WOOD BUILDINGS

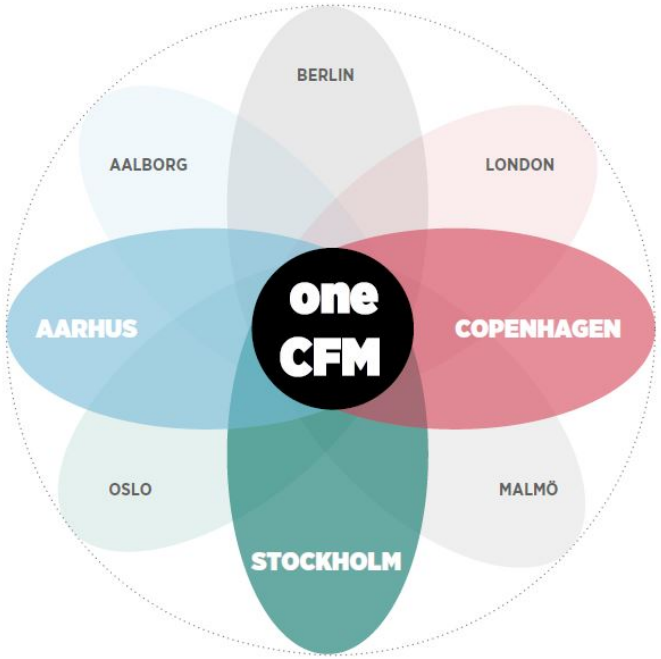
LONE WIGGERS
PARTNER, ARCHITECT MAA.

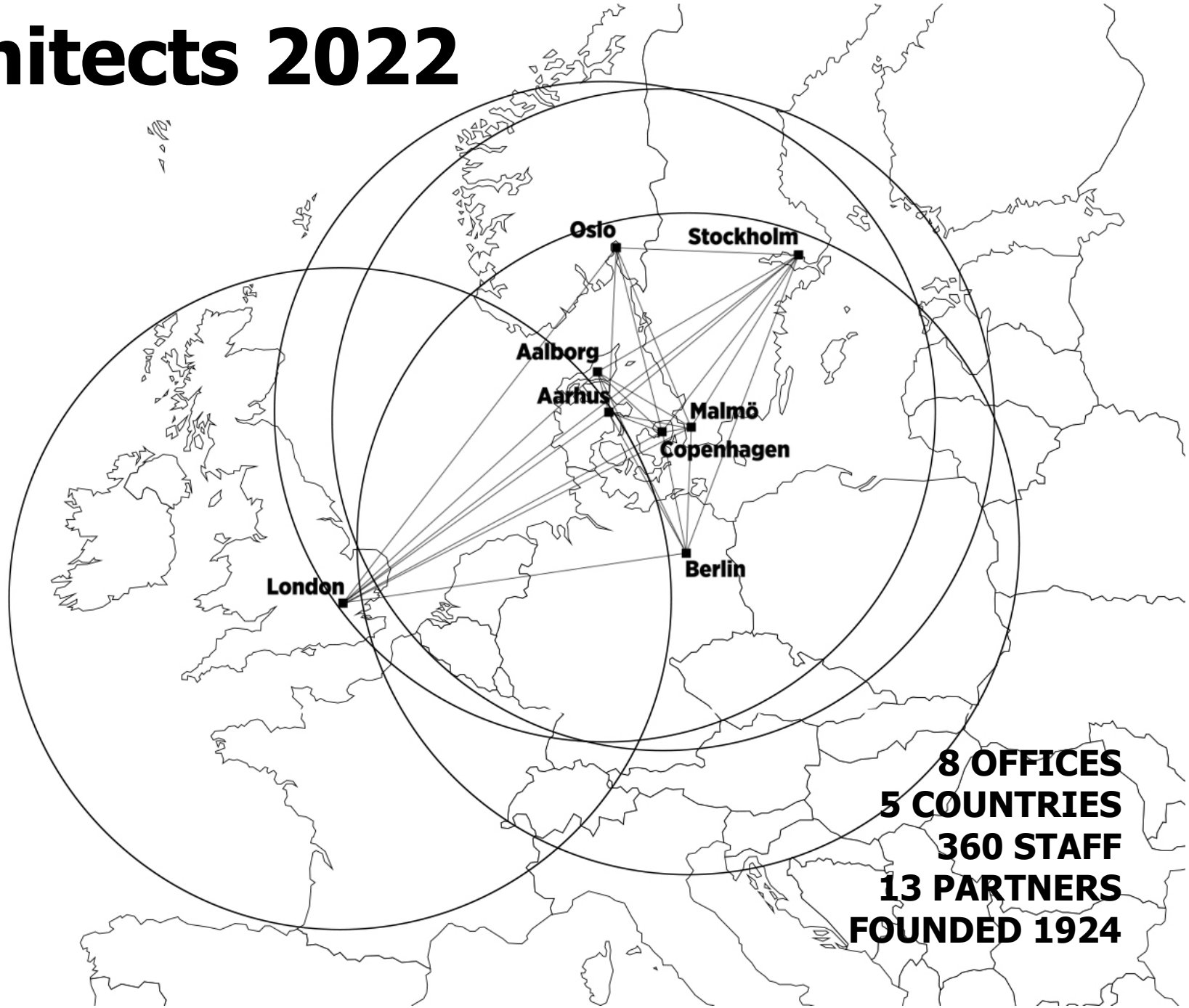
C.F. MØLLER ARCHITECTS

EGURTEK - BILBAO

20.th October 2022

C.F. Møller Architects 2022

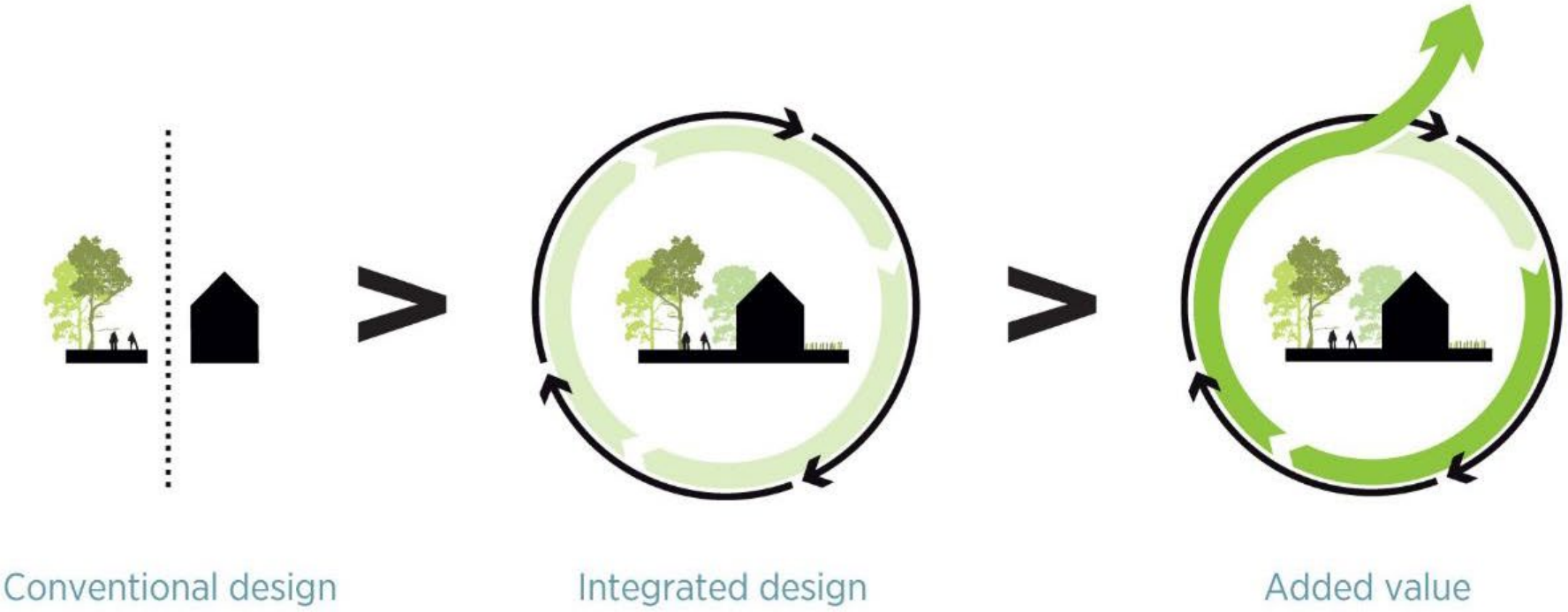




8 OFFICES
5 COUNTRIES
360 STAFF
13 PARTNERS
FOUNDED 1924

CF | MØLLER | ARCHITECTS

”Improve life for people and planet”



Bio-longing and Eco-idealism

”Bosco Verticale”, Milano, Stefano Boeri Architetti

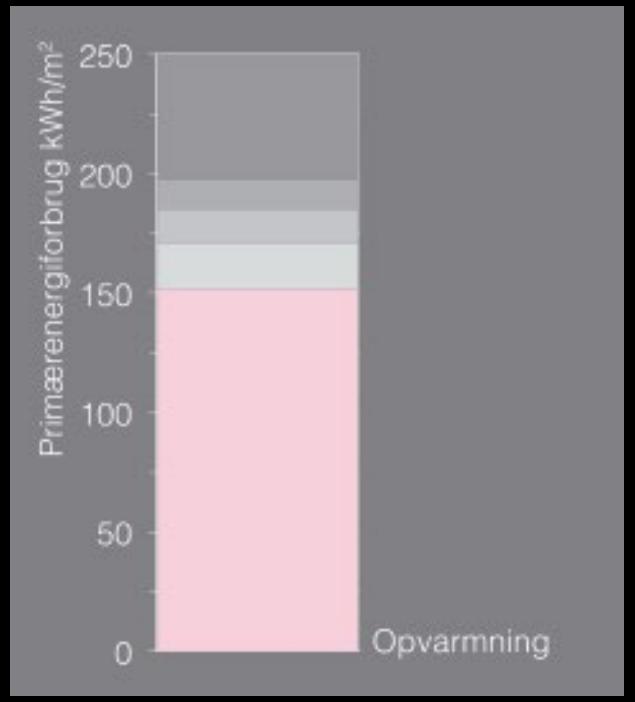
Foto: Boeri Studio

Inspiral architects and design, Ulaman Eco Retreat, Bali

LCA

CF MØLLER ARCHITECTS

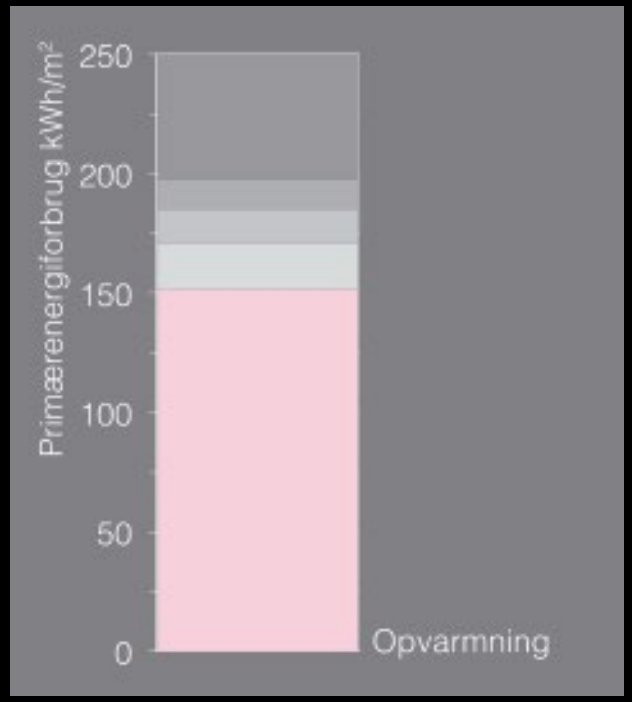
A LOOK BACK…



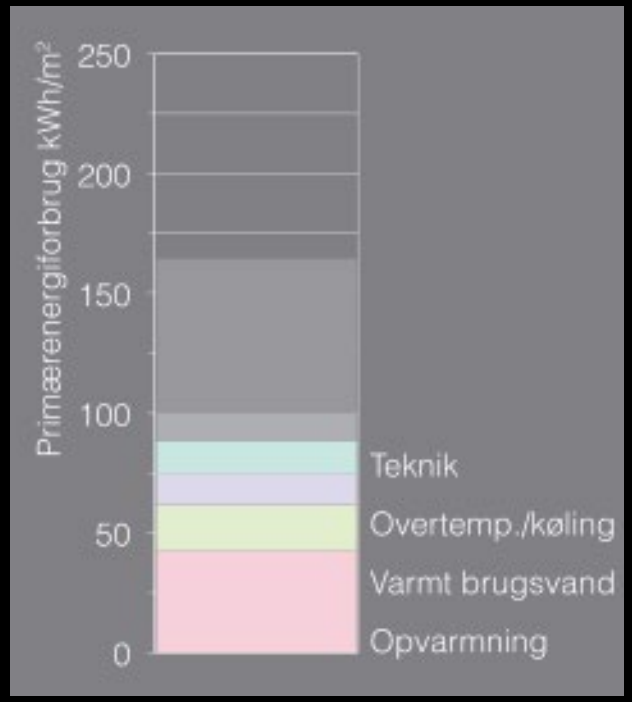
1970's
heat savings

CF MØLLER ARCHITECTS

A LOOK BACK...



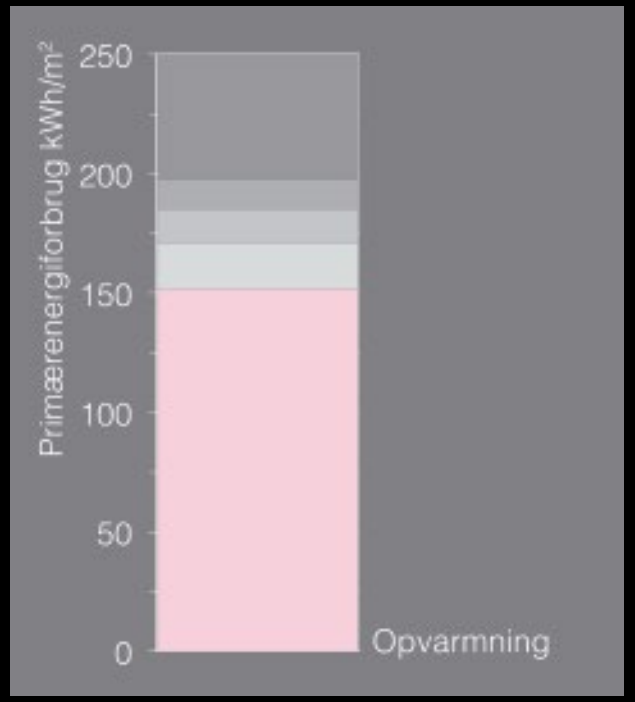
1970's
heat savings



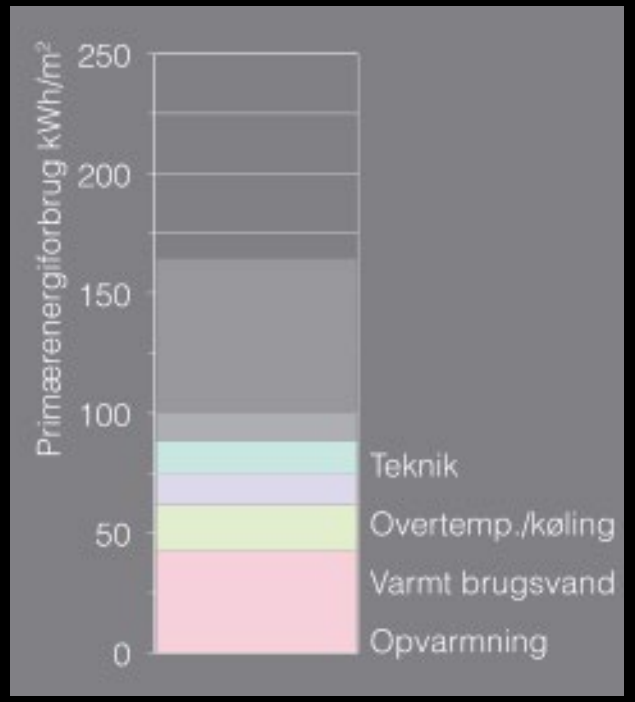
2000's
energy frame

CF MØLLER
ARCHITECTS

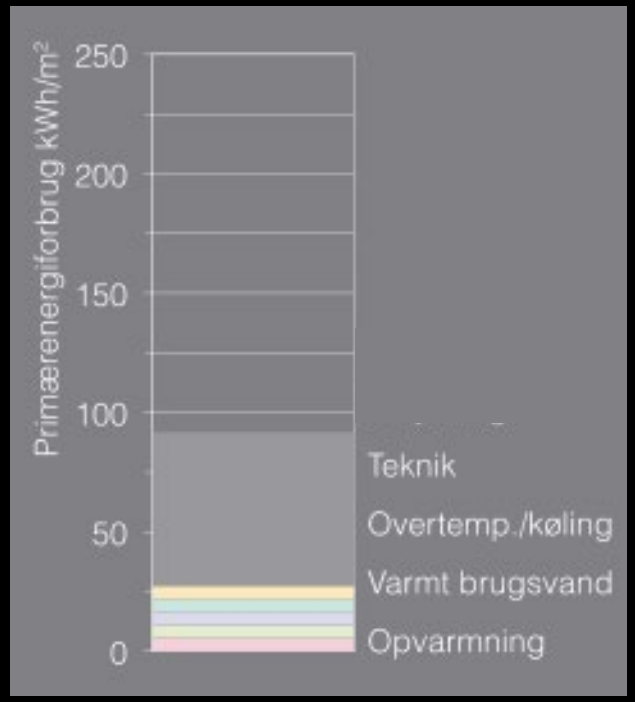
A LOOK BACK...



1970's
heat savings



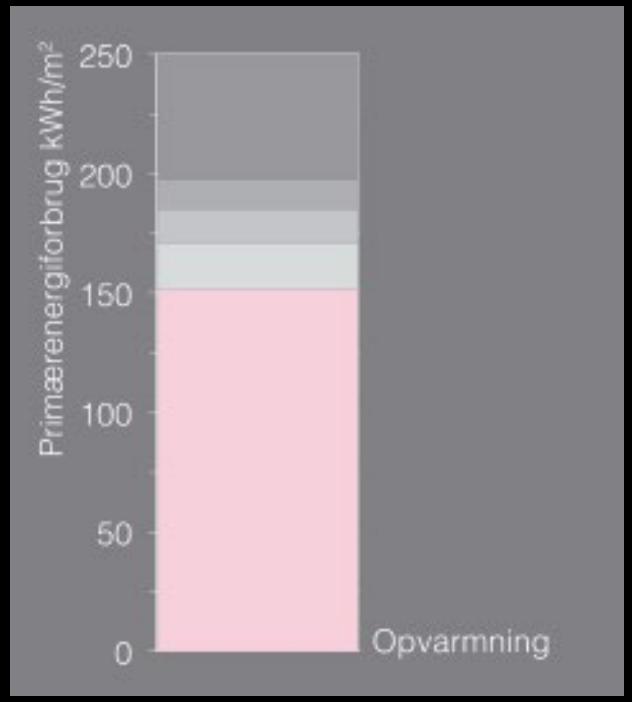
2000's
energy frame



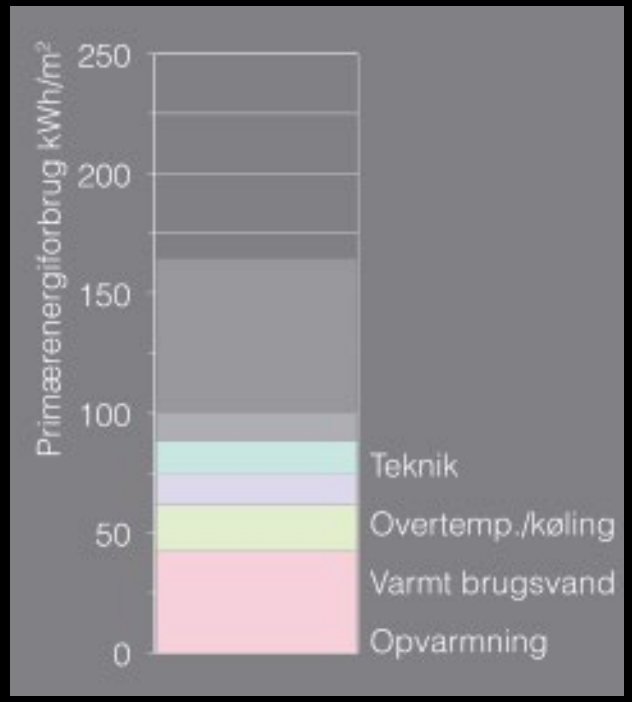
2020's
Climate strategy

CF MØLLER ARCHITECTS

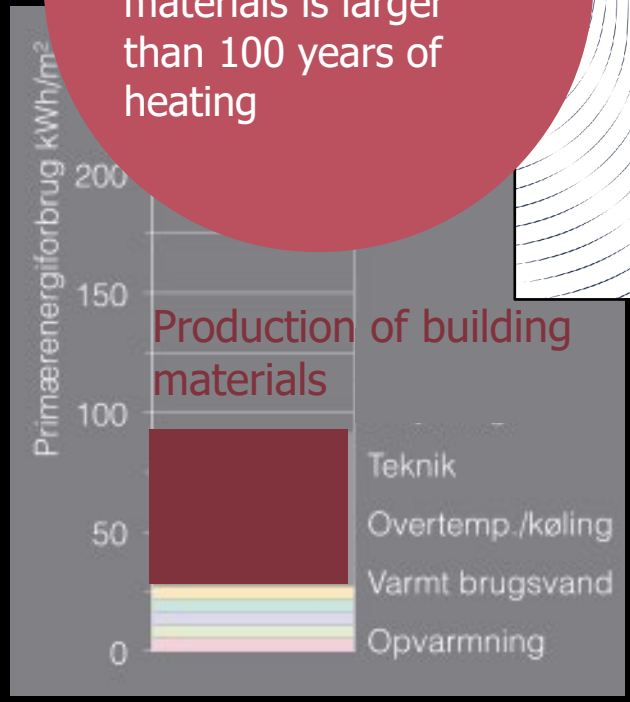
A LOOK BACK...



1970's
heat savings

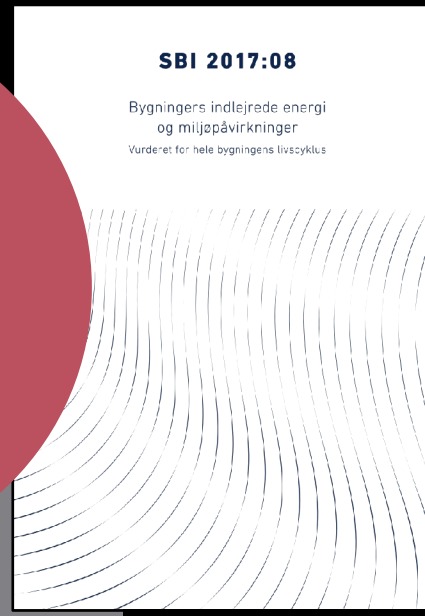


2000's
energy frame



2020's
Climate strategy

For new buildings, environmental impact from materials is larger than 100 years of heating



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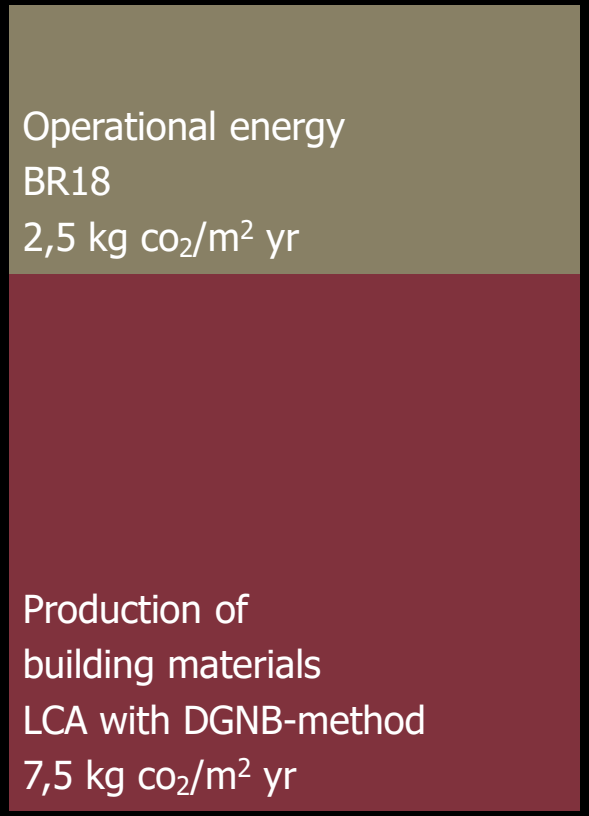
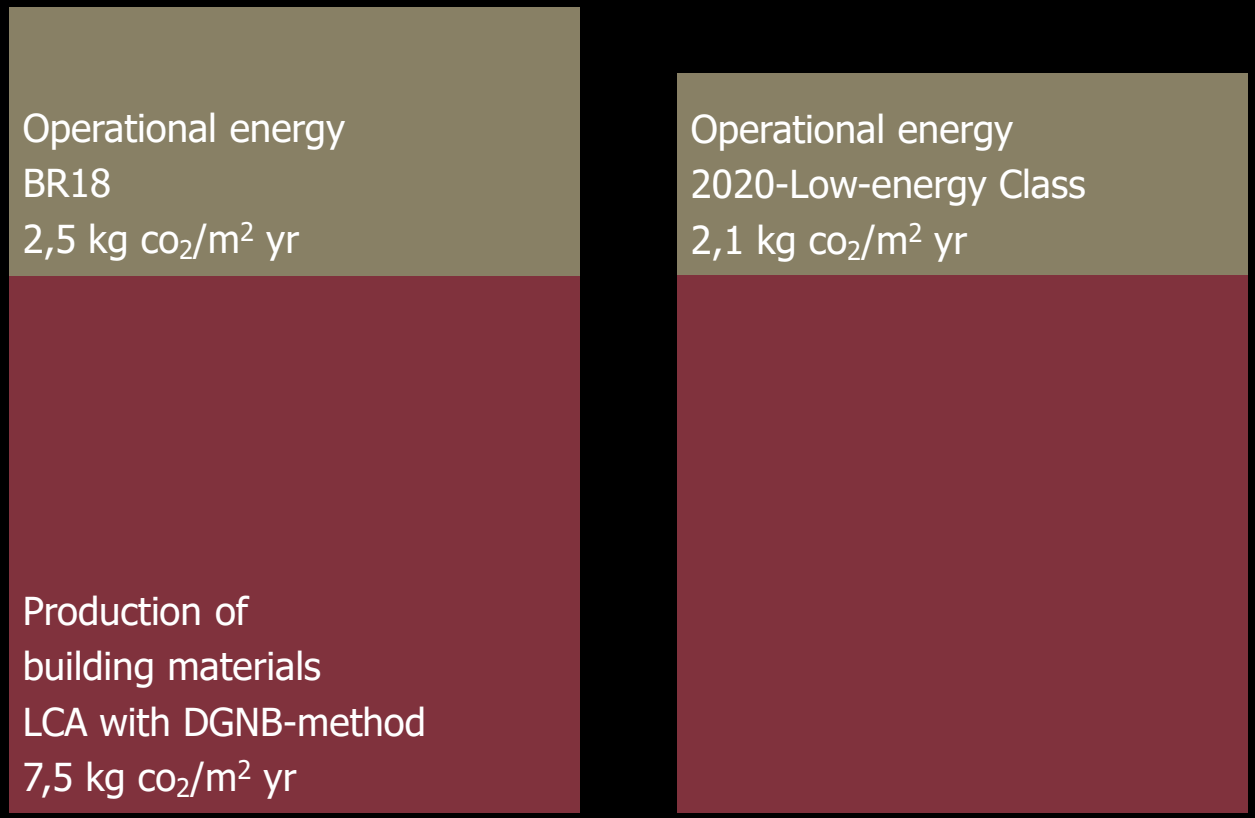
MATERIALS ENVIRONMENTAL IMPACT



Typical
Multistorey housing

CF MØLLER ARCHITECTS

MATERIALS ENVIRONMENTAL IMPACT

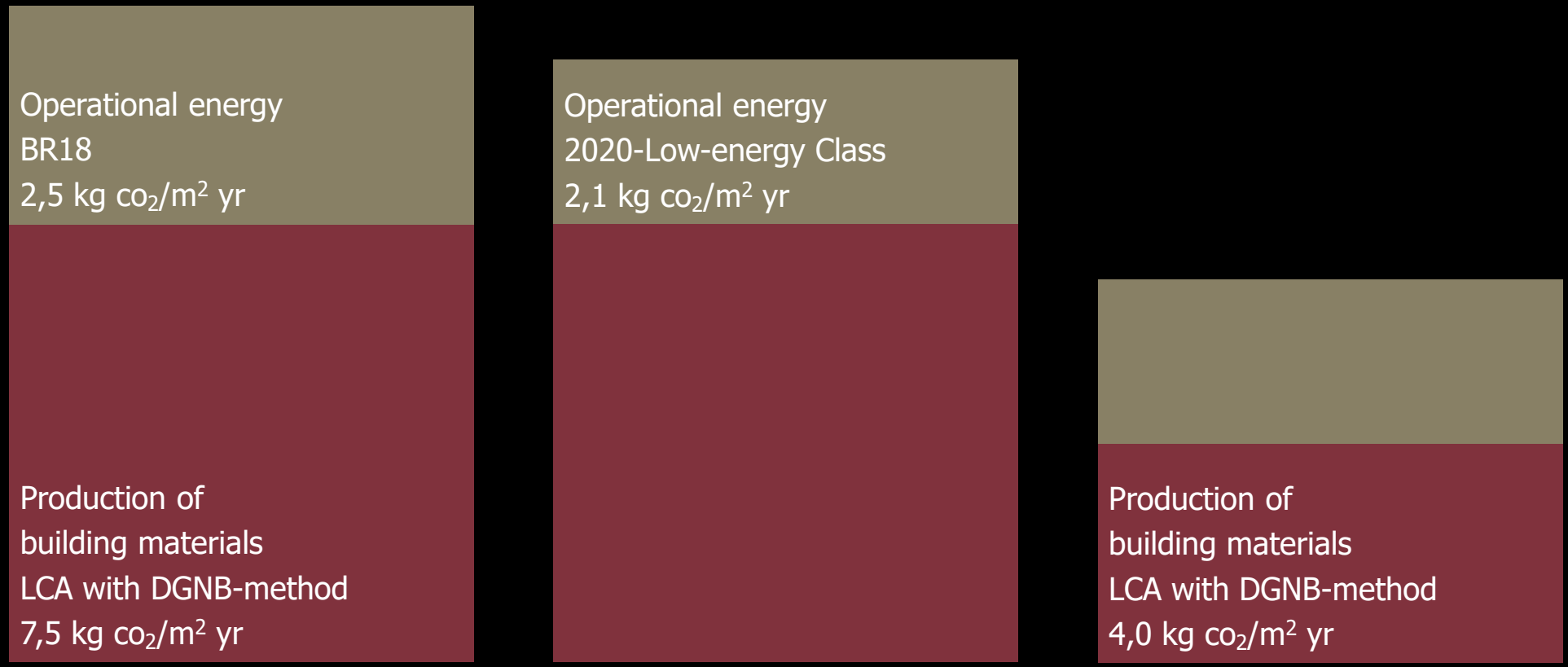


Typical
Multistorey housing

Traditional
energy savings

CF MØLLER ARCHITECTS

MATERIALS ENVIRONMENTAL IMPACT



Typical
Multistorey housing

Traditional
energy savings

New focus on LCA
& timber buildings

MATERIALS ENVIRONMENTAL IMPACT

Operational energy
BR18
2,5 kg co_2/m^2 yr

Production of
building materials
LCA with DGNB-method
7,5 kg co_2/m^2 yr

Typical
Multistorey housing

Operational energy
2020-Low-energy Class
2,1 kg co_2/m^2 yr

Traditional
energy savings

50%
reduction in materials' environmental impact by changing the loadbearing construction to timber

Production of
building materials
LCA with DGNB-method
4,0 kg co_2/m^2 yr

New focus on LCA
& timber buildings

available at www.sciencedirect.com

ScienceDirect

journal homepage www.elsevier.com/locate/envsci

Meta-analysis of greenhouse gas displacement factors of wood product substitution

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ARTICLE INFO

ABSTRACT

A displacement factor can express the efficiency of using biomass to reduce net greenhouse gas (GHG) emissions, by quantifying the amount of emission reduction achieved per unit of wood use. Here we integrate data from 21 different international studies in a meta-analysis of the displacement factors of wood products substituted in place of non-wood materials. We calculate the displacement factors in consistent units of tons of carbon (tC) of emission reduction per tC in wood product. The displacement factors range from a low of −2.9 to a high of 15, with most lying in the range of 1.0 to 3.0. The average displacement factor value is 2.1, meaning that for each tC in wood products substituted in place of non-wood products, there occurs an average GHG emission reduction of approximately 2.1 tC. Expressed in other units, this value corresponds to roughly 3.9 t CO_2 eq emission reduction per ton of dry wood used. The few cases of negative displacement factors are the result of worst-case scenarios that are unrealistic in current practice. This meta-analysis quantifies the range of GHG benefits of wood substitution, and provides a clear climatic rationale for increasing wood substitution in place of other products, provided that forests are sustainably managed and that wood residues are used responsibly.

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Introduction

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doi:10.1016/j.envsci.2009.12.005

TRANSFORMATION IN MATERIAL APPROACH

Embedded energy

Lifecycle approach

Out of the 100% of the worlds CO2-consumption, the production of cement takes up a staggering 7% !

Every time we can reduce the amount of cement/concrete used,

- the climate wins

Wood in construction is a smart, cost-effective way to go forward in the conservation of CO2

Hybrid is much better, than no wood at all

ENGINEERED WOOD – CLT/LVL

FIRE RESISTANT
RENEWABLE SOURCE
LOCALLY PRODUCED
CO2 NEUTRAL
HIGH-TECH INDUSTRIAL PROCESS
LOW WEIGHT
OPTIMIZED TRANSPORTATION
LESS FOUNDATION AND PILING
FEW PEOPLE, EFFECTIVE AND SILENT BUILDING SITE
POSITIVE INDOOR CLIMATE AND HEALTH

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WOOD IN THE FUTURE SUSTAINABLE CITY

Tall (up to -10 storeys) wooden buildings in dense city environments is also a pragmatic choice :

Lightweight

Silent

Fast

Practical (minor foundations into the underground of the modern city)

5 trends for good practice in the field of wooden constructions

1. *Multifunctionality* – flexibility in structures (for future change)
2. *Saving time and cost* – timber´s major benefits + local supply chains
3. *Investing in scalability* – start small and scale up..building skills and expertise
4. *Pushing the boundaries* – diversity in constructions, tall buildings
5. *Circular Design* – end of life concerns

* ”Wood in construction 25 cases of Nordic good practice”, 2019, Nordic council of ministres Report

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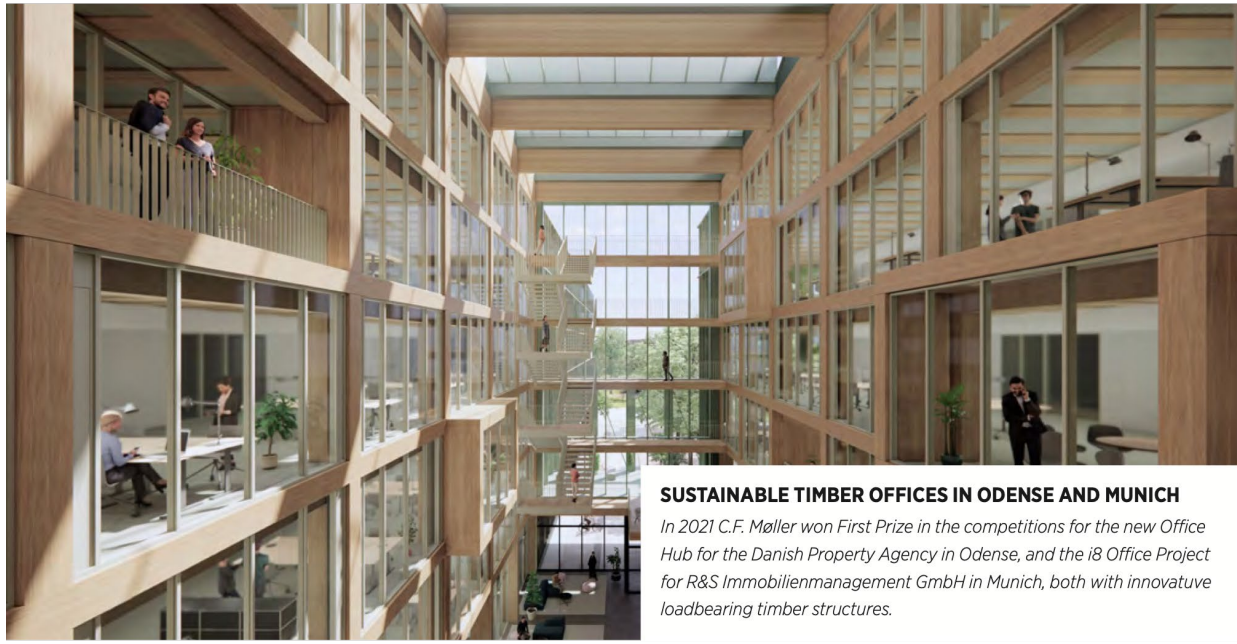
Environmental Impact of Construction Materials

- Environmental impact from materials larger than heating and ventilation
- Focus on life cycle assessment
- Focus on multi-storey timber buildings

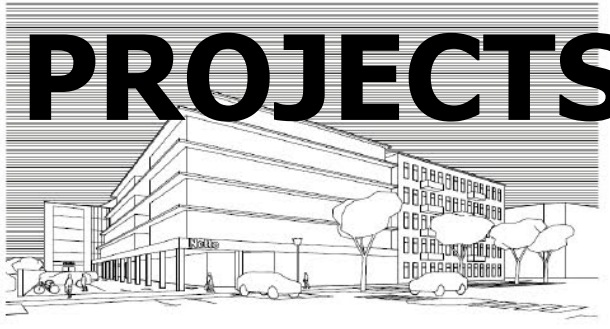


SUSTAINABLE TIMBER OFFICES IN ODENSE AND MUNICH

In 2021 C.F. Møller won First Prize in the competitions for the new Office Hub for the Danish Property Agency in Odense, and the i8 Office Project for R&S Immobilienmanagement GmbH in Munich, both with innovatuve loadbearing timber structures.

BUILD IN WOOD

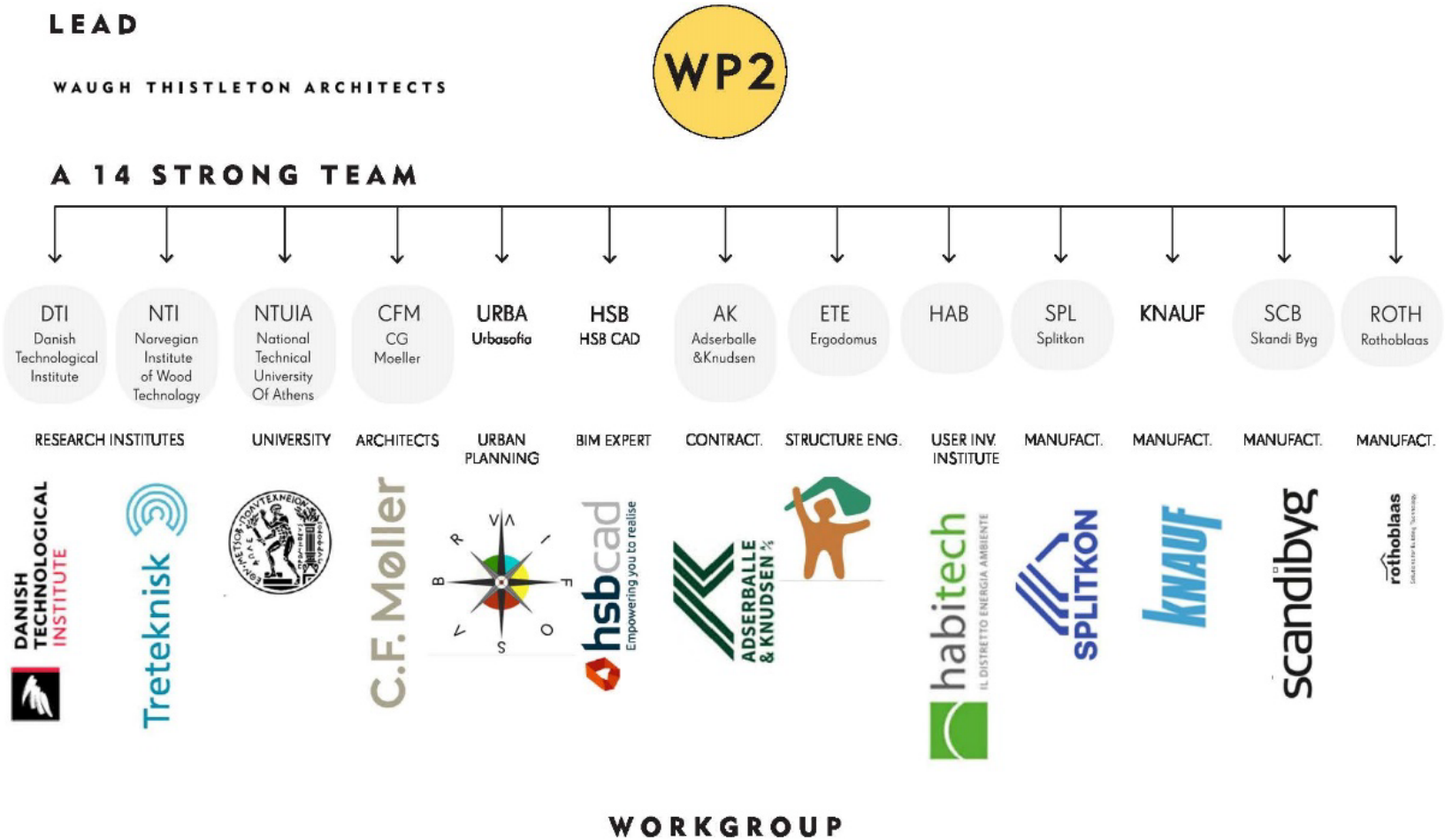
WOOD PROJECTS 400.000 m2



BUILD-IN-WOOD

EUROPEAN RESEARCH ON MODERN TIMBER DESIGN

A €10.1 million project funded by Horizon 2020



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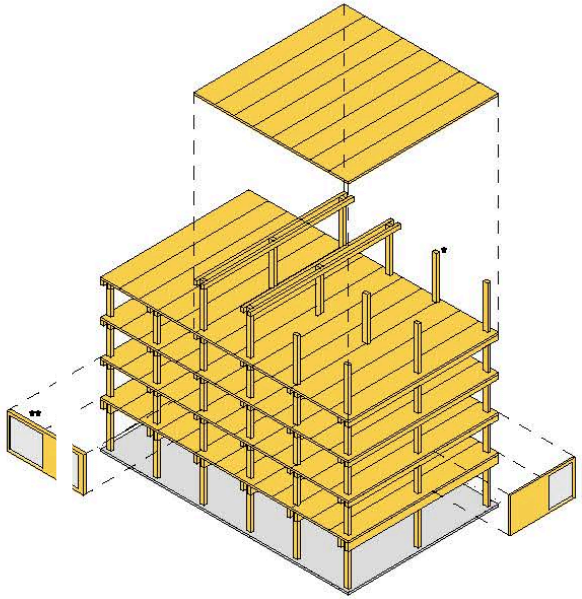
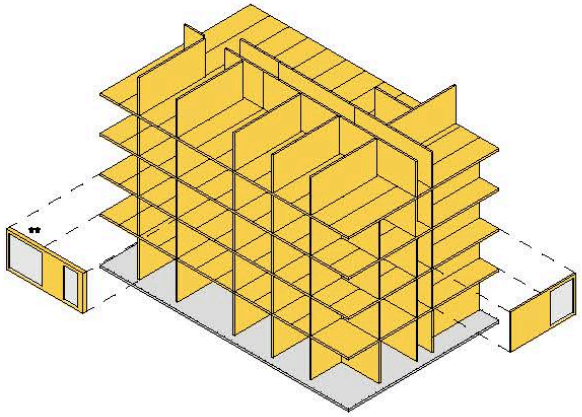
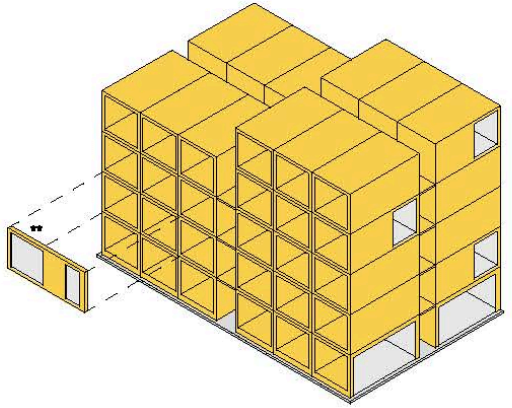
SYSTEM THINKING



OST & BEAM / POST & SLAB



FULL CLT



MODULAR
(CLTCLOSED PANELS

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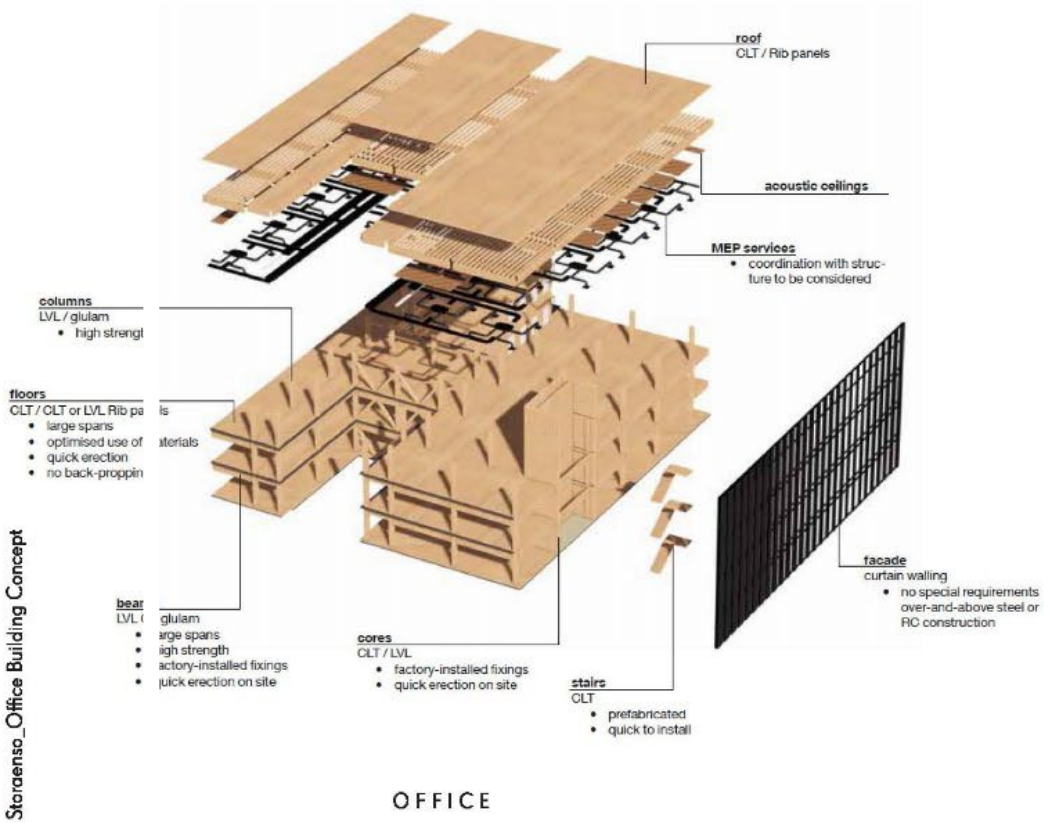
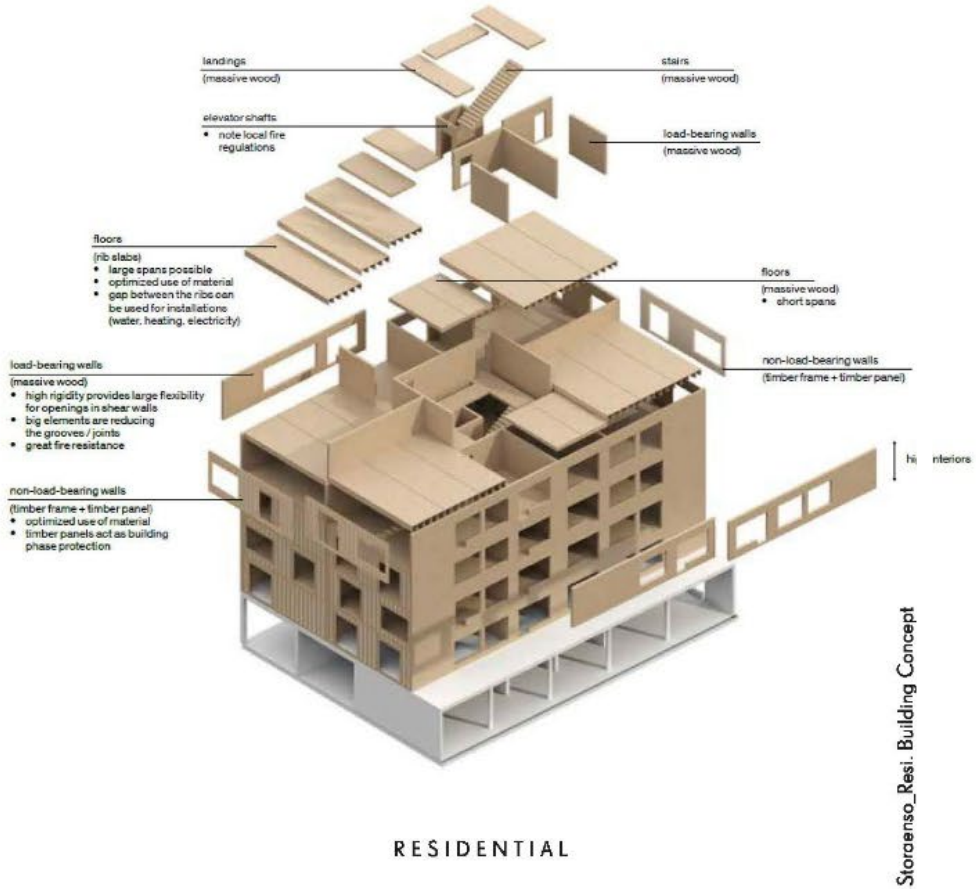
SYSTEM THINKING



OFFICE



RESIDENTIAL

TWO PLATFORMS MADE OF WOOD

CF MØLLER ARCHITECTS

TALL TIMBER

RESEARCH PROJECTS MULTISTOREY BUILDINGS IN WOOD

CHELSEA TOWER

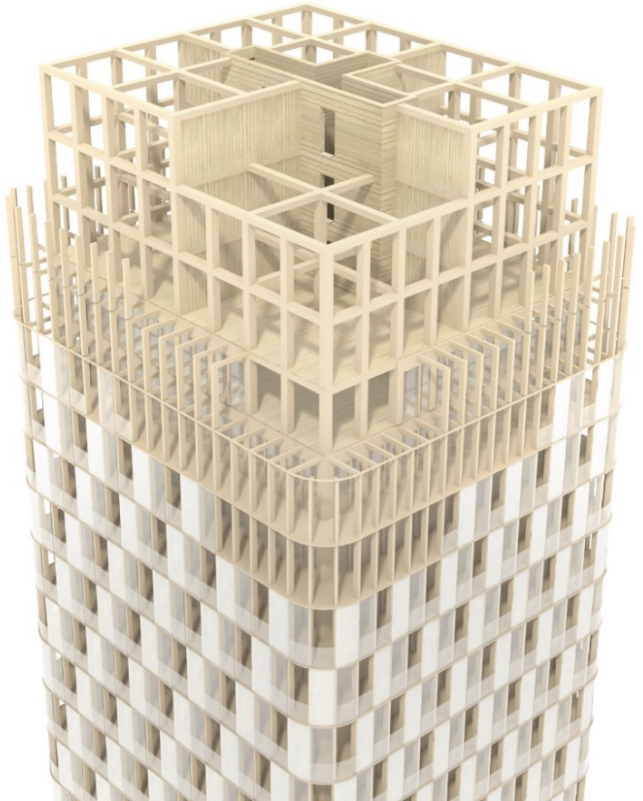
APOGEE TOWERS

HYBRID TOWER

CF MØLLER ARCHITECTS

TALL TIMBER BUILDING

MULTIDISCIPLINARY RESEARCH PROJECT – FORMAS



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CASE
LERCHESGADE ODENSE

Building type: Public administration – 1600 workspaces

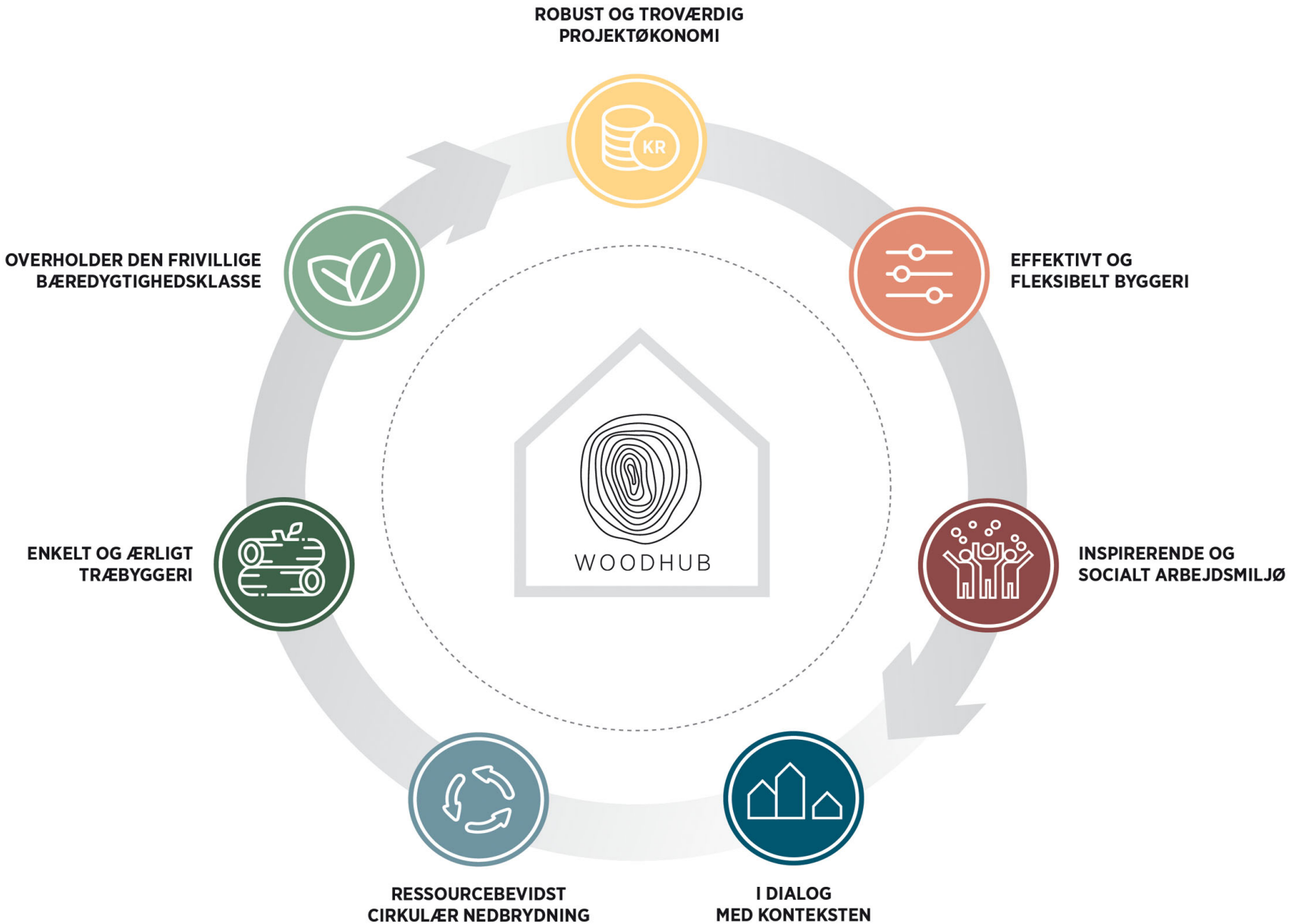
Floor area: 36.500 m² (31.000 timber above ground + parking)

Construction: Timber columns & CLT slabs

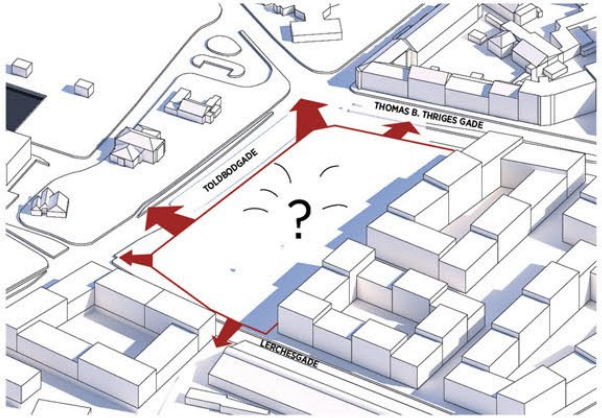
Status: Competition win 2021
Construction start 07/2022
Completion 04/2024

Denmark's largest timber building

CF MØLLER ARCHITECTS


ROBUST OG TROVÆRDIG
PROJEKTØKONOMI
KR
EFFEKTIVT OG
FLEKSIBELT BYGGERI
INSPIRERENDE OG
SOCIALT ARBEJDSMILJØ
I DIALOG
MED KONTEKSTEN
RESSOURCEBEVIDST
CIRKULÆR NEDBRYDNING
ENKELT OG ÆRLIGT
TRÆBYGGERI
OVERHOLDER DEN FRIVILLIGE
BÆREDYGTIGHEDSKLASSE
WOODHUB

CONCEPT - CONTEXT



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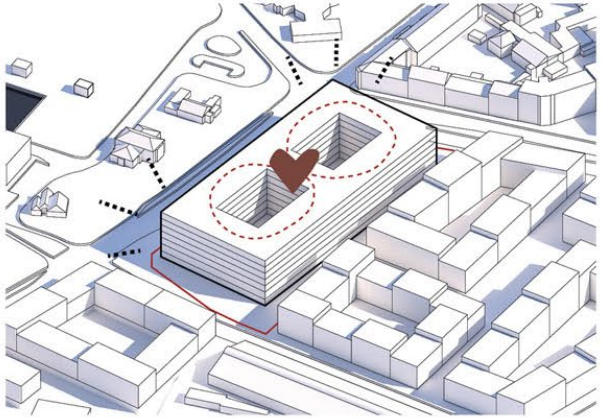
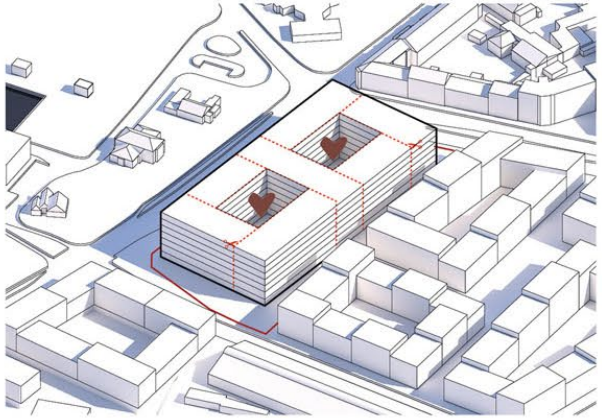


2. ET ENKELT OG RATIONELT GREB



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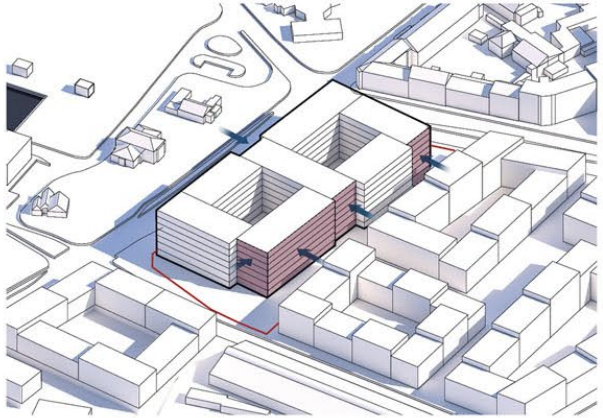
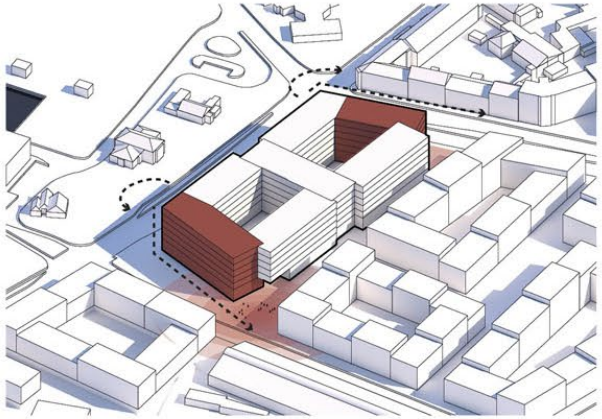
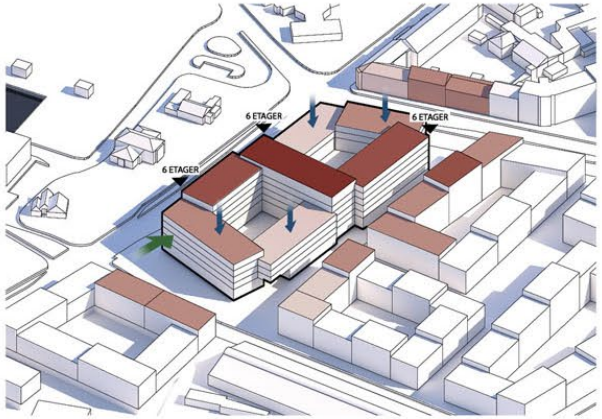


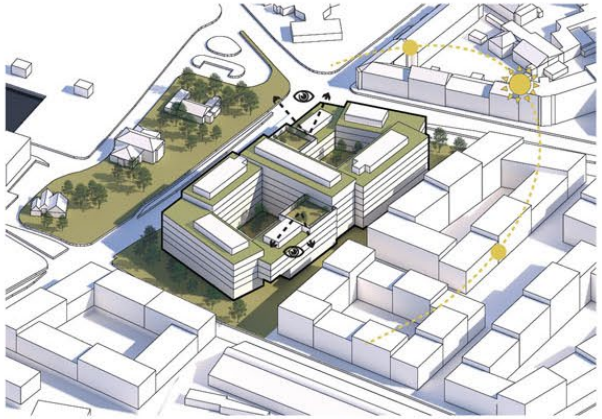
4. FORSKYDNINGER I FACADEN



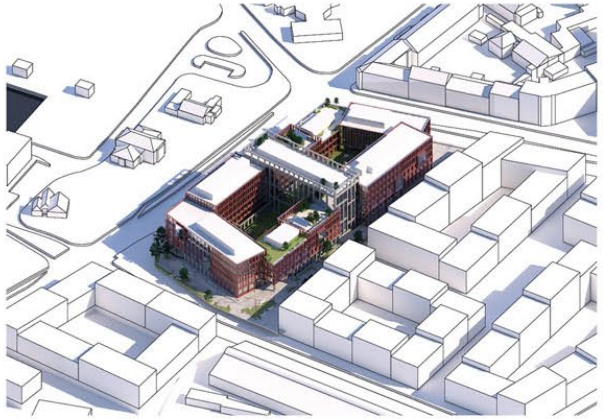
5. I DIALOG MED BYENS RUM



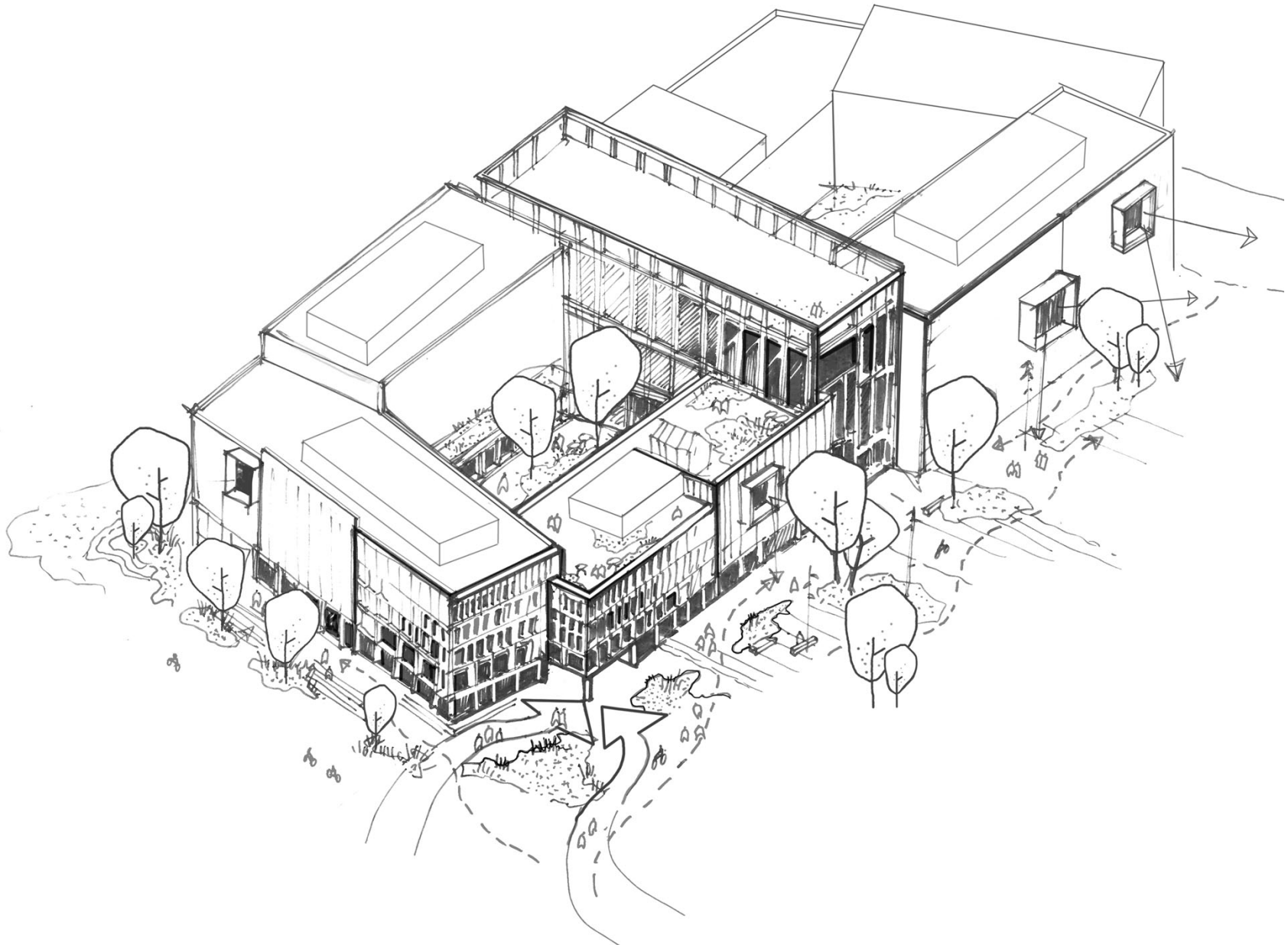
6. NEDTRAPNING ÅBNER HUSET MOD OMGIVELSERNE



7. REKREATIVE GRØNNE ÅNDEHULLER



8. ET DYNAMISK OG LEVENDE UDTRYK



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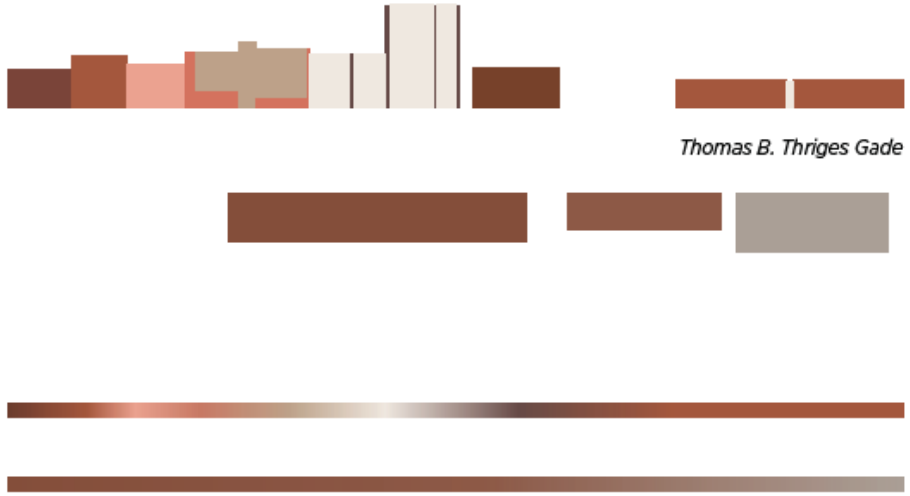
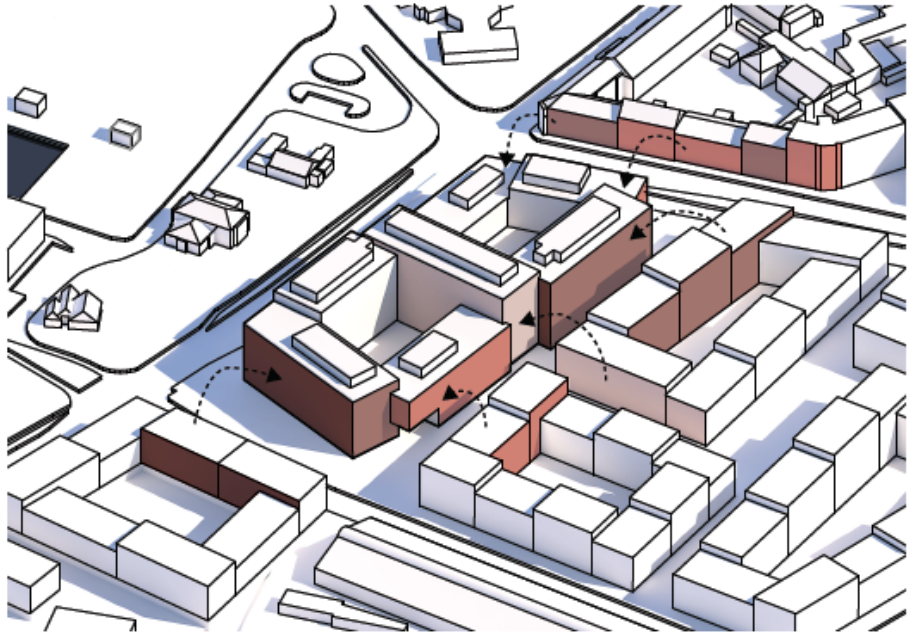
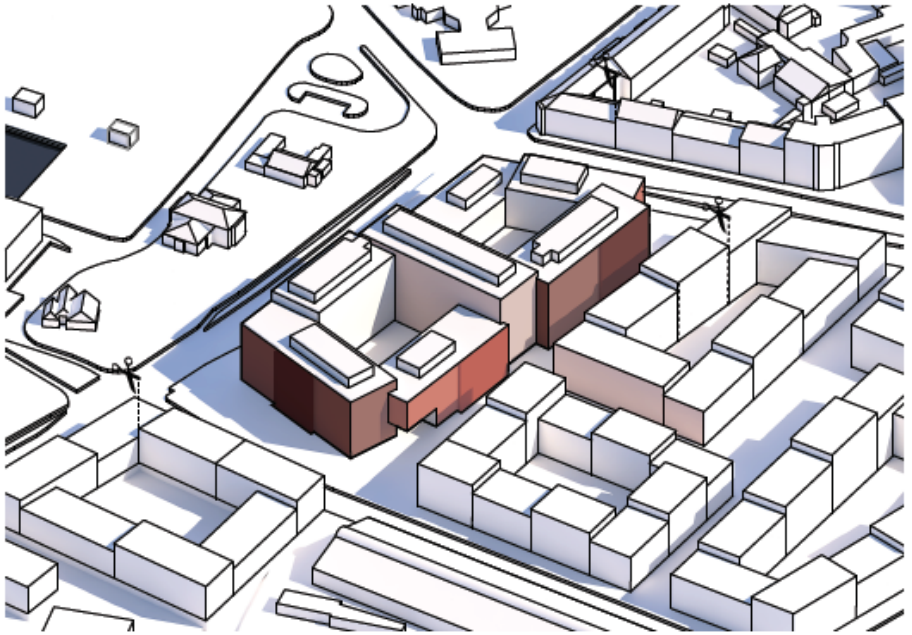


ANALYSE AF FACADEFARVER

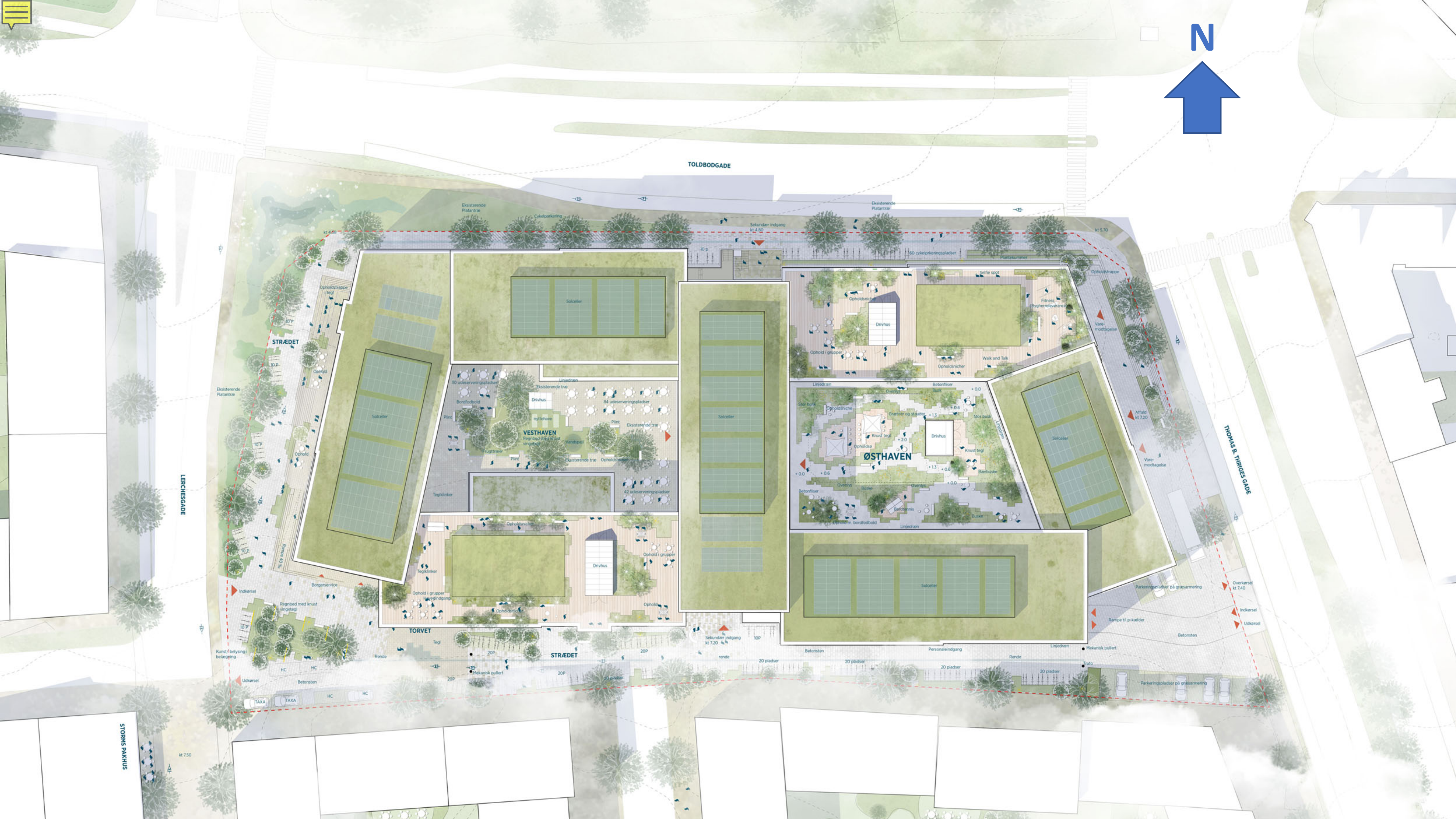
STEMNINGSBILLEDER FRA KONTEKSTEN



FACADERNE TAGER FARVE AF OMGIVELSERNE

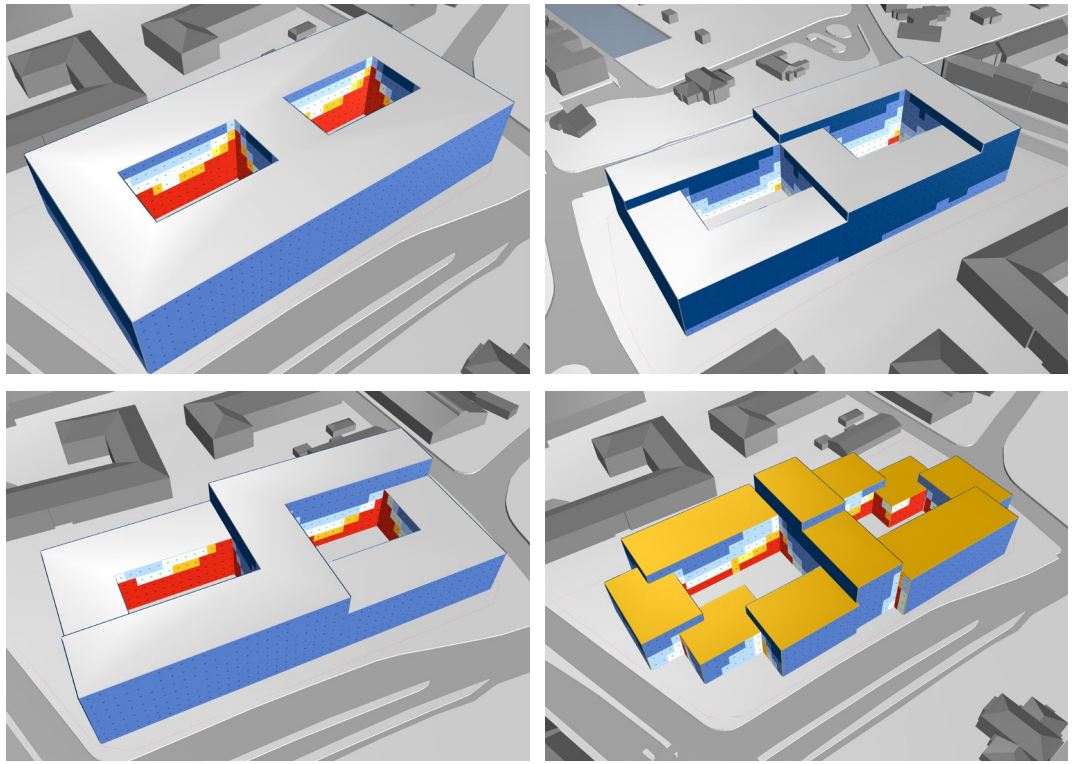


FACADERNE PROPORTIONERES EFTER LOKALE MOTIVER


N
TOLDBODGADE
LERCHESGADE
THOMAS B. THRIGES GADE
STORMS PAKHUS
STRÆDET
STRÆDET
TORVET
VESTHAVEN
ØSTHAVEN
Solceller
Drivhus
Eksisterende Platantræ
Cykelparkering
60 cykelparkeringspladser
Vare-modtagelse
Affald
Indkørsel
Udkørsel
Overkørsel
Rampe til p-kælder
Betonsten
Parkeringspladser på græsarmering
Sekundær indgang
Borgerservice
Personaleindgang
Mekanisk pullert
Trafo
Ophold i grupper
Opholdsnicher
Walk and Talk
Fitness
Selfie spot
Tegl
Rende
20 pladser
HC
TAXA

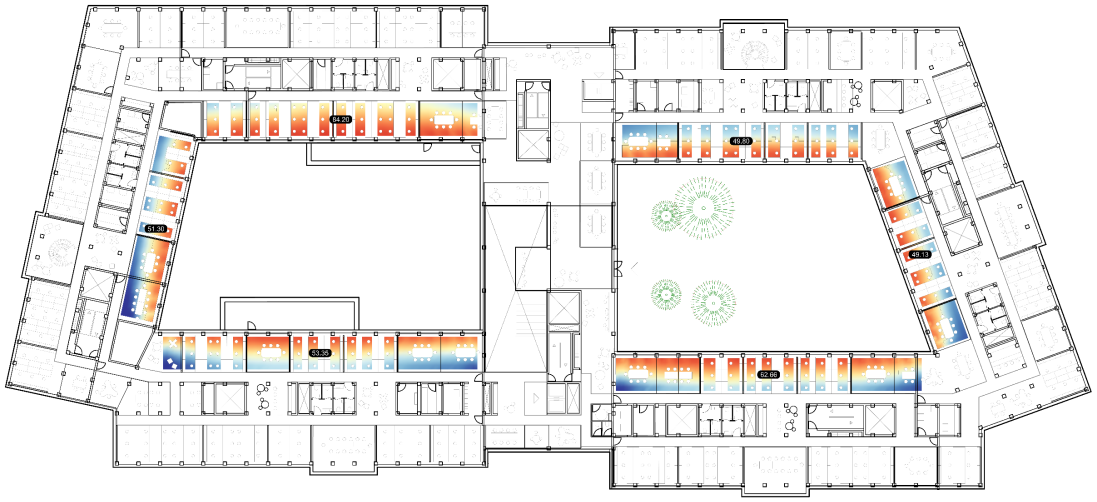
ETAGEPLAN 2.SAL // 1:300

Lerchesgade – From volume study to daylit workareas



20 30 40 50 60 70 80 90 100

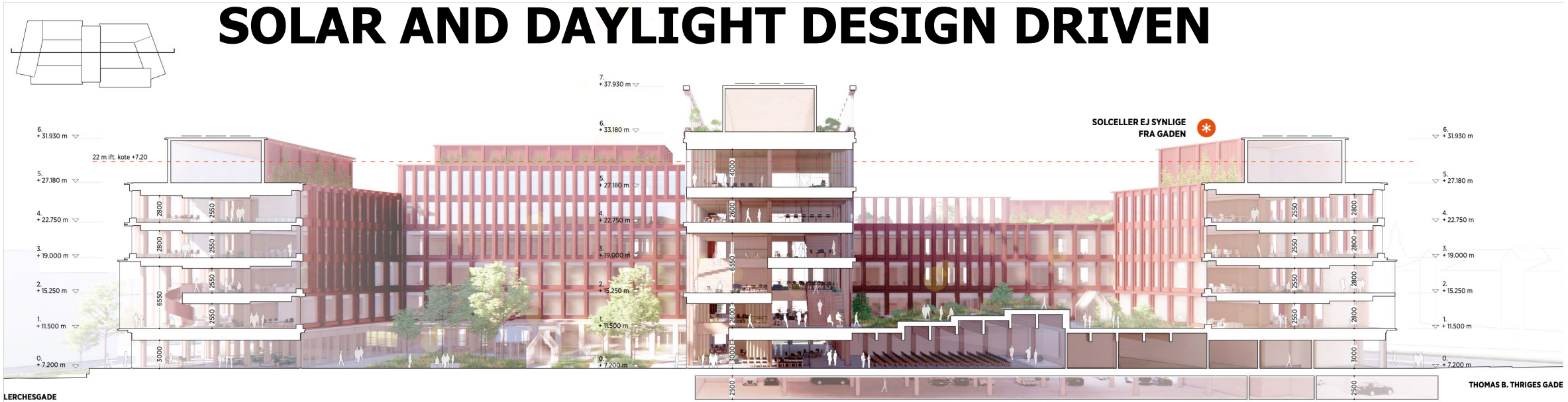
GLAZING AREA
[%]



0 10 20 30 40 50 60 70 80 90 100

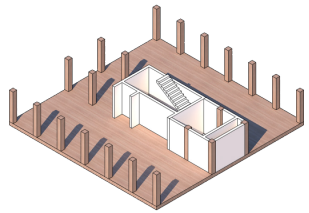
DAYLIGHT AUTONOMY
[% of daylight hours above 300 lux]

SOLAR AND DAYLIGHT DESIGN DRIVEN

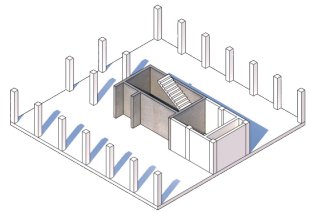


LÆNGDESNIT // 1:300

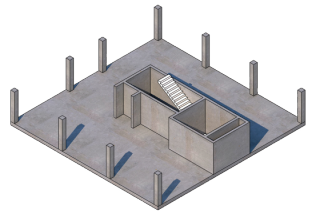
LÆNGDESNIT // 1:300



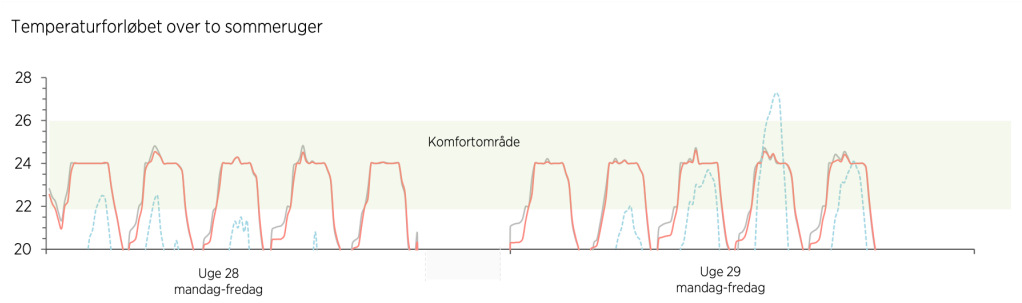
Omfang af træ i projektet



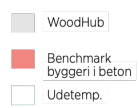
Omfang af beton i projektet

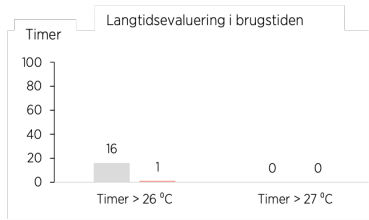


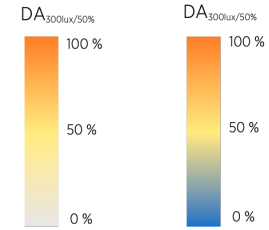
Omfang af beton i benchmarkprojekt

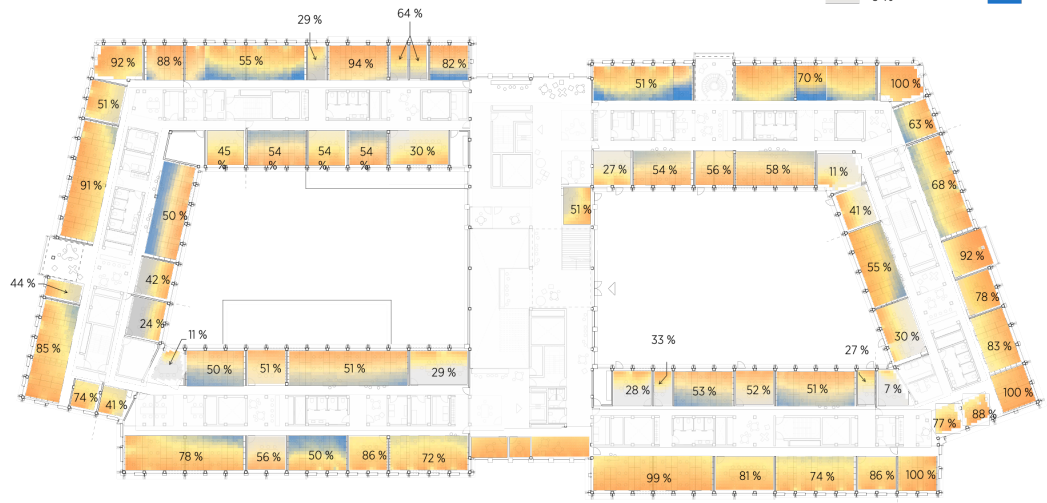


Temperaturforløb for to sommeruger for hhv. WoodHub og et tilsvarende byggeri i beton. Temperaturforløbet svarer direkte på risikolog nr. 4, idet temperaturforløbet viser hvordan rummet i brugstiden er i komfortområdet. Temperaturforløbet viser også hvordan rummets temperaturer reguleres næsten på lige fod med et byggeri, hvor det bærende system er i beton.





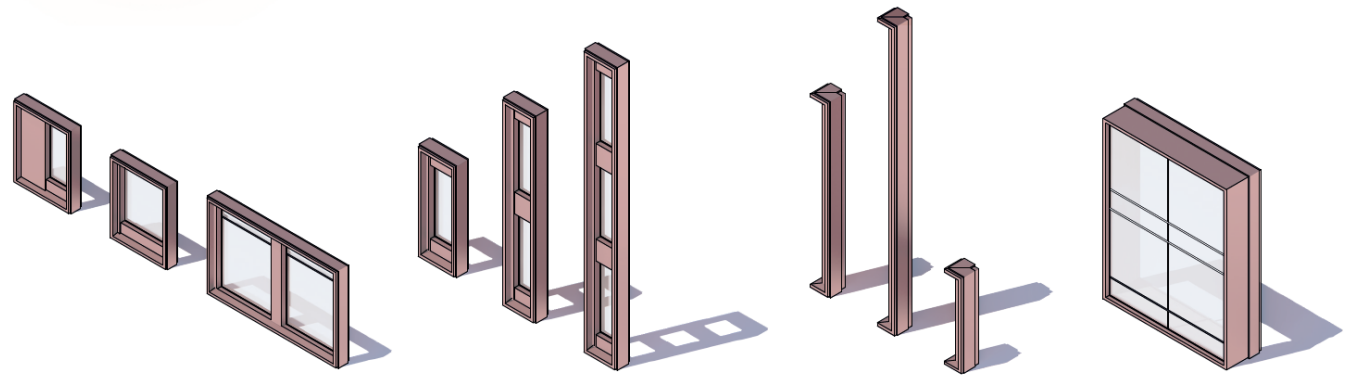




Sikring af dagslysforhold vil styrke den mental sundhed og skabe kontakt til de grønne omgivelser.

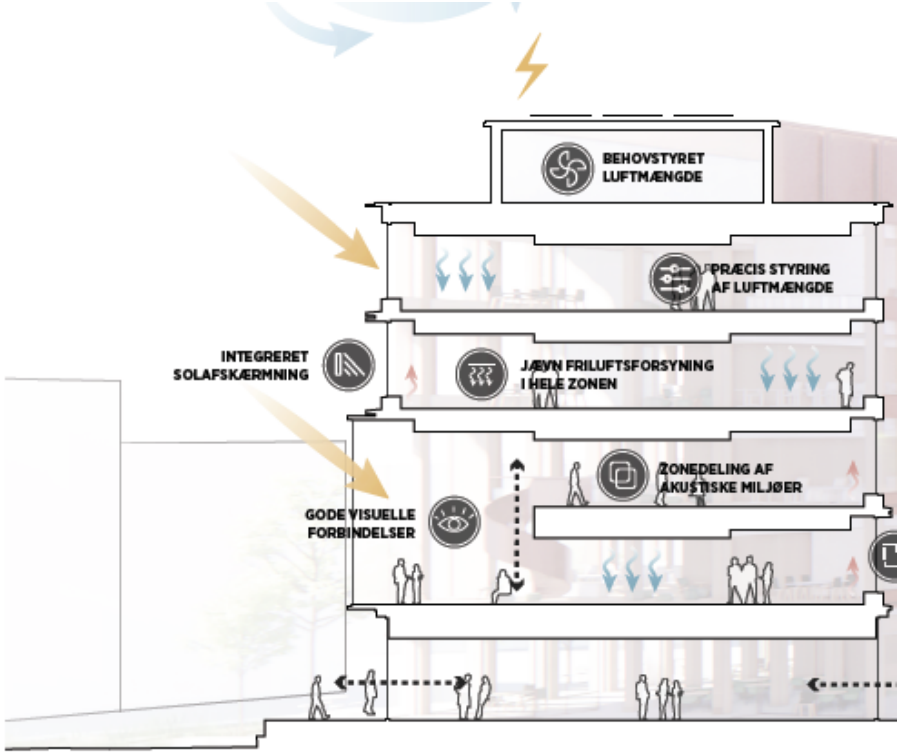
Dagslys

COMPONENTS

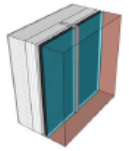


ENKLE OG GENNEMTÆNKTE FACADEMODULER

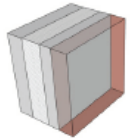
MATERIALS



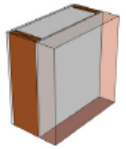
Traditionelt glas/alu-system
rockwool + alubeklædning

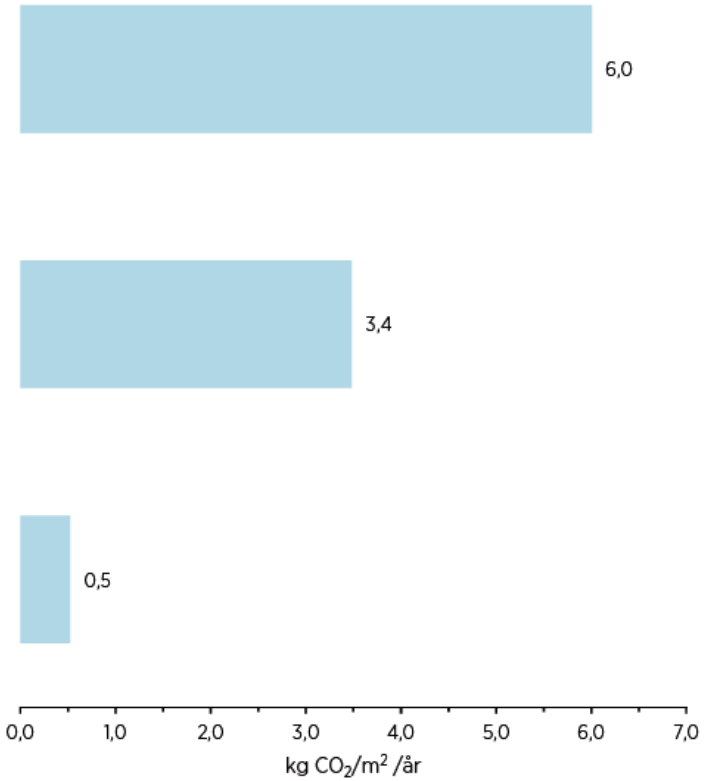


Betonsandwichelement
rockwool + alubeklædning



WoodHub: CO_2-optimeret facadekassetter
trækassetter + knauf isolering + genbrugsalubeklædning





Selvom facader har samme U-værdi, kan der være vidt forskelligt klimaaftryk. Vi har vist dette med ovenstående analyse, hvor der for de tre facadeløsninger kan opnås en U-værdi på 0,15 W/m2K.

Materialernes CO2-udledning derimod spænder fra 0,5 – 6,0 kg CO2/m²/år af facaden, set over en 50-årig periode. Ved at vi indarbejder en trækassetteløsning med genbrugt aluminiumsbeklædning vil CO2-udledning per m² facadeareal være under 10 % af CO2-udledningen, hvis der i stedet arbejdes med et glas/alu facadesystem.

OPTIMALT FACADEDESIGN

- Vinduernes størrelse, udformning og orientering er tilpasset solens påvirkning for at minimere overophedning
- Høje indeklimakrav overholdes og udsyn til omgivelserne bibeholdes uden brug af automatisk solafskærmning
- Facadeløsningen giver den optimale balance mellem anlægs- og driftsomkostninger

Bæredygtig udvikling gennem reduceret miljøpåvirkning.

Dokumenterbart bæredygtigt byggeri gennem LCA-analyser

Træbyggeri der skaber hurtig klimaindsats

FACADES

Space for social interaction
Central MeetingHub for vertical knowledge exchange

Evidense based and Parametrical
Diversified facade openings upper and lower (solar heat and daylight control)
Deeper lamellas S,E,W facades than N.

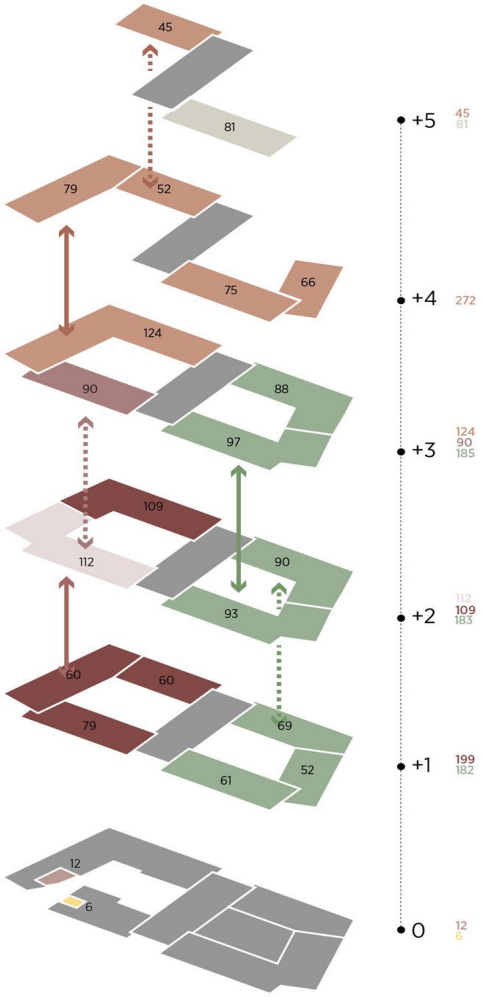
Aesthetics
From flat to spatial
Crisp, transparent, welcoming/ open expression- shadows/light
Variation through composition of simple elements

Sustainability, LCA and flexibility
Recycled aluminium on biobased (wood) facade elements.
On modular timber structure.

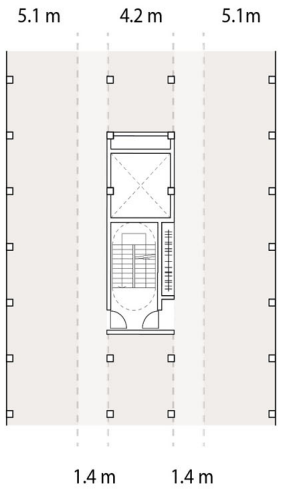
80/20 – PRINCIPLES + FLEXIBILITY

DRIVEN BY MODULAR FLEXIBILITY DEMAND

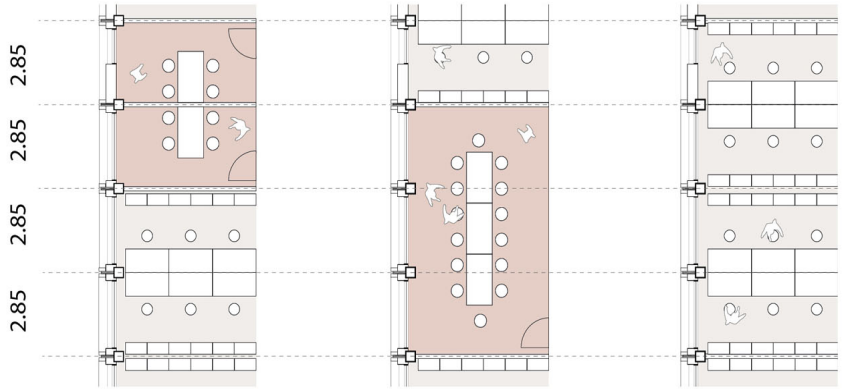
A BALANCE BETWEEN REPETITIVE STANDARDS AND MORE EXTRAVAGANT SPACE



DIMENSIONER



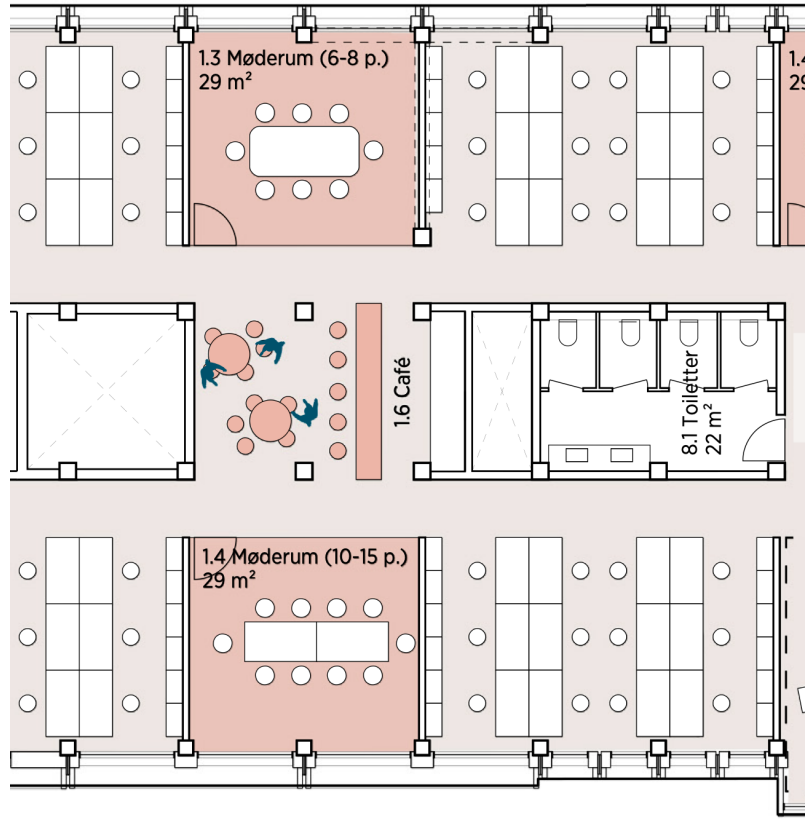
INDBYGGET MODULARITET OG TILPASNINGSEVNE



FLEKSRUM OG SEMIÅBENT KONTORMILJØ

STØRRE MØDERUM

ÅBENT KONTORMILJØ

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VISUALISERING AF DE FLEKSIBLE
TEKNISKE INSTALLATIONER
CF MØLLER
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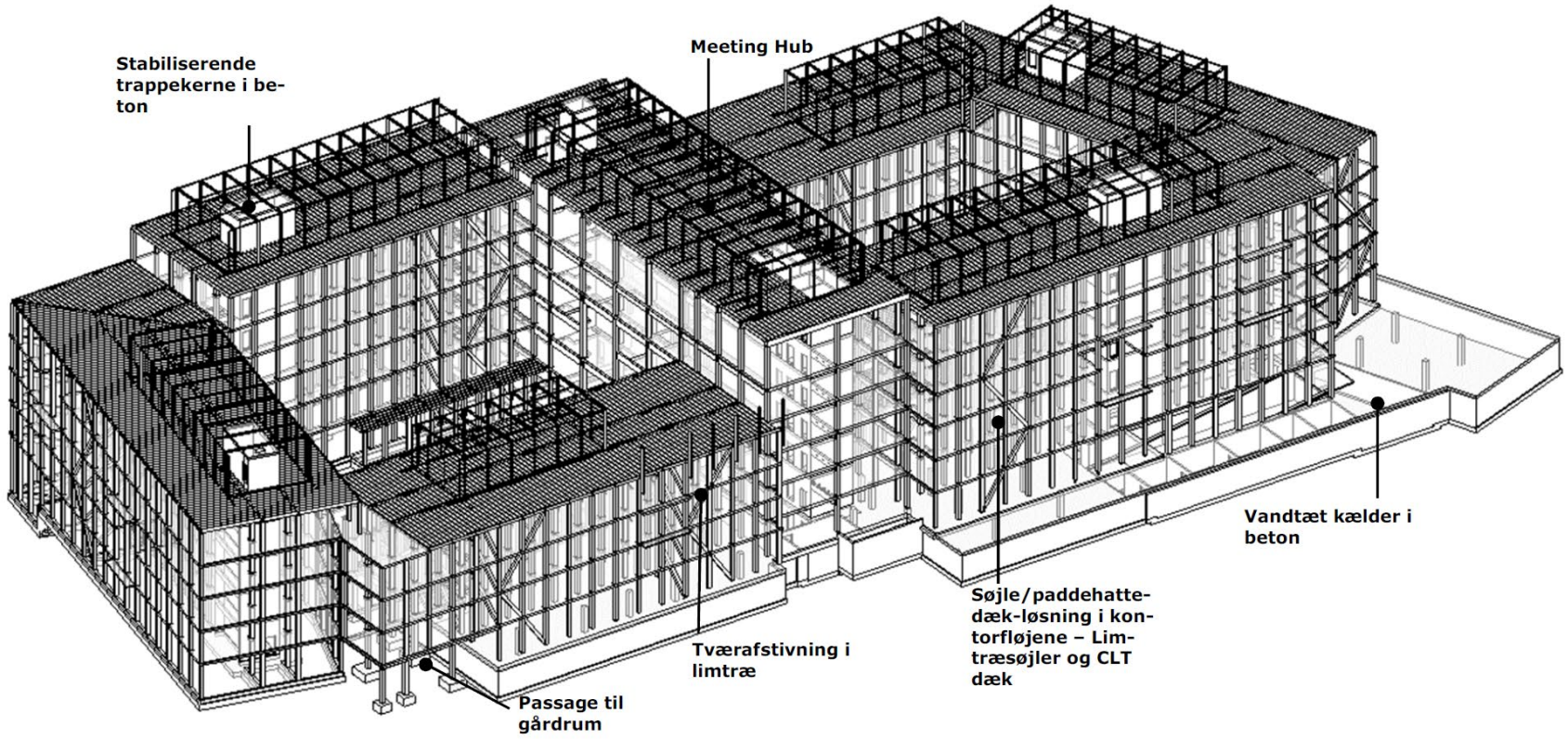
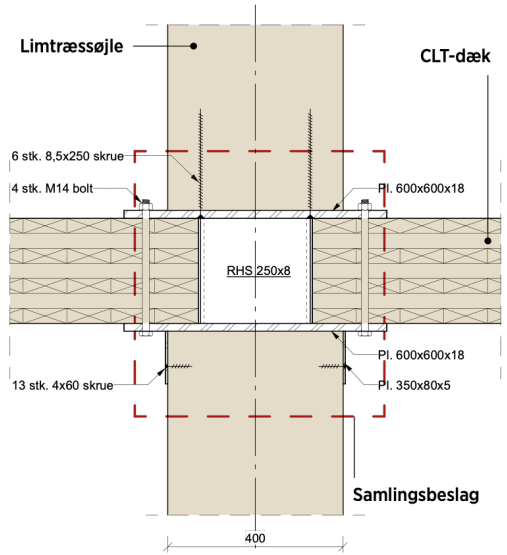
SIMPLE STRUCTURE - REPETITIVE, STRUCTURAL SYSTEM

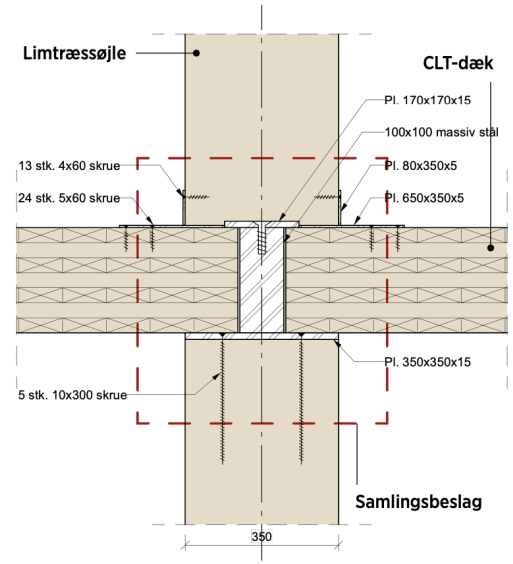


3D konstruktionsmodel af bygning

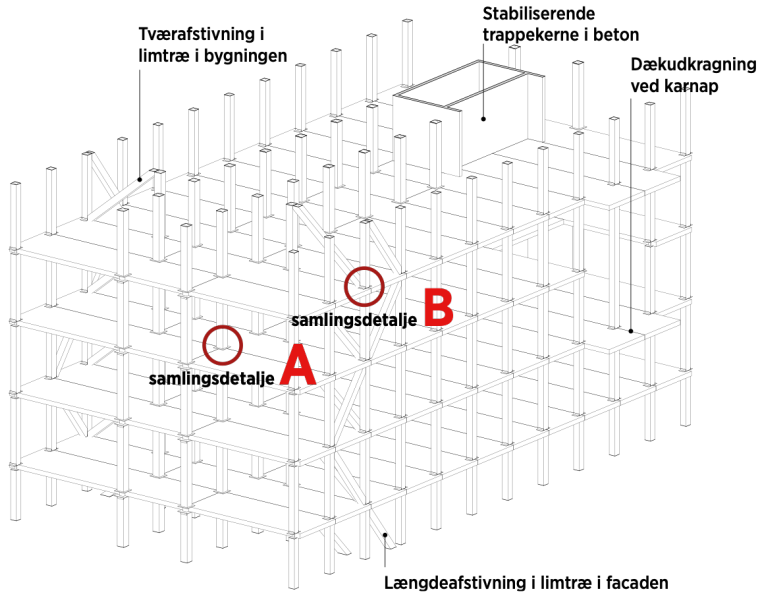
80/20 - PRINCIPLES



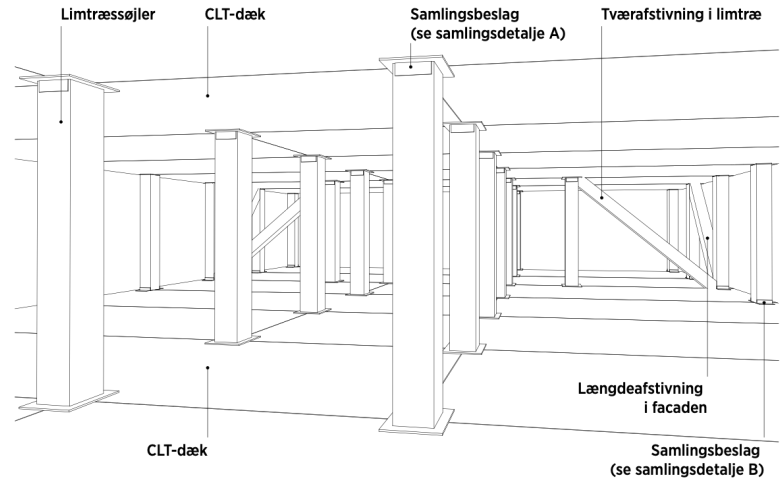
SAMLINGSDETALJE A // *Indvendige søjler*



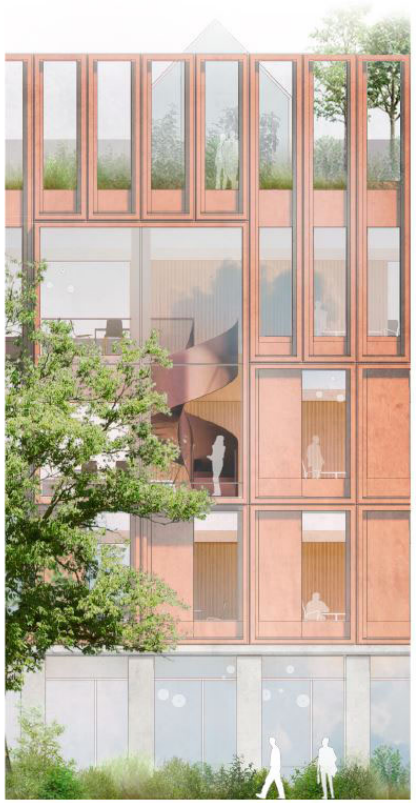
SAMLINGSDETALJE B // Facadesøjler



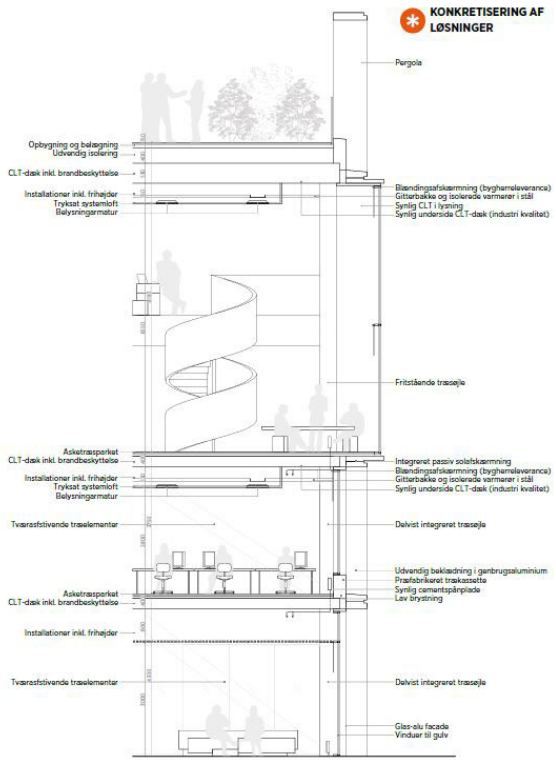
ISOMETRI AF UDSNIT AF KONTORFLØJ



INVENDIGT PERSPEKTIV AF KONSTRUKTIONEN I KONTORUDSNIT



FACADEUDSNIT // 1:100



PRINCIPIELT SNIT // 1:100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BORGERSERVICE
INDGANG
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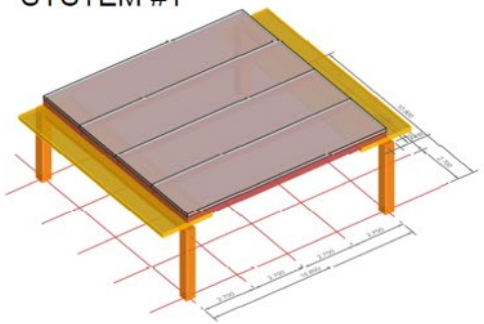
Wooden Constructions - WoodHub

- **Columns: A lot……2,85 m distance 35 x 35 cm thickness (+50mm fire dim)**
- **Alternative : Beams… extra room heights and crossing installations**
- **Limited potential for penetration of beams for installations**
- **Many expressive crossbeams in facades (stiffning of building corners)**

Considerations on construction principles – Variants analysis

SYSTEM ÜBERBLICK
GRUNDRASTER - 1 MODUL
10,80m x 10,80m

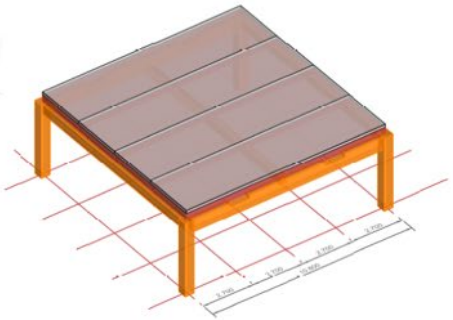
SYSTEM #1



Hauptparameter:

- Flachliegender Unterzug (verkürzt die Spannweite auf ca. 8,10m)
- Unterzüge nur in einer Richtung
- Spannweite der Decken: ca. 8,10m
- Vier Stützen pro Modul

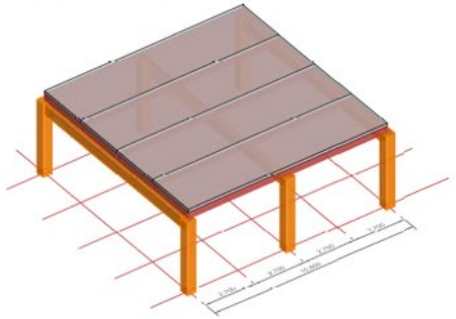
SYSTEM #2



Hauptparameter:

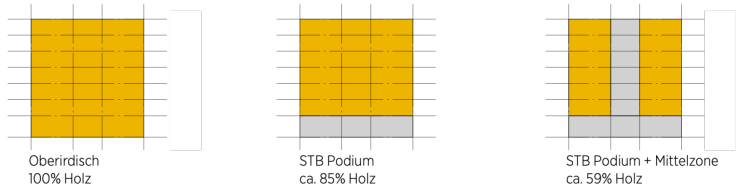
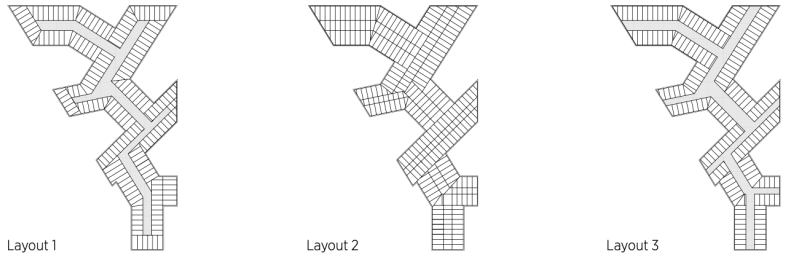
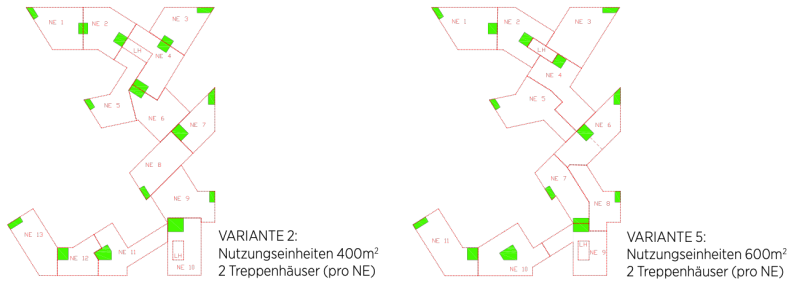
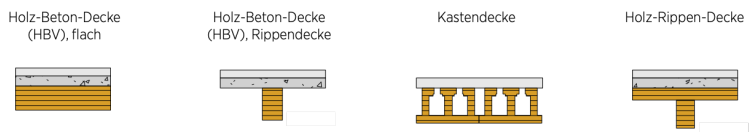
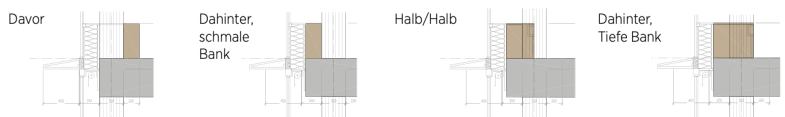
- Unterzüge in zwei Richtungen (umlaufend)
- zusätzlicher Unterzug in der Mitte des Feldes
- Spannweite der Decken: 5,40m
- Vier Stützen pro Modul
- Ausschnitte in den Unterzügen für Haustechnik

SYSTEM #3



Hauptparameter:

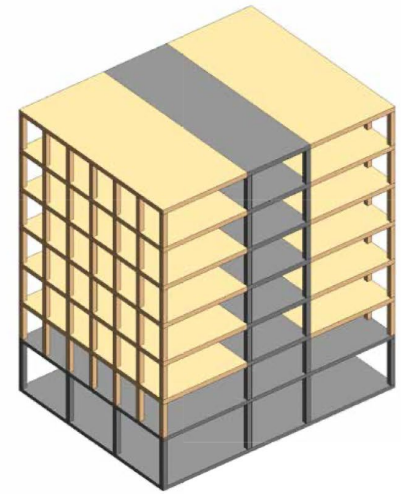
- Unterzüge nur in einer Richtung
- Zusätzliche Tragachse nach 5,40m
- Spannweite der Decken: 5,40m
- Sechs Stützen pro Modul
- Tragsystem mit dem geringsten Materialverbrauch

Bauteile	
Layout	
Nutzungs-einheiten	
Decken	
Fassaden-anschluss	

BAUTEILE:

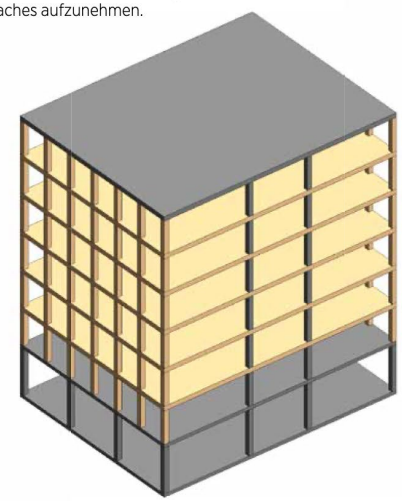
Axonometrie Überblick

Decke über 6.OG nur in der Mittelzone in Stahlbeton um hohe Deckenlasten des begrünten Daches aufzunehmen.



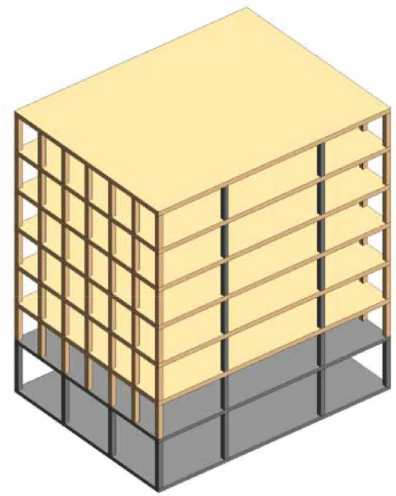
Raster 2
(7,80m - 5,40m - 7,80m)

Decke über 6.OG in Stahlbeton um hohe Deckenlasten des begrünten Daches aufzunehmen.



Raster 2
(7,80m - 5,40m - 7,80m)

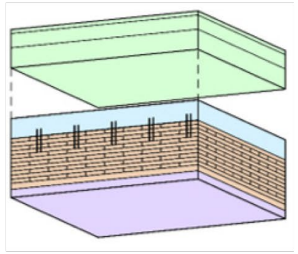
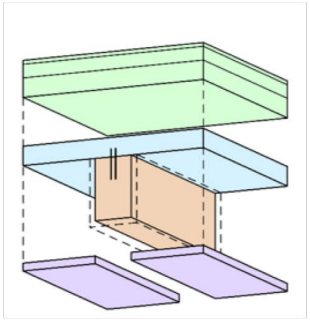
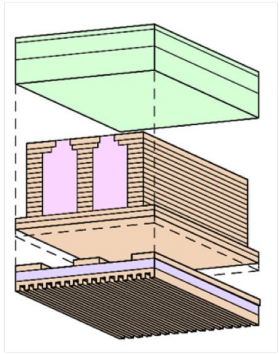
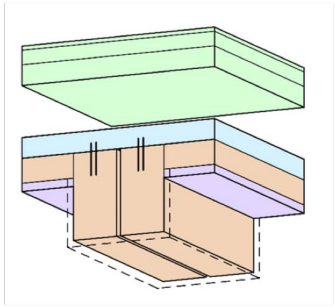
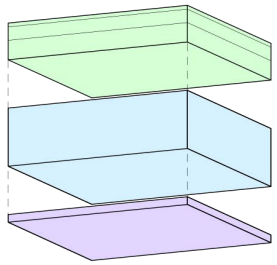
EG UND UG in Stahlbeton, Abfangebene für Fassadenstützen der Obergeschosse unter Decke über EG



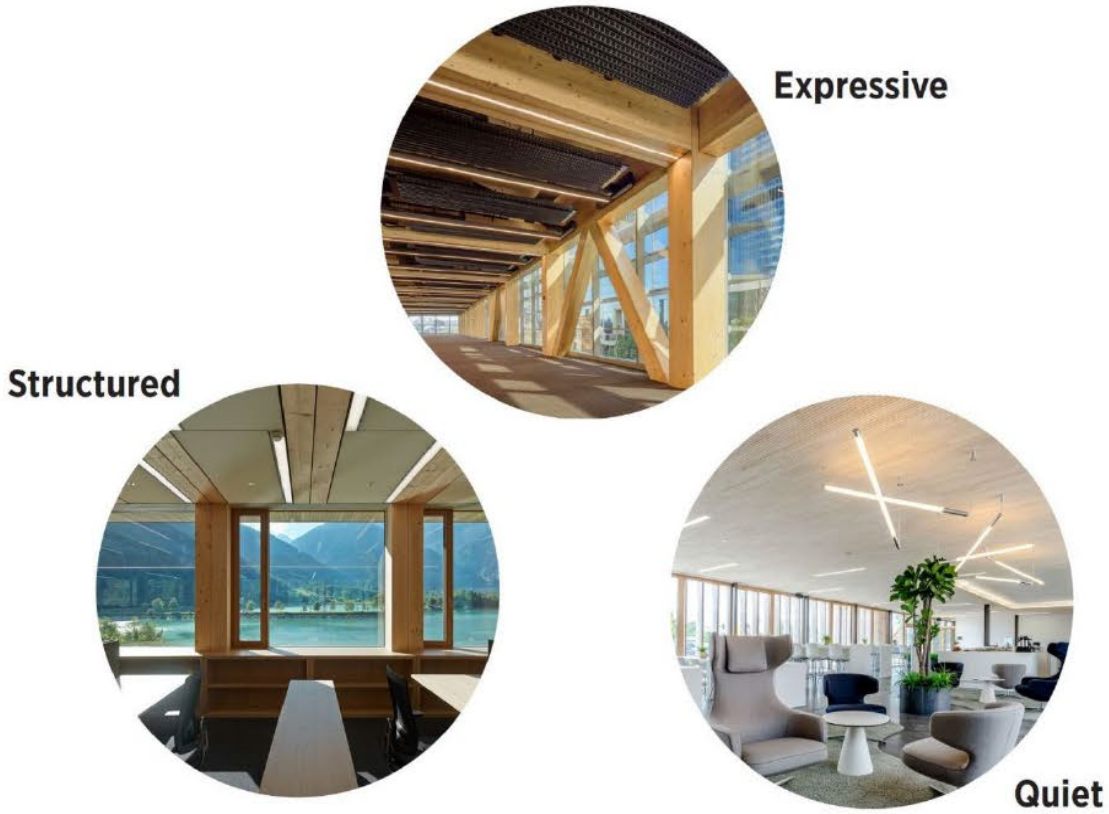
Raster 1
(6,05m - 8,90m - 6,05m)

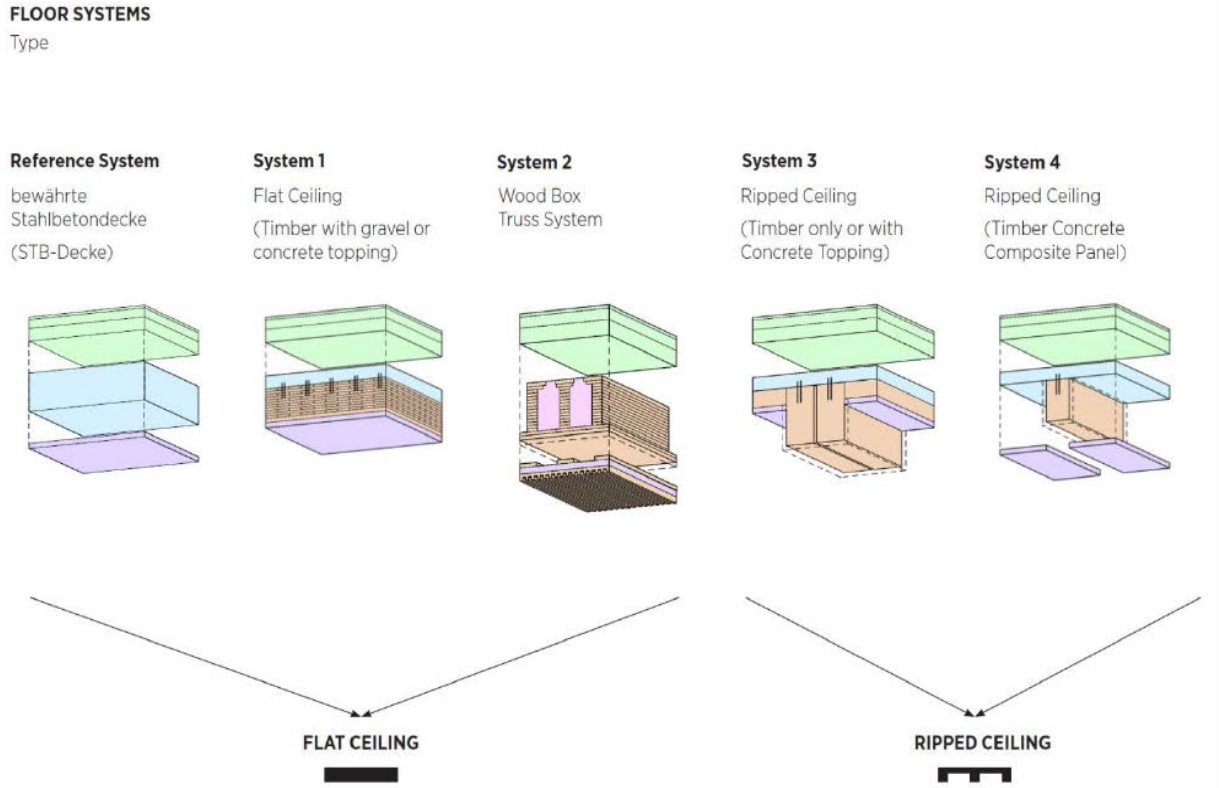
DECKENSYSTEME

Übersicht

System 1	System 2	System 3	System 4	Vergleichssystem
Holz-Beton-Verbund-Flachdecke (BV-F-Decke)	Holz-Beton-Verbund Trägerdecke (HBV-T-Decke)	Holz-Kastendecke (HK-Decke)	Holz-Beton-Verbund-Rippendecke (HBV-R-Decke)	bewährte Stahlbetondecke (STB-Decke)
				
Gesamtdicke inclusive Fußbodenaufbau:				
54cm	69cm	50cm	74cm	55cm
Gewicht Rohdecke (ohne Fußbodenaufbau):				
370kg/m²	335kg/m²	270kg/m²	360kg/m²	850kg/m²
Anteil Holz an Gesamtgewicht der Decke:				
33% Holz	10% Holz	45% Holz	17% Holz	0% Holz

Technologies and tectonic aesthetics of wooden structures





RENDERINGS INNENBEREICHE

Mittelzone

Kommentar:
Auch in der Gangzone bedingen die Flachdecken eine ruhige Untersicht und einfache Anschlussdetails. Durch die Perspektive und den Blickwinkel den Gang hinunter verbinden die Rippen auf der rechten Seite, die im Abstand von 2,70m gelegt sind, sich zu einer geschlossenen Decke und drücken so den Raum nach unten.

FLACHDECKE

System 1

System 3

RIPPENDECKE

System 2

System 4

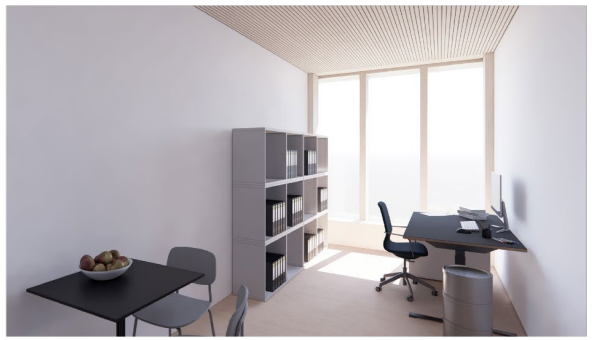
RENDERINGS INNENBEREICHE

Standard Büro (15m²)

Kommentar:
IN den 15m² Standard Büros tritt die Rippendecke mit ihren bis zu 45cm hohen Brettschichtholz (BSH) Unterzügen stark in Erscheinung. Hier sind nicht nur die Gangwand-Anschlüsse eine Herausforderung, sondern auch die seitlichen Trennwände die sich unter den beiden Rippen befinden. Bei den Flachdecken auf der linken Seite, kann man Bürotrennwände in beliebiger Postition und Anzahl anschliessen und vorallem diese auch wieder verändern.

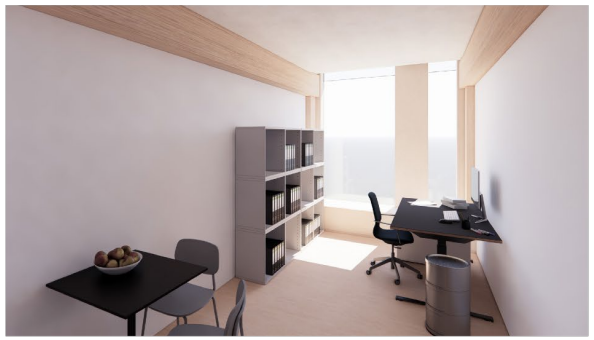
FLACHDECKE

System 1



System 3

RIPPENDECKE



System 2

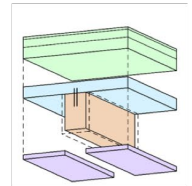
System 4

DECKENSYSTEM 2:
Referenzbeispiele

Kommentar:
In diesen Beispielen sind die Rippen im Abstand von 1,35m gesetzt. Auch sind die Rippen als Doppelbalken ausgebildet. Der Raum zwischen den Rippen wird normalerweise als Installationsraum genutzt. Bei dem BMU Erweiterungsbau ist dies aufgrund des Low-Tech Prinzips und anderweitiger Verortung der Technikelemente (z.b. Im Fußbodenaufbau) nicht notwendig.

LCT ONE und Illwerke Zentrum Montafon
Dornbirn und Vandans
Architektur: Hermann Kaufmann + Partner ZT GmbH
Bauherrschaft: LCT ONE: Cree GmbH (1)
Bauherrschaft: IZM: Vorarlberger Illwerke AG (2)

Holz-Beton-Verbund
Trägerdecke
(HBV-T-Decke)




(2)


(1)


(1)

Bilder: CreebyRhomberg

Teachings from wooden buildings 1:

- **Sound/Acoustics:** Beware of levels of sound moving via air- or flank-transmission. Verify all joints and solutions by acoustician

- **Fire:** Non-pre-accepted solutions for buildings over 4 stories in wood, will demand 120 min non-combustability in Danish building codes. This means extra thicknesses of loadbearing structures as fire dimensioning. Expect interior claddings with gypsum (also CO2) on ceilings and walls, meaning limited visible structural wood.

Teachings from wooden buildings 2:

- **Moisture:** Make thourough moisture-strategy from first idea! (listing of building components with particular focus). Analysis and descriptions of challenges and potential problems as well as solutions). Watch out for roofgardens. Build vertically rather than horizontally, think buildability of fast facade closures into building logistics

- **Wood cladding of facades:** Not effective as savings of CO2. Think about *structural* fire and wood protection, fx extruded soffits, horizontal firestops at deck-separations. Think environmentally friendly, durable wooden qualities, and wood treatments (thermowoods, eco friendly pressure treated wood, charrring etc)

CO2-savings potentials Timber buildings:

- Timber hybrid buildings: down to **6-8 kgCO2/m2/year**

- Pure timber buildings: down to **4-6 kgCO2/m2/year**

- Radical timber projects (biobased and up-/recycled materials, screw foundations, etc.):

under 4 kgCO2/m2/year

Danish regulations Volunteer Building Class by 2029= **7 kg/CO2/m2/year**

The value chain is only just getting ready, - and we need to move fast forward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