HENNINGLARSENARCHITECTS

Design with knowledge
PEDCO High performance Buildings

Jakob Strømann-Andersen
Head of Sustainability Engineering at Henning Larsen Architects
06.10.2016

Agenda

Introduction

Part 1: Foundation

The Danish way

Research, knowledge and design

Results: 2 cases

Part 2: Perspectives

Cincinnati – applying knowledge in an US context

“High performance building is about finding new solutions to known problems

Henning Larsen

Henning Larsen (1925-2013) established the company in 1959 after a study trip to the United States.

He was often described as a “the master of light”.

From 1968 to 1995, he was a professor at the Royal Danish Academy of Fine Arts, School of Architecture in Copenhagen.

Introduction

Office

Henning Larsen Architects has more than 300 employees from 34 different nations.

We have offices I Denmark, The Faroe Islands, Norway, Germany, Saudi Arabia and Hong Kong.

Introduction

International profile

- Offices
- Ongoing and built projects

R&D

/ 17 engineers, PhDs and architects
/ research and development
/ knowledge implemented in the early design stages
/ sustainable design

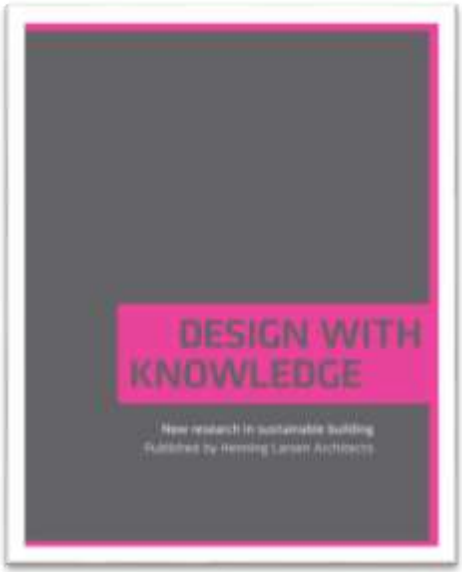
Intelligent solutions are created in cross-disciplinary collaborations

Introduction

We do...

Research & development

Design method & process



Projects

Introduction

Research areas

R&D

RESEARCH

- Artificial light & Daylight — Ph.d
- Materials — Database
- Microclimate — Ph.d
- Energy design — Ph.d
- Facade design — Ph.d

Herlev Hospital
Daylight that strengthen health

Nordea HQ
Materials that fulfill Leed environmental and health requirements

King Abdullah Financial District
Planning that cools

SDU Kolding Campus
Innovative ventilation that creates a good indoor climate

Nordea HQ
Innovative boxfacade that optimizes daylight

DEVELOPMENT

- Build
- Non-Build

The Adaptable House
Adaptability that creates a long livespan

AER App
Renovation strategies right by your side

Industrial PhDs

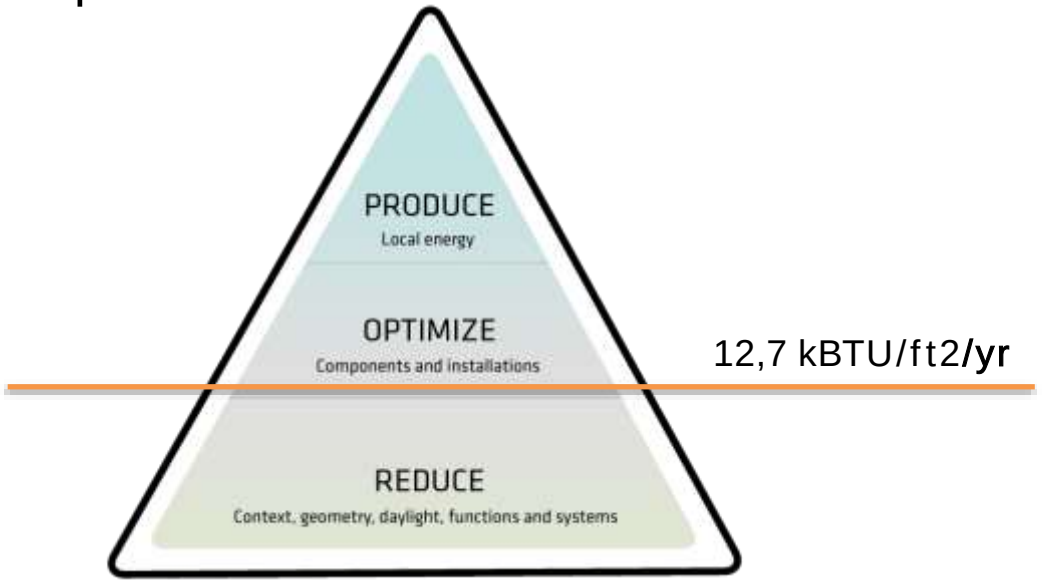
Introduction

Why I do, what I do

To me, the most important thing is

/the importance of daylight in architecture
/architecture as a key to achieve net-zero buildings
/meaningful aesthetics

Our research shows that between 40-50% of a building's energy consumption is determined by its design



REDUCE

Context
Wind, water, daylight, noise and pollution

Body
Geometry, orientation, zones and daylight

Structure
Space, daylight, main functions, zones and construction

Facade
Daylight, technology, indoor climate and user behavior

Introduction

The importance of architecture in the green transition

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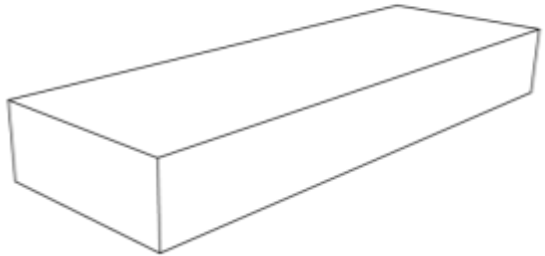
The importance of architecture in the green transition



1. REFERENCE
» 95 kWh/m²/year

1. REDUCE
» 62,9 kWh/m²/year

2. OPTIMIZE
» 48,6 kWh/m²/year

3. PRODUCE
» Determined by products

30 kBTU/ft2/yr

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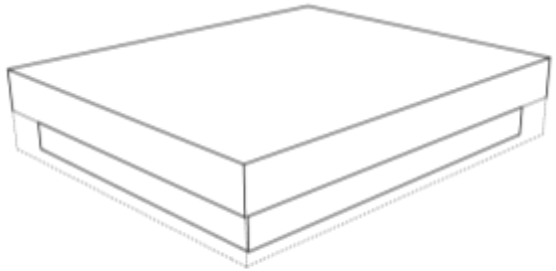
The importance of architecture in the green transition



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20 kBTU/ft2**/yr**

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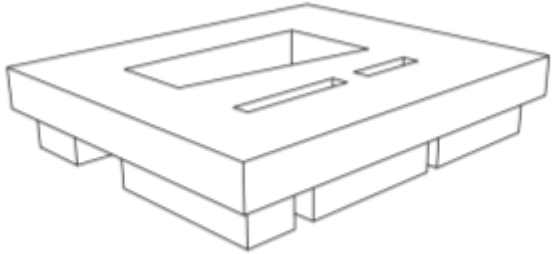

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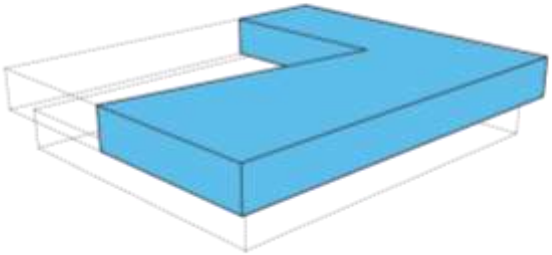

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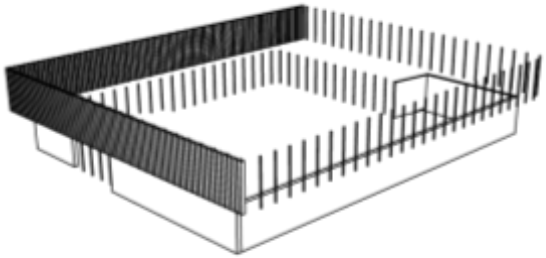

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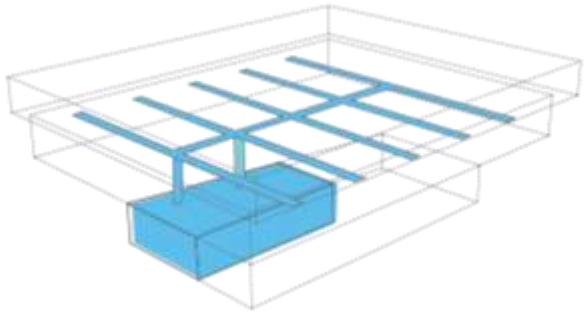

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15 kBTU/ft2/yr

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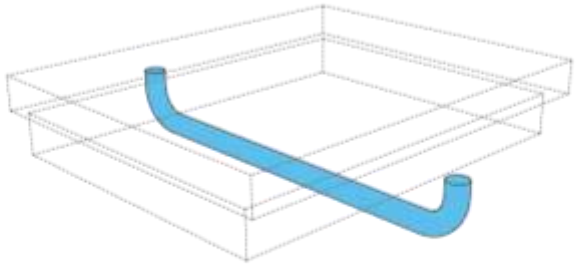

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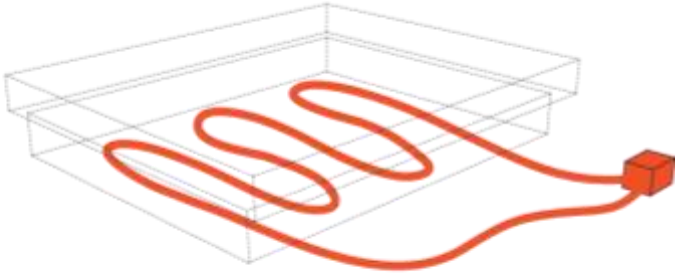

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Net-zero

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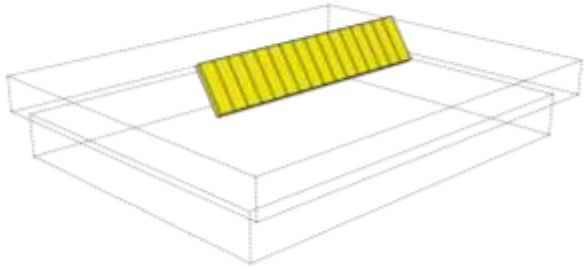

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Net-zero

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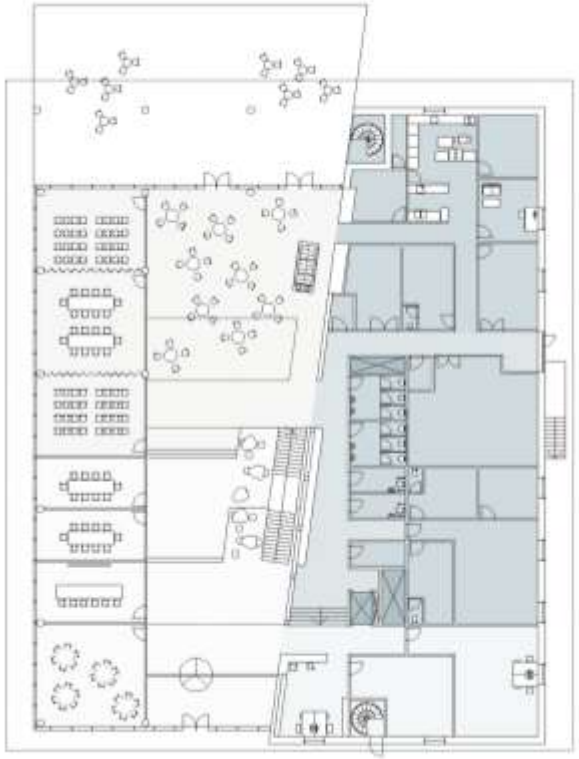


Introduction

The importance of architecture in the green transition

HENNING LARSEN ARCHITECTS

> Beautiful things becomes more beautiful when given meaning and serving a purpose

PART 1
The foundation

“

The Scandinavian way of life is deeply embedded in our approach to the sustainable city and our philosophy about the importance of sustainability

“

But it does not happen by itself. It is a result of political commitment and strategy

We swim in the harbour

From sewer to harbour bath

- Municipal strategies and investments in cleaning the harbor has resulted in a Copenhagen being the first capital in world having a harbour bath in an old industrial harbour

The Municipality of Copenhagen

We sunbath in the cemetery

HENNINGLARSENARCHITECTS

HENNINGLARSENARCHITECTS

Maximum 15 min. walking distance to a green area

- In spite of an increasing population, the Municipality of Copenhagen is determined not to reduce the average green area per citizen

The Municipality of Copenhagen


We bike everywhere

...regardless of the weather

...and family members

Bicycles plays a crucial part in goal of making Copenhagen CO2 neutral in 2025

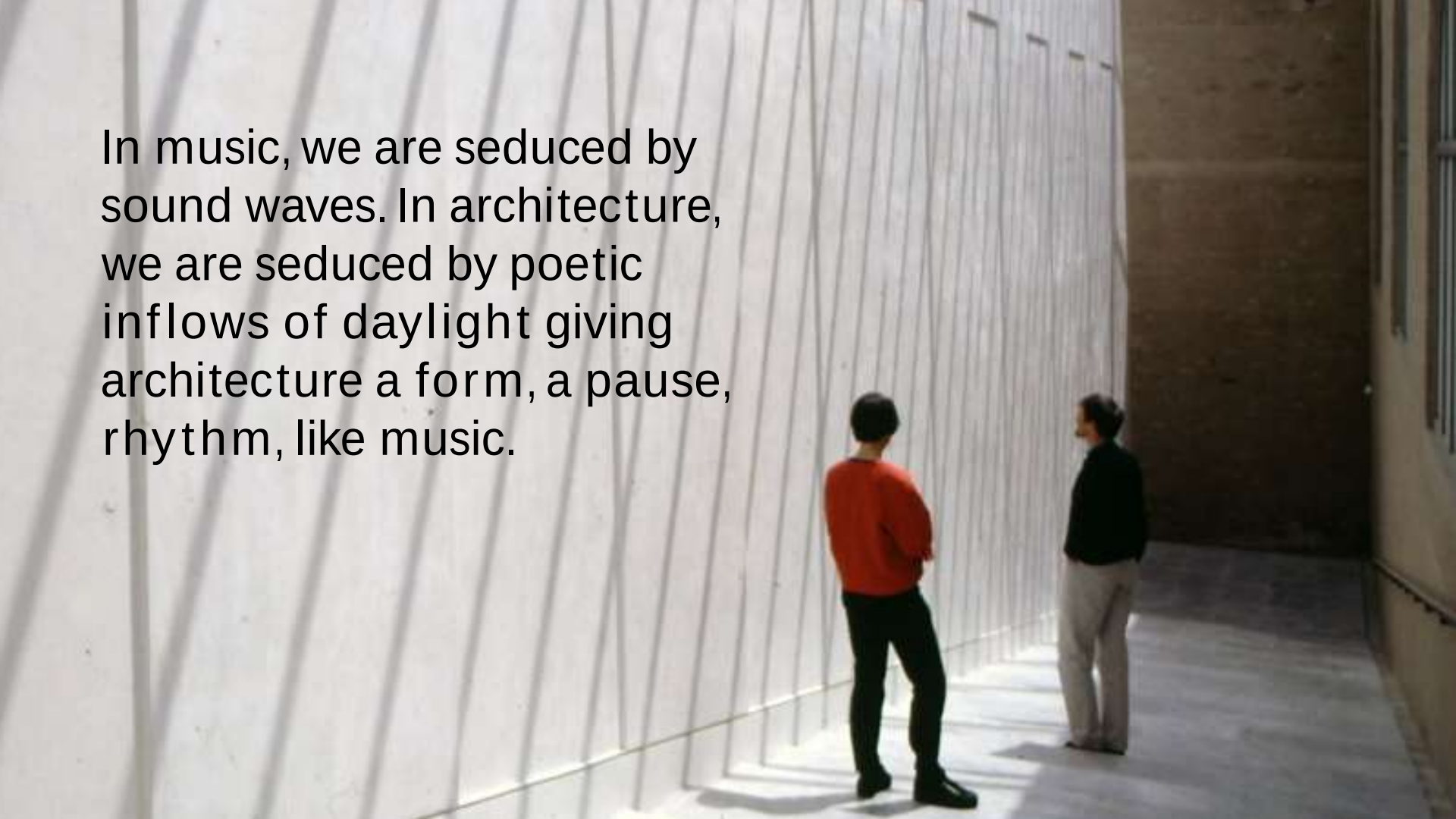
- Bicycle makes up 36 % of all transportation to work and education in Copenhagen = 0 CO2 emission.

- The goal is to increase this number by 14% to 50 by improving the bicycle conditions (wider bike paths, increased maintenance, short cuts, safety)

The Municipality of Copenhagen

We live in a country where it is cloudy 80% of the time...

...which is why we worship daylight


In music, we are seduced by sound waves. In architecture, we are seduced by poetic inflows of daylight giving architecture a form, a pause, rhythm, like music.

Introduction

The importance of daylight

Daylight connects the spatial experience of architecture with electricity meters

The hospitalisation of patients is reduced by 7.3 hours each time the daylight increases by 100 lux

Jorder et al. (2013)

Students achieve 5-14% higher score in the tests and learn 20-26% faster in rooms with good daylight

World Green Building Council, 2013

> We approach academic research as a way of engaging in society and the public debate

How does the generated knowledge inform the design development and the projects?

CASE 1
When spaces for learning go hand in hand with low energy

University of Southern Denmark Campus Kolding

Kolding, Denmark / 2014

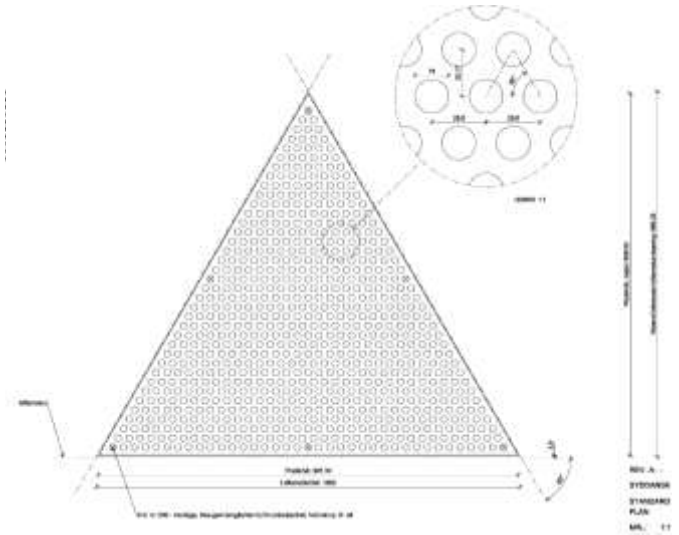

Denmark's first net-zero university

CASE 1 - SDU
Organisation

Common Zone
Service Areas
Classrooms
Offices
Terraces

CASE 1 - SDU

Ventilation integrated in ceiling



Innovative ventilation

CASE 1 - SDU

Daylight infused workspaces

CASE 1 - SDU
Daylight infused workspaces

DAYLIGHT – Group work

CASE 1 - SDU
Daylight infused workspaces

CASE 1 - SDU

Daylight infused workspaces

DAYLIGHT – Study room


DAYLIGHT – Outside

CASE 1 - SDU
Dynamic facade

1600 mobile triangular perforated glass elements mechanically regulates the inflow of light.

CASE 2
When shade is crucial for the architecture

King Abdullah Financial District

Riyadh, Saudi Arabia / 2008-2018

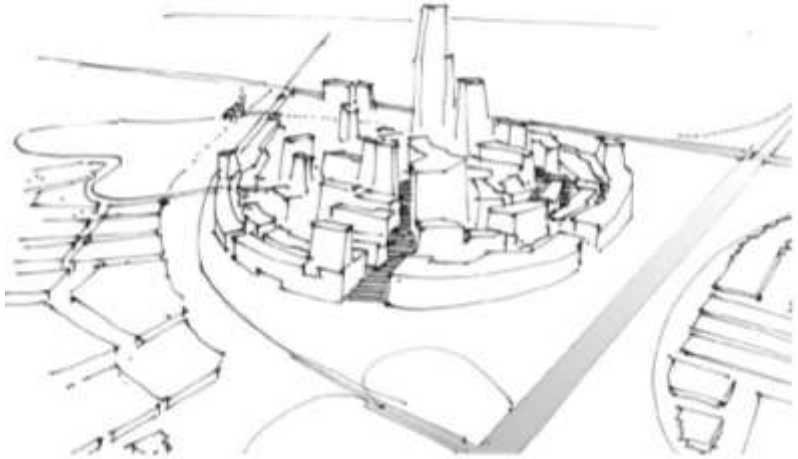
CASE 2 - KAFD

Shade has always been needed

CASE 2 - KAFD

Comfortable micro climate

Concept: Using the logic of the Wadi to create a comfortable microclimate and a vibrant city life

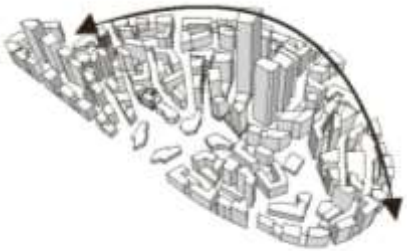



CASE 2 - KAFD
Location in the desert

CASE 2 - KAFD

Strategies

Land use



Microclimate

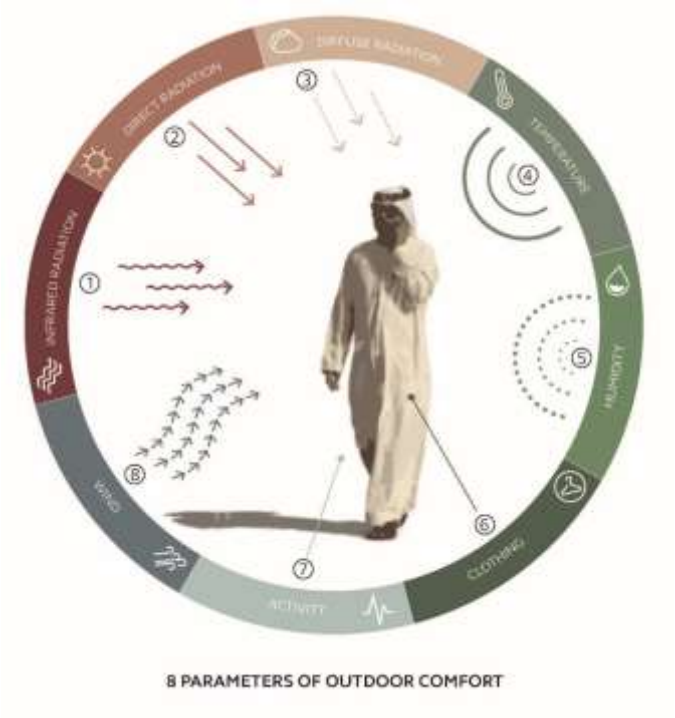
Density

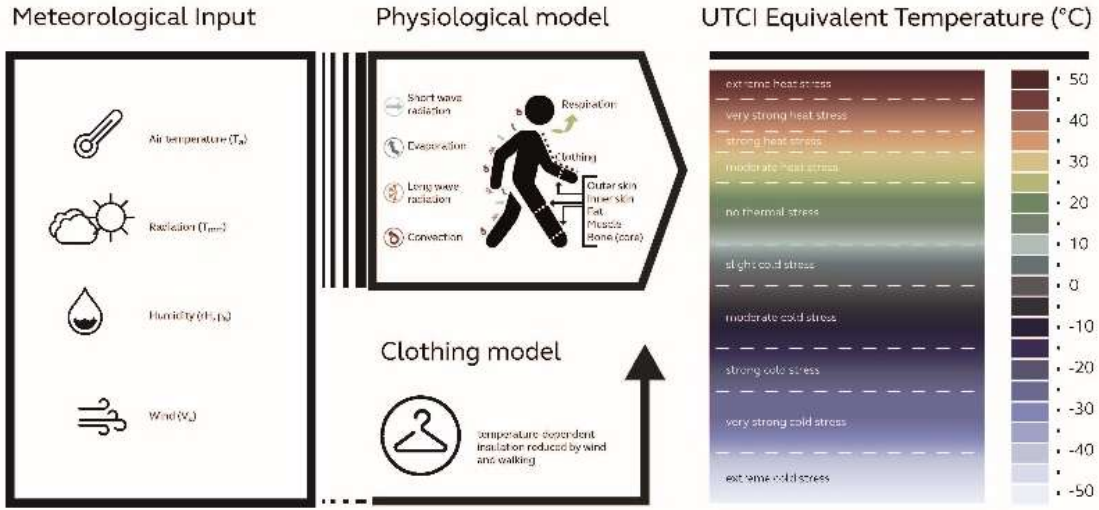
Daylight

Sustainable objective

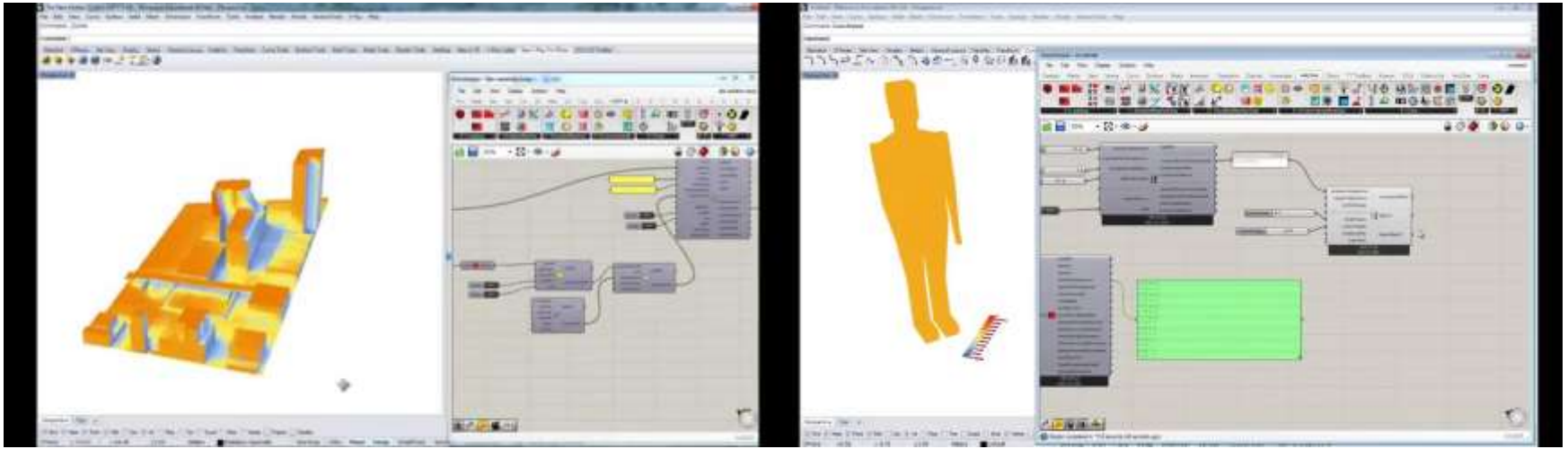
To improve the microclimate and lower the temperatures

Climatic parameters influencing the perceived temperature



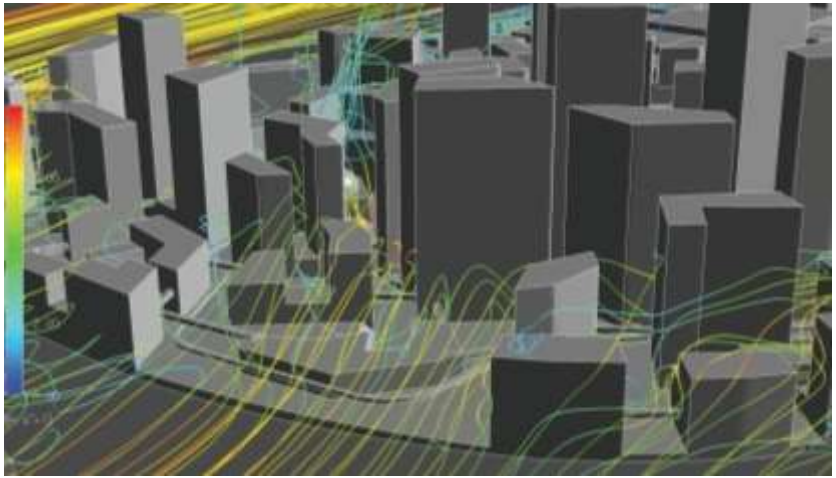


CASE 2 - KAFD
Comfort



CASE 2 - KAFD
Comfort

DESIGN



Studies of wind conditions can guide the design of the city, creating good and comfortable spaces

EVALUATION

CASE 2 - KAFD

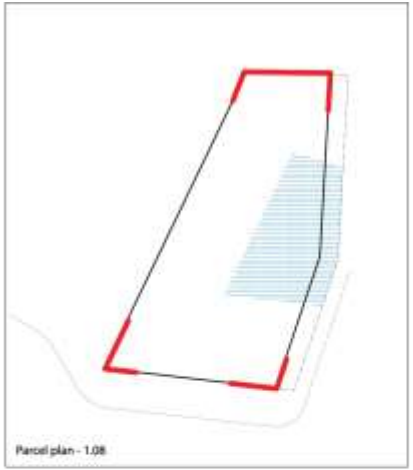
Cooler climate

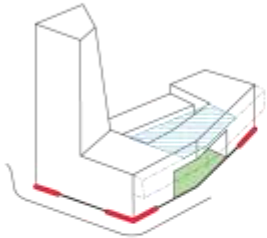
Microclimate and felt temperatures (UTCI physiological temperature)

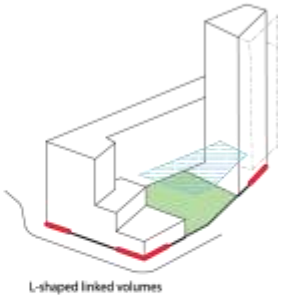
Microclimate and felt temperatures (UTCI physiological temperature)

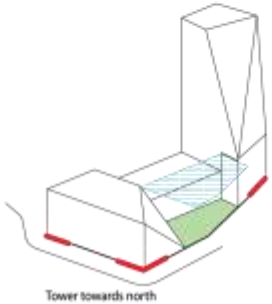
CASE 2 - KAFD

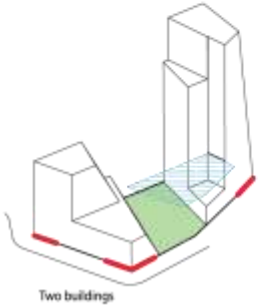
Cooler climate

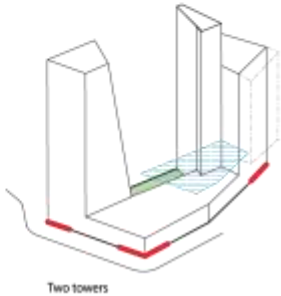












CASE 2 - KAFD

Cooler climate

CASE 2 - KAFD

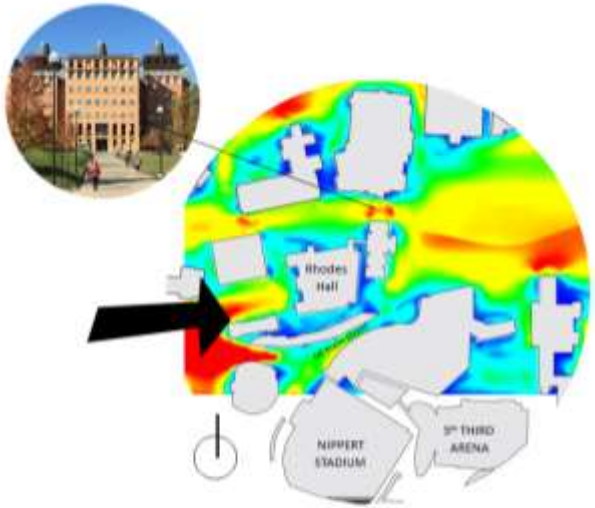
Cooler climate

PART 2
Perspectives

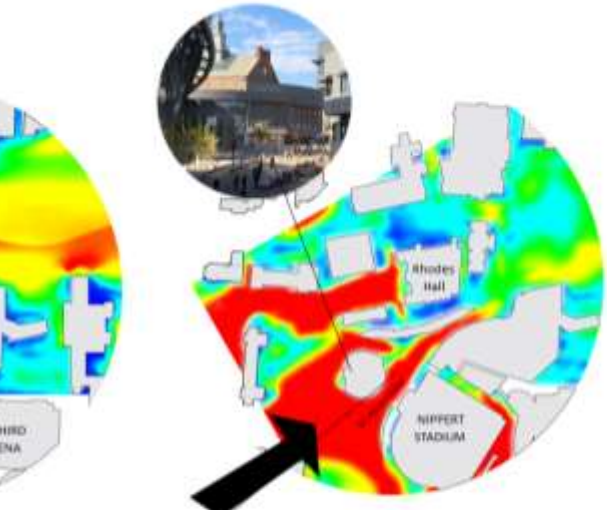
HENNINGLARSENARCHITECTS

CASE
University of Cincinnati
College of Business

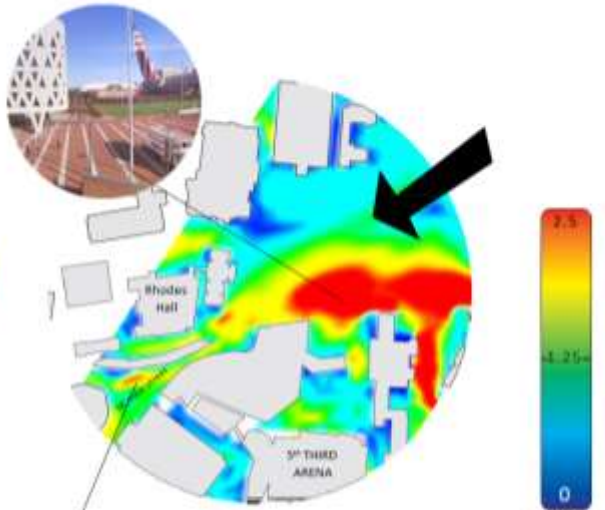
Site Area Windsimualtion



wind direction
WEST



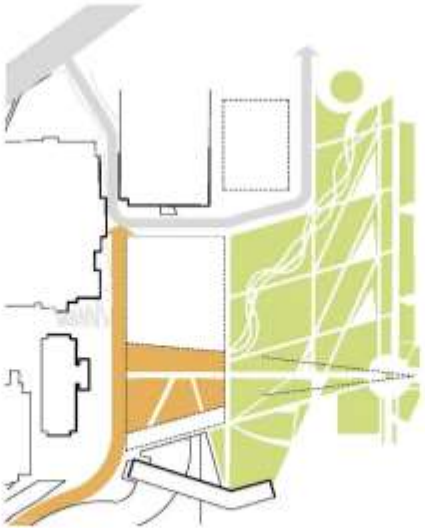
wind direction
W-SW (WEST-SOUTH-WEST)



wind direction
E-NE (EAST-NORTH EAST)

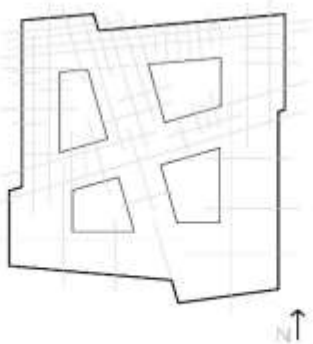
WIND analysis

Site of the College of Business

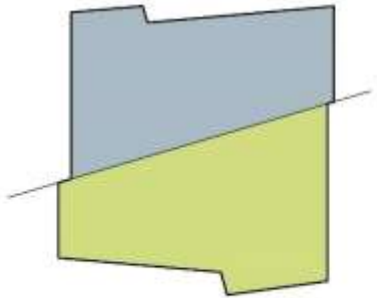


Separating pedestrian and car paths:
creating new Plaza and a drop-off area

Anchoring the College of Business into the site, using
the Force Fields from Hargreaves landscape to create
the building's main
grid and division

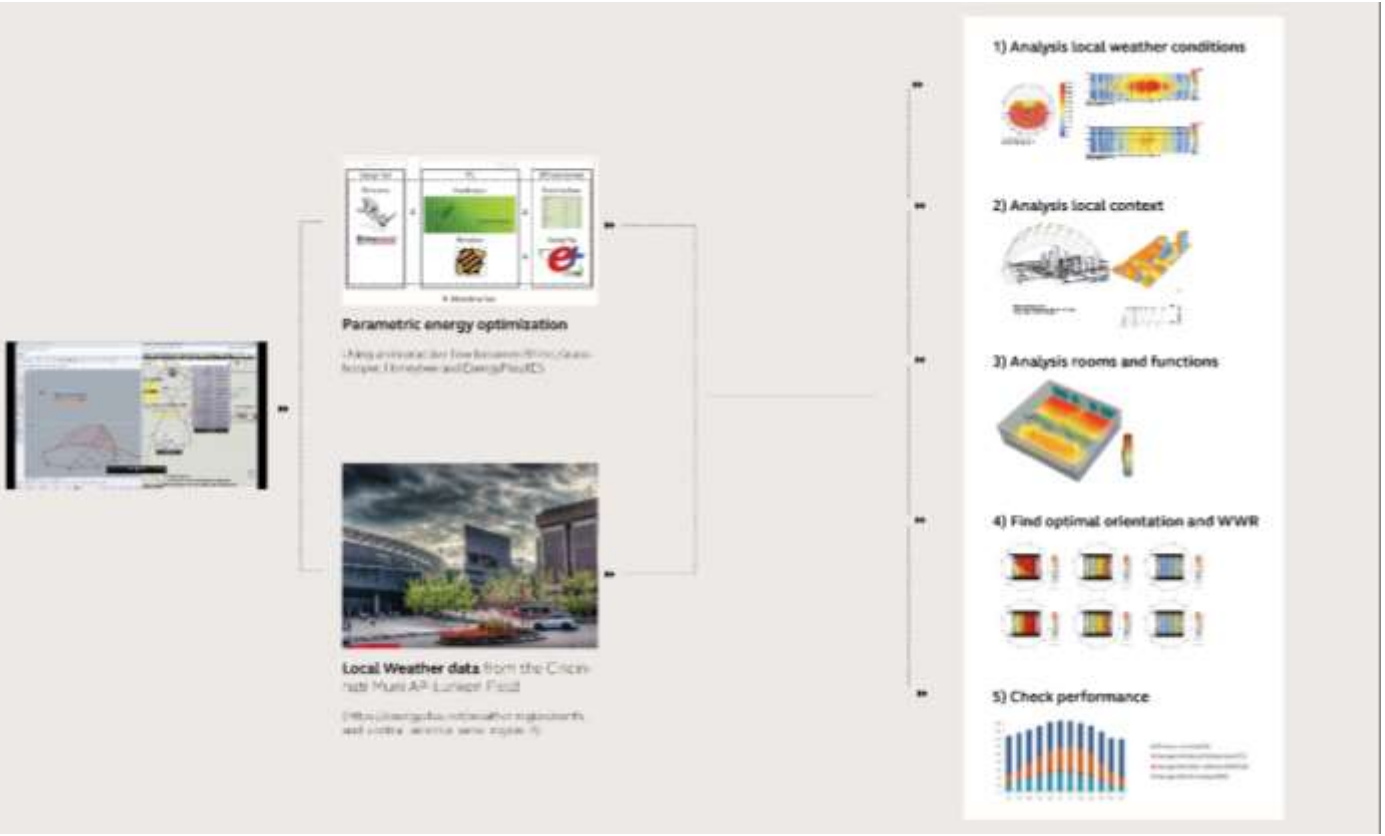


Larger program spaces are placed towards the south, smaller program spaces are placed towards the north



Size of the functions located in the building dictates the split into an area for offices and an area for instructional spaces

All offices and instructional spaces have access to natural daylight


Parametric energy optimization
Local Weather data from the Cincinnati Multi AP Lunker Field
1) Analysis local weather conditions
2) Analysis local context
3) Analysis rooms and functions
4) Find optimal orientation and WWR
5) Check performance

People

250 Btu/h per person

+

Equipment

853Btu/h per person

+

Lighting

4 Btu/(h,ft2)

+

Sun light

?

<

Cooling capacity

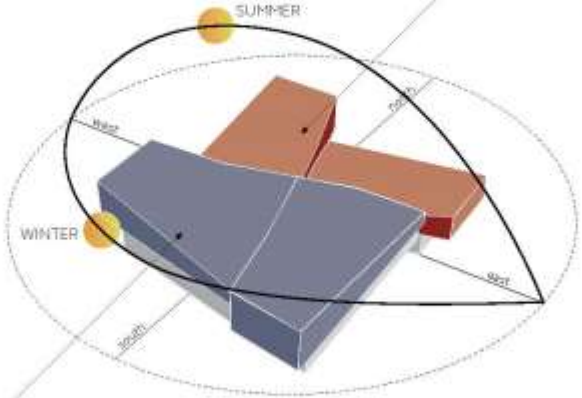
30 Btu/(h,ft2)

The performance and feasibility of utilizing active chilled beams in the proposed building design is dependent on meeting certain envelope transparency ranges.

PROGRAMMING AND ENERGY OPTIMISATION

OFFICE AREAS ARE PLACED NORTH
to avoid overheating, reduce cooling demand and utilize stable daylight

- office have high internal gains and thus high cooling demand
- by placing them north additional solar gains are being avoided
- lighting levels are optimum so lighting demand is also lower further reducing heat gains from lamps



CLASSROOMS ARE PLACED SOUTH

- classrooms can better deal with overheating due to the higher air exchange rates
- they are deeper thus they have less solar gains/energy per floor area
- % of area with high sun exposure is small due to the rooms' depth/size and can be controlled with shading devices

We can reduce annual solar gain cooling loads by approx.

70 %

by locating
the closed office towards north

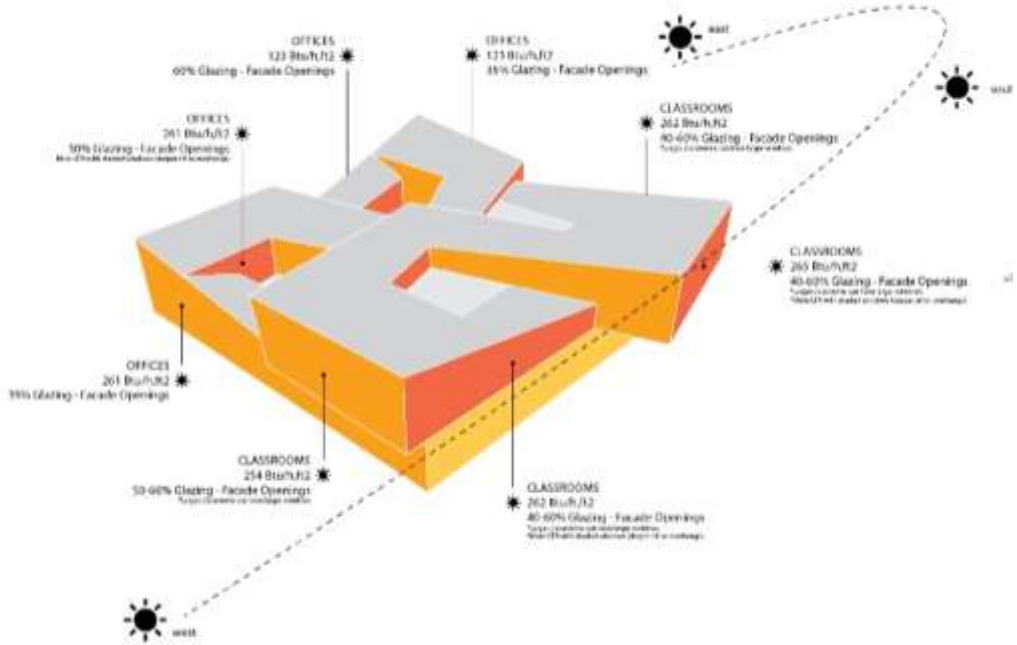
ANNUAL SOLAR IRRADIATION - SOUTH WEST

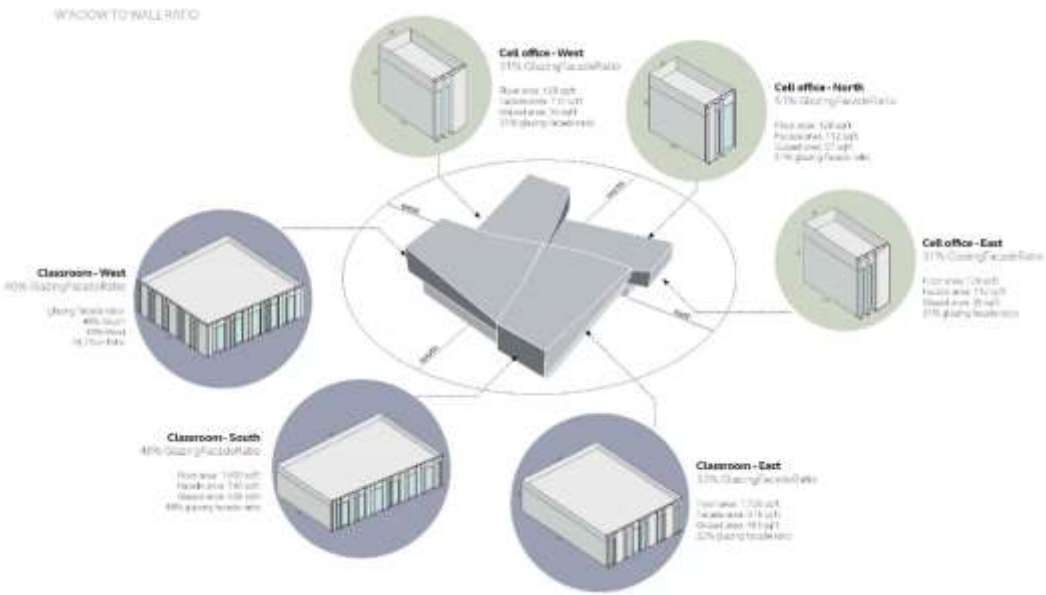
Solar Irradiation kWh/sqm

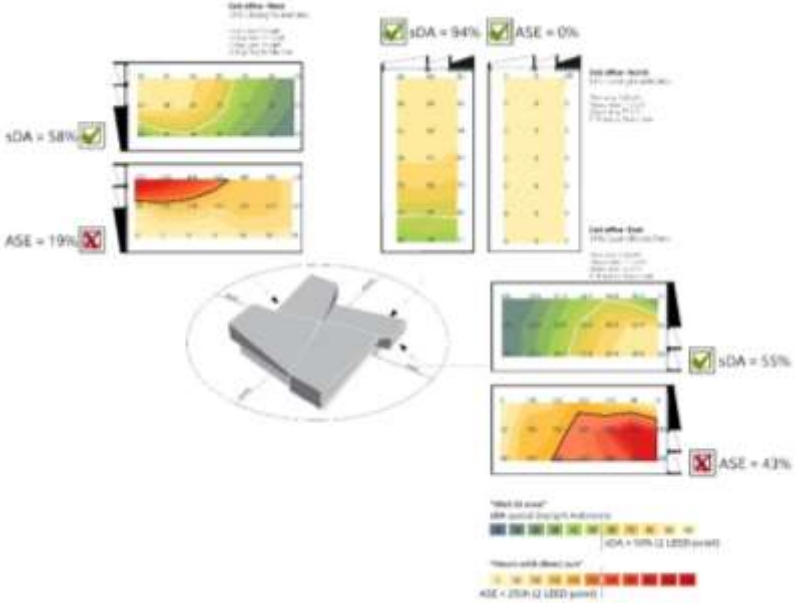
5100 200

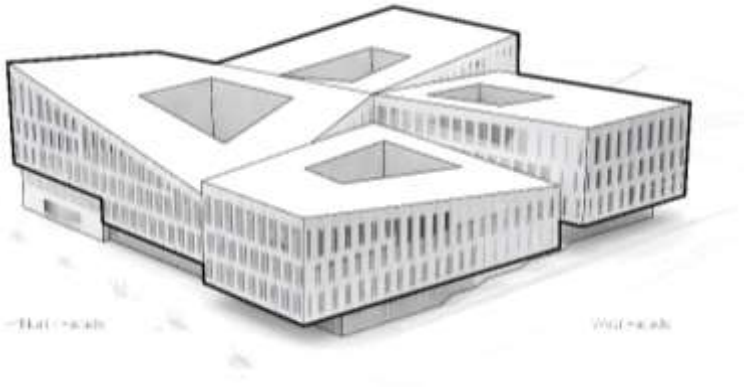
ANNUAL SOLAR IRRADIATION - NORTH EAST

GUIDELINES, WINDOW-TO-WALL RATIO

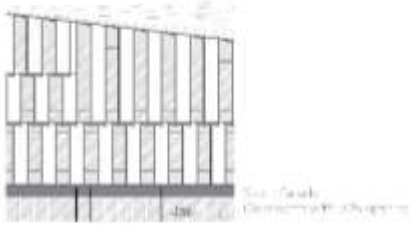



Cell office - West
Cell office - North
Cell office - East
Classroom - West
Classroom - South
Classroom - East


sDA = 94%
ASE = 0%
sDA = 58%
ASE = 19%
sDA = 55%
ASE = 43%

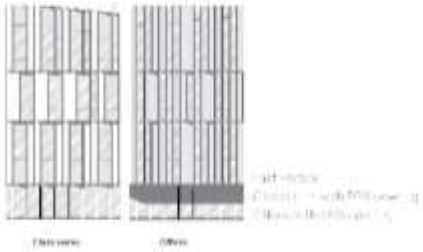


South

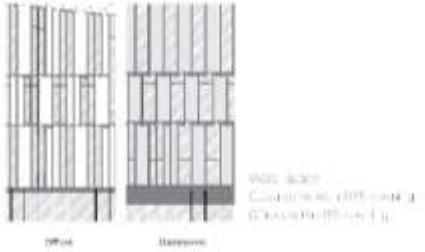


North

East



West



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Contact

Jakob Strømann-Andersen
Head of Sustainability Engineering
PhD, LEED AP BD+C, DGNB Auditor
jstr@henninglarsen.com