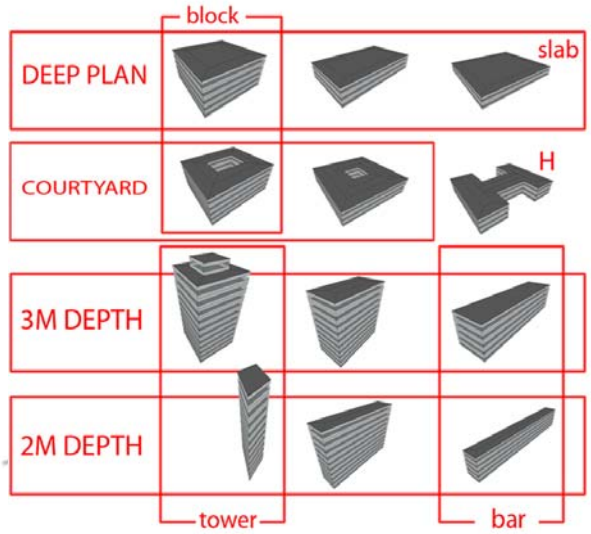
NTNU

Innovation and Creativity

Potential of passive cooling, natural ventilation and solar control in cold climates office buildings

INTRODUCTION

		T.s.	TEK 07	LE
U-value ext.wall	$W/m^2/K$	1.2	0.18	0.18
U-value roof	$W/m^2/K$	0.60	0.13	0.13
U-value floor on ground	$W/m^2/K$	0.50	0.15	0.15
U-value windows, glasses	$W/m^2/K$	2.4	1.2	1.2
Air-tightness	*ach*	3.0	1.5	0.6
Heat recovery system efficiency	-	0.7	0.7	0.85
Occupancy	$Pers./m^2$	0.1	0.1	0.1
Cooling set point temperature	$°C$	26	26	26
Heating set back temperature	$°C$	18	18	18
Lighting load	W/m^2	8	8	8
Equipment load	W/m^2	11	11	11

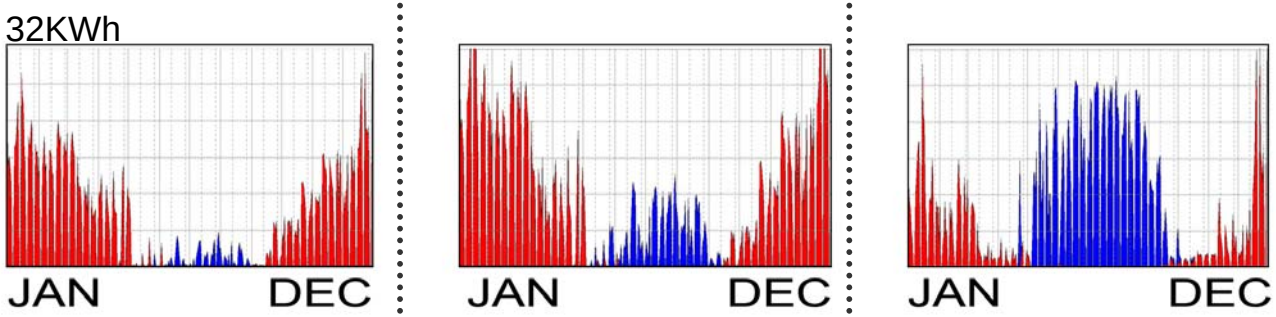


- Extremely stringent requirements: airtight and insulating envelopes
- Elevated internal thermal gains

Morphological analysis:

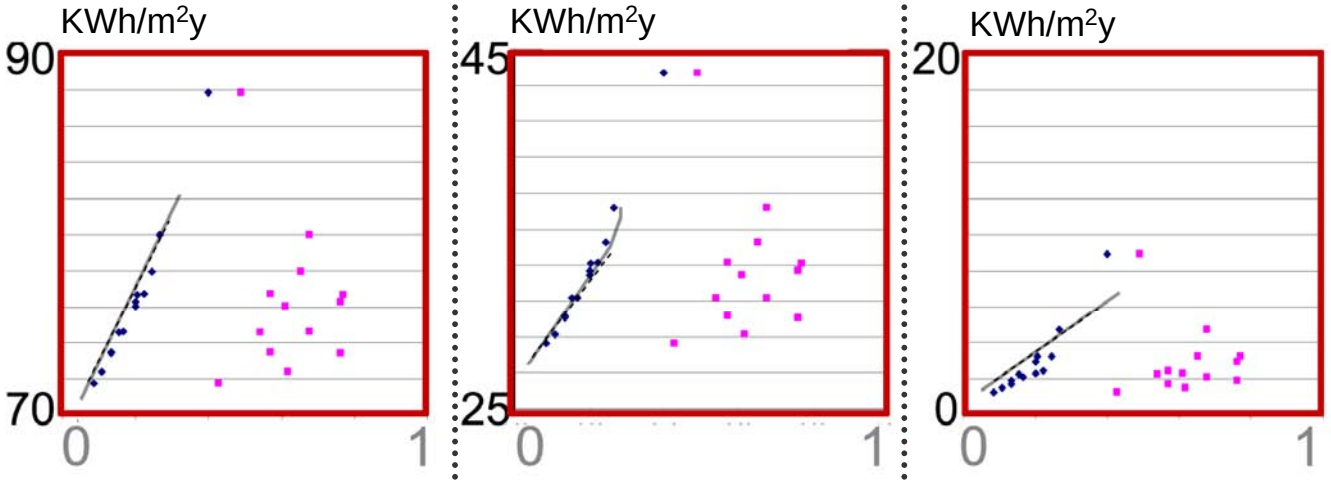
The influence of the shape on the thermal demand results negligible if compared with potential reduction deriving from the use of a proper low energy strategy

INTRODUCTION

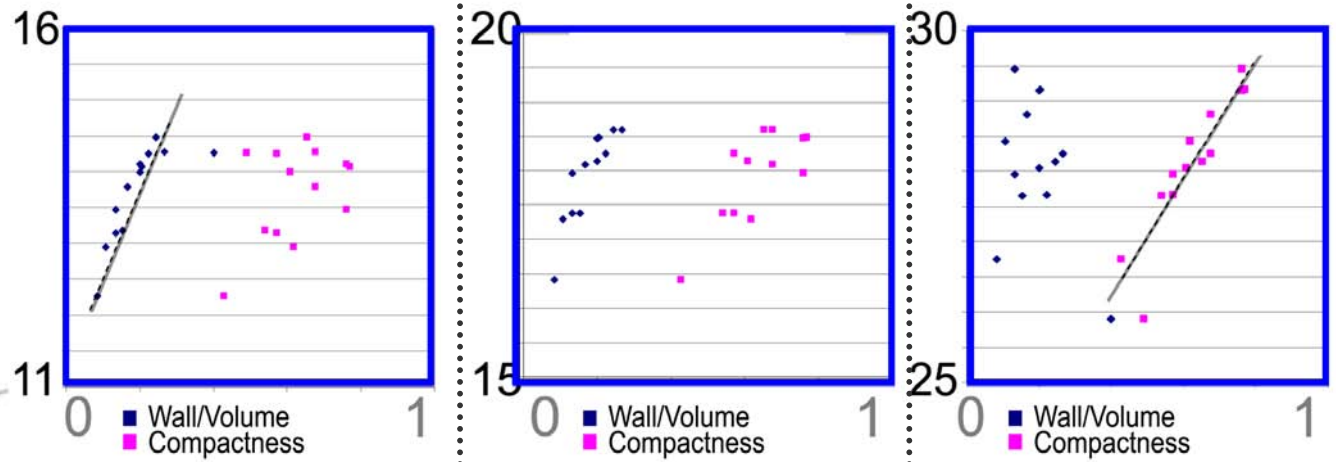


Total demand

Increased need for cooling



HEATING Demand

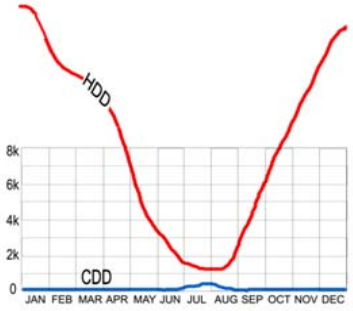


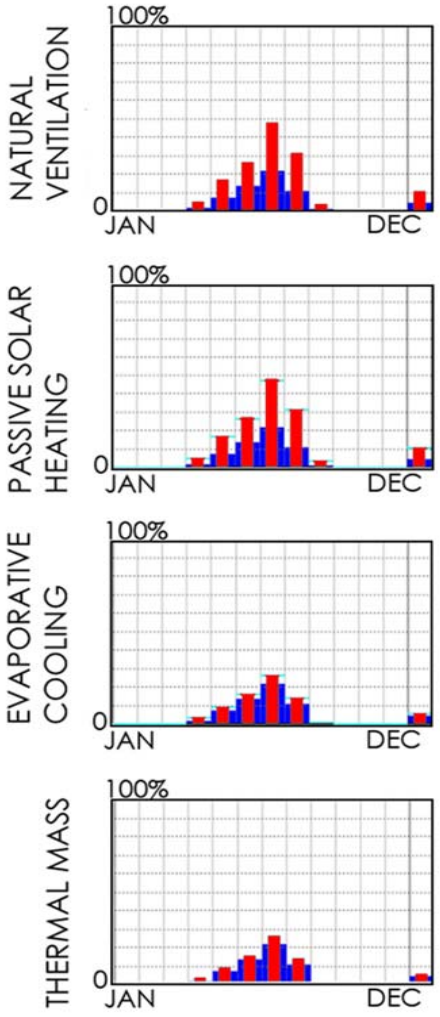
COOLING Demand

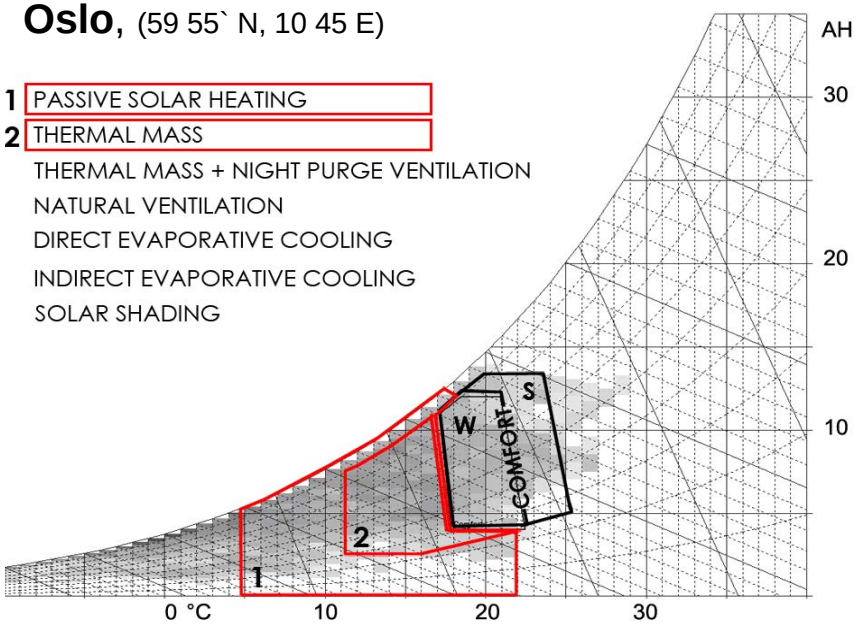
Different nature of the relation between heating and cooling demand and the shape

- Is the shape freer?
- On which canons is based the aesthetic of the project and the definition of the appropriate shape?
- What is the need for cooling suggesting?

CLIMATE/COMFORT - The basis of sustainable design





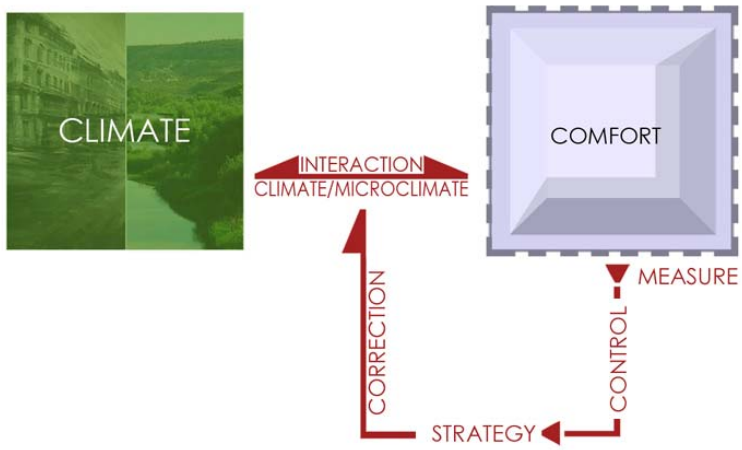


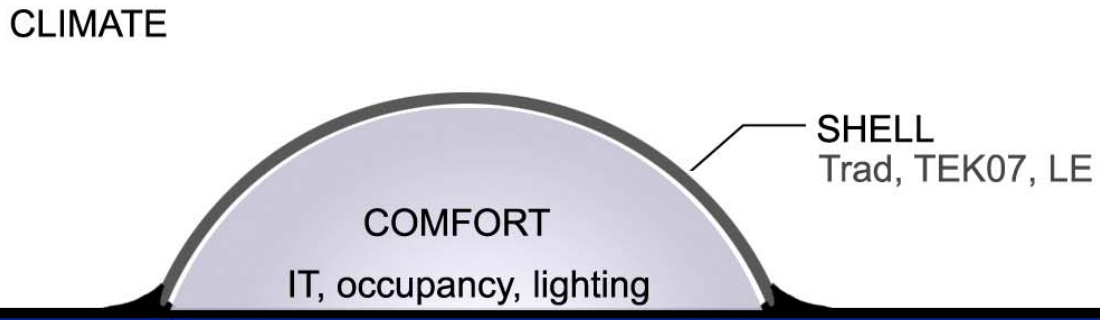
INTRODUCTION

- Heating and cooling **degree hours**
- Szokolay. **Potential of strategy** - increase in the number of hours spent within the comfort zone of each month (defined using the CPZ – control potential zone).
- Maximization of solar heat gain and minimization of thermal losses

CLIMATE/COMFORT

The basis of sustainable design





INTRODUCTION

- Interior: comfort; **internal thermal loads**
- The skin: climatic moderator; **technological development**
- Exterior: **climate change**

- Affecting the traditional approach for the definition of the appropriate **strategy** to adopt

- Altering the **potential** of the different strategies

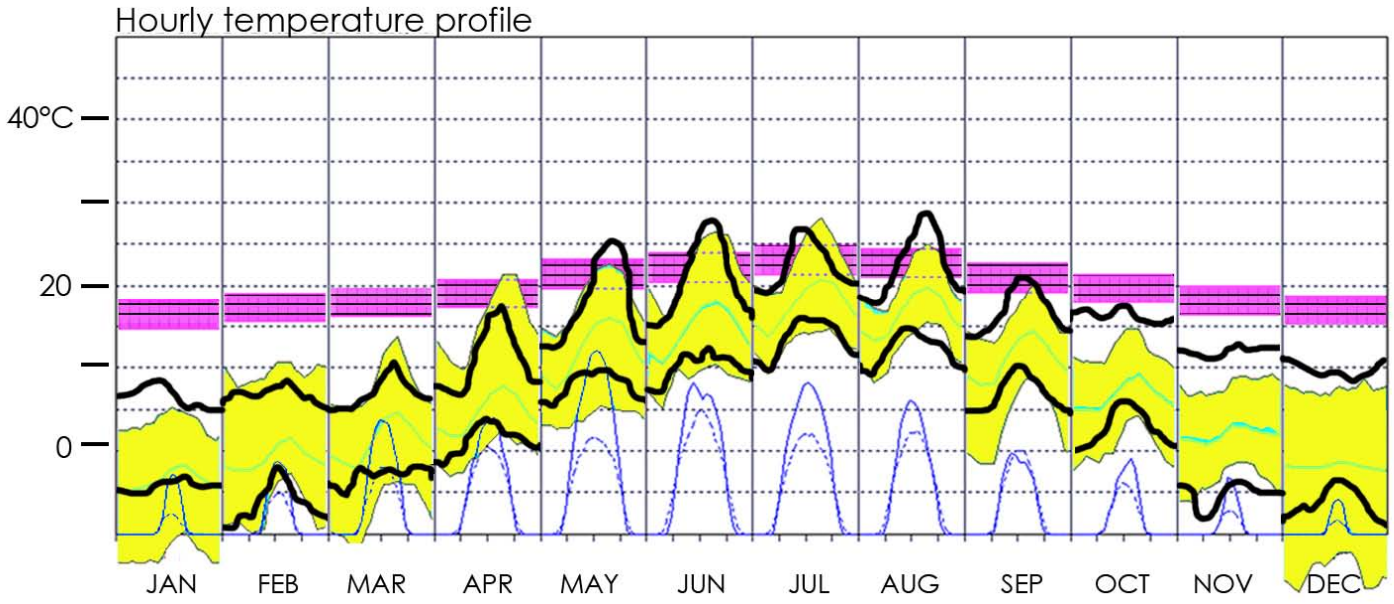
CLIMATE/COMFORT

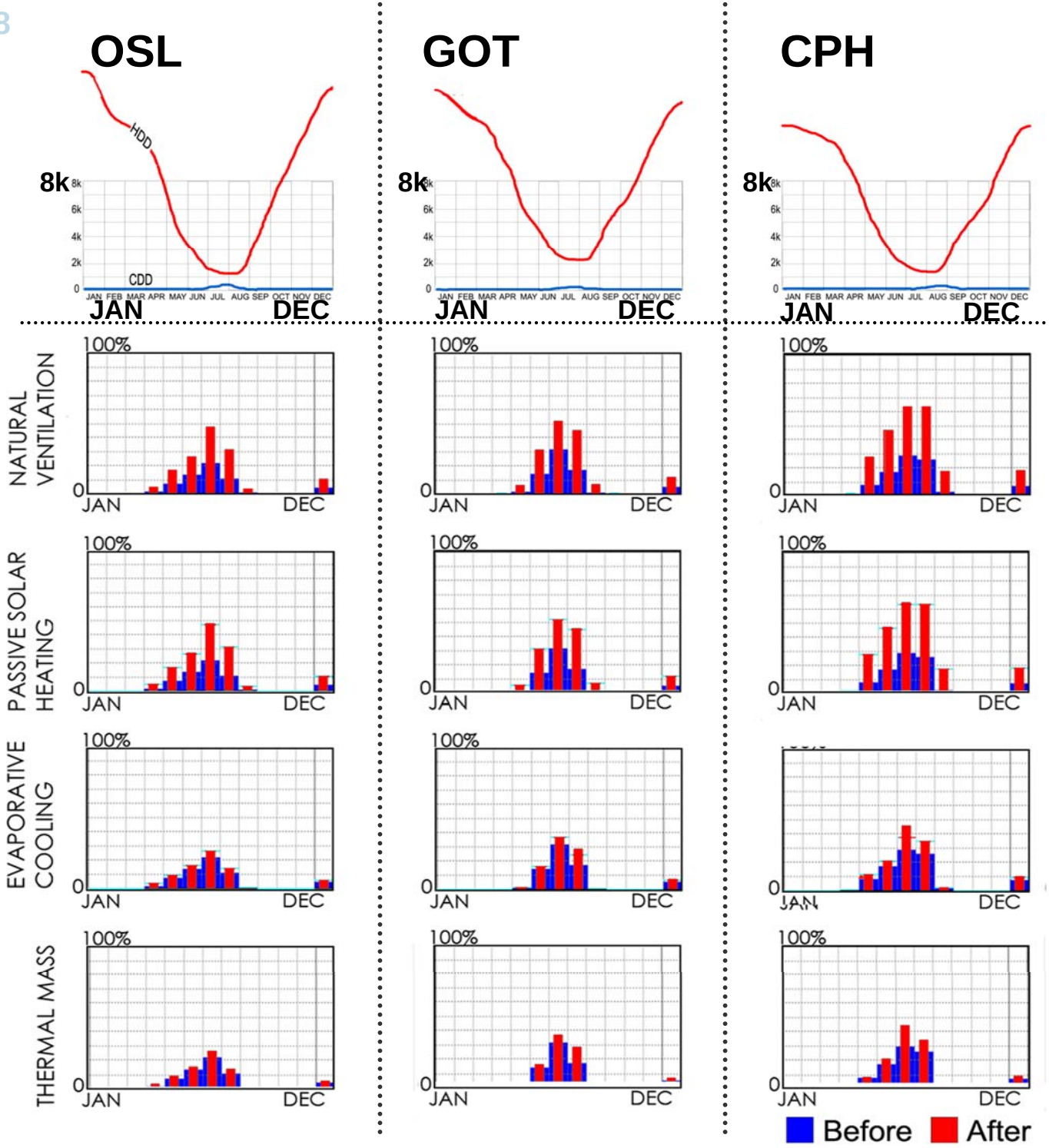
The basis of sustainable design

INTRODUCTION

- A certain grade of uncertainty is arisen by climate change predictions
- Significant increase in the mean temperature and precipitation
- OSL-CPH, Less rigid winters and longer warm seasons

Source: RegClim



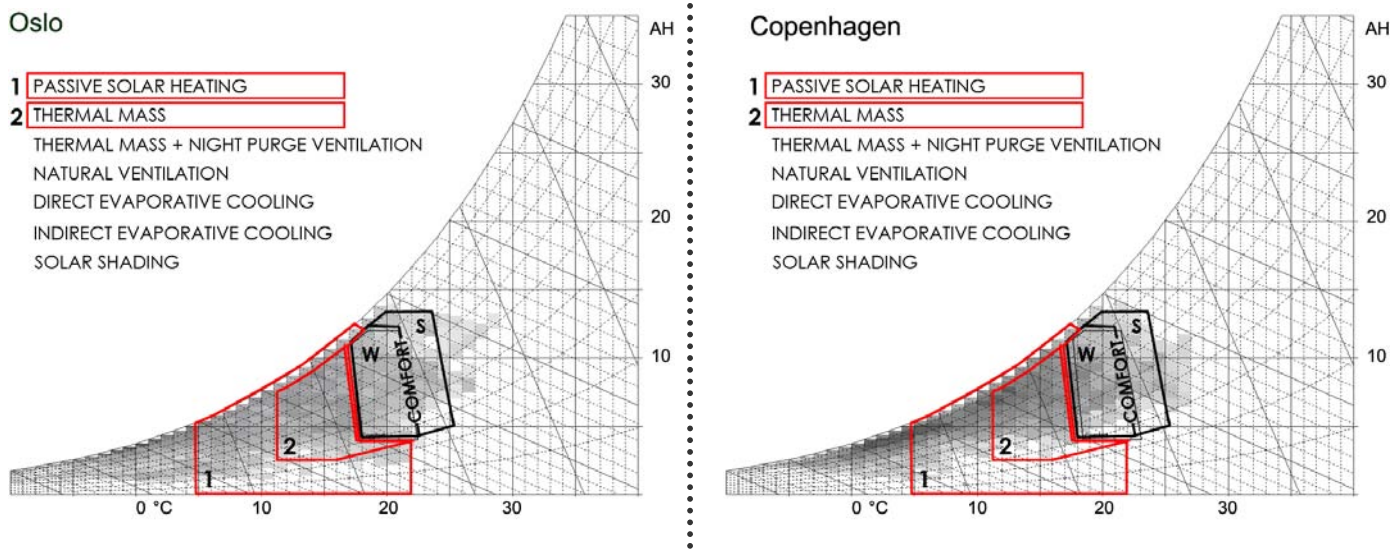


INTRODUCTION

- Significantly lower number of **HDH** but not cooling ones
- Longer overheated period
- Relatively increased **potential** of the strategies for cooling and natural ventilation.

CLIMATE/COMFORT – The basis of sustainable design

OSL ⟷ **CPH**



- quantifying the spontaneous shift of temperatures due to the combination of airtight envelopes and elevated internal loads

METHODOLOGY

Psychrometric chart
low energy strategies

- Deviation between the comfort zones and the distribution of the climatic conditions during the whole year.
- Does **not** suggest the use of different strategies.
- Results **clash empirical experience** of increased need for cooling

METHODOLOGY

		Tr.s.	TEK 07	LE
U-value ext.wall	$W/m^2/K$	1.2	0.18	0.18
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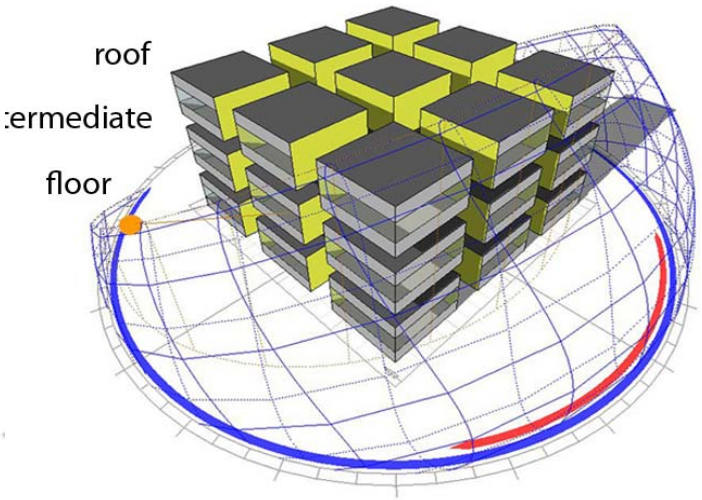
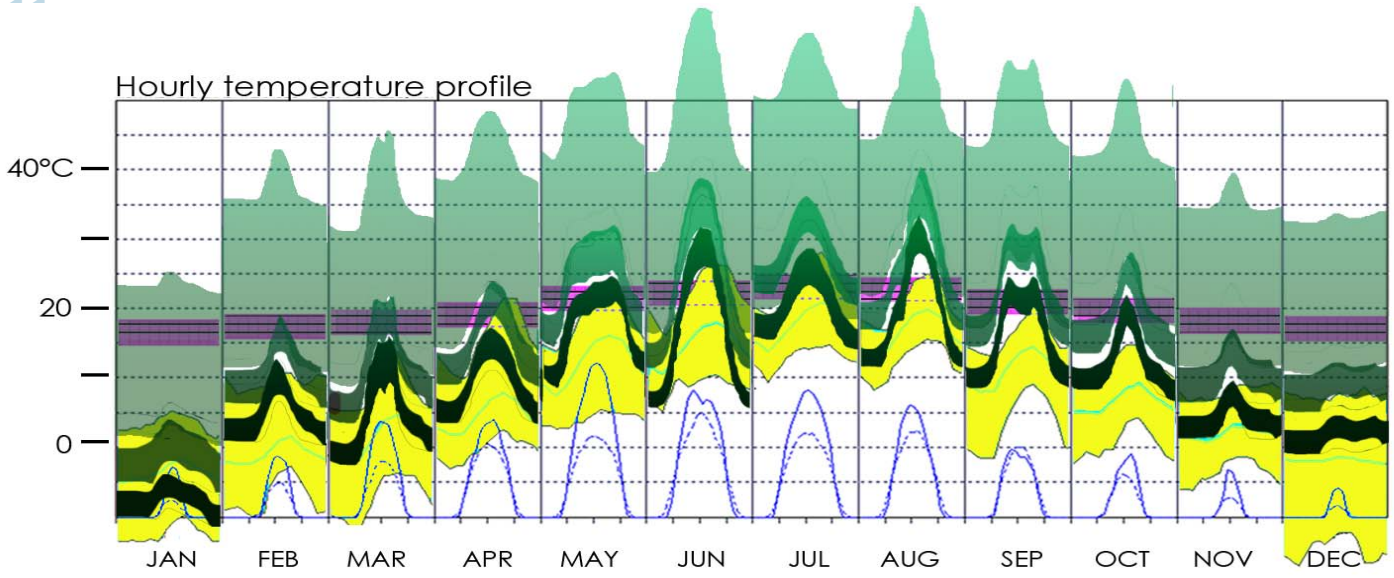


Simulations

- **No HVAC** system
- Working every day from **8 p.m. to 20 p.m.**
- Internal gains: **25-14 W/m²**

RESULTS



MICROCLIMATE — **25 W/m²**

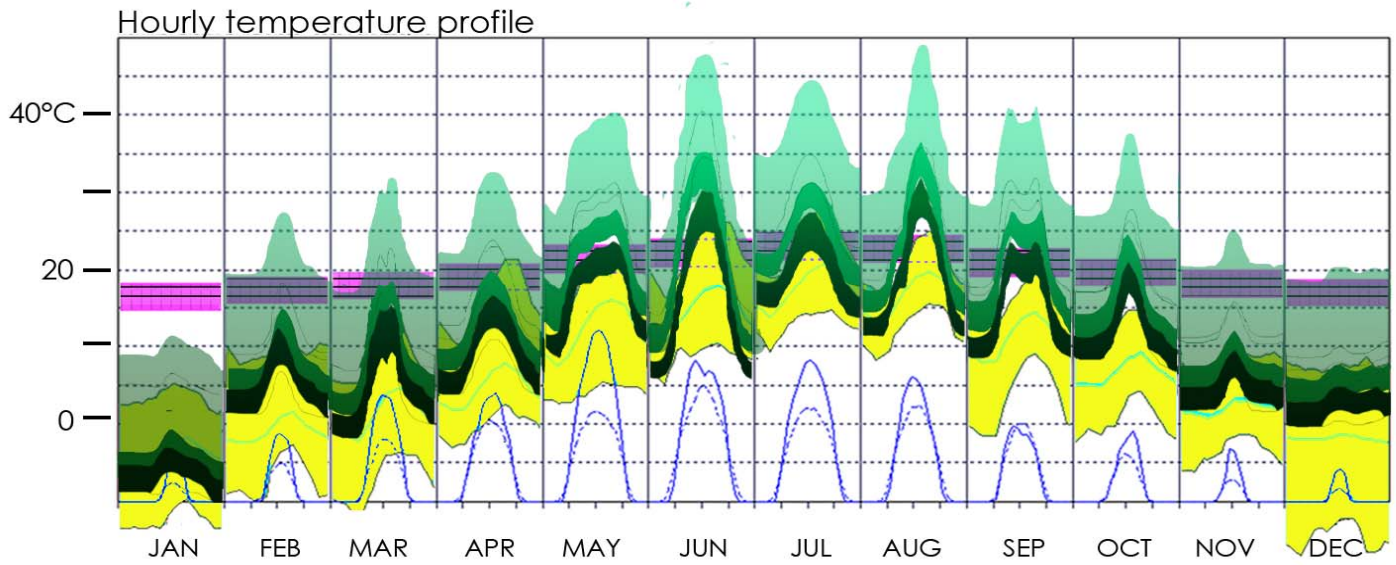
25 LE
25 TEK07
25 Trad. systems

ENVIRONMENTAL EXIGENCIES

Comfort

CLIMATE

Oslo



MICROCLIMATE — **14 W/m²**

14 LE
14 TEK07
14 Trad. systems

ENVIRONMENTAL EXIGENCIES

Comfort

CLIMATE

Oslo

- The more stringent the envelope's technical requirements, the larger the increase of temperature

Tr.S

TEK07

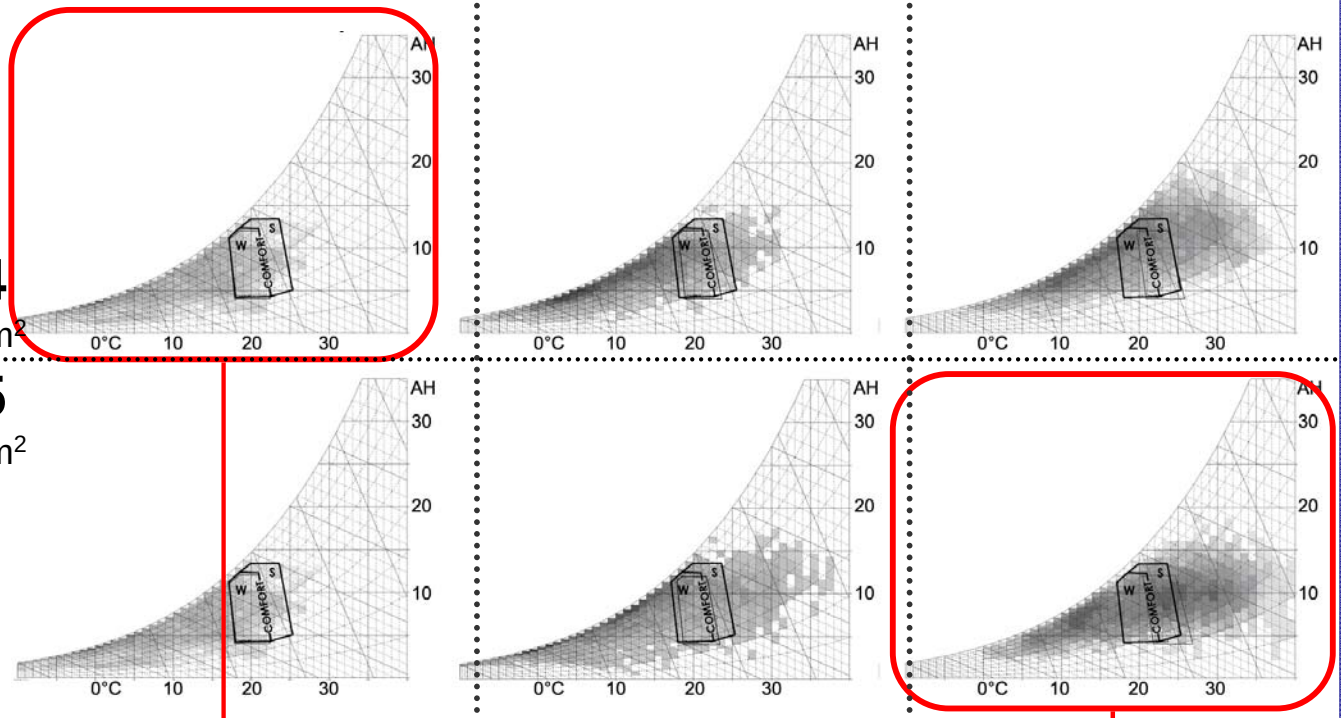
LE

RESULTS

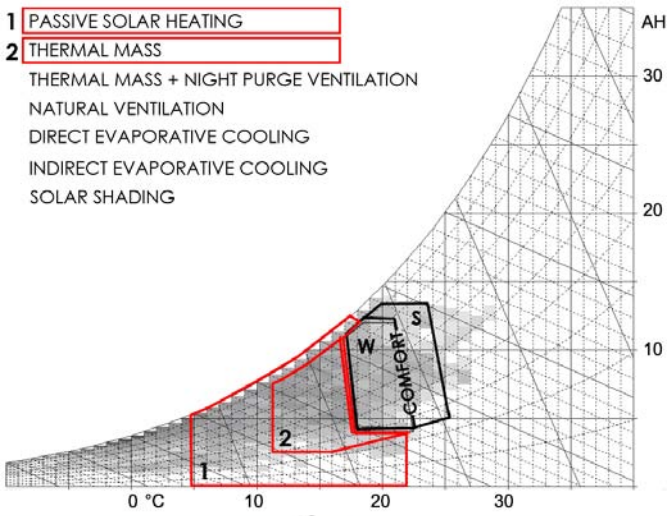
Psychronmetric chart – shift of temperatures in relation to different internal gains and specific characteristics of the skin

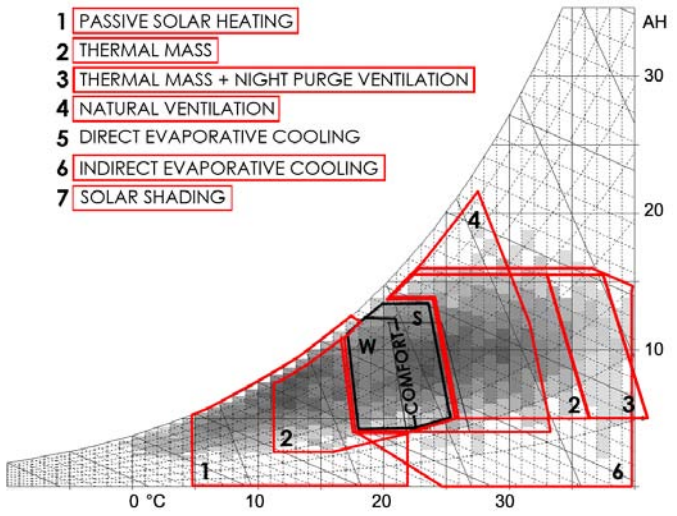
14 W/m^2

25 W/m^2

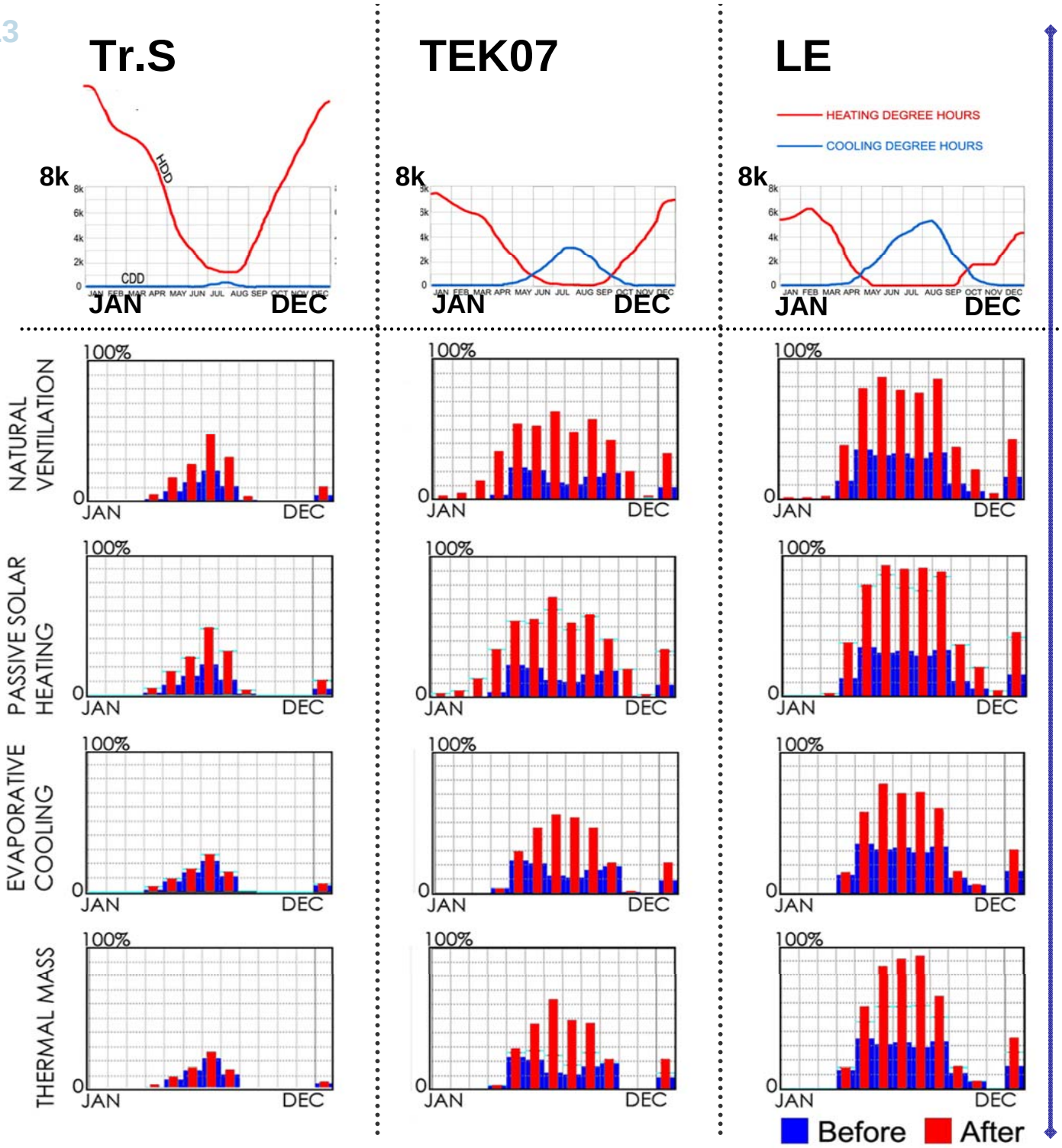


OSL ⟺ **CPH**





- Need of using a different strategy



RESULTS

- Significantly increased number of **cooling degree hours**

- Significantly increased **potential** of the strategies for cooling and natural ventilation.

ARCHITECTURAL DESIGN - PROCESS

- In order to define an efficient strategy for coping with the increased cooling demand is necessary to include in the climate/comfort comparison the spontaneous shift of temperatures due to internal gains

- The spontaneous increase of temperatures is strictly related to the specific characteristics of the envelope

- The more stringent the envelope the higher the number of cooling degree hours and the potential of the strategies for cooling and natural ventilation

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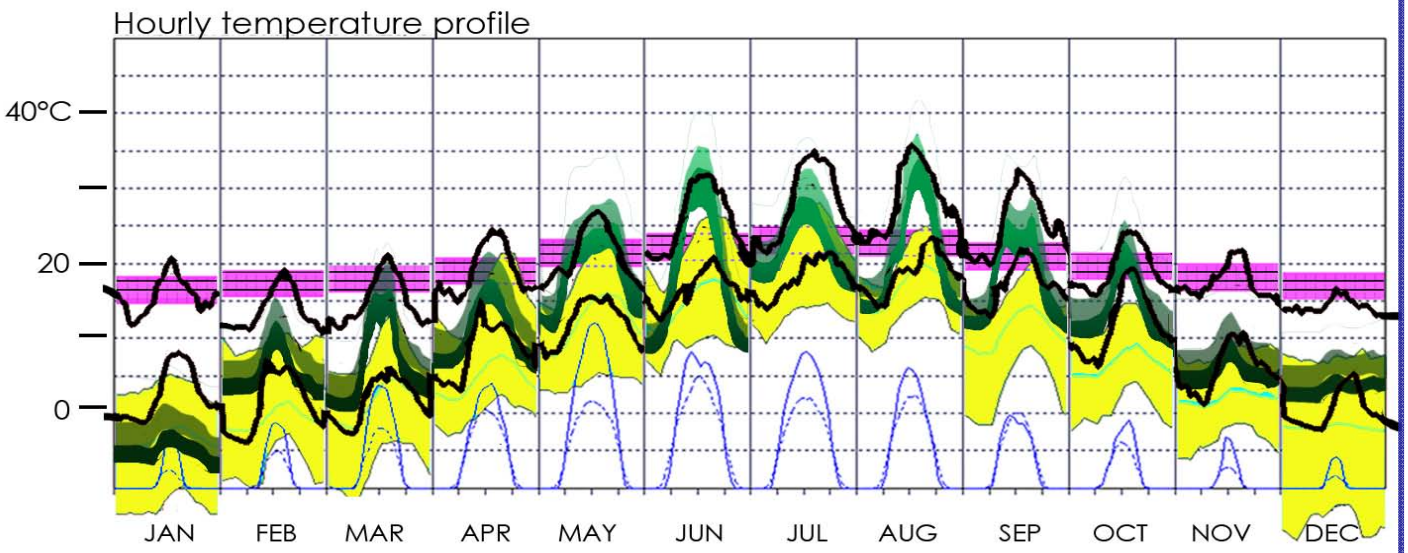
DISCUSSION



- **TEK07**

MICROCLIMATE

14 / 25 TEK07

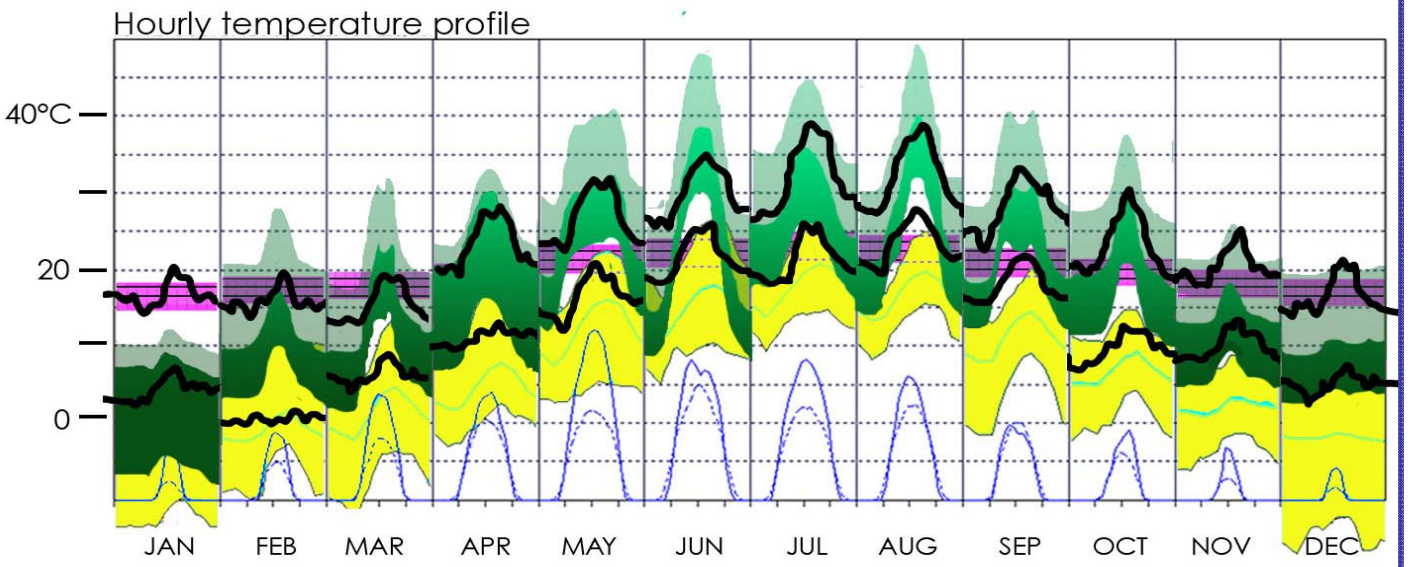
ENVIRONMENTAL EXIGENCIES

Comfort

CLIMATE

Rome

Oslo



- **LE**

MICROCLIMATE

14 / 25 LE

ENVIRONMENTAL EXIGENCIES

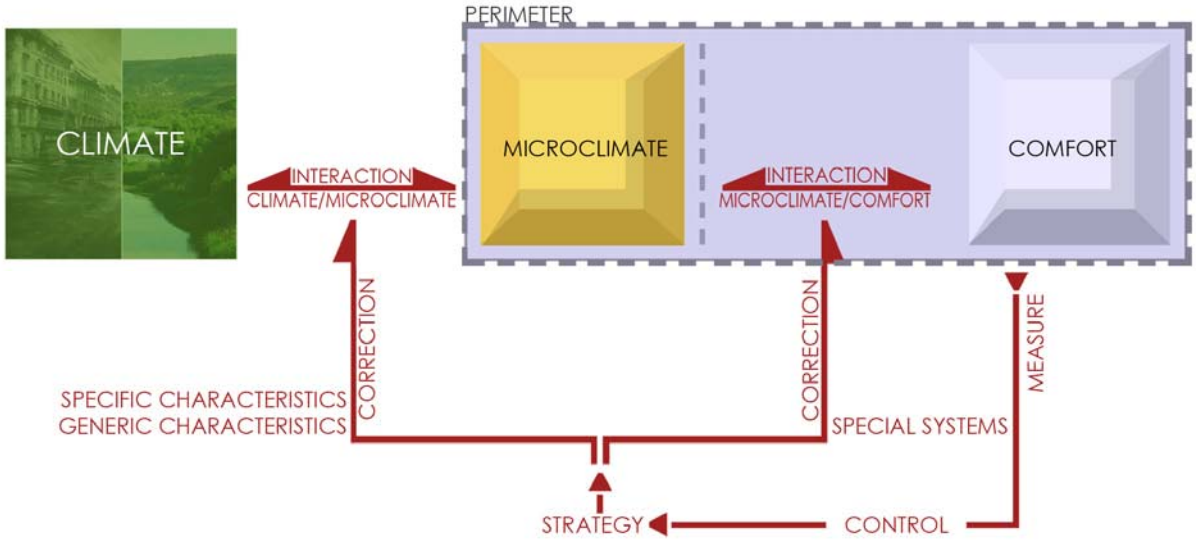
Comfort

CLIMATE

Athens

Oslo

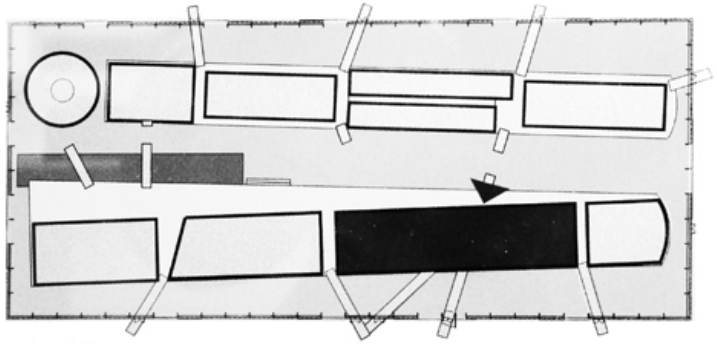
- A force strong enough to completely upset the whole architectural concept of the building.



DISCUSSION

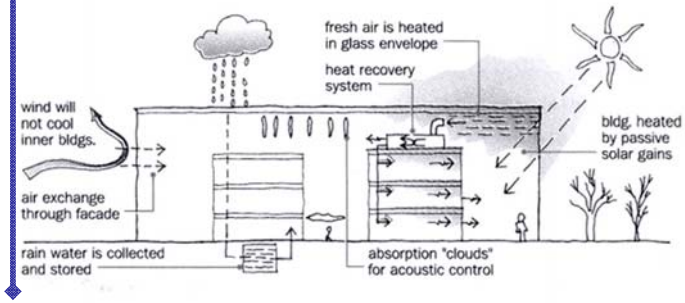
- Thermal comparison is split into two different steps: climate-microclimate-comfort
- Is not calling TEK07 and LE requirements into question
- Environmental adaptability to changing conditions and use of the potentially positive shift of temperatures
- The use of in-between spaces

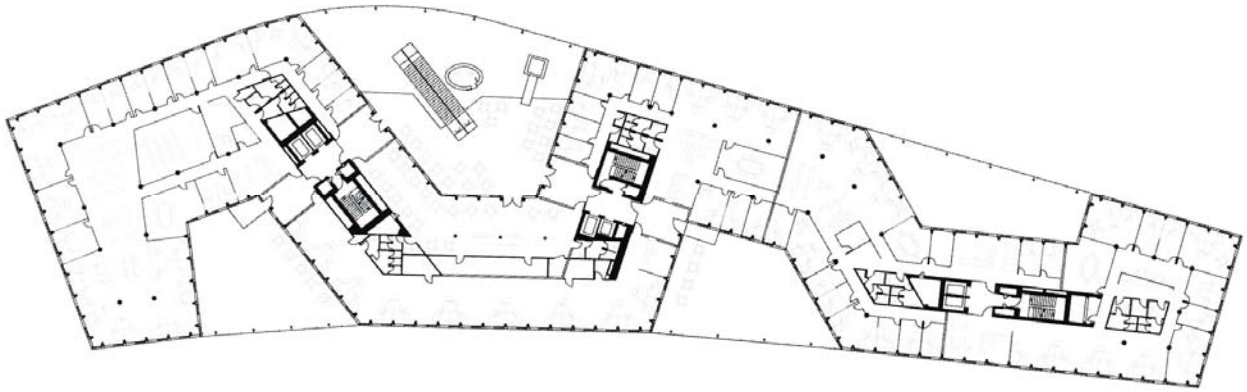
In-between spaces can be as thin as a blade – double skin facades – as thick as plazas – atrium.



Jourda & Perraudin

Akademie Mont Cenis

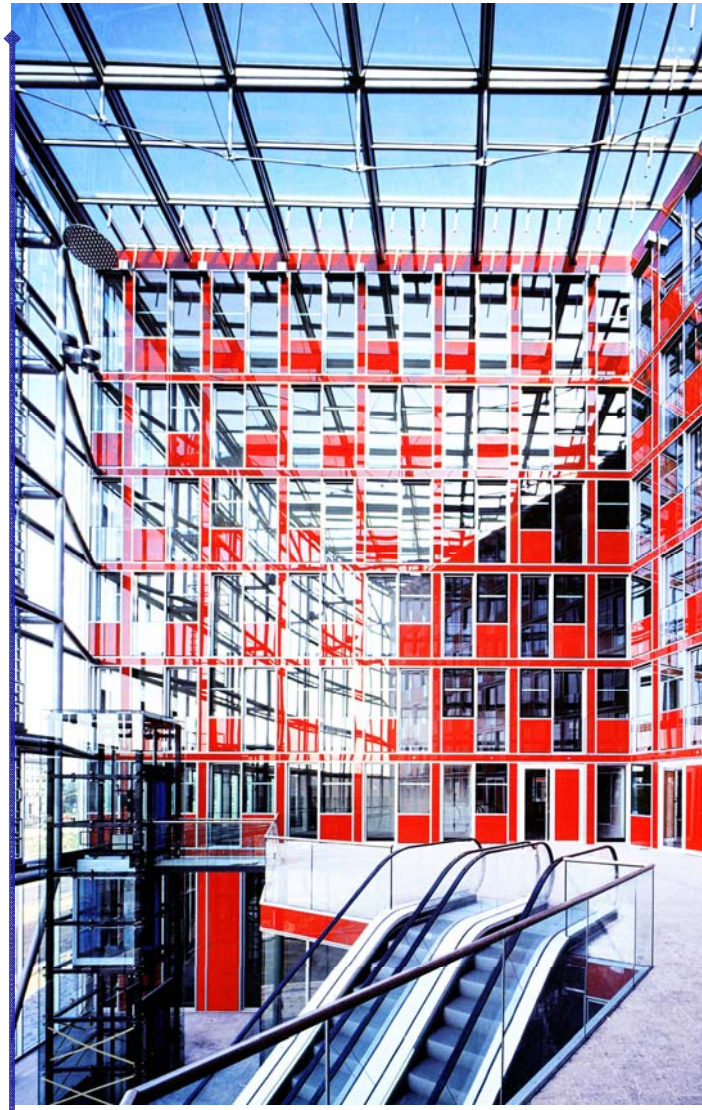




Gaternabb + Schossig

Capricorn Haus - Hamburg

In-between spaces represent the phisical registration of the tension between the form defined from the exterior as climate moderator and the internal functional program



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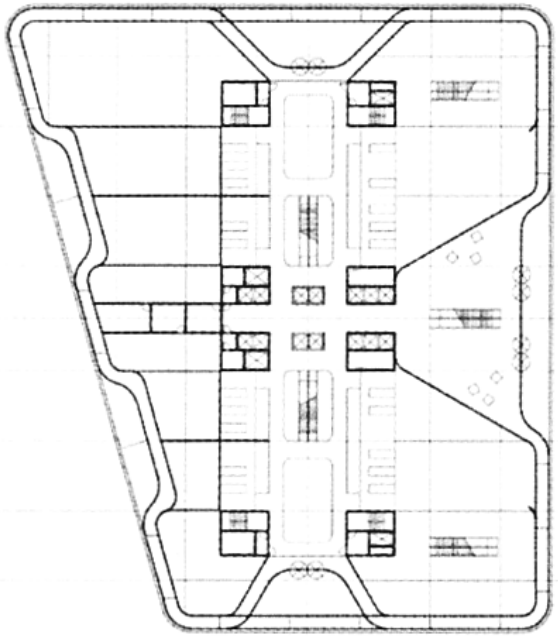

Gerkan, Mard and partner

Zhongguancun tower

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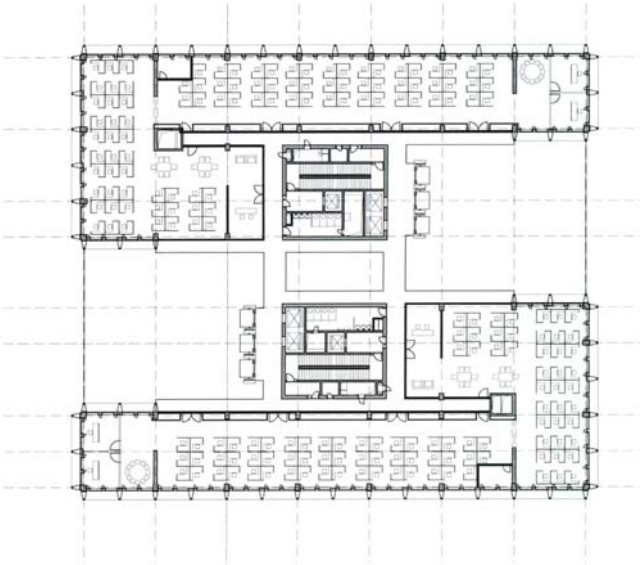
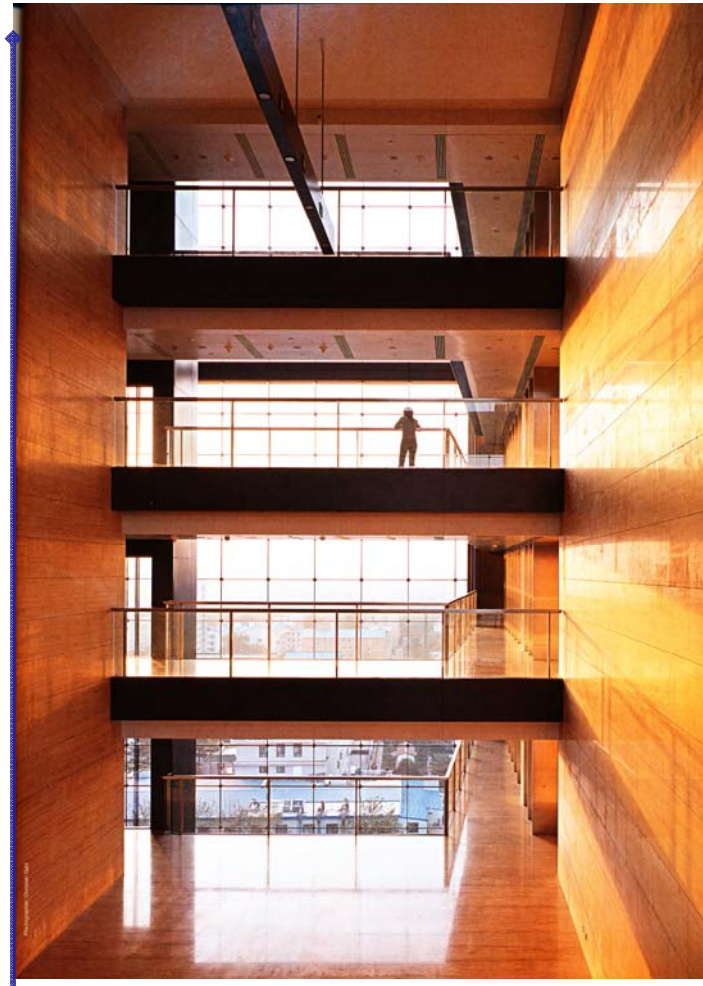
Innovation and Creativity





Gerkan, Mard and partner

CYTS tower

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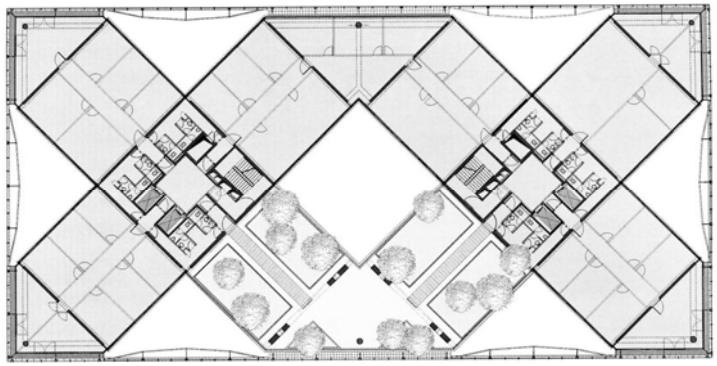
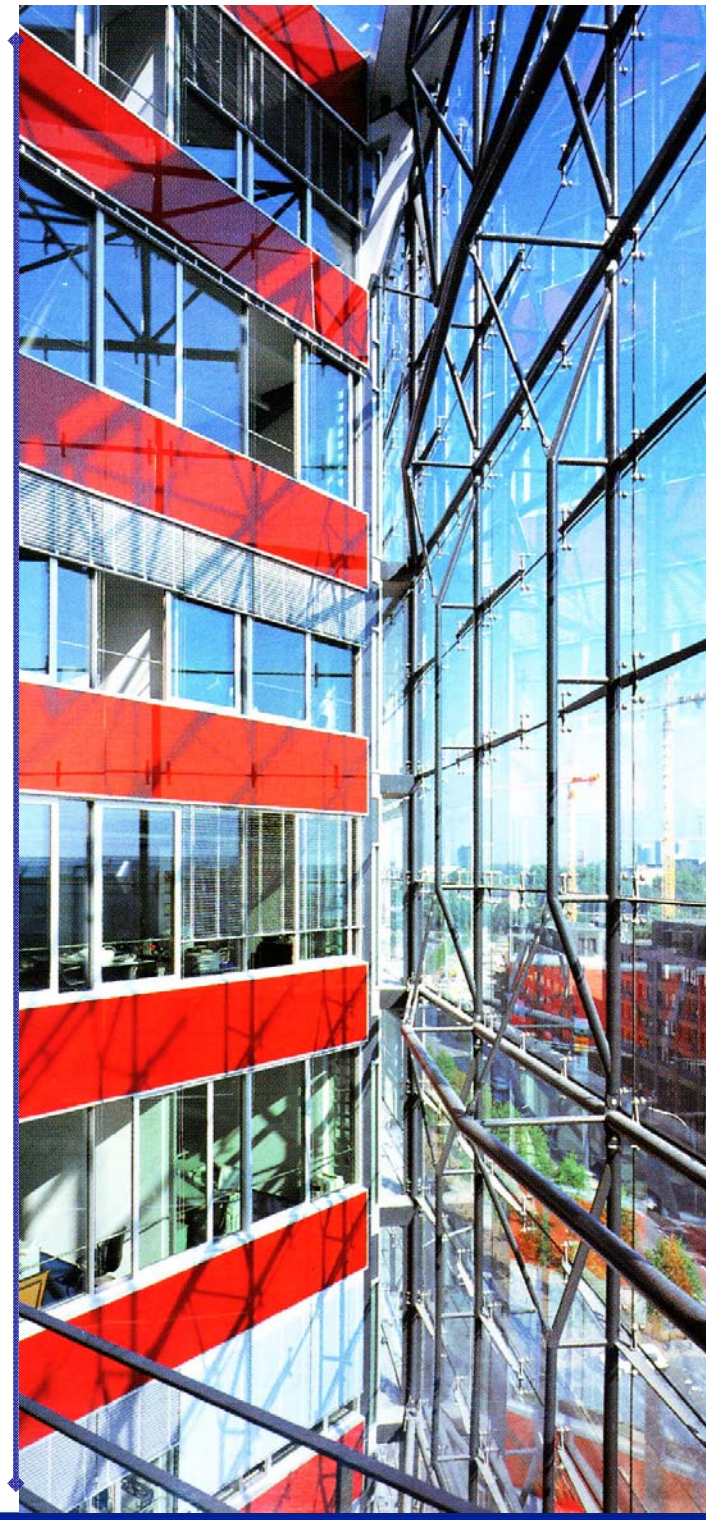
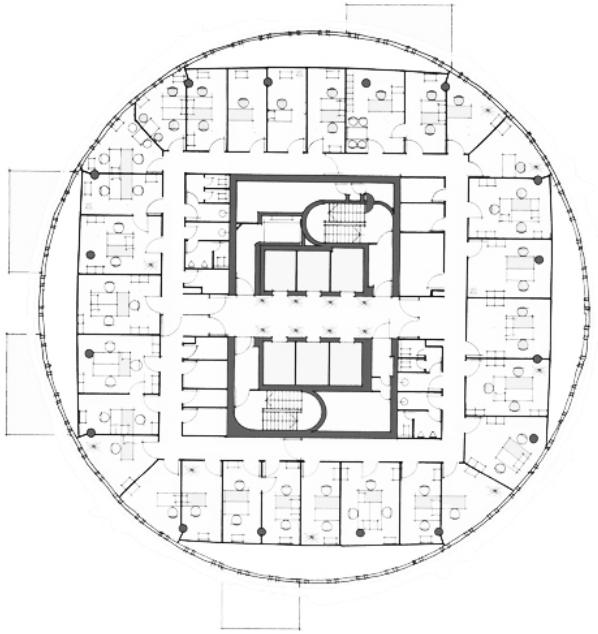


Gatermann + Schossig Architekten

Burohochaus XX - Dusseldorf

They are the most evident implication of the dissociation between the environmental and functional performances into different architectural components

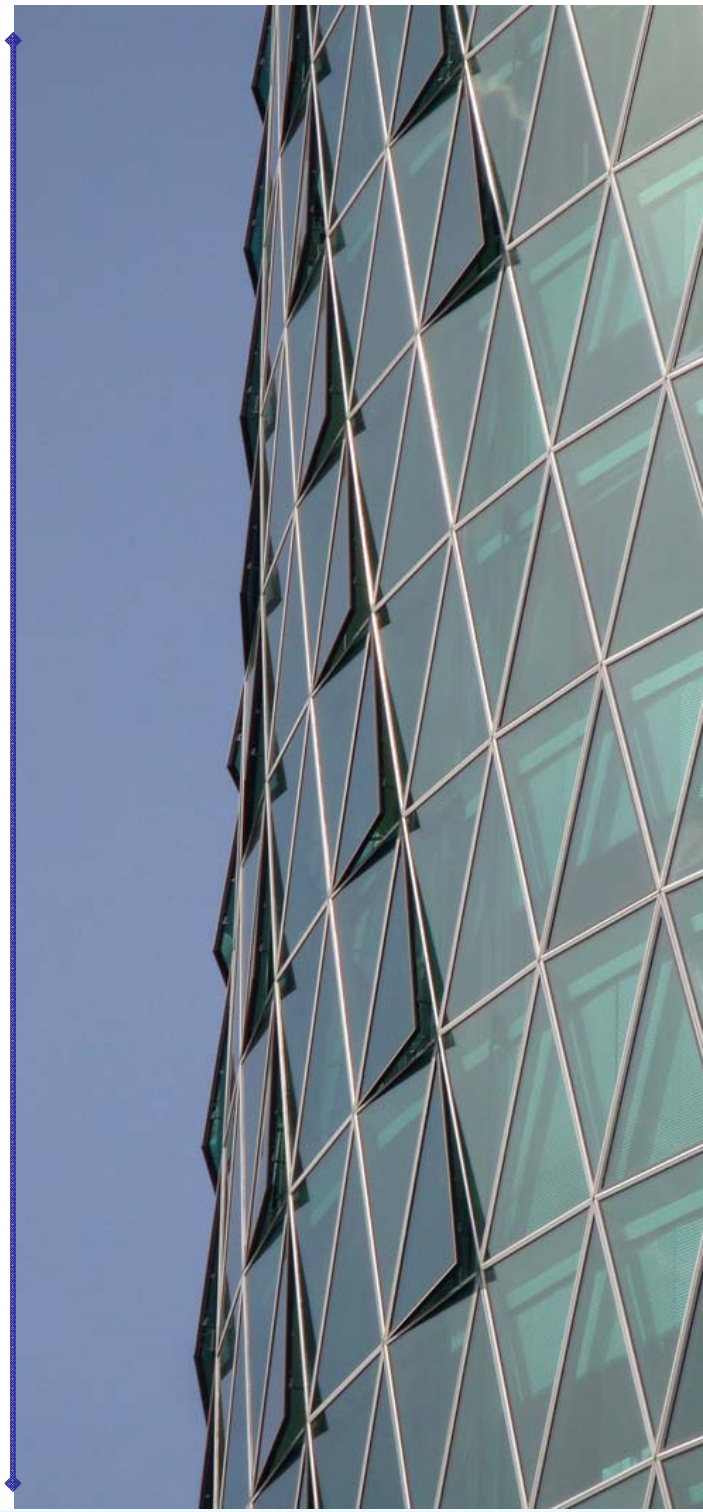




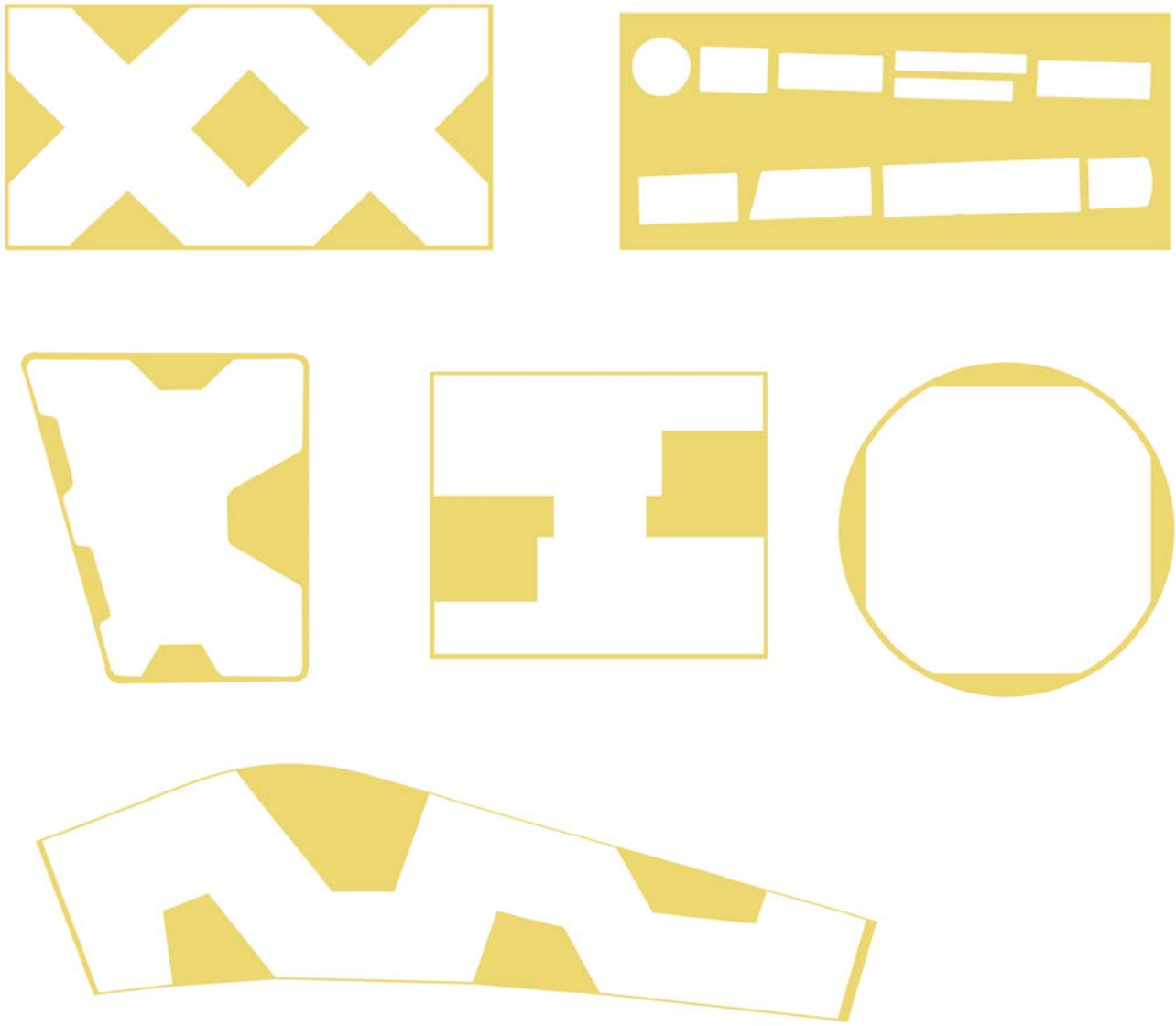
Schneider + Schumacher

Westhafen tower - Frankfurt

In-between spaces permit the coexistence of different shapes, solving apparent contradictions internal to sustainable design



THE SPACE IN-BETWEEN



- The form is not freer but physical expression of the low energy strategy adopted

The use of in-between spaces is conceptually identified with environmental sensitivity of the form

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ARCHITECTURAL IMPLICATIONS - PRODUCT

- The conception of a form bounded to the physical dimensions of the environment starting from the exterior contradict the dogma of modern architecture that wants the form as direct physical expression of the internal functional program
- Leading architectural design of cold climates office buildings into a new complexity
- New inedited architectural scenarios

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