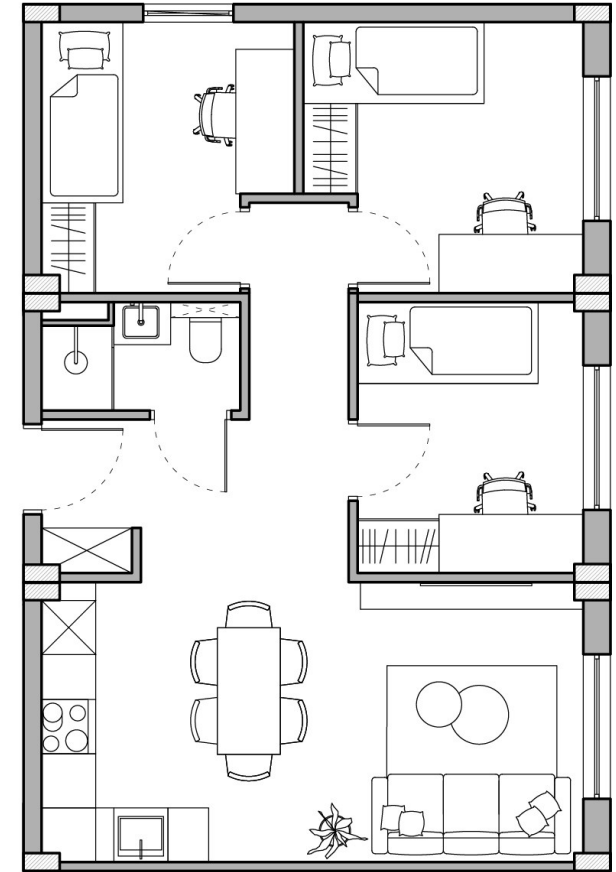
LIVING UNIT | DIFFERENT TYPOLOGIES



SINGLE STUDIO

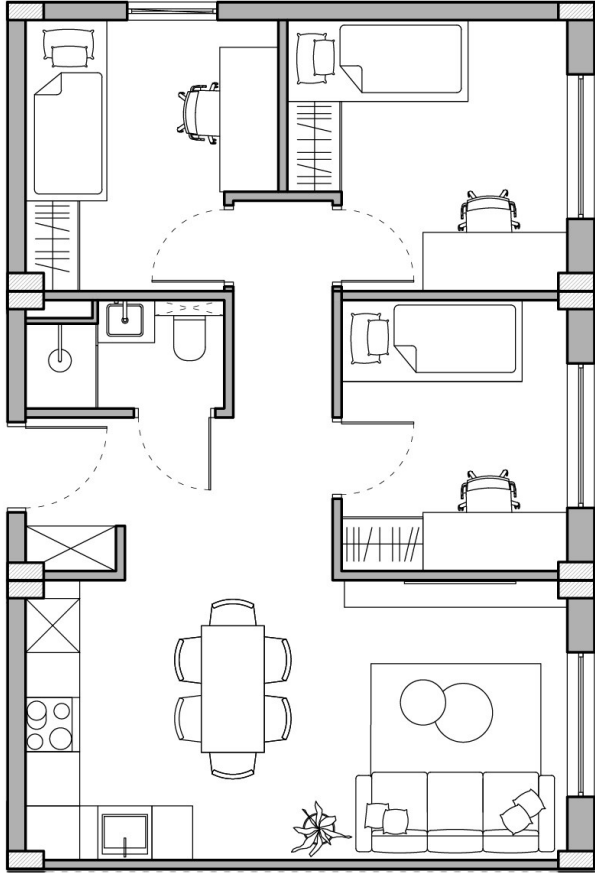
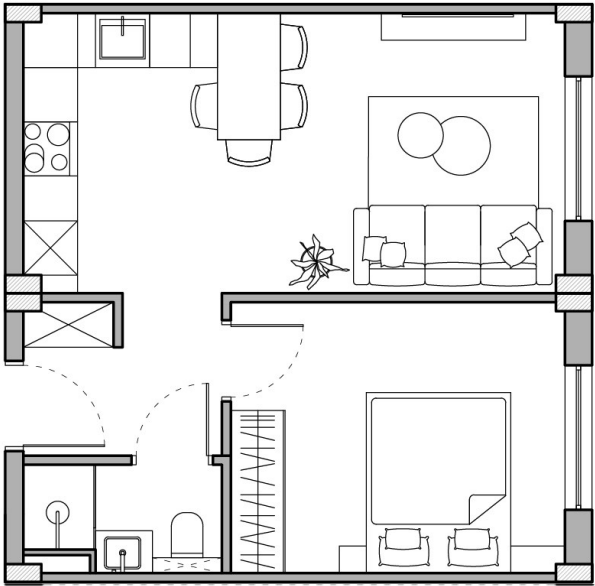
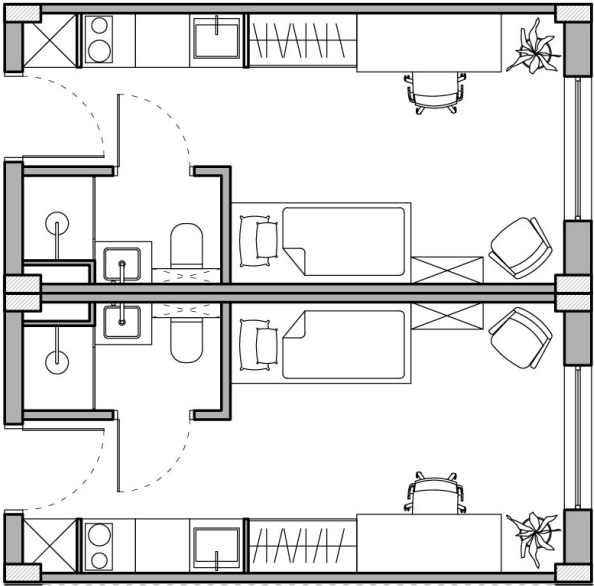


DOUBLE APARTMENT



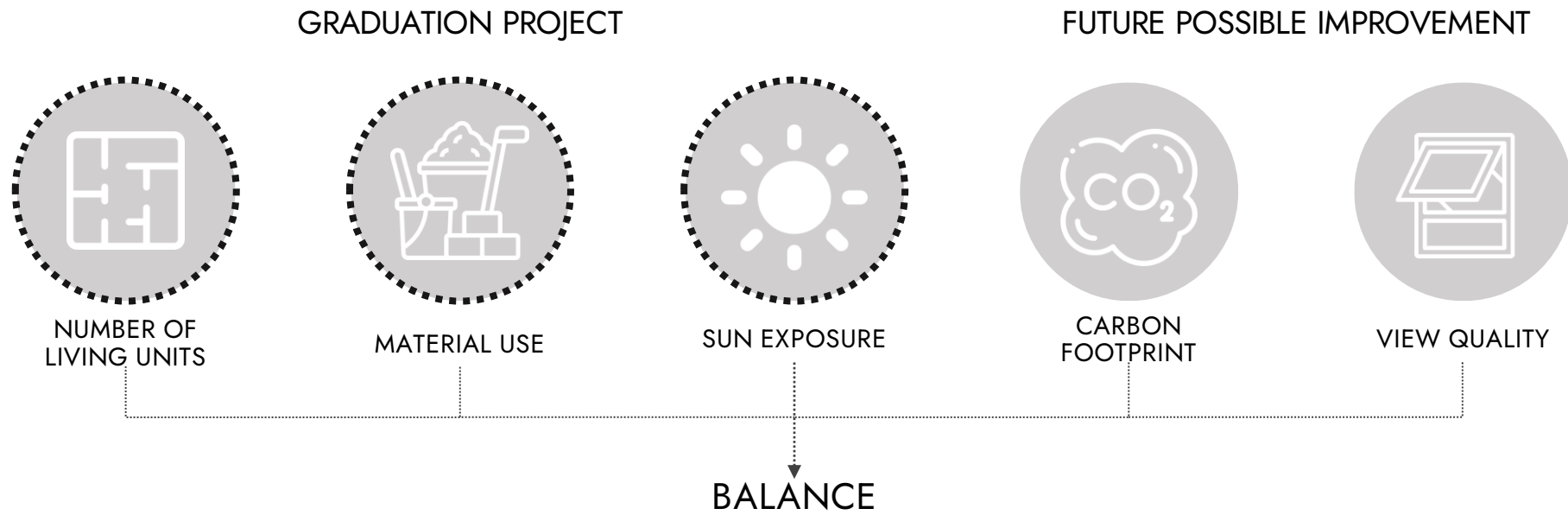
CO-HOUSING APARTMENT

LIVING UNIT | COMPLEMENTARY FACILITIES

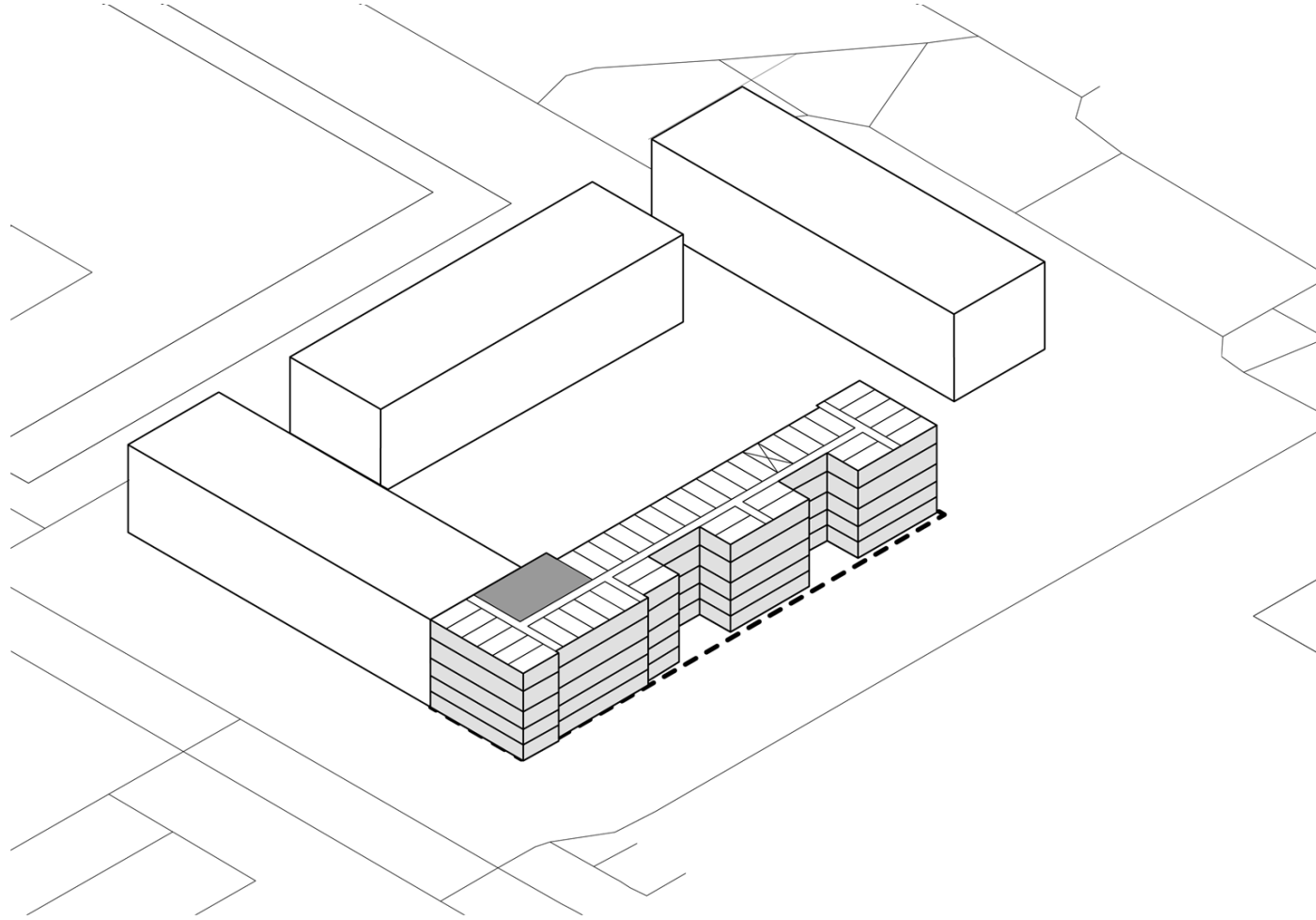


ALGORITHM

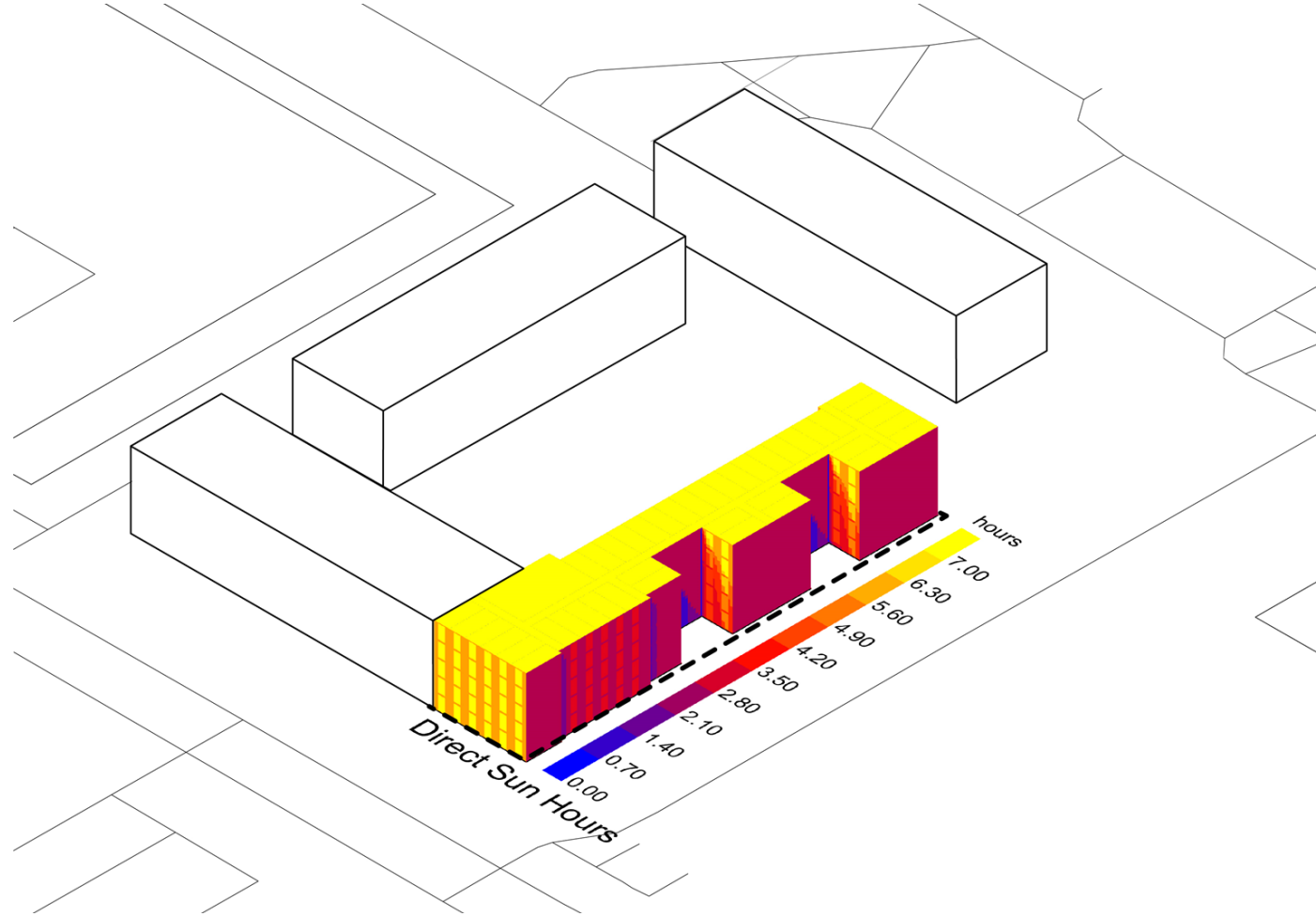
ALGORITHM | QUALITATIVE OBJECTIVES



ALGORITHM | SOLAR STUDY – SUN HOURS



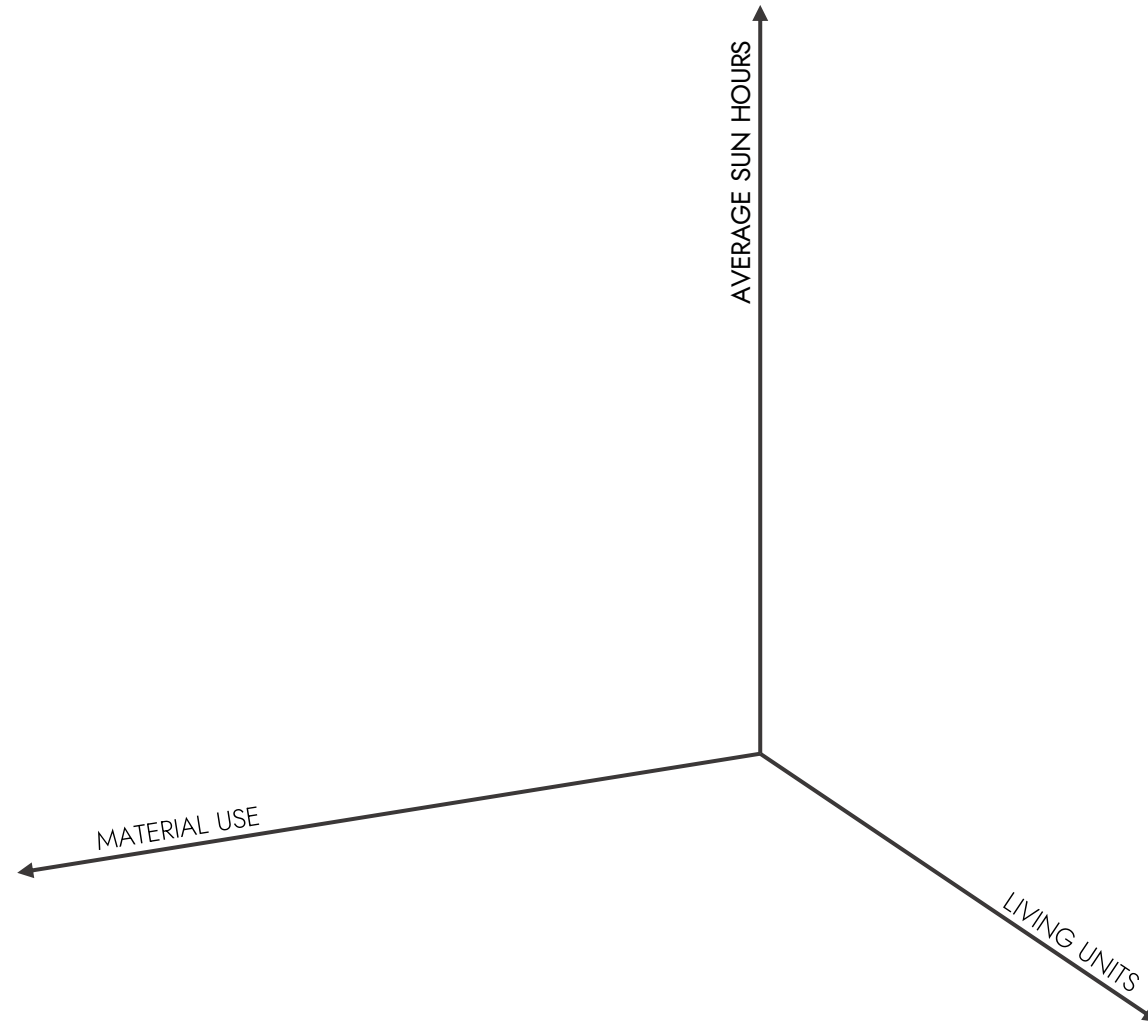
ALGORITHM | SOLAR STUDY – SUN HOURS



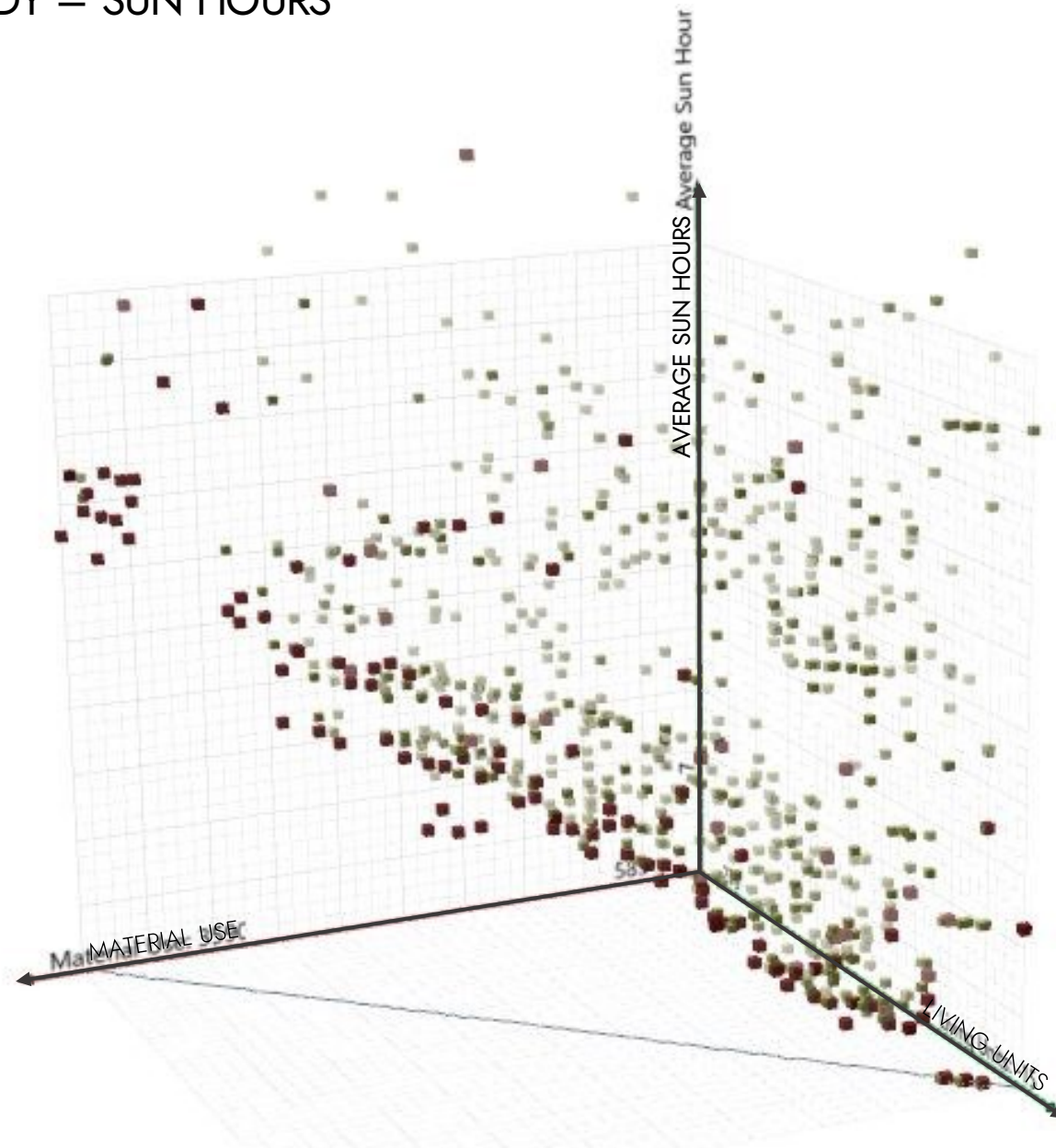
ALGORITHM | SOLAR STUDY – SUN HOURS



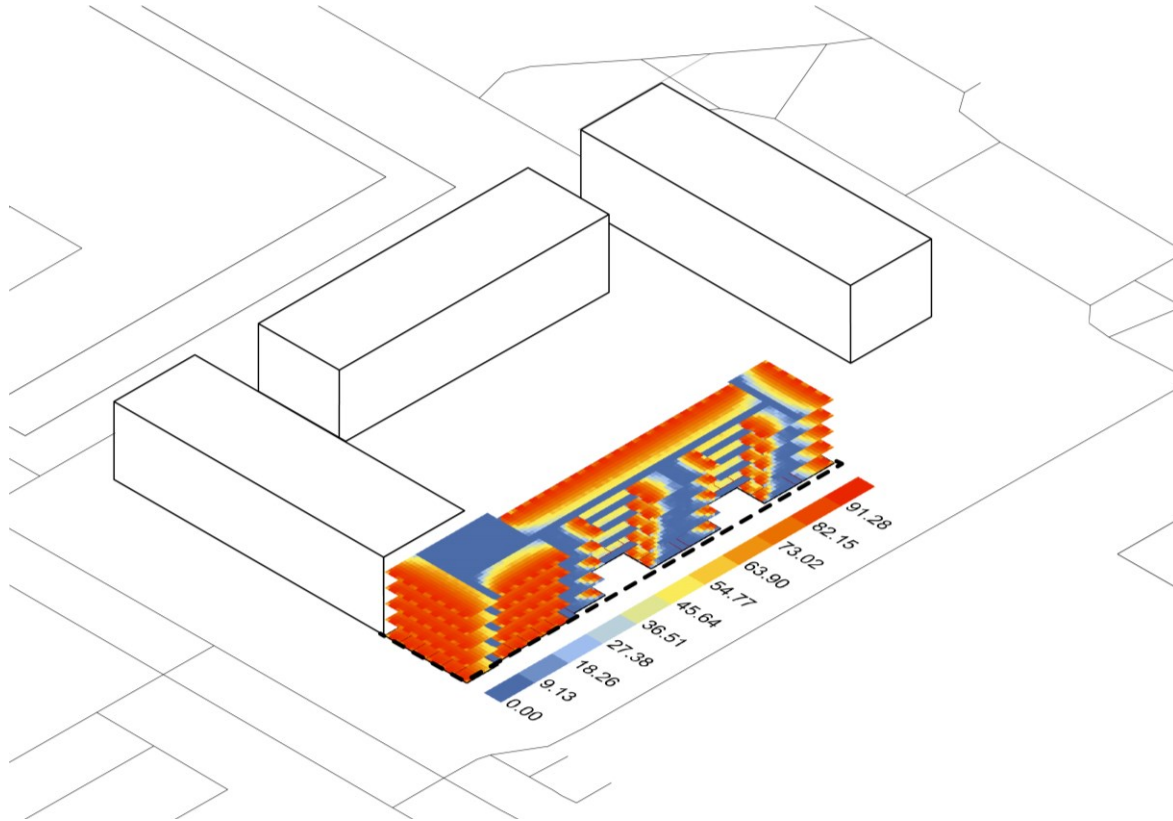
ALGORITHM | SOLAR STUDY – SUN HOURS



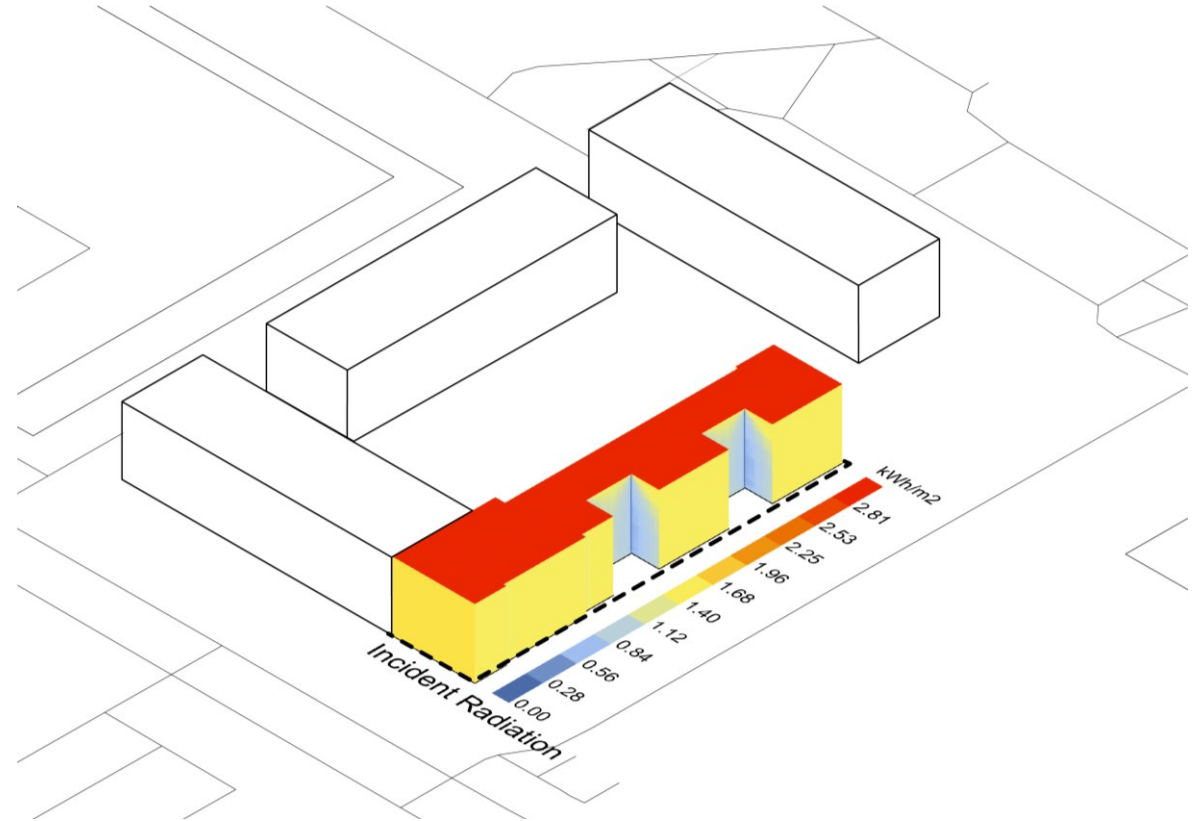
ALGORITHM | SOLAR STUDY – SUN HOURS



ALGORITHM | SOLAR STUDY



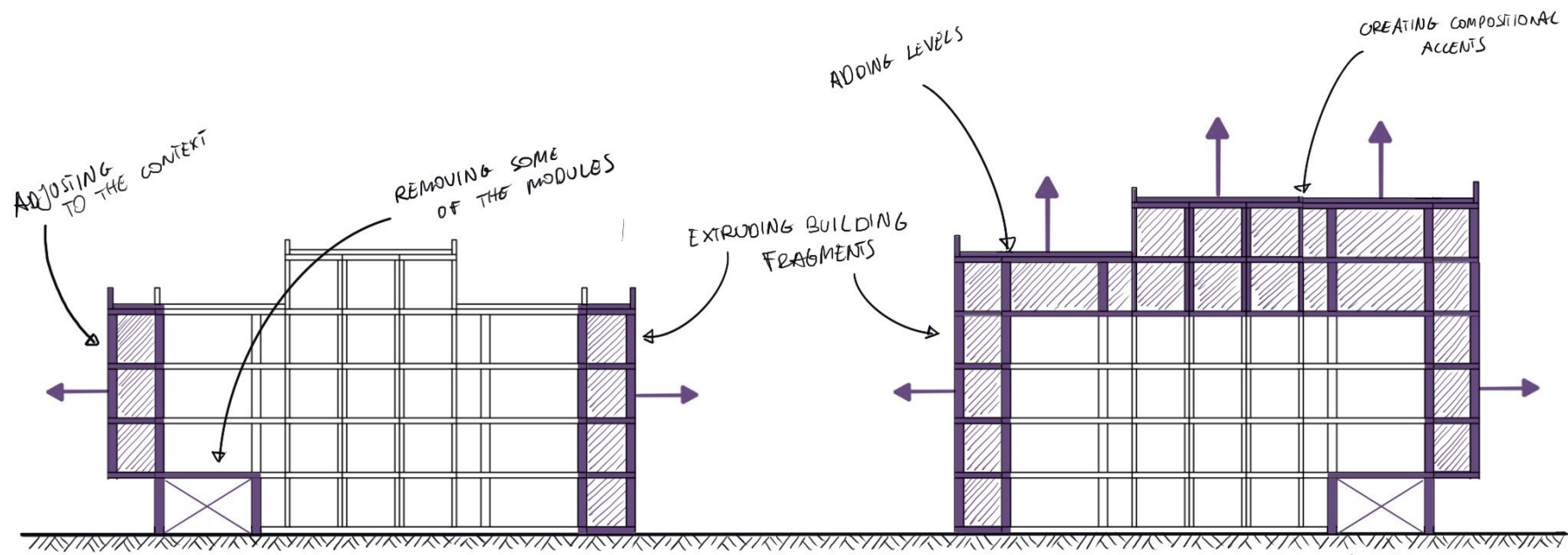
sDA(300/50%)
- Pass / Fail



SOLAR RADIATION
- Facade solution
- PV placement
- Heating and Cooling efficiency

FURTHER DESIGN DIRECTIONS

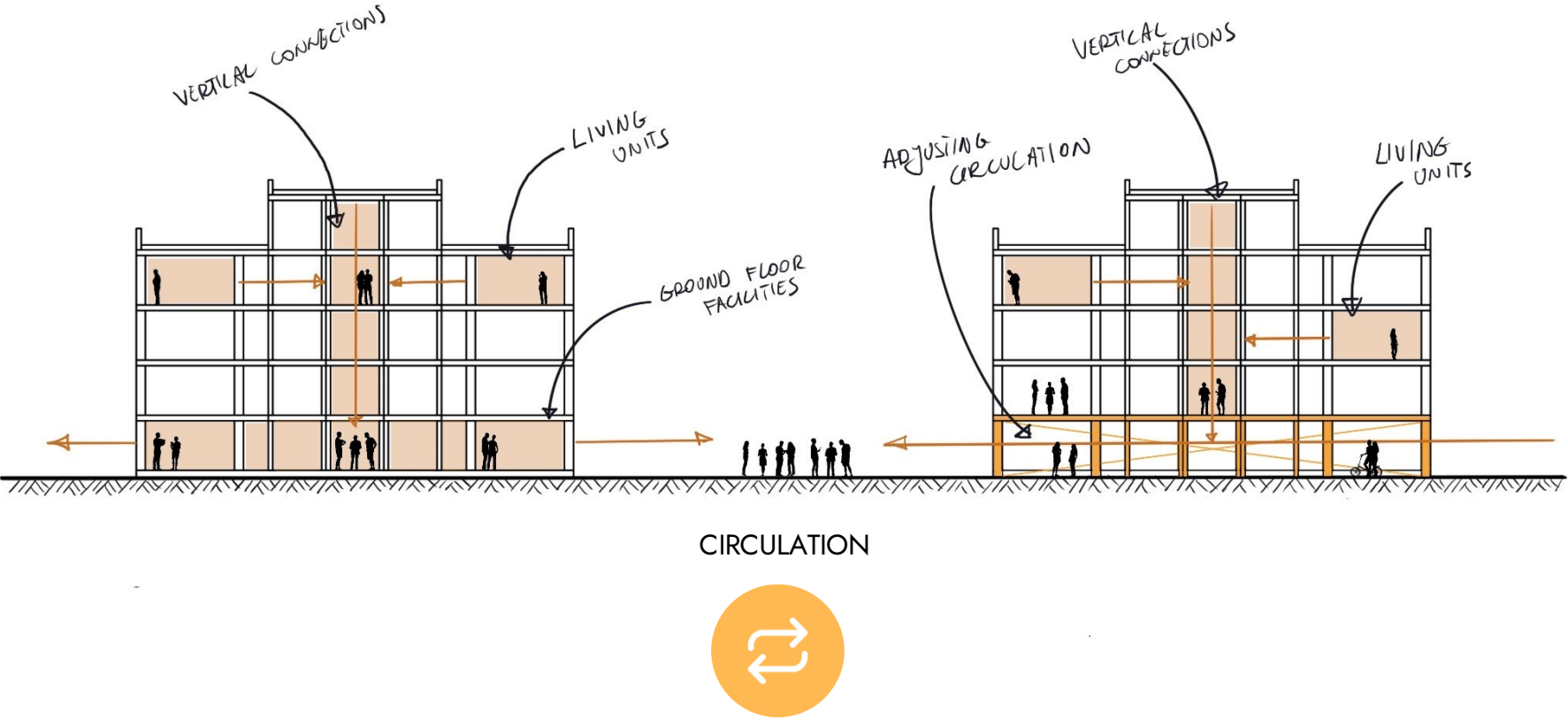
DESIGN DIRECTIONS | URBAN SCALE



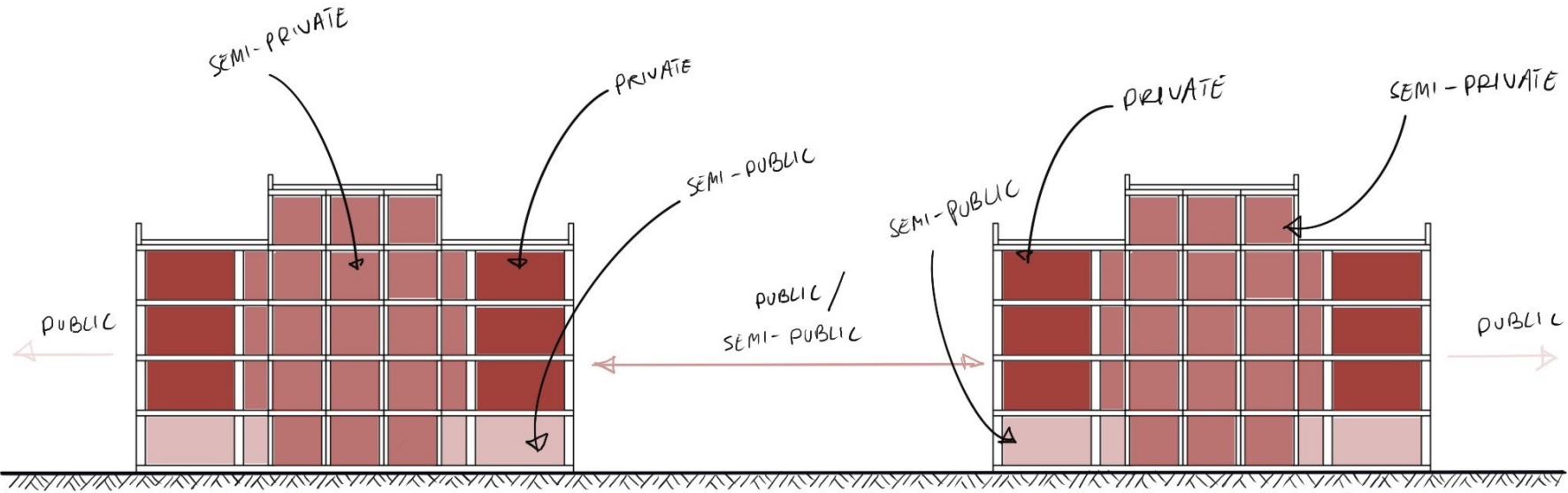
URBAN COMPOSITION



DESIGN DIRECTIONS | URBAN SCALE



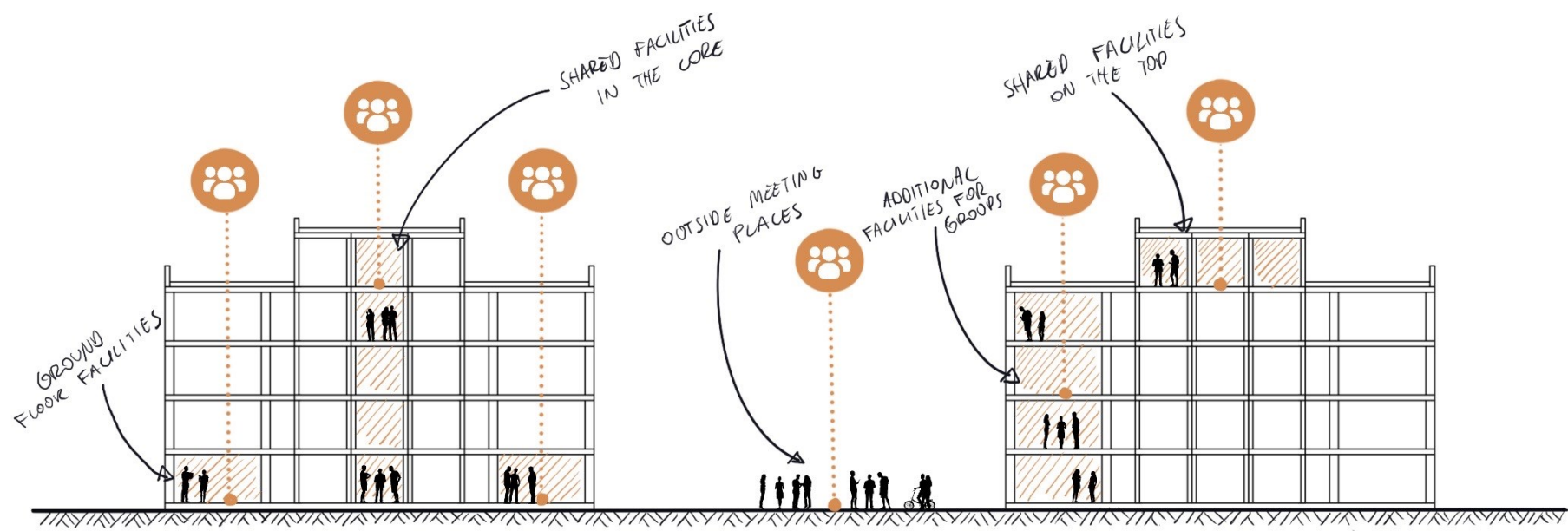
DESIGN DIRECTIONS | URBAN SCALE



PRIVATE / PUBLIC BALANCE



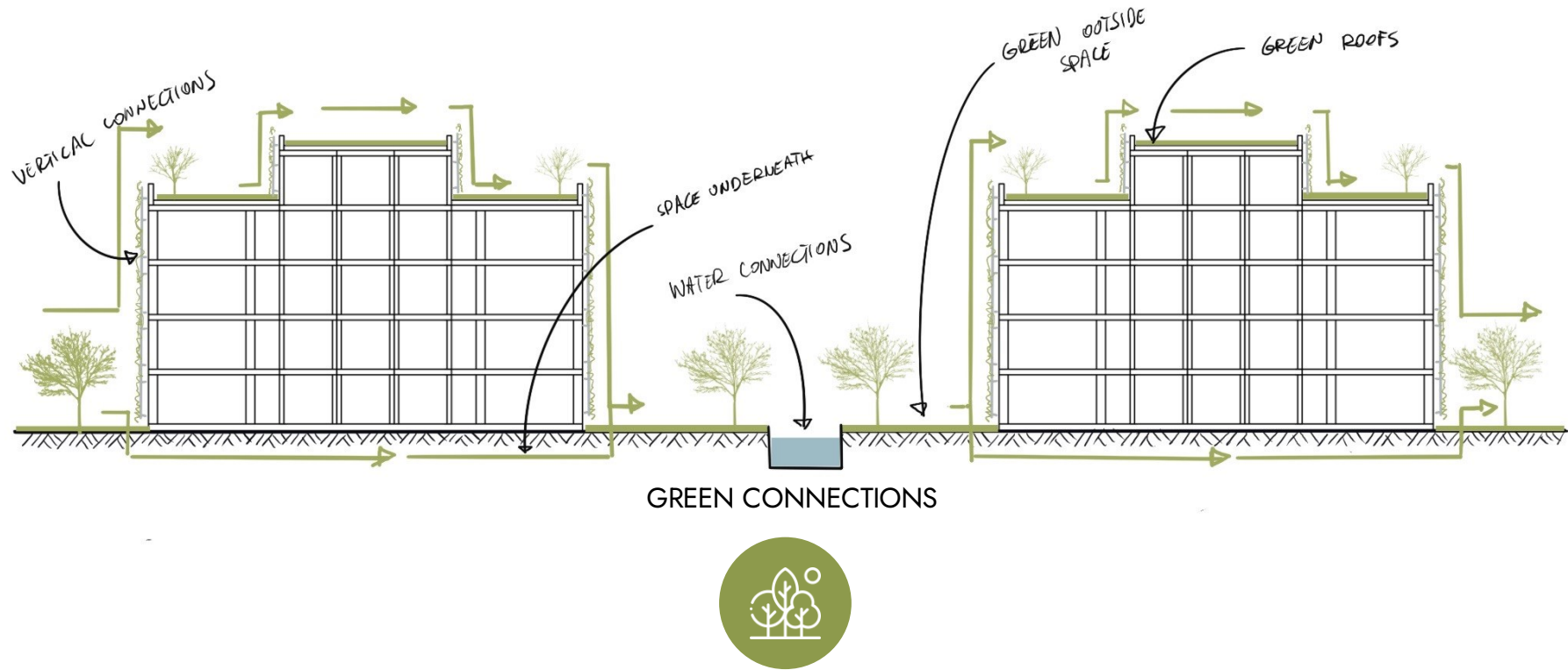
DESIGN DIRECTIONS | URBAN SCALE



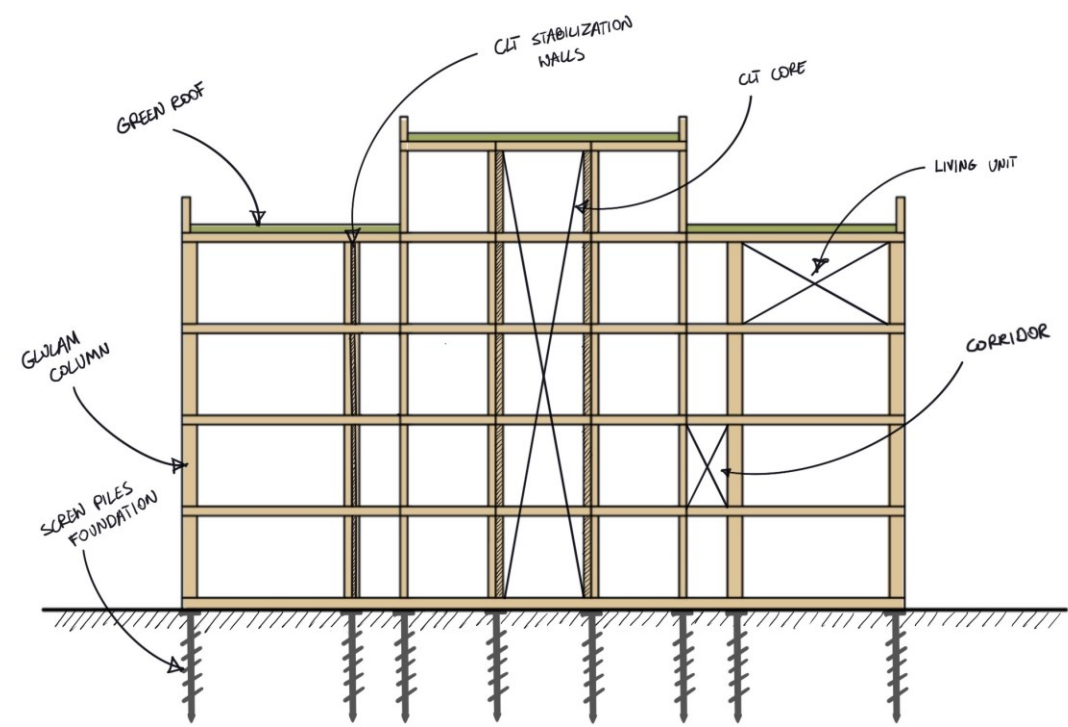
POINTS OF SOCIAL INTERACTIONS



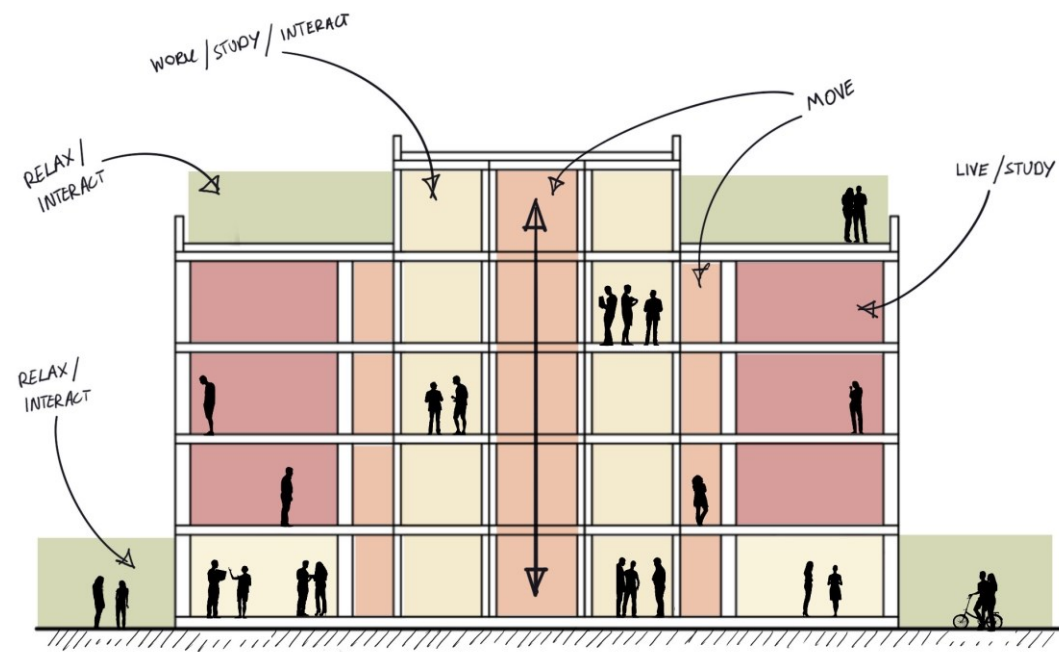
DESIGN DIRECTIONS | URBAN SCALE



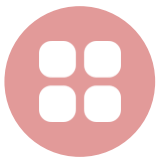
DESIGN DIRECTIONS | BUILDING SCALE



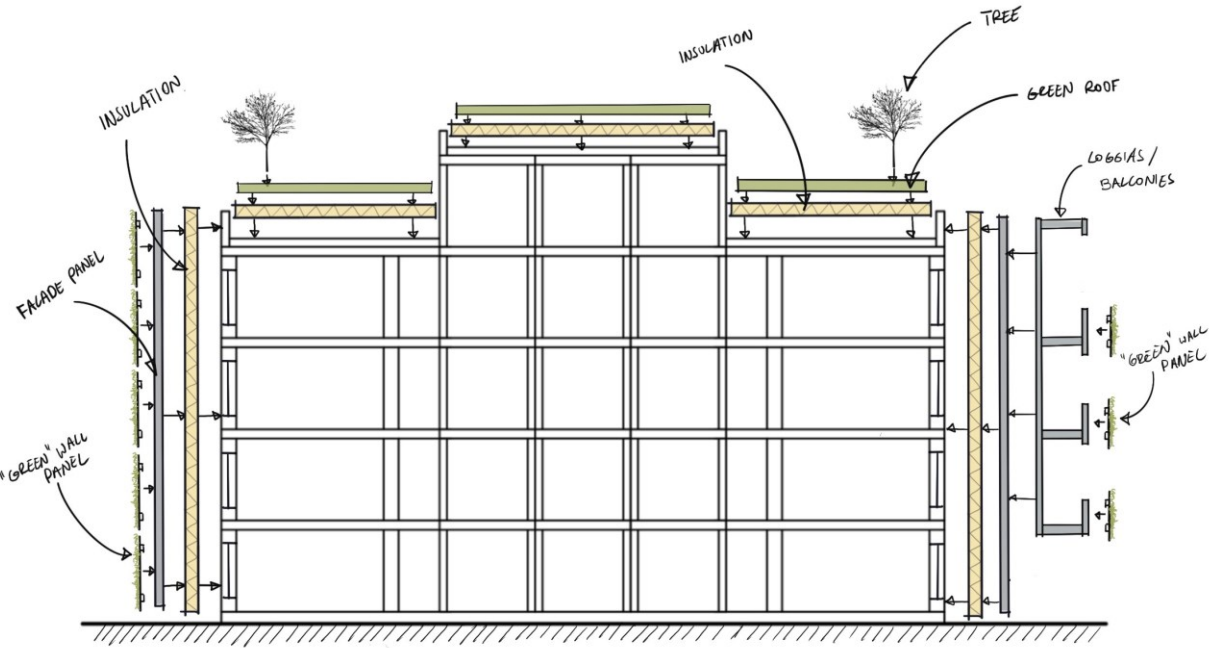
MATERIALS



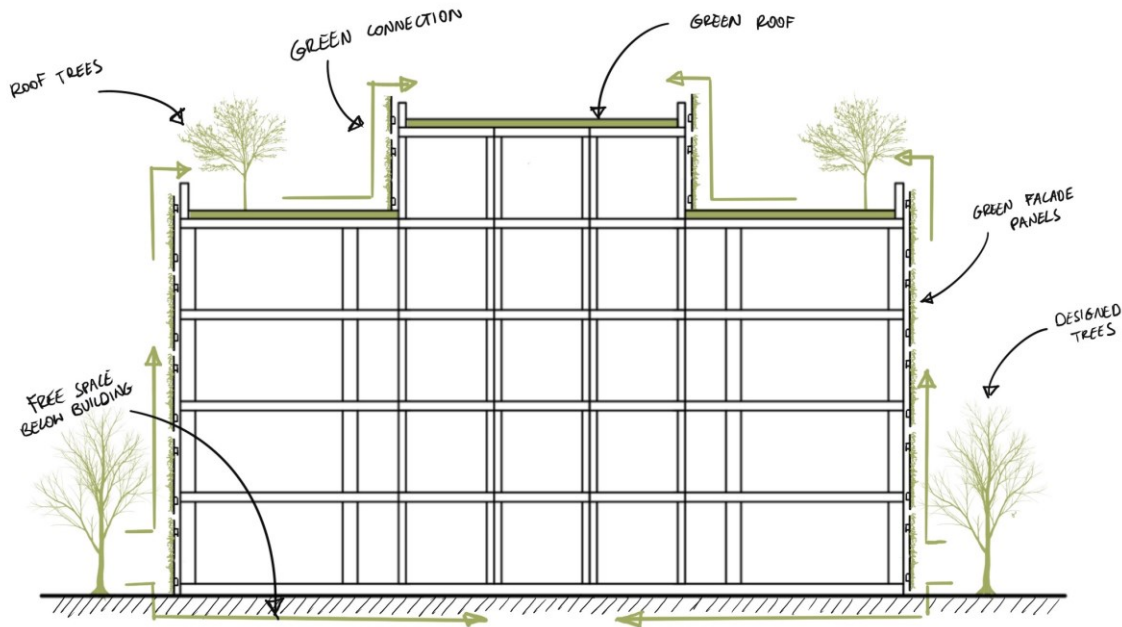
FUNCTIONALITY



DESIGN DIRECTIONS | BUILDING SCALE



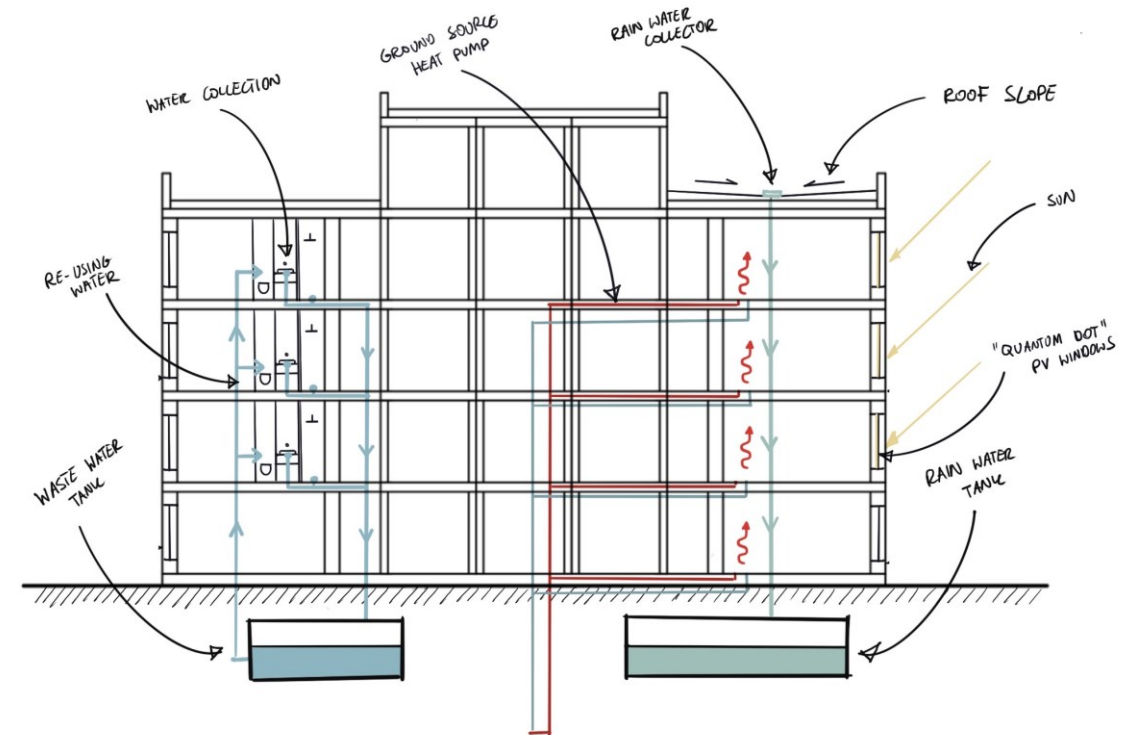
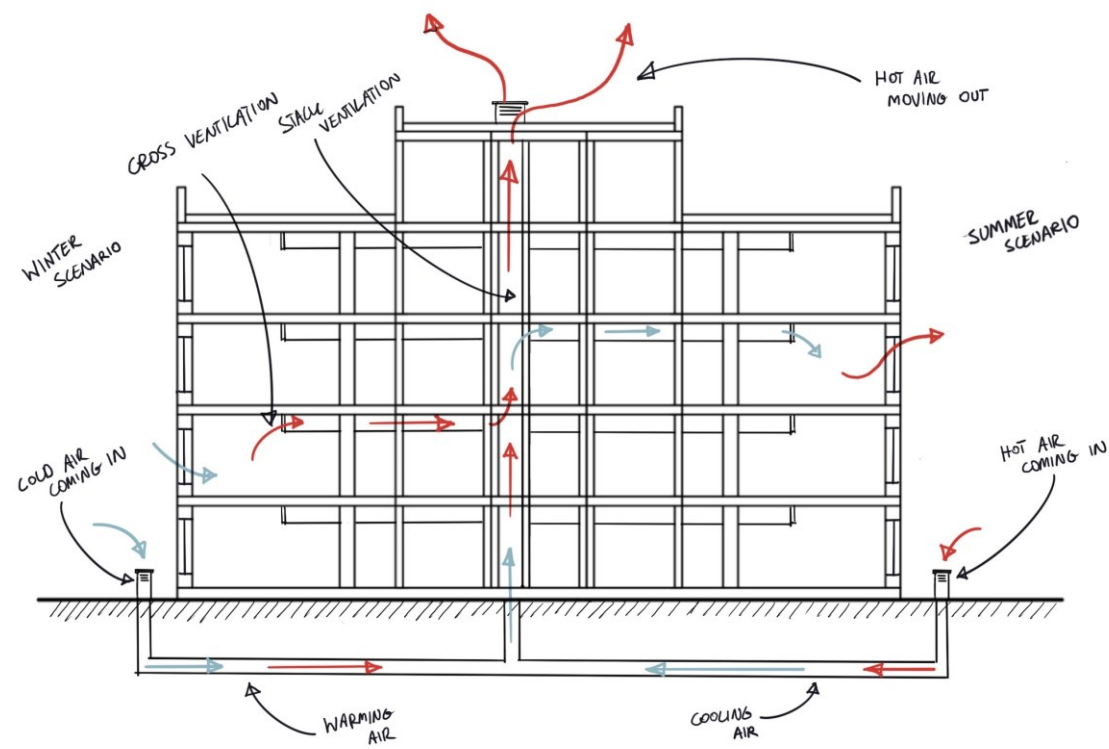
SKIN



GREEN CONNECTIONS



DESIGN DIRECTIONS | BUILDING SCALE



CIRCULAR SYSTEMS



DESIGN DIRECTIONS | 4-STEP PROCESS



URBAN COMPOSITION



PRIVATE/PUBLIC



GREEN CONNECTIONS
(URBAN)



FUNCTIONALITY



GREEN CONNECTIONS
(BUILDING)



CIRCULATION



POINTS OF SOCIAL
INTERACTIONS



MATERIALS



SKIN



CIRCULAR SYSTEMS

DESIGN DIRECTIONS | 4-STEP PROCESS



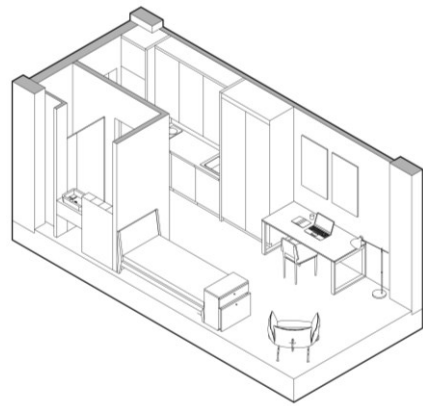
CREATING A STRATEGY

MODULE+

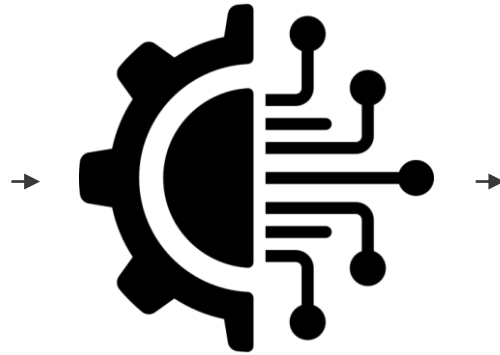
TOWARDS AFFORDABLE & QUALITATIVE STUDENT HOUSING

MODULE+

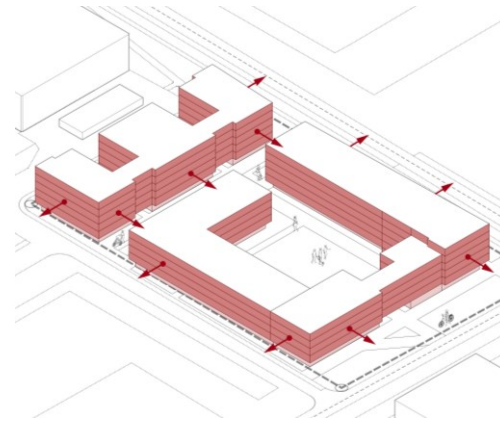
TOWARDS AFFORDABLE & QUALITATIVE STUDENT HOUSING



MODULE



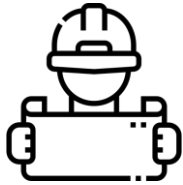
ALGORITHM



DESIGN
DIRECTIONS

MODULE+

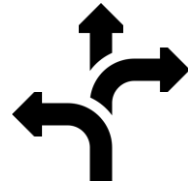
TOWARDS AFFORDABLE & QUALITATIVE STUDENT HOUSING



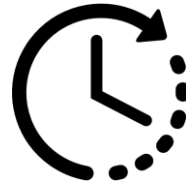
Tool / guidance for
architects & universities



Any location



Flexible



Time saving



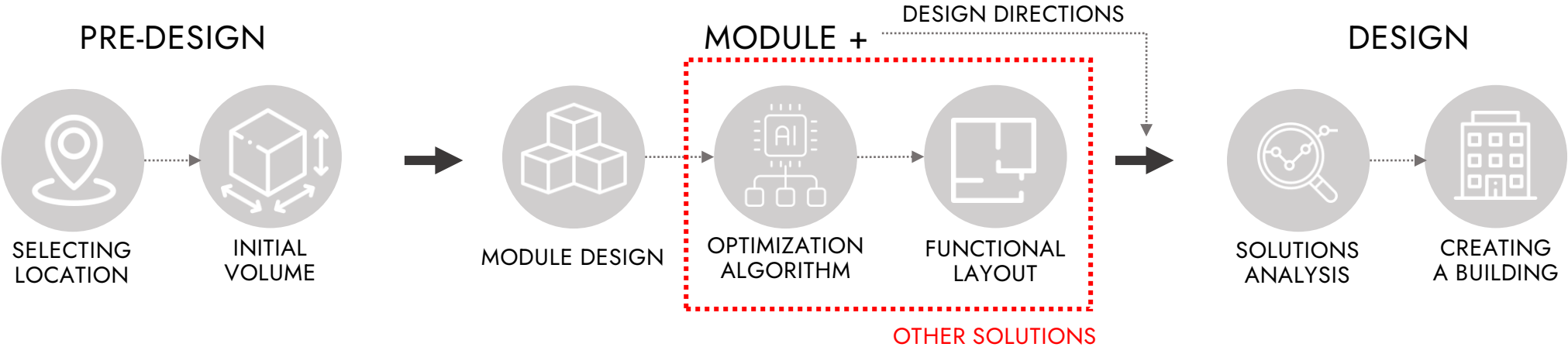
Specific data –
thoughtful decisions



Sustainable



Affordable
& qualitative housing



DESIGN

PRE-DESIGN



SELECTED LOCATION



Juni 2019

**TU Delft
Campus Zuid**

PRE-DESIGN | TU DELFT CAMPUS



PRE-DESIGN | SELECTED LOCATION



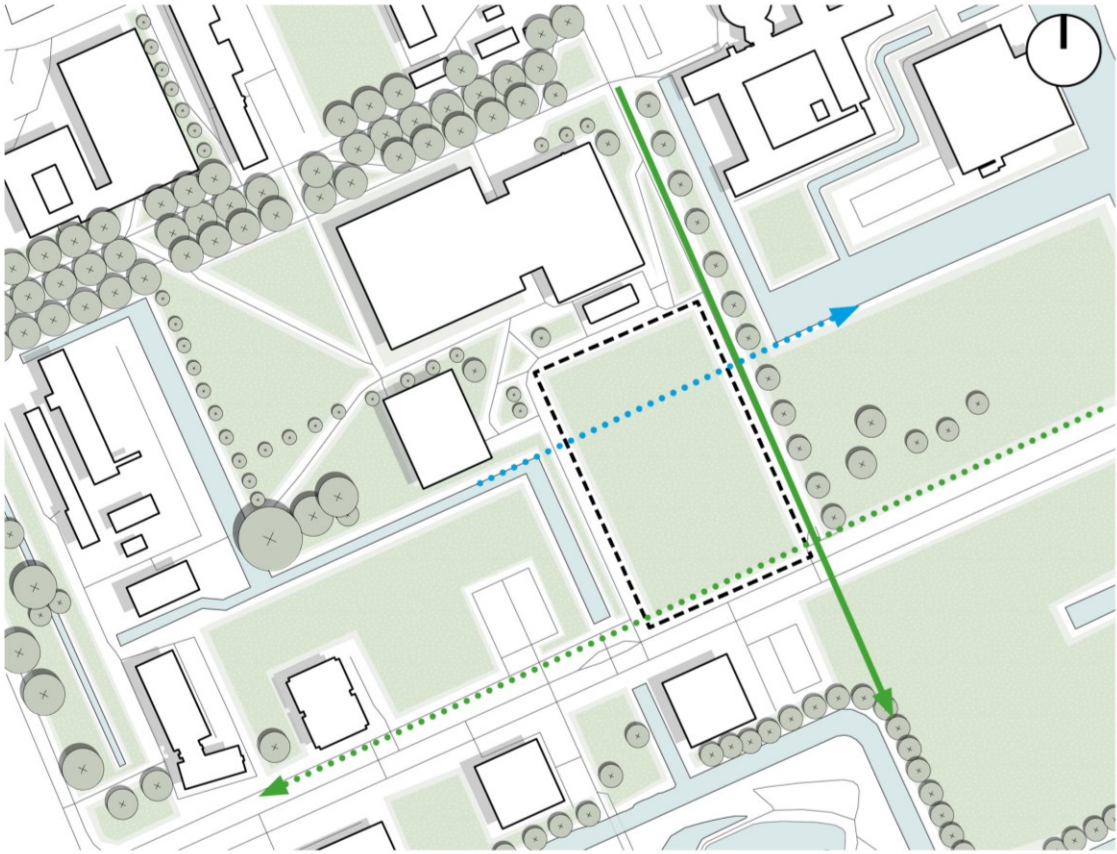
PRE-DESIGN | SITE ANALYSIS

DEVELOPMENT AREAS



- EDUCATION & RESEARCH
- RESEARCH & BUSINESS
- PLANNED BUILDINGS

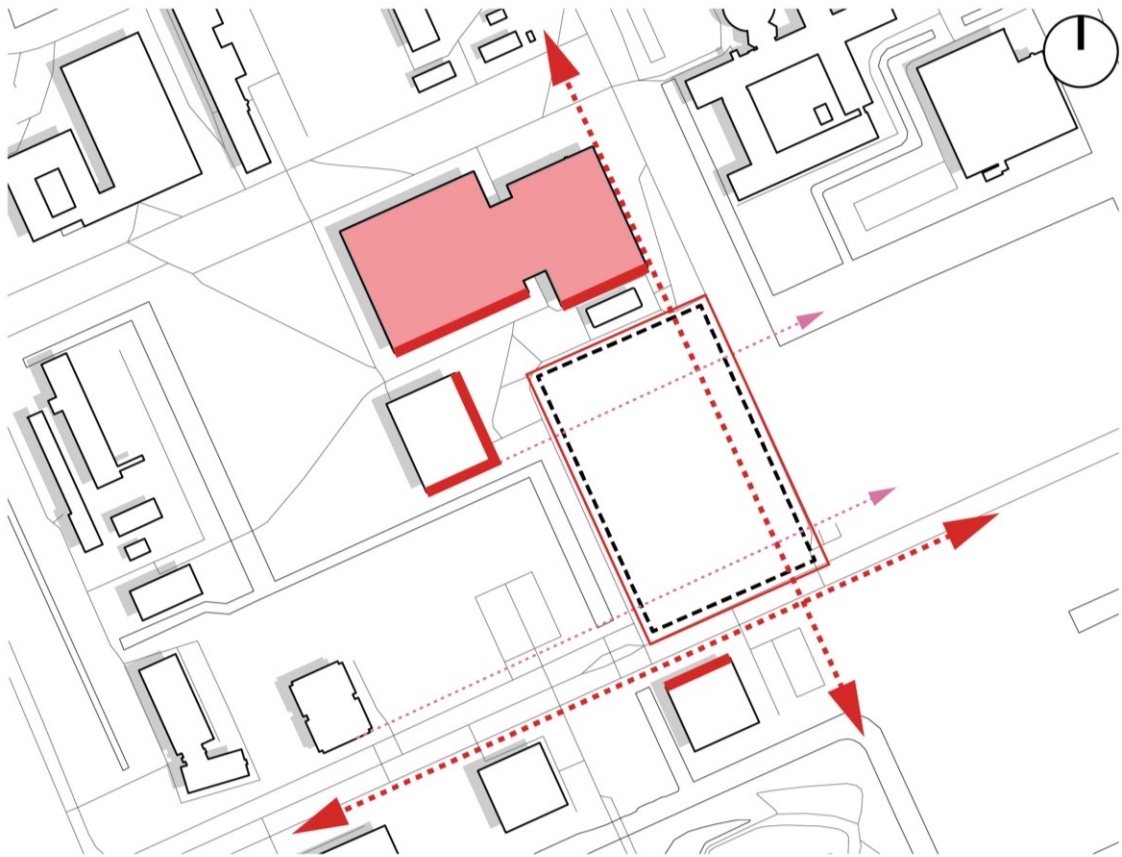
GREEN CONNECTIONS



- GREEN CORRIDORS
- PLANNED GREEN CORRIDOR
- WATER CONNECTION

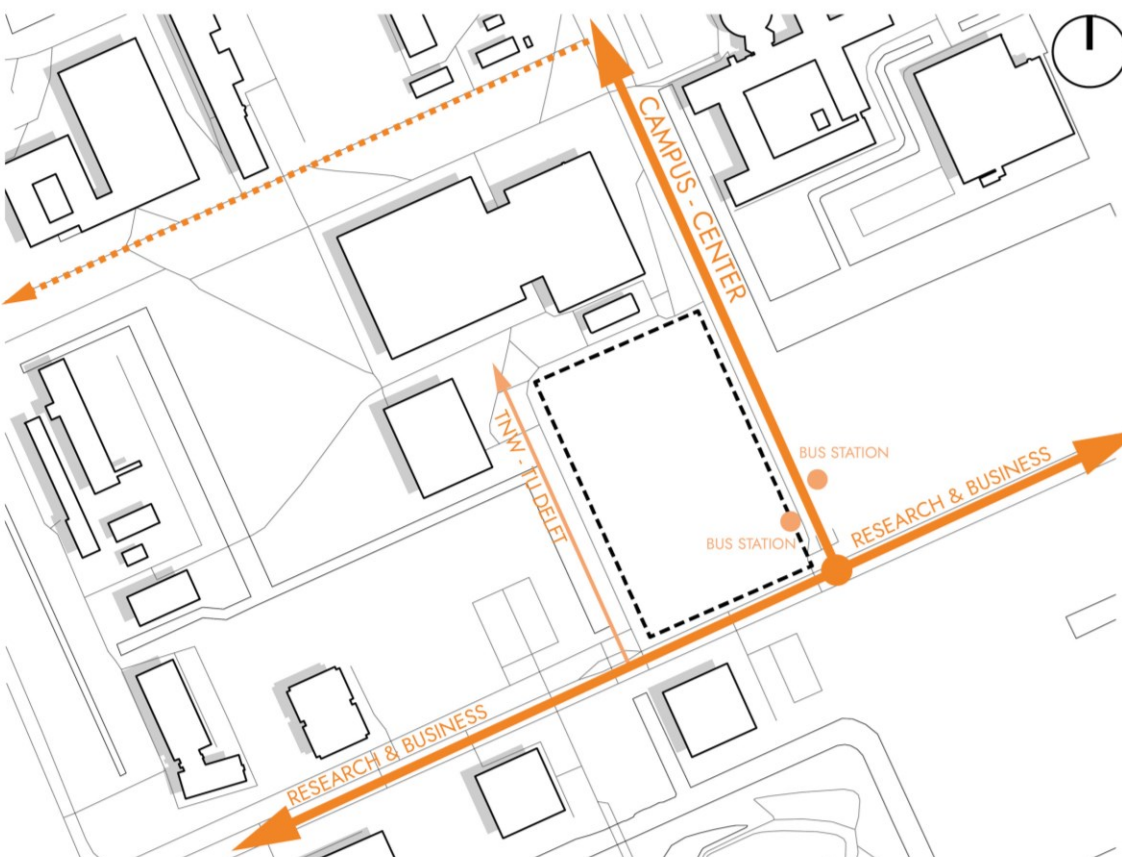
PRE-DESIGN | SITE ANALYSIS

COMPOSITION



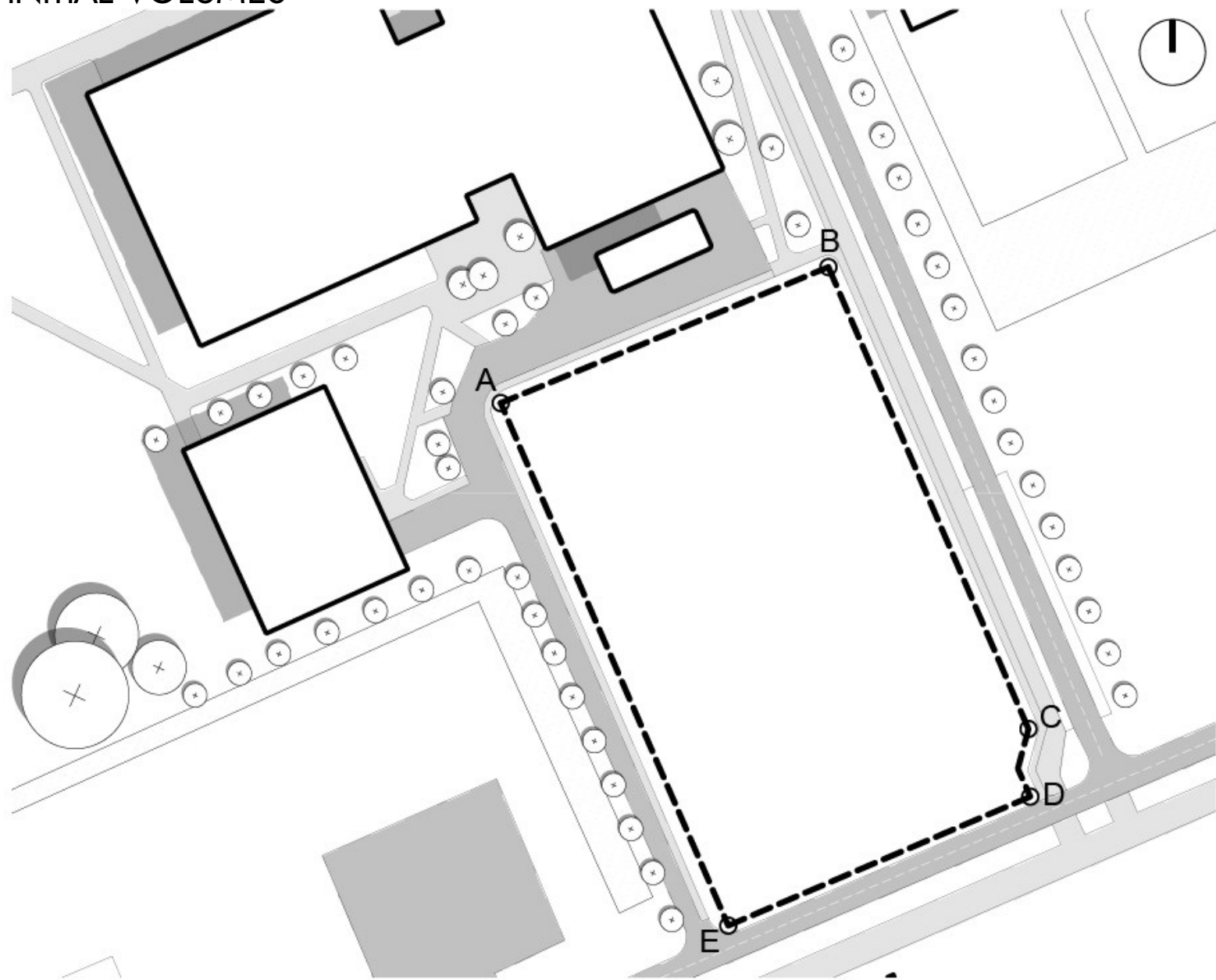
- DOMINANT
- STRONG BARRIER
- WEAK BARRIER
- MAIN COMPOSITION AXIS
- SECONDARY COMPOSITION AXIS

CONNECTIONS

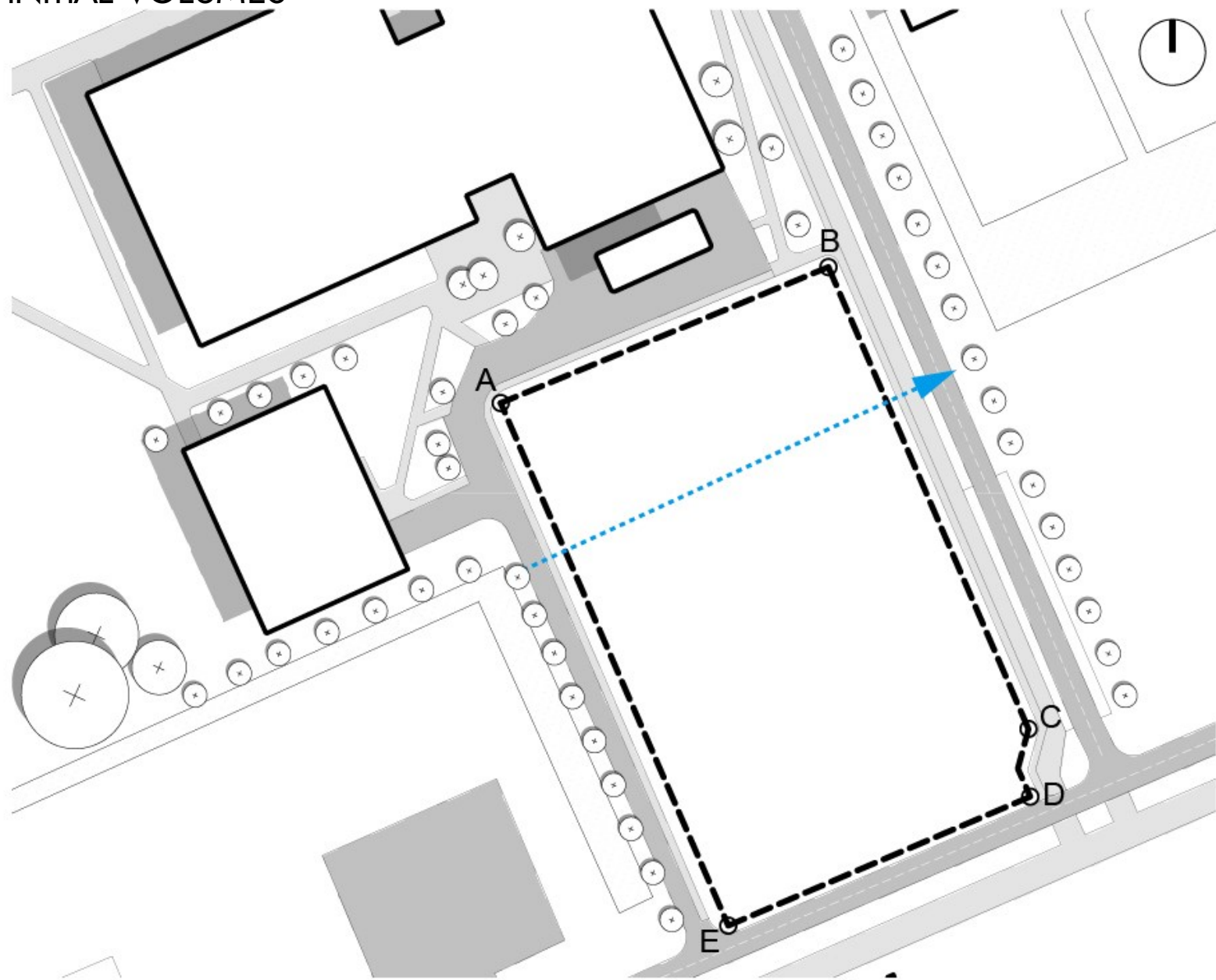


- MAIN CONNECTIONS
- SECONDARY CONNECTIONS
- CONNECTIONS IN CLOSEST SURROUNDING
- PUBLIC TRANSPORT

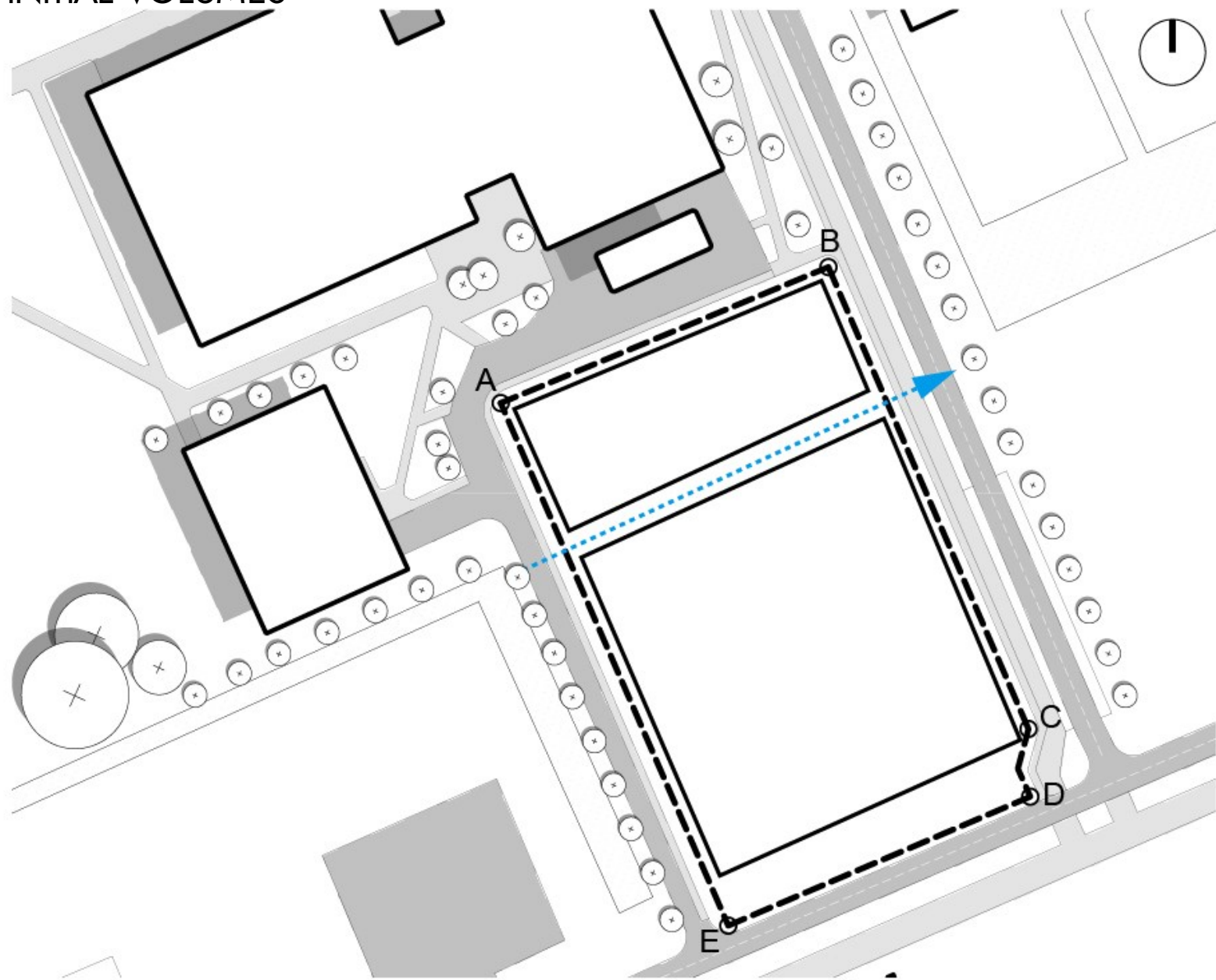
PRE-DESIGN | INITIAL VOLUMES



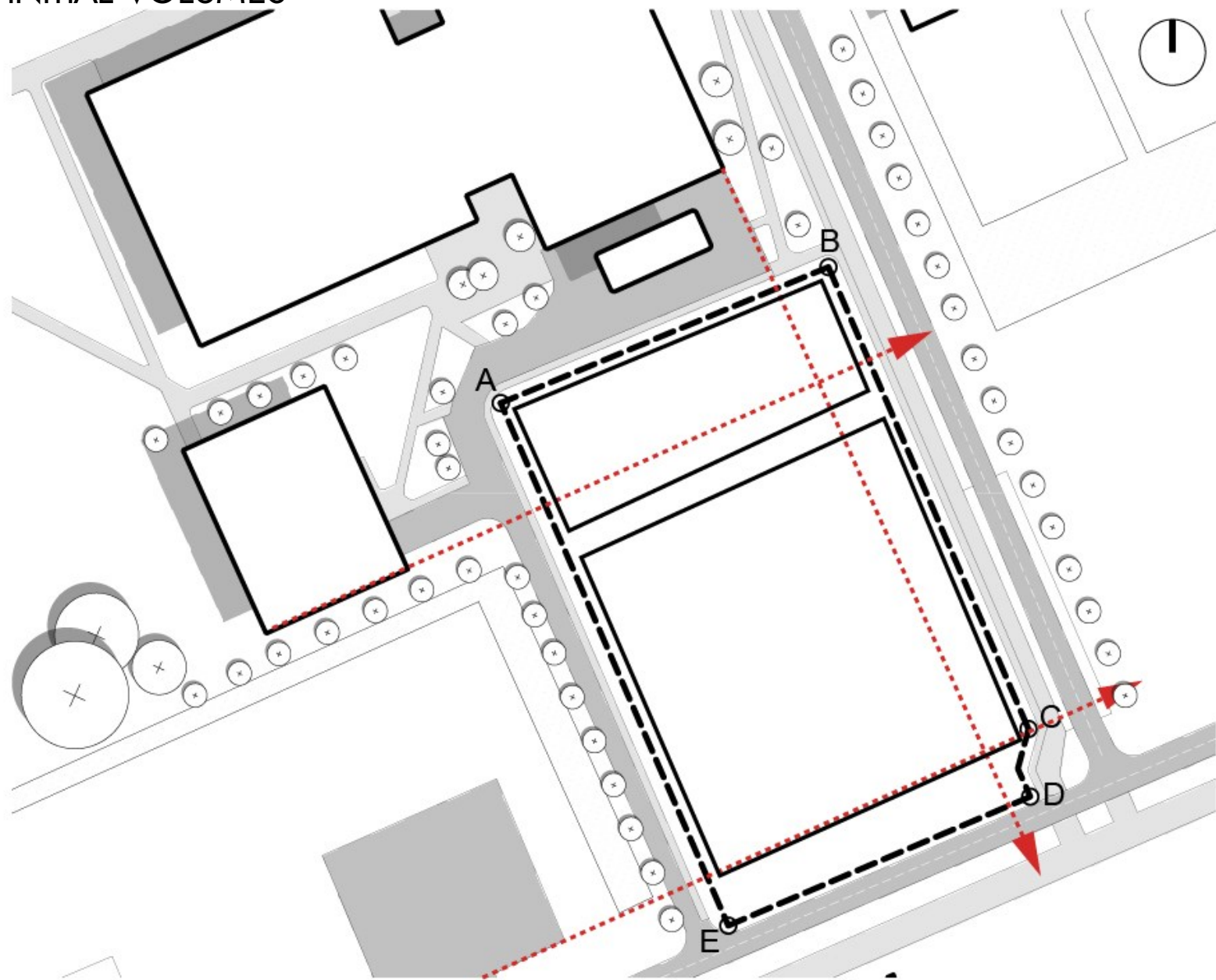
PRE-DESIGN | INITIAL VOLUMES



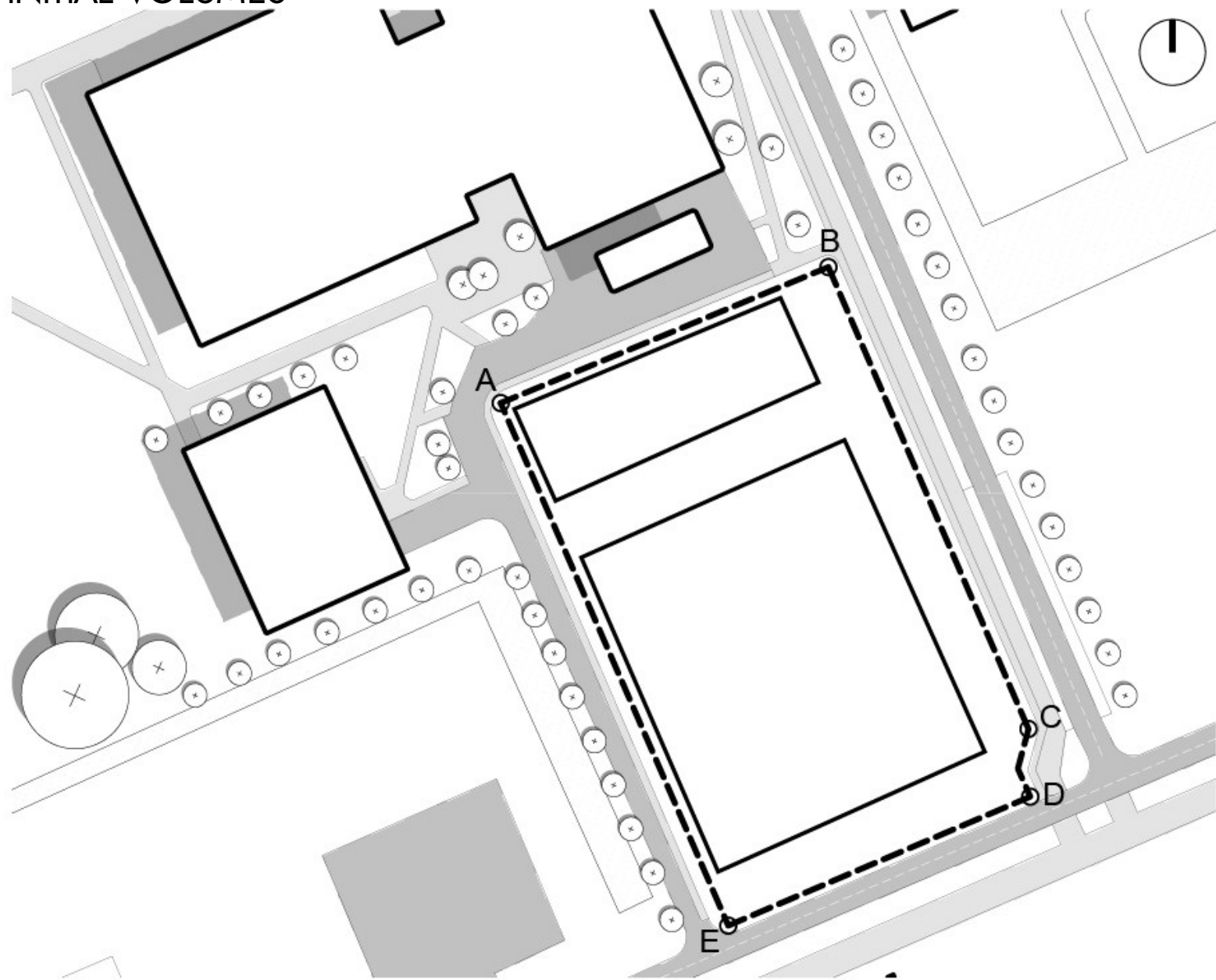
PRE-DESIGN | INITIAL VOLUMES



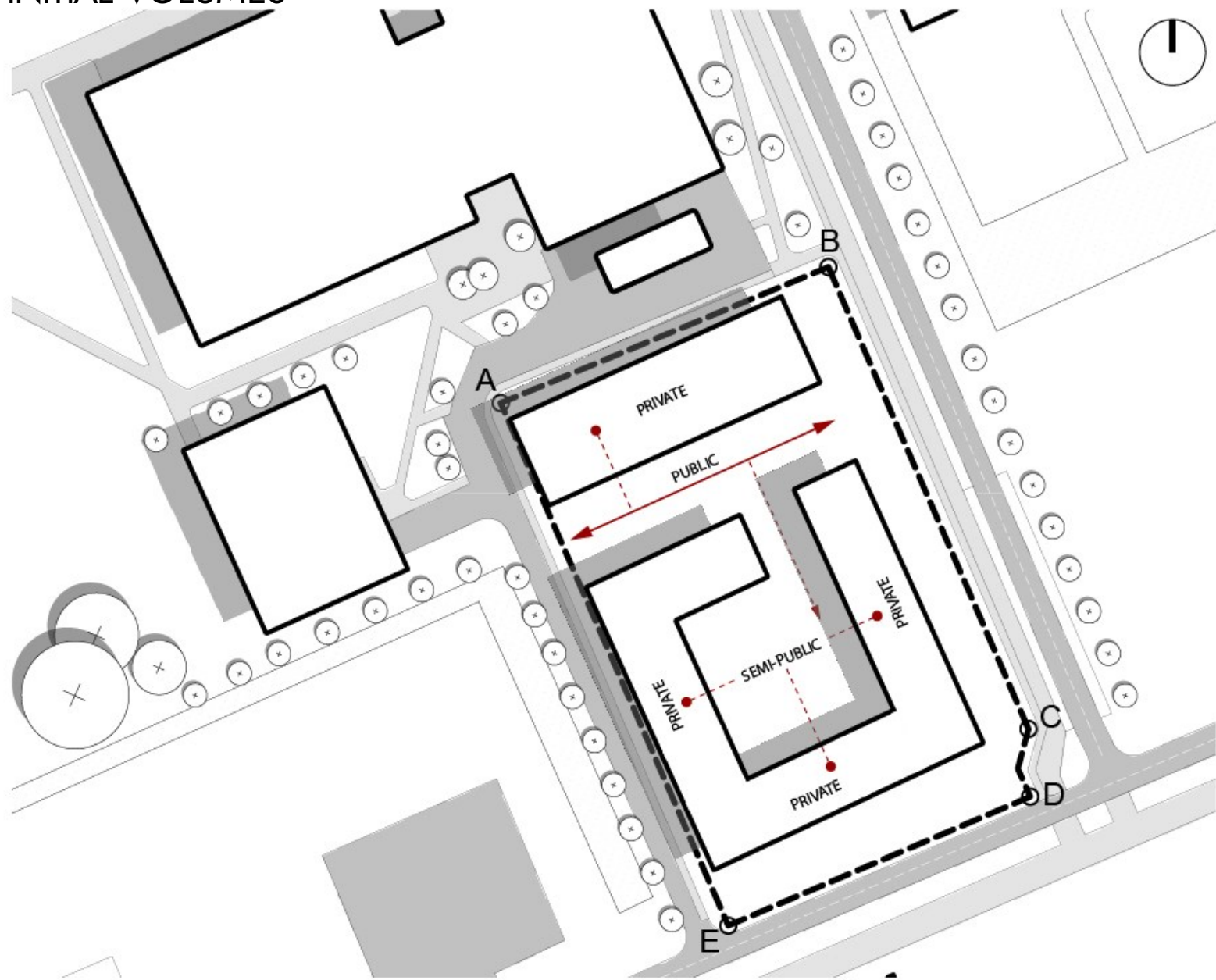
PRE-DESIGN | INITIAL VOLUMES



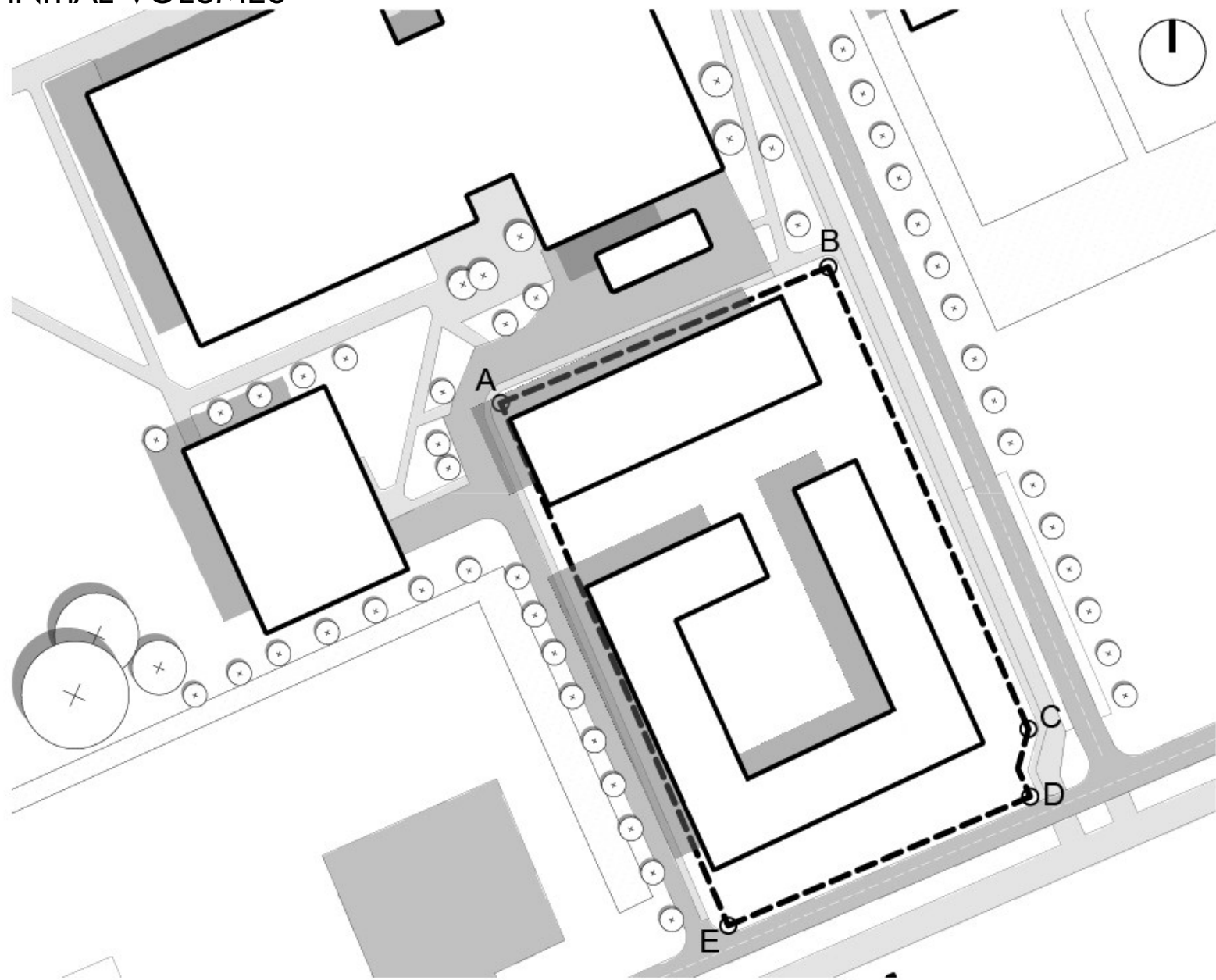
PRE-DESIGN | INITIAL VOLUMES



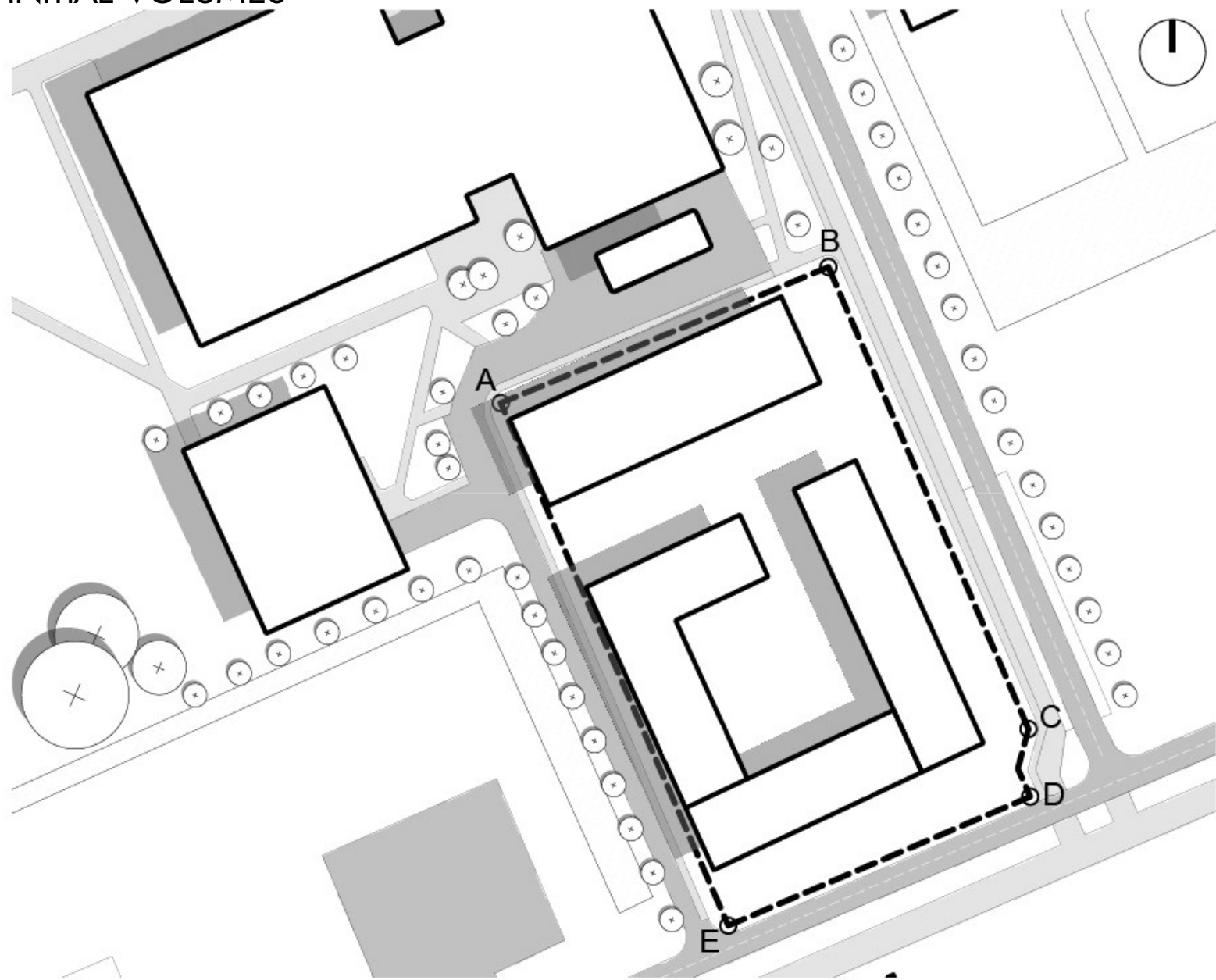
PRE-DESIGN | INITIAL VOLUMES



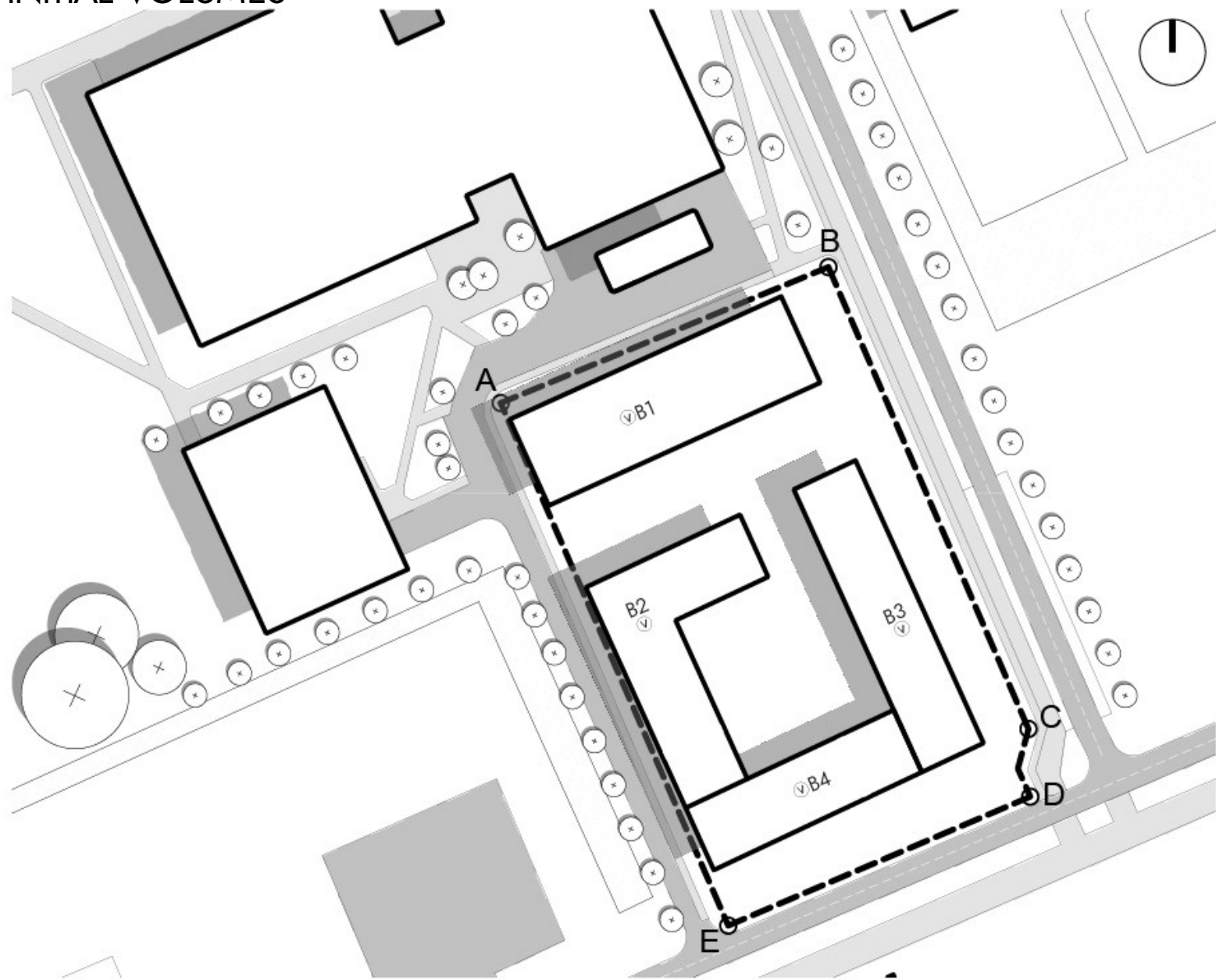
PRE-DESIGN | INITIAL VOLUMES



PRE-DESIGN | INITIAL VOLUMES



PRE-DESIGN | INITIAL VOLUMES



MODULE+

MODULE+ | SETTING INITIAL DATA

Rhino 7 Licencja Lab Edukacyjne

FileEditViewCurveSurfaceSubDSolidMeshDimensionTransformToolsAnalyzeRenderPanelsHelp

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):

module width - range:

—

module height:

max. building height (m):

core area (%):

corridor width:

min. view distance:

Objectives

1. Living Units

☐

2. Material Use

☐

3. Average Sun Hours

☐

RUN

RESULTS:

Total Living Units:

number of floors:

total area:

area per floor:

Total Material Use:

floor:

load-bearing:

partition walls:

elevation:

Average Sun Hours:

sDA:

solar radiation:

P5 PRESENTATION | aE | MODULE+

MODULE+ | SETTING INITIAL DATA

Rhino 7 Licencja Lab Edukacyjne

FileEditViewCurveSurfaceSubDSolidMeshDimensionTransformToolsAnalyzeRenderPanelsHelp

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):18

module width - range:300—350

module height:300

max. building height (m):15

core area (%):10

corridor width:150

min. view distance:800

Objectives

1. Living Units

2. Material Use

3. Average Sun Hours

RUN

RESULTS:

Total Living Units:

number of floors:

total area:

area per floor:

Total Material Use:

floor:

load-bearing:

partition walls:

elevation:

Average Sun Hours:

sDA:

solar radiation:

P5 PRESENTATION | aE | MODULE+

MODULE+ | SETTING INITIAL DATA

Rhino 7 Licencja Lab Edukacyjne

File Edit View Curve Surface SubD Solid Mesh Dimension Transform Tools Analyze Render Panels Help

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):

18

module width - range:

300

—

350

module height:

300

max. building height (m):

15

core area (%):

10

corridor width:

150

min. view distance:

800

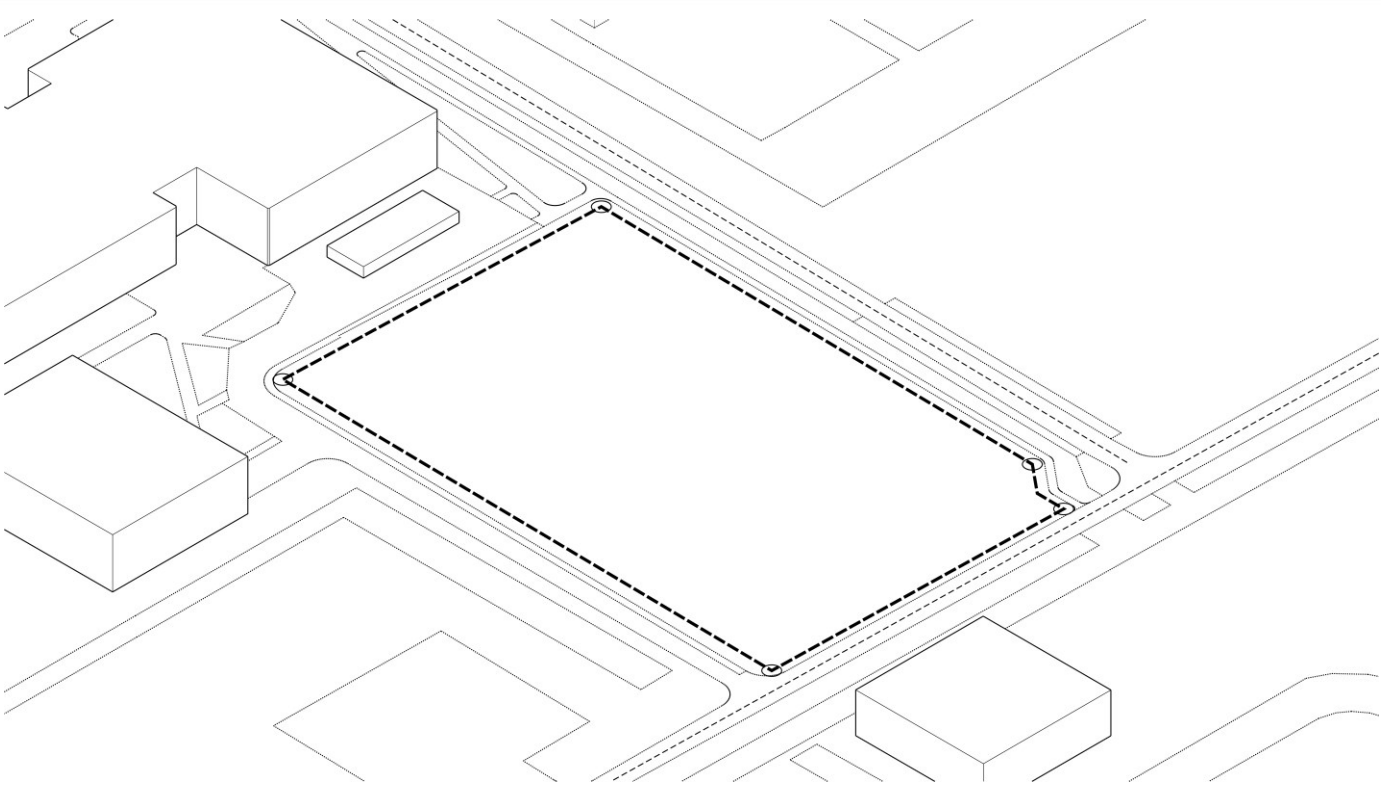
Objectives

1. Living Units

2. Material Use

3. Average Sun Hours

RUN



RESULTS:

Total Living Units:

number of floors:

total area:

area per floor:

Total Material Use:

floor:

load-bearing:

partition walls:

elevation:

Average Sun Hours:

sDA:

solar radiation:

P5 PRESENTATION | aE | MODULE+

MODULE+ | SETTING INITIAL DATA

Rhino 7 Licencja Lab Edukacyjne

File Edit View Curve Surface SubD Solid Mesh Dimension Transform Tools Analyze Render Panels Help

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):

18

module width - range:

300

—

350

module height:

300

max. building height (m):

15

core area (%):

10

corridor width:

150

min. view distance:

800

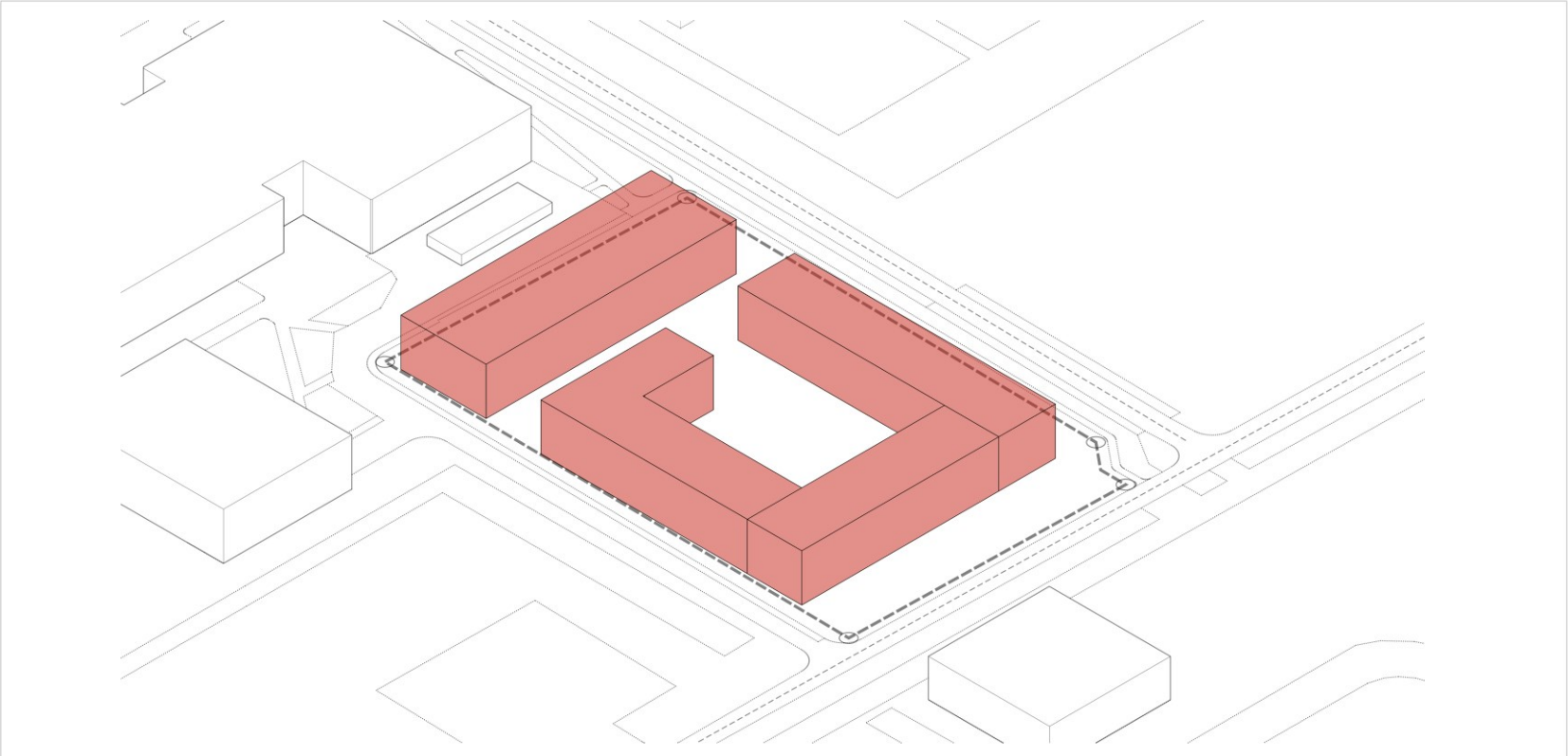
Objectives

1. Living Units

2. Material Use

3. Average Sun Hours

RUN



RESULTS:

Total Living Units:

number of floors:

total area:

area per floor:

Total Material Use:

floor:

load-bearing:

partition walls:

elevation:

Average Sun Hours:

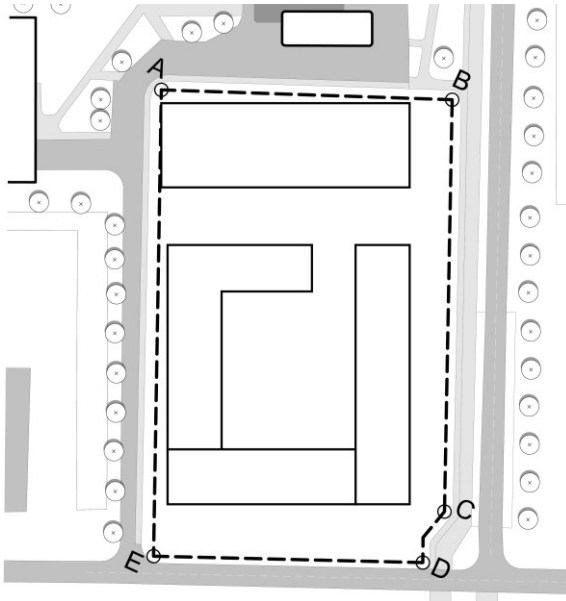
sDA:

solar radiation:

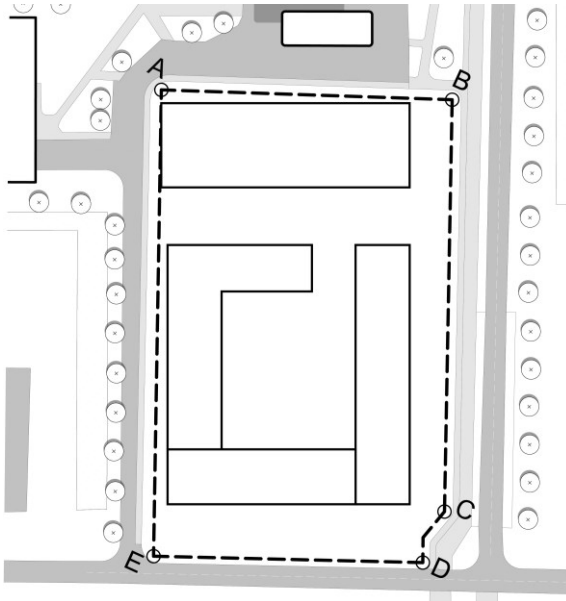
P5 PRESENTATION | aE | MODULE+

MODULE+ | RUNNING THE SCRIPT

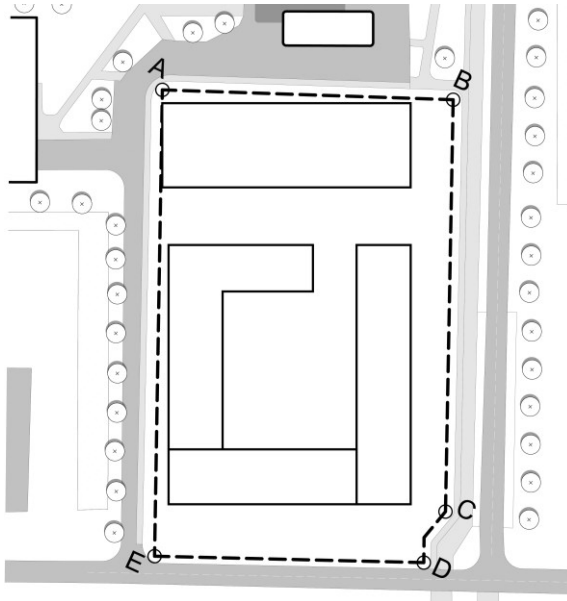
BUILDING 1



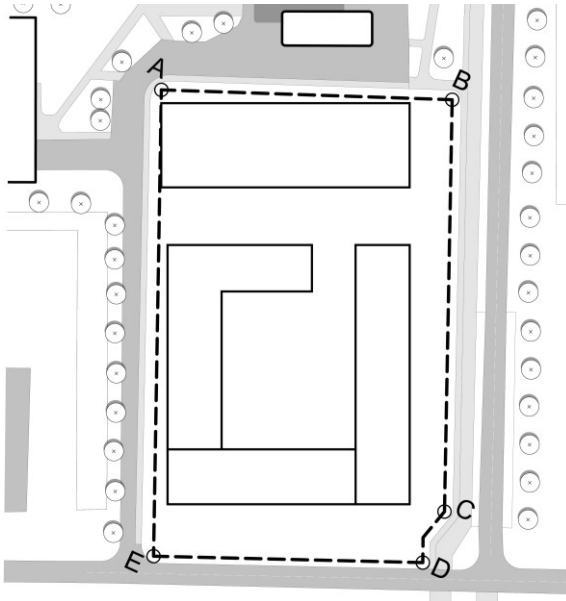
BUILDING 2



BUILDING 3

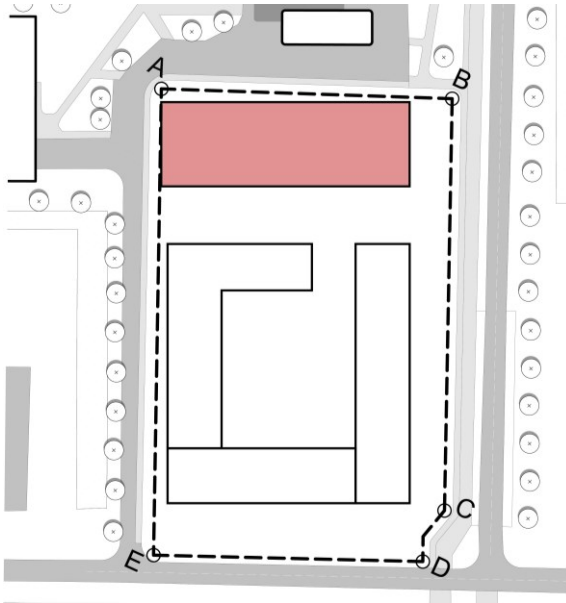


BUILDING 4

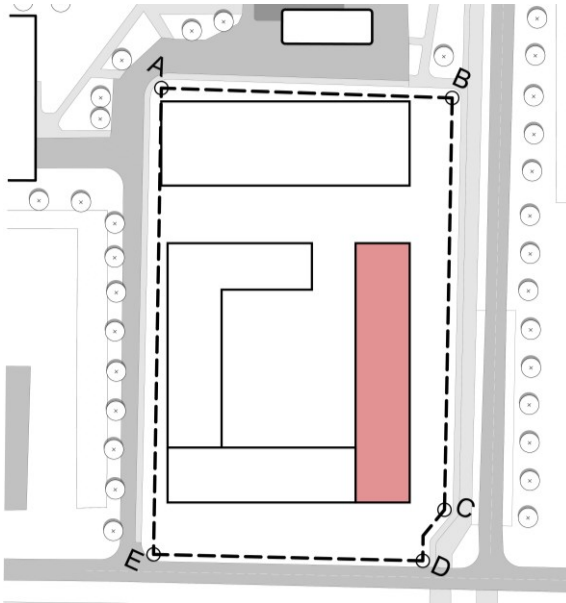


MODULE+ | RUNNING THE SCRIPT

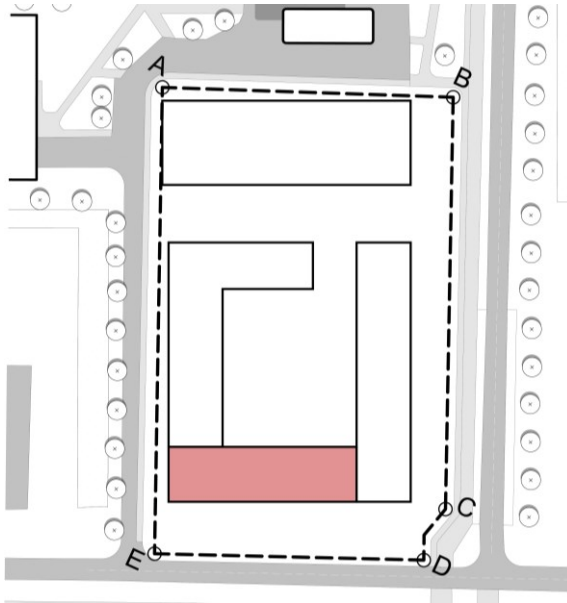
BUILDING 1



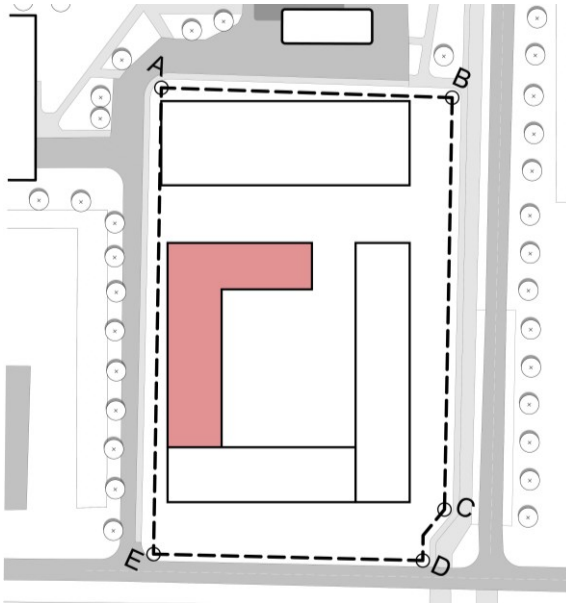
BUILDING 2



BUILDING 3

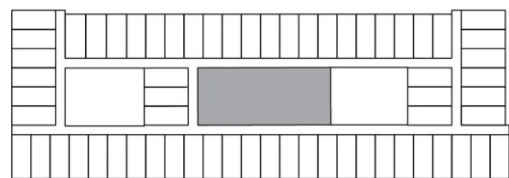


BUILDING 4

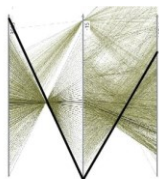


MODULE+ | RUNNING THE SCRIPT

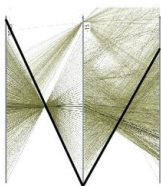
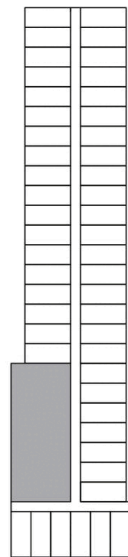
BUILDING 1



Living units: 320
Material use: 4120 m3
Average sun hours: 4,66h

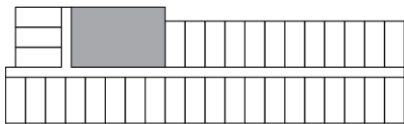


BUILDING 2

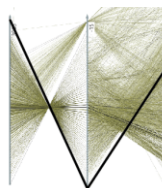


Living units: 245
Material use: 3155 m3
Average sun hours: 4,45h

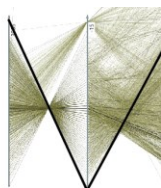
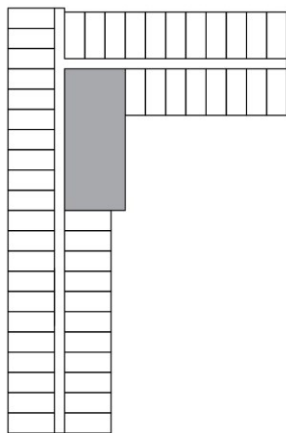
BUILDING 3



Living units: 170
Material use: 2240 m3
Average sun hours: 5,03h



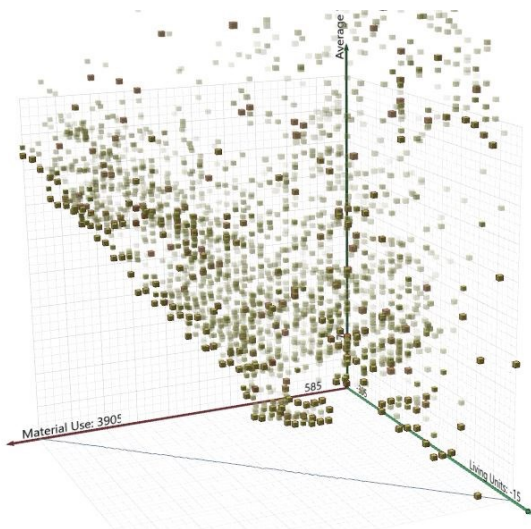
BUILDING 4



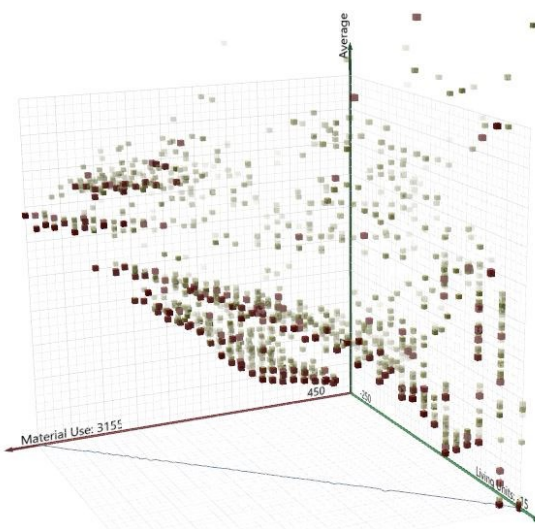
Living units: 255
Material use: 3320 m3
Average sun hours: 4,52h

MODULE+ | ANALYSING RESULTS

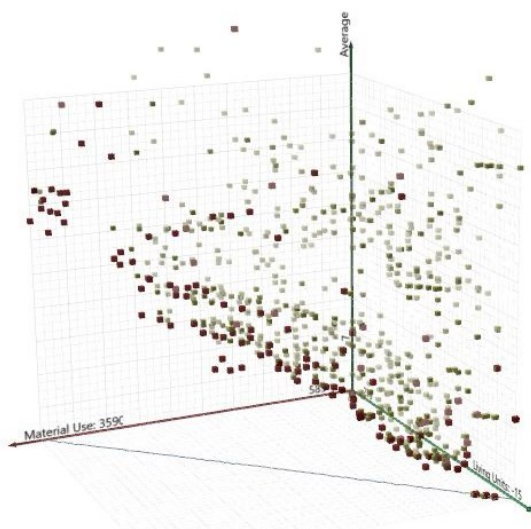
BUILDING 1



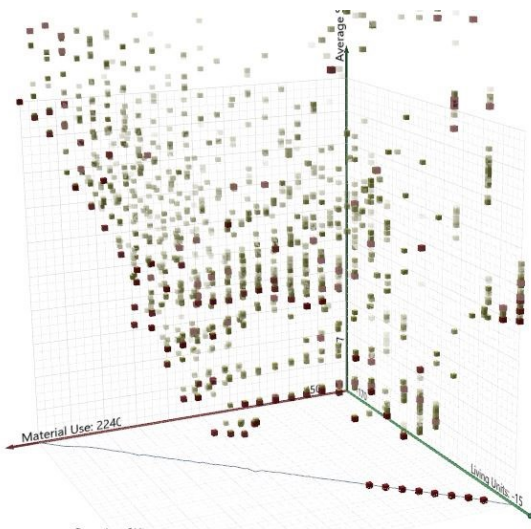
BUILDING 2



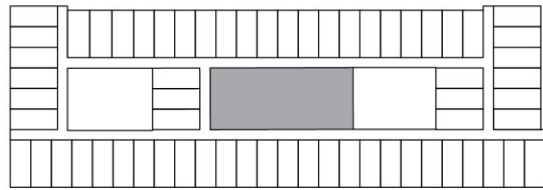
BUILDING 3



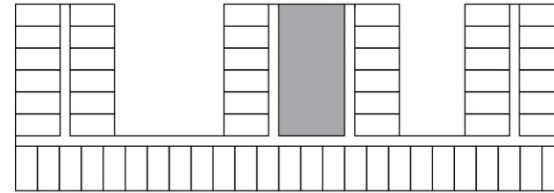
BUILDING 4



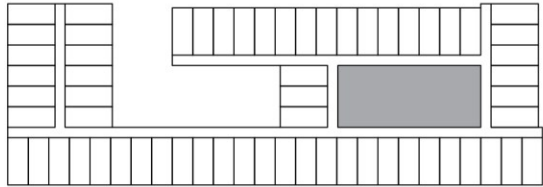
MODULE+ | ANALYSING RESULTS – BUILDING 1



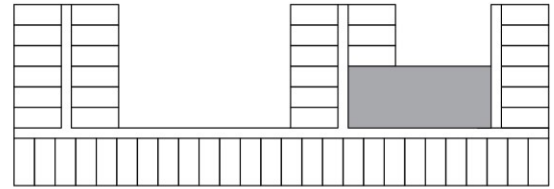
Living units: 320
Material use: 4120 m³
Average sun hours: 4,66h



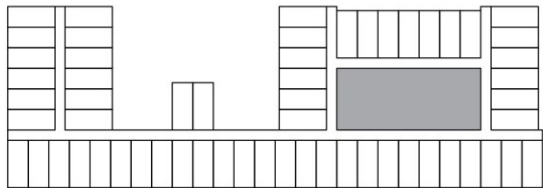
Living units: 305
Material use: 3900 m³
Average sun hours: 5,20h



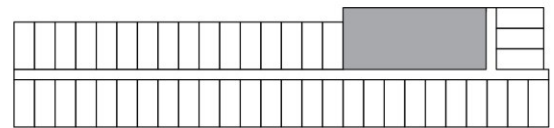
Living units: 305
Material use: 3905 m³
Average sun hours: 4,79h



Living units: 265
Material use: 3470 m³
Average sun hours: 5,50h

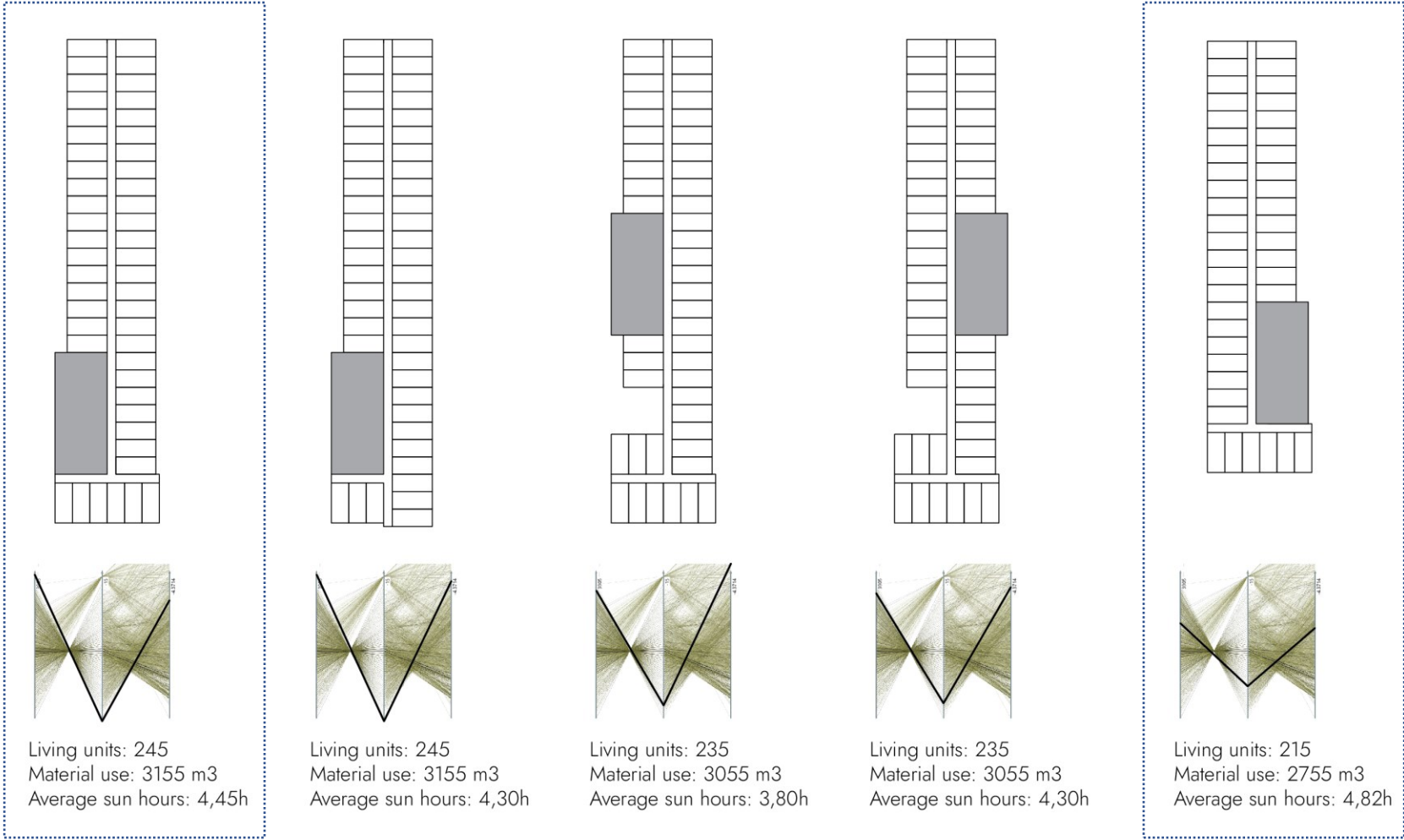


Living units: 290
Material use: 3715 m³
Average sun hours: 5,1h

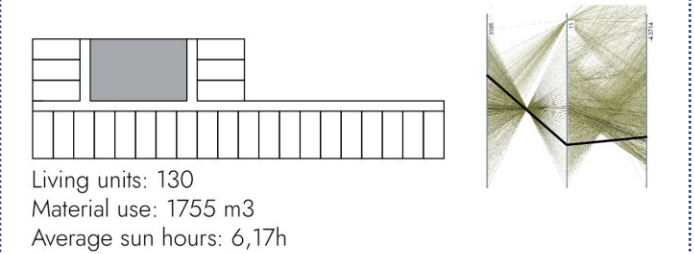
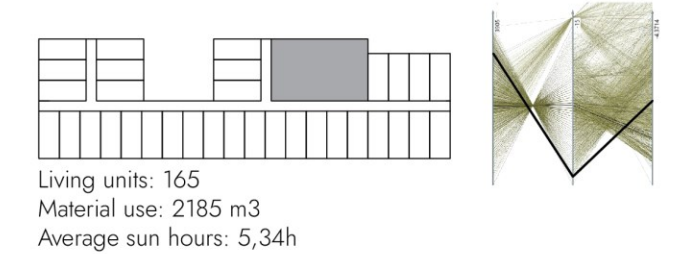
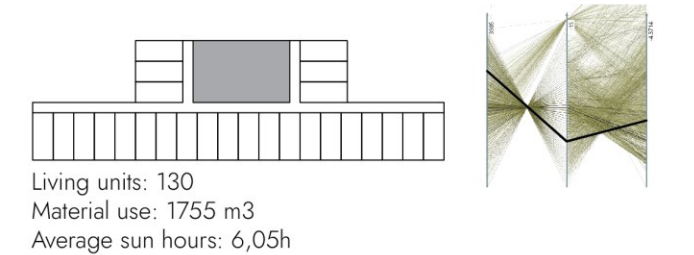
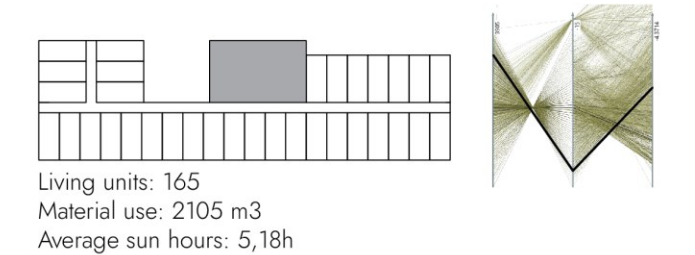
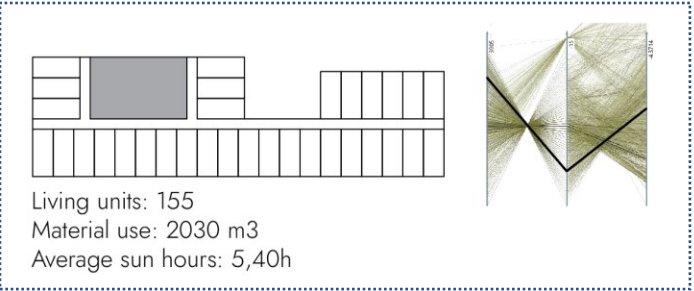
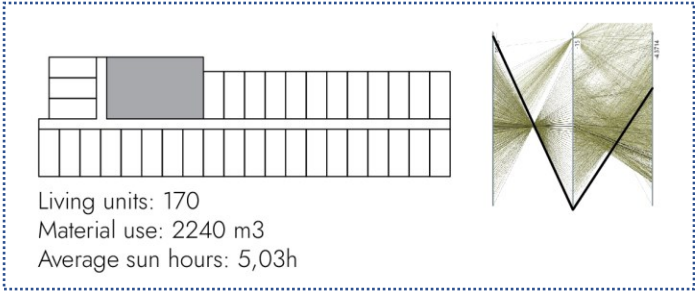


Living units: 225
Material use: 2980 m³
Average sun hours: 4,87h

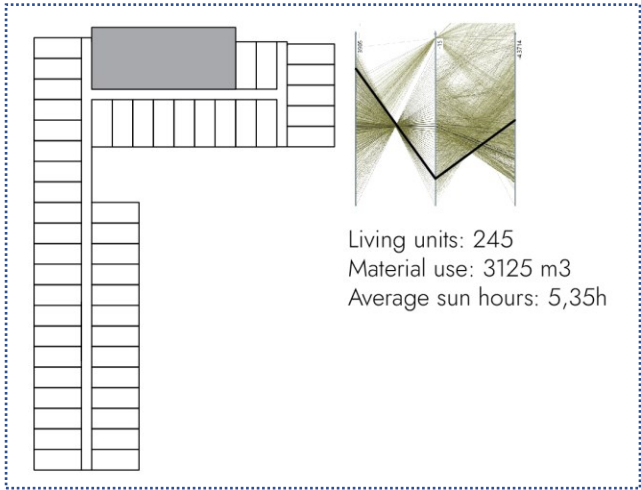
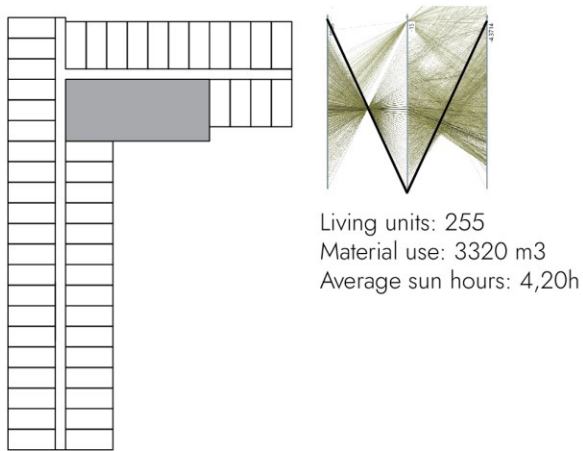
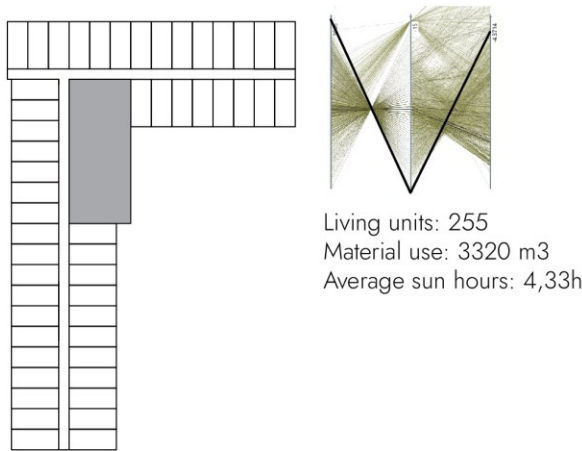
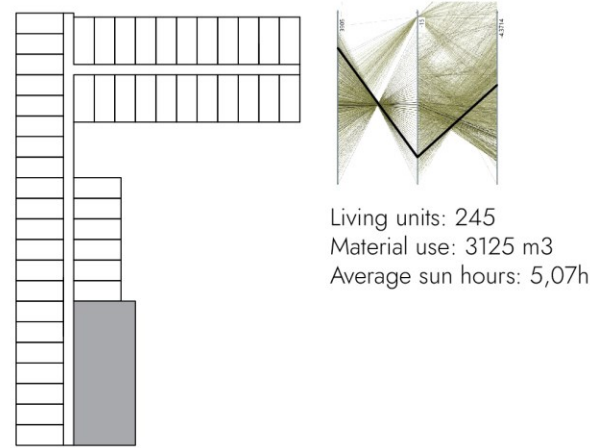
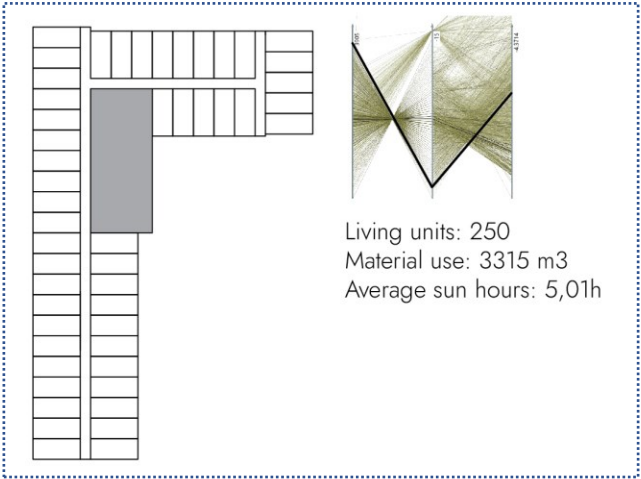
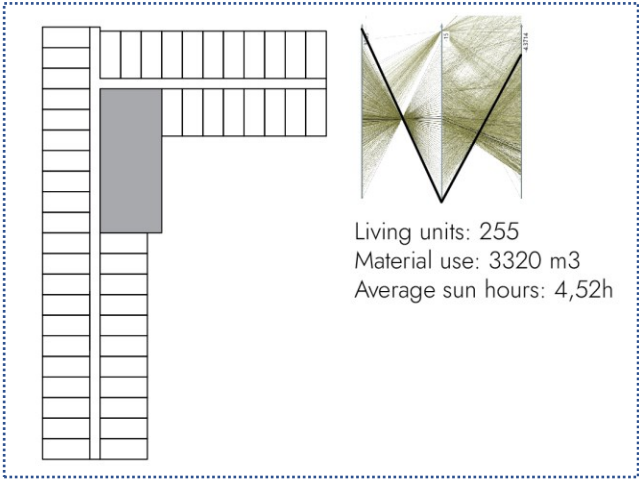
MODULE+ | ANALYSING RESULTS – BUILDING 2



MODULE+ | ANALYSING RESULTS – BUILDING 3



MODULE+ | ANALYSING RESULTS – BUILDING 4



MODULE+ | ANALYSING RESULTS

Rhino 7 Licencja Lab Edukacyjnej

File Edit View Curve Surface SubD Solid Mesh Dimension Transform Tools Analyze Render Panels Help

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):

18

module width - range:

300

 —

350

module height:

300

max. building height (m):

15

core area (%):

10

corridor width:

150

min. view distance:

800

Objectives

1. Living Units

☒

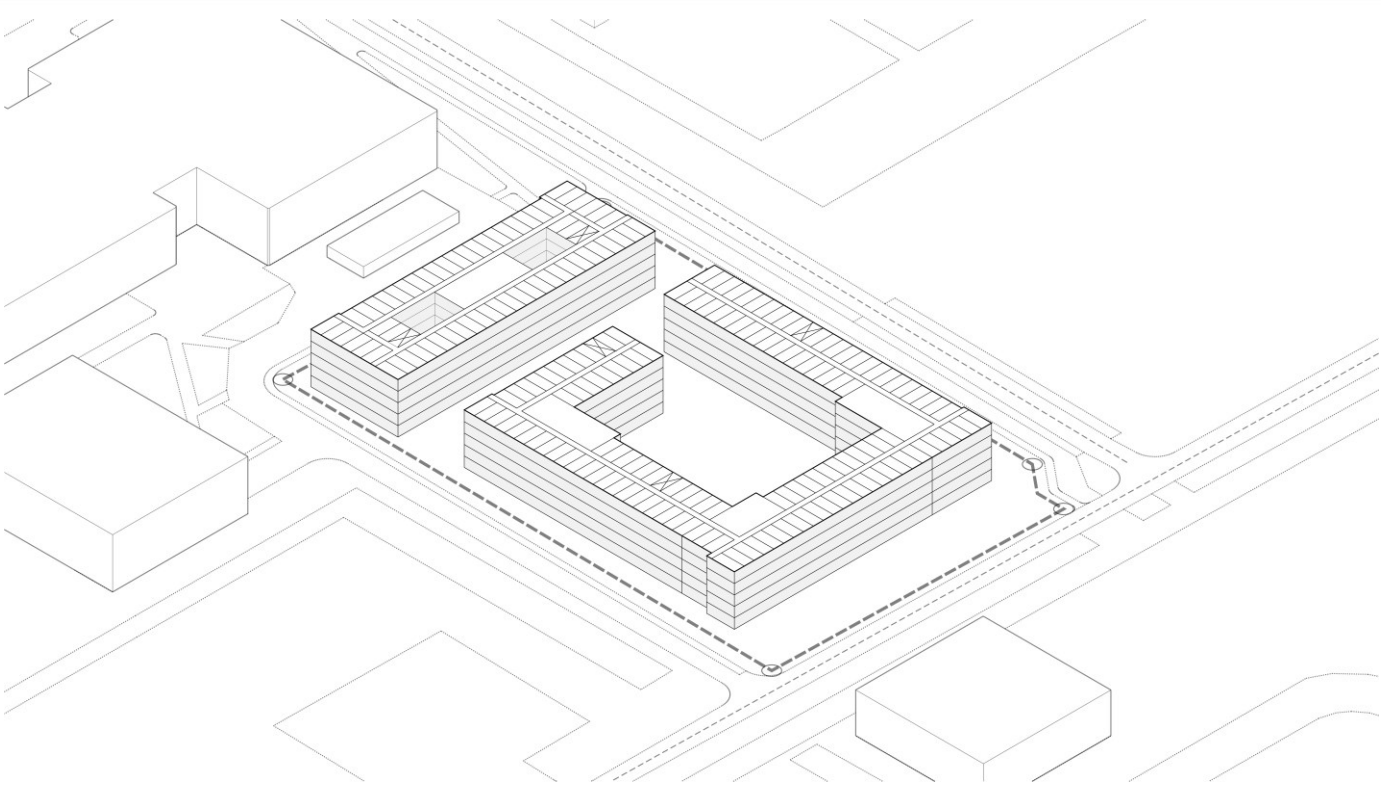
2. Material Use

☒

3. Average Sun Hours

☒

RUN



RESULTS:

Total Living Units: 955

number of floors: 5
total area: 26855 m2
area per floor: 5371 m2

Total Material Use: 12835 m3

floor: 2334 m3
load-bearing: 362 m3
partition walls: 44 m3
elevation: 51 m3

Average Sun Hours: 4,67

sDA: 69% (failed)
solar radiation: 32854 kWh/m2

P5 PRESENTATION | aE | MODULE+

MODULE+ | ANALYSING RESULTS

Rhino 7 Licencja Lab Edukacyjnej

File Edit View Curve Surface SubD Solid Mesh Dimension Transform Tools Analyze Render Panels Help

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):

18

module width - range:

300

—

350

module height:

300

max. building height (m):

15

core area (%):

10

corridor width:

150

min. view distance:

800

Objectives

1. Living Units

2. Material Use

3. Average Sun Hours

RESULTS:

Total Living Units: 865

number of floors: 5

total area: 25090 m2

area per floor: 5018 m2

Total Material Use: 11405 m3

floor: 2108 m3

load-bearing: 319 m3

partition walls: 39 m3

elevation: 51 m3

Average Sun Hours: 5,45

sDA: 76% (passed)

solar radiation: 33059 kWh/m2

MODULE+ | ANALYSING RESULTS

Rhino 7 Licencja Lab Edukacyjne

File Edit View Curve Surface SubD Solid Mesh Dimension Transform Tools Analyze Render Panels Help

Command:

MODULE+

TOWARDS AFFORDABLE & QUALITATIVE LIVING ENVIRONMENT

Parameters

module area (m2):

18

module width - range:

300

 —

350

module height:

300

max. building height (m):

15

core area (%):

10

corridor width:

150

min. view distance:

800

Objectives

1. Living Units

☒

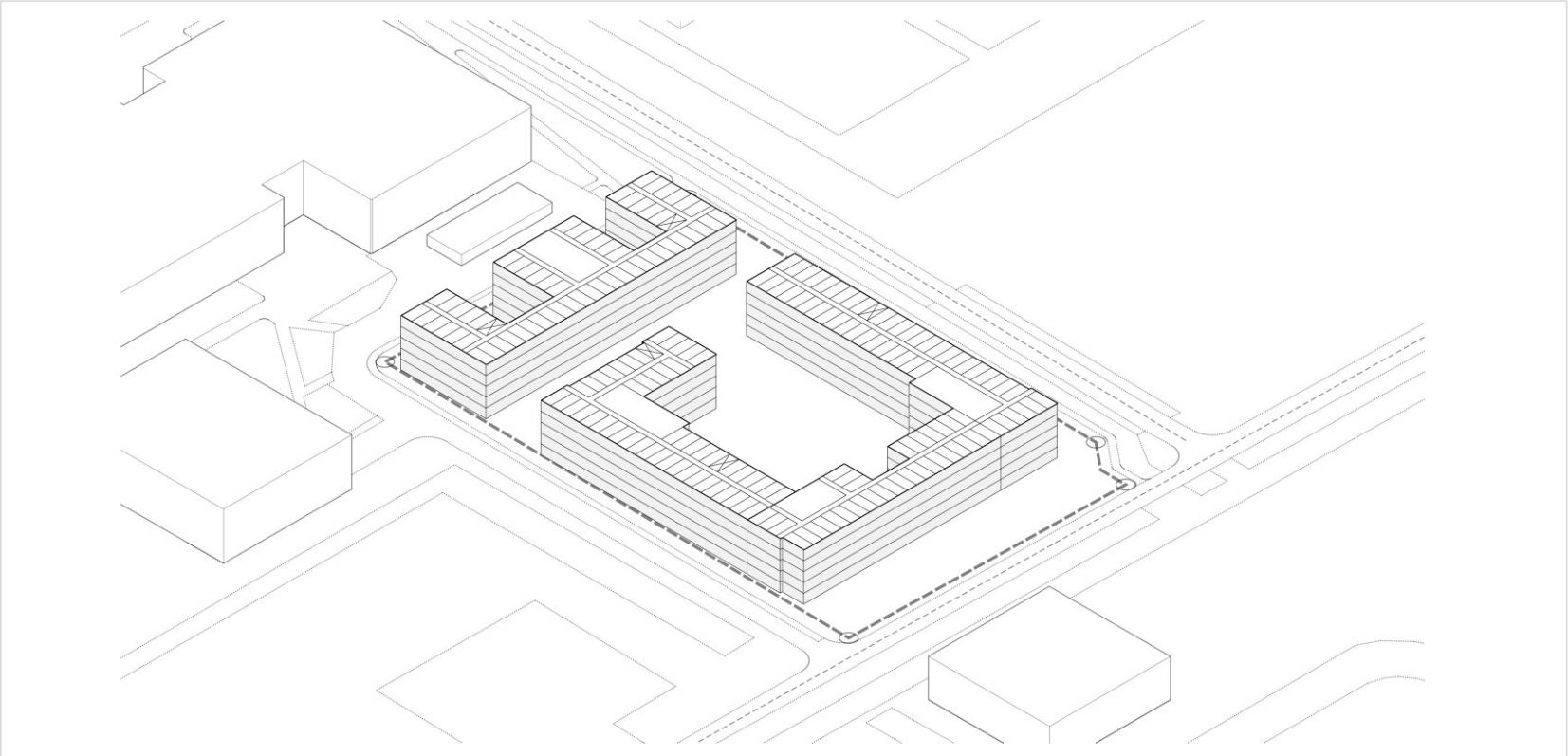
2. Material Use

☒

3. Average Sun Hours

☒

RUN



RESULTS:

Total Living Units: 930

number of floors: 5
total area: 27115 m2
area per floor: 5431 m2

Total Material Use: 12555 m3

floor: 2290 m3
load-bearing: 351 m3
partition walls: 43 m3
elevation: 52 m3

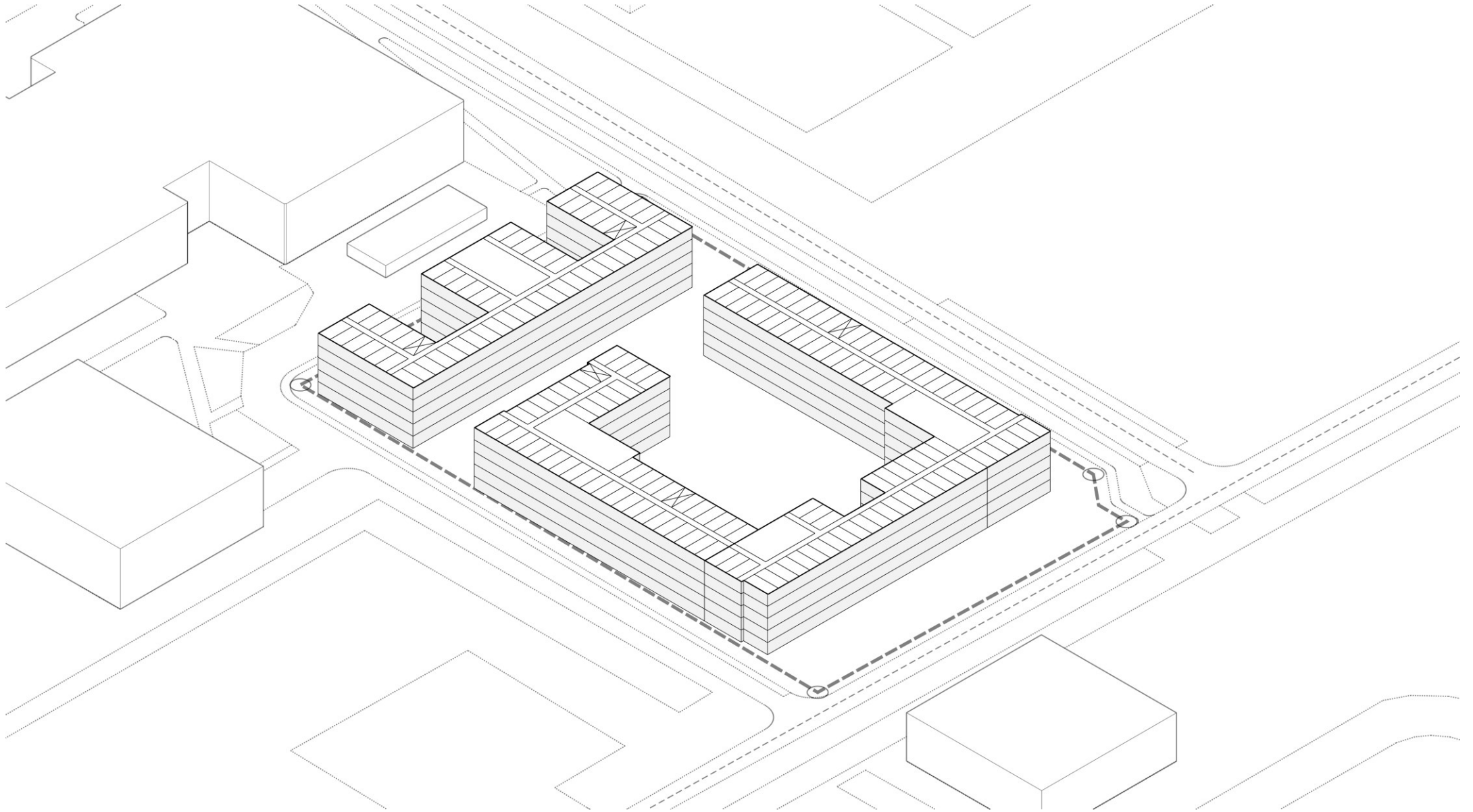
Average Sun Hours: 5,1

sDA: 75% (passed)
solar radiation: 32968 kWh/m2

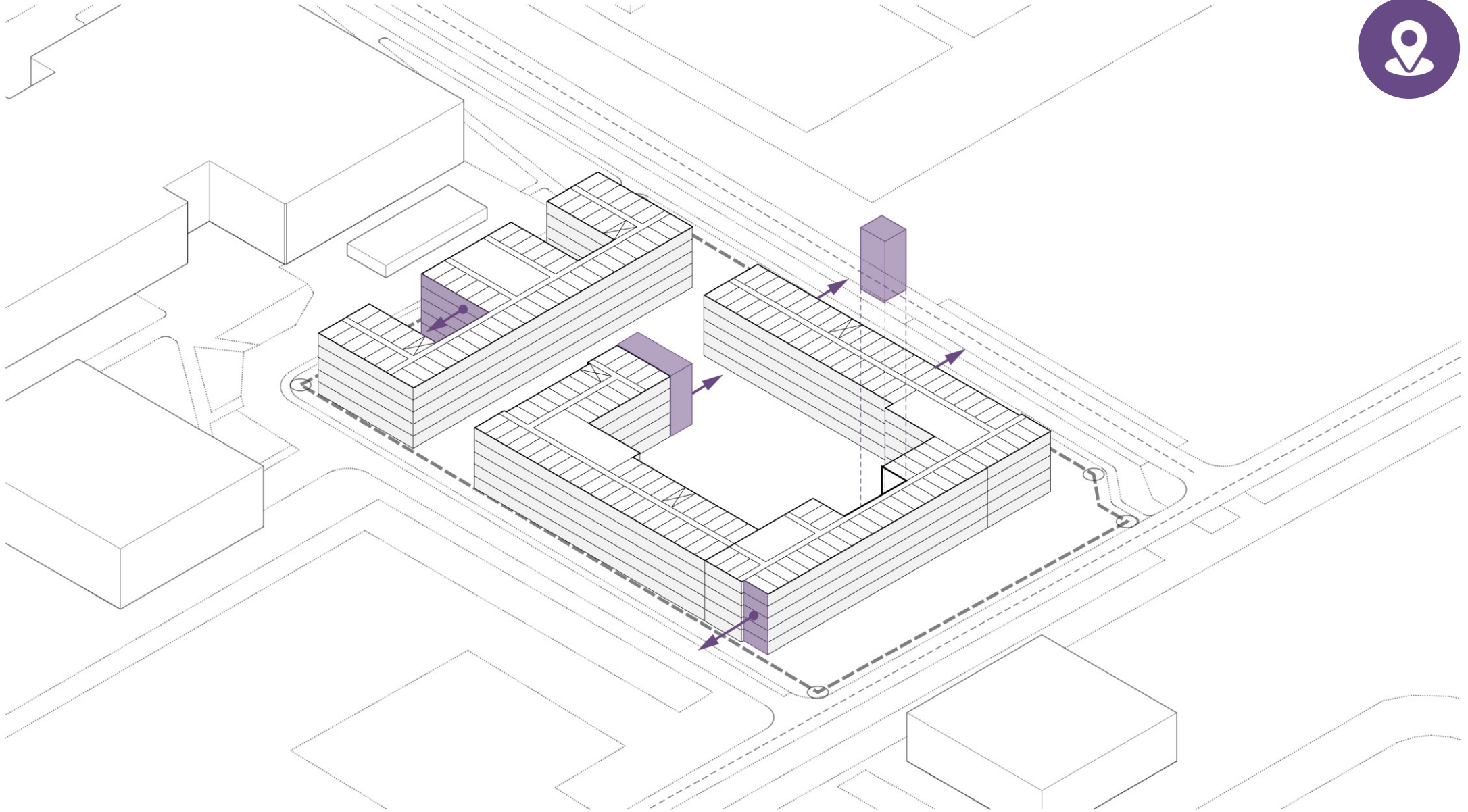
P5 PRESENTATION | aE | MODULE+

DESIGN

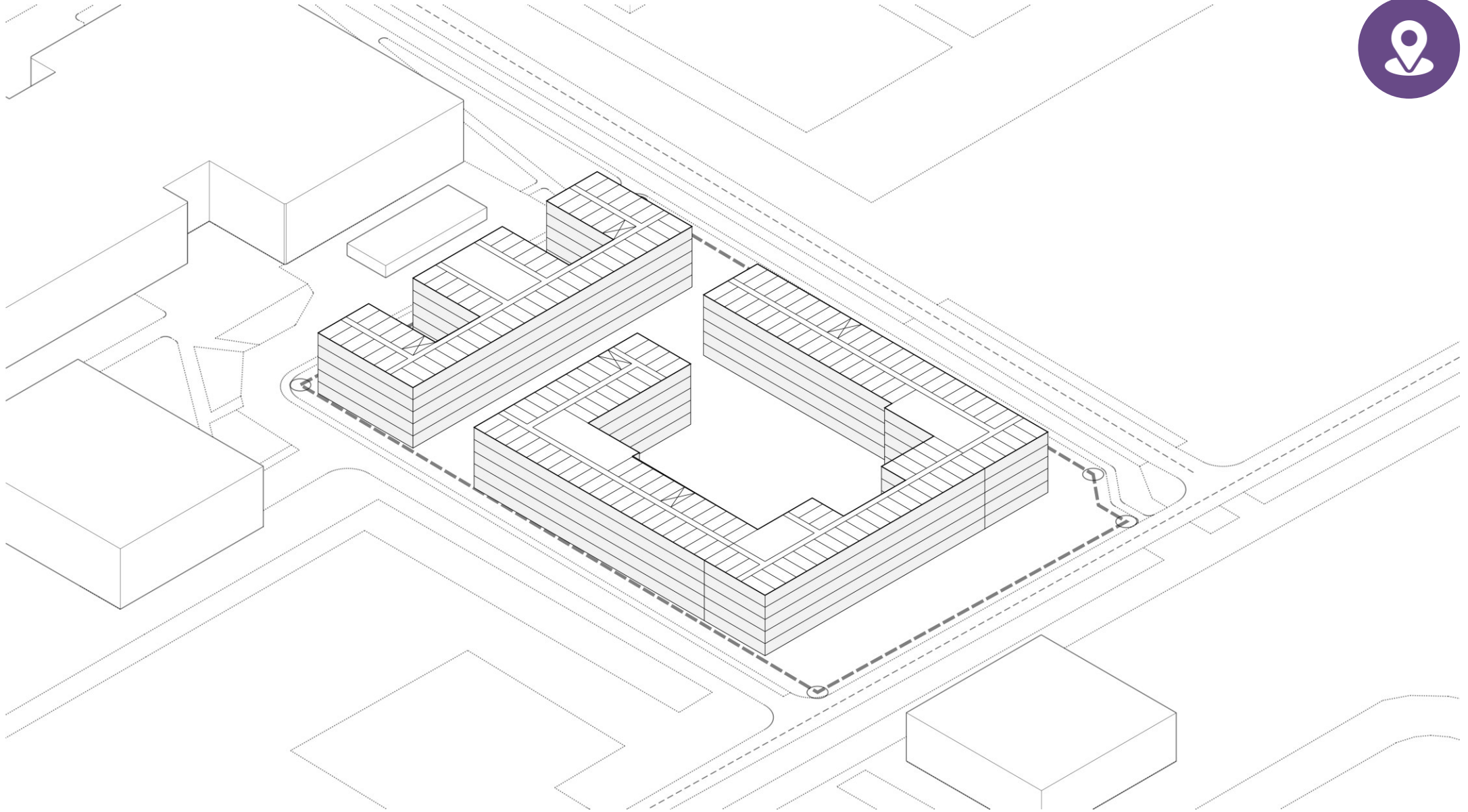
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



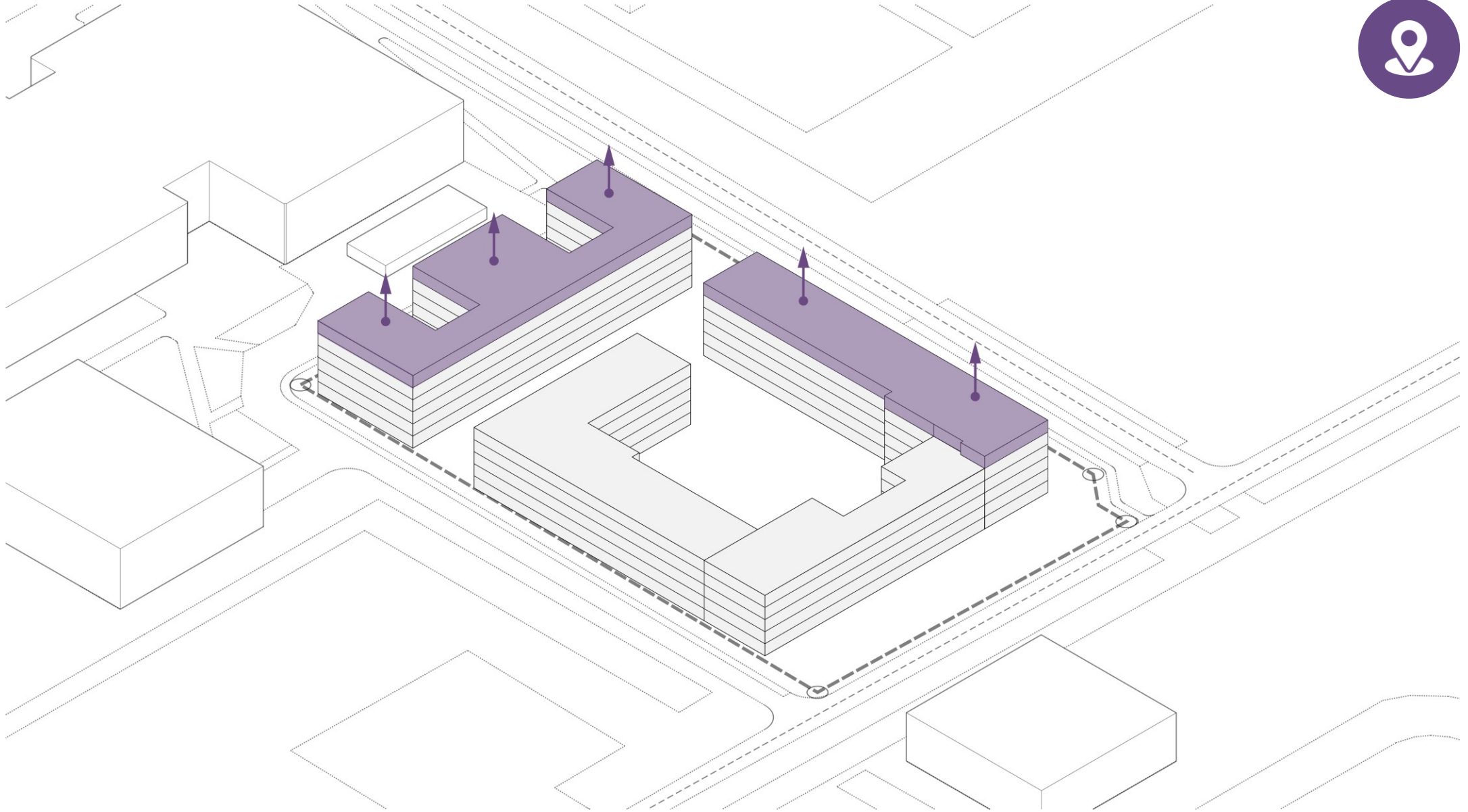
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



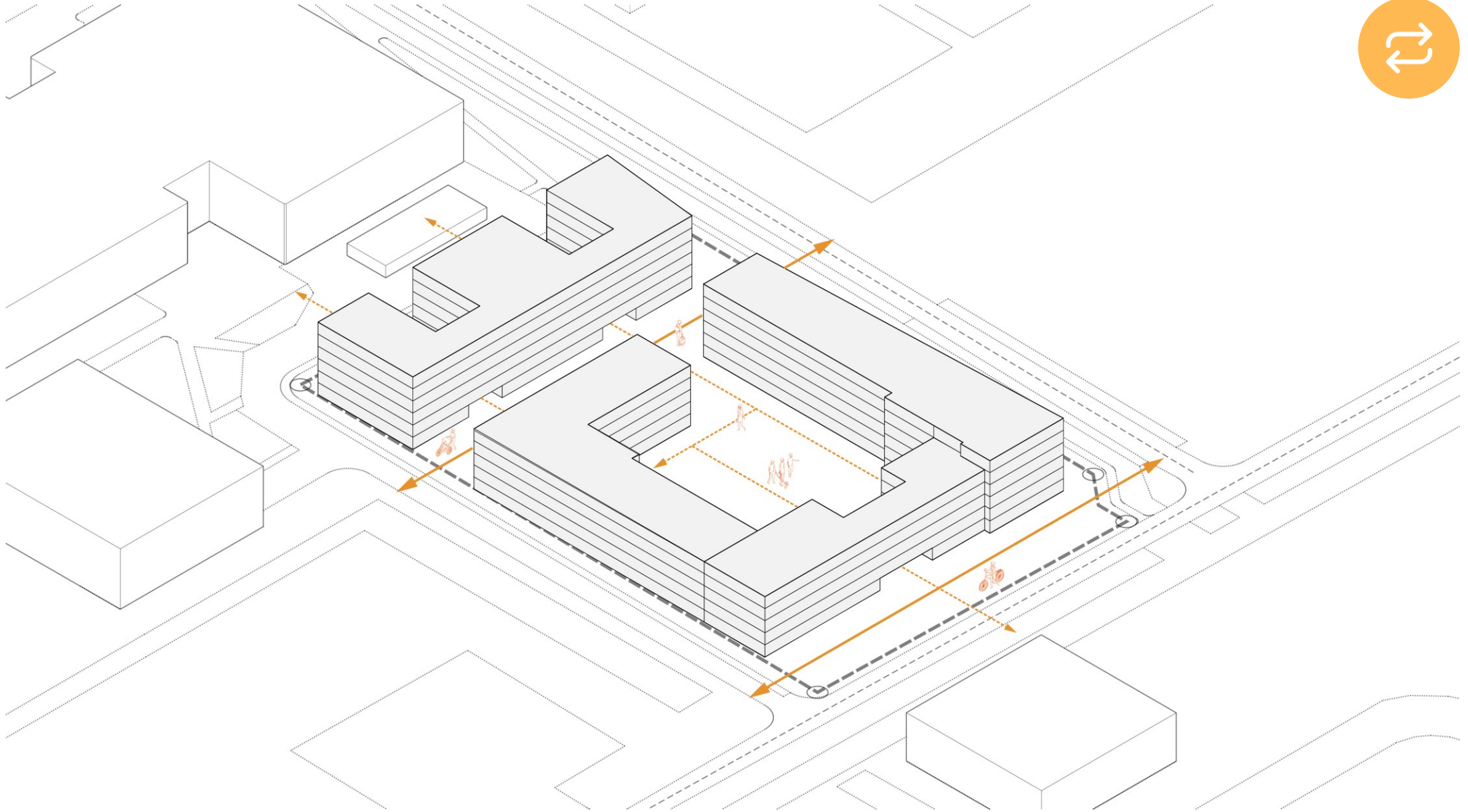
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



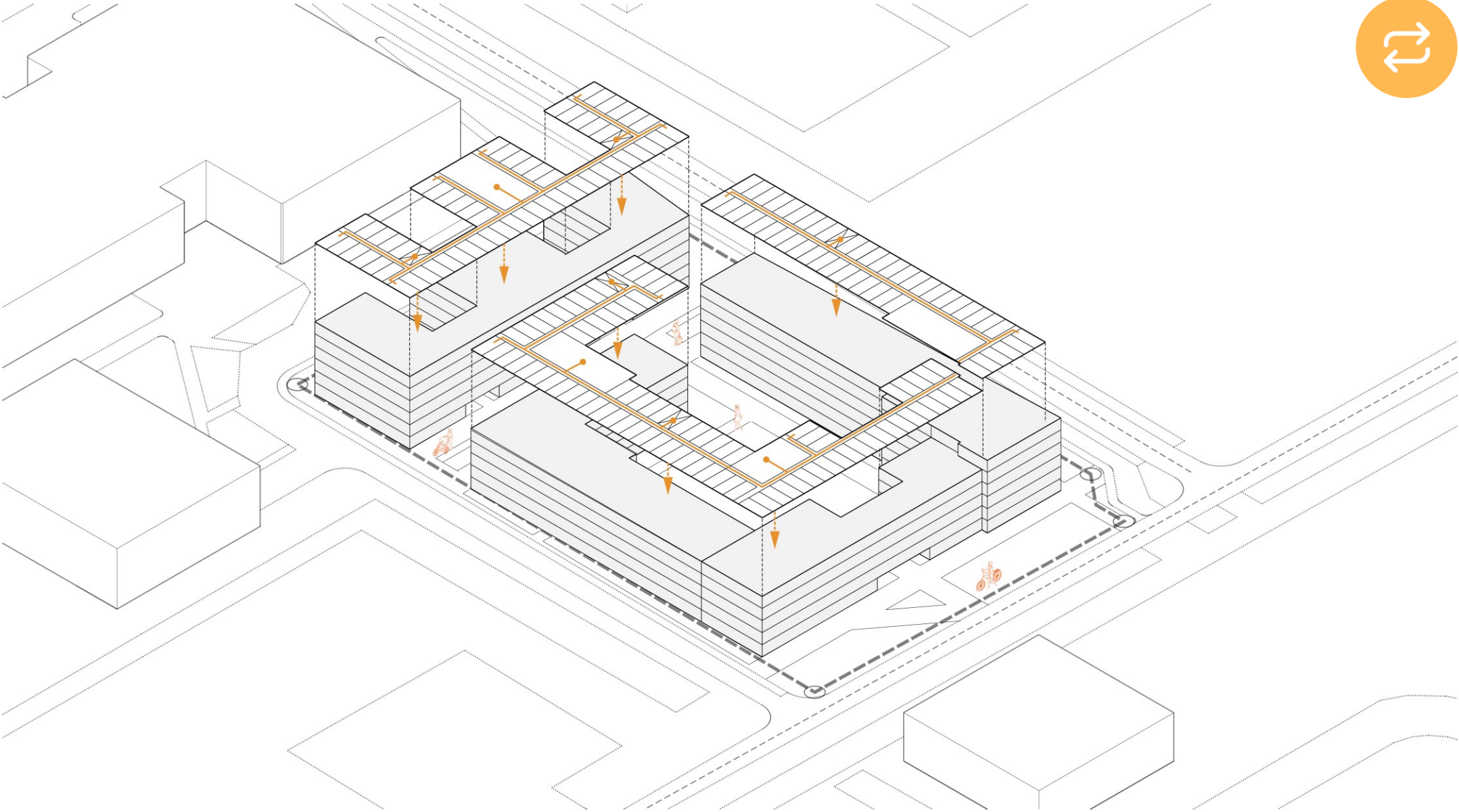
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



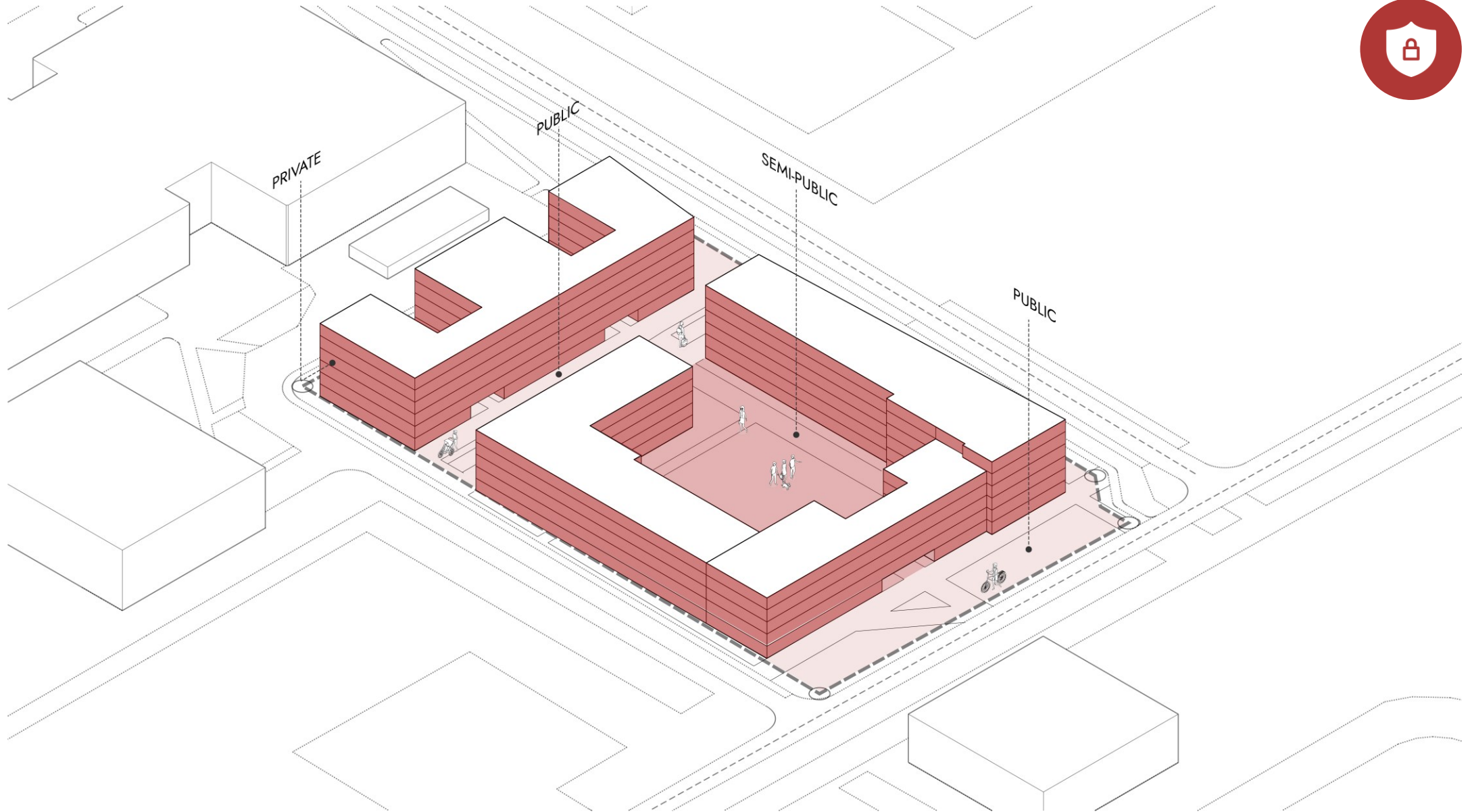
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



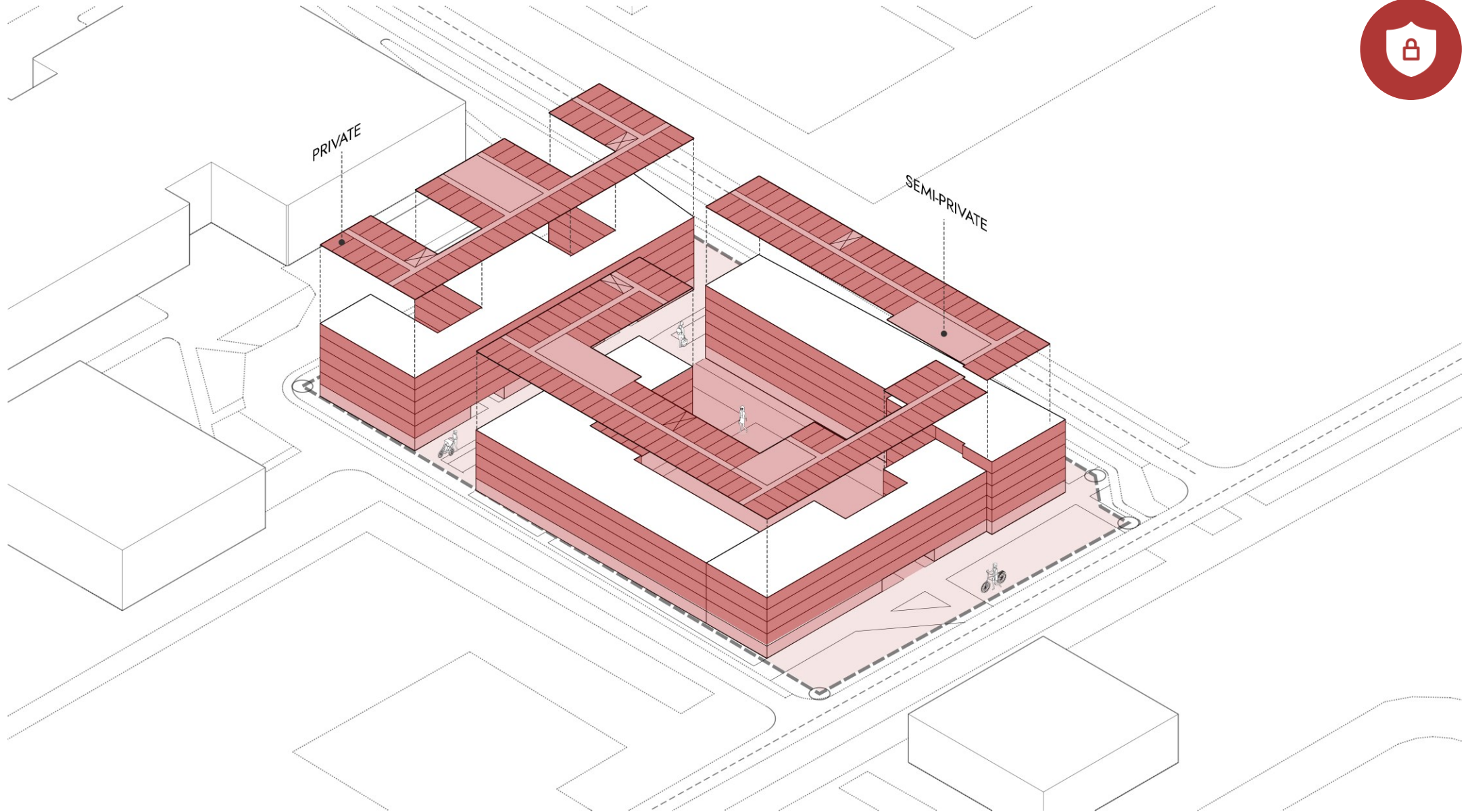
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



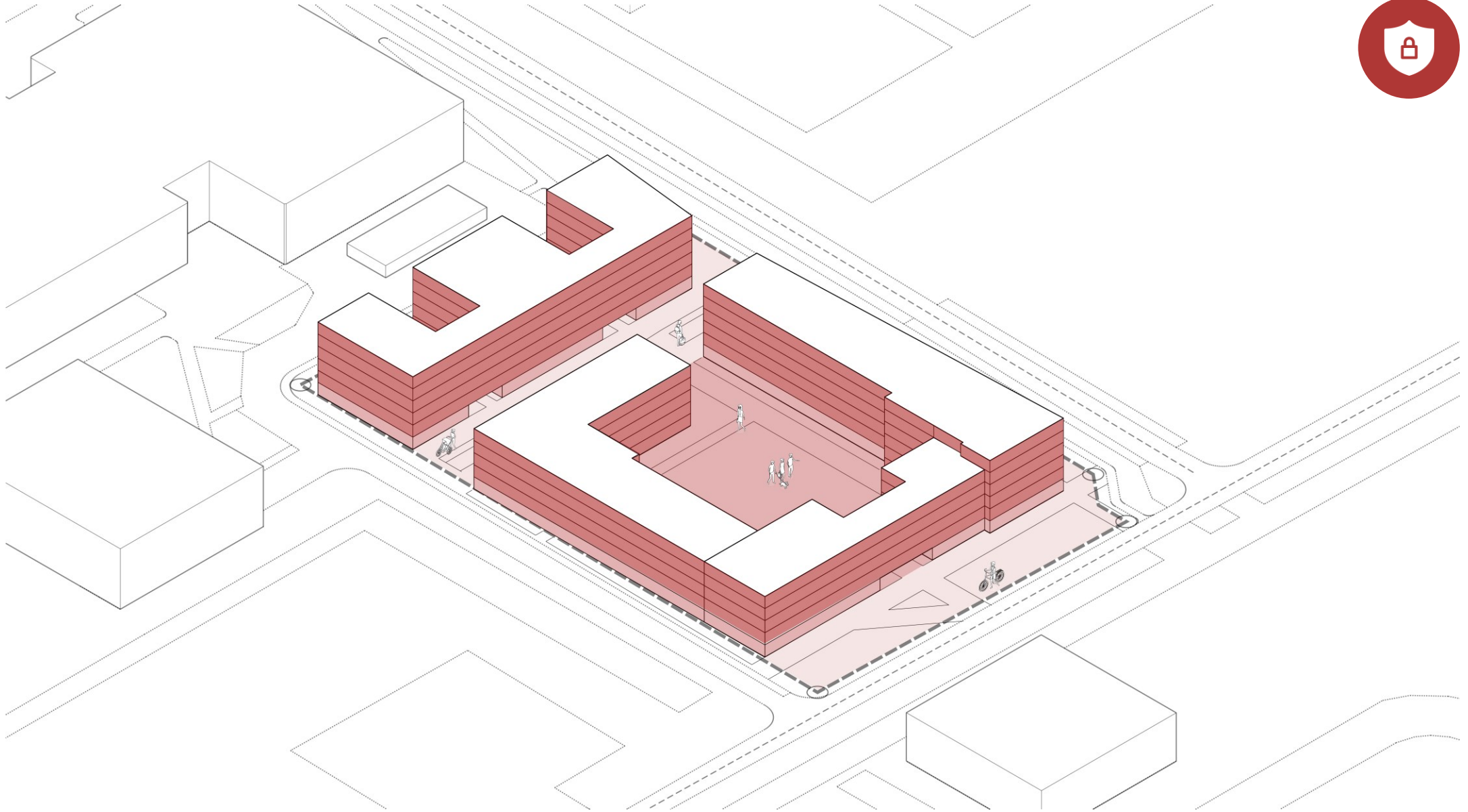
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



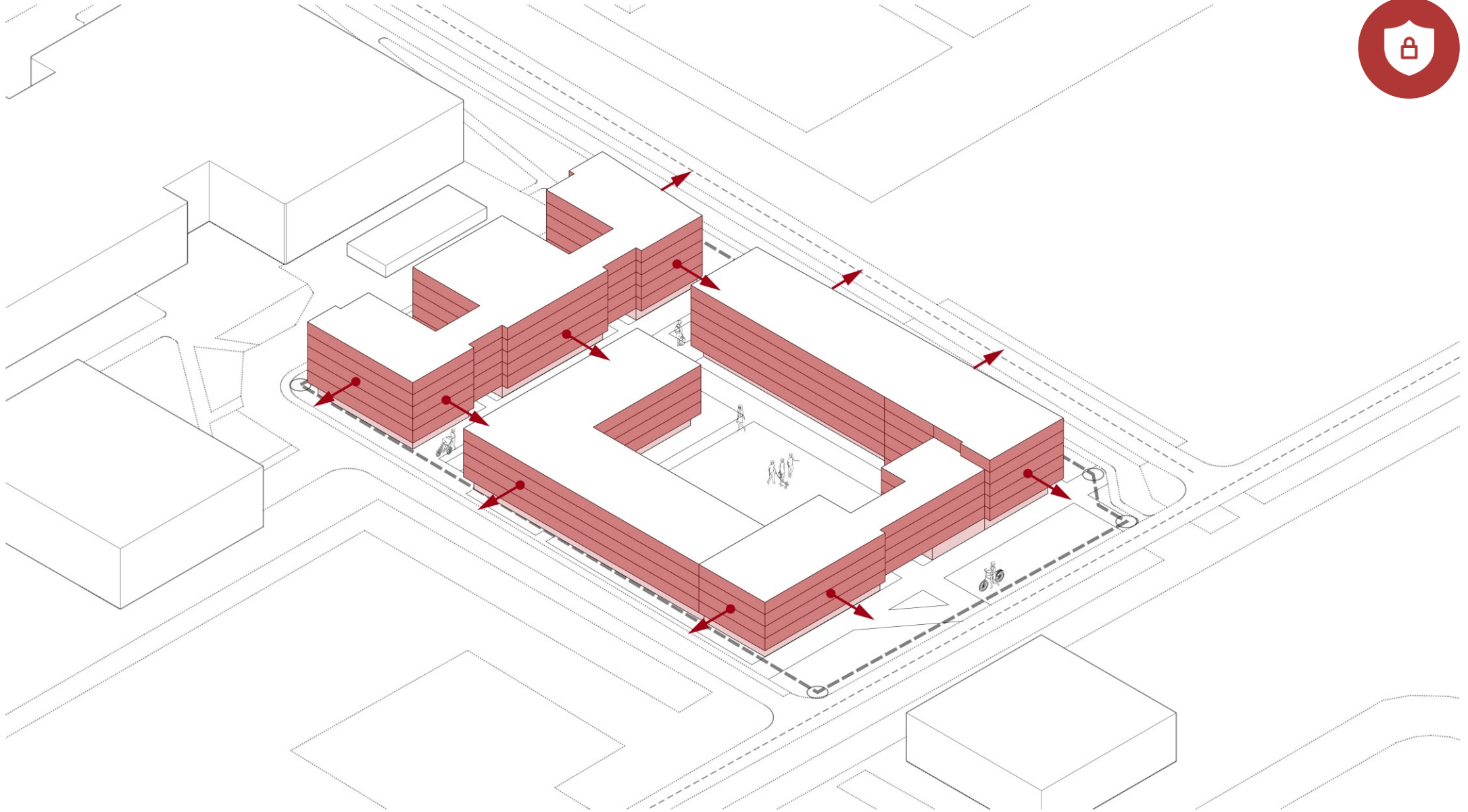
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



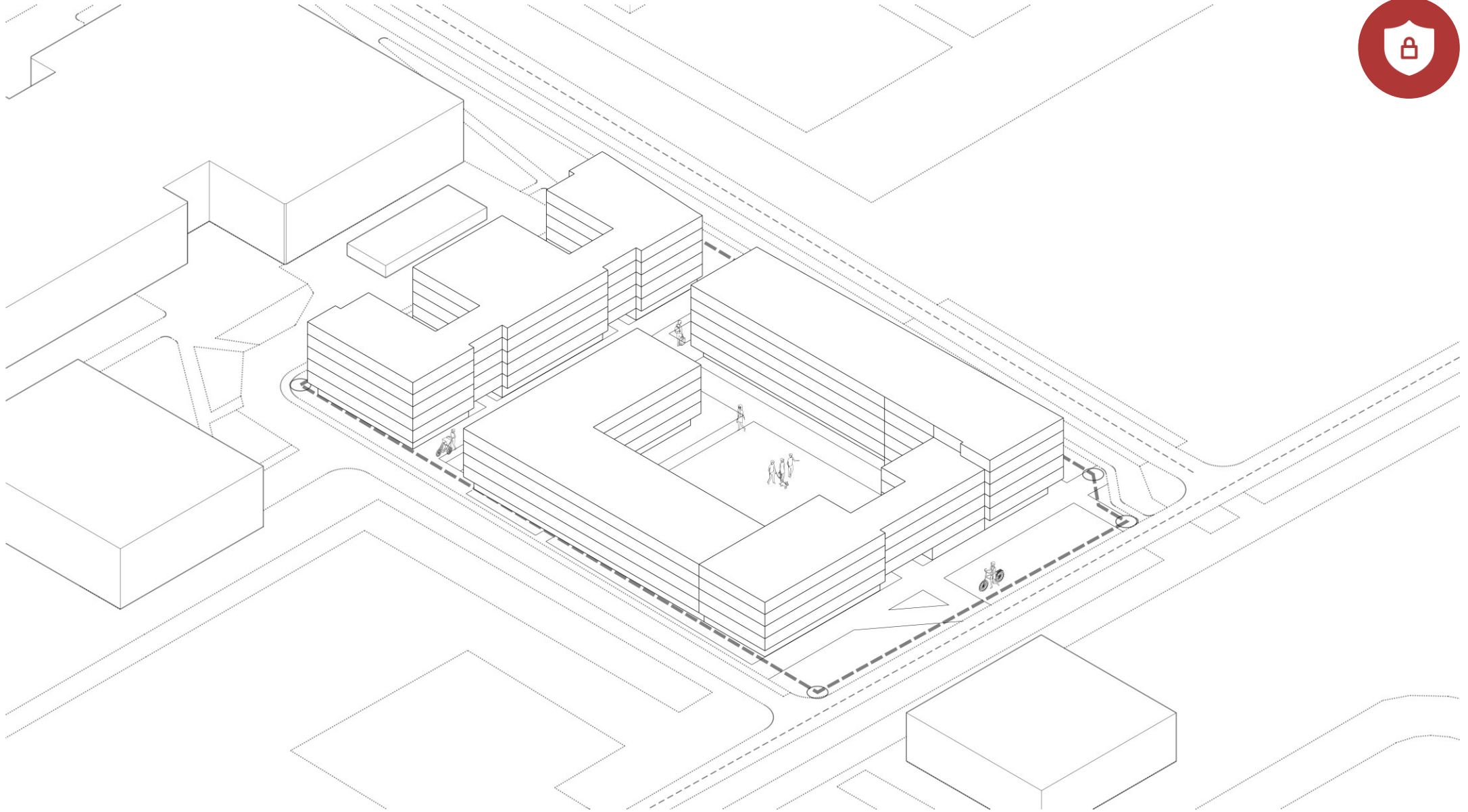
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



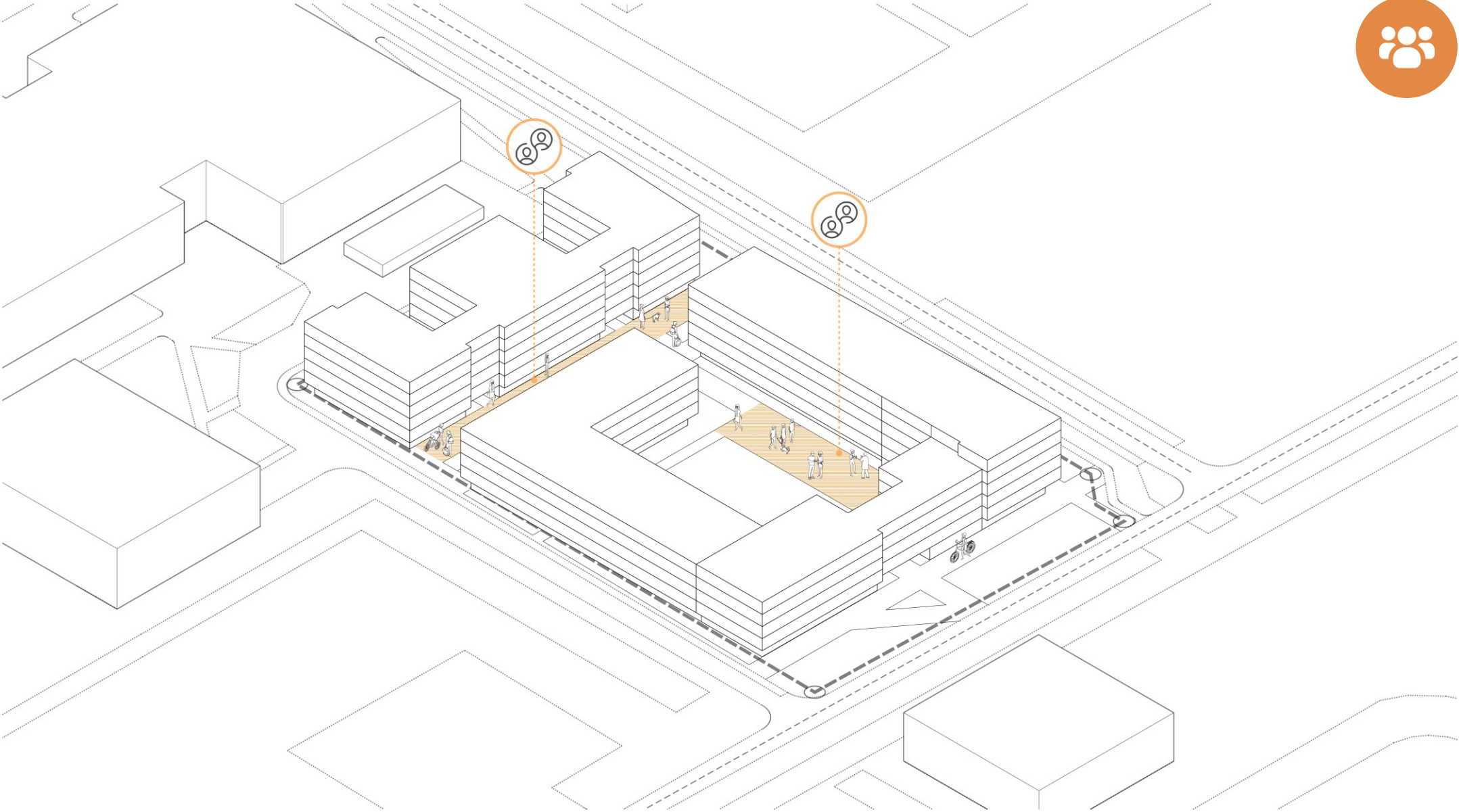
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



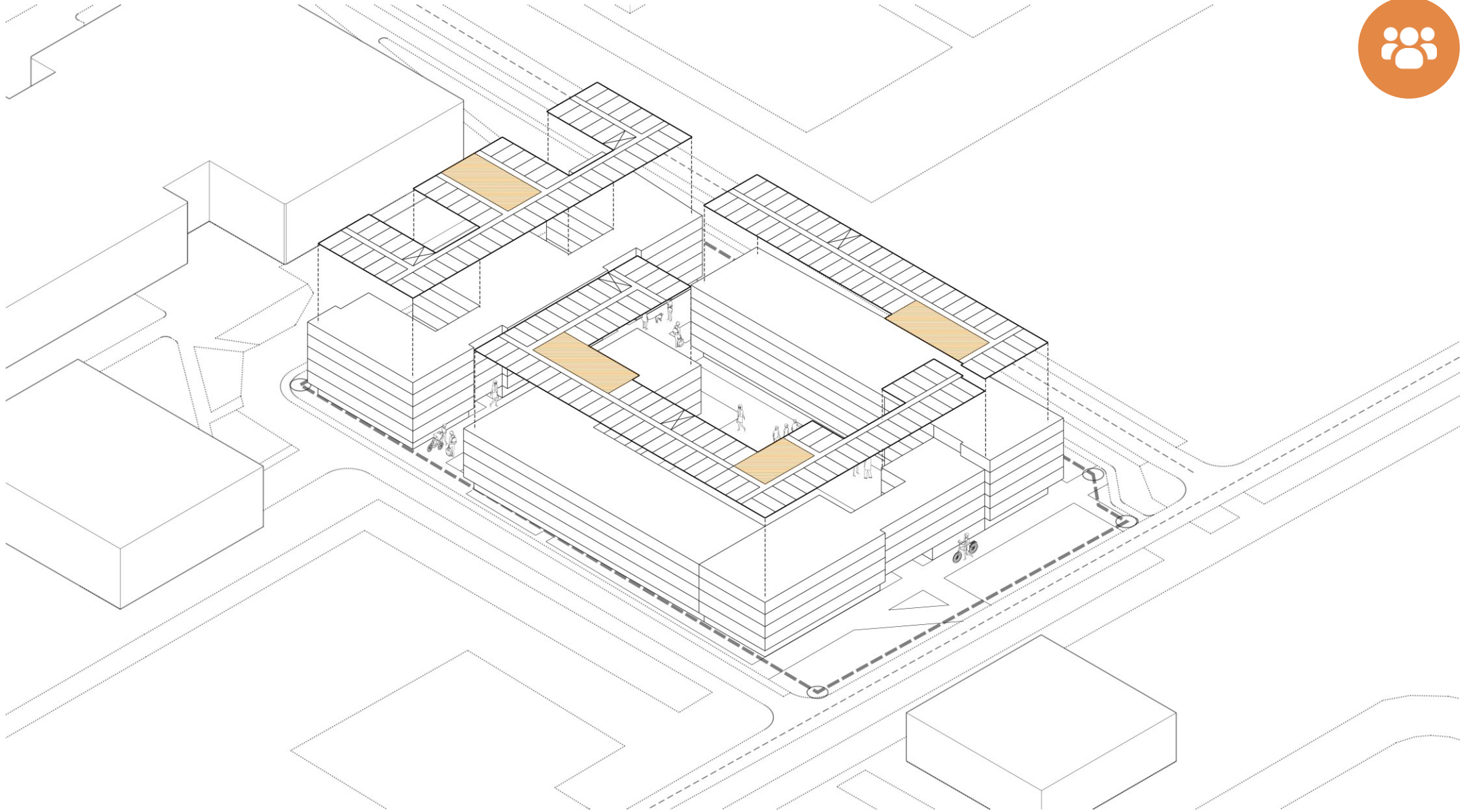
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



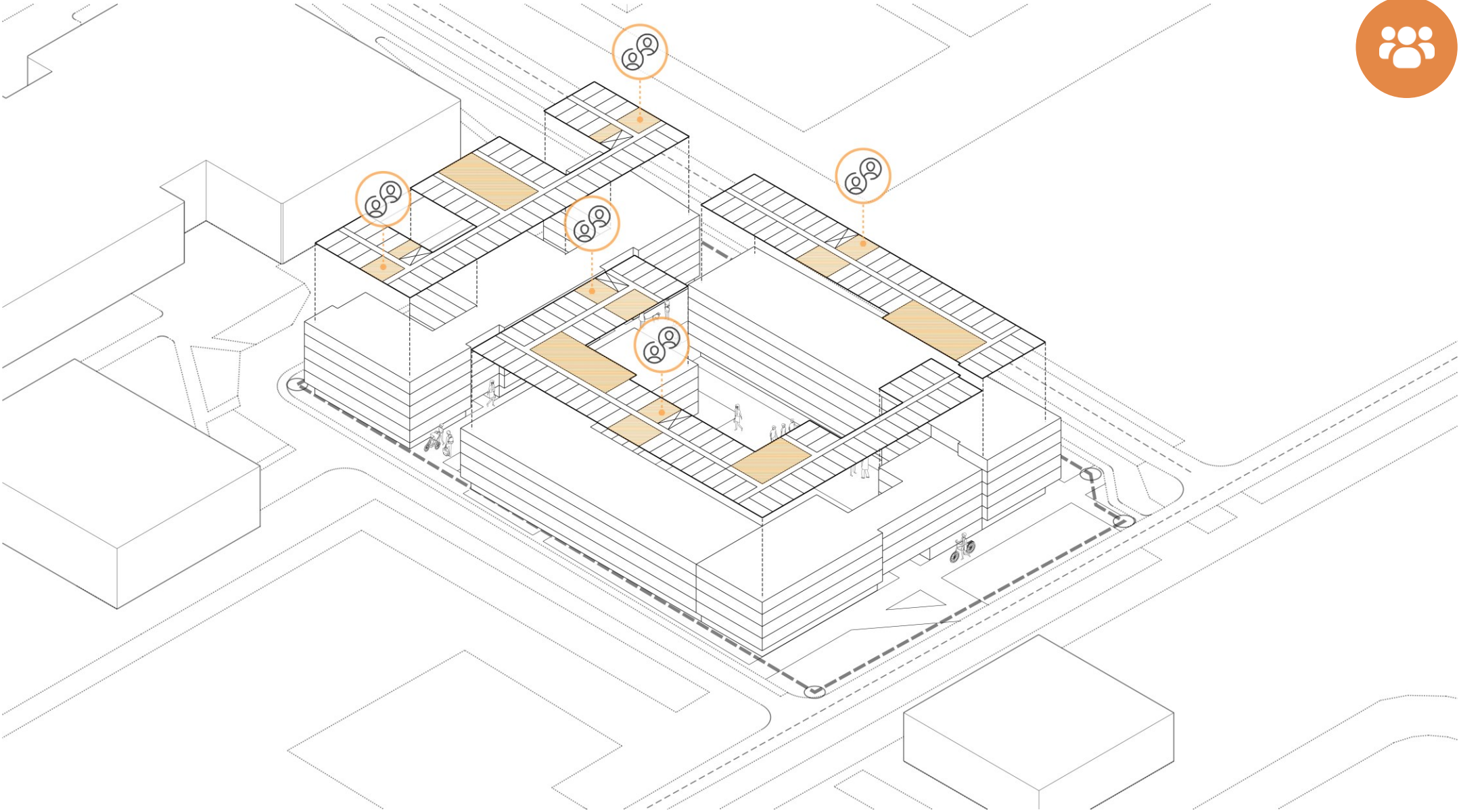
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



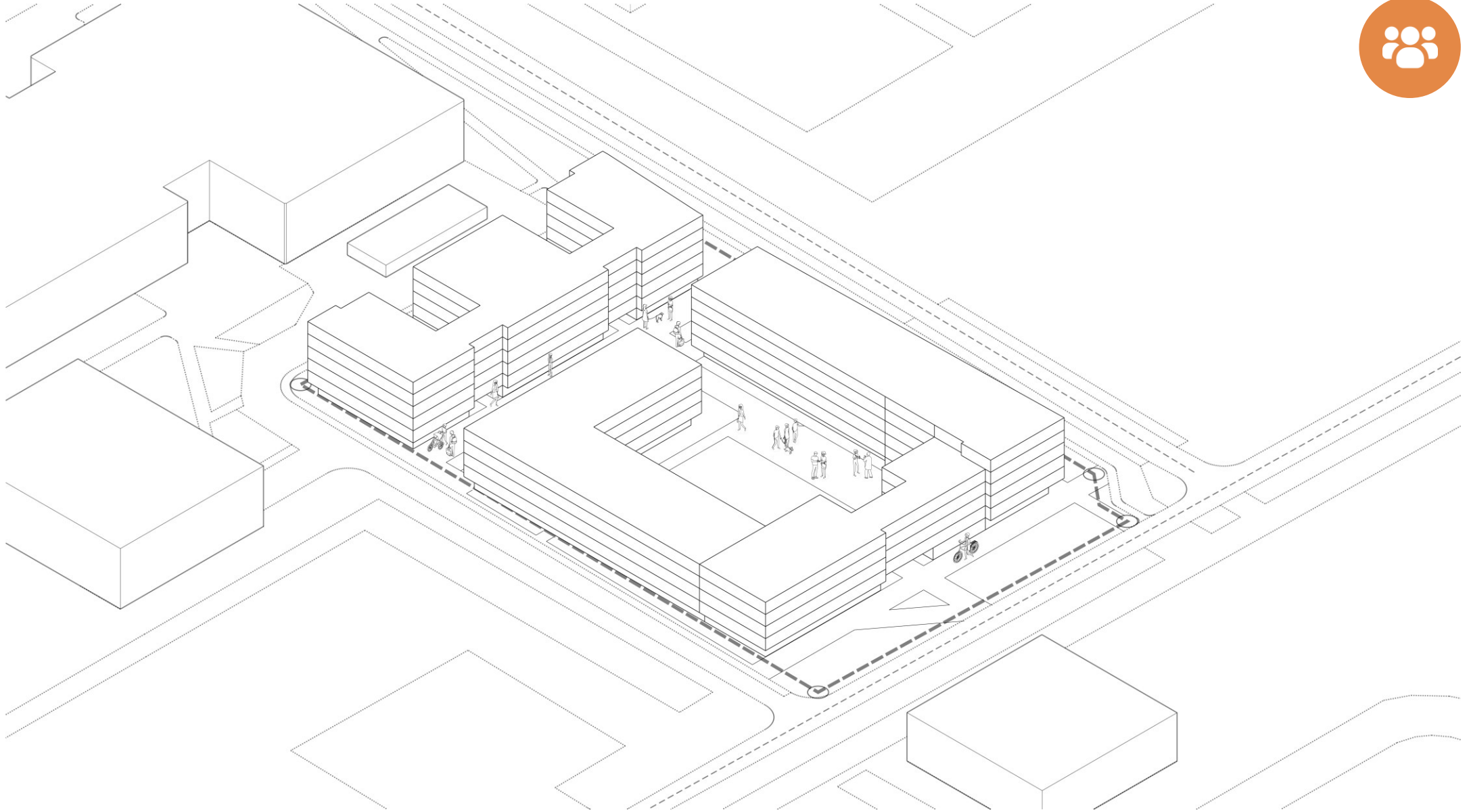
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



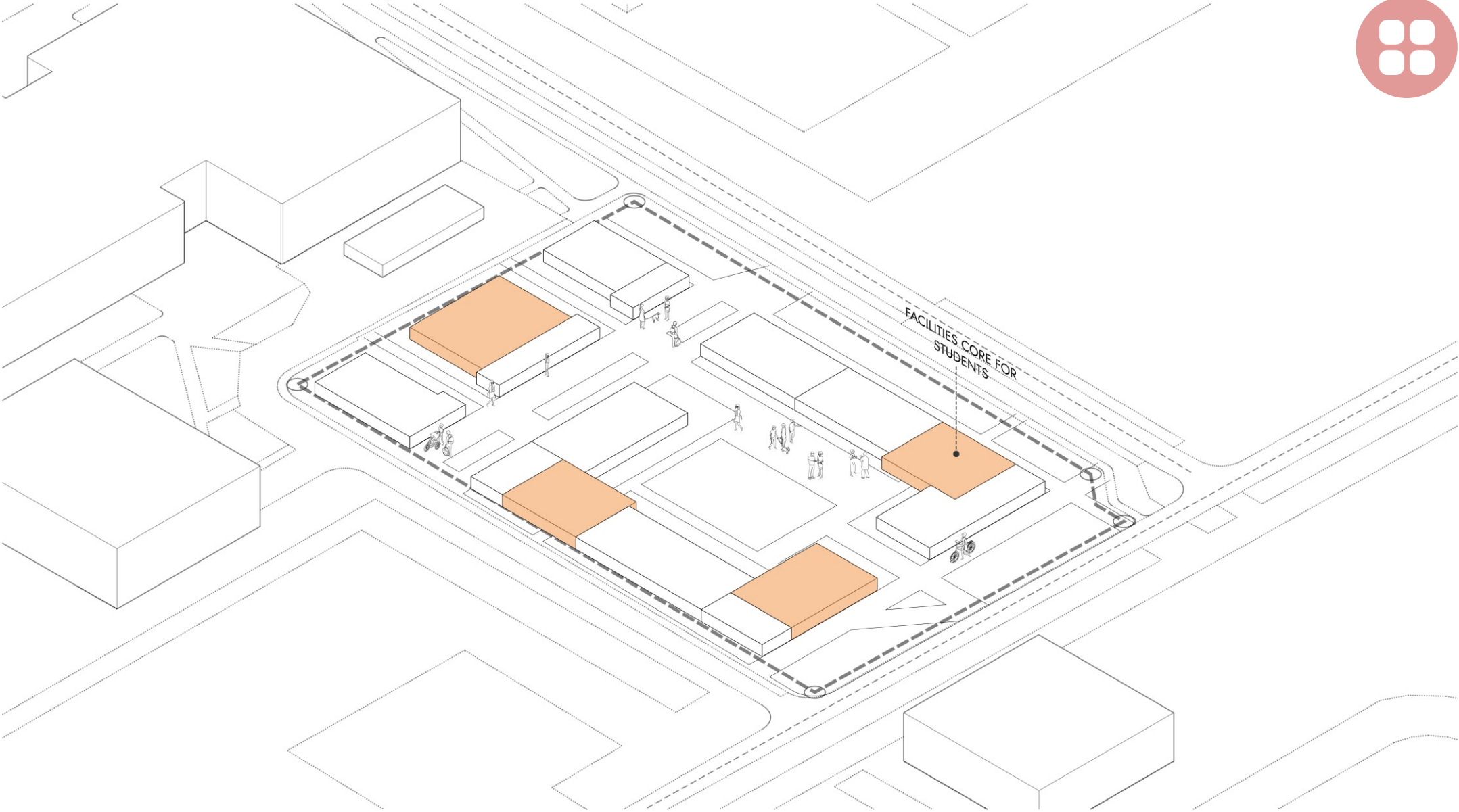
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



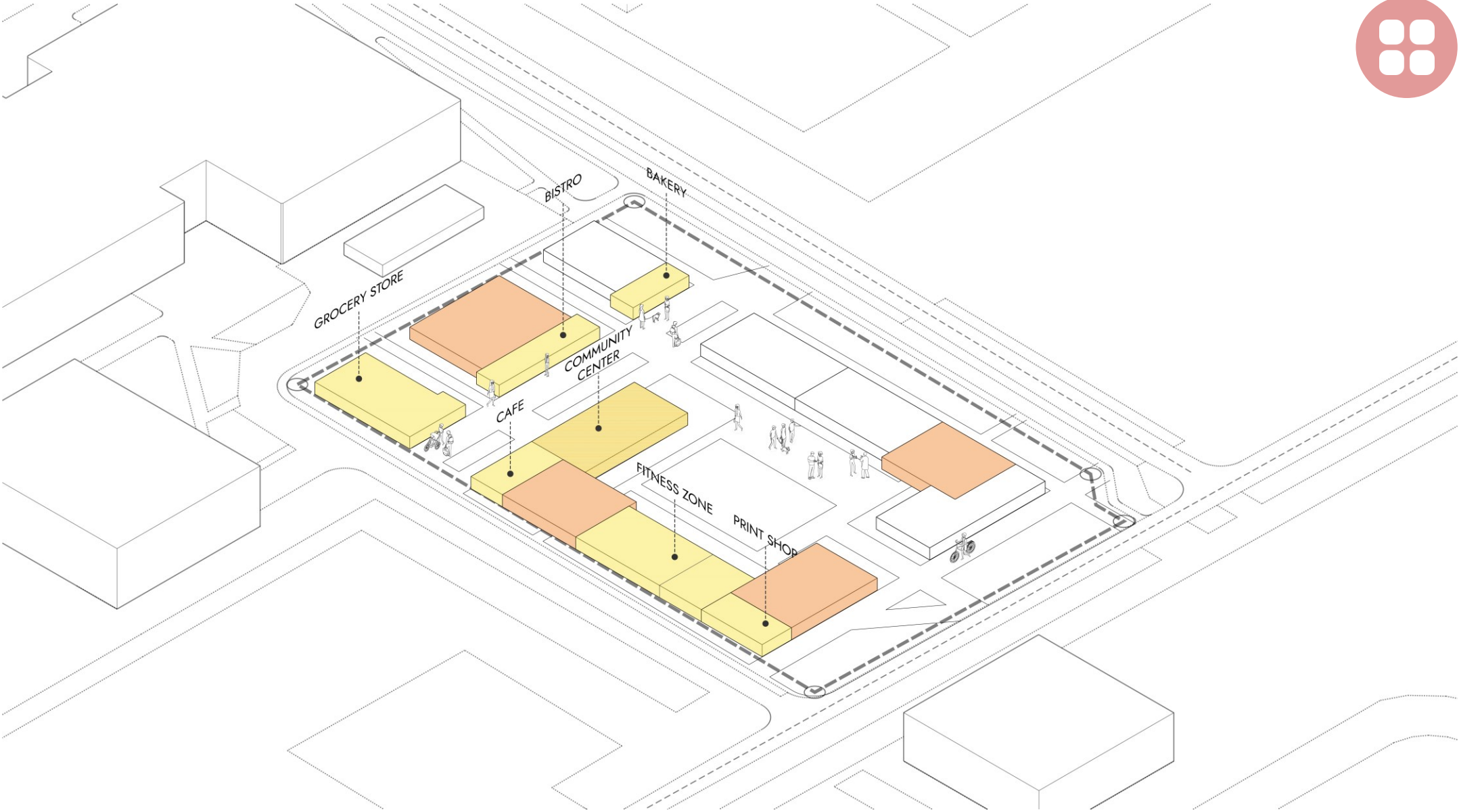
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



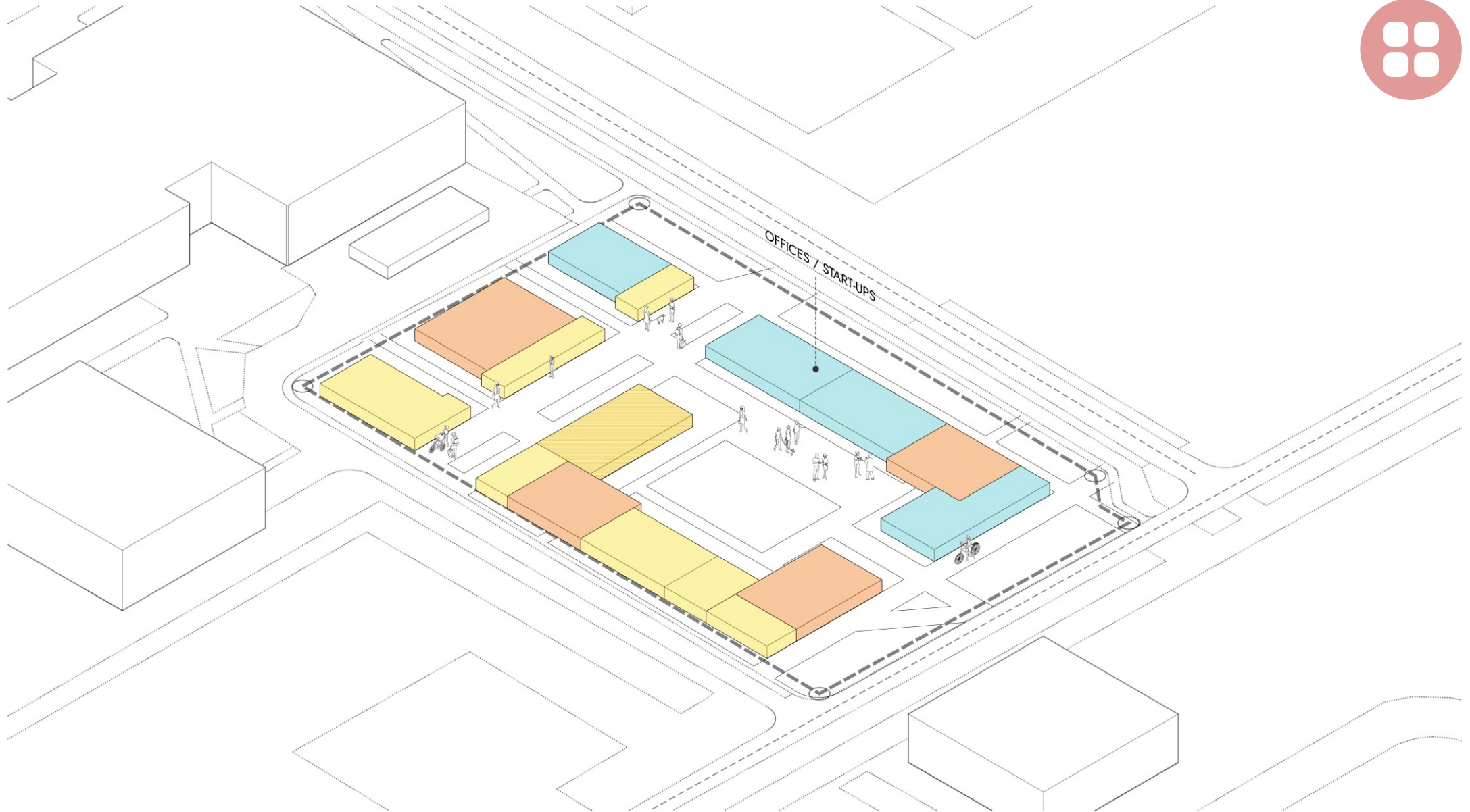
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



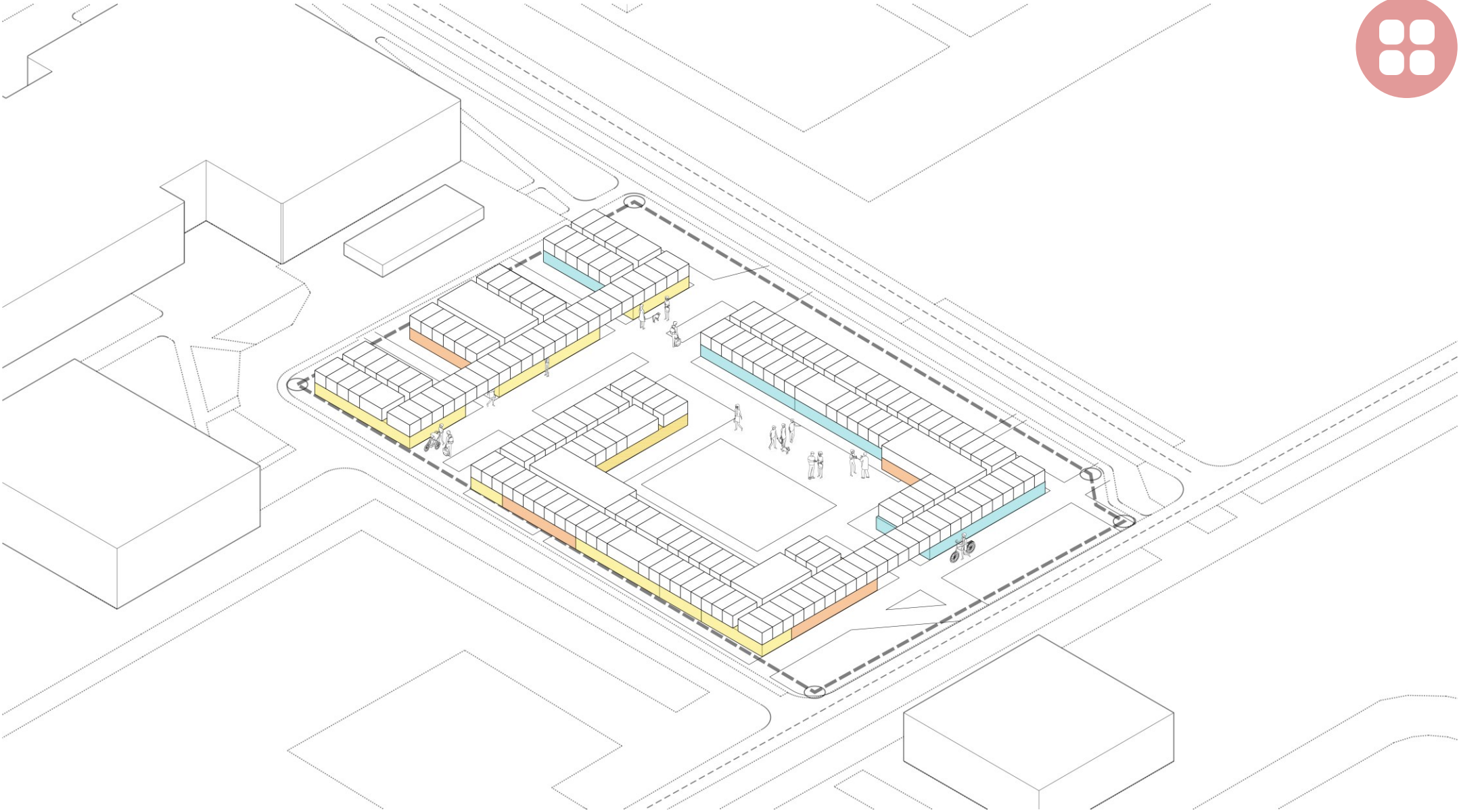
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



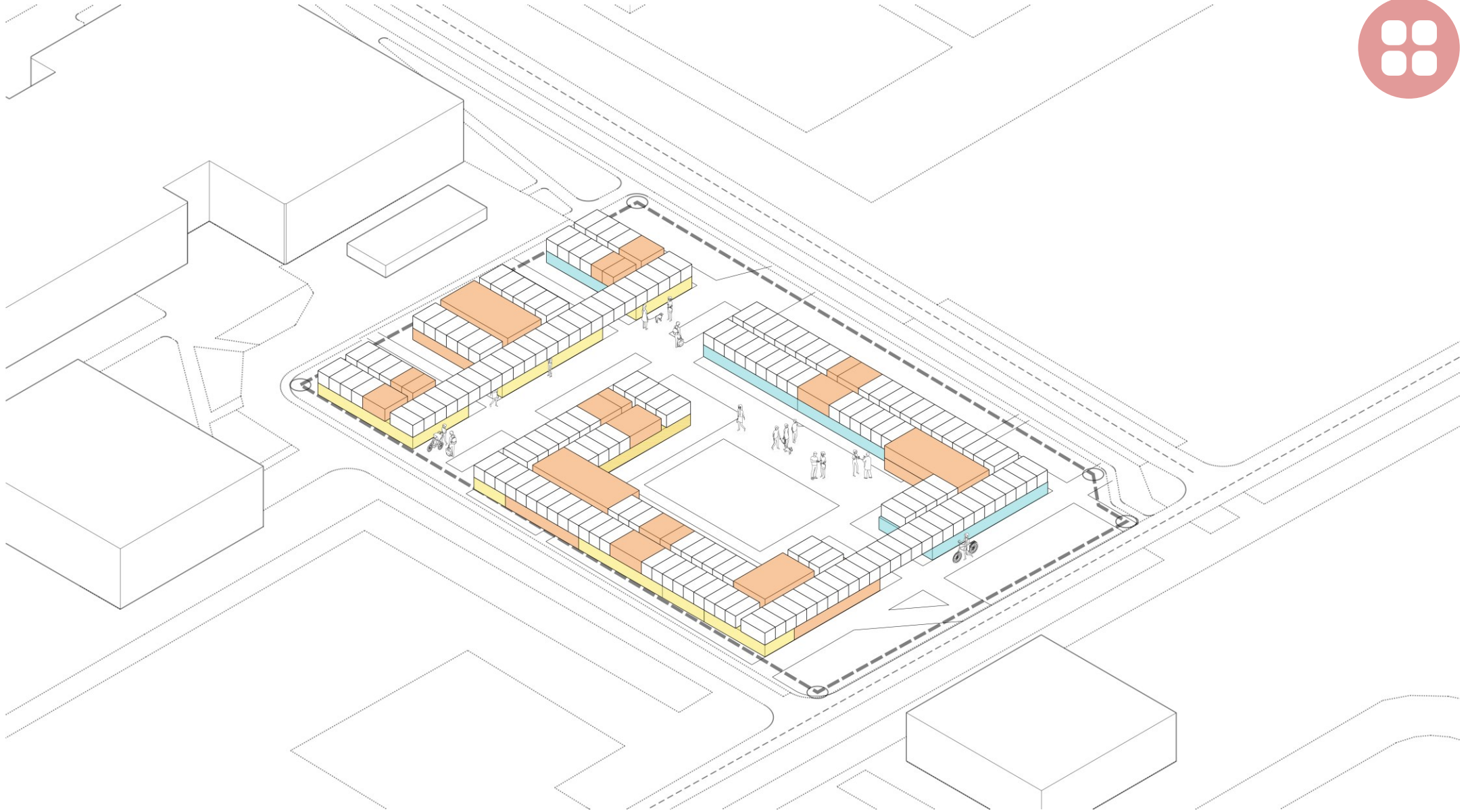
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



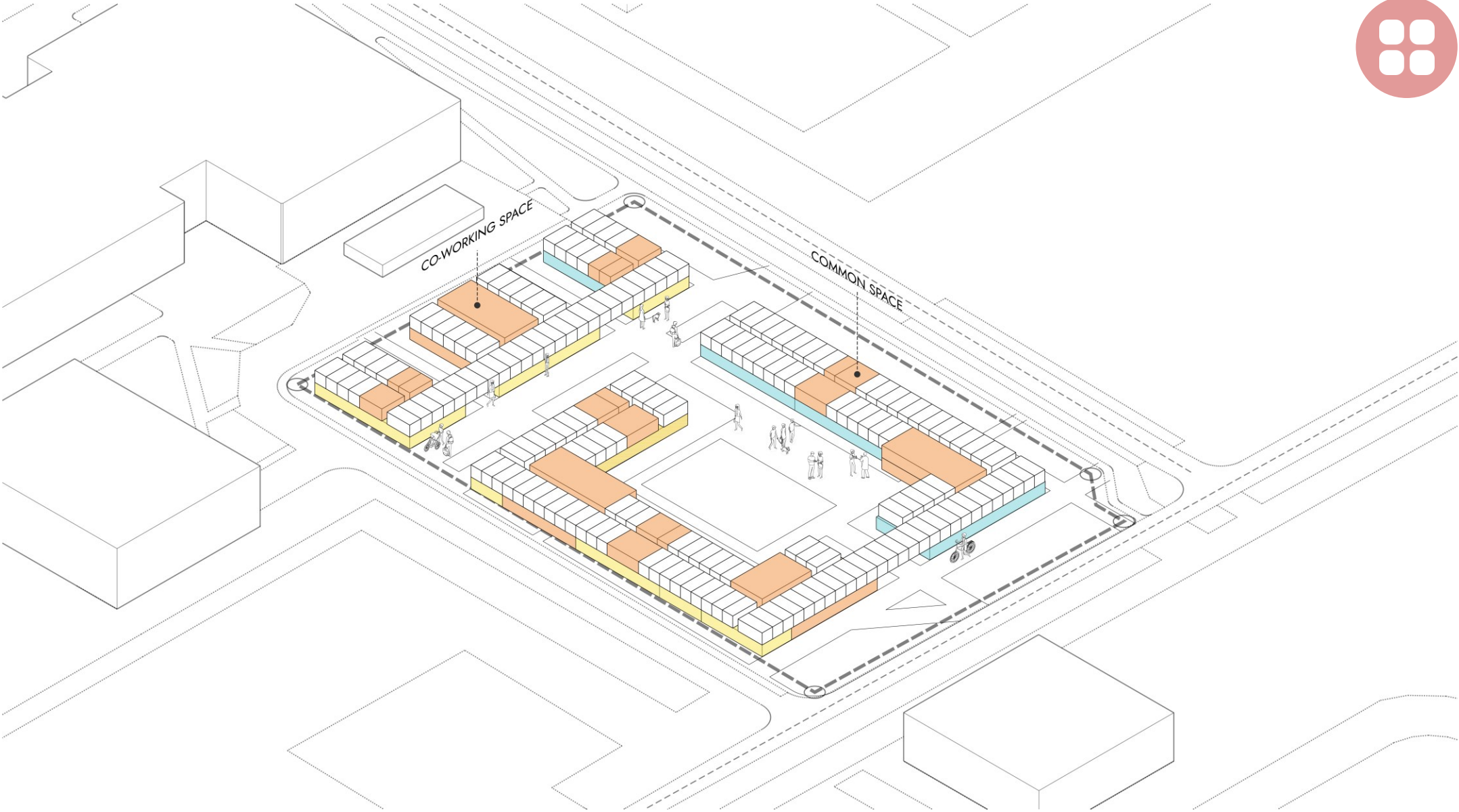
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



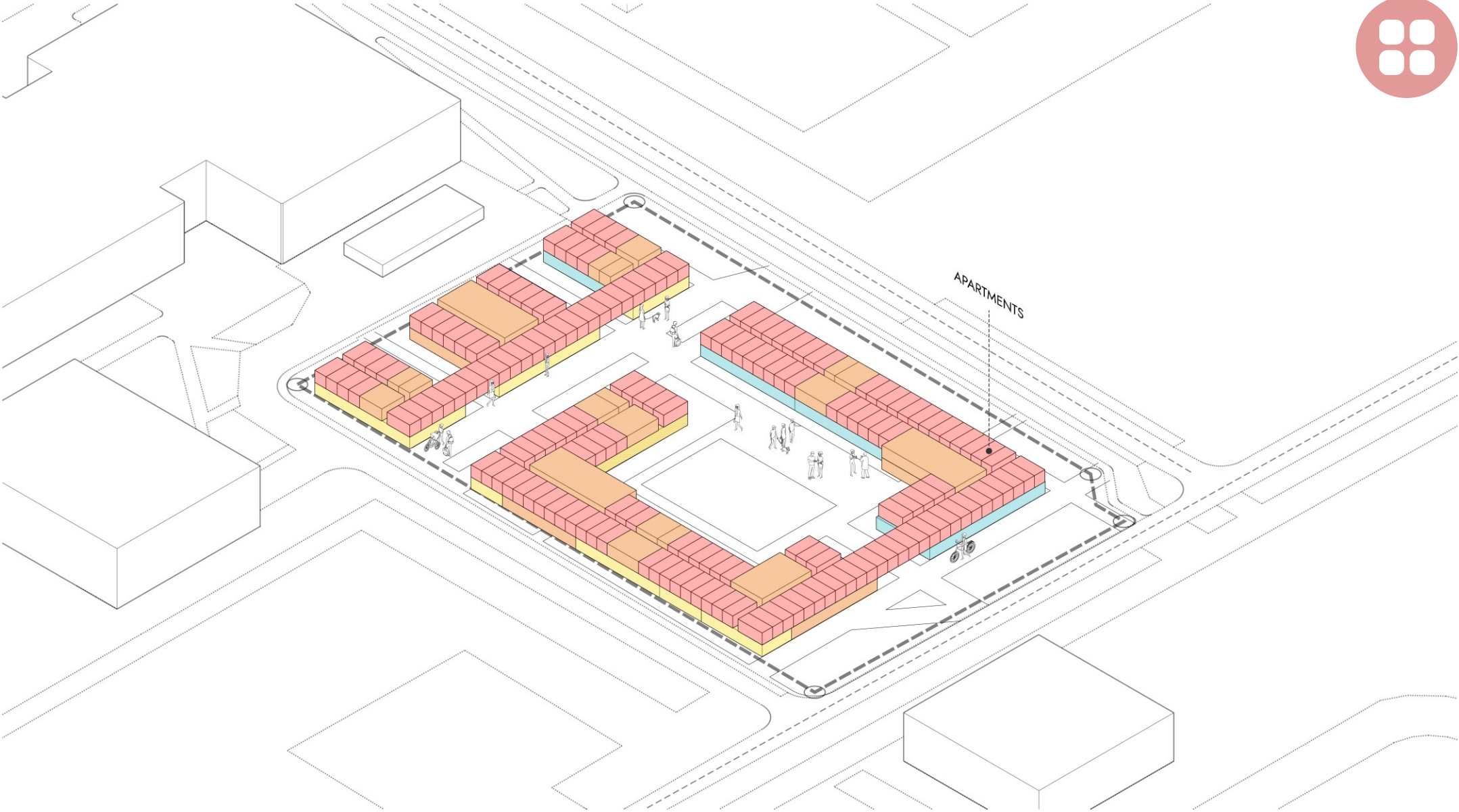
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



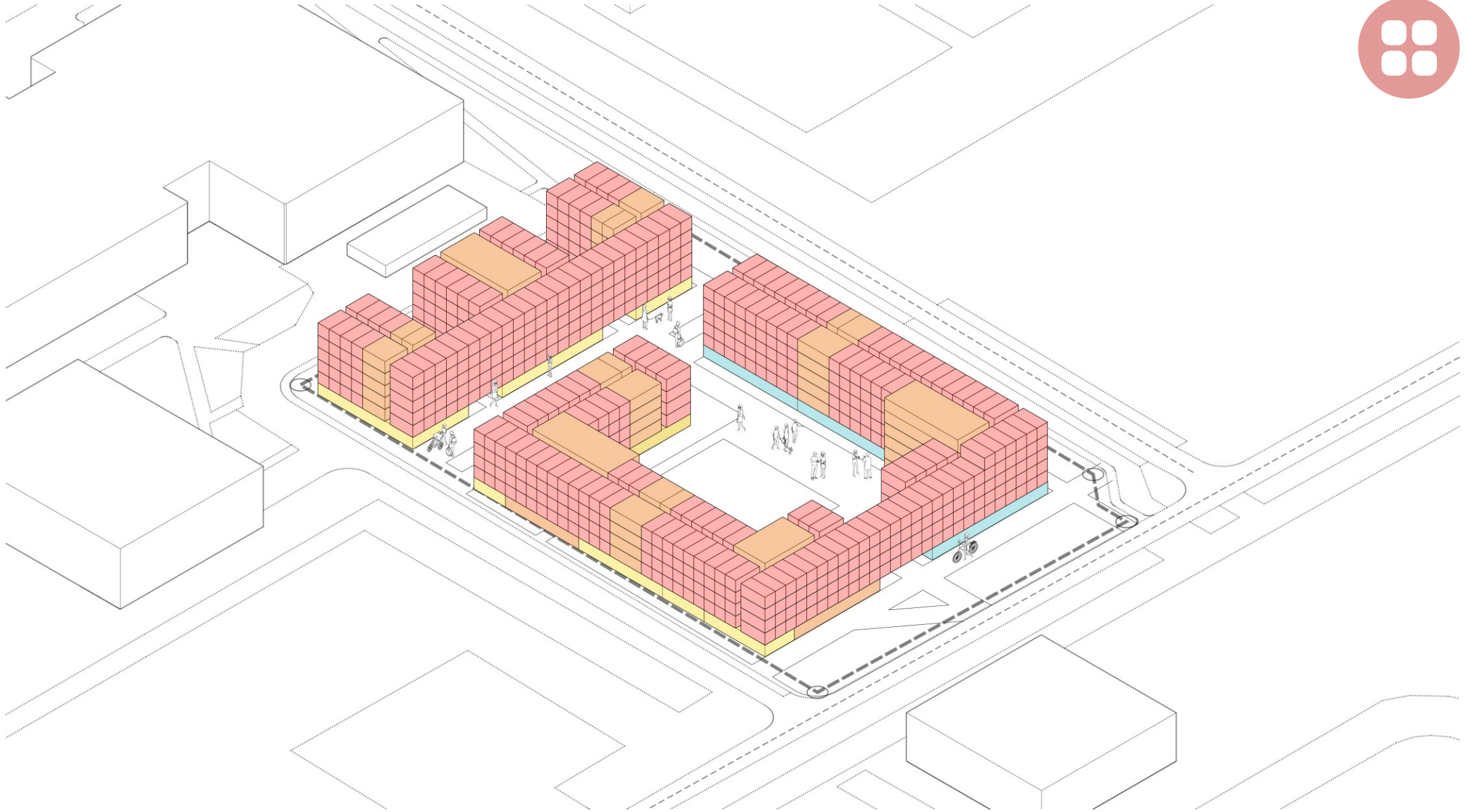
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



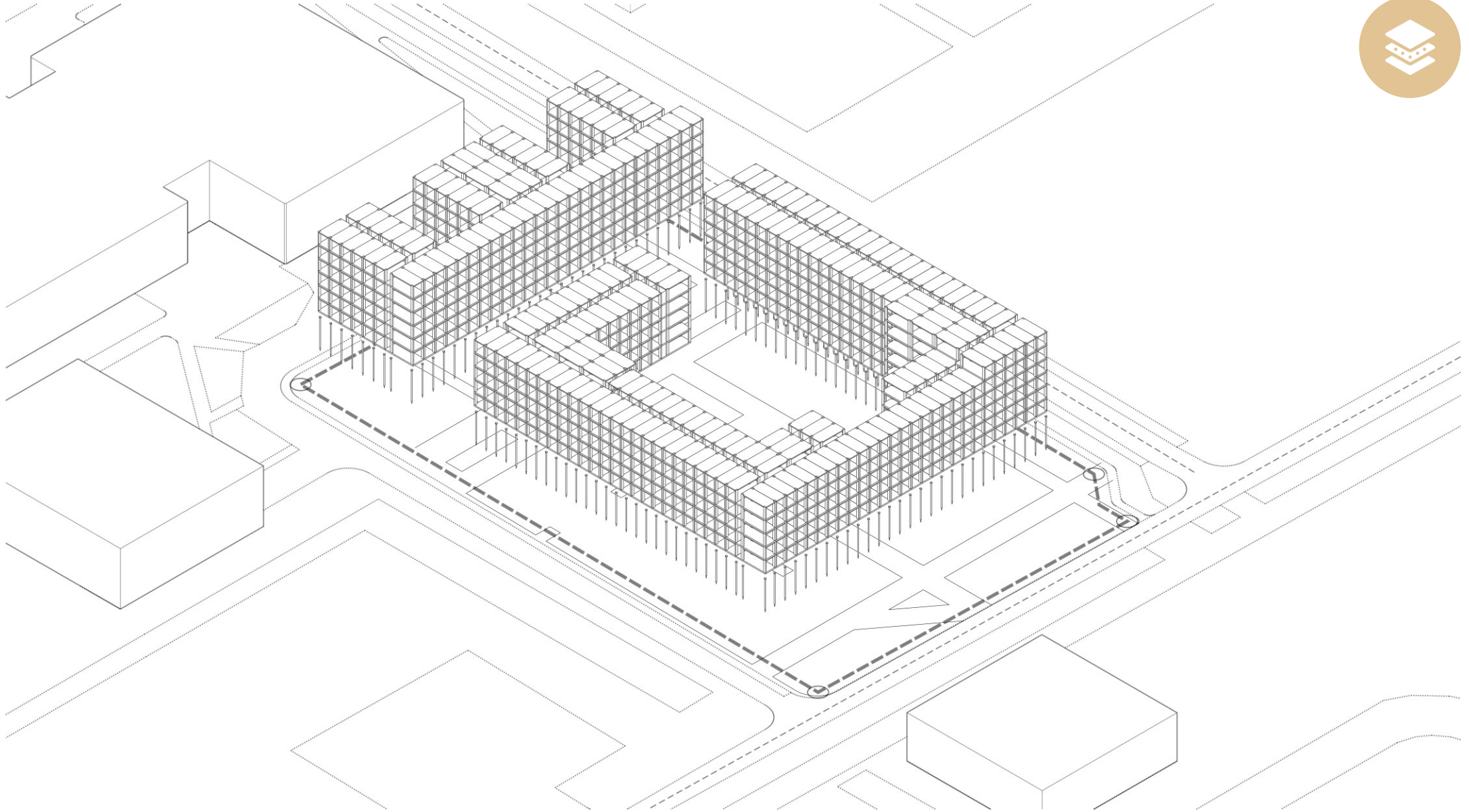
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



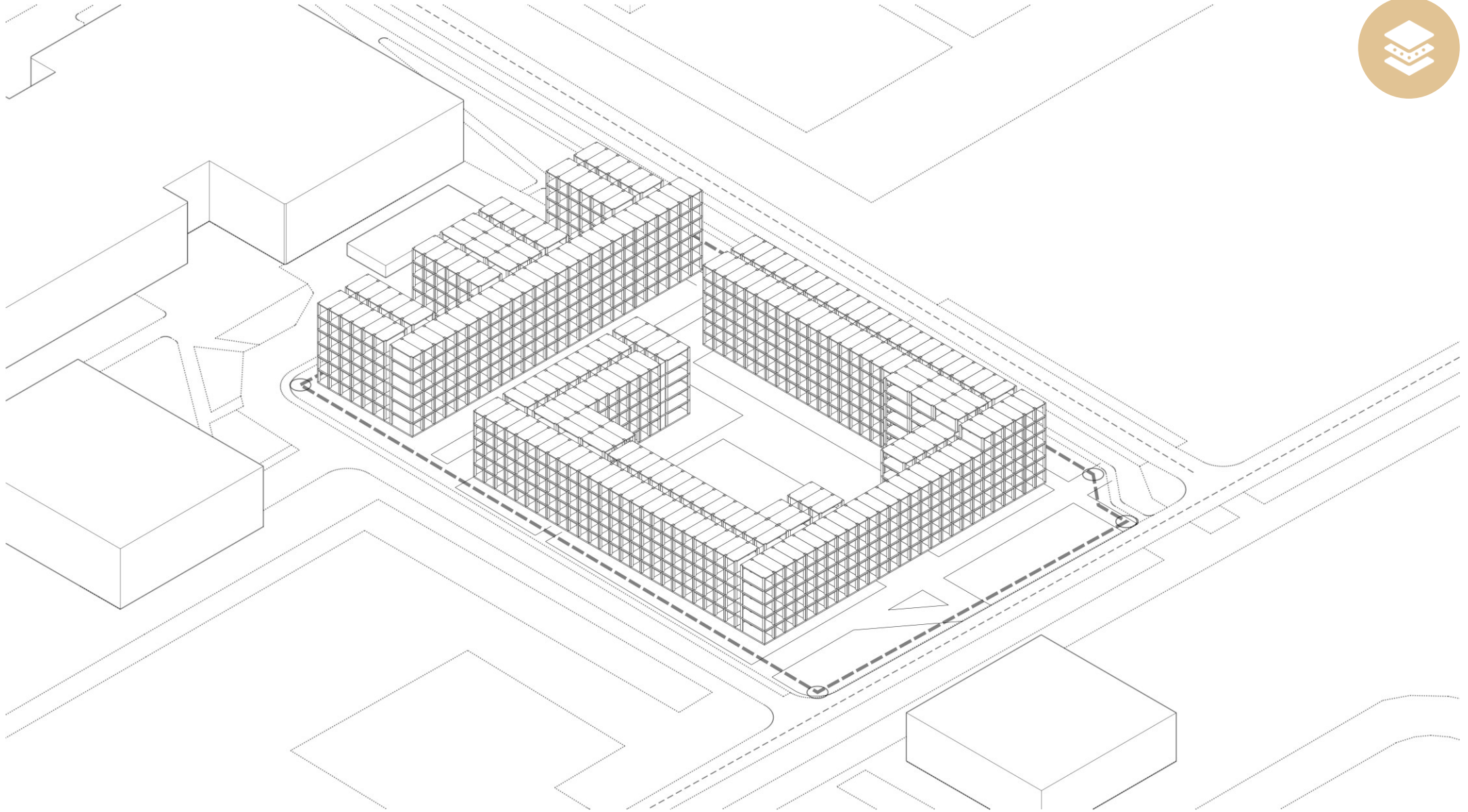
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



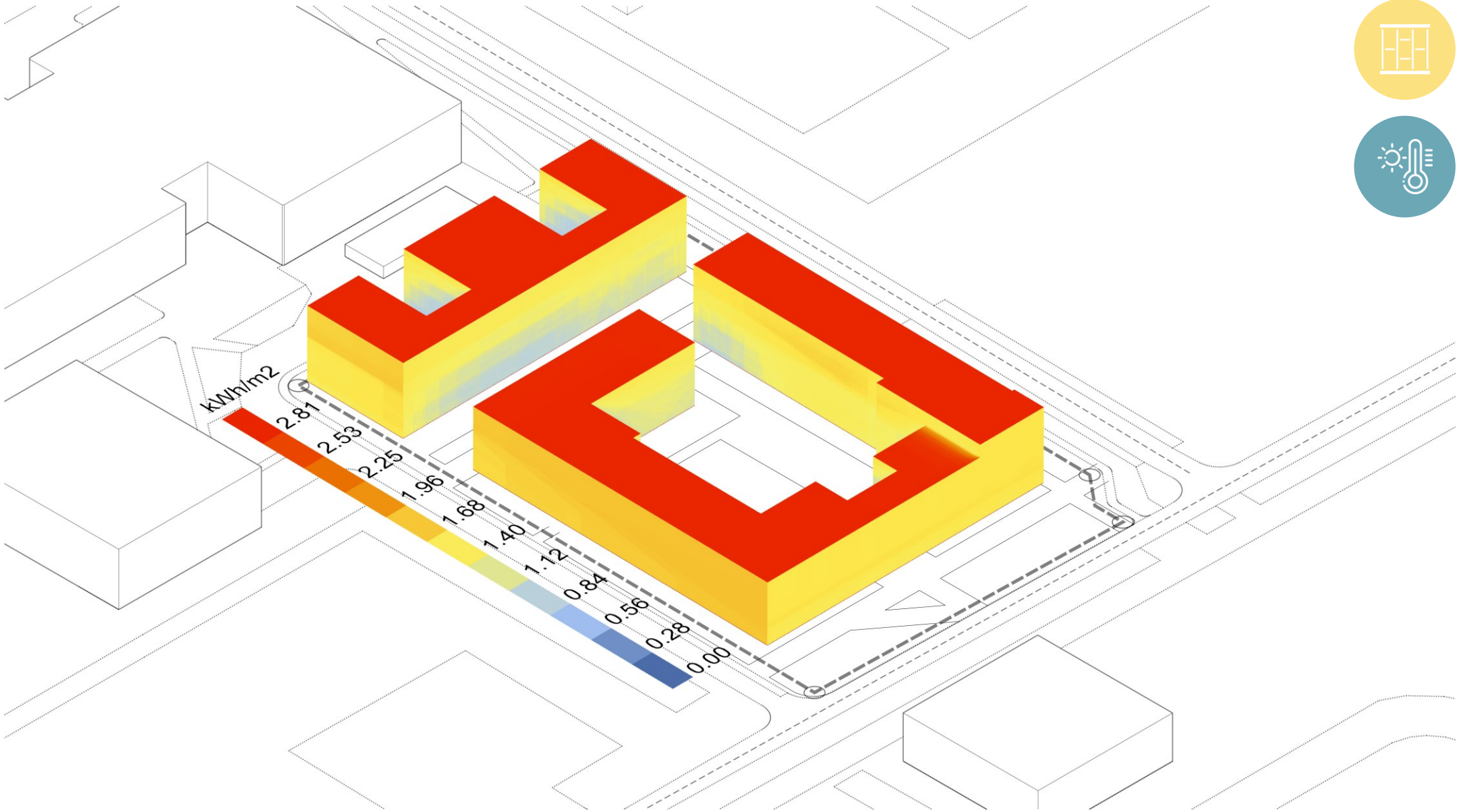
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



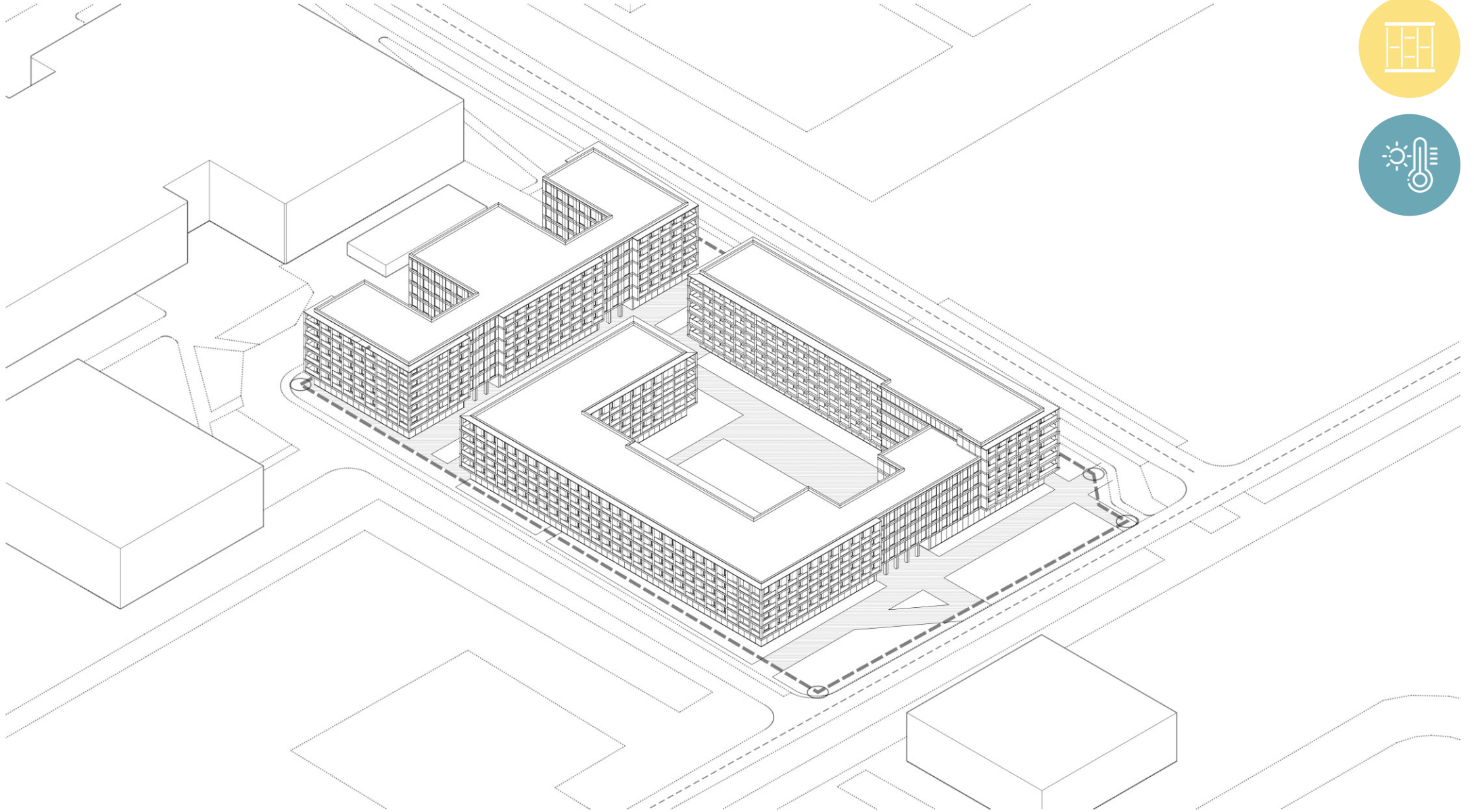
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



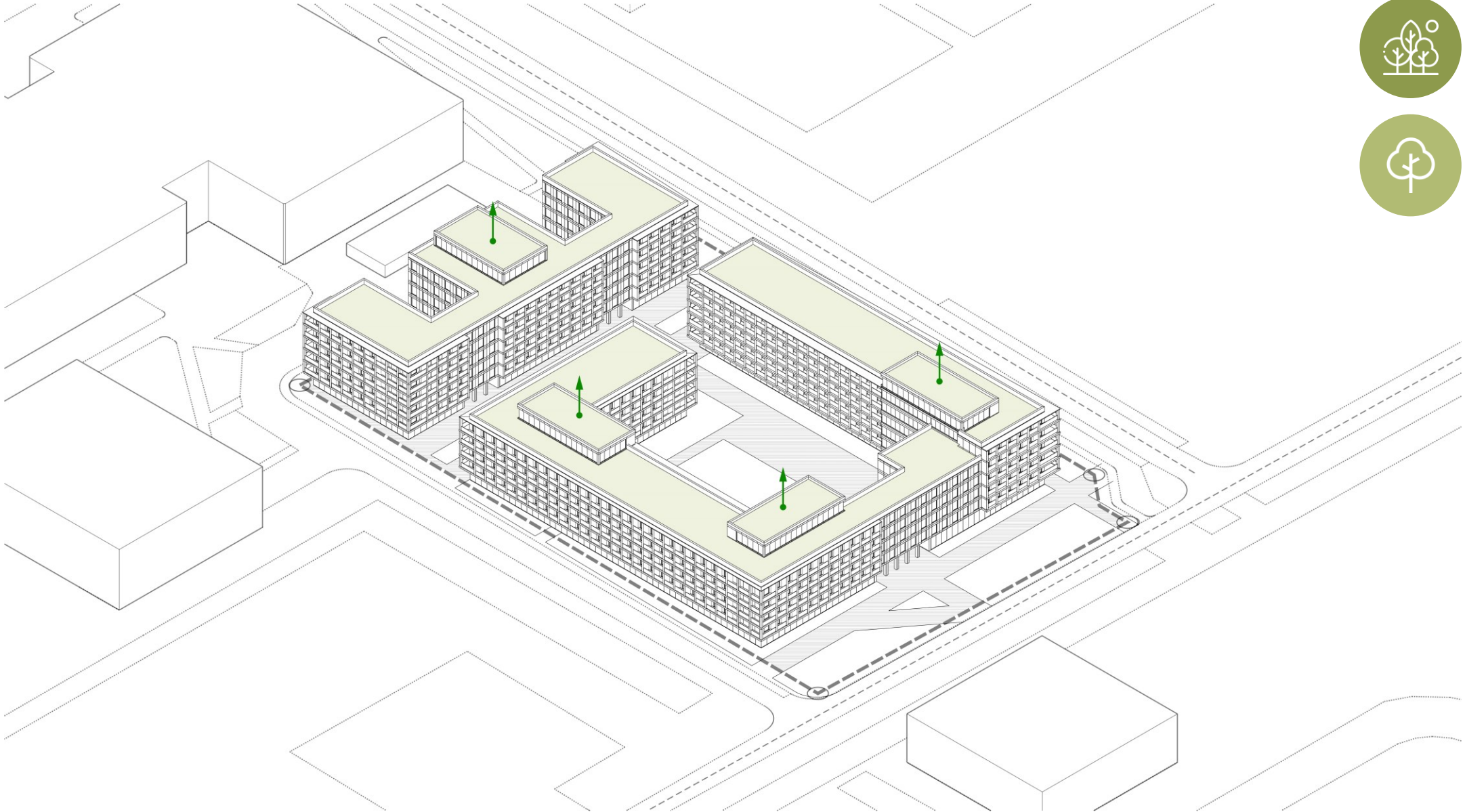
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



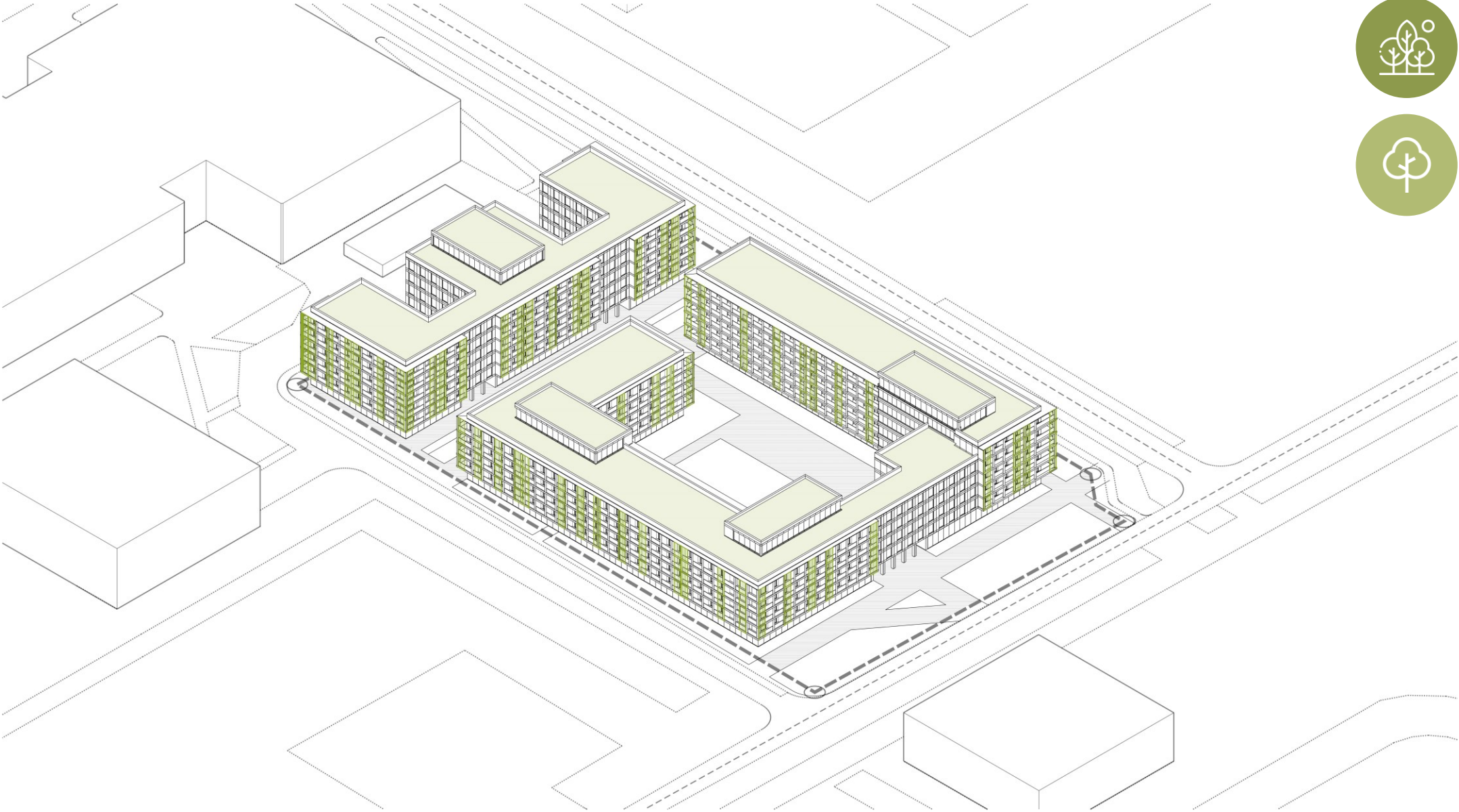
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



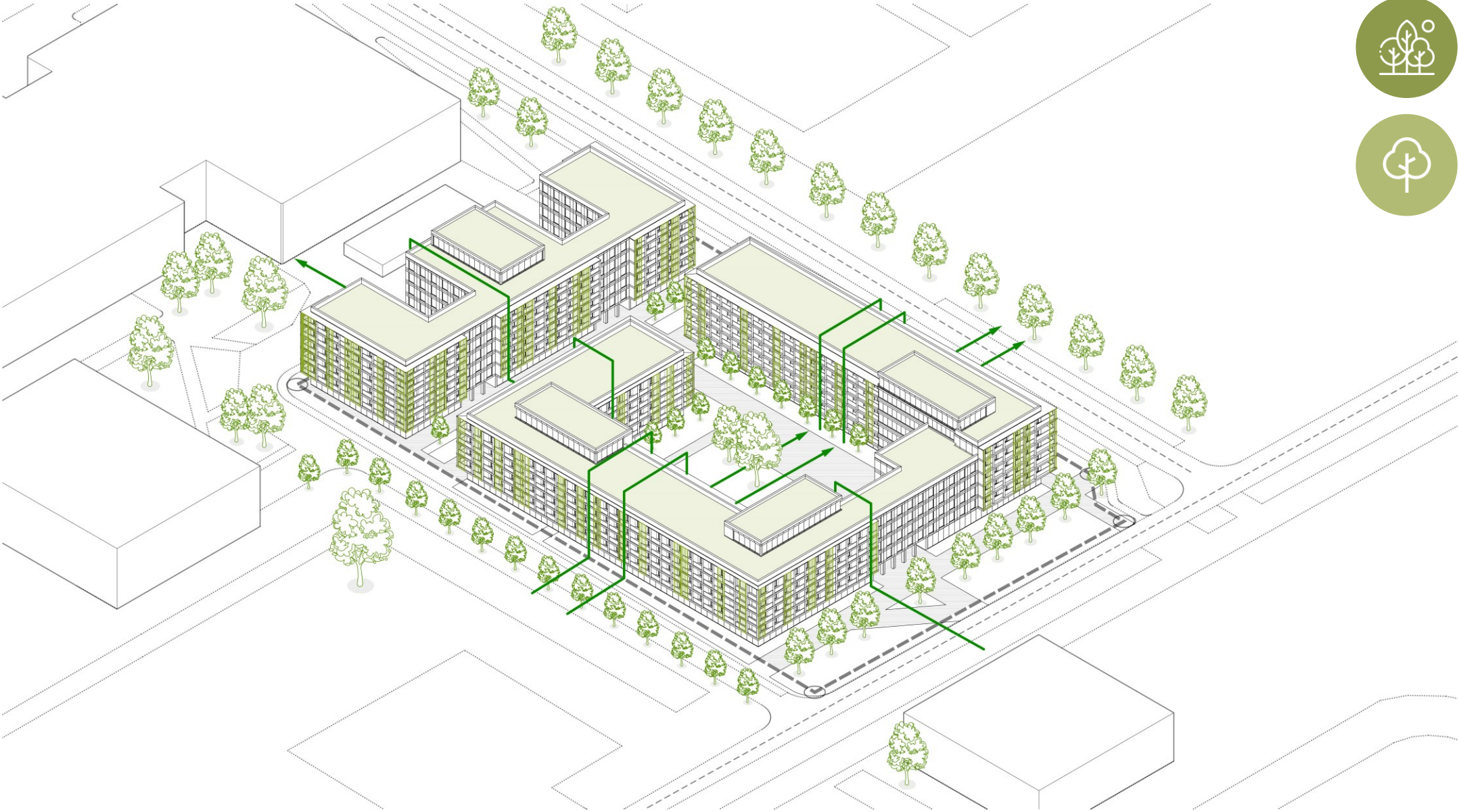
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



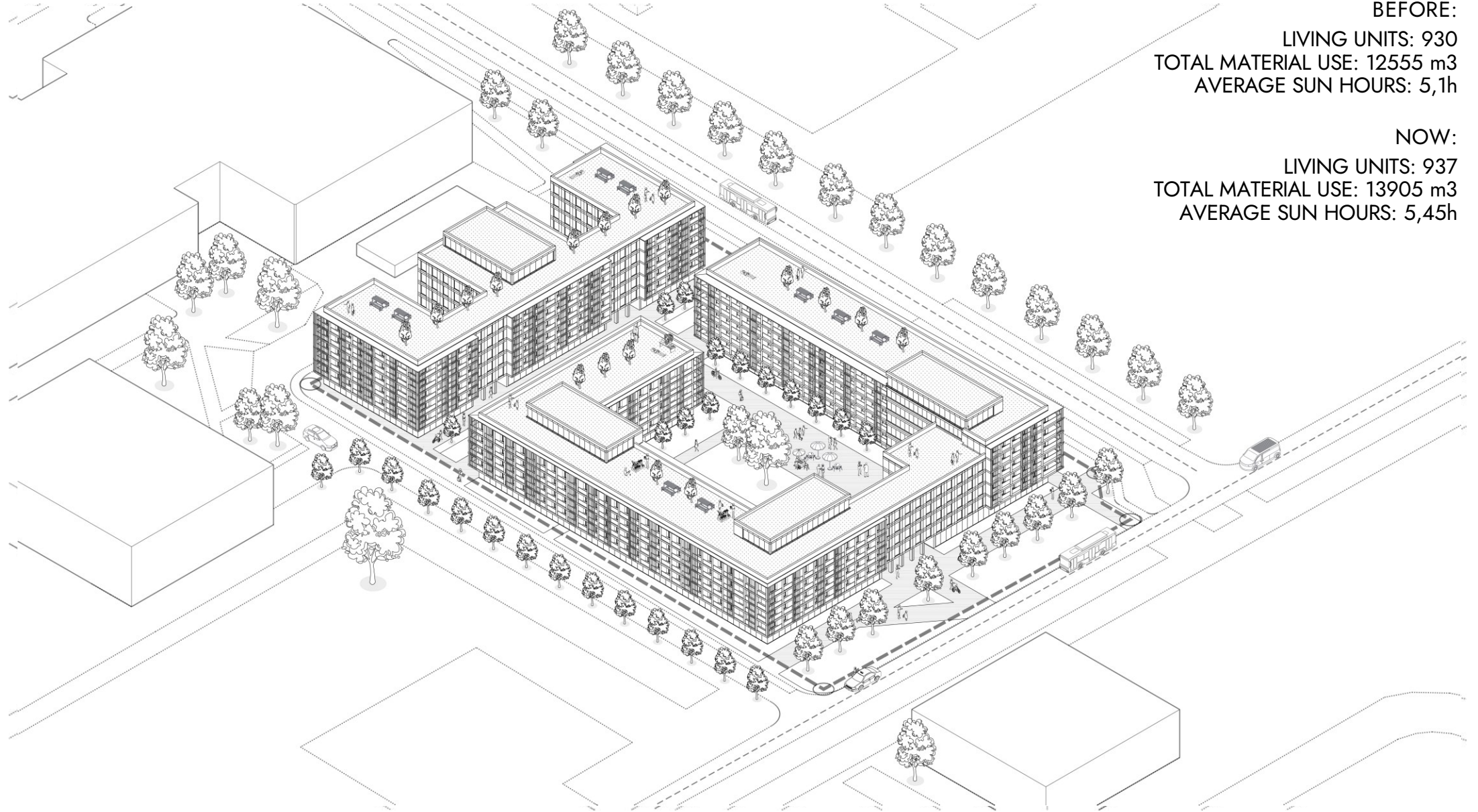
DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



DESIGN | IMPLEMENTING FURTHER DESIGN DIRECTIONS



BEFORE:

LIVING UNITS: 930

TOTAL MATERIAL USE: 12555 m³

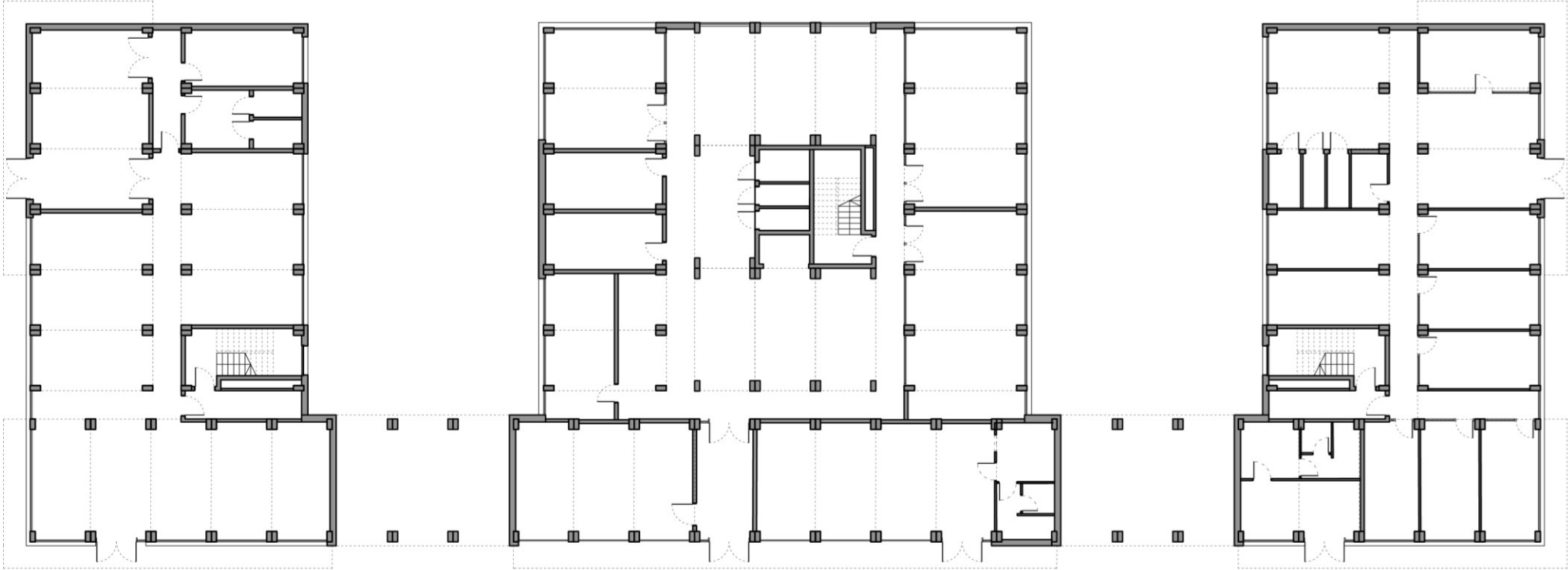
AVERAGE SUN HOURS: 5,1h

NOW:

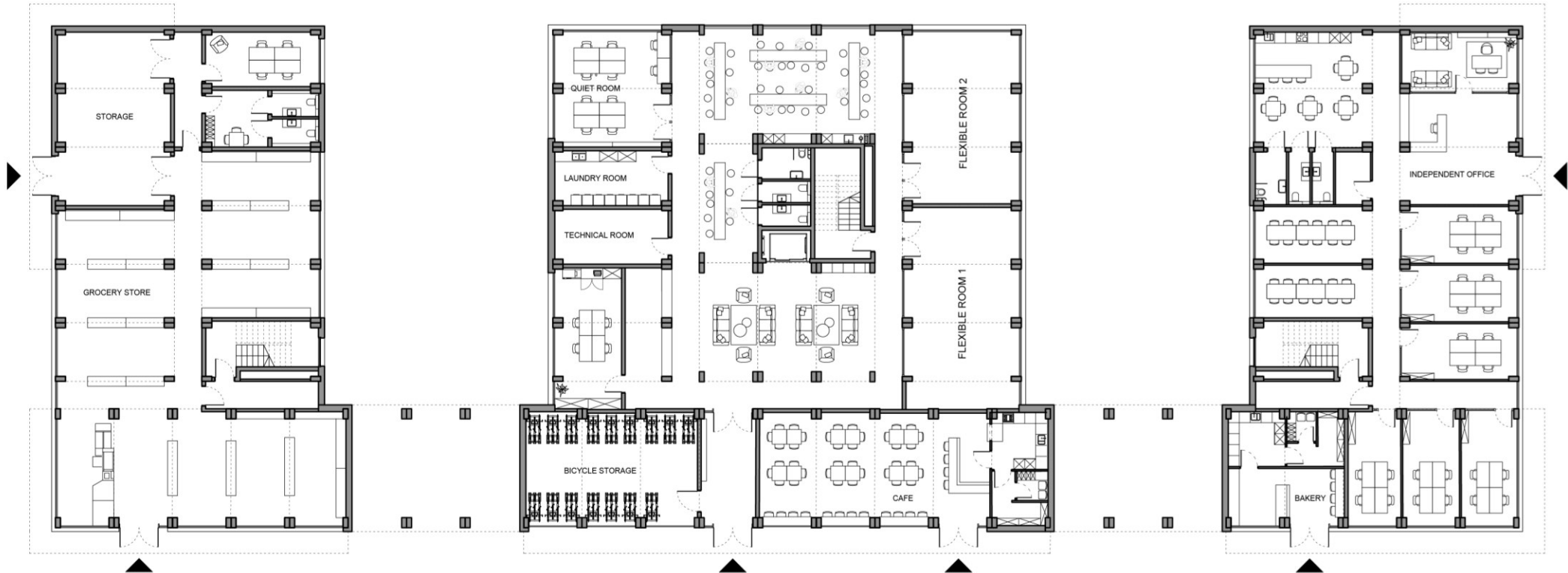
LIVING UNITS: 937

TOTAL MATERIAL USE: 13905 m³

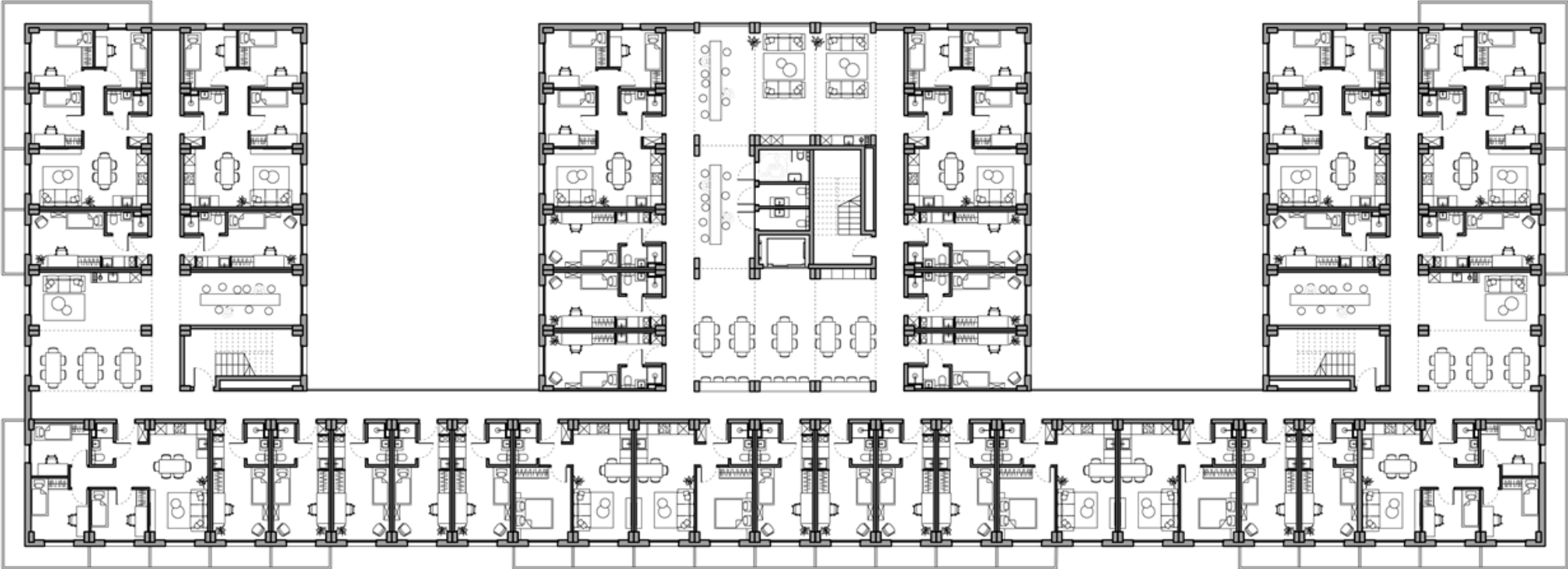
AVERAGE SUN HOURS: 5,45h



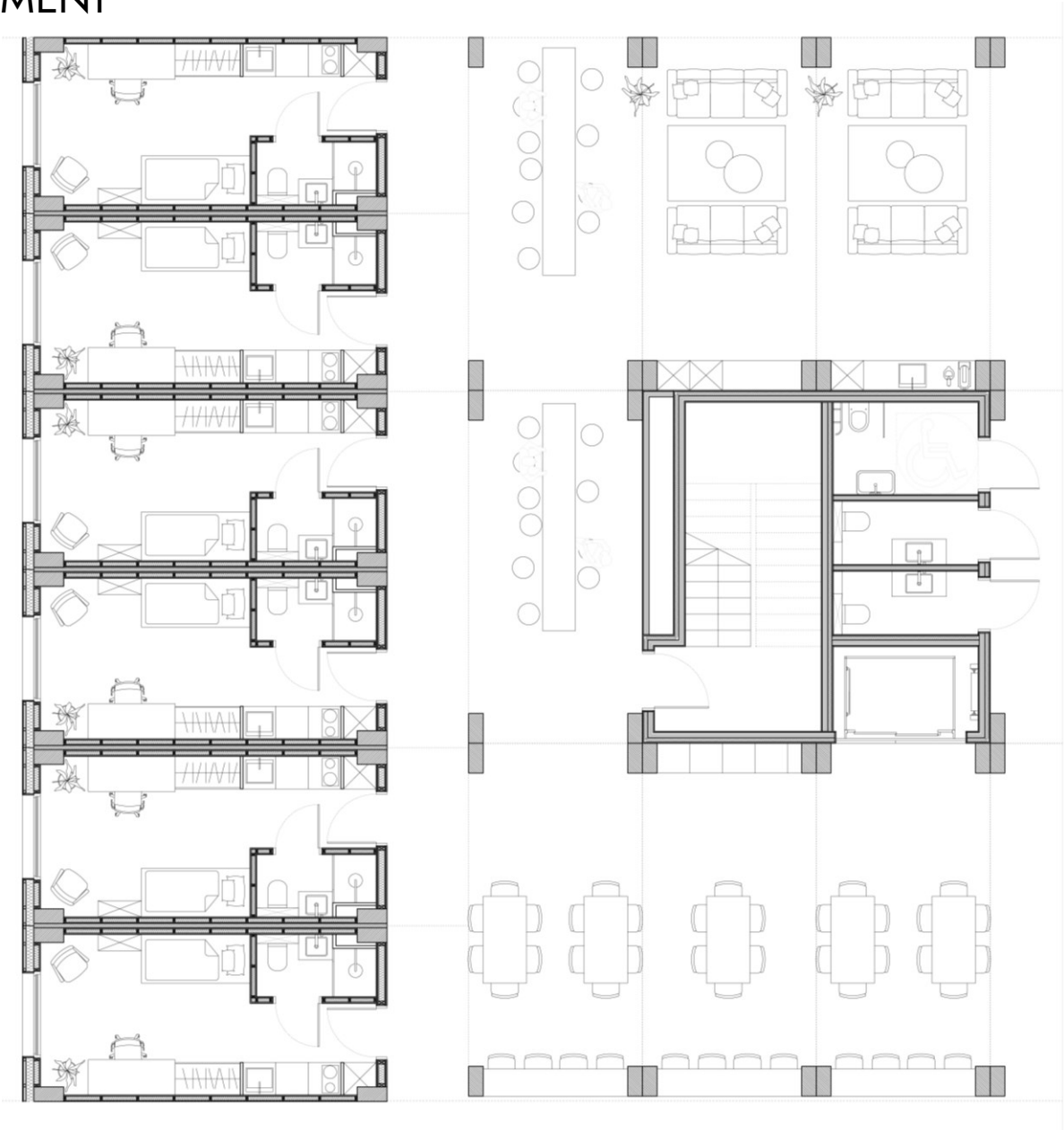
DESIGN | LEVEL 0



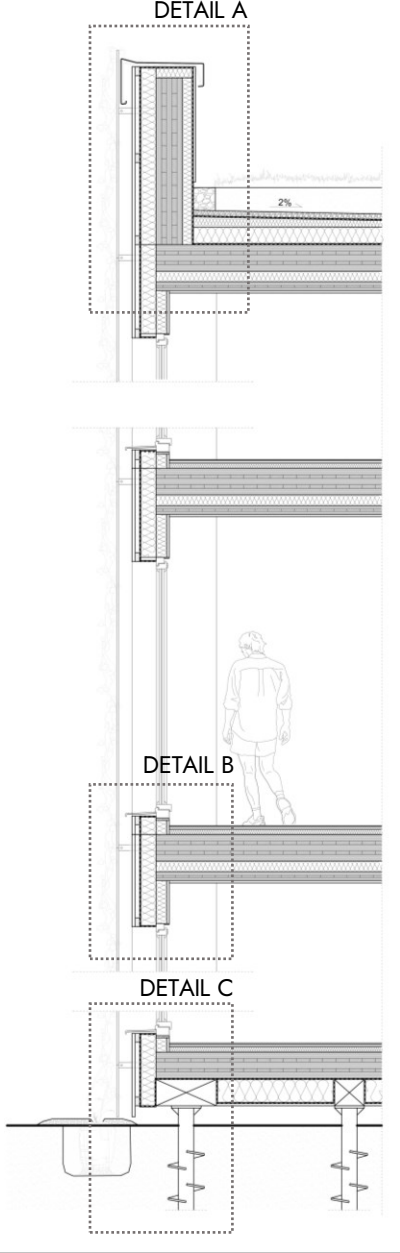
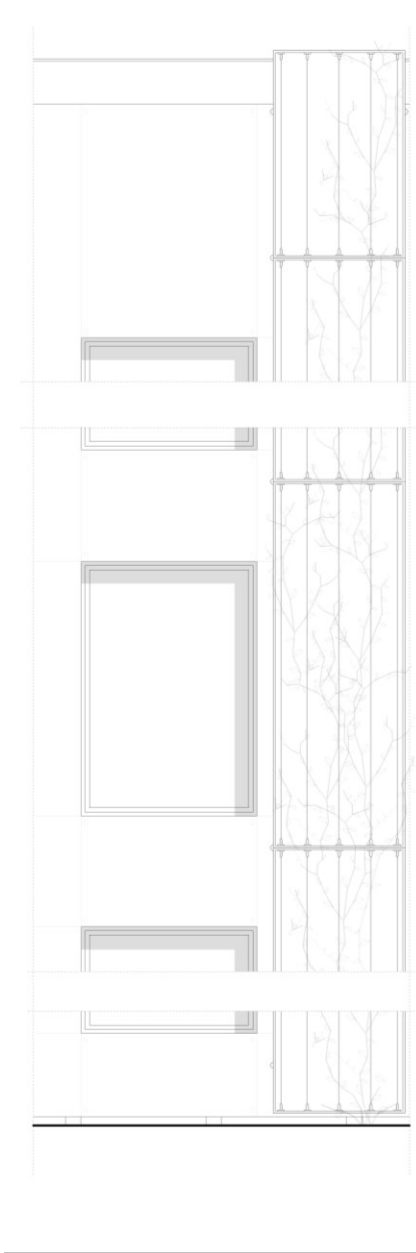
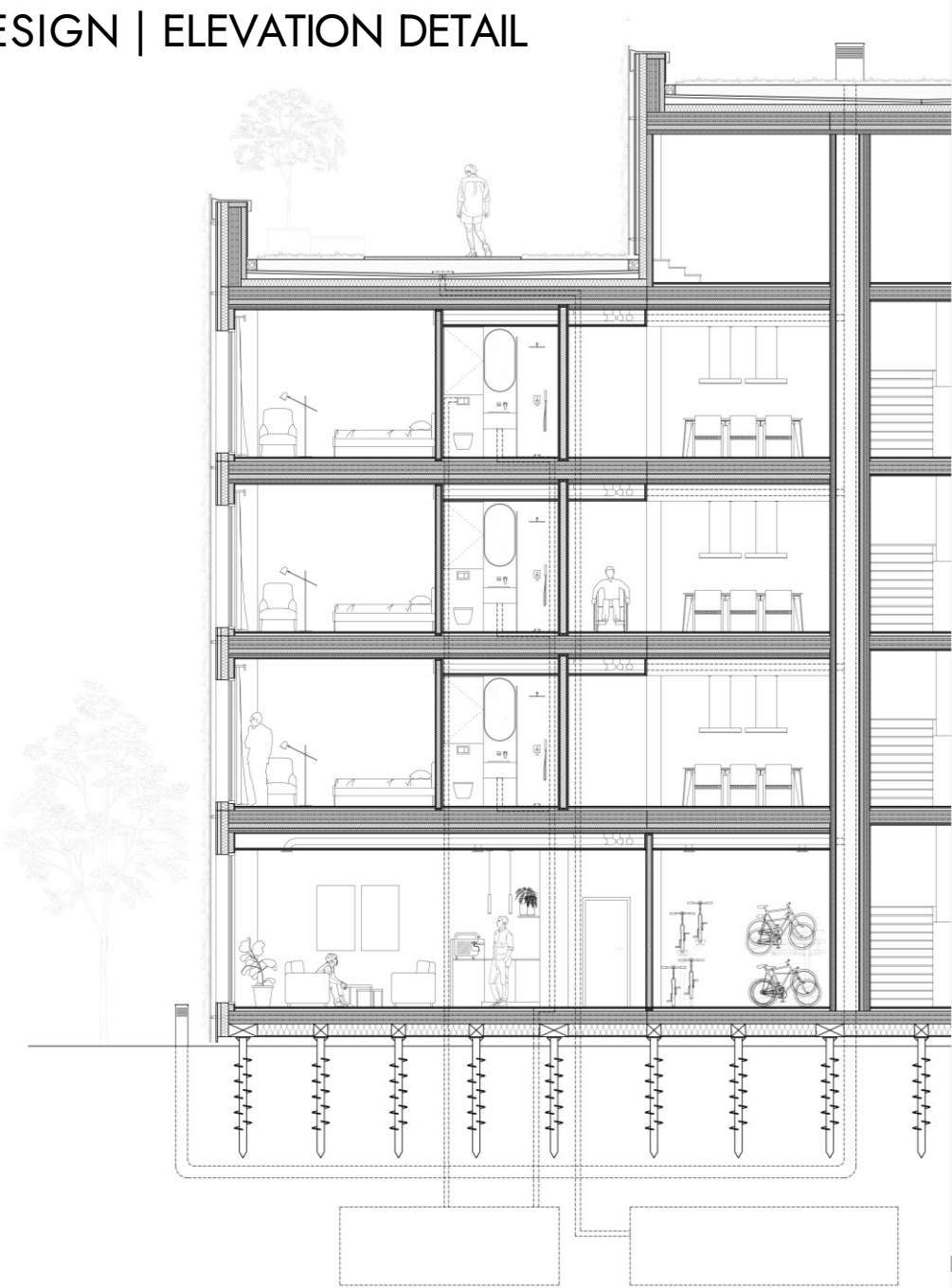
DESIGN | LEVEL 1

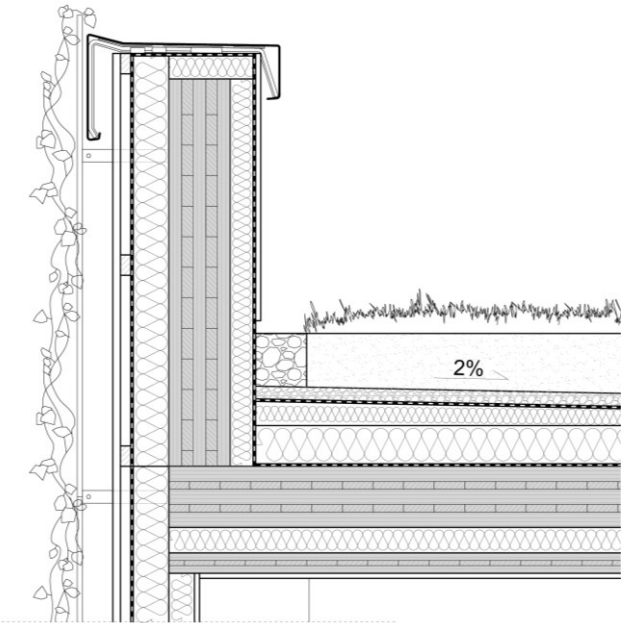


DESIGN | FLOORPLAN - FRAGMENT

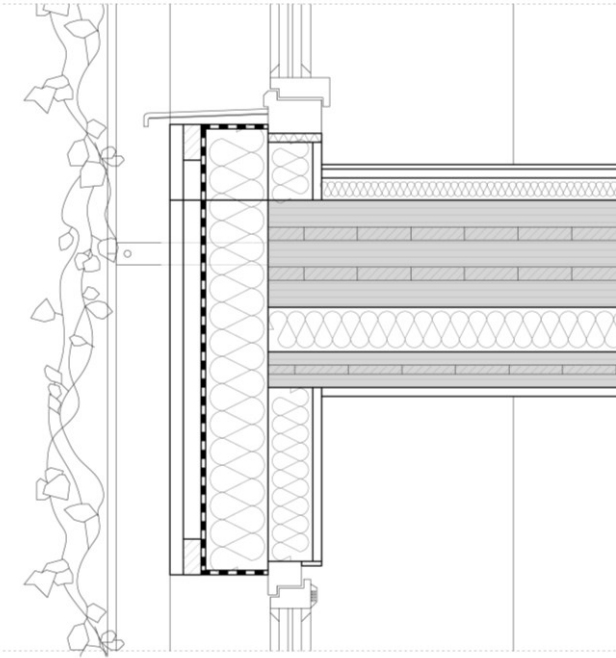


DESIGN | ELEVATION DETAIL

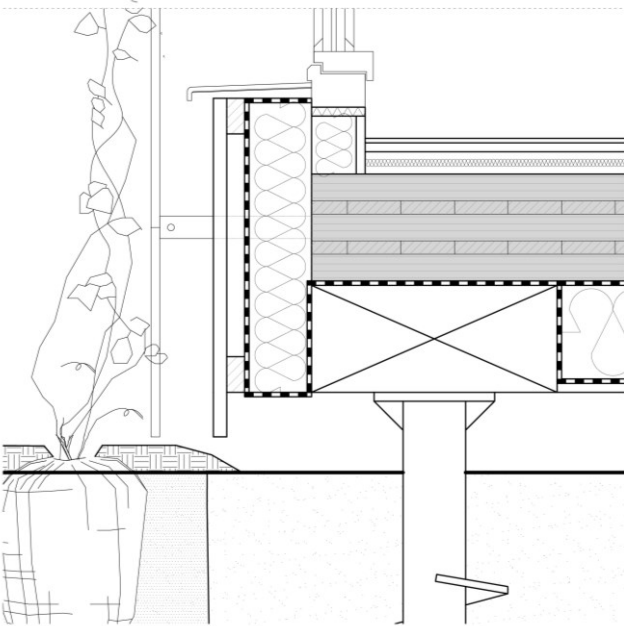




DETAIL A

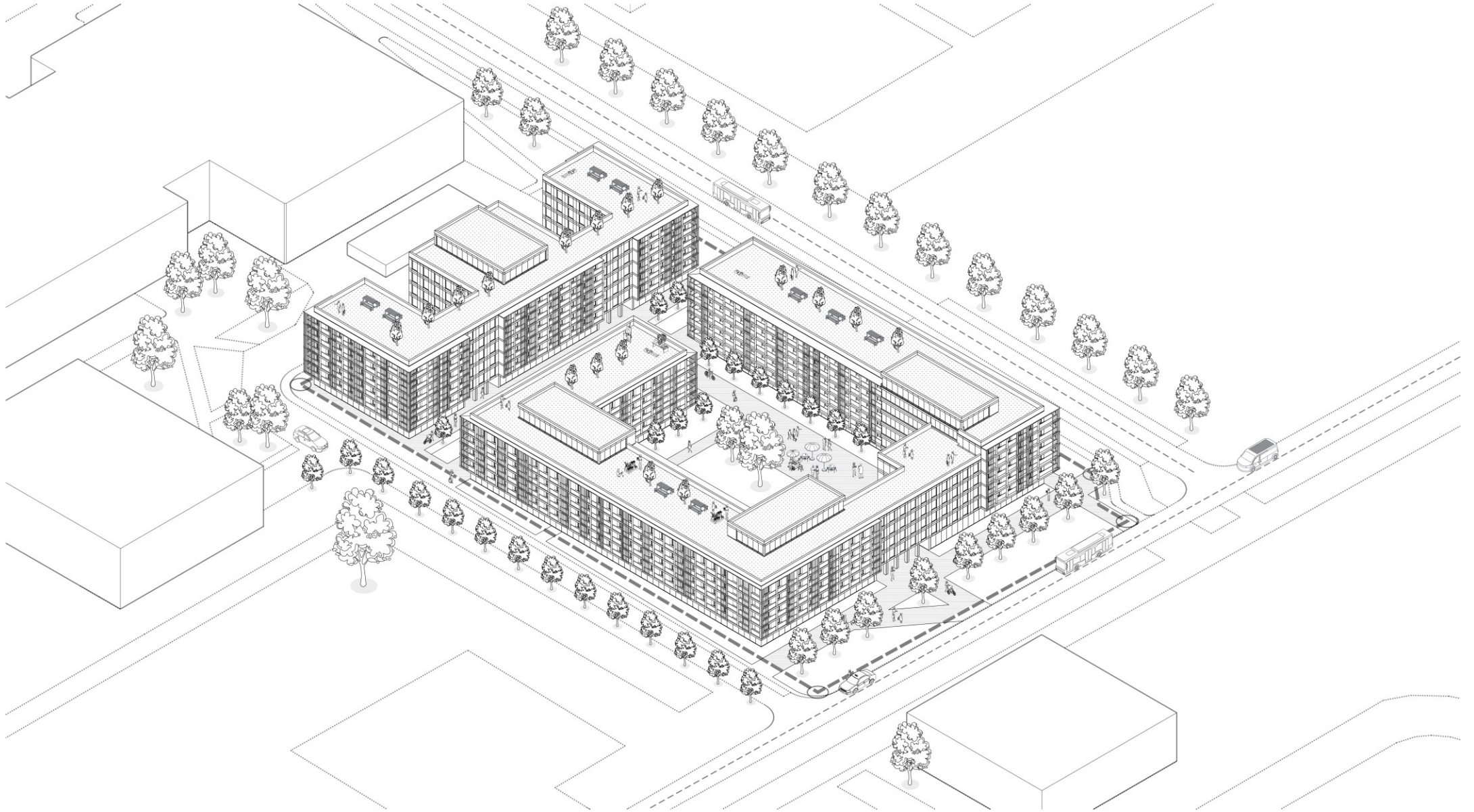


DETAIL B



DETAIL C

DESIGN | AFFORDABLE AND QUALITATIVE STUDENT HOUSING



CONCLUSIONS & REFLECTIONS

CONCLUSION AND REFLECTIONS | BENEFITS & LIMITATIONS

BENEFITS:

- MODULE+ serves as a complete strategy, including precisely designed modules, optimization algorithm and further design approaches
- It allows for significant streamline of the design process and construction time reduction
- Designed modules serves as an universal, but at the same time flexible and adaptable architectural solution
- The created algorithm:
 - Automates repetitive tasks by generating functional layouts
 - Optimizes the generated solutions in terms of the number of units, material consumption and sun exposure
 - Provides precise data that allows to make a reliable and well-thought-out decision
 - Allows architect to focus on higher-level design thinking
- Further design directions - supported by research in the field of architecture and sociology - facilitate and improve the adaptation of generated solutions in a qualitative living environment
- MODULE+ has the potential to direct the project towards affordable and qualitative student housing

CONCLUSION AND REFLECTIONS | BENEFITS & LIMITATIONS

LIMITATIONS:

- MODULE+ strategy, in the scope presented in this presentation, is in an experimental version and requires refinement, improvement and further testing
- The architect takes full responsibility for the solutions generated by the algorithm
- The use of a strategy, for example universal modules, limits to some extent the freedom of design and the form of the building
- The use of AI for generation and optimization can minimize the joy of design and poetry in architecture

“Architecture is about the people”

Francis Kere.

THANK YOU!