Thursday, January 31, 2013

Sustainable Value Perspective for Architecture

- Energy efficiency parameters implemented in the design from the first sketches of the creative process

PhD MSc Sustainability Engineer, Jakob Strømann-Andersen,
Department of Sustainability, Henning Larsen Architects A/S

buildingSMART

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AGENDA

POINT OF DEPARTURE

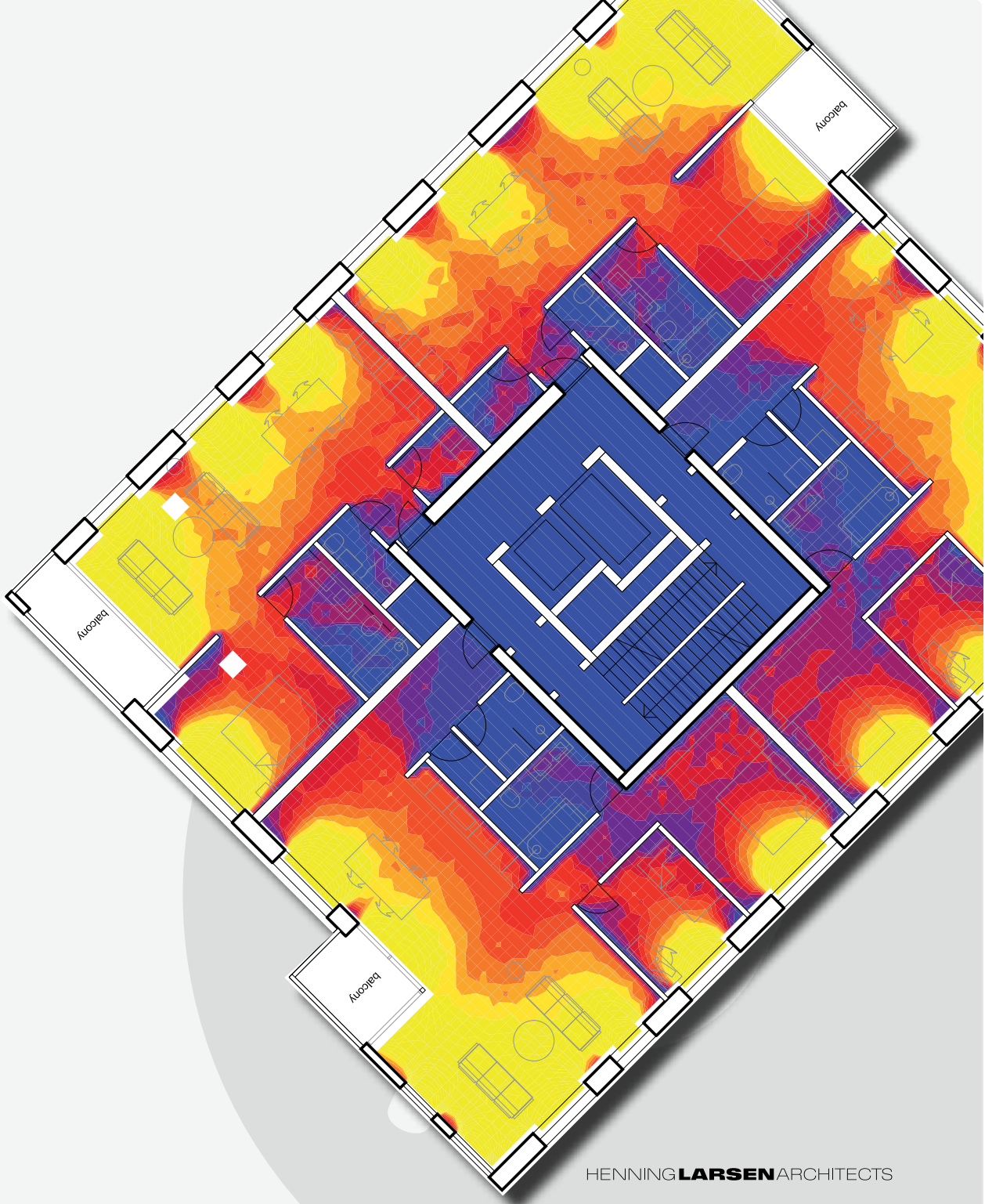
Henning Larsen Architects
Research area

CASE STUDIES

Density, Thomas B. Thriges Gade
Typologies, KAFD
Texture, Carlsberg City District

SUM-UP

Tendensies in sustainability



sustainability

POINT OF DEPARTURE

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Henning Larsen,
founded the company in 1959.

- Henning Larsen Architects employs 180 people from almost 20 different nations.
- 65% of the turnover derives from international projects. Projects in more than 20 countries.
- Offices in Denmark, Germany and Saudi Arabia, Norway and Tyrkey

“the master of light...”

HENNING**LARSEN**ARCHITECTS

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HENNINGLARSENARCHITECTS

Department of Sustainability

- 12 people employed in the sustainable department
- Last year we designed 500.000 m^2 of low-energy buildings without adding renewables

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FIELD OF WORK...

Scientificwork

Energy and Buildings 43 (2011) 2011–2020

Contents lists available at ScienceDirect

Energy and Buildings

journal homepage: www.elsevier.com/locate/enbuild

The urban canyon and building energy use: Urban density versus daylight and passive solar gains

J. Strømann-Andersen [a,*], P.A. Sattrup [b]

[a] Department of Civil Engineering, Technical University of Denmark, Brovej Building 118, 2800 Kgs. Lyngby, Denmark
[b] Institute of Building Technology, Royal Danish Academy of Fine Arts School of Architecture, Philip de Langes Allé 10, 1435 Copenhagen K, Denmark

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Daylight
Solar radiation
Integrated design

ABSTRACT

The link between urban density and building energy use is a complex balance between climatic factors and the spatial, material and use patterns of urban spaces and the buildings that constitute them. This study uses the concept of the urban canyon to investigate the ways that the energy performance of low-energy buildings in a north-European setting is affected by their context.

This study uses a comprehensive suite of climate-based dynamic thermal and daylight simulations to describe how these primary factors in the passive energy properties of buildings are affected by increases in urban density.

It was found that the geometry of urban canyons has an impact on total energy consumption in the range of up to +30% for offices and +19% for housing, which shows that the geometry of urban canyons is a key factor in energy use in buildings. It was demonstrated how the reflectivity of urban canyons plays an important, previously underestimated role, which needs to be taken into account when designing low-energy buildings in dense cities. Energy optimization of urban and building design requires a detailed understanding of the complex interplay between the temporal and spatial phenomena taking place, merging qualitative and quantitative considerations.

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1. Introduction

One of the most basic and fundamental questions in urban master planning and building regulations is how to secure common access to sun, light and fresh air, but for the owners of individual properties, it is often a question of getting the most of what is available. There is potential for repetitively recurring conflict between public and private interest. Solar access and the right to light remain contested territory in any society, vital as they are to health, comfort and pleasure.

Traditional urban planning has sought to control the proportions of the streets, because the basic geometry of building heights and distances between buildings regulates access to light and solar heat. Zoning laws and building regulations usually establish height-to-distance ratios that limit the overshadowing that buildings may cause for public spaces and other buildings. A similar geometric abstraction of urban space – the urban canyon [1] – has been used in urban climatology, to describe the way that urban spaces create special environmental conditions. It is a spatial archetype that allows us to integrate knowledge from several different specialized fields of research. In geometric terms, the urban canyon is described as the height/width ratio of the space between adjacent buildings.

Cities develop over time, and the proportions of urban canyons have long lasting impacts on the future energy consumption for the heating, cooling and lighting of the buildings that define them and the environmental qualities of the streets, squares, courtyards or gardens that comprise them. Urban development is a rather slow process in most industrialized societies, but the impact of site conditions on building energy use multiply over the years – more than other processes that affect a buildings performance over its lifetime. So, considering that one of the main challenges to architects and engineers in the next decades will be how to improve the energy performance of our buildings and cities, we need to improve our knowledge of both urban and building design through research on the dynamic interplay between climate, context and building energy use. The passive properties of buildings are likely to play a much more important role in the total energy consumption, as winter heat losses are reduced with better insulation, glazing and air tightness.

Urban densification is one strategy for sustainable development, focusing on energy savings through efficient transport systems, shared infrastructures and minimizing heat gains and losses that dominate energy budgets. It has been established that densification is a balancing act between these opportunities on the one hand, and ensuring solar access for low-energy buildings and urban

* Corresponding author. Tel.: +45 4525 1868; fax: +45 4525 1700; mobile: +45 6170 7016.
E-mail address: jasta@byg.dtu.dk (J. Strømann-Andersen).

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Research & design

Projects

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RESEARCH AREA...

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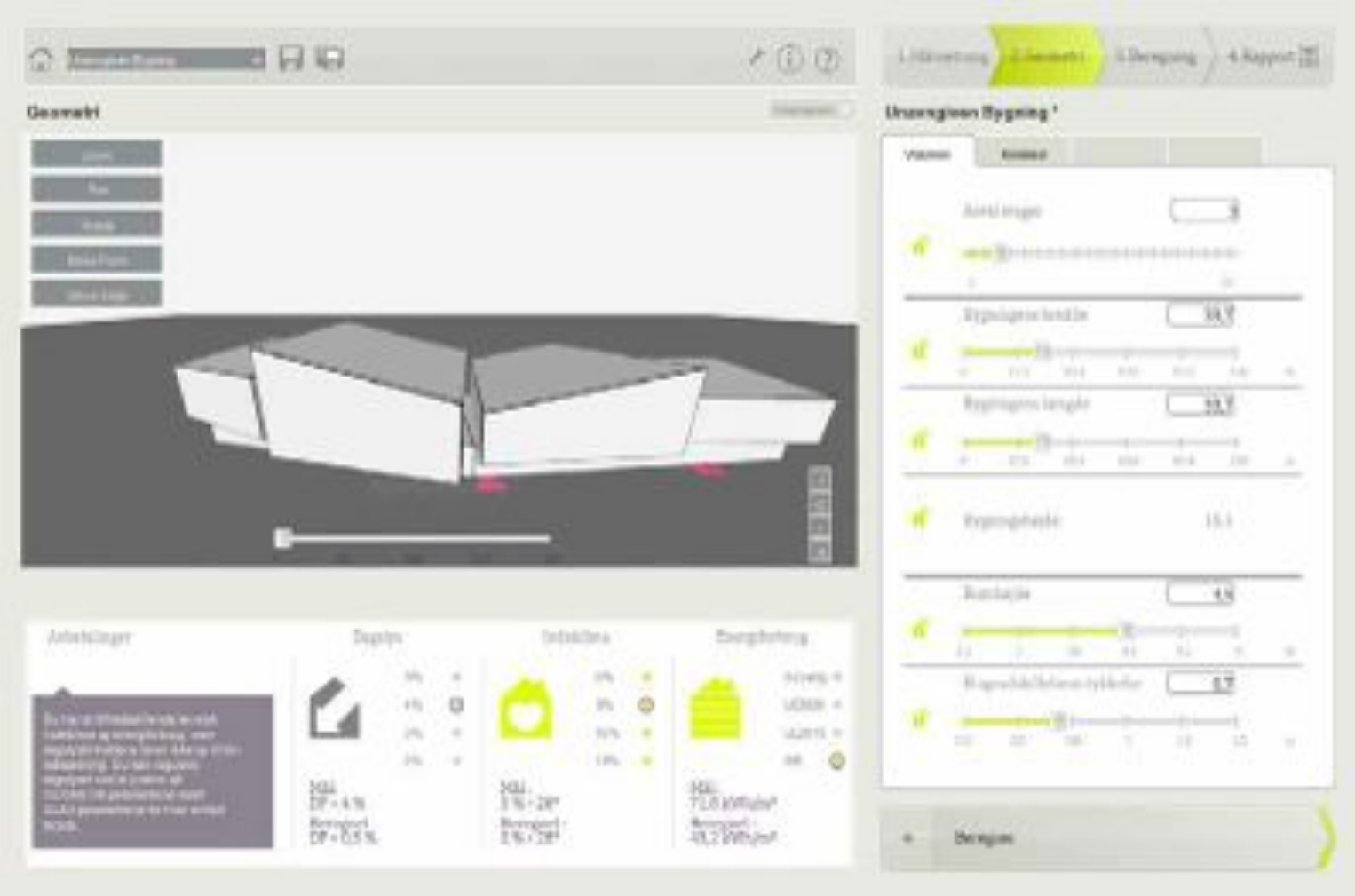
RESEARCH AREA...



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RESEARCH AREA...

Up to 50 % of the energy performance is fixed with the architect´s first sketch on the napkin

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DESIGN PROCESS

How is put into practice?

Context

– Wind, water, daylight, noise and polution

Body

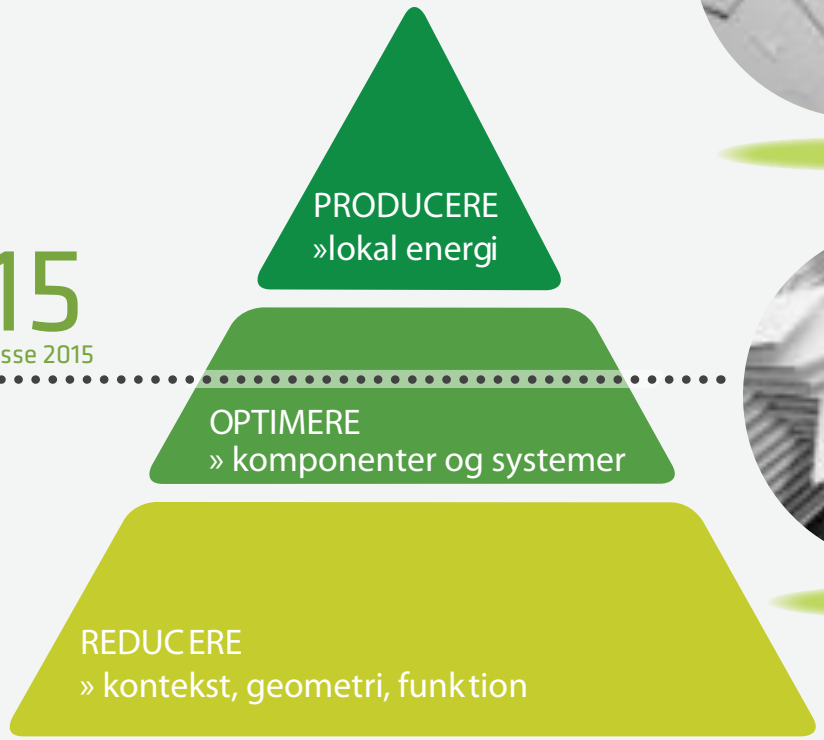
– Geometry, orientation, zones and daylight

Structure

– Space, daylight, main functions, zones and construction

Facade

– Technology, indoor climate and user behavior



2015

Lavenergiklasse 2015

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	71 kWh/m² år	41 kWh/m² år inkl. energifaktor for omregning til 2015	25 kWh/m² år inkl. energifaktor for omregning til 2020
Construction cost using **traditional** design approach		+6 %	+10 %
Construction cost using **integrated** design approach		+3 %	+5 %

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SCIENTIFIC WORK / CASESTUDIES

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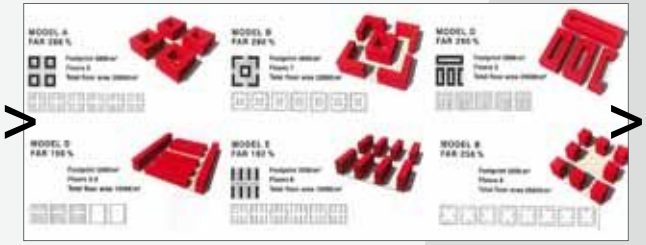
How openBIM can help you structure the city

1. Density

>>

2. Typologies



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3. Texture

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URBAN DENSITY

1. Density

>>

2. Typologies

>>

3. Fabric/Texture

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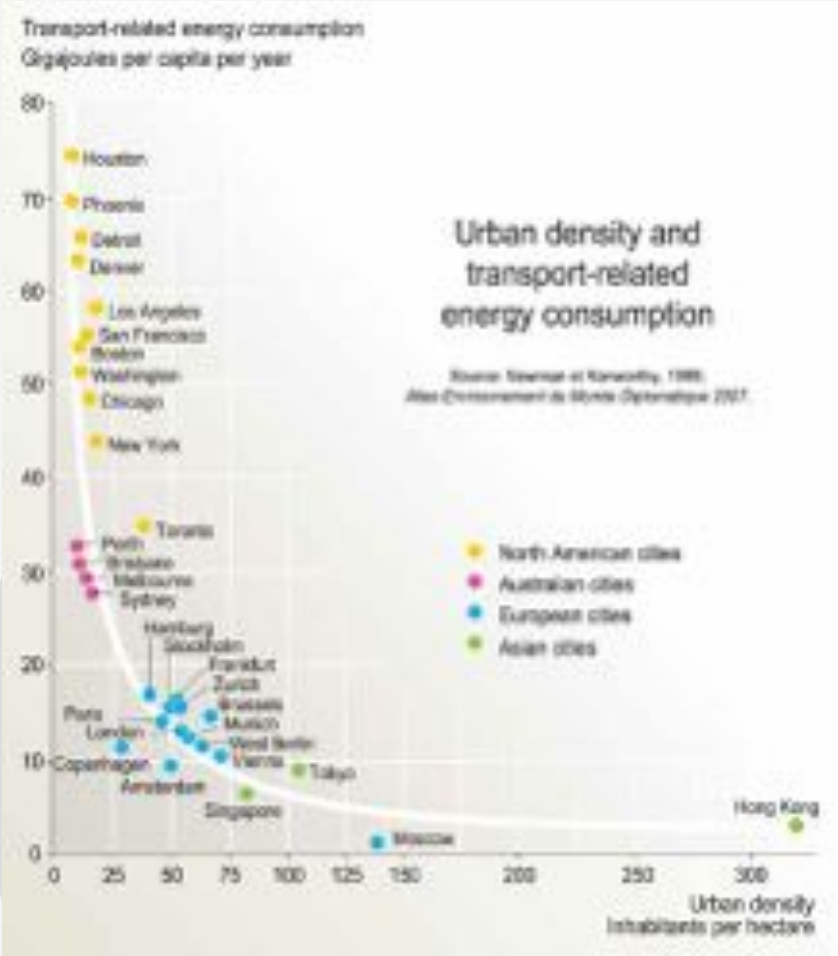
URBAN DENSITY

"Sustainable cities must be compact and high-density"

George Monbiot´s, The Guardian, june 2011



The Newman and Kenworthy hyperbola: Urban density and transport-related energy consumption

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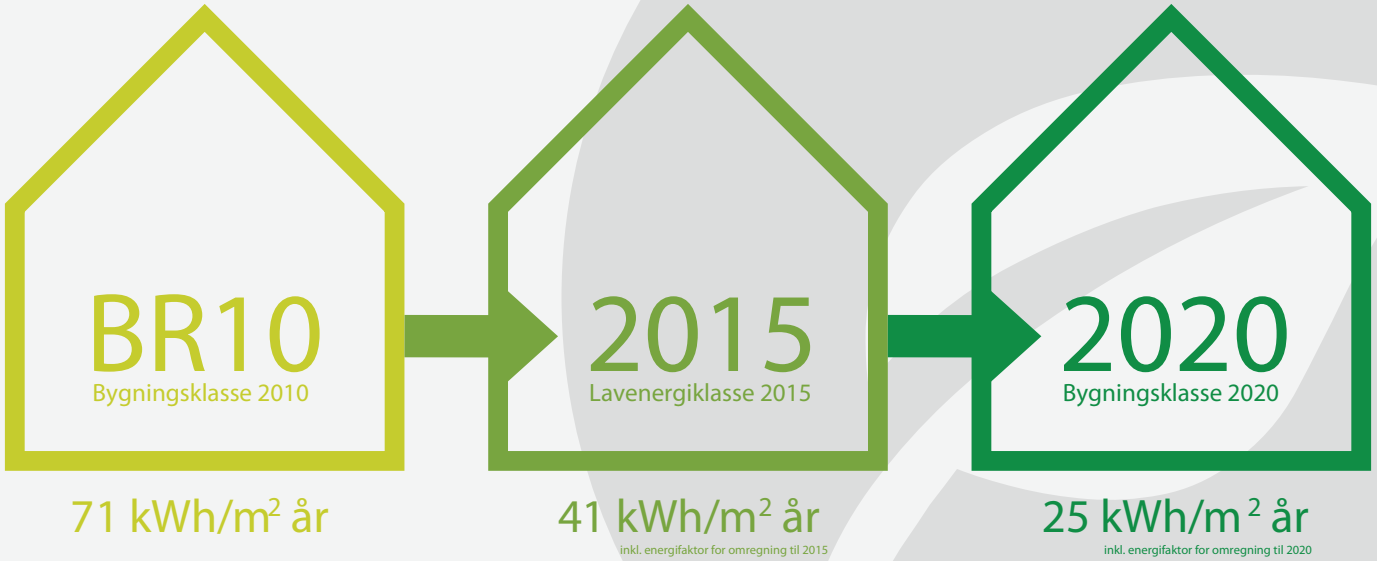
URBAN DENSITY

The challenge

Danish building regulations state that, by 2020, all building energy consumption should be reduced by roughly **50 %**.

Compared to 2010 regulations, Danish building regulations



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URBAN DENSITY

SCIENTIFIC WORK

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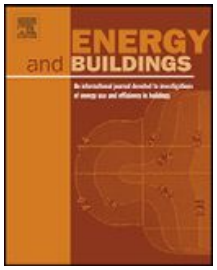

The urban canyon and building energy use: Urban density versus daylight and passive solar gains

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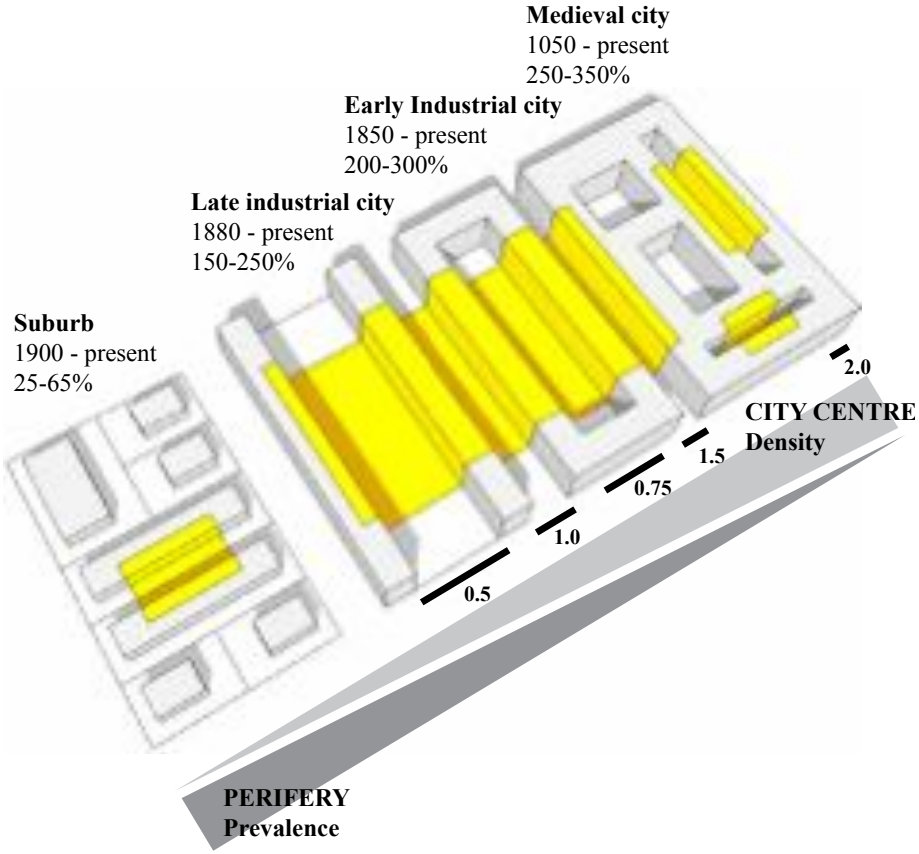
[a] Department of Civil Engineering, Technical University of Denmark, Brovej Building 118, 2800 Kgs. Lyngby, Denmark
[b] Institute of Building Technology, Royal Danish Academy of Fine Arts School of Architecture, Philip de Langes Allé 10, 1435 Copenhagen K, Denmark

URBAN DENSITY

SCIENTIFIC WORK



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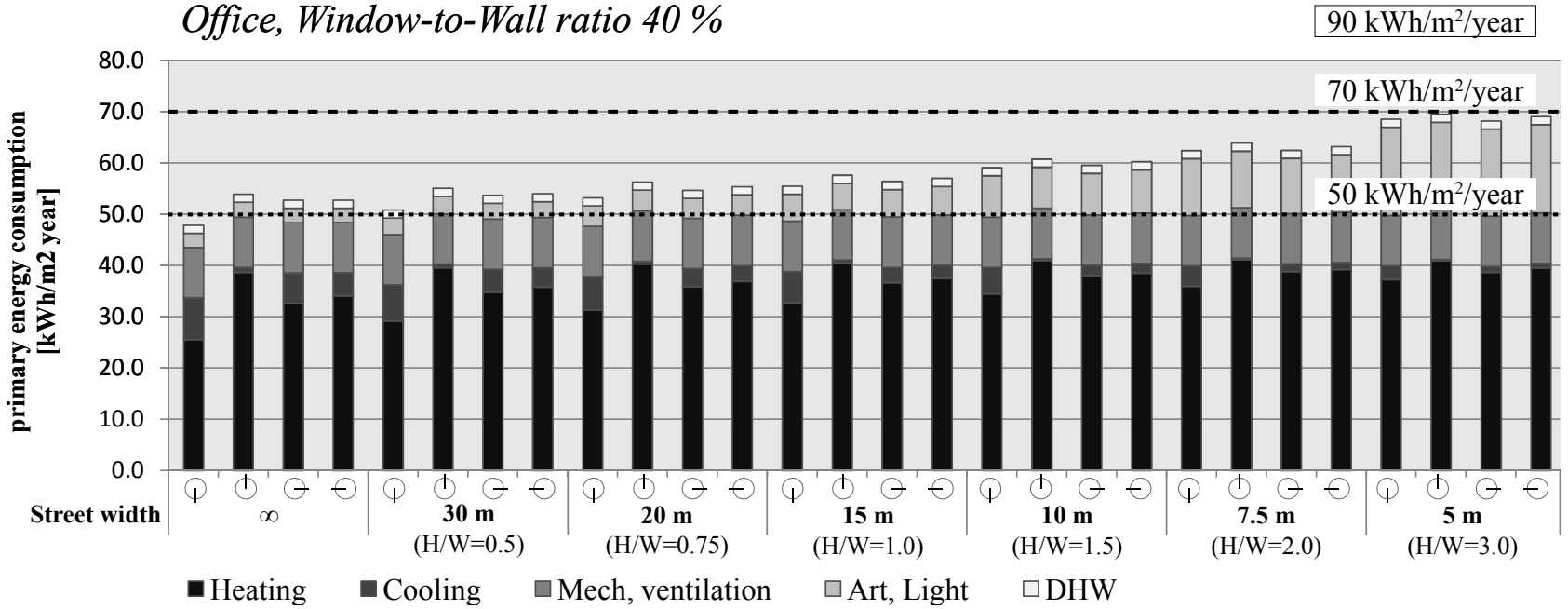
URBAN DENSITY

SCIENTIFIC WORK

Urban density versus total energy consumption

Office, Window-to-Wall ratio 40 %



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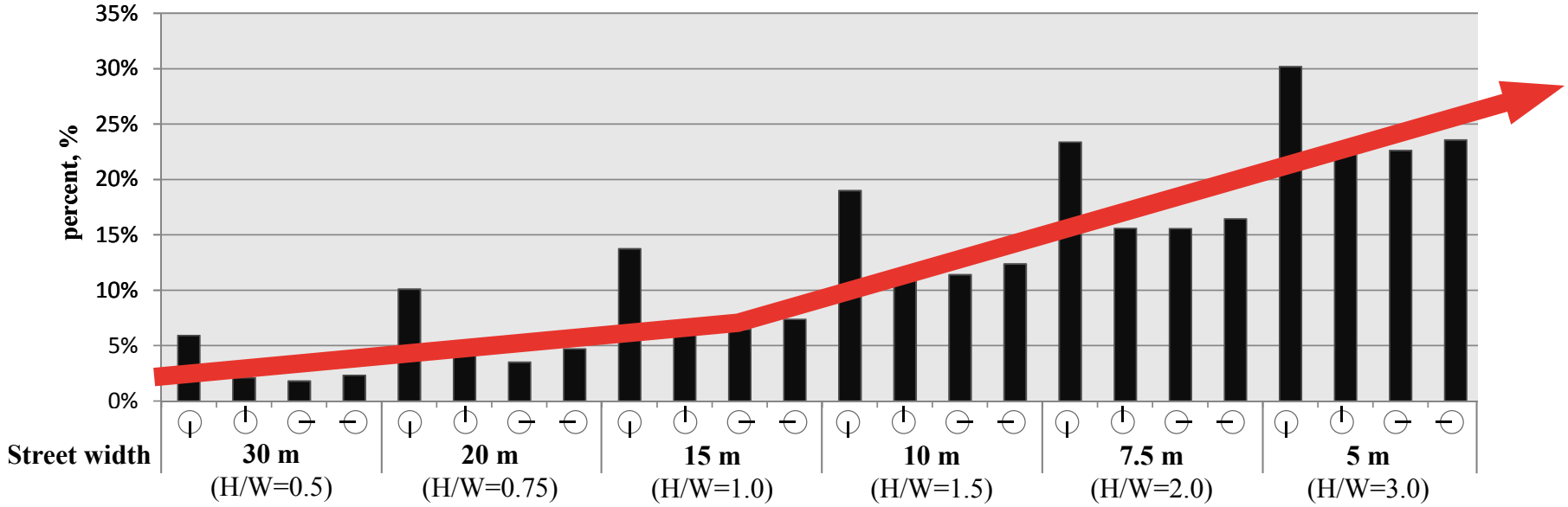
URBAN DENSITY

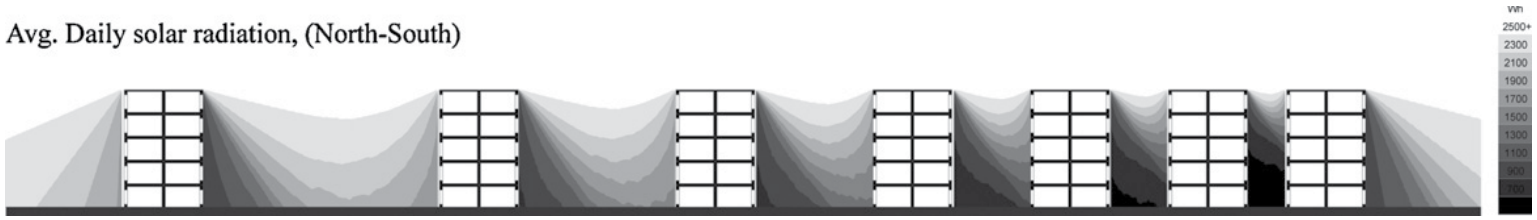
SCIENTIFIC WORK

Relative deviation

Office, Window-to-Wall ratio 40 %



Avg. Daily solar radiation, (North-South)



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URBAN DENSITY

CASE STUDIES

THOMAS B. THRIGES GADE

Project facts:

Location:	Odense, Denmark
Client:	City of Odense
Gross floor area:	50,000 m^2
Year of design:	2011–2012
Type of assignment:	Competition
Design team:	Polyform, Henning Larsen Architects, Dress & Sommer, WTM Engineers International (D); Argus (D); Jonathan Speirs + Major (UK)

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URBAN DENSITY

CASE STUDIES

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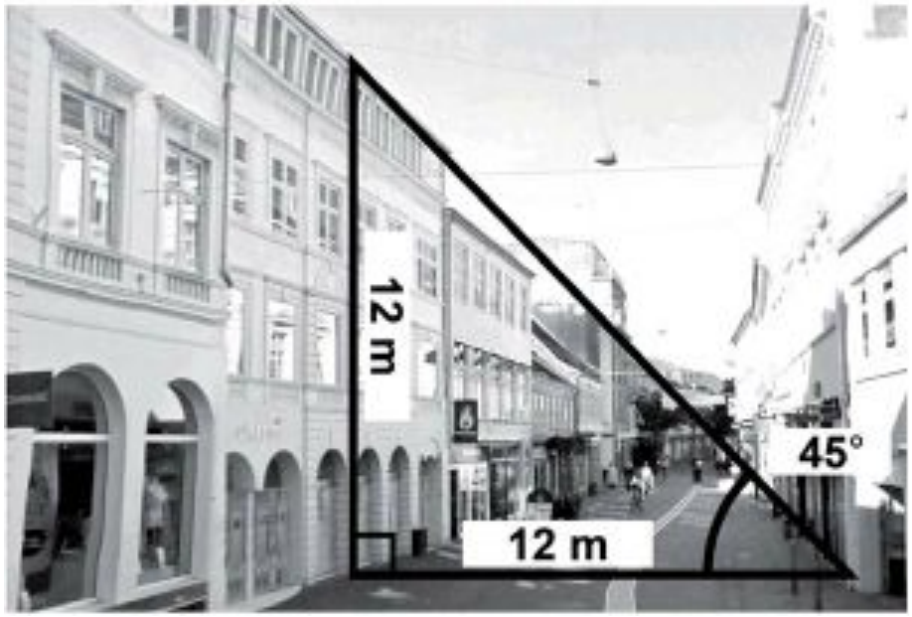
URBAN DENSITY

CASE STUDIES

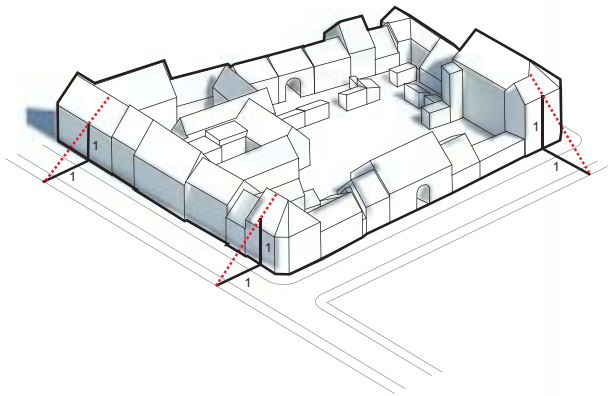


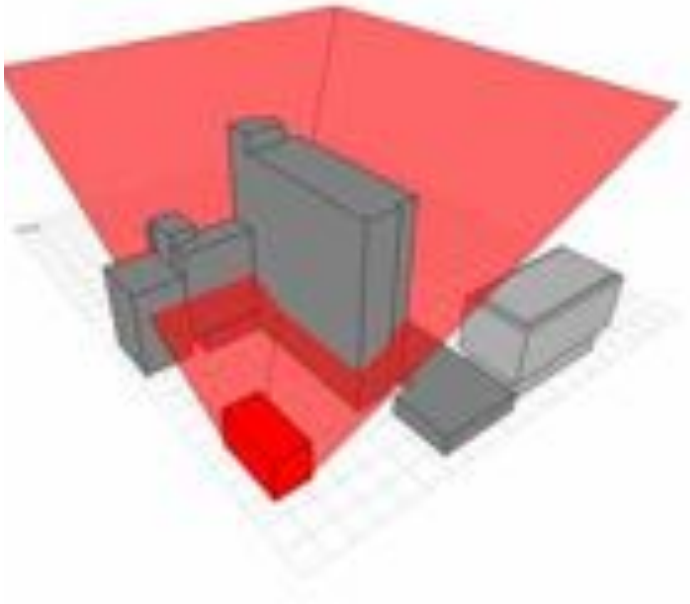
Vestergade, 5000 odense C

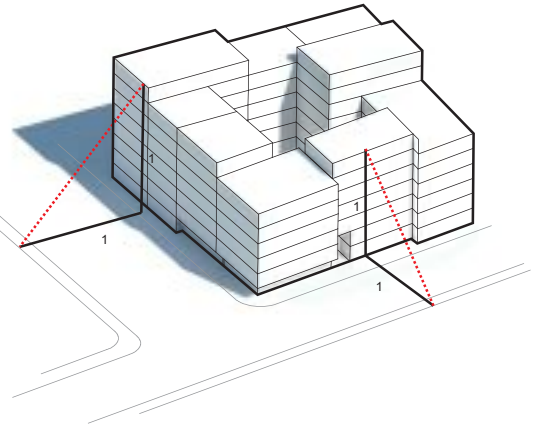
Note: The Vertical Sky Component is a measure of the amount of skylight incident on a vertical plane. For a standard overcast sky, the maximum value is 50% (since the point is on a vertical plane, clearly only half the hemisphere can contribute).

URBAN DENSITY

CASE STUDIES







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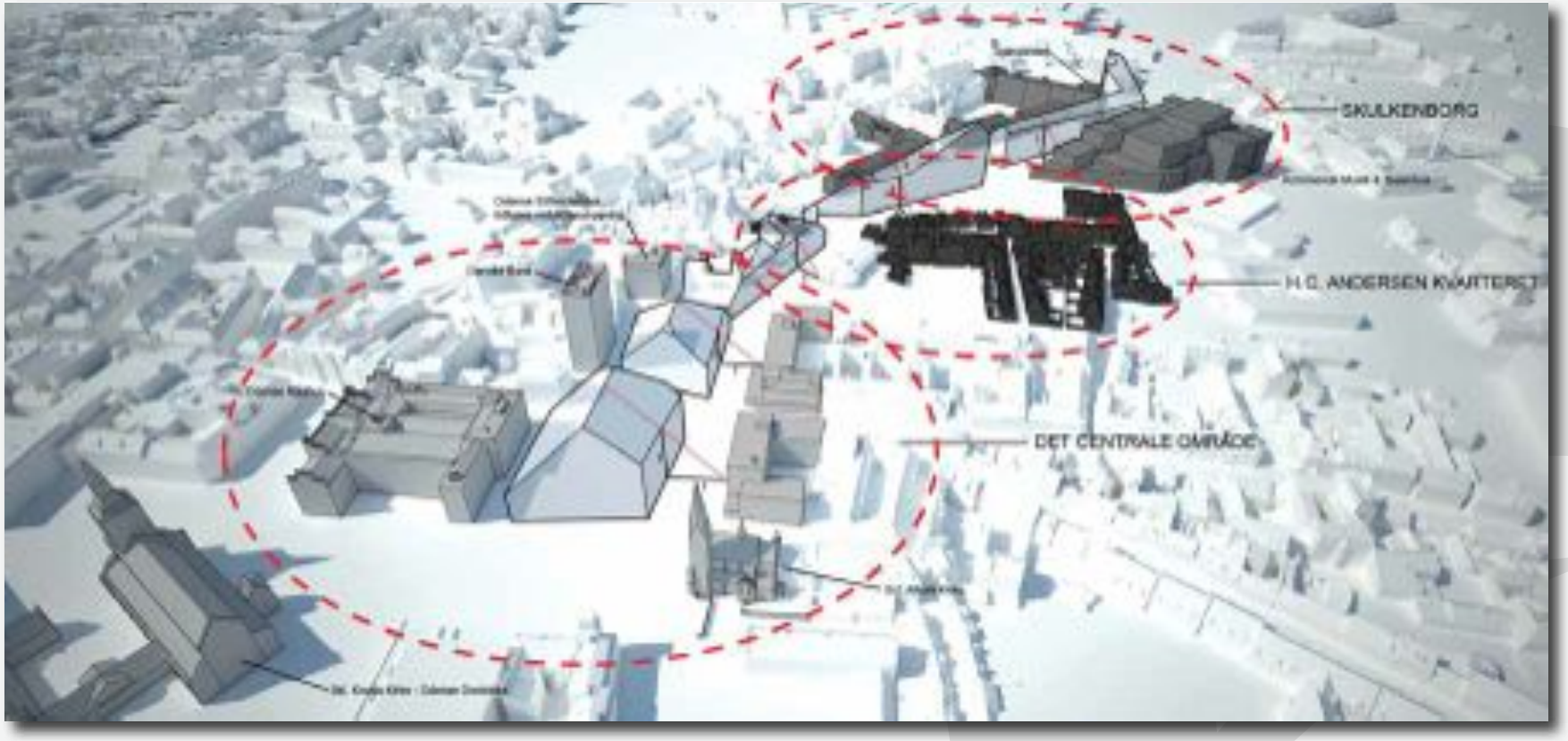
URBAN DENSITY

CASE STUDIES



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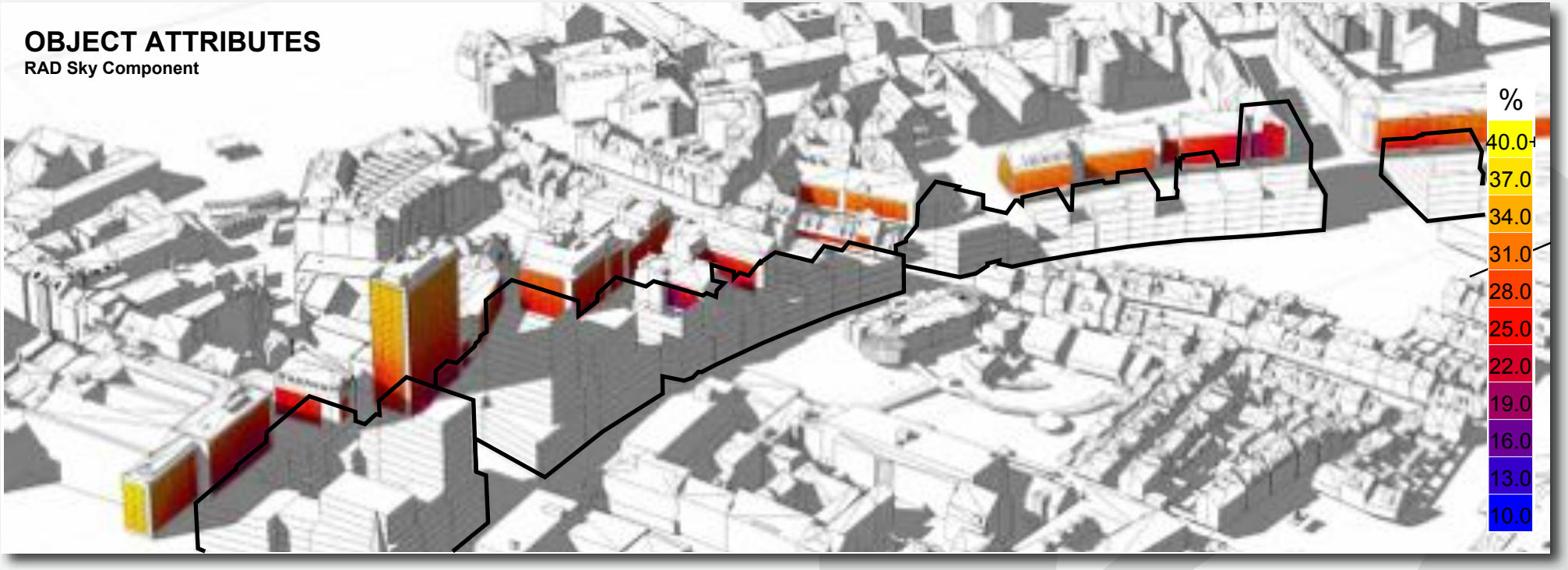
URBAN DENSITY

CASE STUDIES



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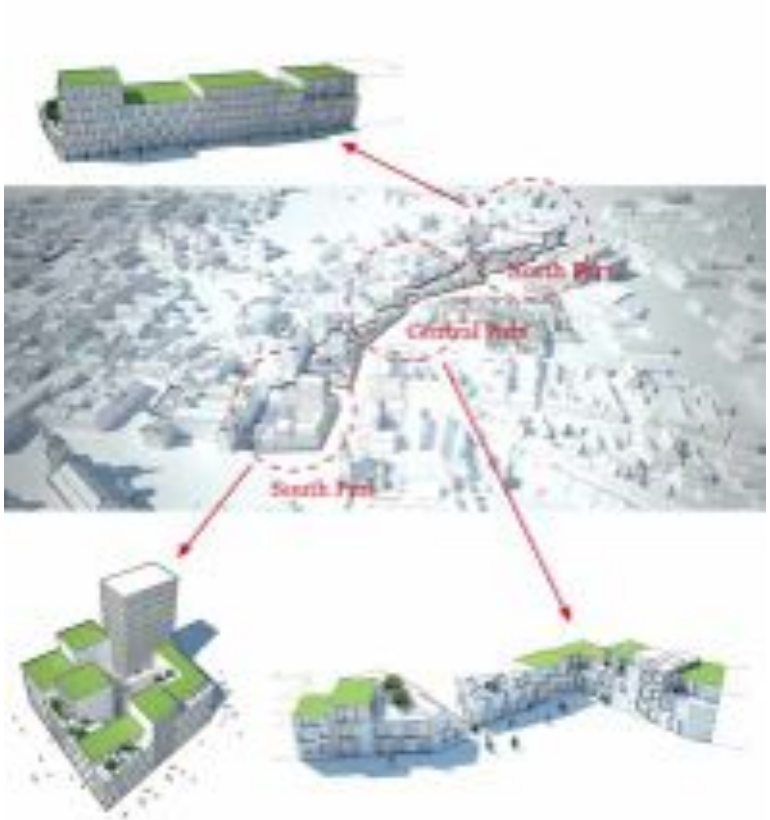
URBAN DENSITY

CASE STUDIES

Meeting the scale of the city...



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URBAN DENSITY

CASE STUDIES

Lessons to be learned

1. Use BIM the analyse and understand the surrounding context to find the right density.

2. Use the knowledge to design and structure your own building.

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WHY IS THIS IMPORTANT?

"IT CAN GO WRONG"

An example…

Before

Ørestad Gymnasium before Ørestad School was built.

After

WHY IS THIS IMPORTANT?

"IT CAN GO WRONG"

Before

Ørestad Gymnasium before Ørestad School was built.

After

Ørestad School under construction.

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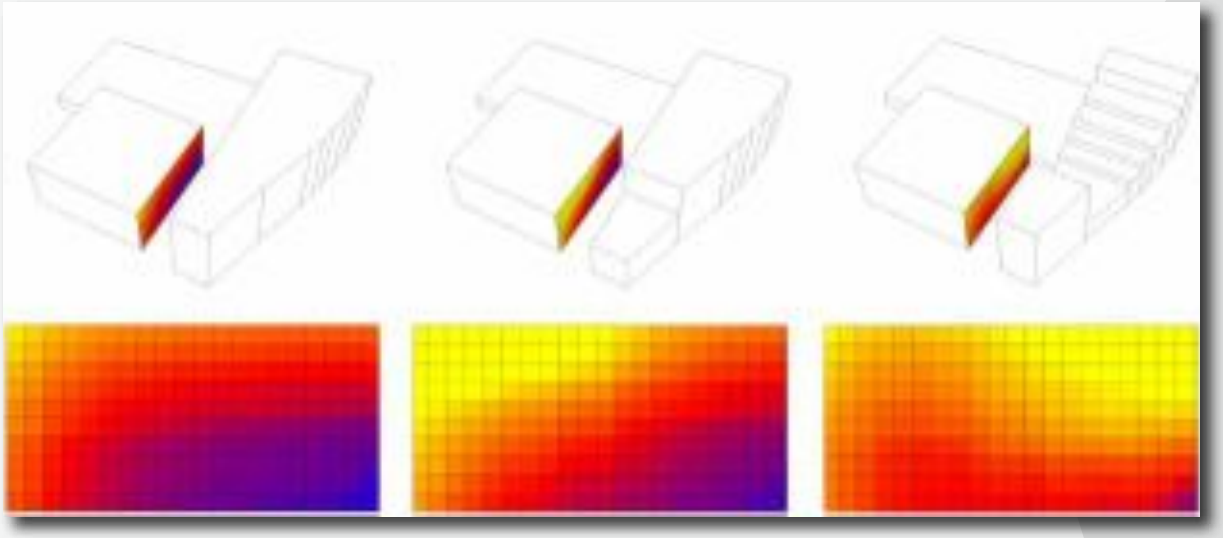
WHY IS THIS IMPORTANT?

"IT CAN GO WRONG"



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WHY IS THIS IMPORTANT?

Energy consumption for heating in Ørestad High School has increased by 2-5 MWh per month

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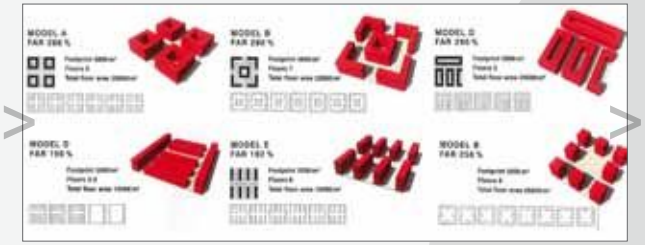
THE STRUCTURE OF A CITY

URBAN TYPOLOGIES

1. Density

>>

2. ypologies



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3. Fabric/Texture

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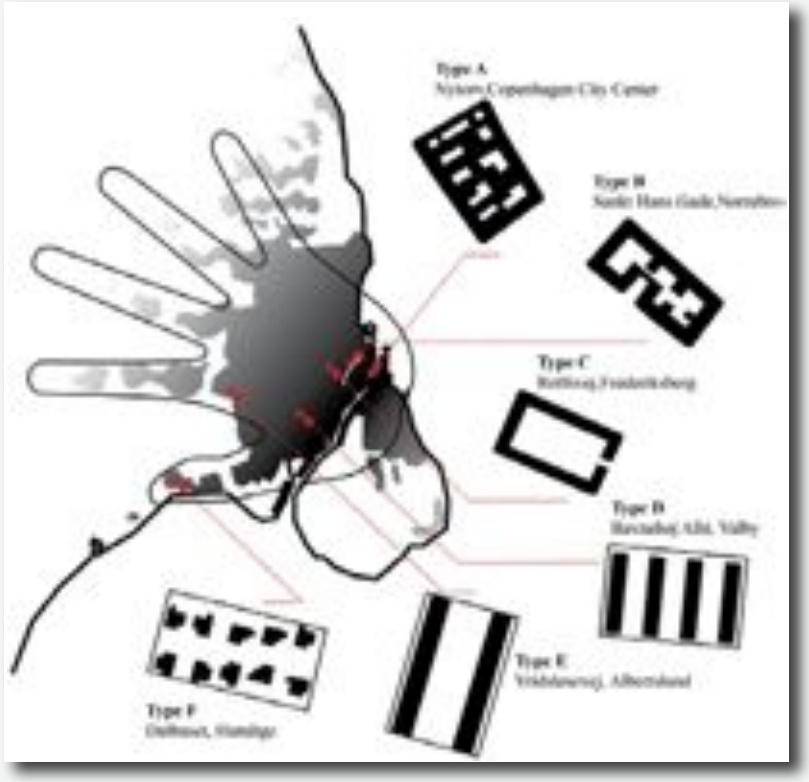
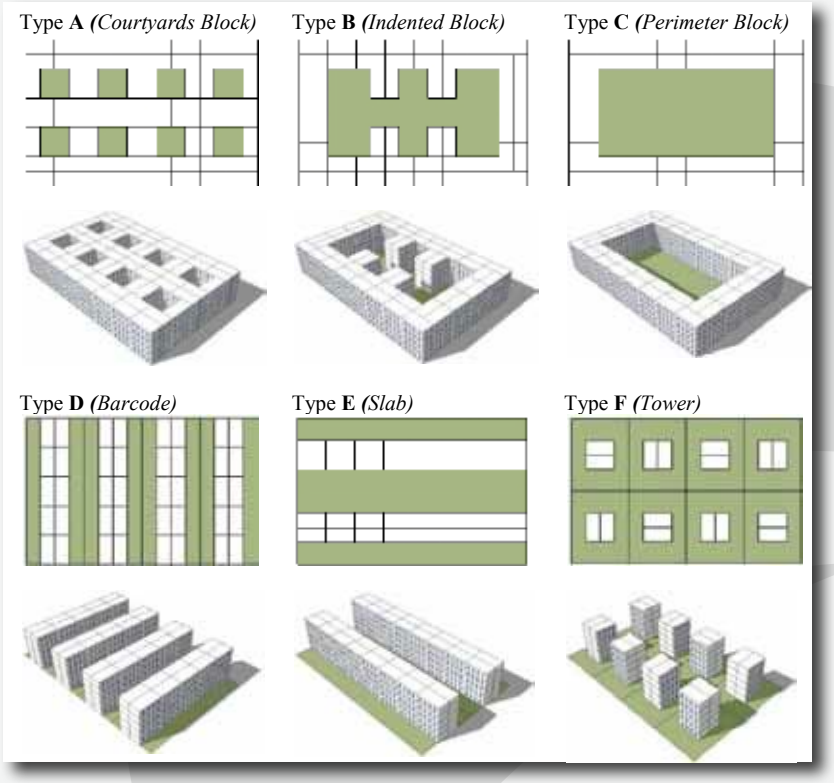
URBAN TYPOLOGIES

CASE STUDIES



Samples of urban patterns and their location in Copenhagen (“Finger plan”)



Six traditional urban building patterns

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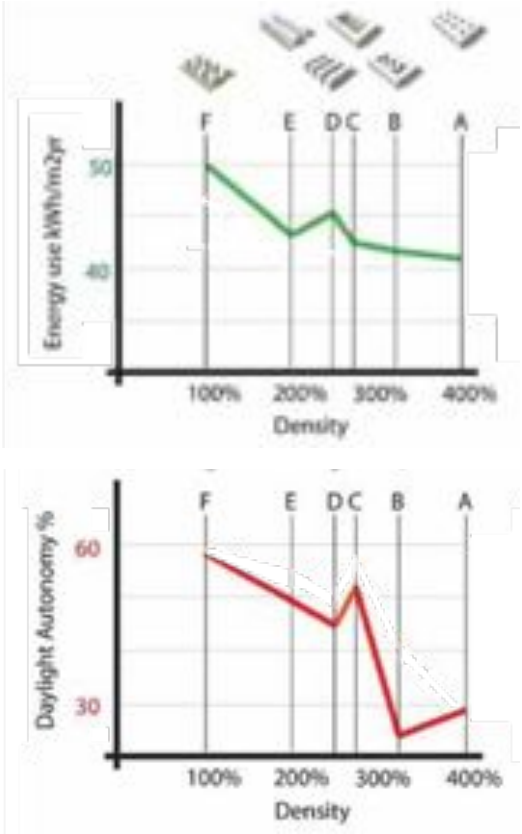
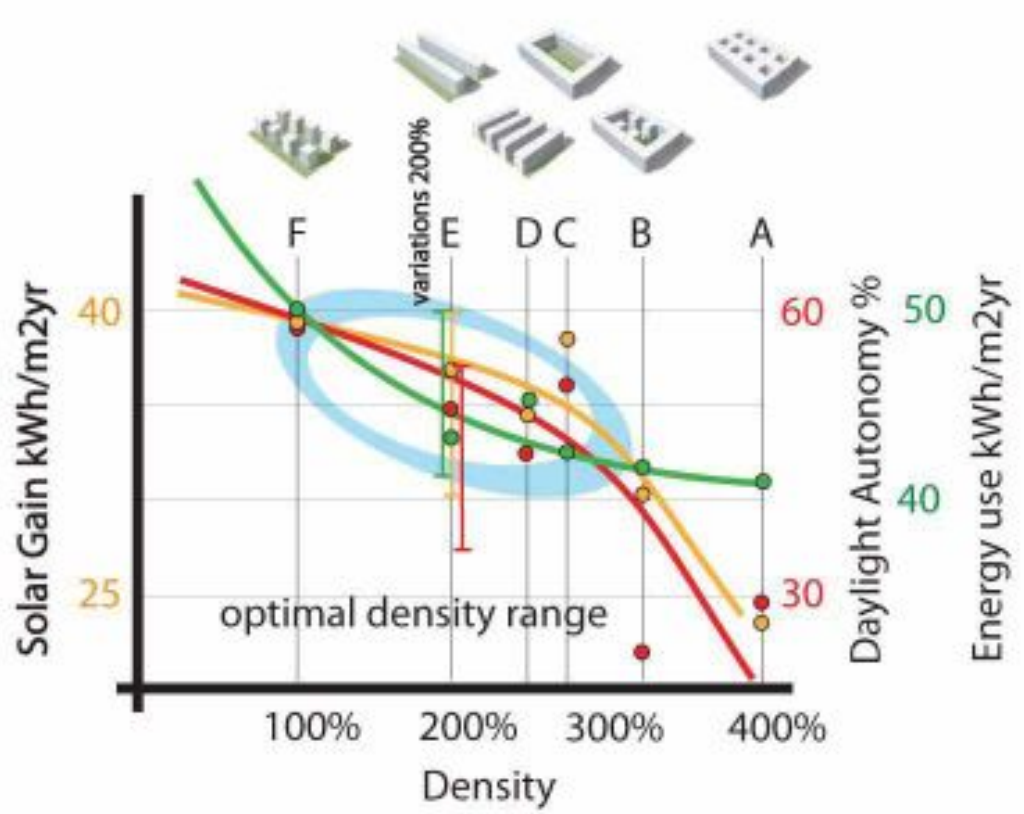
URBAN TYPOLOGIES

CASE STUDIES





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URBAN TYPOLOGIES

CASE STUDIES

KING ABDULLAH FINANCIAL DISTRICT

Project facts:

Location:	Riyadh, Saudi Arabia
Client:	Capital Market Authority and Public Pensions Agency
Gross floor area:	3,500,000 m^2
Year of design:	2010

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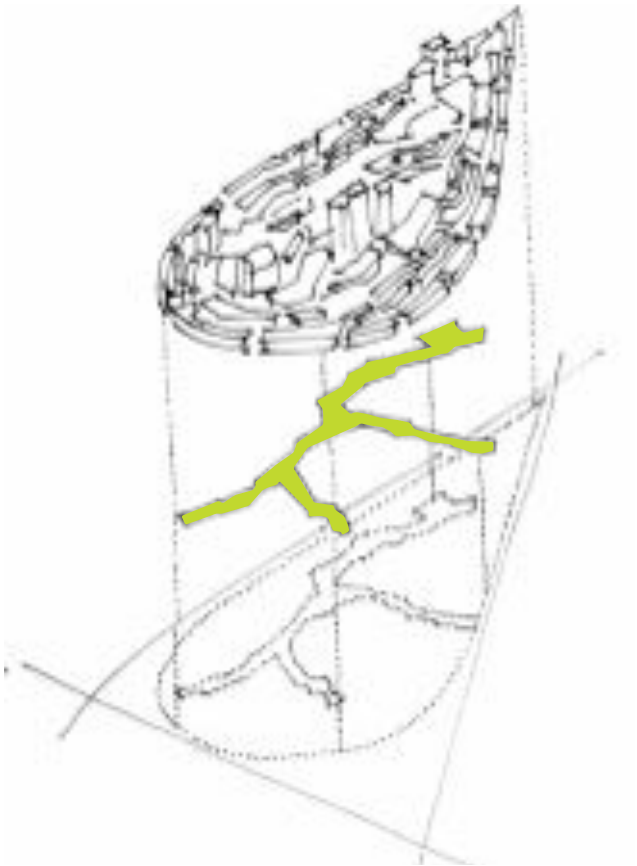
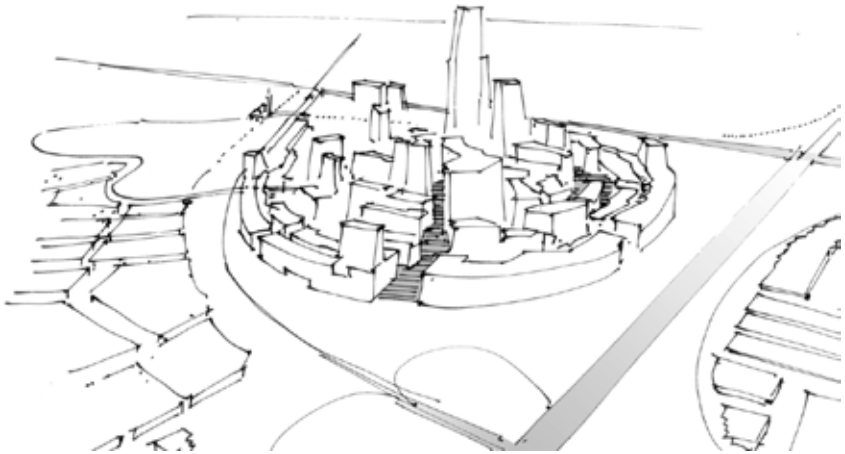
URBAN TYPOLOGIES

CASE STUDIES





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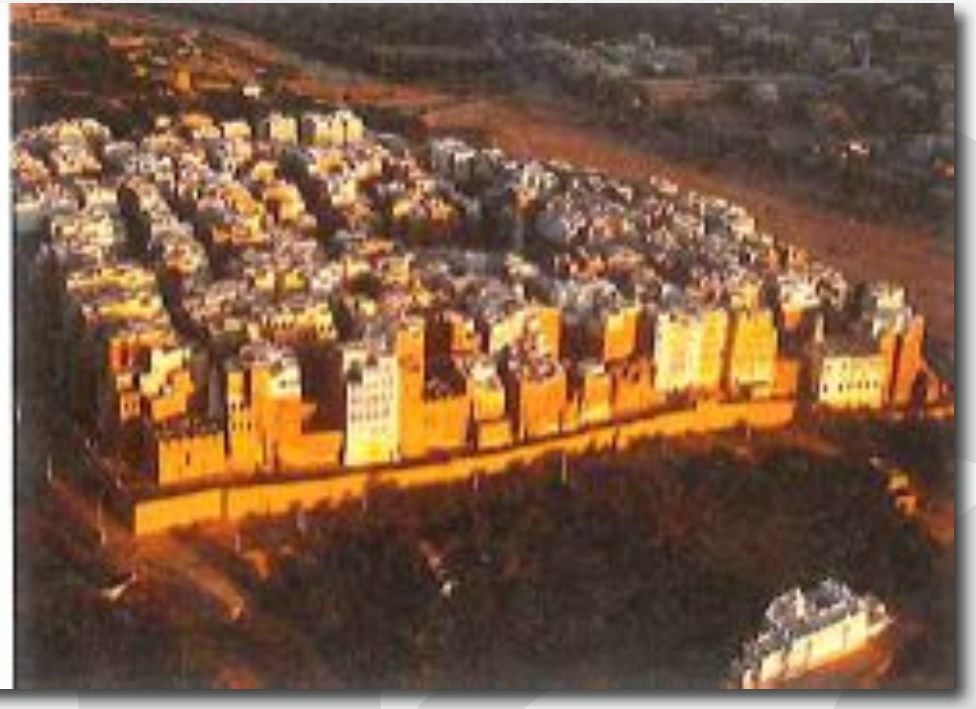
URBAN TYPOLOGIES

CASE STUDIES



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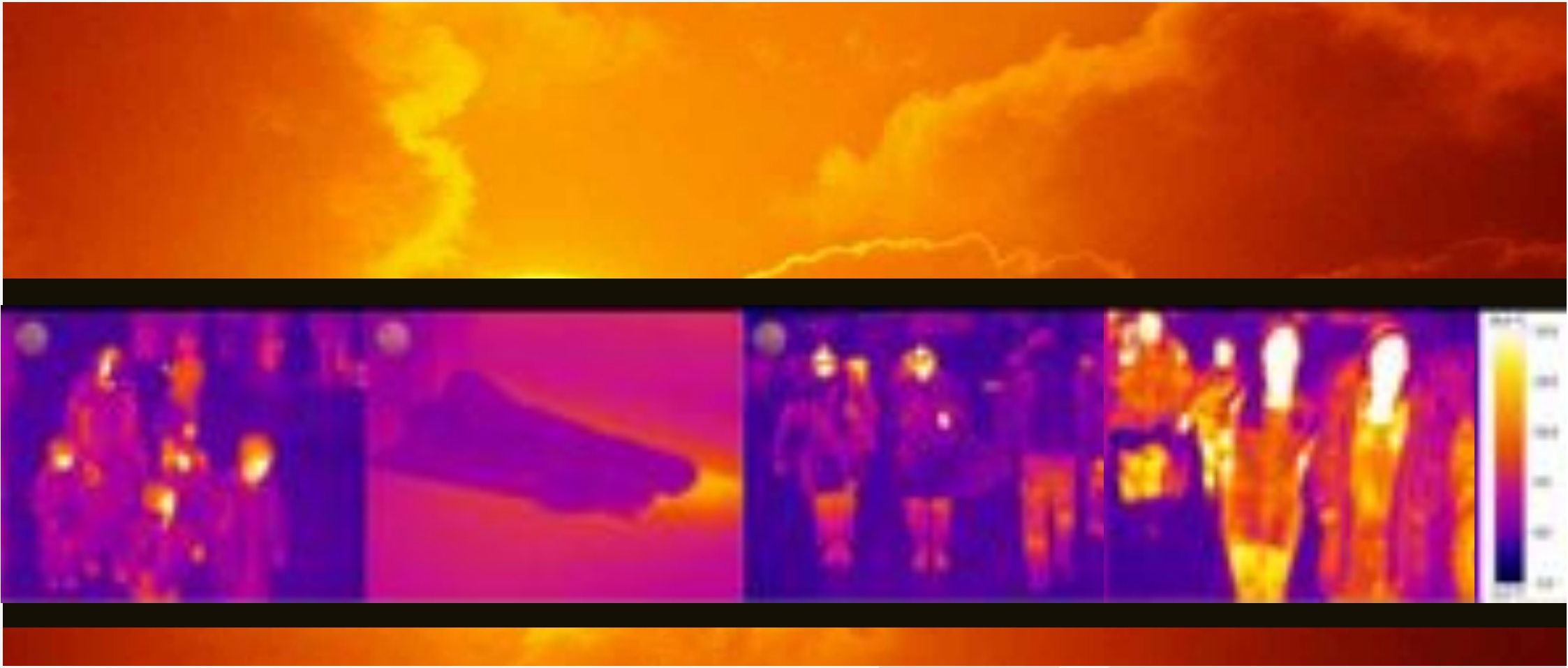
URBAN TYPOLOGIES

CASE STUDIES



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URBAN TYPOLOGIES

CASE STUDIES

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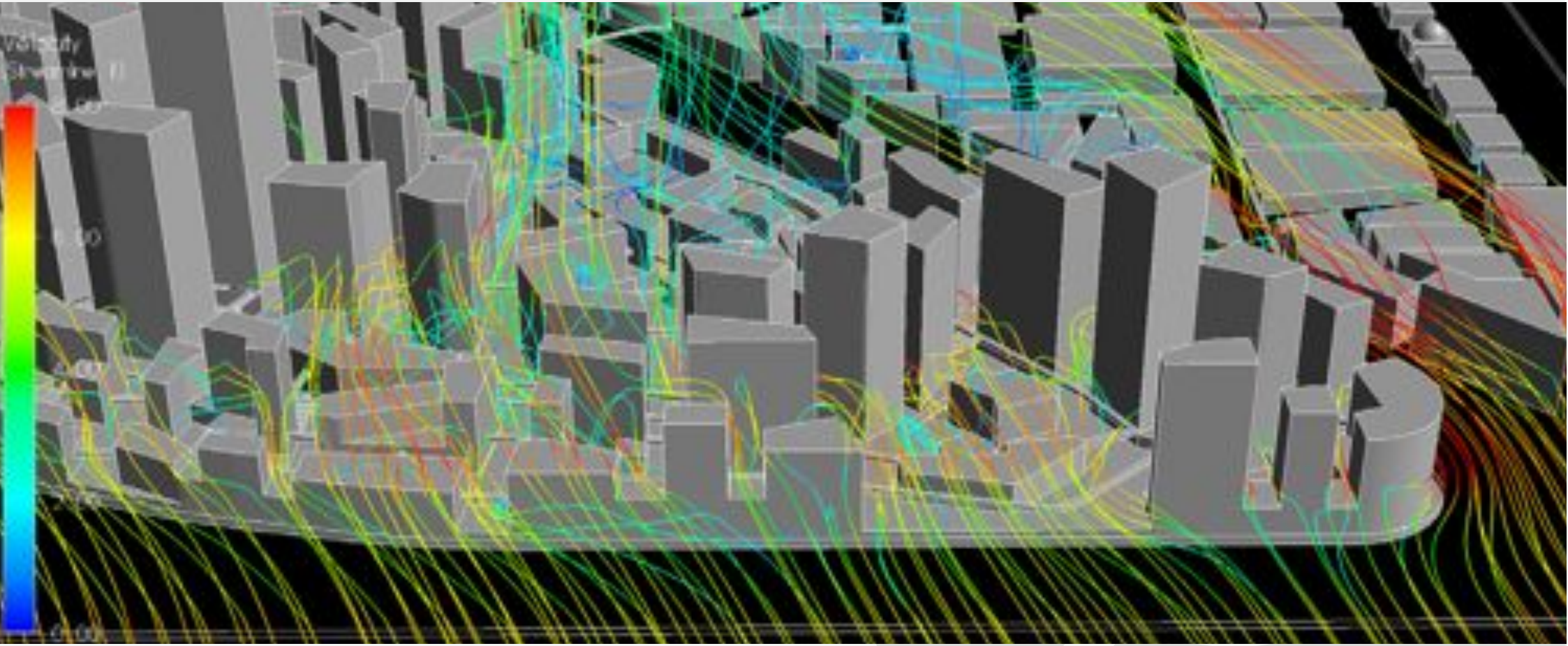
URBAN TYPOLOGIES

CASE STUDIES



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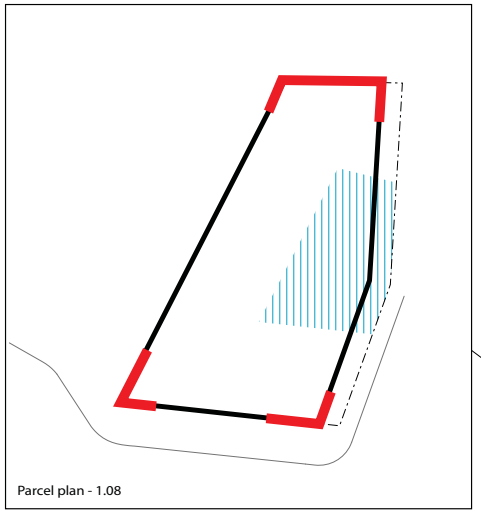
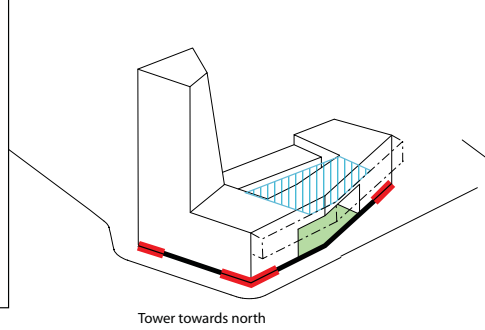
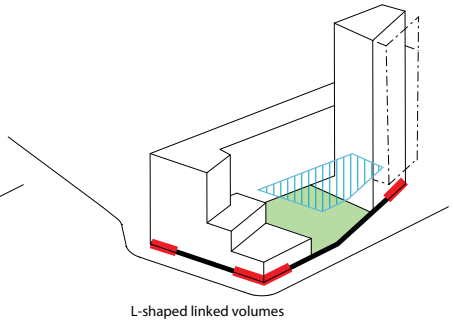
URBAN TYPOLOGIES

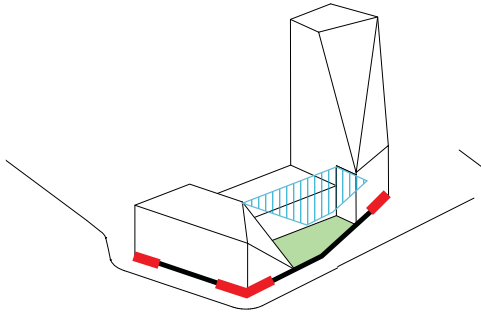
CASE STUDIES

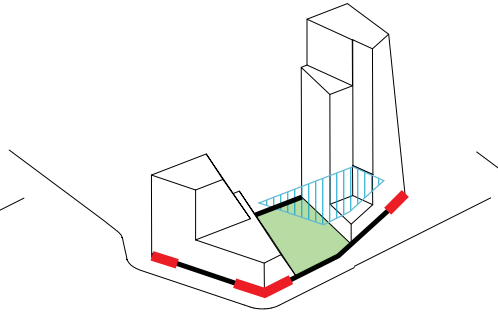


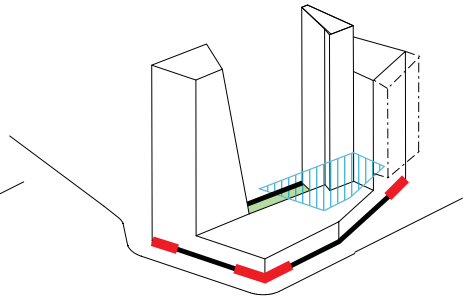
Regulation of building typologies…


Tower towards north


L-shaped linked volumes


Tower towards north


Two buildings


Two towers

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URBAN TYPOLOGIES

CASE STUDIES

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URBAN TYPOLOGIES

CASE STUDIES

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URBAN TYPOLOGIES

SCIENTIFIC WORK

Lessons to be learned

1.Use BIM the imagine and plan the city in 3D.

2.And use all your senses when you do it.

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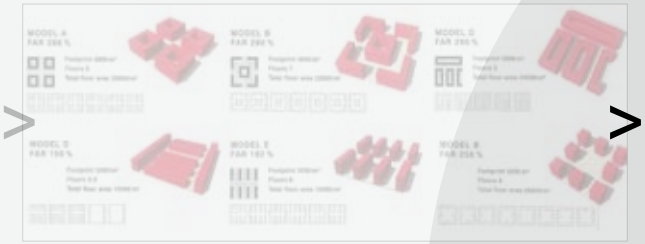
THE STRUCTURE OF A CITY

URBAN TEXTURE

1. Density

>>

2. Typologies



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3. Texture

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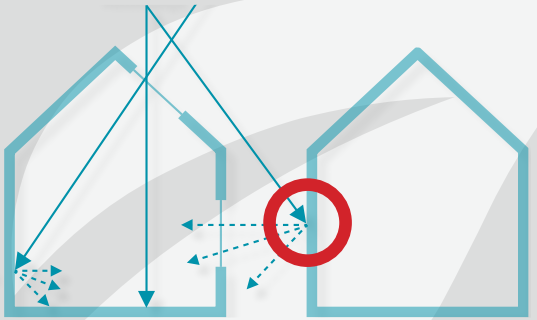
URBAN TEXTURE

SCIENTIFIC WORK

LaSalle Street Canyon. Façade reflectance approximately equal to 15–25%.

Wall Street Canyon. Façade reflectance approximately equal to 45–55%.



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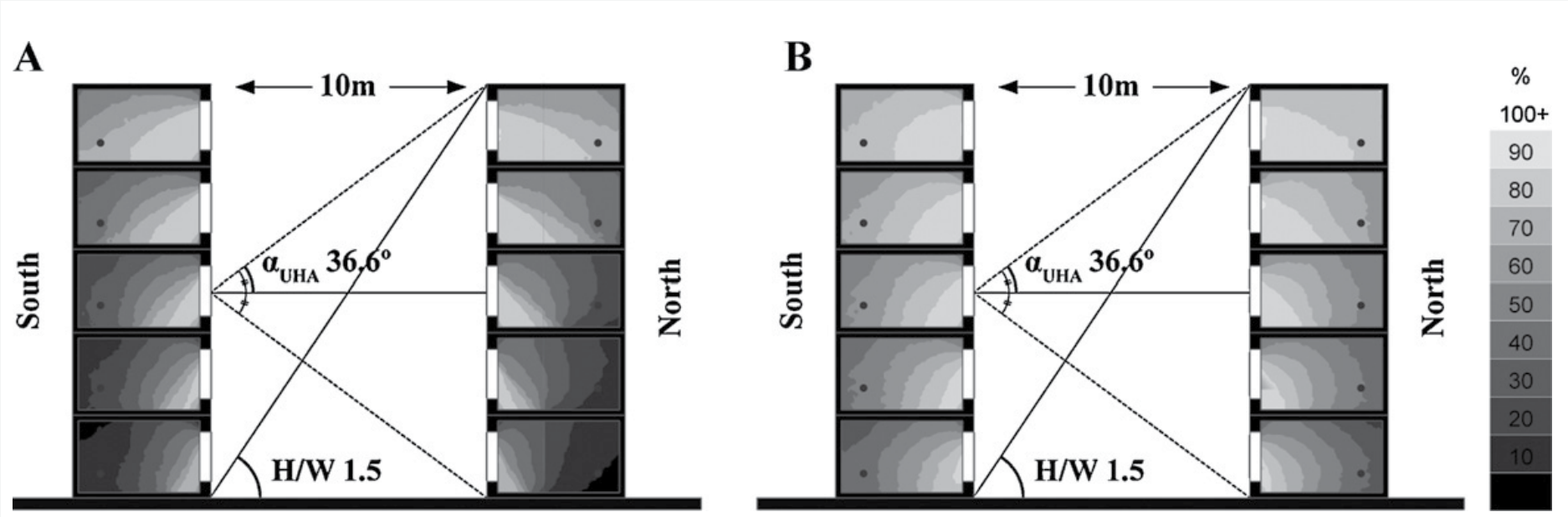
URBAN TEXTURE

SCIENTIFIC WORK



Black fiber-cement board, reflec. 15%

Yellow bricks, reflec. 45%

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URBAN TEXTURE

CASE STUDIES

CARLSBERG CITY DISTRICT

Project facts:

Location:	Copenhagen, Denmark
Client:	Carlsberg Properties
Gross floor area:	80,000 m2
Year of design:	2011
Architect team:	Henning Larsen Architects, Dorte Mandrup Architects, Polyform Architects and Signal Architects.

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URBAN TEXTURE

CASE STUDIES

- *Existing buildings*
- *Towers*
- *Masterplan*
- *Project area*

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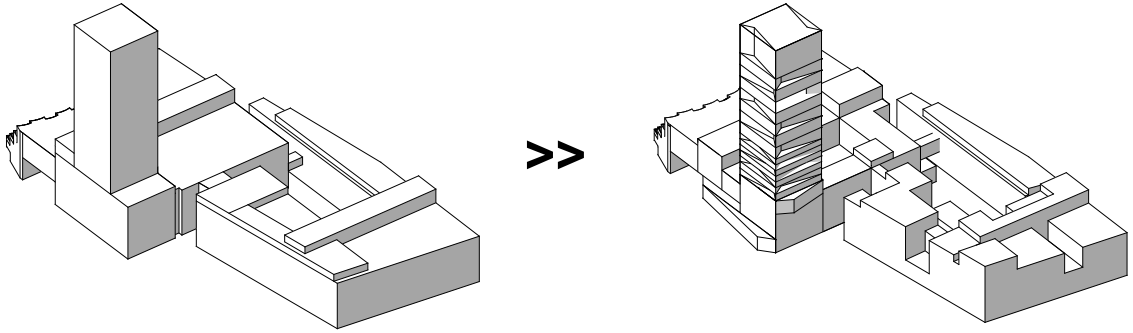
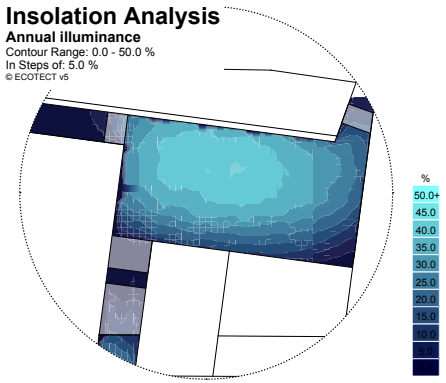
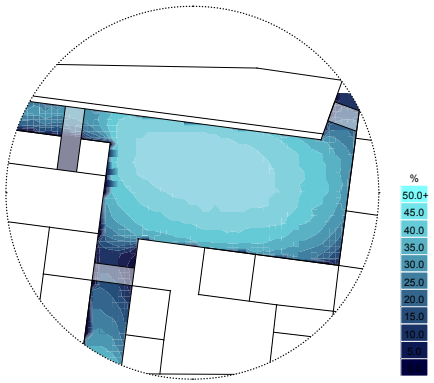
CASE STUDIES





Daylight Autonomy = 24 %

DA > 10.000lux,



Daylight Autonomy = 36 %

By optimizing the geometry and the façade's reflectanc-es, we can improve the avail-able daylight (DA) on the square by 12%

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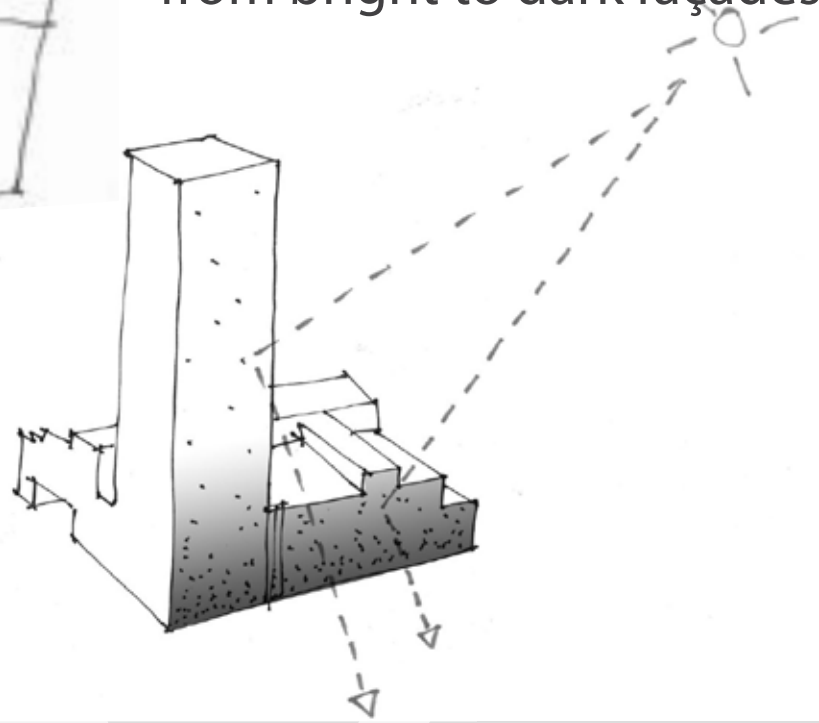
URBAN TEXTURE

CASE STUDIES

Select a number of "active" façades

Create a vertical differentiation – from bright to dark façades upwards



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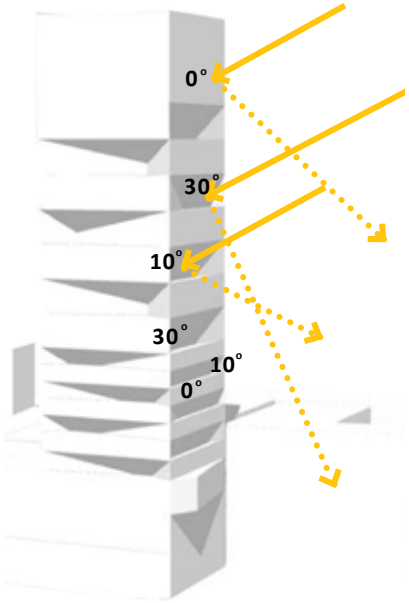
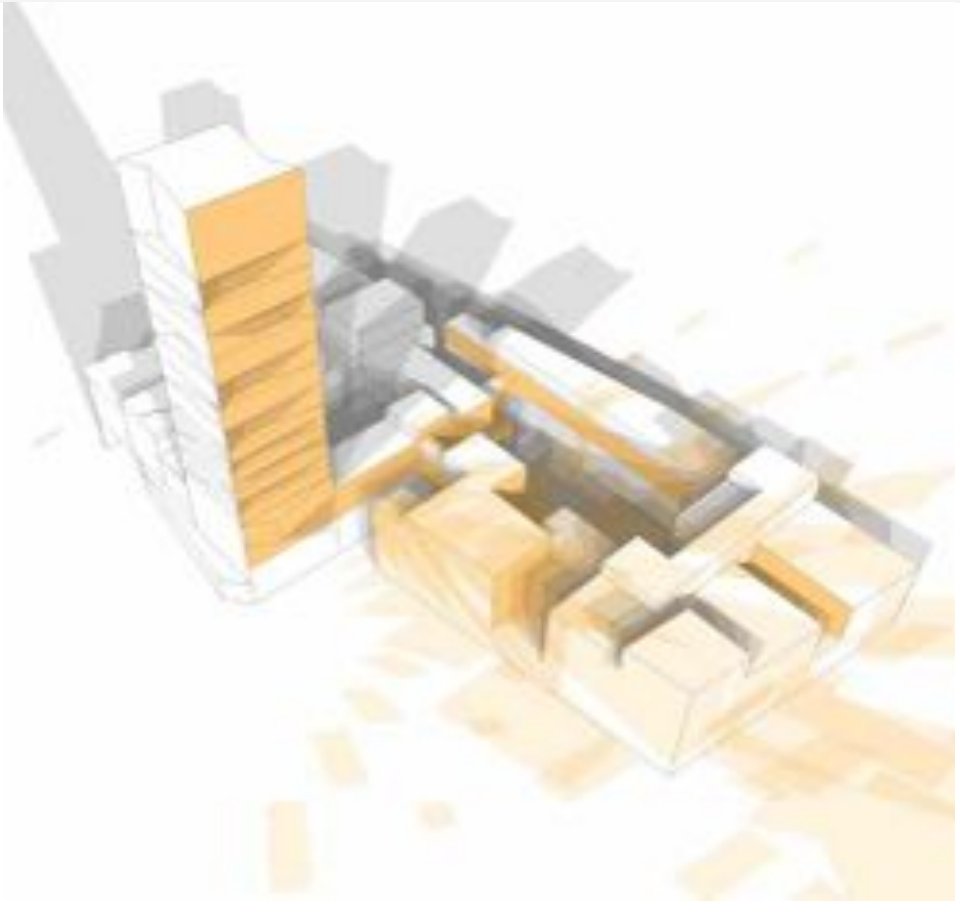
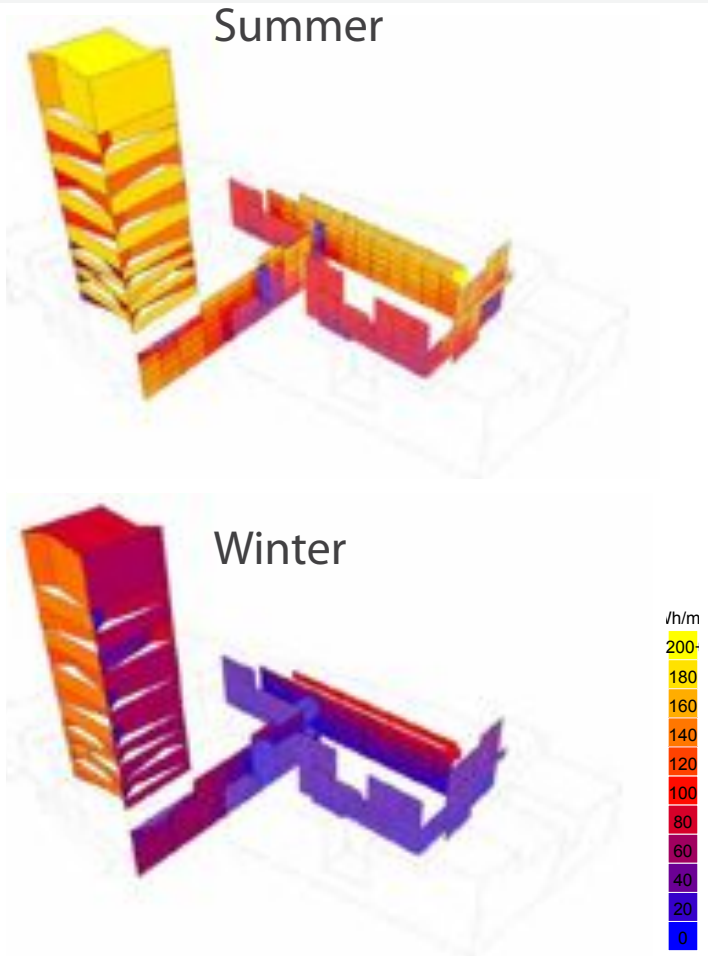
CASE STUDIES







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URBAN TEXTURE

CASE STUDIES

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HENNINGLARSENARCHITECTS

URBAN TEXTURE

Lessons to be learned

1.Don´t privatise the daylight.

2. Share and protect it - and we will get more out of it...

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DISCUSSION

SUM-UP

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HENNINGLARSENARCHITECTS

SUM-UP

Simulation and tools

Sketch design

Detailed design

Architects
- Intuition

Engineers
- Analysis

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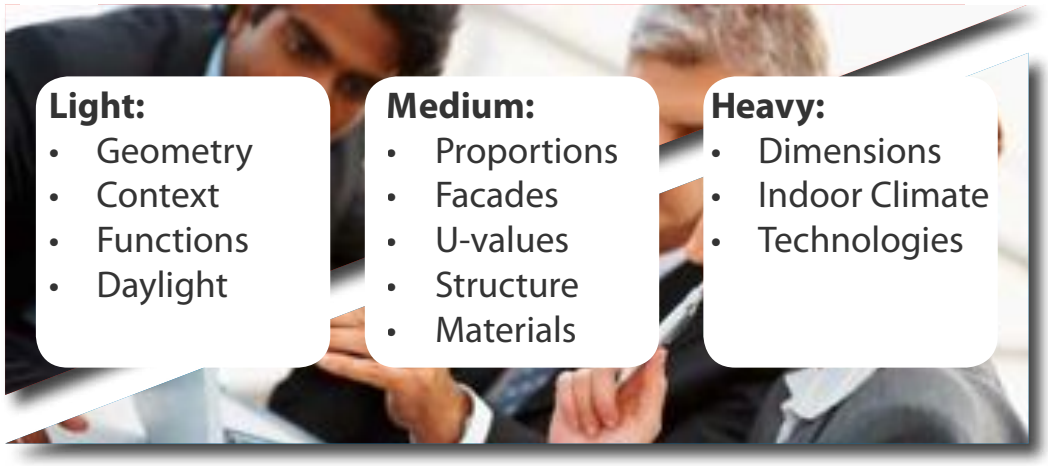
SUM-UP

Simulation and tools

Sketch design → **Detailed design**

Architects
- Intuition



Engineers
- Analysis

- **A+E:3D**
- **iDbuild**

- **ECODESIGNER**
- **Ecotect**
- **BE10**

- **BSIM**
- **LCA/LCC**
- **DAYSIM**
- **IES-VE**
- **ENERGY-PLUS**

SUM-UP

Tendensies in sustainability...

- Materials; changeability and health
- Master planning; Structure and daylight
- Value chain; business cases

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SUM-UP

Sustainability...

- ...is the largest breakthrough since modernism.
- ...changes the concept of beauty.
- ...must be incorporated in the aesthetic design solutions.
- ...should create a social change.

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THANK YOU...

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HENNINGLARSENARCHITECTS