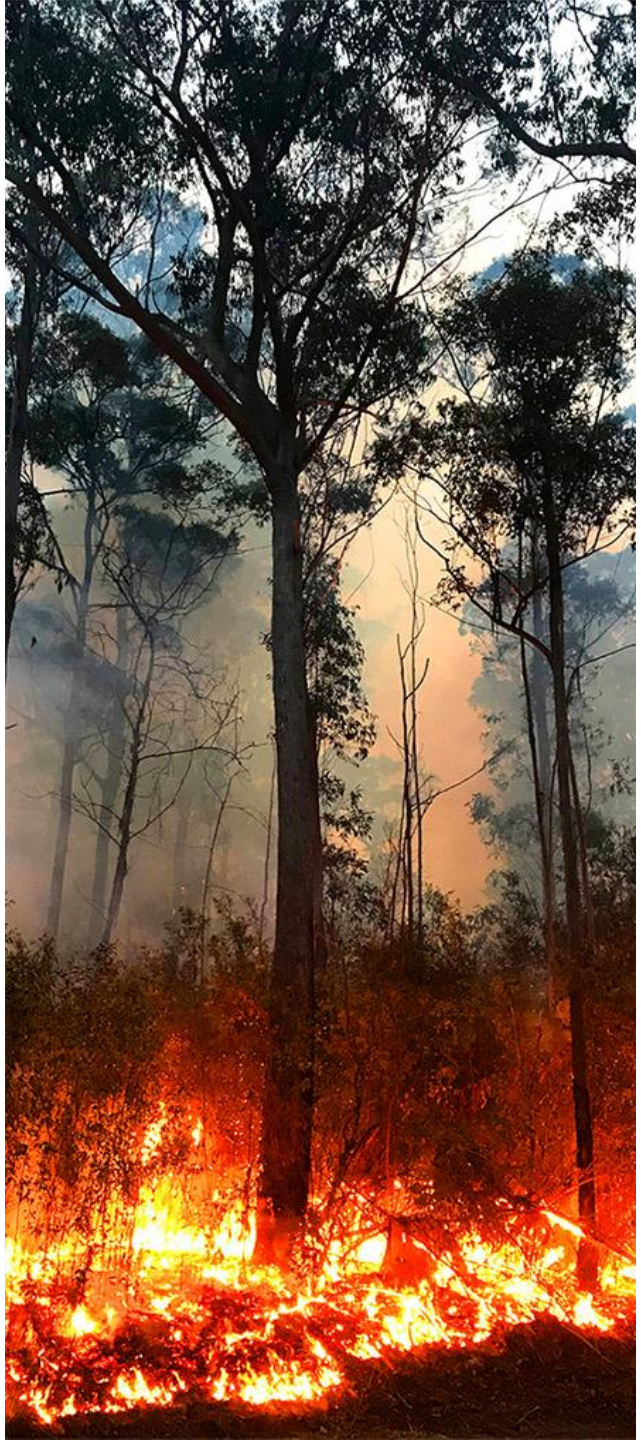
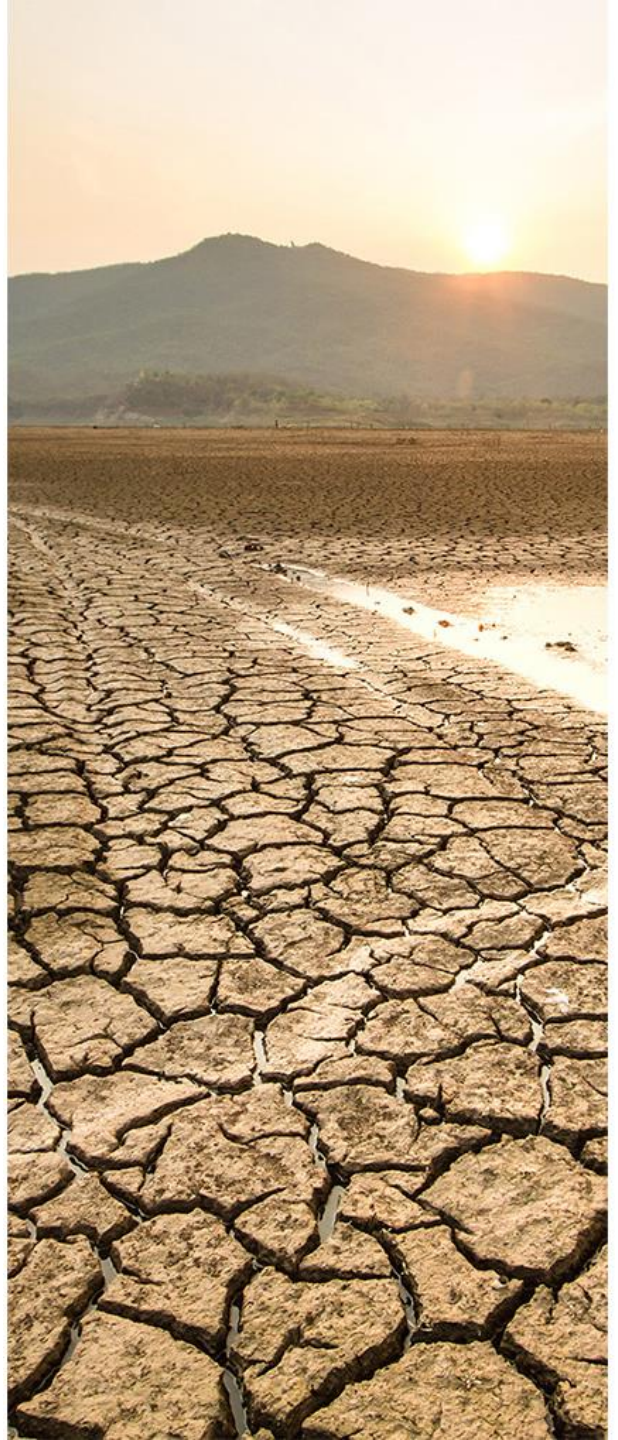
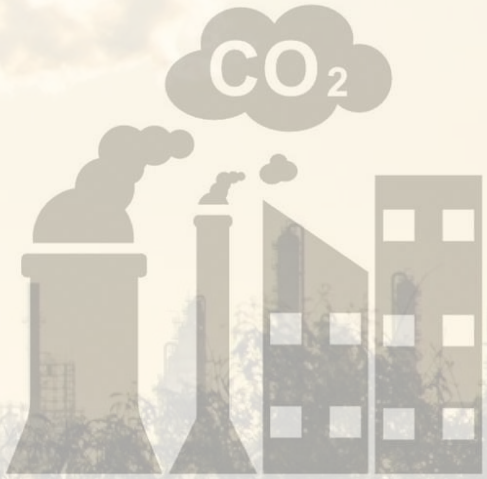




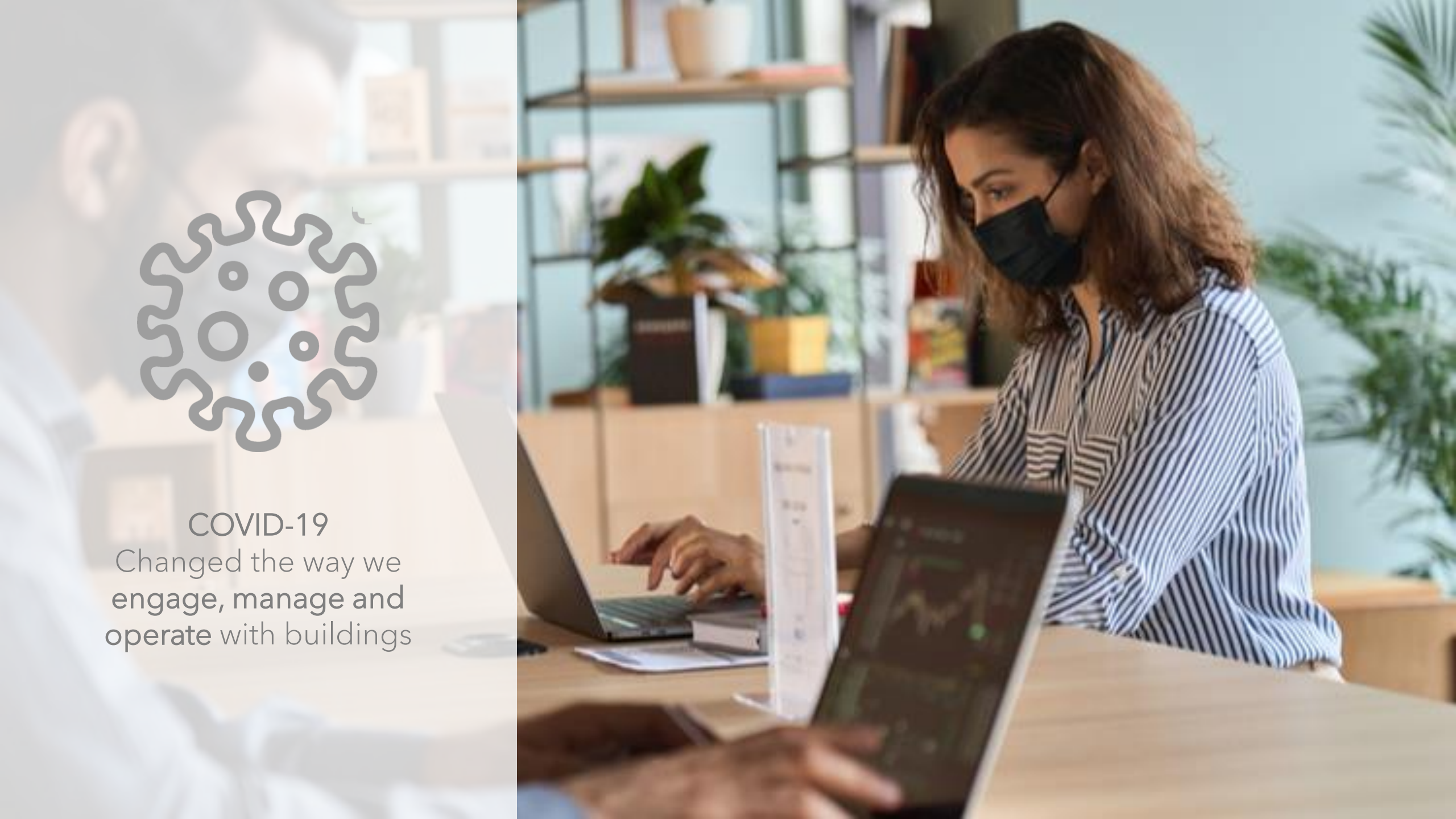



40% of emissions from the built environment

2020-30: Tipping point for decarbonisation

Climate risk is now accepted as financial risk.

(JLL, 2022)



COVID-19
Changed the way we
engage, manage and
operate with buildings

Reconfiguring workspace configurations for a sustainable future

Understanding the links between new working trends and the sustainability of workspaces in a post pandemic reality.

Sanjana Maria John

P5 presentation | 19.05.2024

TU Delft

OVERVIEW

01 | Problematisation

02 | Literature Review

03 | Research Design

04 | Empirical research

- Synthetic data
- Case Studies
- Mobility

05 | Discussion

06 | Conclusions

07 | Limitations and recommendations

01

PROBLEMATISATION

INCREASED ENERGY USE IN OFFICE BUILDINGS

Expanding office space

INCREASED ENERGY USE IN OFFICE BUILDINGS

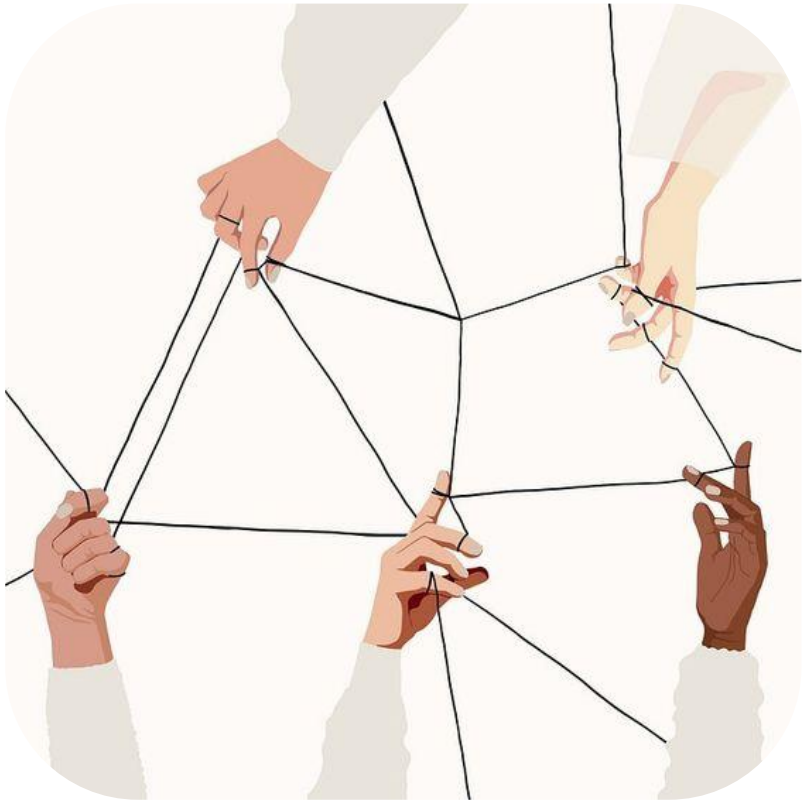
Larger work force and

increased building utilisation

INCREASED ENERGY USE IN OFFICE BUILDINGS

Advances in digital technology

SHIFTING WORK PROCESSES:



Shifting boundary conditions.

Impacts on building portfolio.

SHIFTING WORK PROCESSES:

Shifting boundary conditions.

Impacts on building portfolio.

Opportunity to **facilitate** improved sustainability targets

MAIN RQ:

How is the energy consumption of the workspace environment impacted by hybrid modes of working?

SUB- QUESTIONS

SQ01 | What is hybrid working?

SUB- QUESTIONS

SQ01 | What is hybrid working?

SQ02 | How has the definition of a ‘workspace’ evolved due to hybrid working?

SUB- QUESTIONS

SQ01 | What is hybrid working?

SQ02 | How has the definition of a 'workspace' evolved due to hybrid working?

SQ03 | How has hybrid working impacted the use of office space?

SUB- QUESTIONS

SQ01 | What is hybrid working?

SQ02 | How has the definition of a 'workspace' evolved due to hybrid working?

SQ03 | How has hybrid working impacted the use of office space?

SQ04 | How is the energy footprint of a user impacted by the dynamic occupancy that results from hybrid working?

02

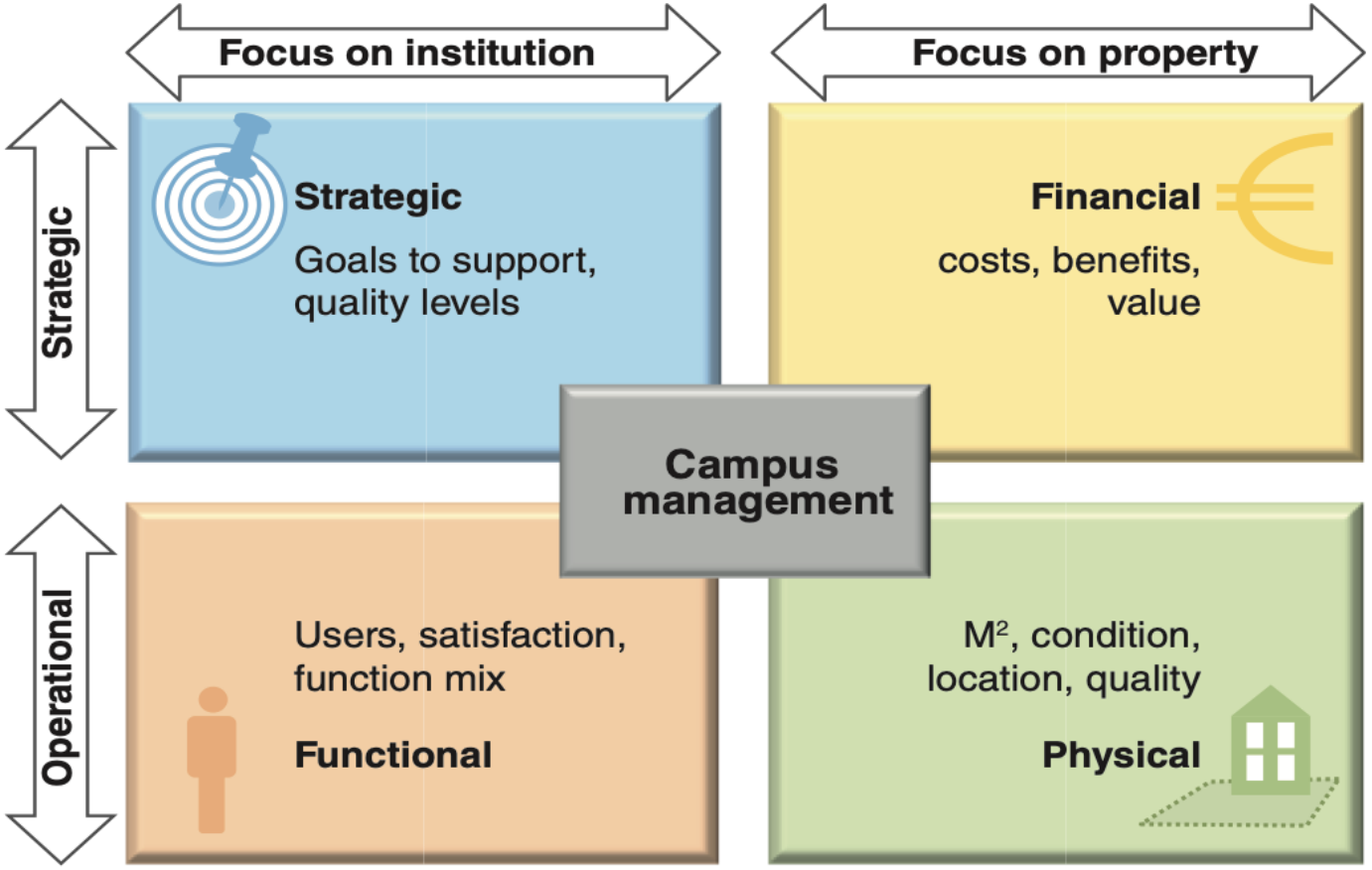
LITERATURE REVIEW

WHAT IS HYBRID WORKING?

"a form of organising and/or performing work…..which could also be performed at the ***employer's premises****, is carried out* ***away from those premises*** *on a regular basis".*

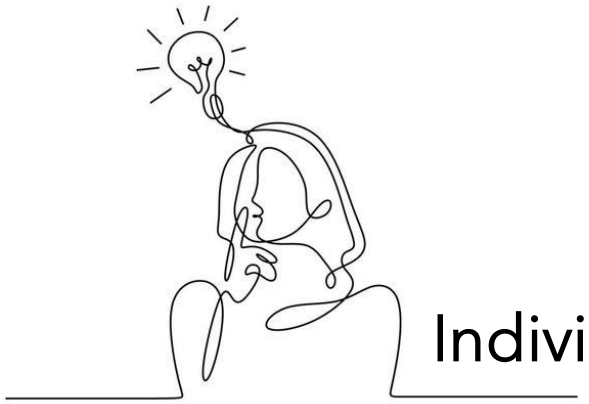
European Framework Agreement on Telework (2002)

FOUR PERSEPECTIVES



Den Heijer (2021)

FUNCTIONAL EFFECTS



Individual Level

- Productivity
- Flexibility
- Autonomy

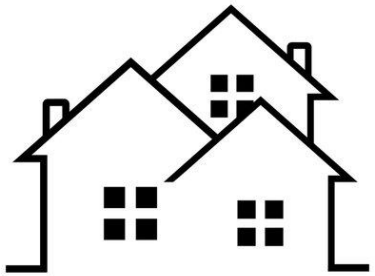
- Well being

Organisational Level

- Communication
- Coordination
- Conflict

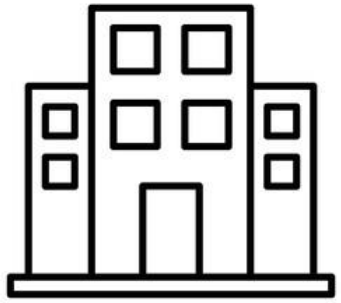
- Cohesion and culture

DIVERSIFICATION OF TASKS



HOME STREAM

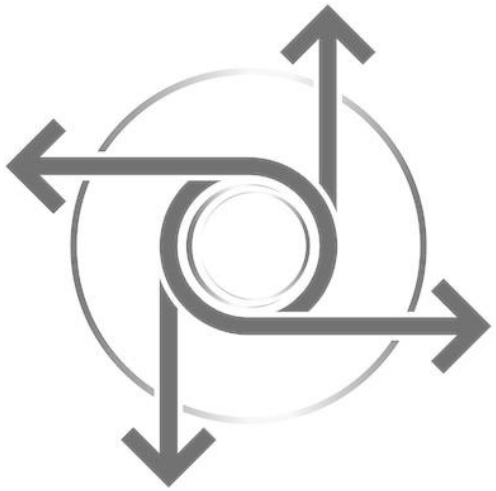
- Routine tasks
- Less support
- High productivity



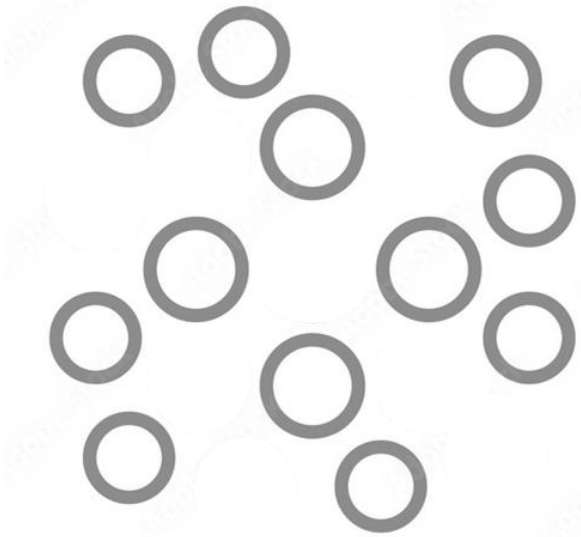
OFFICE STREAM

- Team and managerial support
- Intense interactions with colleagues
- Build social cohesion

MANAGEMENT OF SPACE



Flexiblility is key



Densification trend being reversed

Evaluated from a **user perspective**

Hybrid working

and

energy consumption?

(heating/ cooling/ lighting)

Operational emissions account for 28% of all global carbon emissions.

(Azari, 2019)

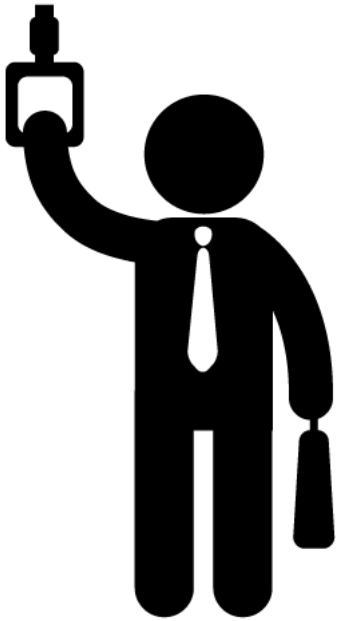
Occupancy behaviour

Utilization behaviour

Energy performance of workspace environment resulting from hybrid working is also a measure of other factors.

Referred to as *rebound effects*.

REBOUND EFFECTS:



Commute

Non work travel

Home

TO SUMMARISE:

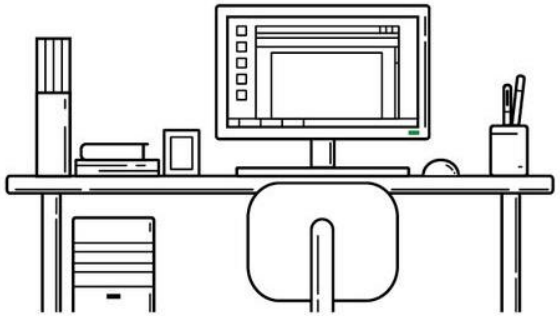
Offices are expected to evolve into "***workplace ecosystems***" (Molla, 2022) which facilitate *"learning development, collaborating, mentoring, socialising"*.

GAP: This thesis attempts to aid in this transition by establishing clear evidence of the impacts of these **new working processes** on overall **energy consumption** of the **workspace environment**.

03

RESEARCH METHODOLOGY

RESEARCH METHODS: QUANTITATIVE DESIGN, 3 STAGES

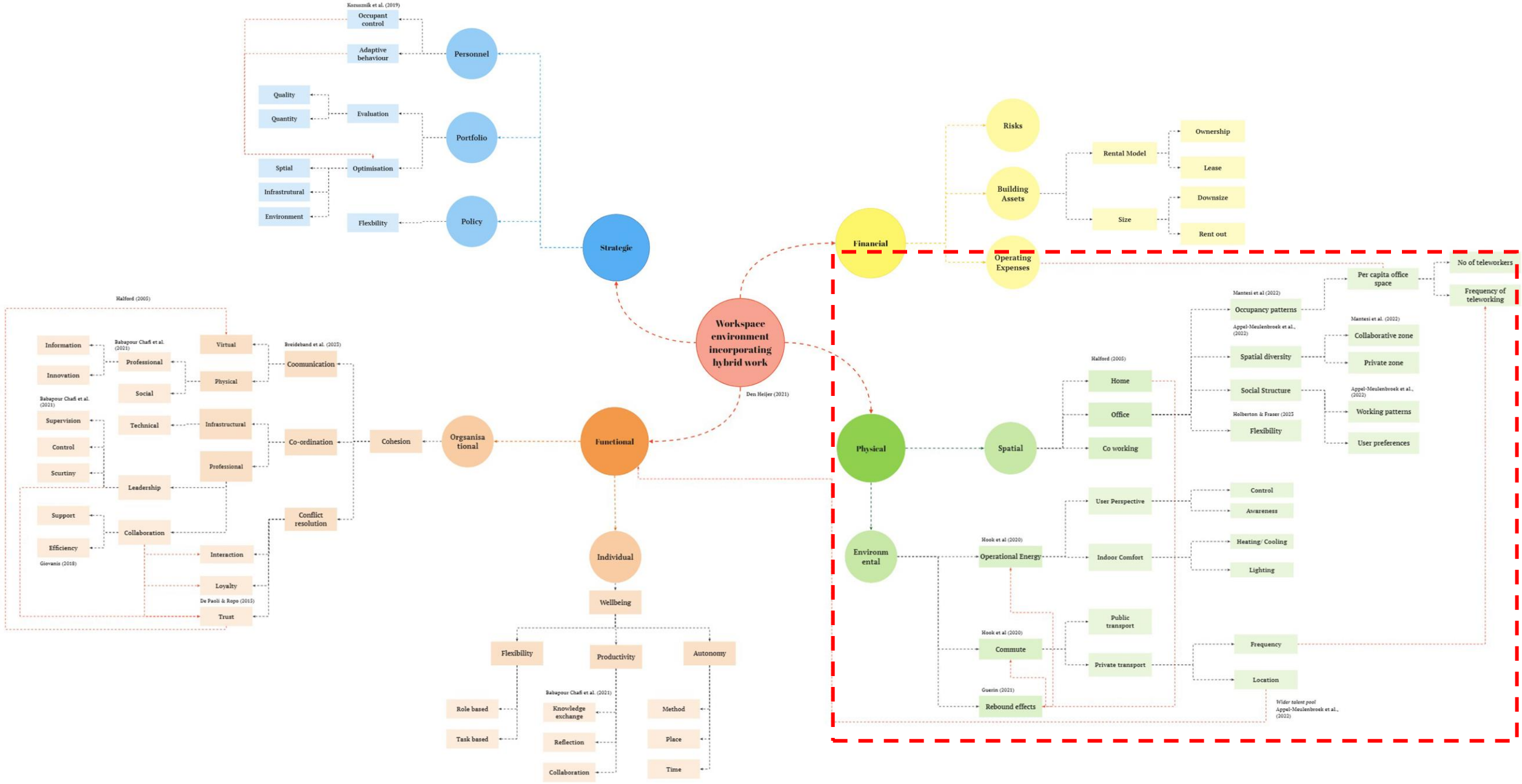


IDENTIFICATION

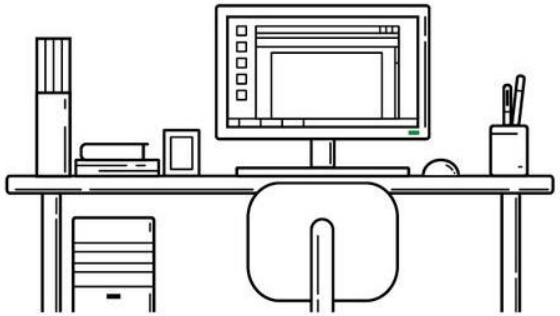
SQ 01, SQ 02

Conceptual framework

Key performance measures


Workspace environment incorporating hybrid work
Den Heijer (2021)
Strategic
Kozusznik et al. (2019)
Occupant control
Adaptive behaviour
Personnel
Quality
Quantity
Evaluation
Portfolio
Sptial
Infrastrutural
Environment
Optimisation
Flexbility
Policy
Financial
Risks
Building Assets
Rental Model
Ownership
Lease
Size
Downsize
Rent out
Operating Expenses
Functional
Physical
Spatial
Mantesi et al (2022)
Occupancy patterns
Per capita office space
No of teleworkers
Frequency of teleworking
Appel-Meulenbroek et al., (2022)
Spatial diversity
Mantesi et al. (2022)
Collaborative zone
Private zone
Social Structure
Holberton & Fraser (2023
Flexibility
Appel-Meulenbroek et al., (2022)
Working patterns
User preferences
Halford (2005)
Home
Office
Co working
Environmental
Hook et al (2020)
Operational Energy
User Perspective
Indoor Comfort
Control
Awareness
Heating/ Cooling
Lighting
Hook et al (2020)
Commute
Public transport
Private transport
Frequency
Location
Guerin (2021)
Rebound effects
Wider talent pool
Appel-Meulenbroek et al., (2022)
Orgsanisational
Cohesion
Co-ordination
Coomunication
Breideband et al. (2023)
Virtual
Physical
Infrastructural
Professional
Conflict resolution
Halford (2005)
Information
Innovation
Babapour Chafi et al. (2021)
Professional
Social
Supervision
Control
Scurtiny
Technical
Leadership
Support
Efficiency
Collaboration
Giovanis (2018)
Interaction
Loyalty
Trust
De Paoli & Ropo (2015)
Individual
Wellbeing
Flexibility
Productivity
Autonomy
Role based
Task based
Babapour Chafi et al. (2021)
Knowledge exchange
Reflection
Collaboration
Method
Place
Time

RESEARCH METHODS:



IDENTIFICATION

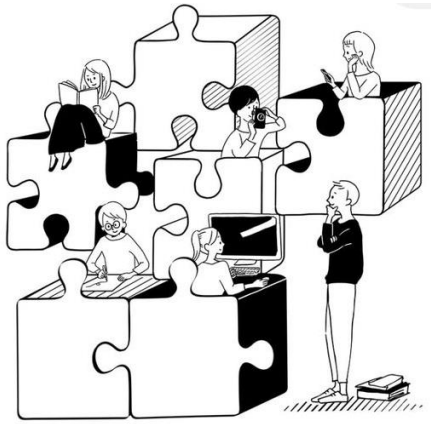
SQ 01, SQ 02

- Conceptual framework
- Key performance measures

COLLECTION

SQ 03, SQ 04

- Synthetic data simulations
- Multi case study
- Mobility



SYNTHESIS

MRQ

- Updated System mapping
- Recommendations for practitioners

RESEARCH GOALS:

01 | Contribute to **the study of workplace management** based on current trends of socialisation, working processes and use of space.

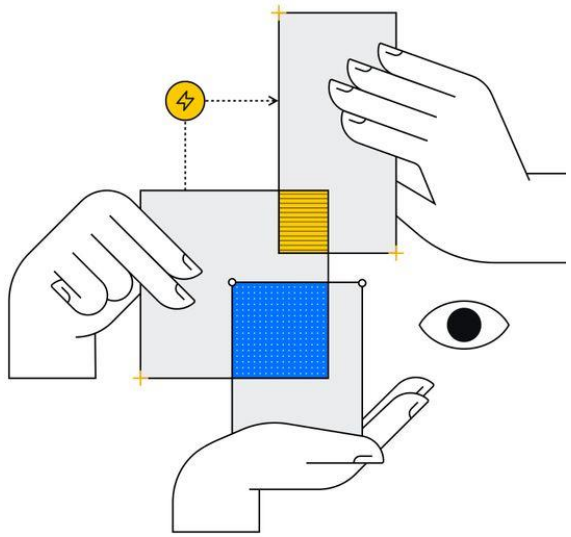
02 | **Establish evidence** of the impacts of new working processes on energy consumption.

03 | Provide **practical recommendations** for RE professionals and business owners to facilitate improved decision-making at the building and societal level.

04

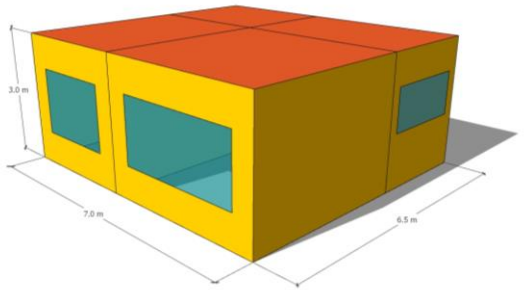
SYNTHETIC DATA

SCENARIO DESIGN

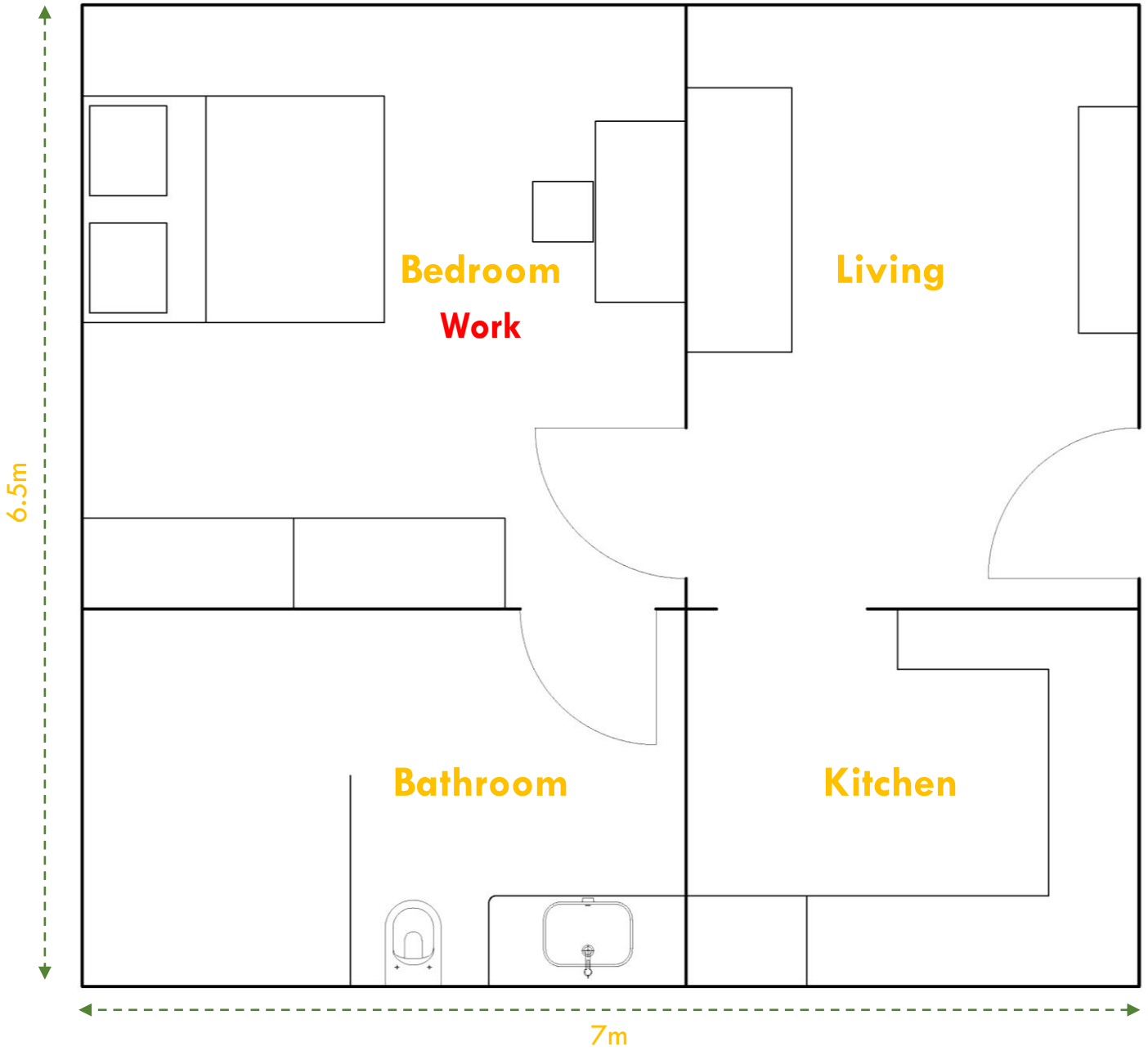


- Designed different **workspace templates** to produce energy simulations.
- Understand **context**:
  - Where and how people **live**.
  - Where, when and how people **work**.

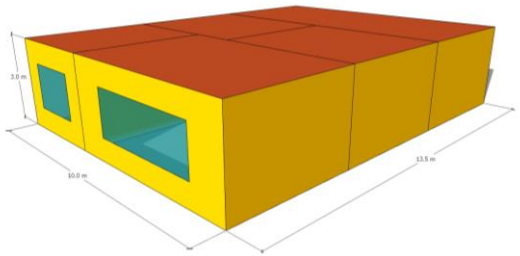
HOUSEHOLD
TYPE 01



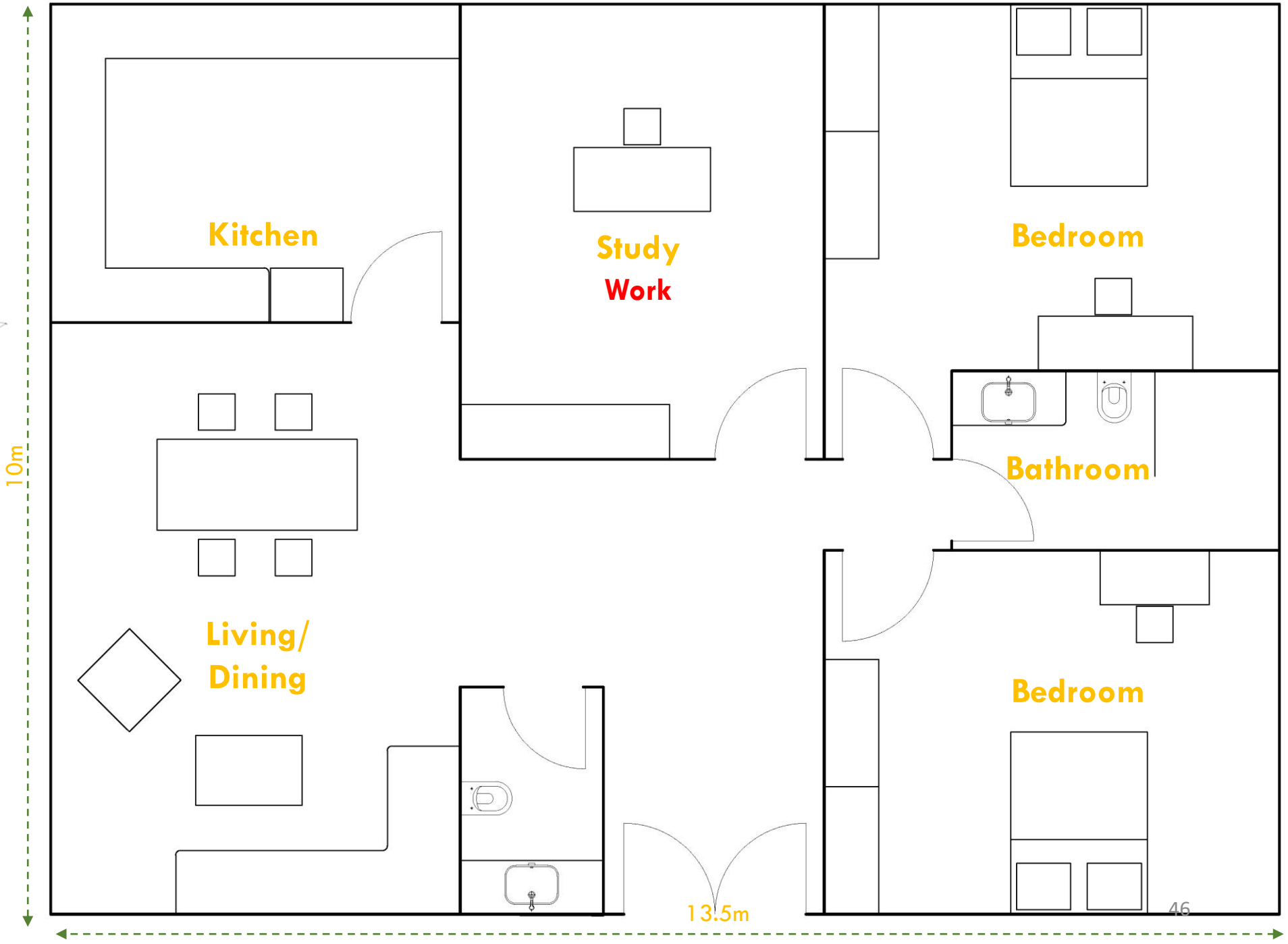
- Single person household
- Around 40 sq m
- Combined work + live



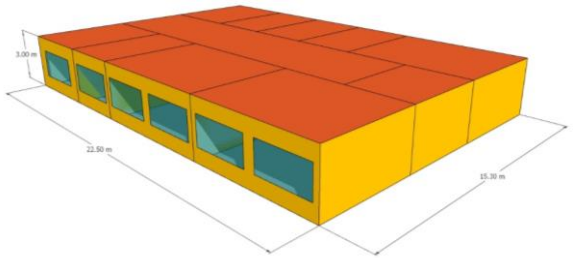
HOUSEHOLD
TYPE 02



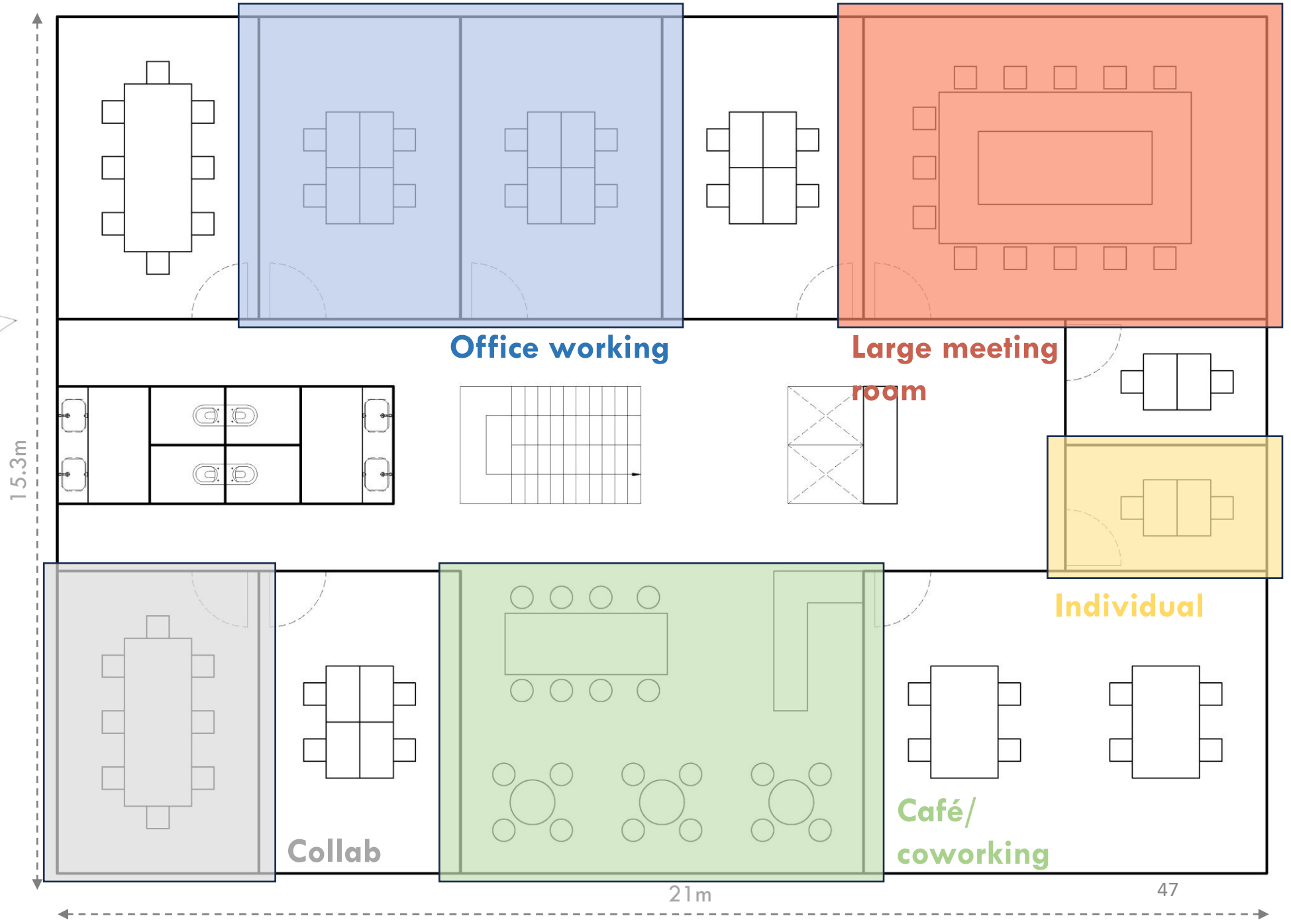
- Multi person household
- Around 140 sq m
- Separate work + live



OFFICE PROTOTYPE



- Activity based workspace
- Variety of zones

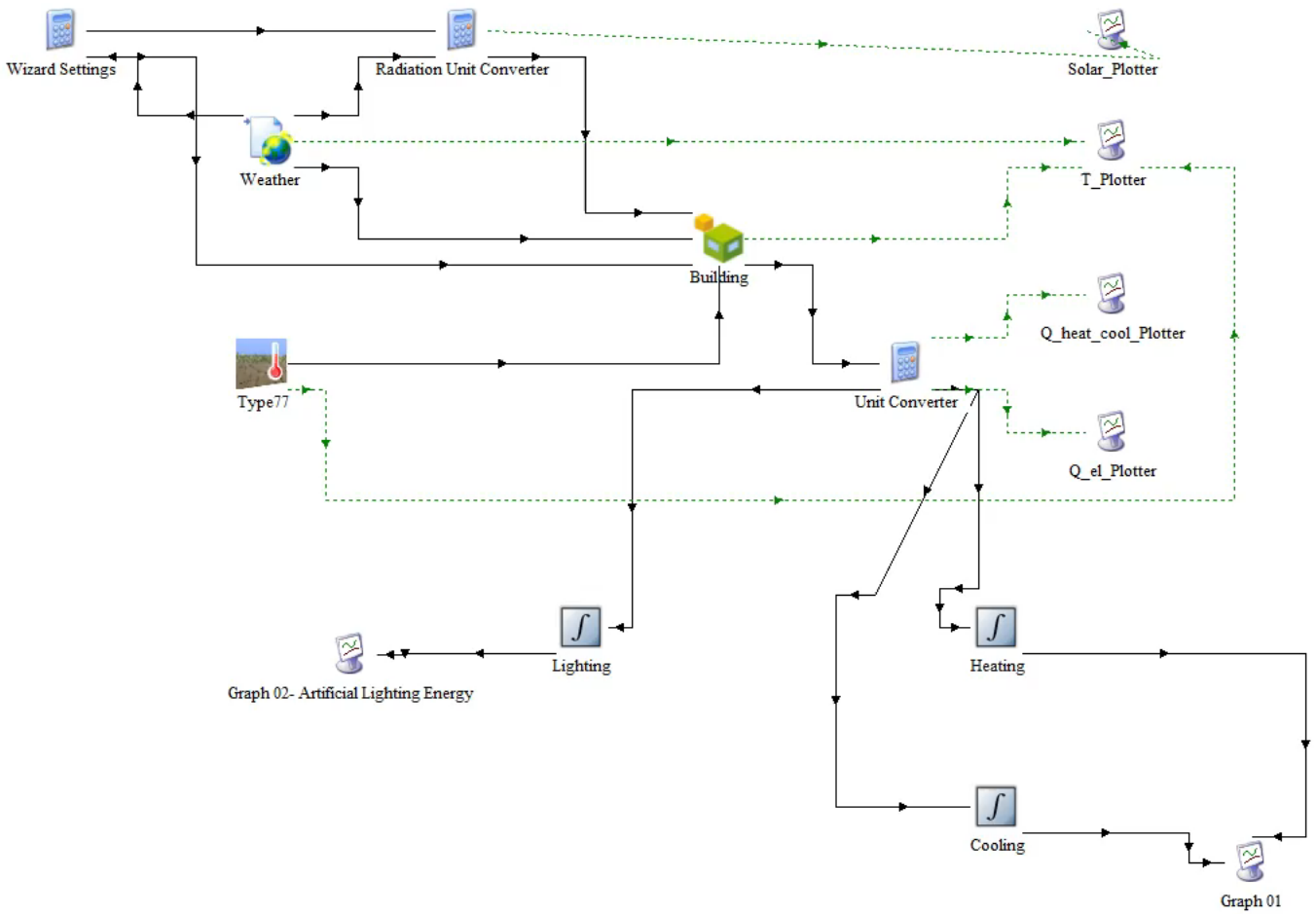


Work moving towards *“structured hybrid”* with a set number of days that people are required to come into the office.

OCCUPANCY PATTERNS: HYBRID WORKING WEEK

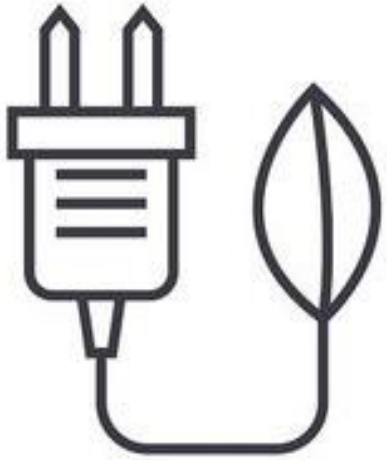
ENERGY SIMULATIONS

- Simulated the energy required to heat the workspaces for
  - **Hybrid** working scenario
  - **Non hybrid** (WFO) working scenario
- Period of 1 year (Jan 1st to Dec 31st)
- At 1-hour intervals


Wizard Settings
Radiation Unit Converter
Solar_Plotter
Weather
T_Plotter
Building
Q_heat_cool_Plotter
Type77
Unit Converter
Q_el_Plotter
Lighting
Heating
Graph 02- Artificial Lighting Energy
Cooling
Graph 01

Controllers
Electrical
Ground Coupling
HVAC
Hydrogen Systems
Hydronics
Loads and Structures
Obsolete
Output
Physical Phenomena
Solar Thermal Collectors
Thermal Storage
Utility
Weather Data Reading and F

RESULTS

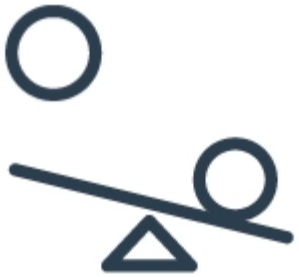


Energy savings for offices

Increased energy use at home

Couple energy to occupancy

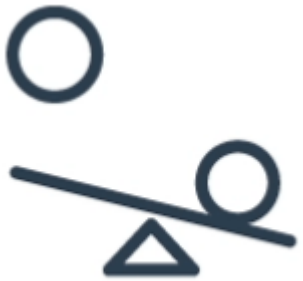
IMPLICATIONS



Hybrid work

Improved version

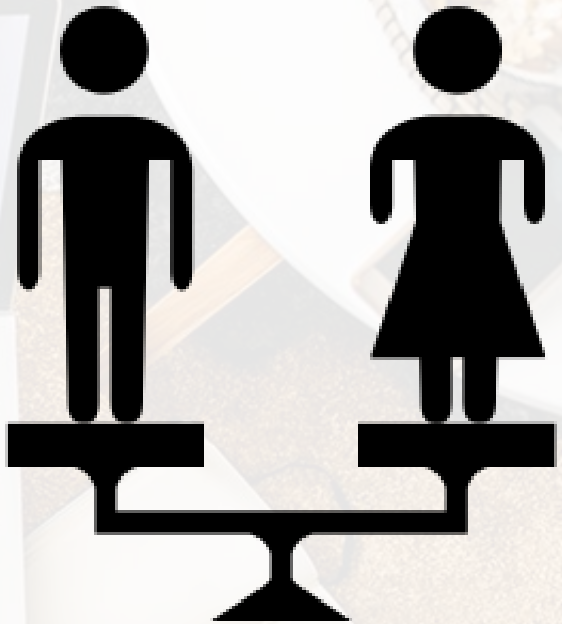
IMPLICATIONS



Inequality

Financial inequality

Function of household **composition** and household **size**.
Spatial inequalities are a result of **economic** inequalities



Gender

Skewed gendered roles.
Women at risk of **detaching** from professional work.

04

CASE STUDIES

CASE STUDIES

- Two case studies
- Analysis of
  - Occupancy data
  - Energy usage data

CASE 01: ING BELGIUM

- Corporate multinational bank
- 50/50 Hybrid working policy in place

ING MARNIX

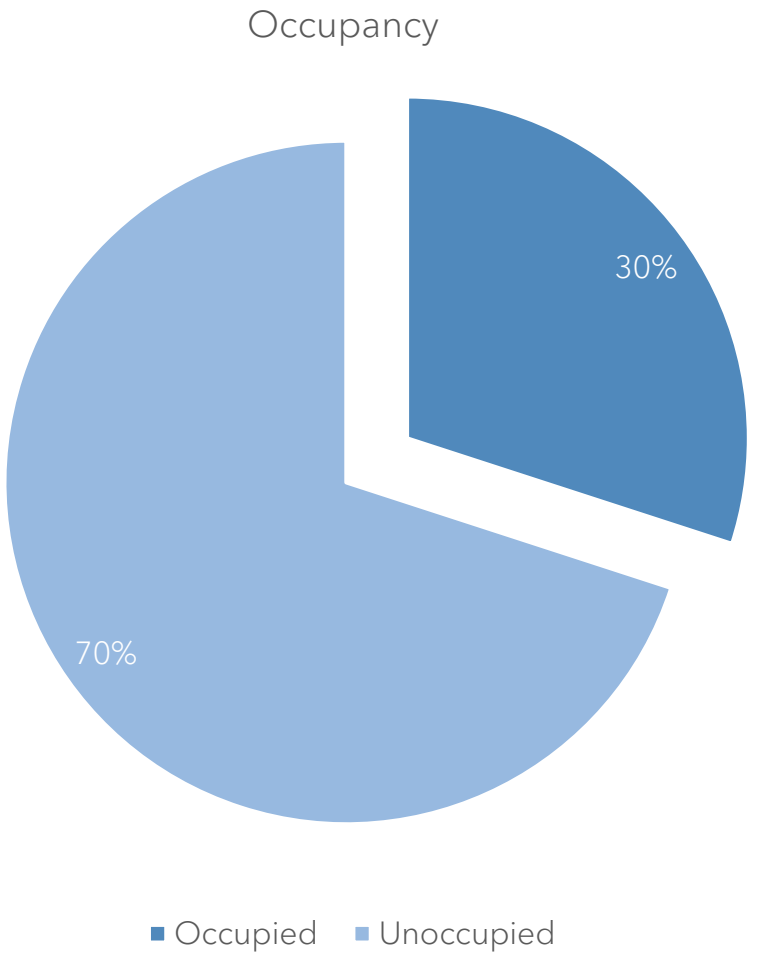
ING LOUVAIN-LA-NEUVE (LLN)

ING GHENT

ING COURS SAINT MICHEL (CSM)

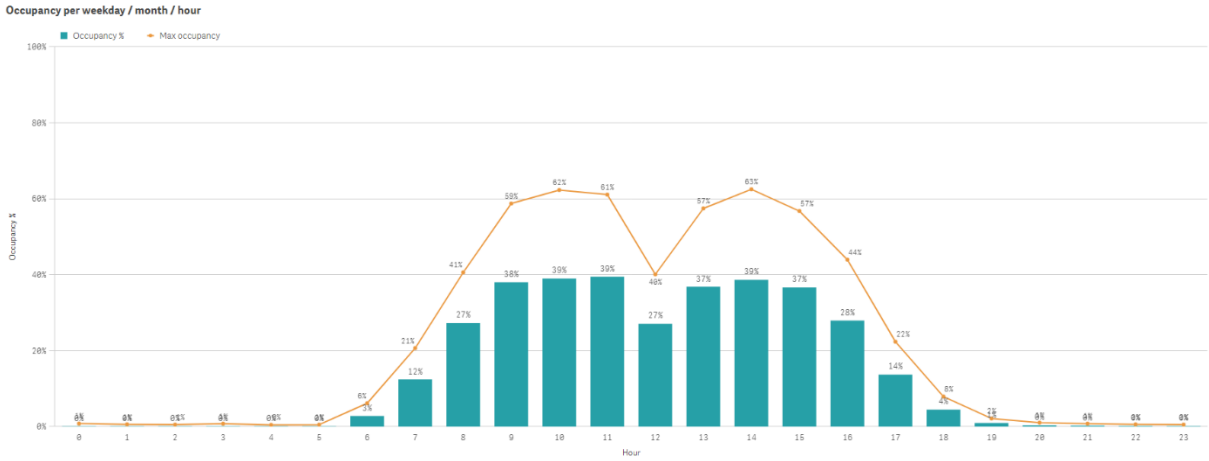
ING BELGIUM : Analysis

- Analysed occupancy data for 10 months (July 2023 – April 2024)
- Average occupancy – 30% (max 67%)

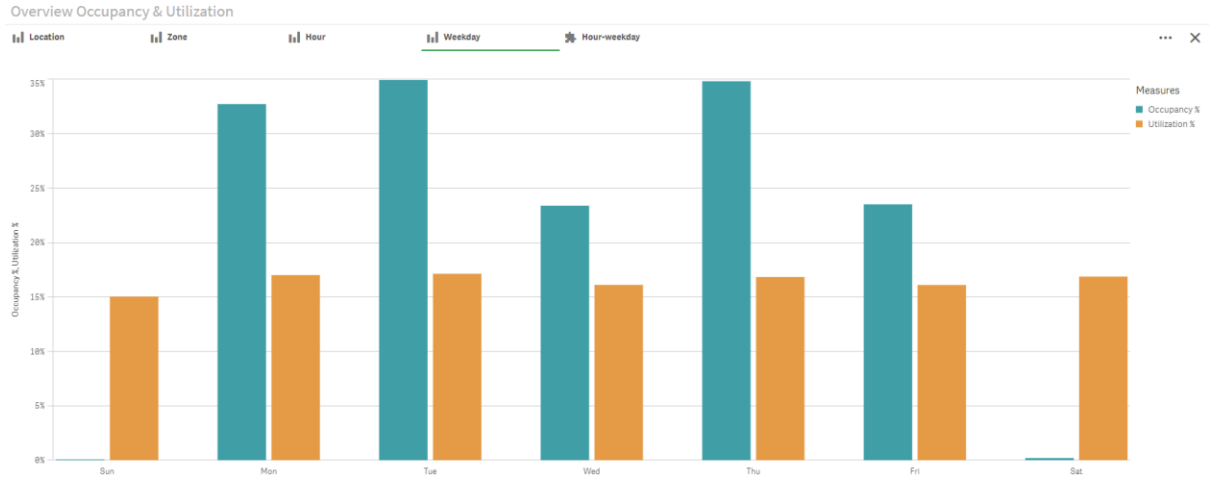


ING BELGIUM : Analysis

- Analysed for 10 months (July 2023 – April 2024)
- Average occupancy – 30% (max 67%)
- Standardised occupancy patterns through the day and across the week



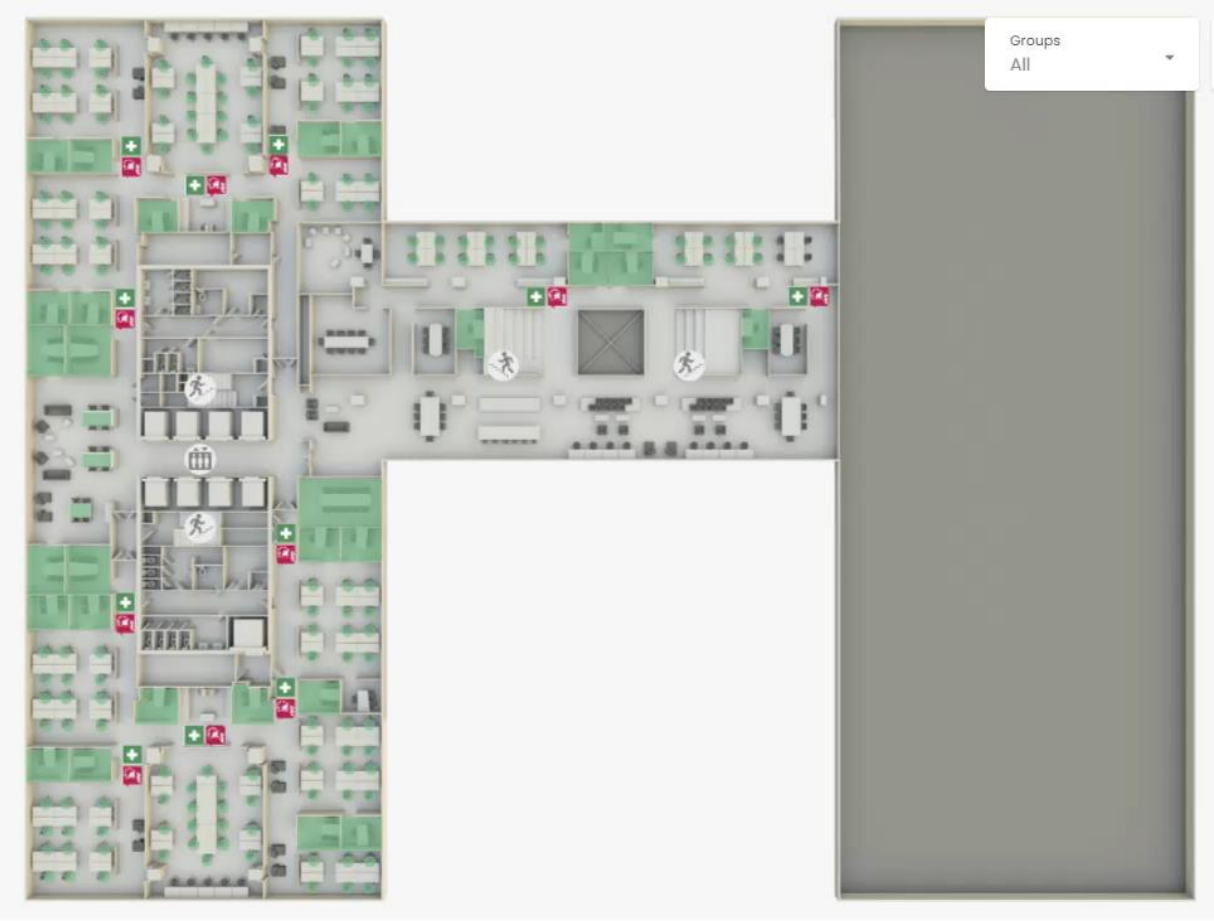
DAILY OCCUPANCY



WEEKLY OCCUPANCY

ING BELGIUM : Analysis

- Analysed for 10 months (July 2023 – April 2024)
- Average occupancy – 30% (max 67%)
- Standardised occupancy patterns through the day and across the week
- Despite recent renovations, the spatial provision does not align with user behaviour.



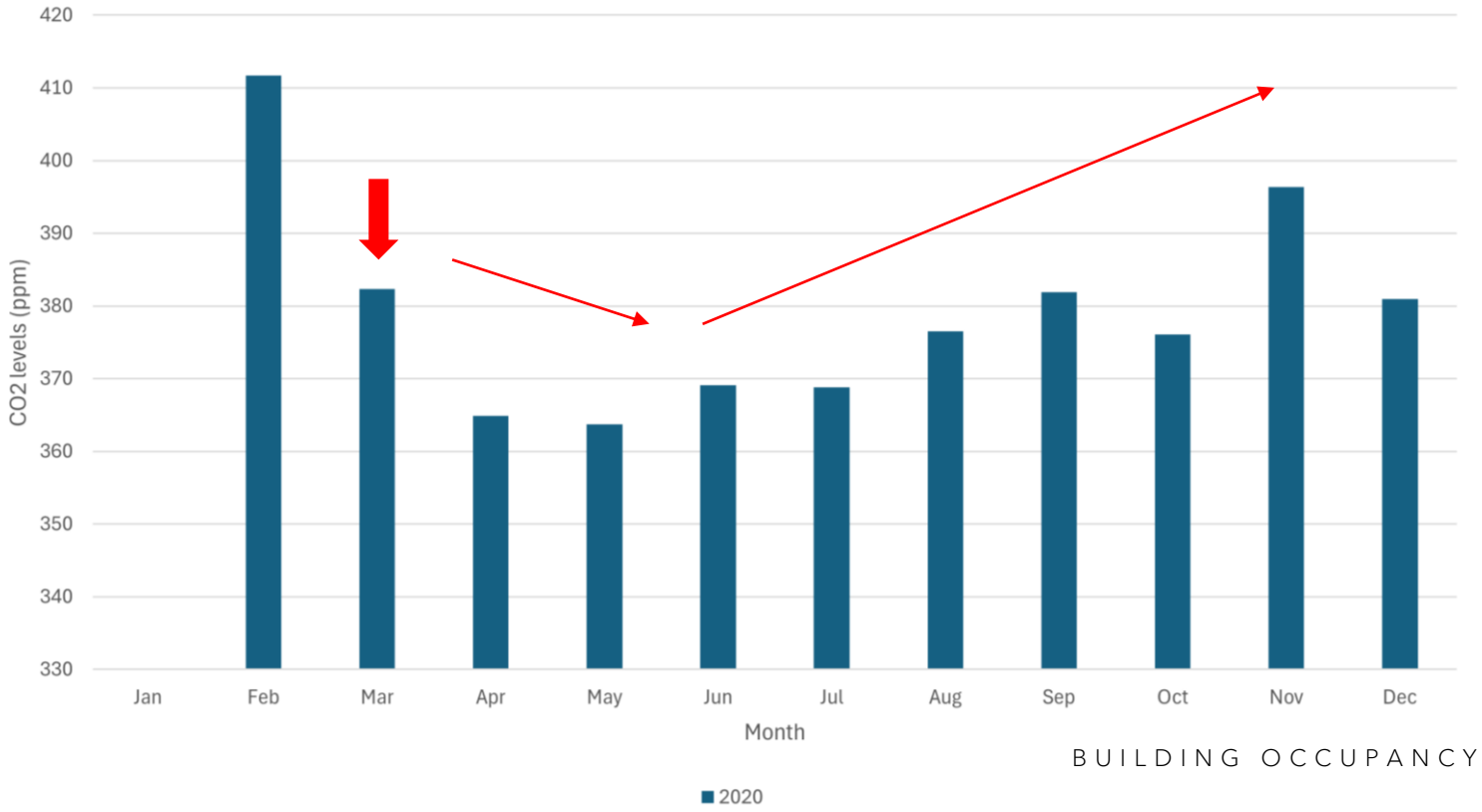
ING MARNIX OCCUPANCY

CASE 02: BUILDING 28, TU Delft

- Extension of the Computer Science faculty.
- Research based offices
- 40/60 Hybrid working policy in place

OCCUPANCY

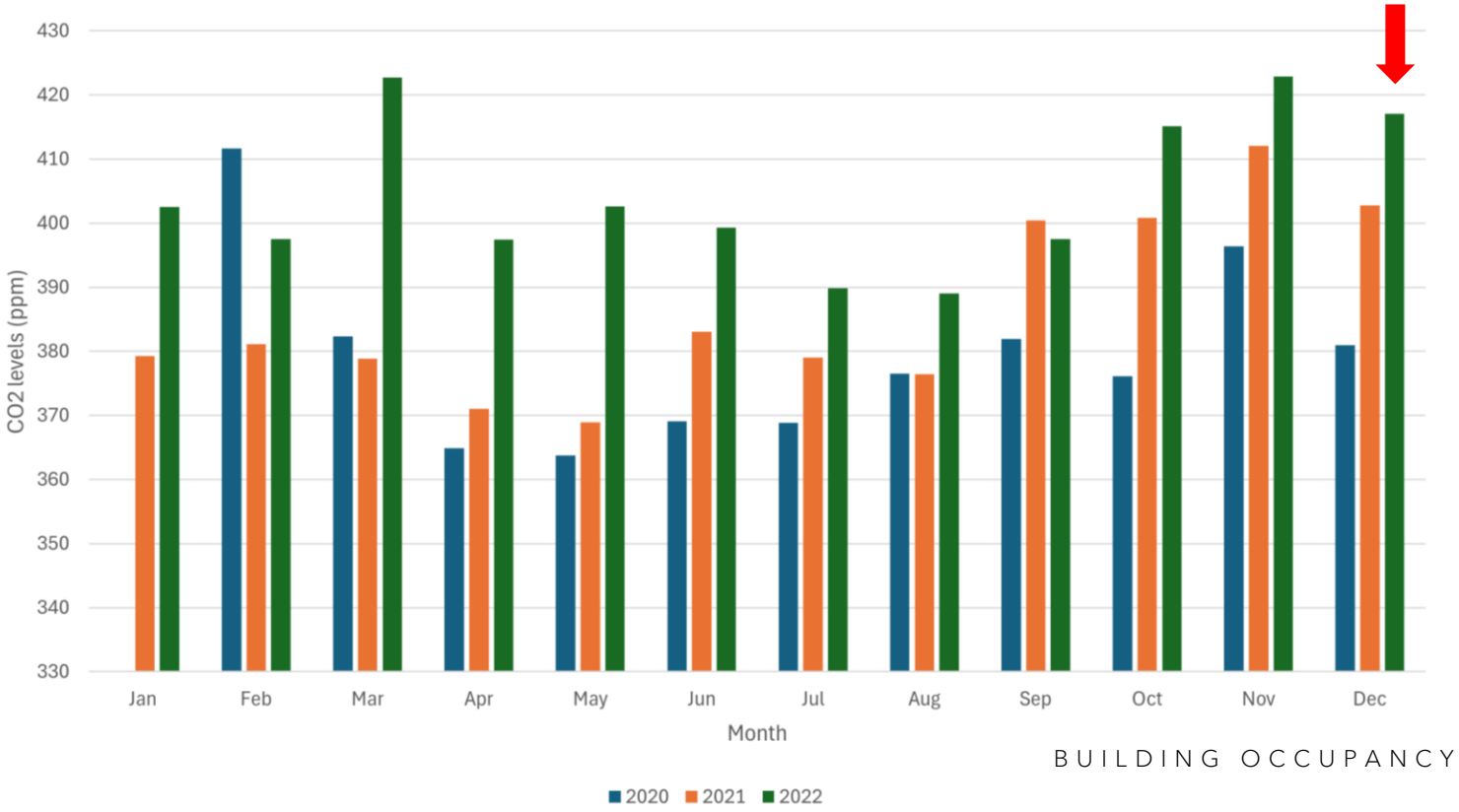
- Analysed for 3 years (2020- 2022)
- March 2020- Covid measures imposed



OCCUPANCY

- Analysed for 3 years (2020- 2022
- March 2020- Covid measures imposed

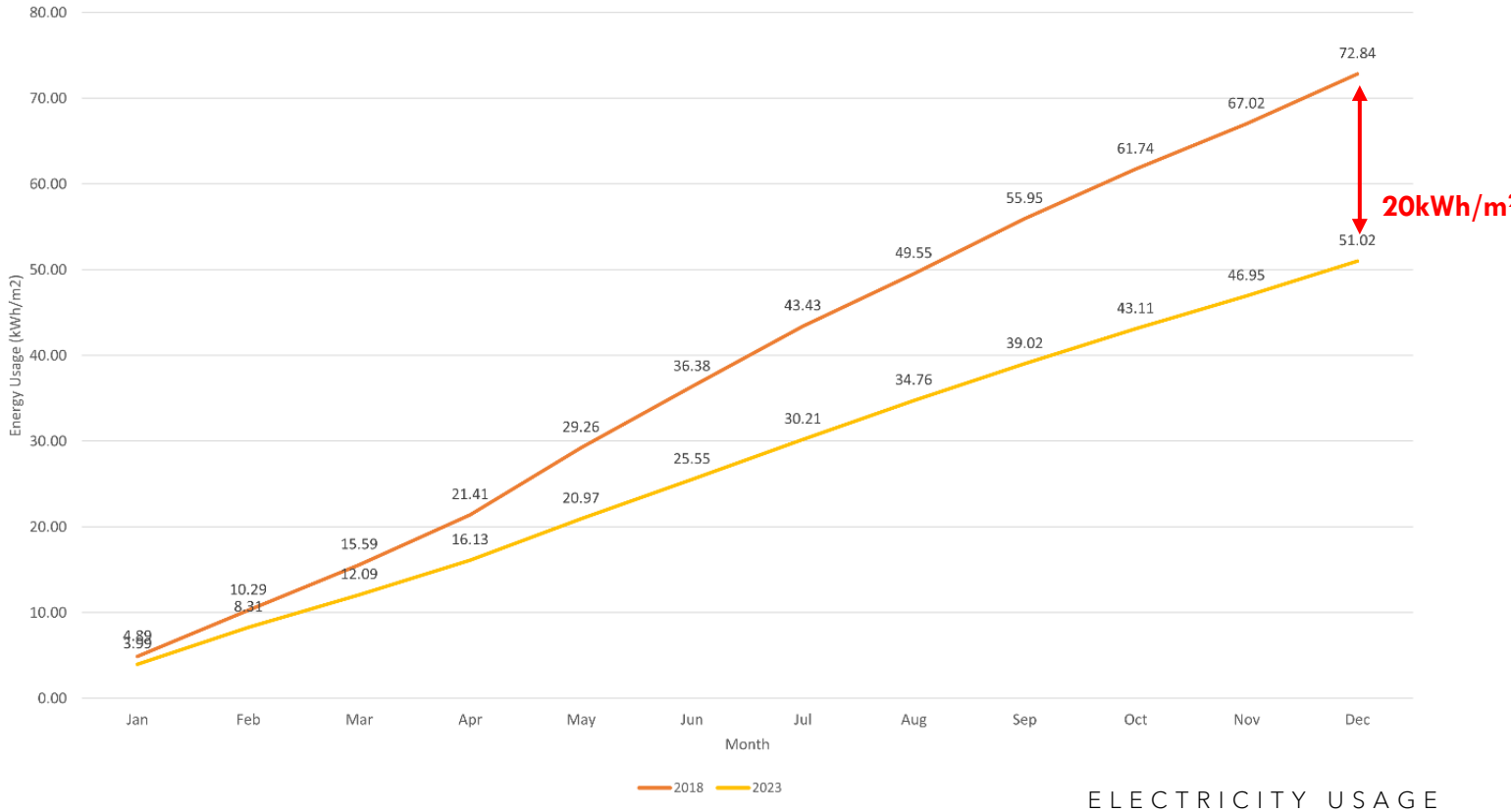
- Occupancy gradually picks up in 2021, and peaks in 2022.
- No reduction of spatial footprint during this time.



BUILDING OCCUPANCY

ENERGY USE (ELECTRICITY)

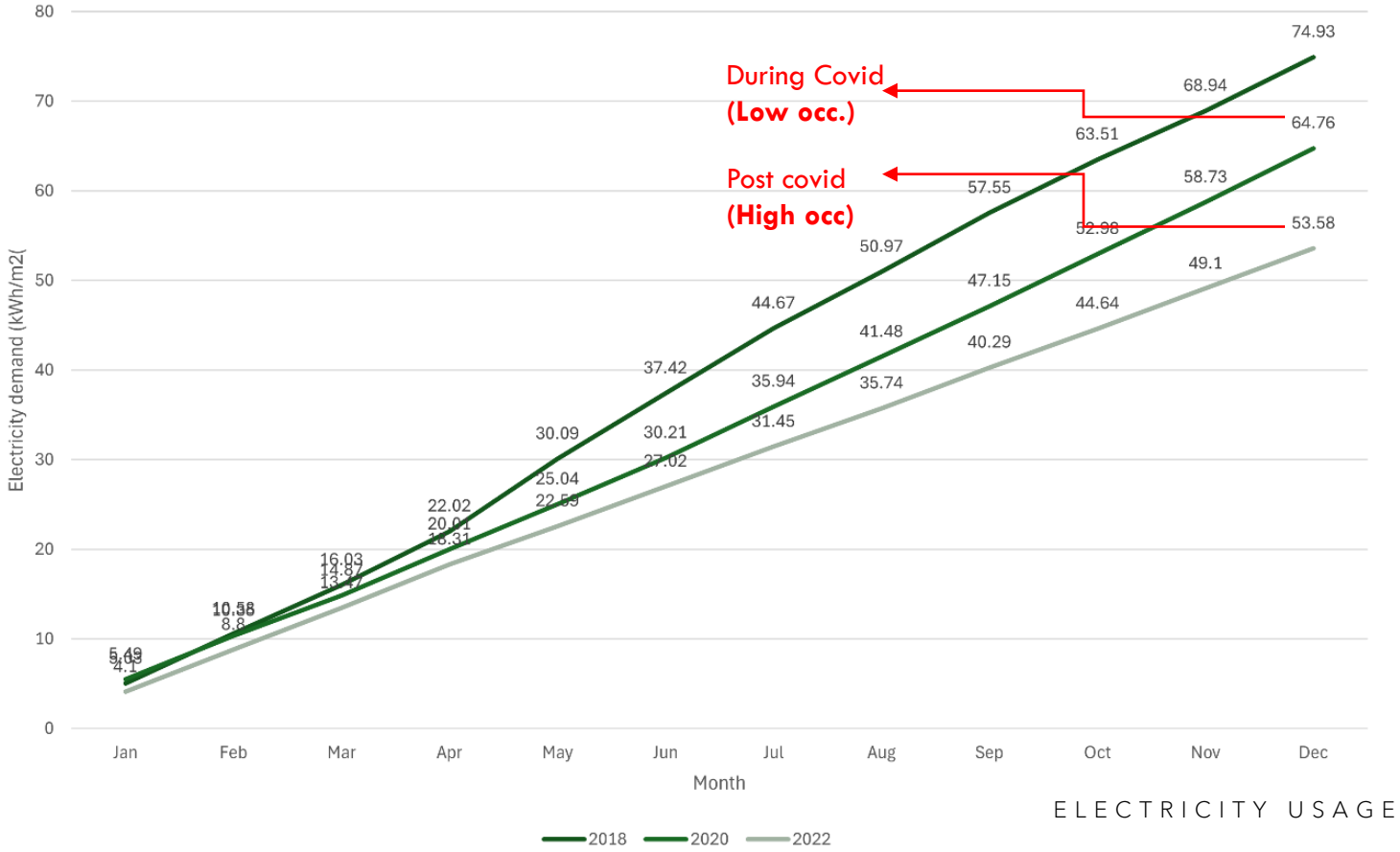
- Analysed for 5 years (2018- 2023)
- Drastic reduction in energy use, pre and post covid.



ELECTRICITY USAGE

ENERGY USE (ELECTRICITY)

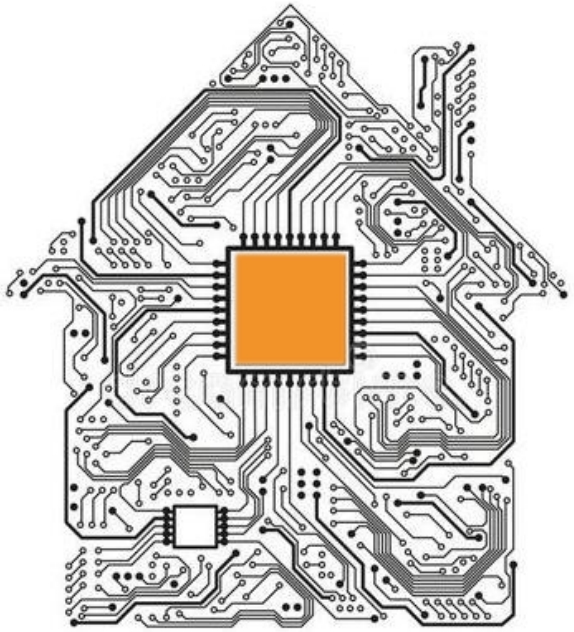
- Analysed for 5 years (2018- 2023)
- Drastic reduction in energy use, pre and post covid.
- Energy use for the same years that occupancy was analysed
  - Low occupancy in 2020, but high energy use
  - Higher occupancy in 2022, but lower energy use
  - Reduced energy demand could be a function of the BMS system they have.



ELECTRICITY USAGE

IMPLICATIONS

Contextual and employee specific solutions



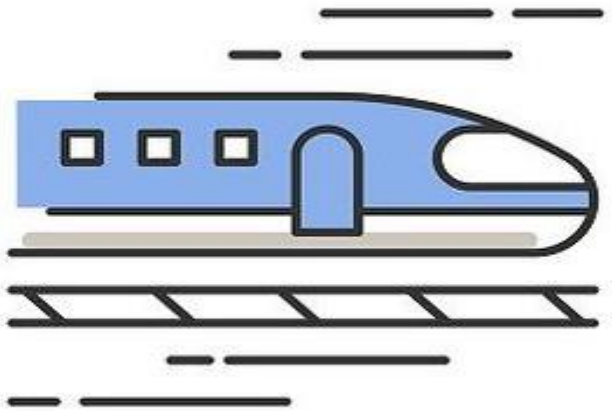
Retrofit offices – smart systems

Induce awareness

04

MOBILITY

MOBILITY



- Desk research on trends in the Netherlands and Europe
- Impacts of hybrid working on commute

FINDINGS

68 minutes saved per week

Largest switch among knowledge workers and public transport users

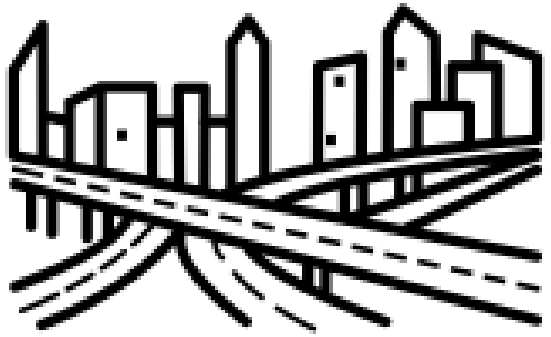
Tendency to live further away from work

Increased job opportunities due to hybrid working, in economically advantageous regions

IMPLICATIONS

Increased suburbanisation

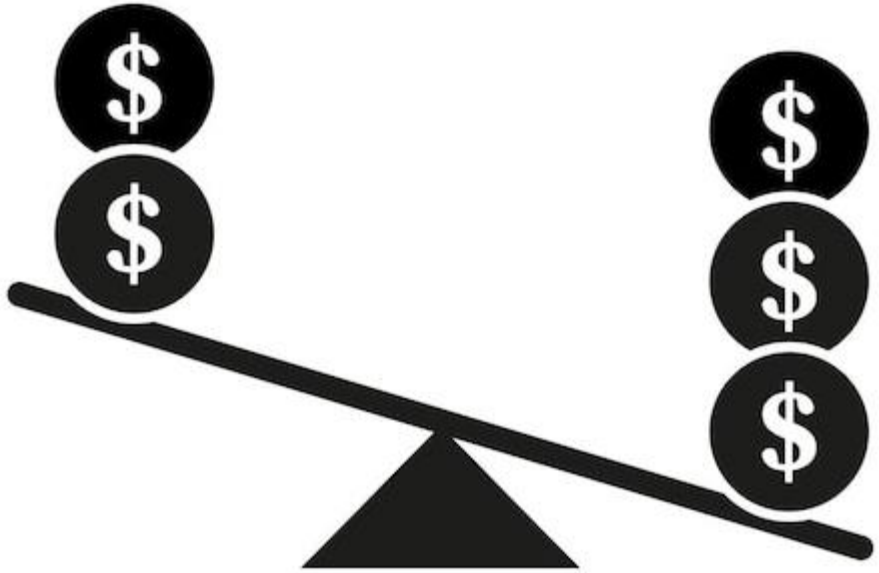
Modal Shift



Infrastructural and macro level changes

IMPLICATIONS

Rebound



Increased disparity

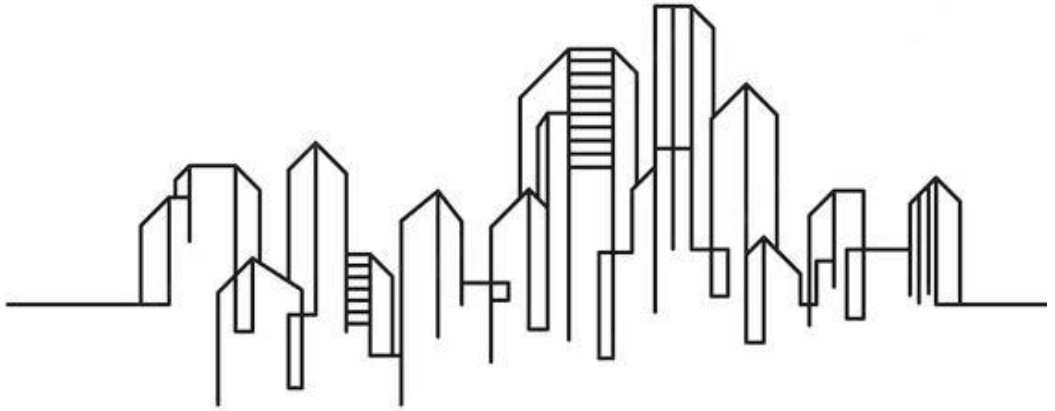
05

DISCUSSION

PRACTICAL IMPLICATIONS

BUILDING SCALE

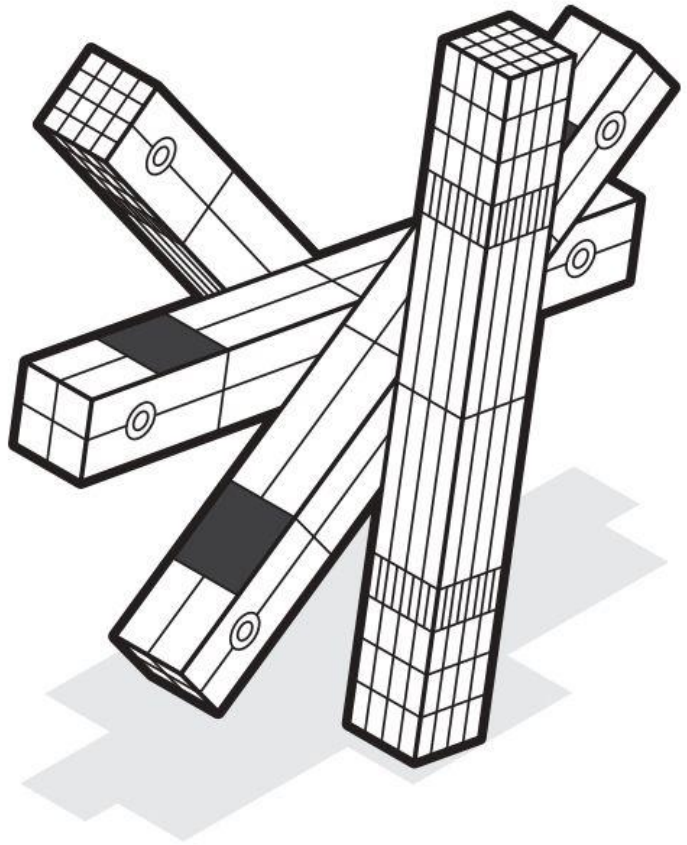
- Environmental Sustainability
- Financial Sustainability
- Social Sustainability



MACRO SCALE

- Expanding Knowledge networks
- Increasing Suburbanisation
- Emergence of NeWSPs

ENVIRONMENTAL SUSTAINABILITY

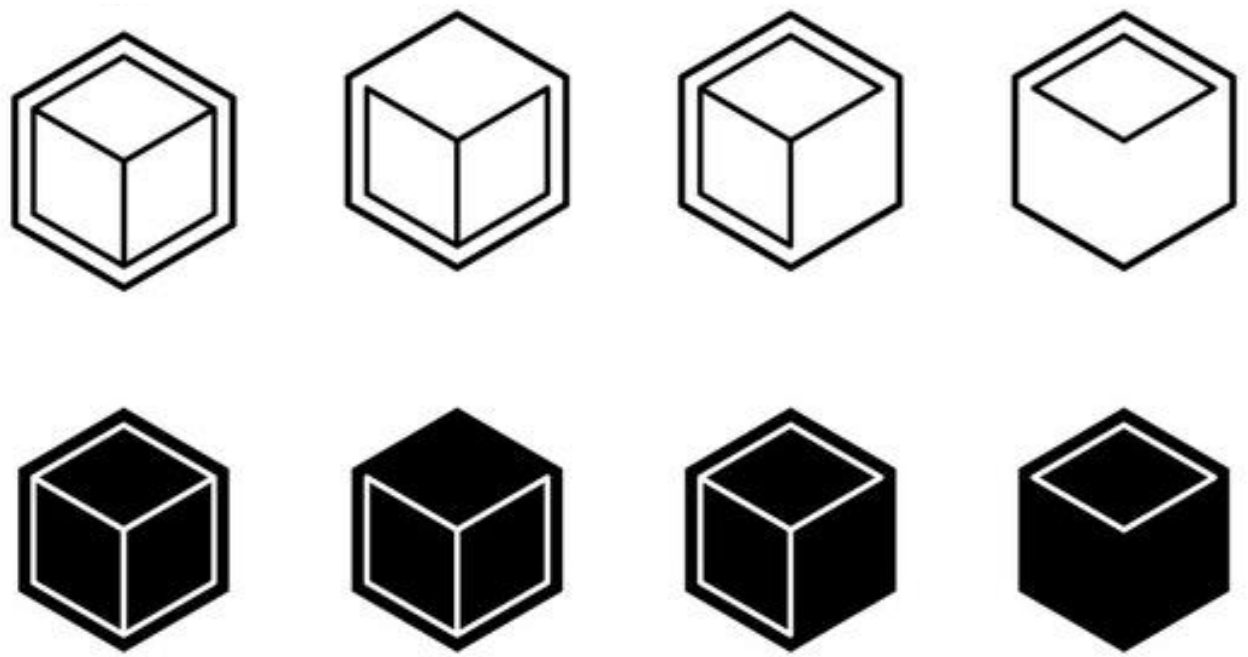


Flexible space

Renovating and improving existing building services

- Dynamic response of energy usage to occupancy levels
- Use of technology to streamline the energy efficiency of space.

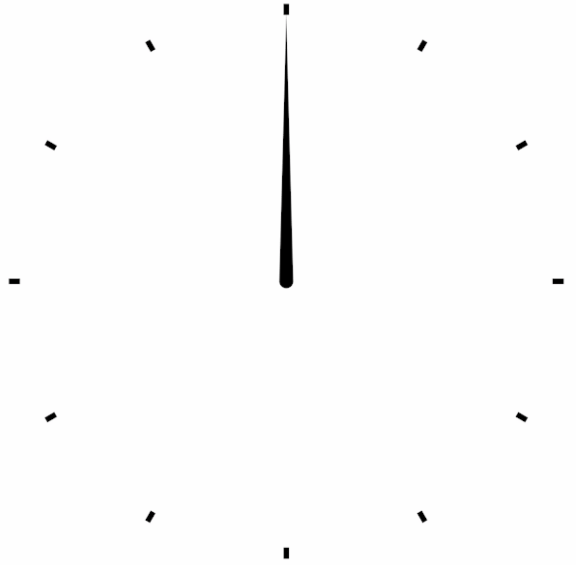
Portfolio Rightsizing



Modular solutions/

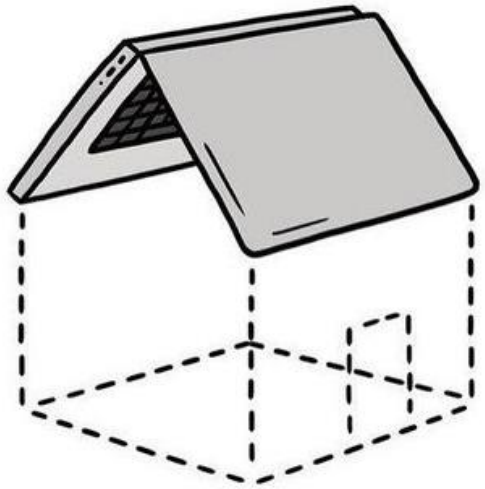
Hybrid buildings

Portfolio Rightsizing



Temporal optimization

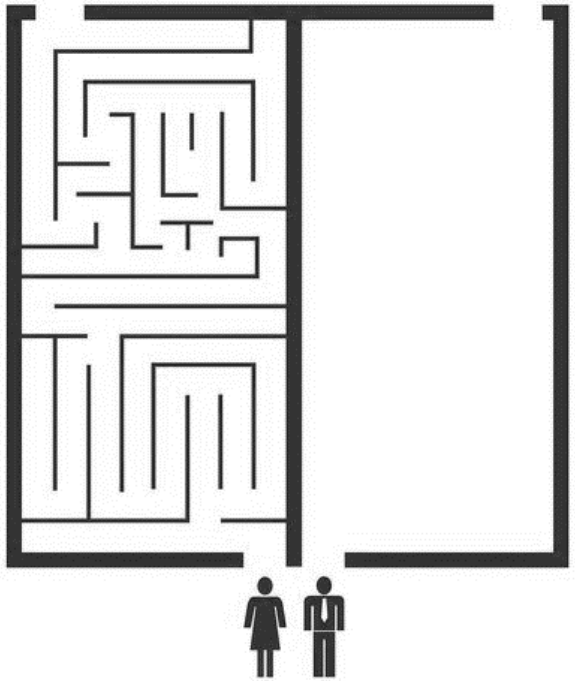
SOCIAL SUSTAINABILITY



Benefits in favour of employer

- Operational costs shifted from offices to homes
- Reinforces inequalities spatially and economically

SOCIAL SUSTAINABILITY

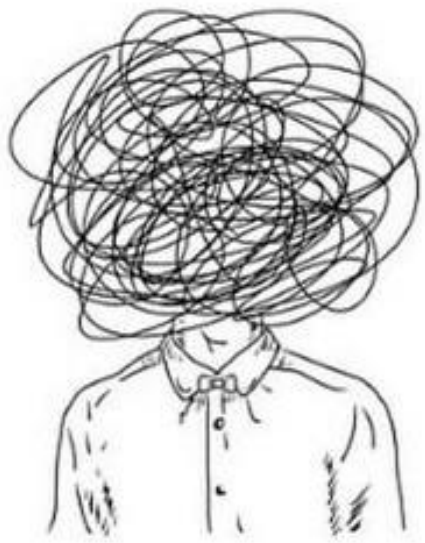


Benefits in favour of employer

Persistent gender inequality

- Men and women experience telework differently
- Women struggle to manage double workloads

SOCIAL SUSTAINABILITY



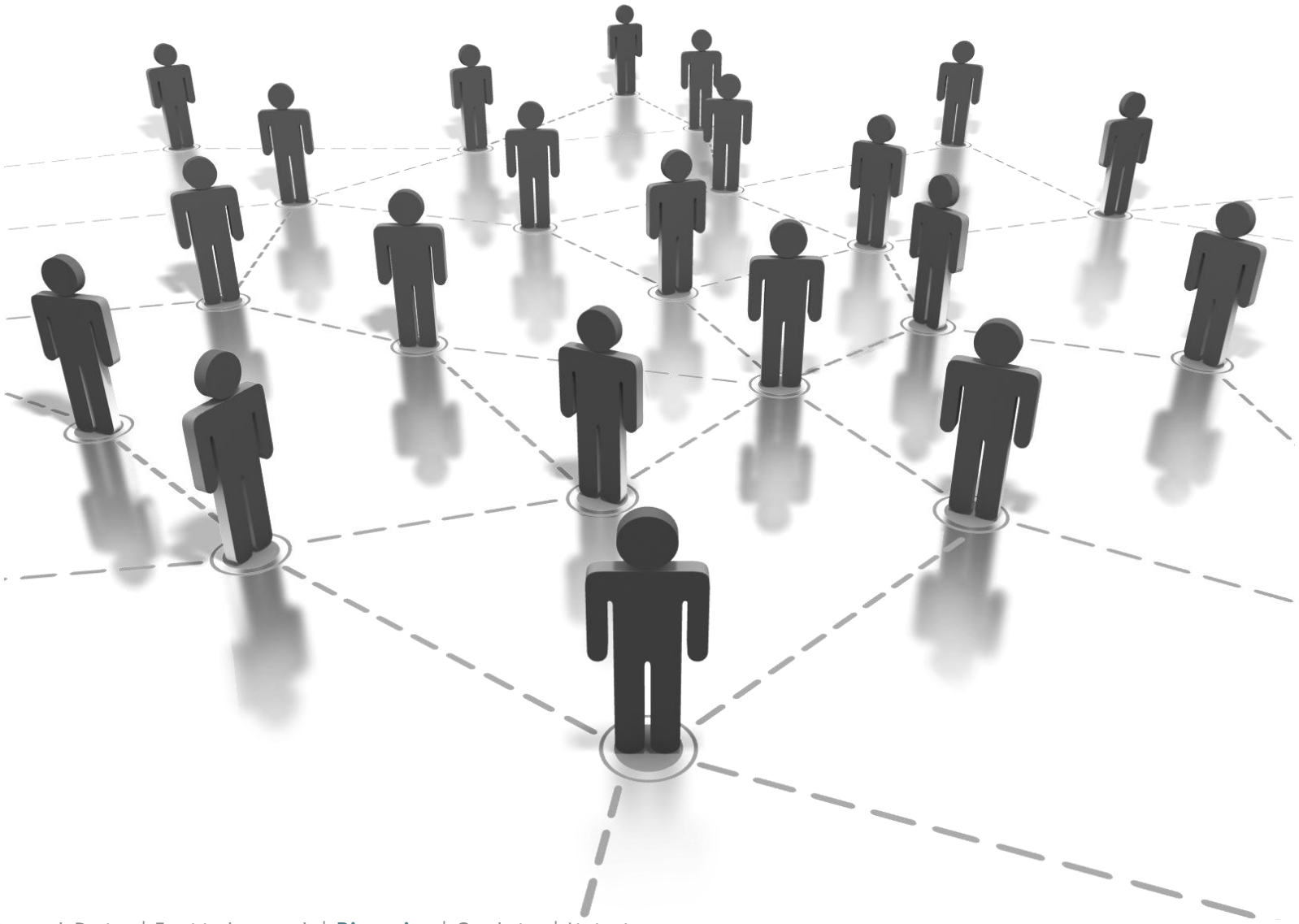
Benefits in favour of employer

Persistent gender inequality

Weakened organisational alignment

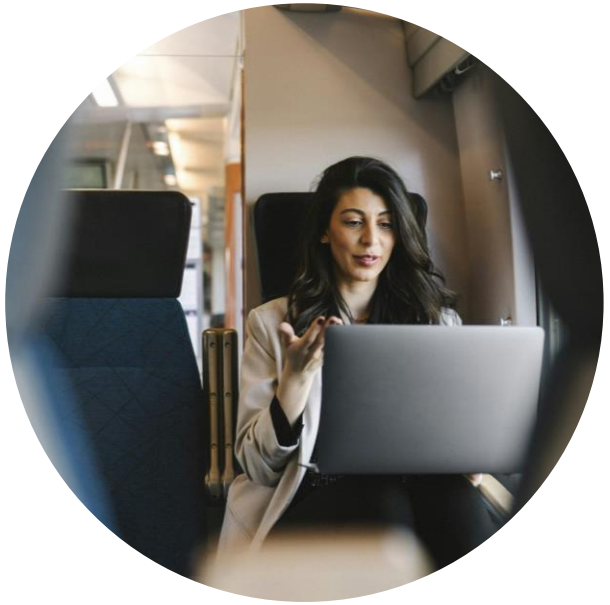
- Reduced social and professional ties
- Possibility of 'Quiet quitting' and high organisational attrition

EXPANDED KNOWLEDGE NETWORKS



NEW WORKING SPACES (NEWSPS)

Cafes and coworking



Mobility hubs

Satellite offices

06

CONCLUSION

SQ01 | WHAT IS HYBRID WORKING?

- **Flexibility** to either work at home or in embodied organisational spaces
- **Advantages** and **disadvantages** at employee, manager and organisational level.
  - Empowerment and work satisfaction
  - Reduced space needs and costs
  - Socio-spatial isolation

SQ02 | HOW HAS THE DEFINITION OF A 'WORKSPACE' EVOLVED DUE TO HYBRID WORKING?

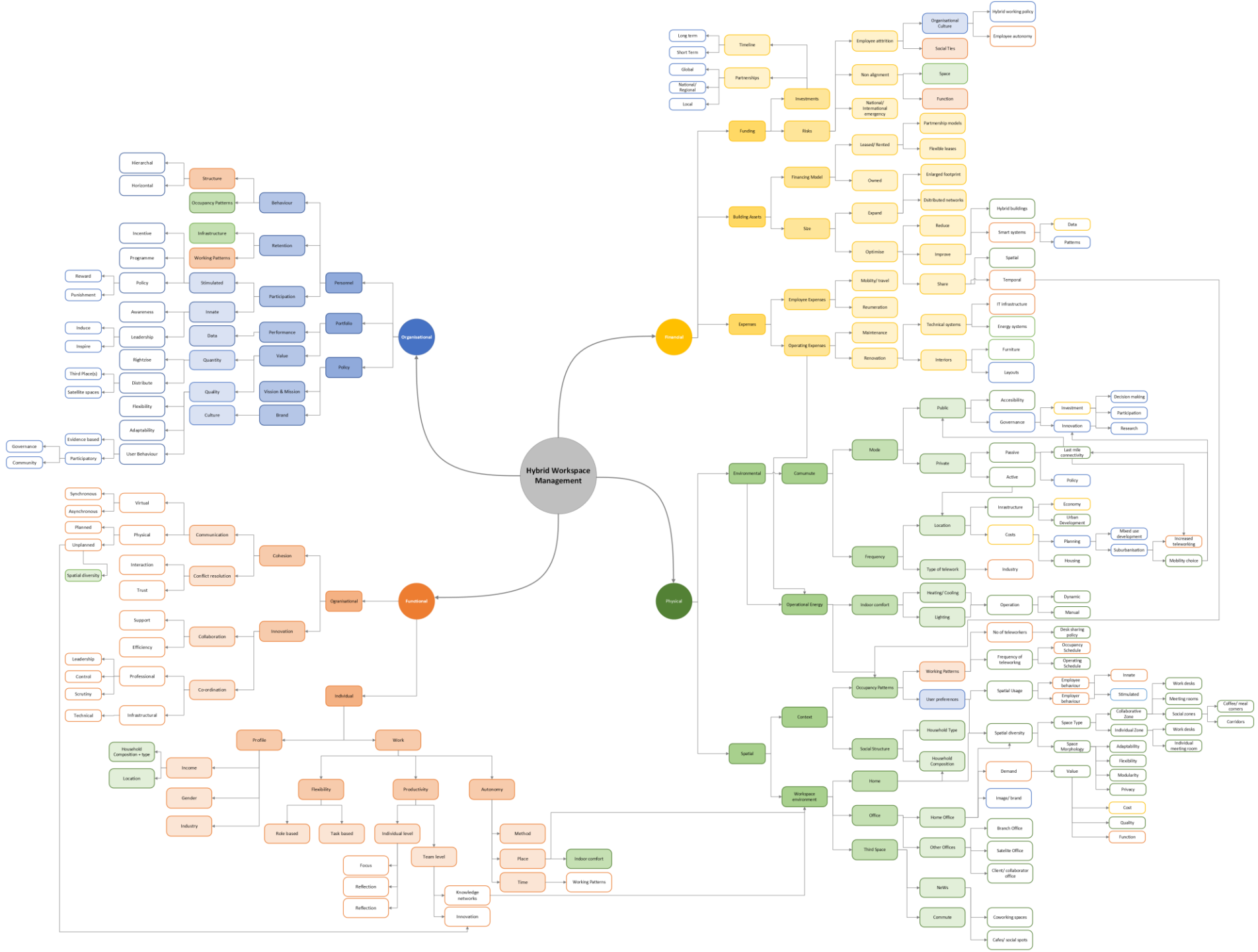
- Two **distinct** physical spaces
- **Reconfiguration** of office spaces
  - Activity-based workspaces with more 'we' than 'me' space
  - Contextual and employee specific
- Conception of **alternate** working spaces.

SQ03 | HOW HAS HYBRID WORKING IMPACTED THE USE OF OFFICE SPACE?

- Changing **employee** behaviour
- Role of the office space has been **redefined**
  - **Standardised** occupancy patterns
- **Flexibility** key to future strategies

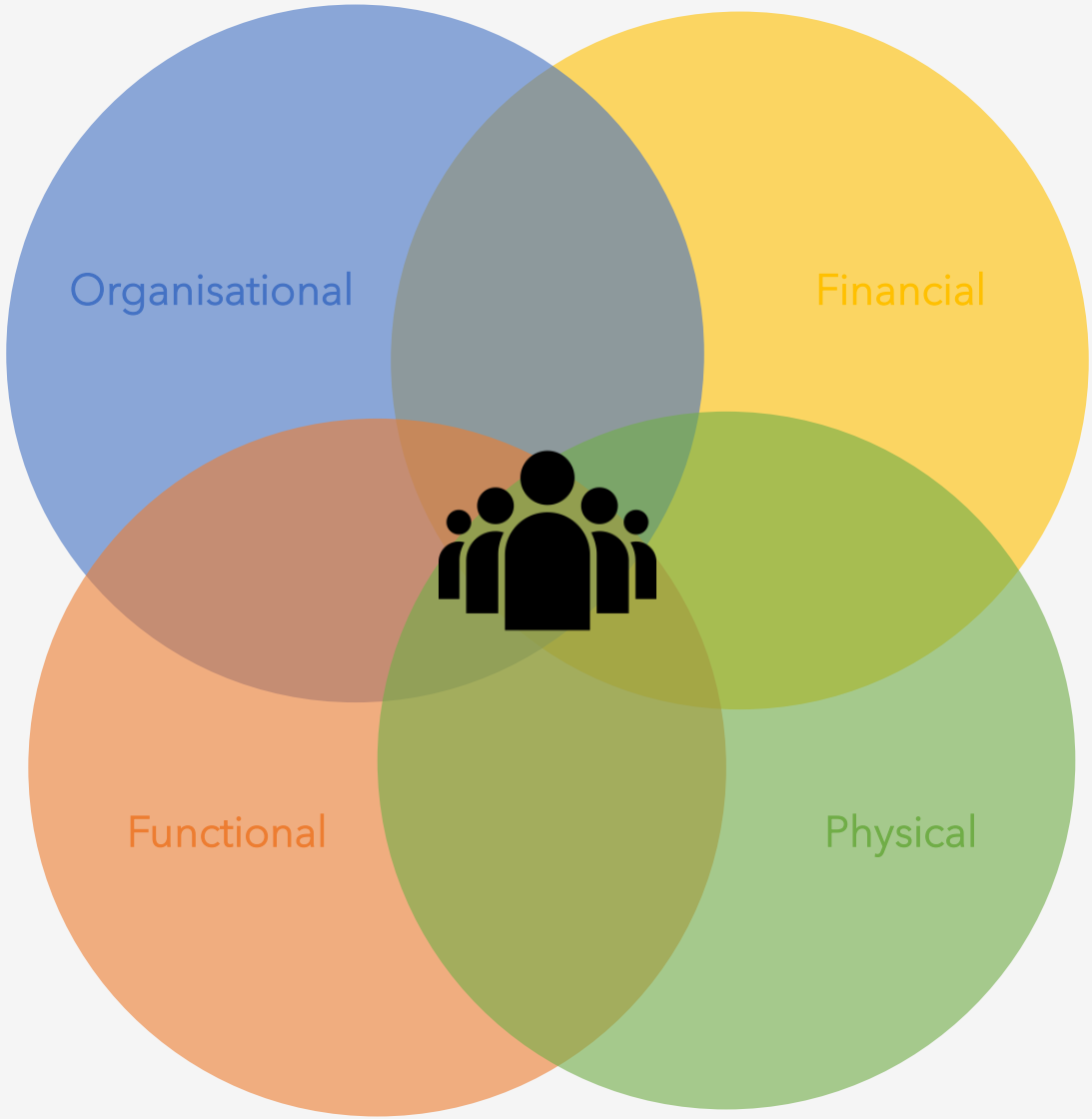
SQ04 | HOW IS THE ENERGY FOOTPRINT OF A USER IMPACTED BY THE DYNAMIC OCCUPANCY THAT RESULTS FROM HYBRID WORKING?

- Energy **savings** for offices
  - Couple energy to occupancy
  - Savings **offset** onto employee
- Enhanced job **accessibility** due to workforce dispersion
- Lack of **infrastructural** support and **regional strategies** will offset savings.


Hybrid Workspace Management
Organisational
Hierarchal
Horizontal
Structure
Occupancy Patterns
Behaviour
Incentive
Programme
Policy
Reward
Punishment
Infrastructure
Working Patterns
Stimulated
Retention
Participation
Personnel
Awareness
Leadership
Induce
Inspire
Rightsize
Distribute
Third Place(s)
Satellite spaces
Flexibility
Adaptability
User Behaviour
Evidence based
Participatory
Innate
Data
Quantity
Quality
Culture
Performance
Value
Brand
Portfolio
Vission & Mission
Policy
Governance
Community
Functional
Organisational
Synchronous
Asynchronous
Planned
Unplanned
Spatial diversity
Virtual
Physical
Interaction
Trust
Communication
Conflict resolution
Cohesion
Support
Efficiency
Leadership
Control
Scrutiny
Technical
Professional
Infrastructural
Collaboration
Co-ordination
Innovation
Individual
Profile
Work
Household Composition + type
Location
Income
Gender
Industry
Flexibility
Productivity
Autonomy
Role based
Task based
Individual level
Team level
Focus
Reflection
Reflection
Knowledge networks
Innovation
Method
Place
Time
Indoor comfort
Working Patterns
Financial
Timeline
Long term
Short Term
Partnerships
Global
National/ Regional
Local
Funding
Investments
Risks
Employee atttrition
Non alignment
National/ International emergency
Organisational Culture
Social Ties
Hybrid working policy
Employee autonomy
Space
Function
Building Assets
Financing Model
Size
Partnership models
Leased/ Rented
Flexible leases
Owned
Enlarged footprint
Distributed networks
Expand
Optimise
Reduce
Improve
Share
Hybrid buildings
Smart systems
Data
Patterns
Spatial
Temporal
Expenses
Employee Expenses
Operating Expenses
Mobility/ travel
Reumeration
Maintenance
Renovation
Technical systems
Interiors
IT Infrastructure
Energy systems
Furniture
Layouts
Physical
Environmental
Comumute
Mode
Public
Private
Accessibility
Governance
Investment
Innovation
Decision making
Participation
Research
Passive
Active
Last mile connectivity
Policy
Frequency
Location
Type of telework
Innastructure
Costs
Economy
Urban Development
Planning
Housing
Mixed use development
Suburbanisation
Increased teleworking
Mobility choice
Industry
Operational Energy
Indoor comfort
Heating/ Cooling
Lighting
Operation
Dynamic
Manual
Spatial
Context
Occupancy Patterns
Working Patterns
User preferences
No of teleworkers
Frequency of telework
Desk sharing policy
Occupancy Schedule
Operating Schedule
Social Structure
Household Type
Household Composition
Spatial Usage
Employee behaviour
Employer behaviour
Innate
Stimulated
Work desks
Meeting rooms
Social zones
Work desks
Individual meeting room
Coffee/ meal corners
Corridors
Spatial diversity
Space Type
Collaborative Zone
Individual Zone
Space Morphology
Adaptability
Flexibility
Modularity
Privacy
Demand
Image/ brand
Value
Cost
Quality
Function
Workspace environment
Home
Office
Third Space
Home Office
Other Offices
NeWs
Commute
Branch Office
Satellite Office
Client/ collaborator office
Coworking spaces
Cafes/ social spots

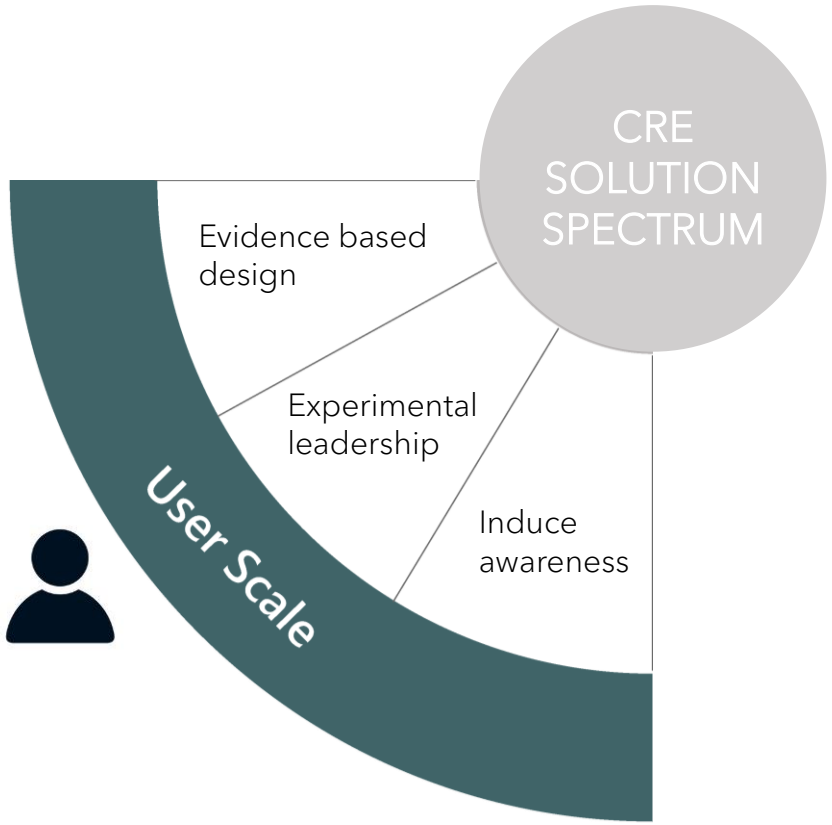
How is the energy consumption of the workspace environment impacted by hybrid modes of working?

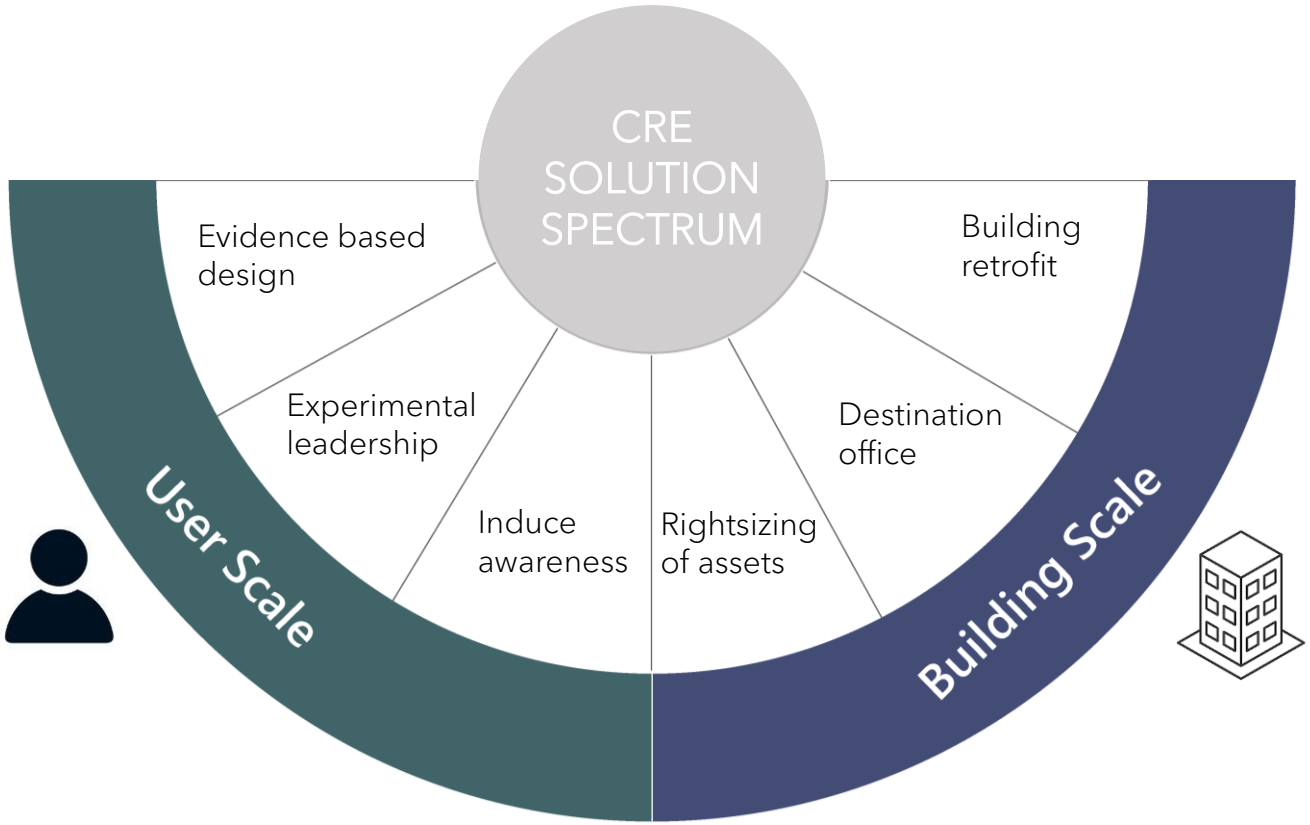
Disproportionate

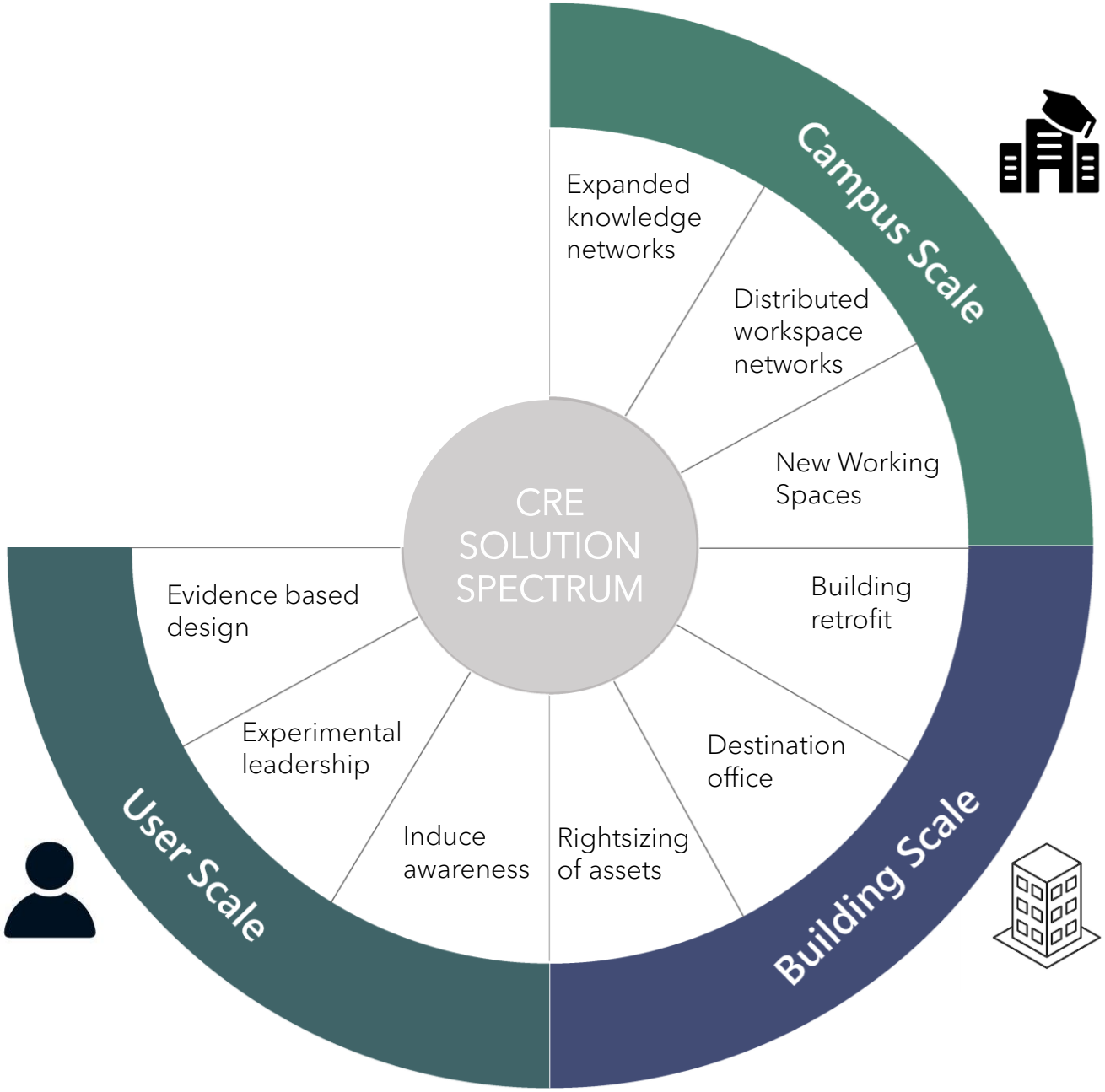


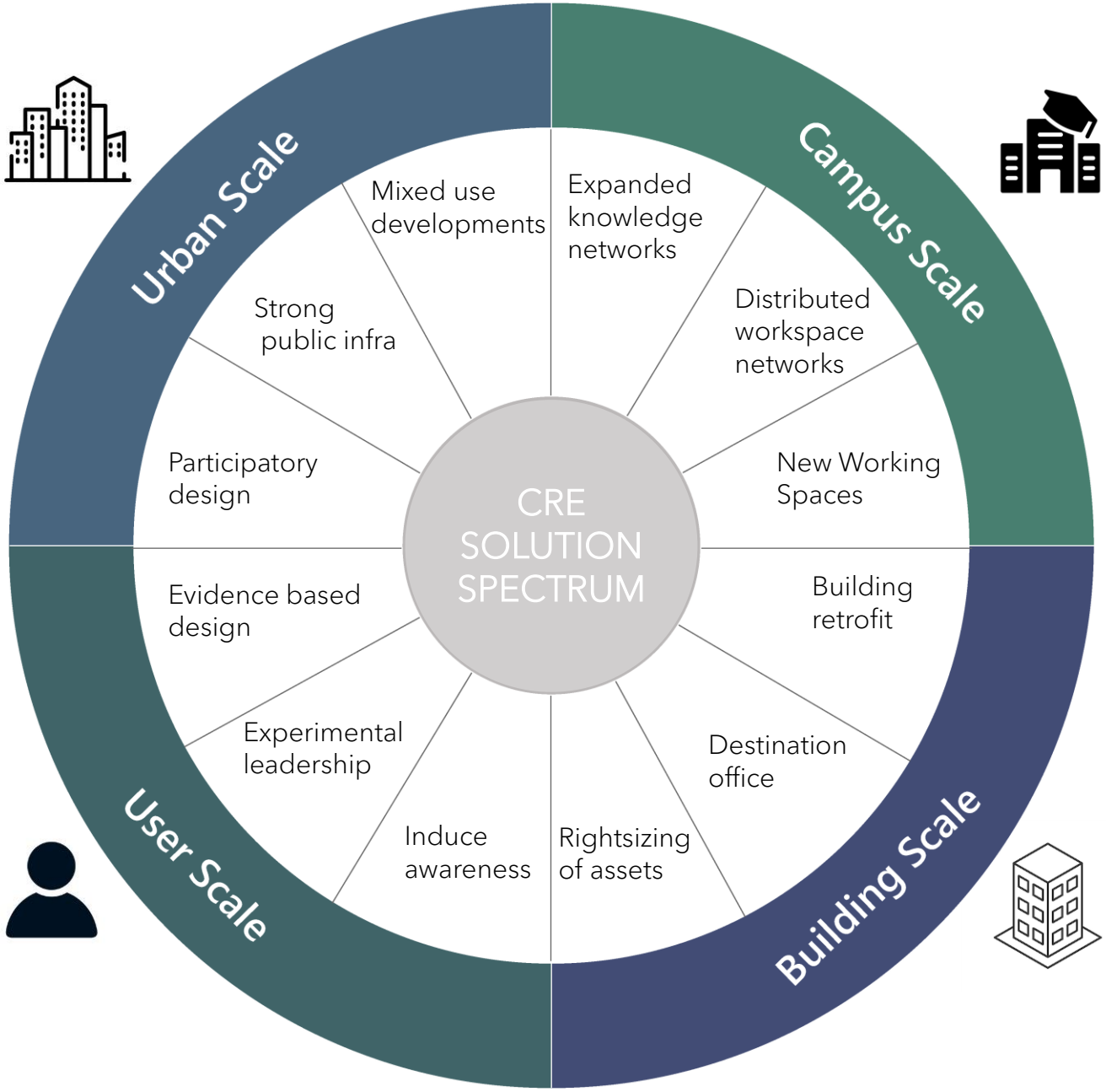
benefits

Sustainability is a dynamic, complex, and expansive notion that spans many perspectives


CRE
SOLUTION
SPECTRUM
Evidence based
design
Experimental
leadership
Induce
awareness
User Scale


CRE
SOLUTION
SPECTRUM
Evidence based design
Experimental leadership
Induce awareness
Rightsizing of assets
Destination office
Building retrofit
User Scale
Building Scale


Campus Scale
Expanded knowledge networks
Distributed workspace networks
New Working Spaces
CRE SOLUTION SPECTRUM
Building retrofit
Destination office
Rightsizing of assets
Induce awareness
Experimental leadership
Evidence based design
User Scale
Building Scale


Urban Scale
Campus Scale
User Scale
Building Scale
CRE SOLUTION SPECTRUM
Mixed use developments
Expanded knowledge networks
Strong public infra
Distributed workspace networks
Participatory design
New Working Spaces
Evidence based design
Building retrofit
Experimental leadership
Destination office
Induce awareness
Rightsizing of assets

07

LIMITATIONS

LIMITATIONS

- Simplified model simulations with optimistic occupancy standards.
- Case study design.
- Impacts of climate change and warming temperature on energy demand not considered.
- Generalising results difficult due to contextualities.

RECOMMENDATIONS

- Adding a qualitative dimension.
- Other industries and working models.
- Implications of Co-working spaces to be further studied.

Inclusive, sustainable, future proof urban systems.

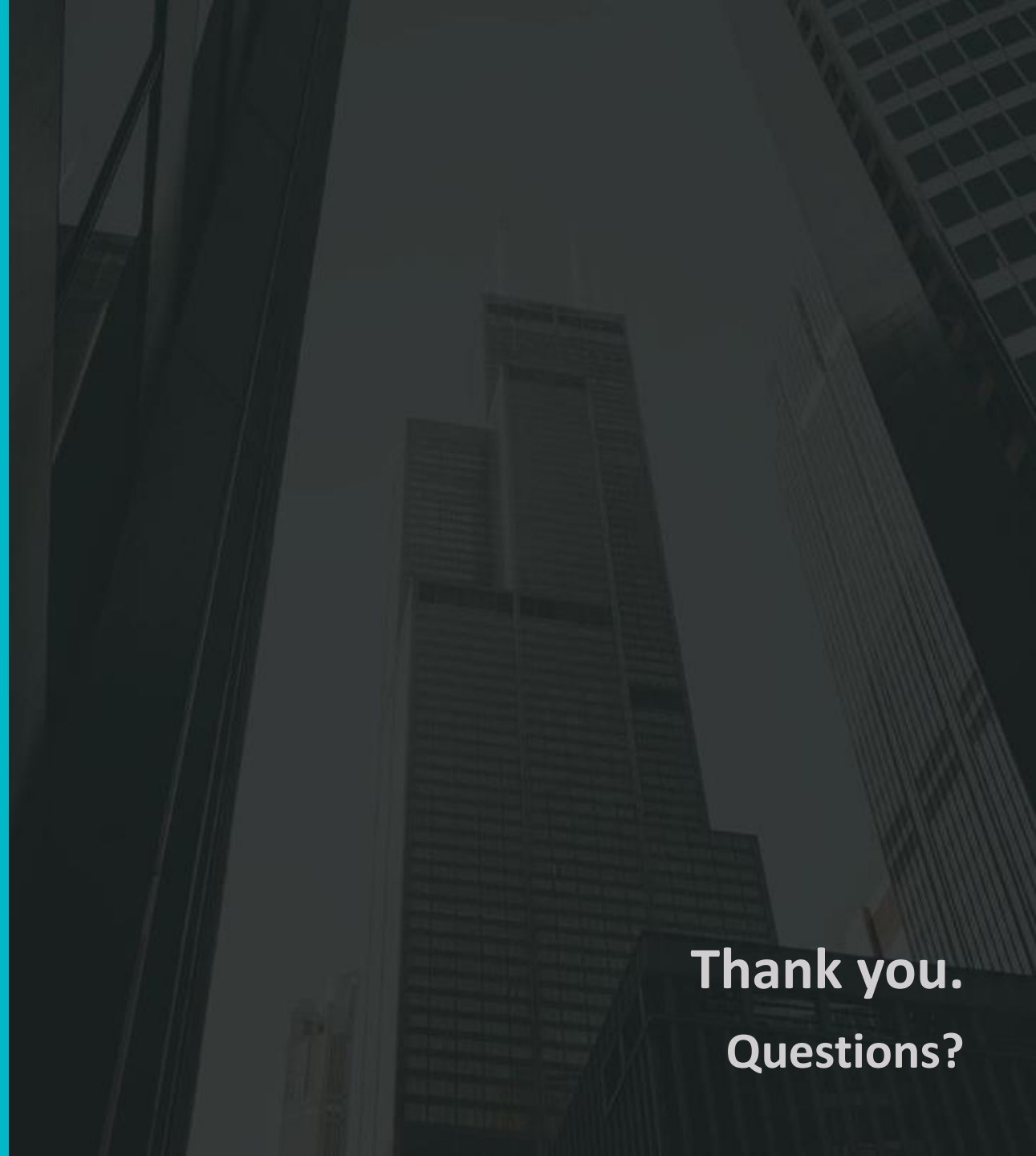
Reconfiguring workspace configurations for a sustainable future

Understanding the links between new working trends and the sustainability of workspaces in a post pandemic reality.

Sanjana Maria John

P5 presentation | 19.05.2024

TU Delft



Thank you.

Questions?