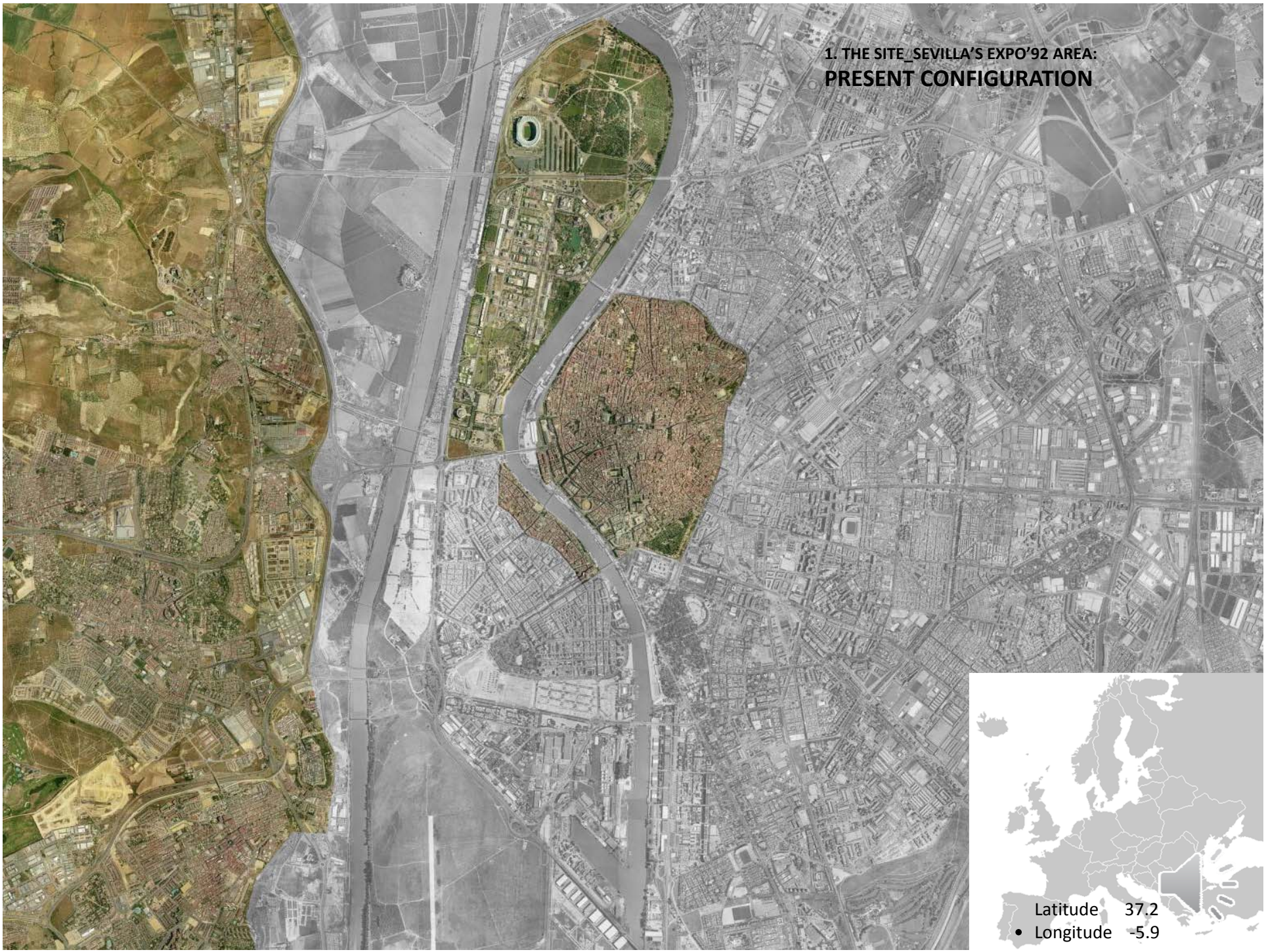
REVITALIZING SEVILLA'S EXPO '92 AREA

LA CARTUJA ISLAND, SEVILLA, SPAIN

Carlos Cerezo, Natalia Escobar, Jiseok Park, Amaia Puras

1. THE SITE: SEVILLA'S EXPO 92 AREA



1. THE SITE_SEVILLA'S EXPO'92 AREA:

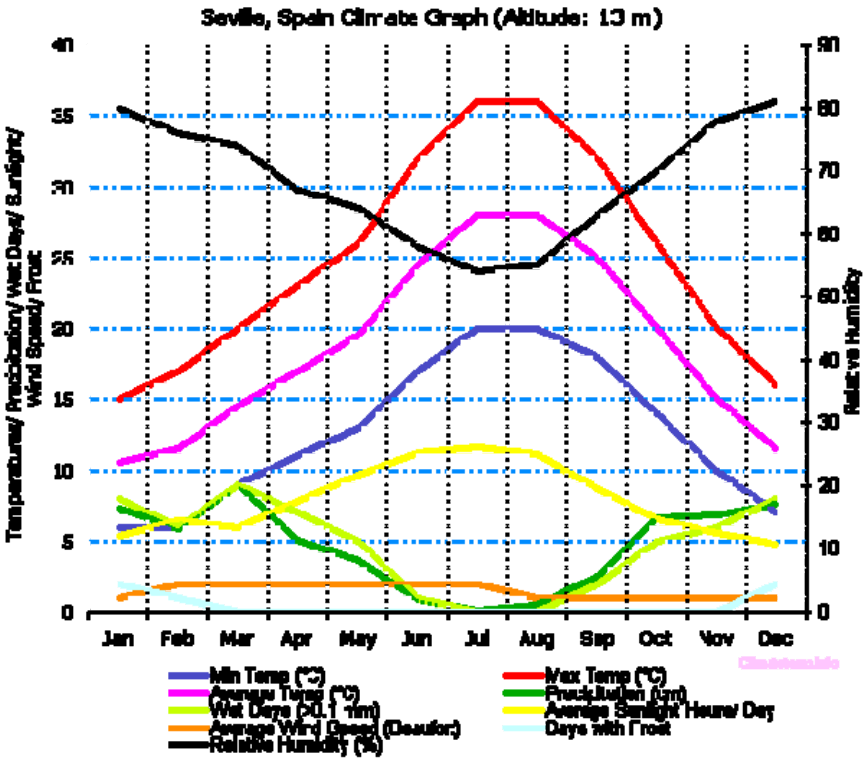
PRESENT CONFIGURATION

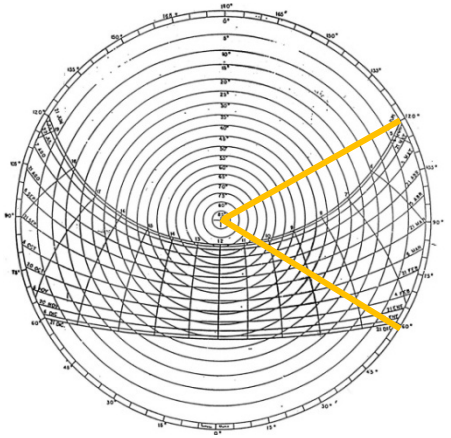
- Latitude 37.2
- Longitude -5.9

1. THE SITE_SEVILLA'S EXPO'92 AREA: SEVILLA's CLIMATE

The U value : ASHRAE and Spanish TECHNICAL CODE.

ELEMENT	ASHRAE	CTE	FINAL VALUES
Ext. Wall	0,36	0,82	**0,59**
Roof	0,12	0,45	**0,42**
Floor	0,22	0,52	**0,25**
Glazing	4,26(0,25)	5,2(0,46)	**2,27(0,24)**
Partition	-	-	**1,63**





SUMMER design (JULY):

Max. Temperature **45 C**

Ave. Max. Month Temperature **38 C**

Ave. Min. Month Temperature 23 C

WINTER design (JANUARY):

Min. Temperature **-2 C**

Ave. Max. Month Temperature 15 C

Ave. Min. Month Temperature **5 C**

Sun position peaks:

21 June (12 solar time) Altitude **75º**

21 June (5/19 solar time) Altitude 5º

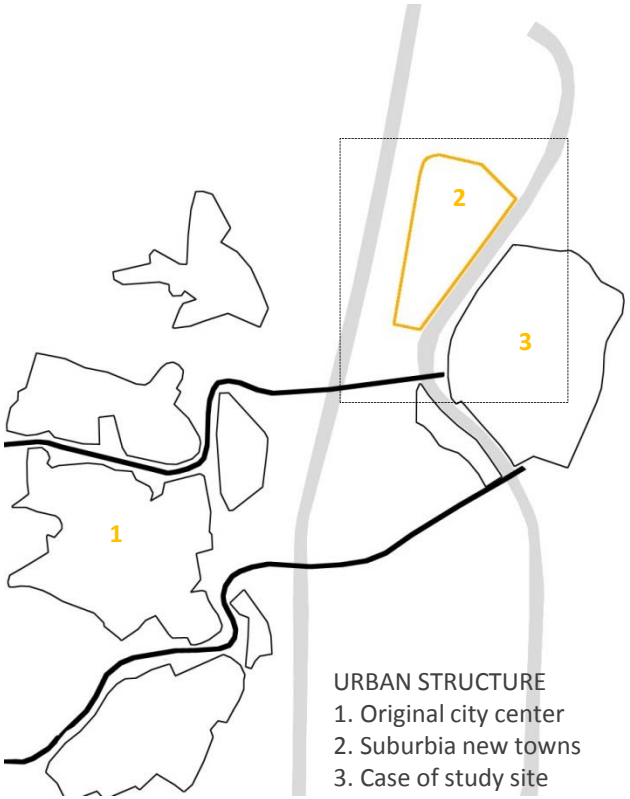
21 Dec (12 solar time) Altitude 30º

21 Dec (7/17 solar time) Altitude **5º**

1. THE SITE_SEVILLA'S EXPO'92 AREA:

RELATIONSHIP WITH THE GRID

HISTORICAL CITY CENTER + NEW SUBURBAN DEVELOPMENTS



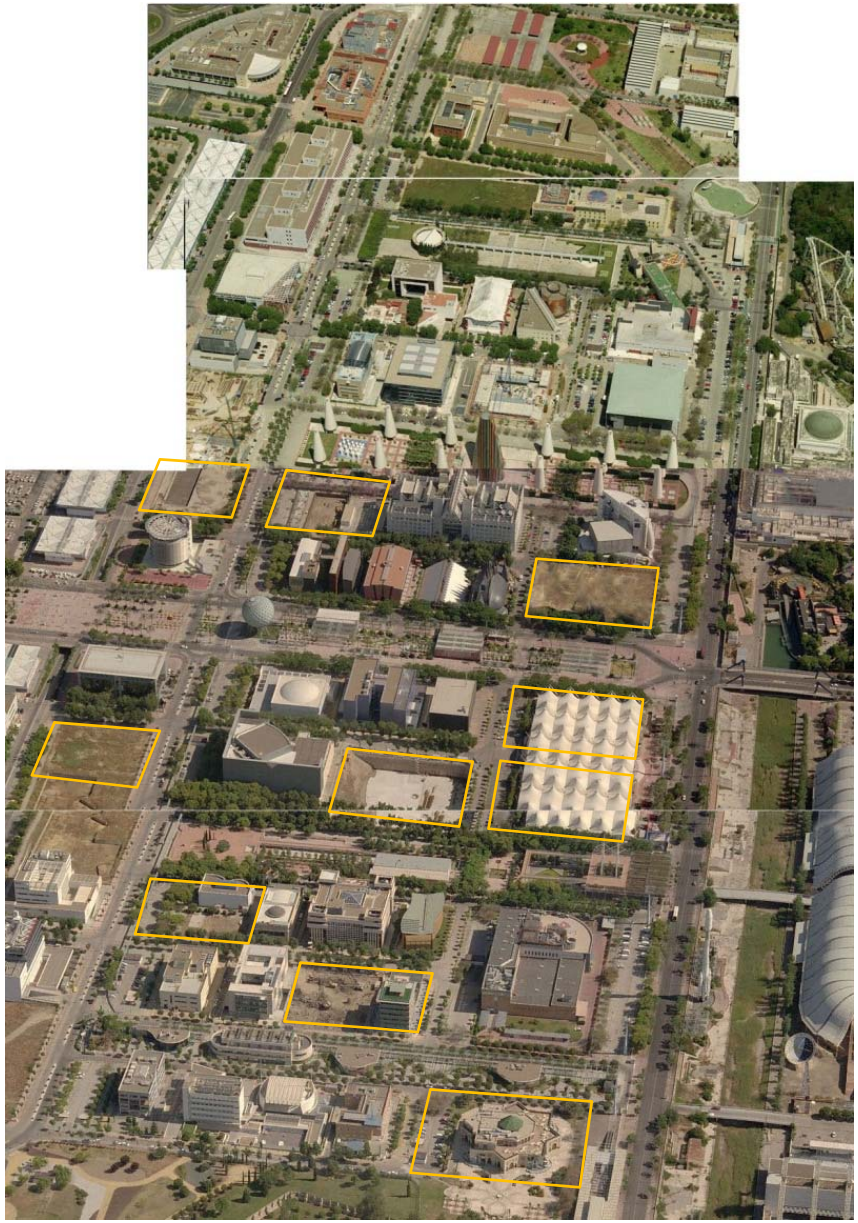
URBAN STRUCTURE
1. Original city center
2. Suburbia new towns
3. Case of study site

1. SUBURBIA MEW SETTLEMENTS
- Individual 2 story housing
- Low land occupation 20-30%
- Low built area values 0,4-0,6 m2 b/m2

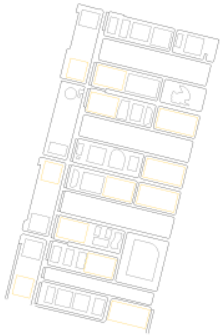
2. FORMER EXPO / TECHNO PARK
- Office and service buildings 4 – 6 stories
- Medium land occupation 50-60%
- High built area values 2,0-2,5 m2 b/m2

3. HISTORICAL CITY CENTER
- Mixed use multi-family 2-5 stories
- High land occupation 70-90%
- High built area values 3,0-4,0 m2 b/m2

2. THE PROPOSAL: REVITALIZING EXPO 92



2.1 PROPOSAL: REVITALIZATION + DENSIFICATION



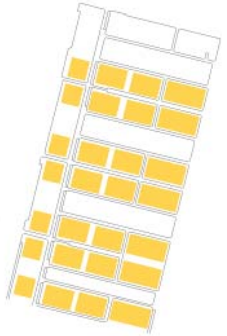
A. ORIGINAL CONFIGURATION

EXISTENT BUILDINGS
Energy use

B. INFILL

EXISTENT BUILDINGS
Energy use
Embodied energy

NEW BUILDINGS
Energy use
Transportation energy savings



C. TABULA RASA

EXISTENT BUILDINGS
Deconstruction energy

NEW BUILDINGS
Energy use
Transportation energy savings

2. PROPOSAL:

ANALYSIS PARAMETERS AND SIMULATION TOOLS

BUILDING LEVEL

A) Improve thermal and energy performance by **passive design**.

Energy use modeling: **Design Builder (E+)**

PROTOBLOCK LEVEL

A) Define best layout for **mixed use block**.

Energy use modeling: **Rhino + UMI + E+**

B) Improve street outdoor comfort for **pedestrians**.

Radiation levels: **Radiance + DIVA**

Wind velocity CFD: **Flow Designer (Stationary model)**

C) Study potential for energy production: **PVs and solar thermal**.

Radiation levels: **Radiance + DIVA**

Thermal panels simulation: **F-chart (Klein & Beckman method)**

NEIGHBORHOOD

A) Study effects of **climate change** over energy use.

Energy use modeling: **Rhino + UMI + E+**

Climate change weather files: **CC World Weather Generator (University of Southampton)**

B) Compare LCA energy use for **3 scenarios** and **infill vs tabula rasa**.

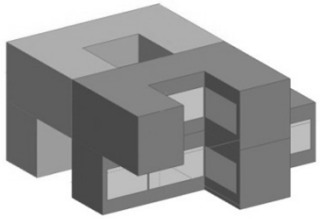
Energy use modeling: **Rhino + UMI + E+**

Embodied energy : **Simplified LCA with BEDEC database from Tech. Inst. Of Catalonia**

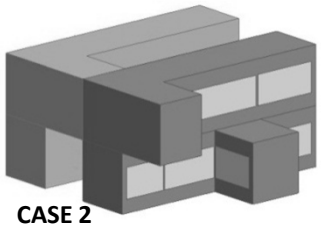
C) Evaluate **walkability** and uses potential.

Walkability: **Walkscore Method + RHINO plug in**

2. BUILDING CONFIGURATIONS: RESIDENTIAL TYPOLOGIES



CASE 1



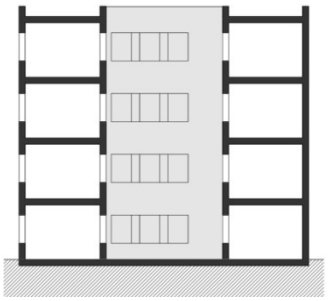
CASE 2

CASE 1

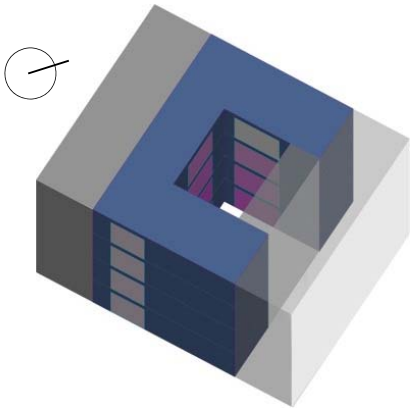
TOTAL ENERGY CONSUMPTION:
34.5 kWh/n2
OPERATIVE TEMPERATURE
25-28ºC
SOLAR GAINS
1.3 kWh/m2

CASE 2

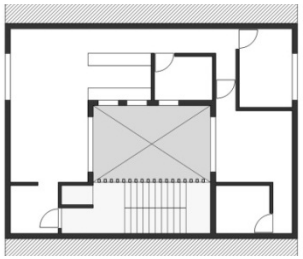
TOTAL ENERGY CONSUMPTION
41 kWh/m2
OPERATIVE TEMPERATURE
24-28ºC
SOLAR GAINS
2kWh/m2



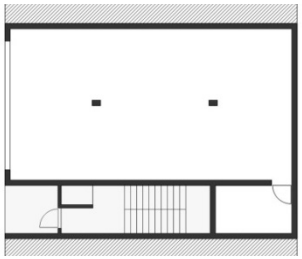
Section A



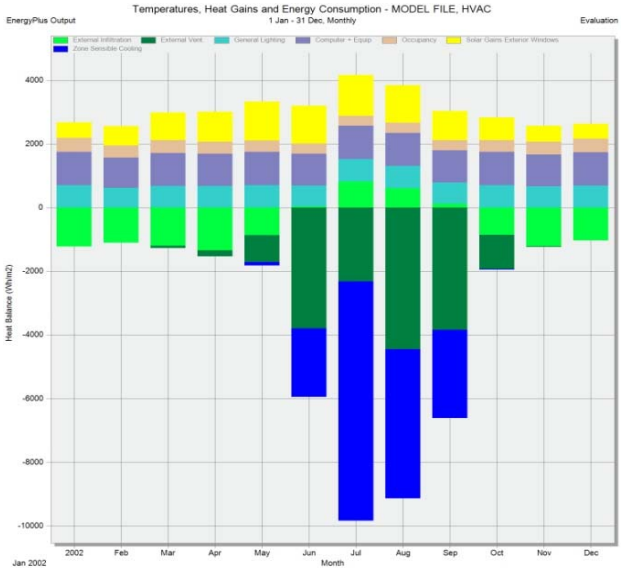
CASE 3



Housing floor



Commercial floor



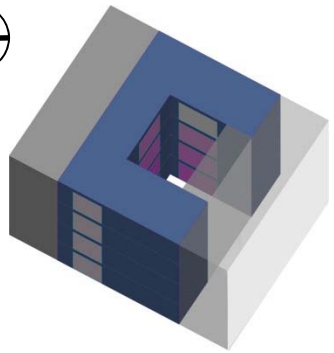
CASE 3

TOTAL ENERGY CONSUMPTION
34.5kWh/m2

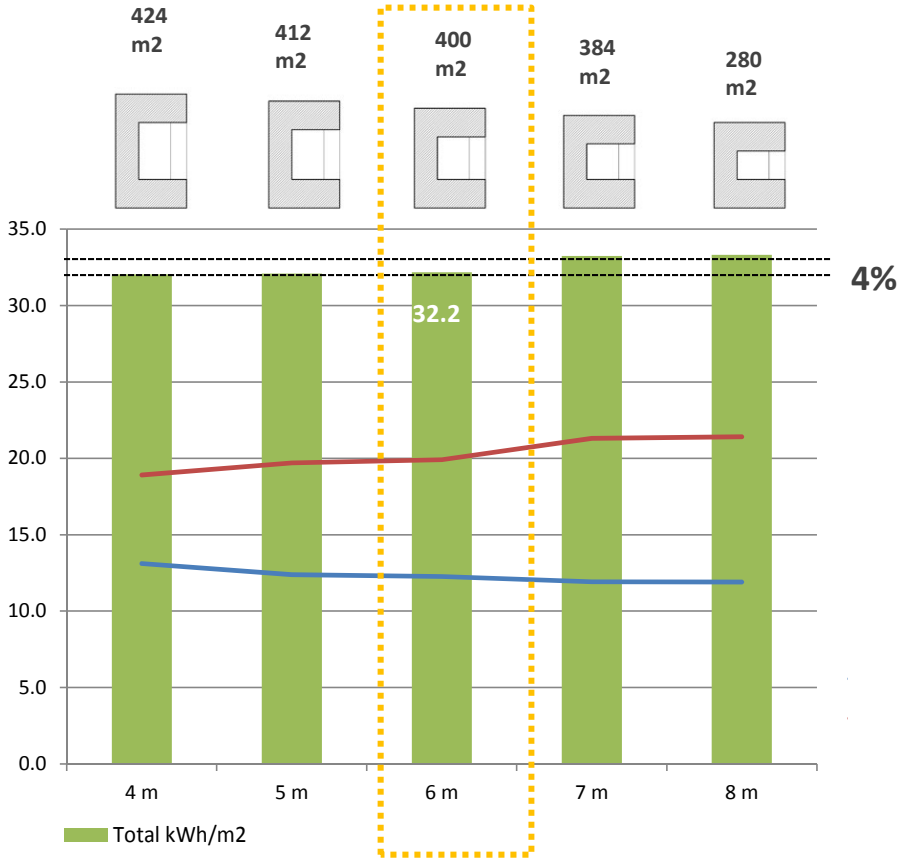
OPERATIVE TEMPERATURE
24-27ºC

SOLAR GAINS
1.2kWh/m2

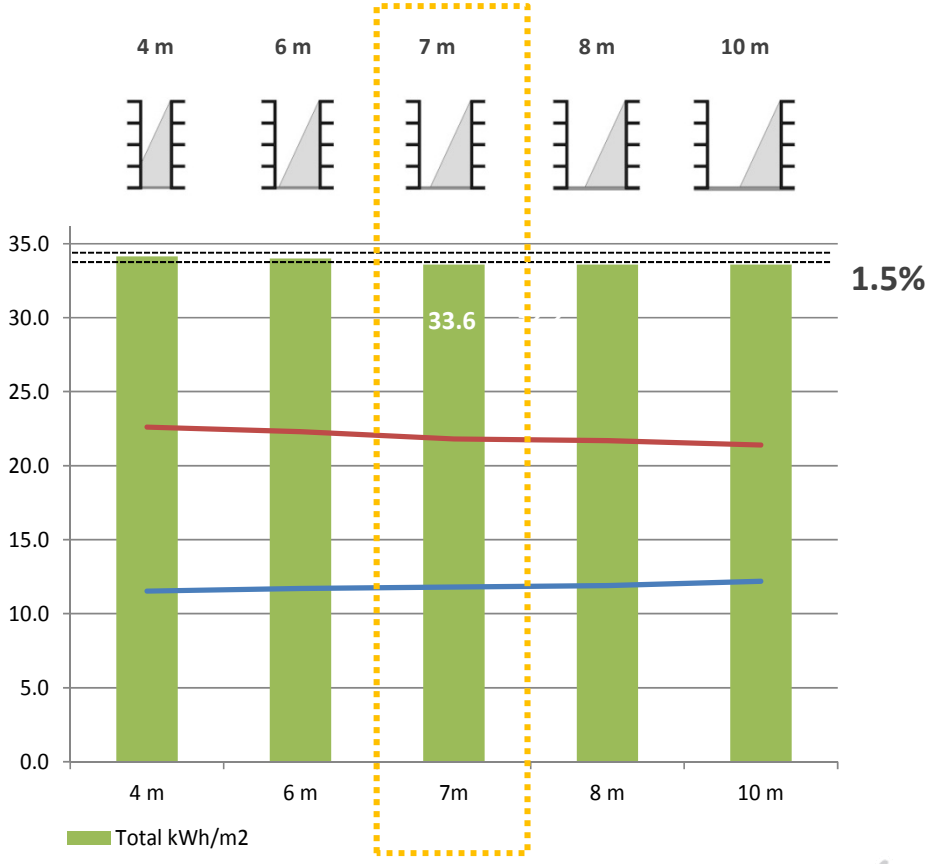
2.3 BUILDING CONFIGURATIONS: TYPOLOGIES
RESIDENTIAL



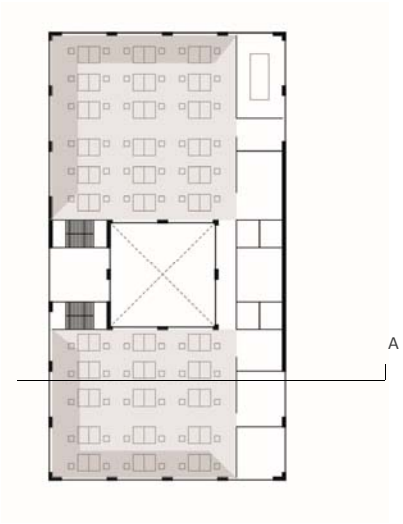
HEAT/COOL ENERGY USE
Comparison of patio size



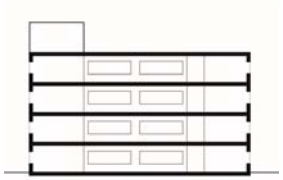
HEAT/COOL ENERGY USE
Comparison of street size



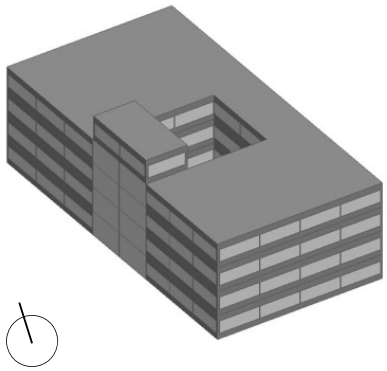
2.3 BUILDING CONFIGURATIONS: OFFICE TYPOLOGIES

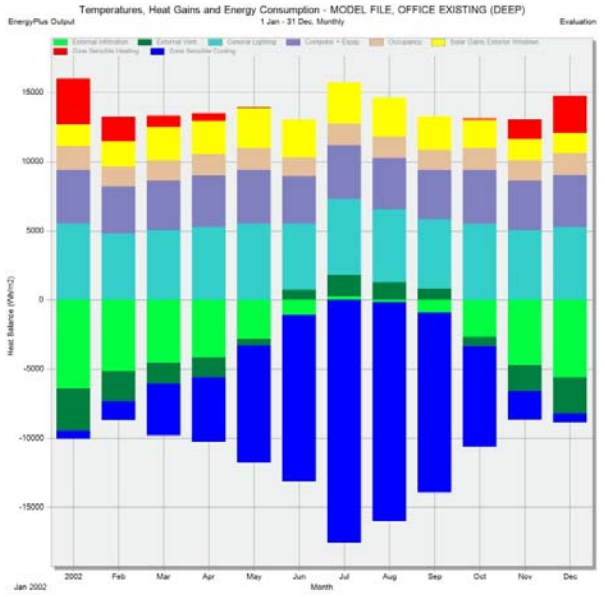


Typical floor plan



Section A



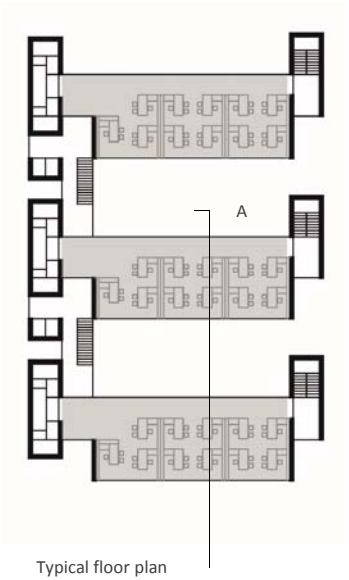


EXISTENT OFFICE

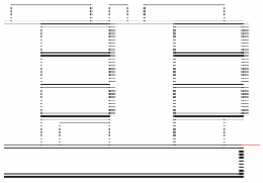
TOTAL ENERGY CONSUMPTION
150kWh/m2

OPERATIVE TEMPERATURE
24-30ºC

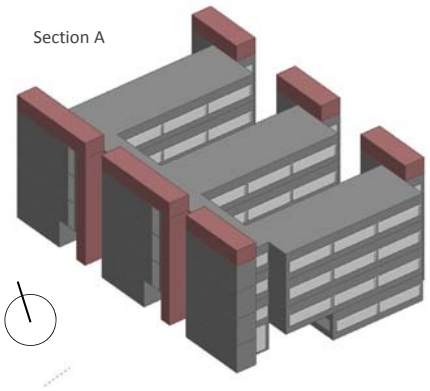
FULLY AIRE CONDITIONED

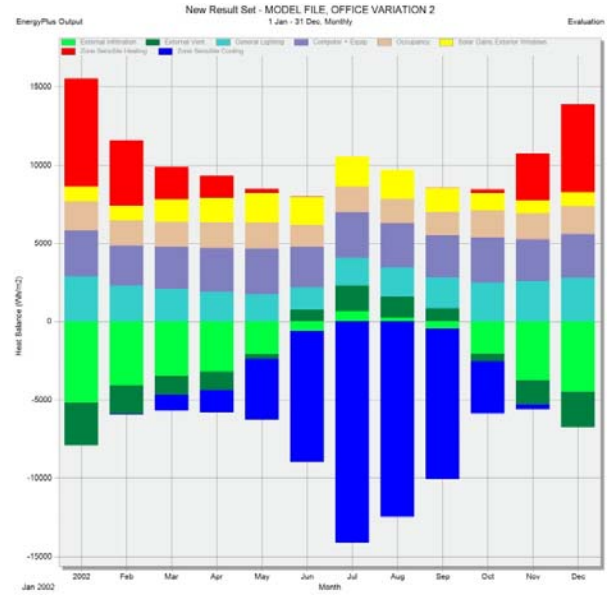


Typical floor plan



Section A





NEW OFFICE

TOTAL ENERGY CONSUMPTION
101kWh/m2

OPERATIVE TEMPERATURE
24-28ºC

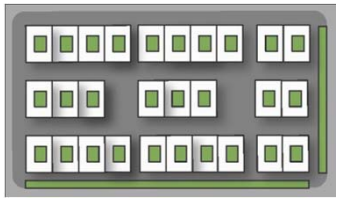
FULLY AIR CONDITIONED

-32% energy

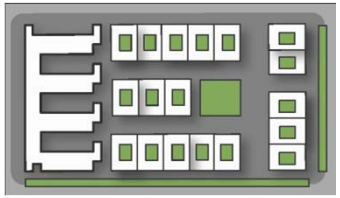
2.4 URBAN PROTOBLOCK: TYPOLOGIES

The selection of the block to be analyzed was motivated by several parameters:

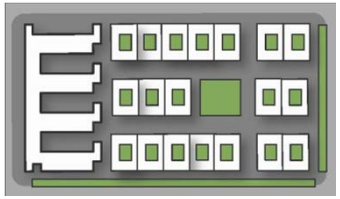
-Closeness to existent buildings
- Situation by one of the green boulevards
- Closeness to water stream
- Closeness to empty lots to be filled with new buildings



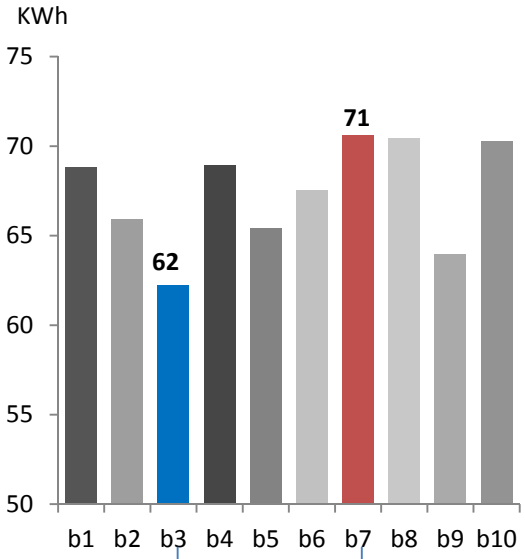
RESIDENTIAL ONLY

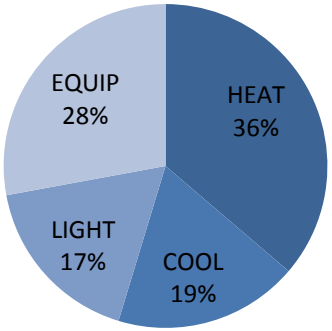


MIXED USE A



MIXED USE B





Energy use breakdown

2. URBAN PROTOBLOCK: RESIDENTIAL

NUMBER OF BUILDINGS: **28 BUILDINGS**

NUMBER OF FLOORS: **4 FLOORS/BUILDING**

NUMBER OF OCCUPANTS: **336 RESIDENTS**

FLOOR AREA PER BUILDING: **400 m2/BUILDING**

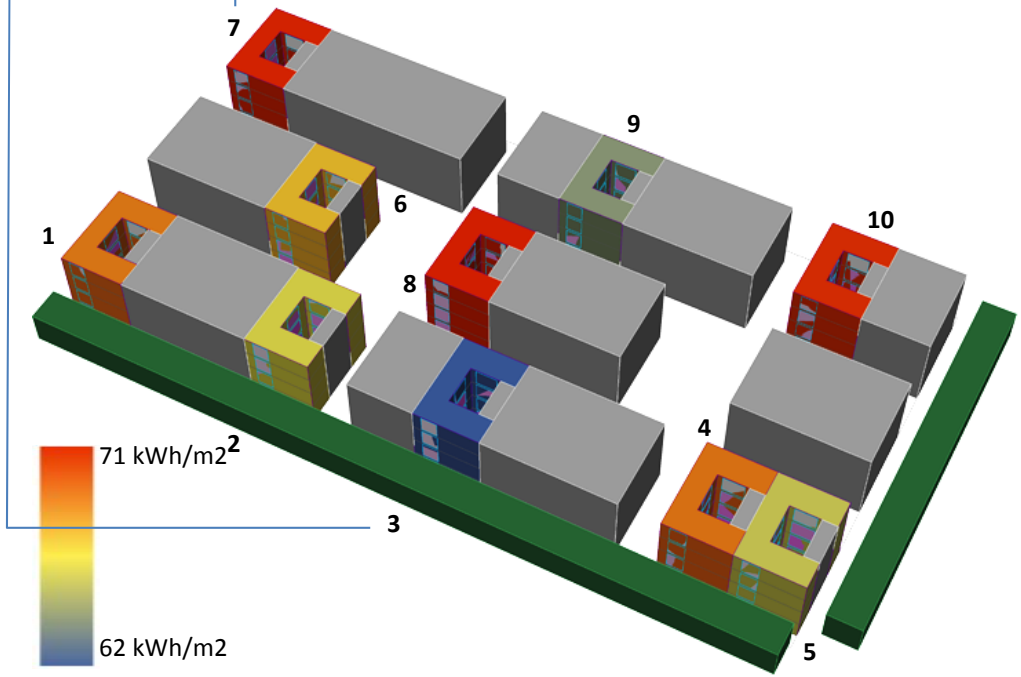
TOTAL FLOOR AREA: **11200 m2 IN TOTAL**

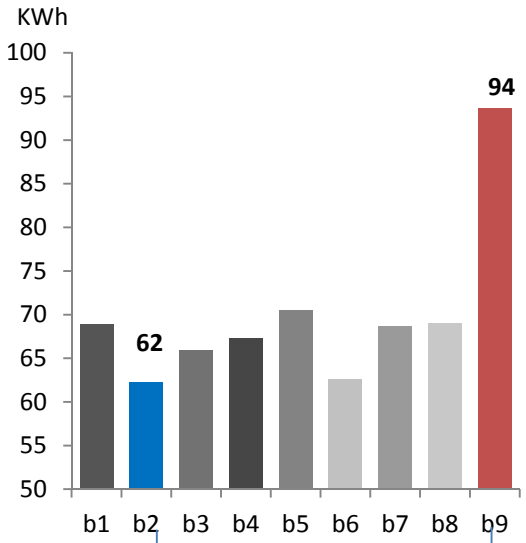
BLOCK SIZE: **7836**

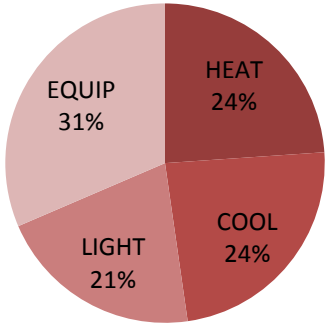
FAR: **1.429**

RESIDENTIAL urban results

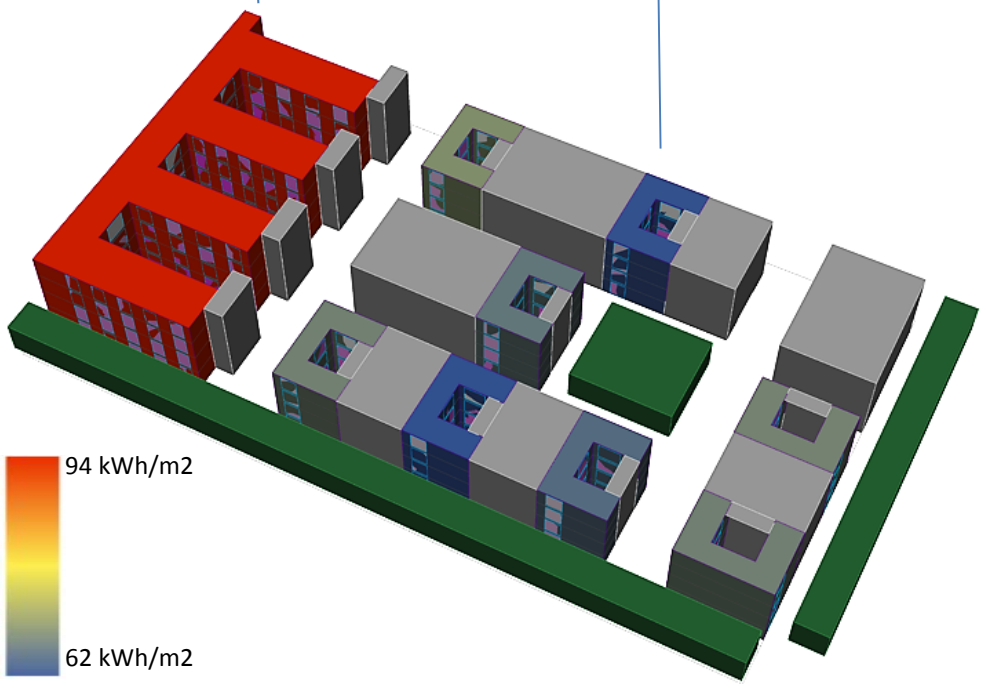
Total energy use = 744800 kWh – 66.5 kWh/m2







Energy use breakdown



2. URBAN PROTOBLOCK: MIXED USE A

NUMBER OF BUILDINGS: 1**8 residential + 1 office BUILDINGS**

NUMBER OF FLOORS: **4 FLOORS/BUILDING**

NUMBER OF OCCUPANTS: **216 RESIDENTS + 300 WORKERS = 516**

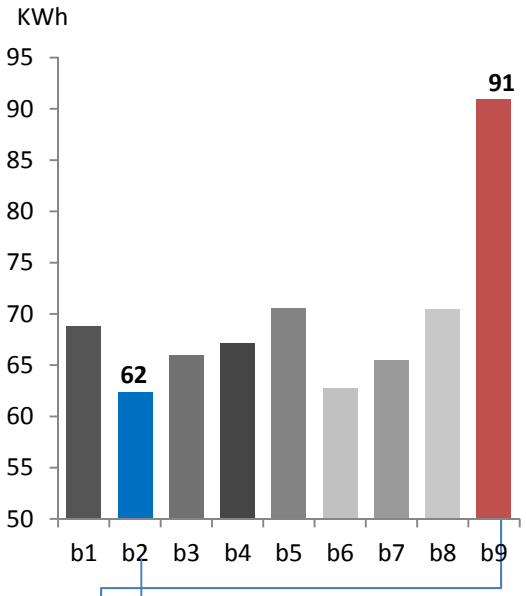
FLOOR AREA PER BUILDING: **400 m2/residential 4000m2/office**

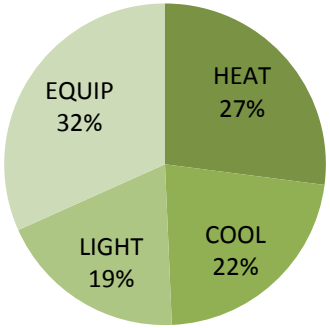
TOTAL FLOOR AREA: (7200+4000) **11200 m2 IN TOTAL**

BLOCK SIZE: **7836**

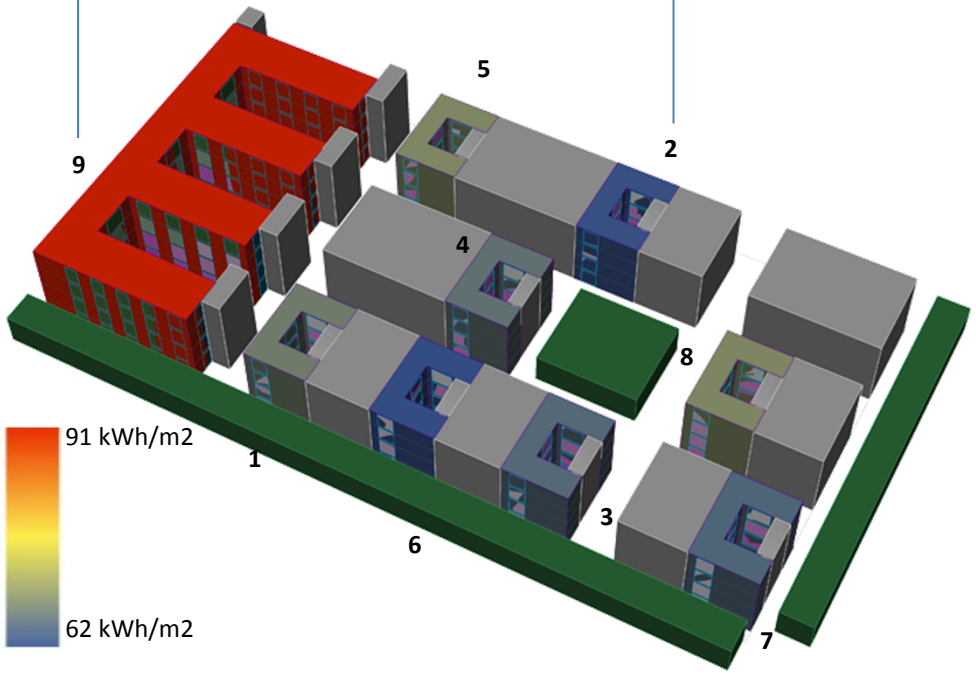
FAR: **1.43**

MIXED A urban **results**
Total energy use = 869400kWh - 75 kWh/m2





Energy use breakdown



2. URBAN PROTOBLOCK: MIXED USE B

NUMBER OF BUILDINGS: 17 **residential + 1 office BUILDINGS**

NUMBER OF FLOORS: **4 FLOORS/BUILDING**

NUMBER OF OCCUPANTS: **204 RESIDENTS + 300 WORKERS = 504**

FLOOR AREA PER BUILDING: **400 m2/residential 4000m2/office**

TOTAL FLOOR AREA: (6800+4000) **10800 m2 IN TOTAL**

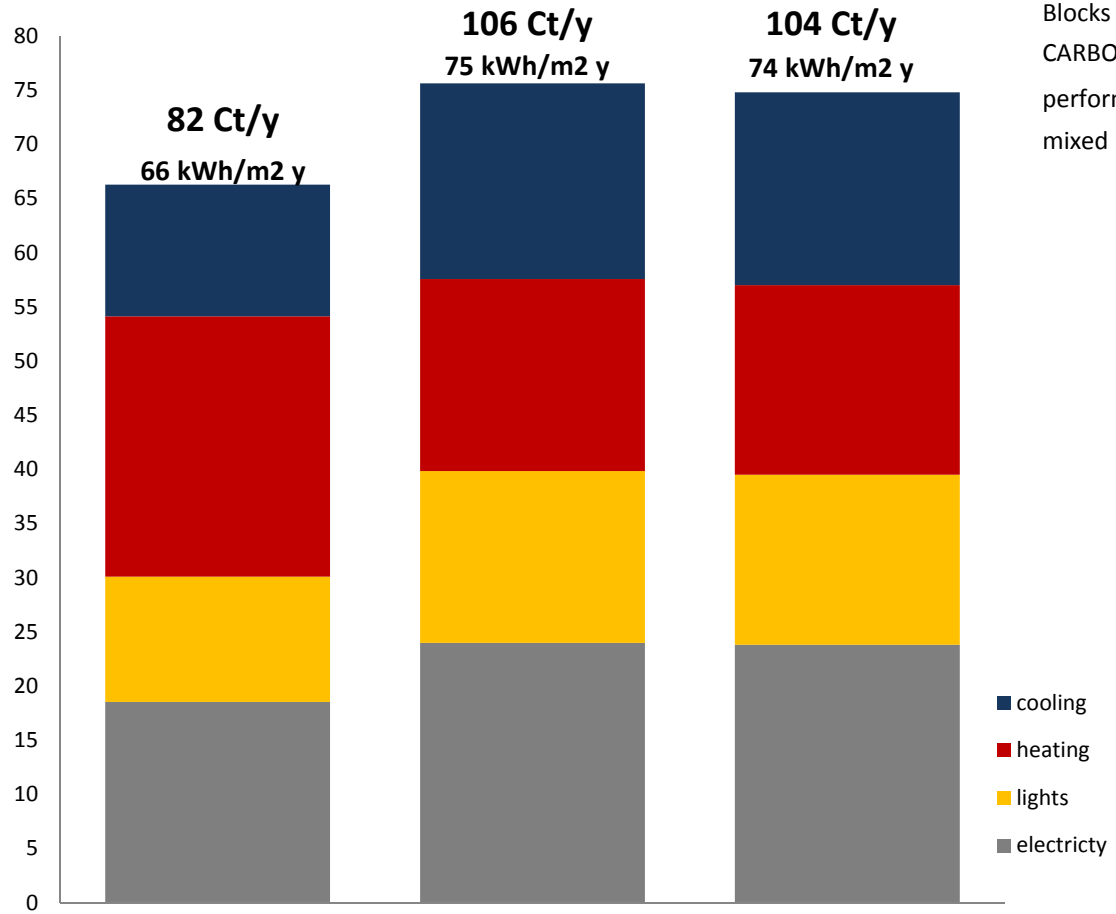
BLOCK SIZE: **7836**

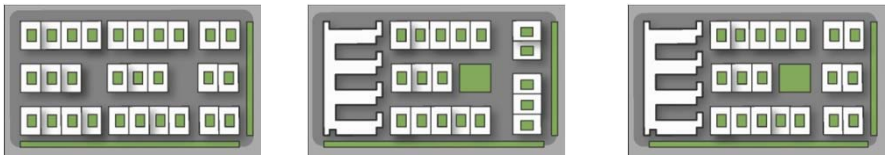
FAR: **1.38**

MIXED B urban **results**
Total energy use = 846400kWh - 74 kWh/m2

2.5 URBAN PROTOBLOCK: COMPARISON RESULT

Blocks are compared considering ENERGY USE / m2 year and CARBON EMISSIONS / year, concluding that for mixed use B (block 3) performs better for both metrics with a **2%** improvement over mixed use B.





Residential ONLY:

1ST

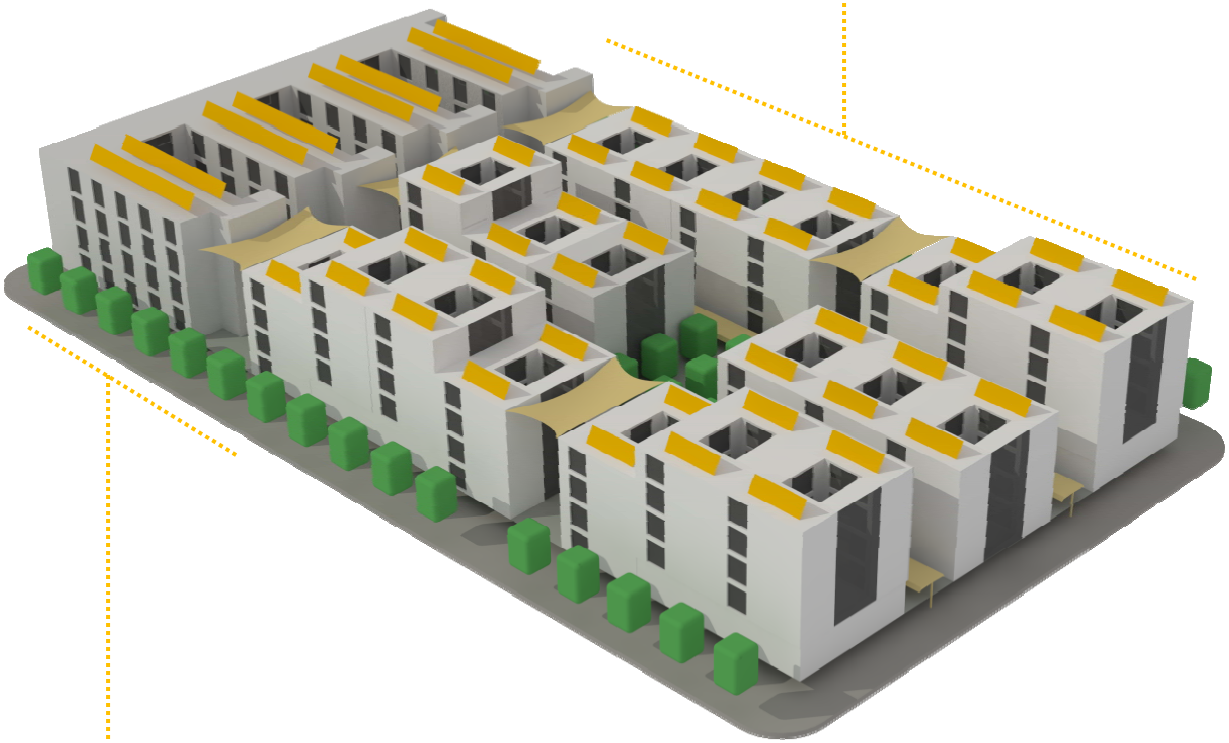
MIXED USE A:

3ND

MIXED USE B:

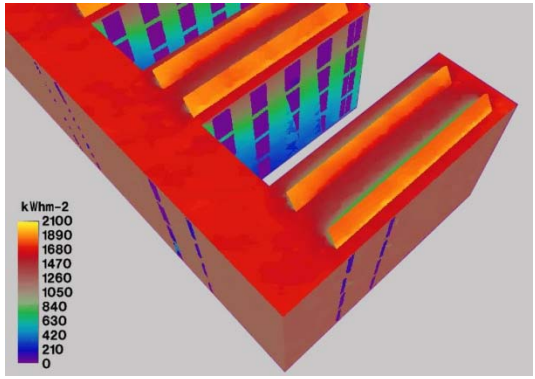
2RD

2. URBAN PROTOBLOCK: SOLAR ENERGY



SOLAR PANELS DHW and heating	**DATA**
Deposit volume	1500 l
Performance	16.3%
Energy produced	**7500 KWh**
Percentage	**70.4%** > 70%

Panels total Area: 24.12 m2
Angle: 60º
Orientation: South
Surface: 400 m2



PV PANELS Electricity	**DATA**
Energy produced	**56000 KWh**
Percentage	**14.9%**

Panels total Area: 259.2 m2
Angle: 60º
Orientation: South
Distance between panels: 3 m

2. URBAN PROTOBLOCK: OUTDOOR COMFORT ANALYSIS

METHOD FOR ANALYSIS

The outdoor comfort for the pedestrians is measured by comparing two methods based in empirical formulas:

- **THERMAL SENSATION INDEX (TS)**
  Developed by Naguchi and Givoni in 1997.

- **ACTUAL SENSATION VOTE (ASV)**
  Developed by Nikoulopuolo et al. in 2004.

1	VERY COLD
2	QUITE COLD
3	COLD
4	COMFORT
5	HOT
6	QUITE HOT
7	VERY HOT

TS

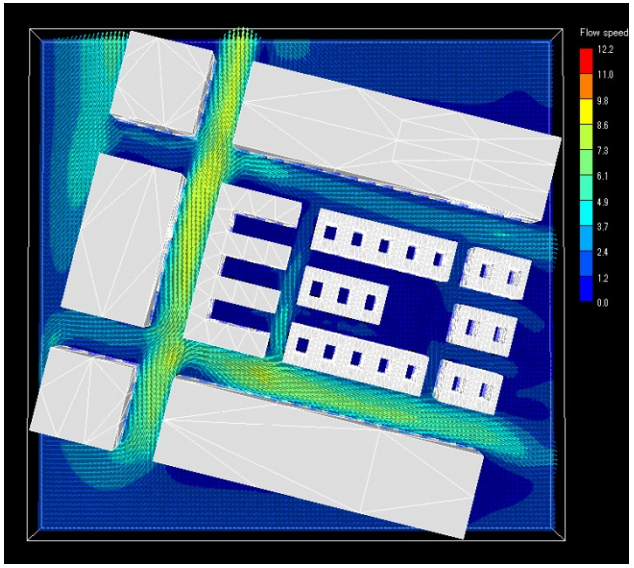
-2	VERY COLD
-1	COLD
0	COMFORT
1	HOT
2	VERY HOT

ASV

TS = 1.7 + 0.1118*Ta + 0.0019*SR - 0.322*WS - 0.0073*RH + (0.0054*ST)

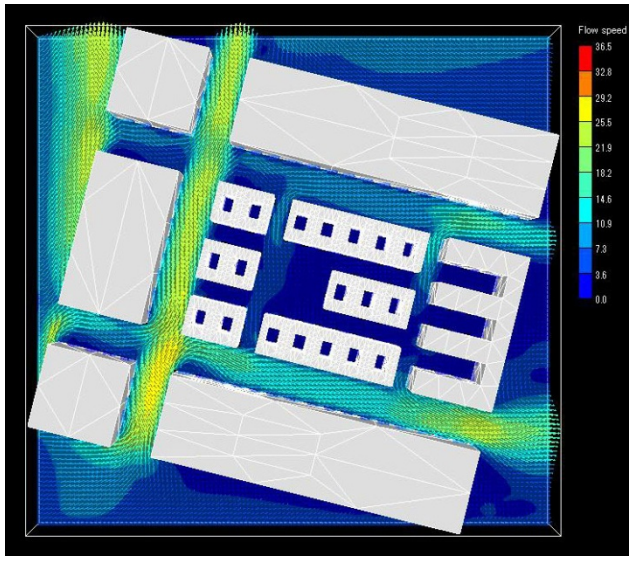
ASV = 0.034*Ta + 0.0001*SR - 0.86*WS - 0.001*RH - 0.412

3. WIND VELOCITY



7-9 m/s main st
6-7 m/s office st
3-5 m/s internal st
1-2 m/s plaza

WS 10 m/s southwest



7-9 m/s main st
6-7 m/s office st
3-5 m/s internal st
3-5 m/s plaza

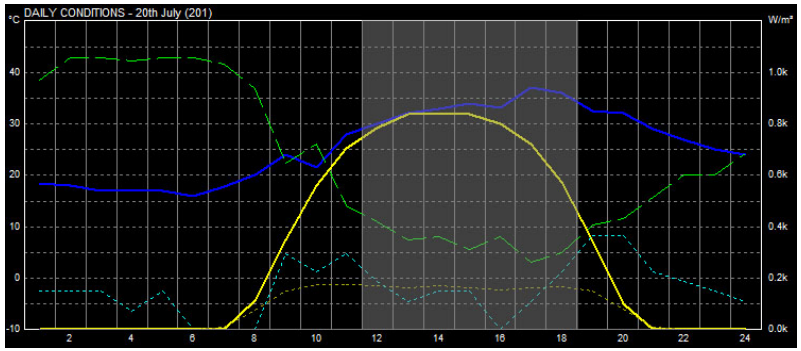
WS 10 m/s southwest

2. URBAN PROTOBLOCK: OUTDOOR COMFORT ANALYSIS

CONSIDERED PARAMETERS

1. AIR TEMPERATURE

From weather information
Period considered: between 12 and 5 pm, summer design week
28-37 C.



2. RELATIVE HUMIDITY

Average of 30%
Raise until 70% when considering water features.

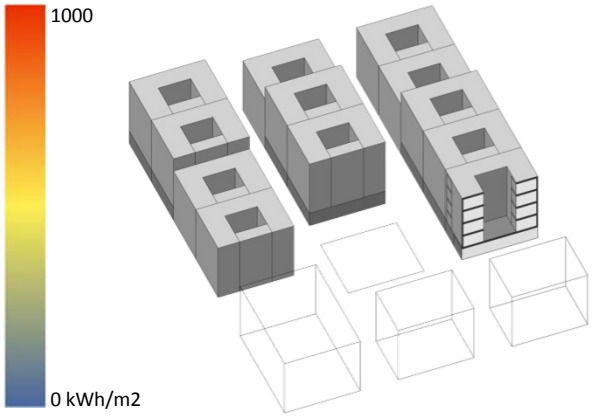
3. WIND VELOCITY

Most likely situation of wind direction _ SOUTH-WEST
Velocity of 10 m/s
Effects through the block with Flow Designer CFD software.

4. SOLAR RADIATION

Radiation simulation run by DIVA in several situations of shading, to obtain kwh/m2 at a height of 1.5 m per hour

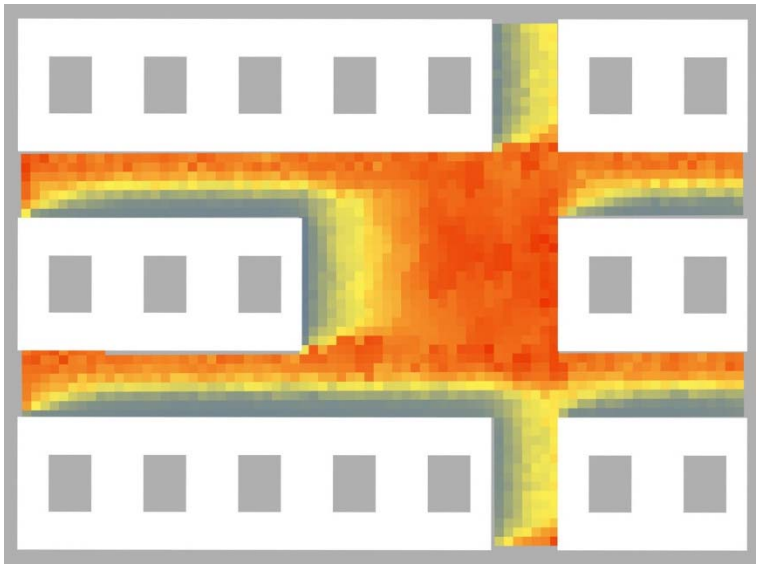
4. SOLAR RADIATION



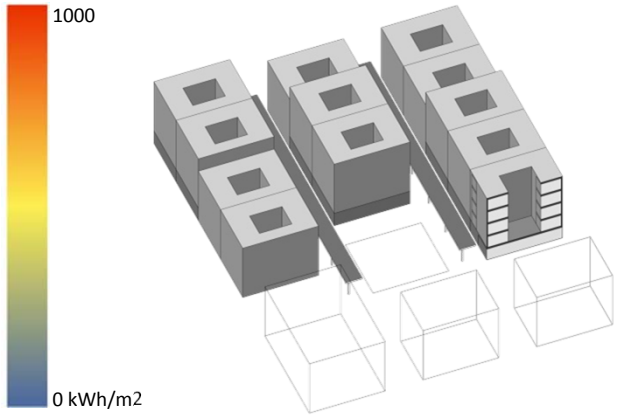
CASE 1

STREETS / NO SHADING
PLAZA / NO SHADING
TRANSVERSAL / NO SHADING

12-17 h RADIATION 1.5 m h



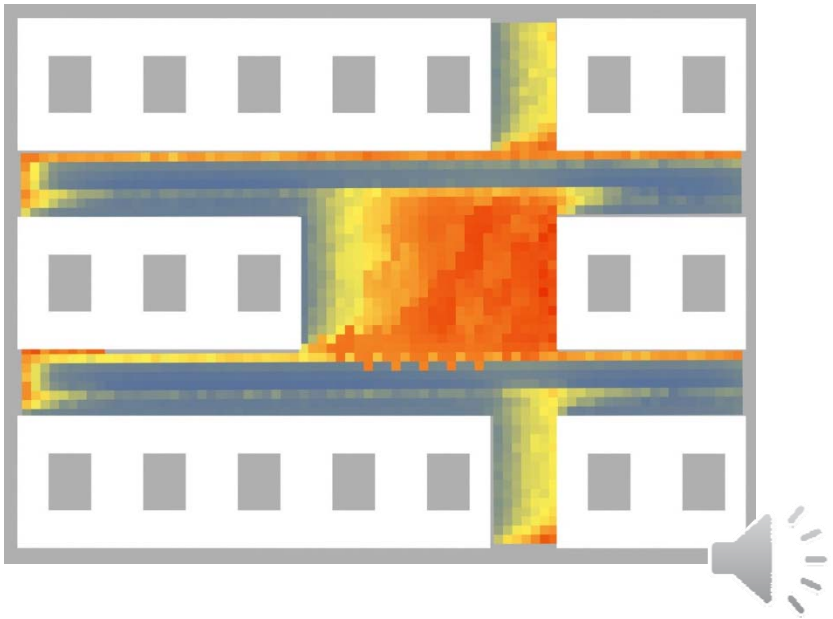
2. URBAN PROTOBLOCK: OUTDOOR COMFORT ANALYSIS



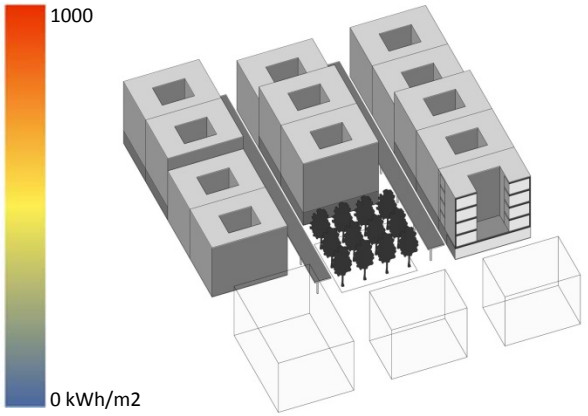
CASE 2

STREETS / PERGOLA
PLAZA / NO SHADING
TRANSVERSAL / NO SHADING

12-17 h RADIATION 1.5 m h



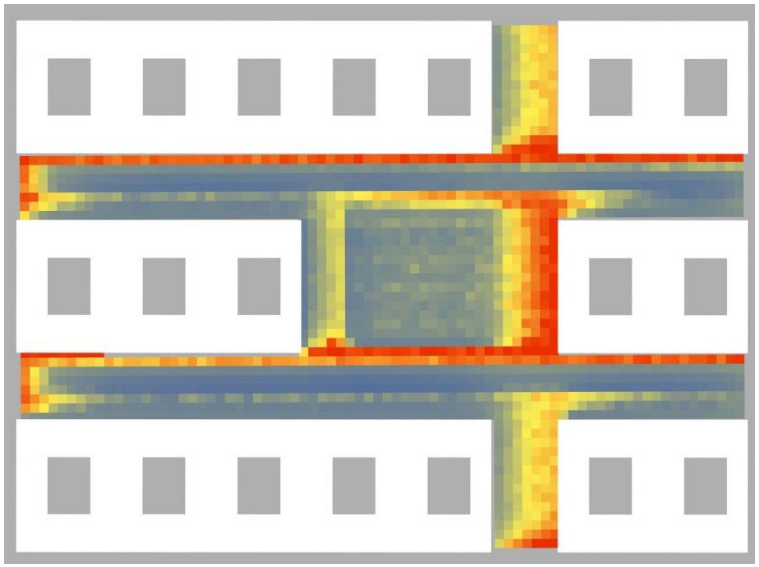
2. URBAN PROTOBLOCK: OUTDOOR COMFORT ANALYSIS

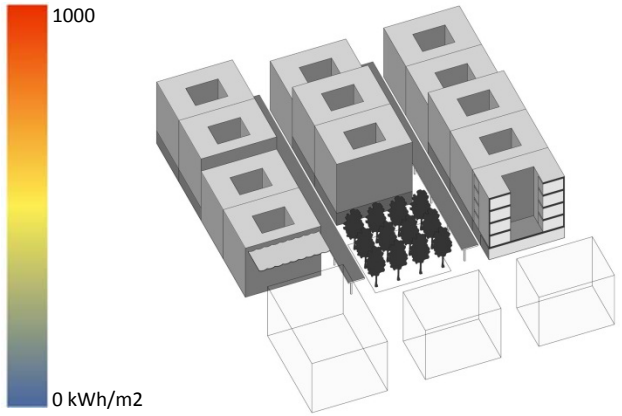


CASE 3

STREETS / PERGOLA
PLAZA / TREES
TRANSVERSAL / NO SHADING

12-17 h RADIATION 1.5 m h

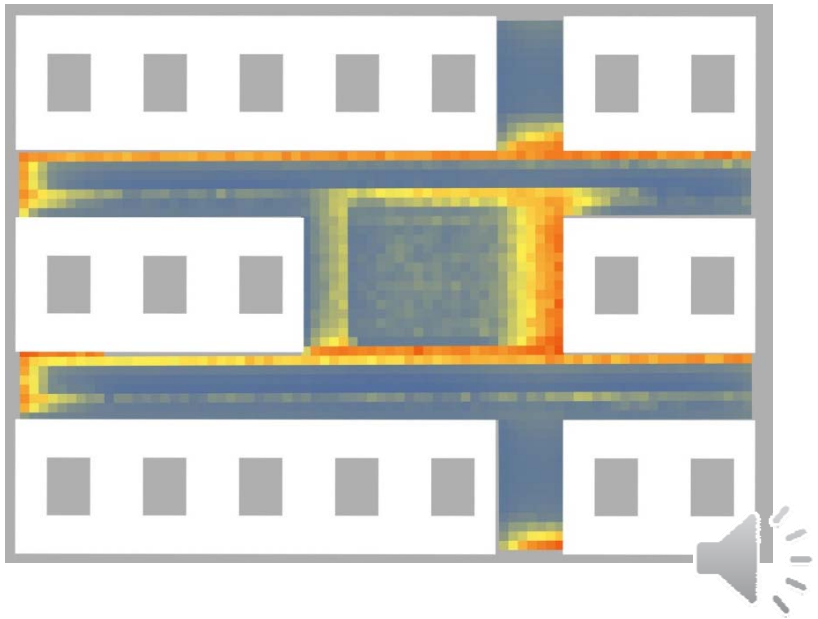




CASE 4

STREETS / PERGOLA
PLAZA / TREES
TRANSVERSAL / FABRIC

12-17 h RADIATION 1.5 m h



2. URBAN PROTOBLOCK: OUTDOOR COMFORT ANALYSIS

TS AND ASV COMPARISON

STREETS: SHADED
TEMPERATURES BELOW 37ºC
WIND SPEED OVER 3.5 m/s
(Not between 16-18pm)

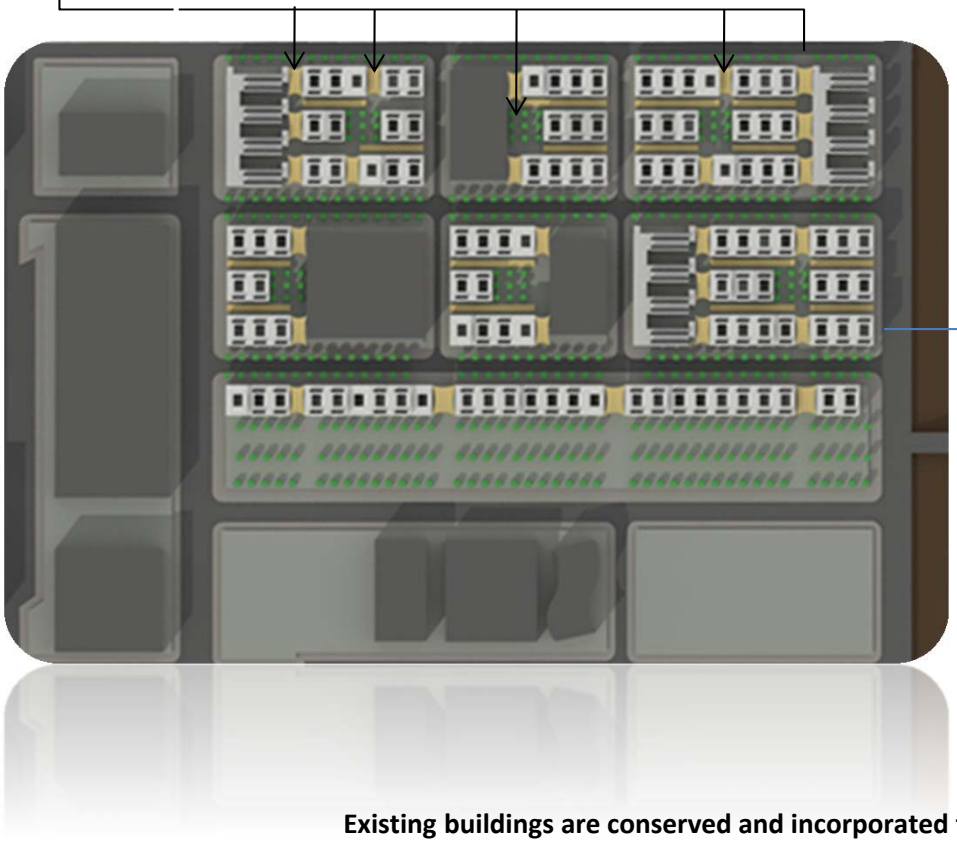
PLAZA: SHADED
TEMPERATURES BELOW 31ºC
WIND SPEED OVER 2 m/s
(Not between 14-18pm)
WATER FEATURES = Humidity increase = COMFORT UPTO 34ºC

CASE	Ta	SR	WS	RH	TS	Level of Comfort	ASV	Level of Comfort
	C	W/m2	m/s	%				
0. GENERAL/no shading/wind sw 2/T37	37	1000	2	25	7.02	VERY HOT	0.75	HOT
1. STREET/cloth/wind sw 5/T37	37	100	5	25	4.26	COMFORT	0.40	COMFORT
1. STREET/pergola/wind sw 3.7/T37	37	0	3.7	25	4.48	COMFORT	0.50	COMFORT
1. PLAZA/trees/wind sw 2/T37	37	100	2	25	5.22	HOT	0.66	HOT
2. STREET/cloth/wind sw 5/T30	30	100	5	40	3.37	COMFORT	0.15	COMFORT
2. STREET/pergola/wind sw 3.7/T30	30	0	3.7	40	3.58	COMFORT	0.25	COMFORT
2. PLAZA/trees/wind sw 2/T30	30	100	2	40	4.33	COMFORT	0.41	COMFORT
3. PLAZA/trees/wind sw 2/T37/water	37	100	2	80	4.82	HOT	0.60	HOT
4. PLAZA/trees/wind sw 2/T30/water	30	100	2	80	4.04	COMFORT	0.37	COMFORT

These results only work as a comparative reference between solutions because the experimental data does not come from the site, and due to the fact that some other factors such as the surface temperature have not been taken into account.

2. URBAN NEIGHBORHOOD: DESIGN GUIDELINES

The general longitudinal structure of the place is conserved but transversal streets are created to reduce the block size to a residential scale.



Blocks are densified contain mix used buildings of housing, retail and offices.

.

Public squares are located inside the block to provide a lively atmosphere.

Retail is located in the squares and in the main longitudinal axes.

Existent boulevards are filled with a row of houses in order to provide shadow and to reduce the scale of the public space.

Shading devices are provided in the forms of trees, textiles and pergolas,.

Housing is configured in an attached disposition of rows creating pedestrian comfortable paths in between

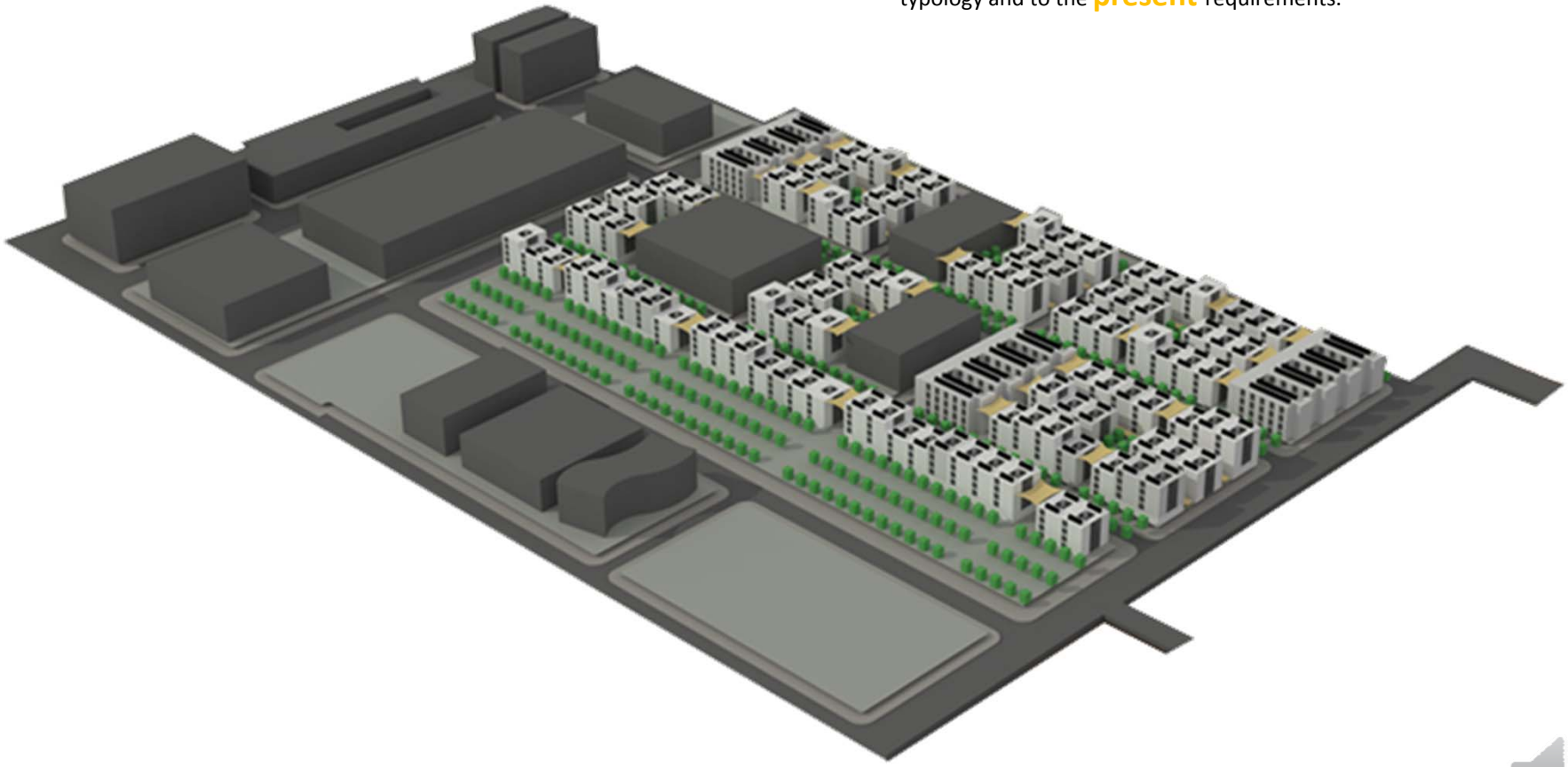
Existing buildings are conserved and incorporated to the offices provision.

2. SUSTAINABLE NEIGHBORHOOD: **PROPOSAL**

The height of the buildings is in accordance with the existent and with the dimensions of the streets.

The neighborhood is properly connected, providing an **expansion** to the overwhelmed old city center.

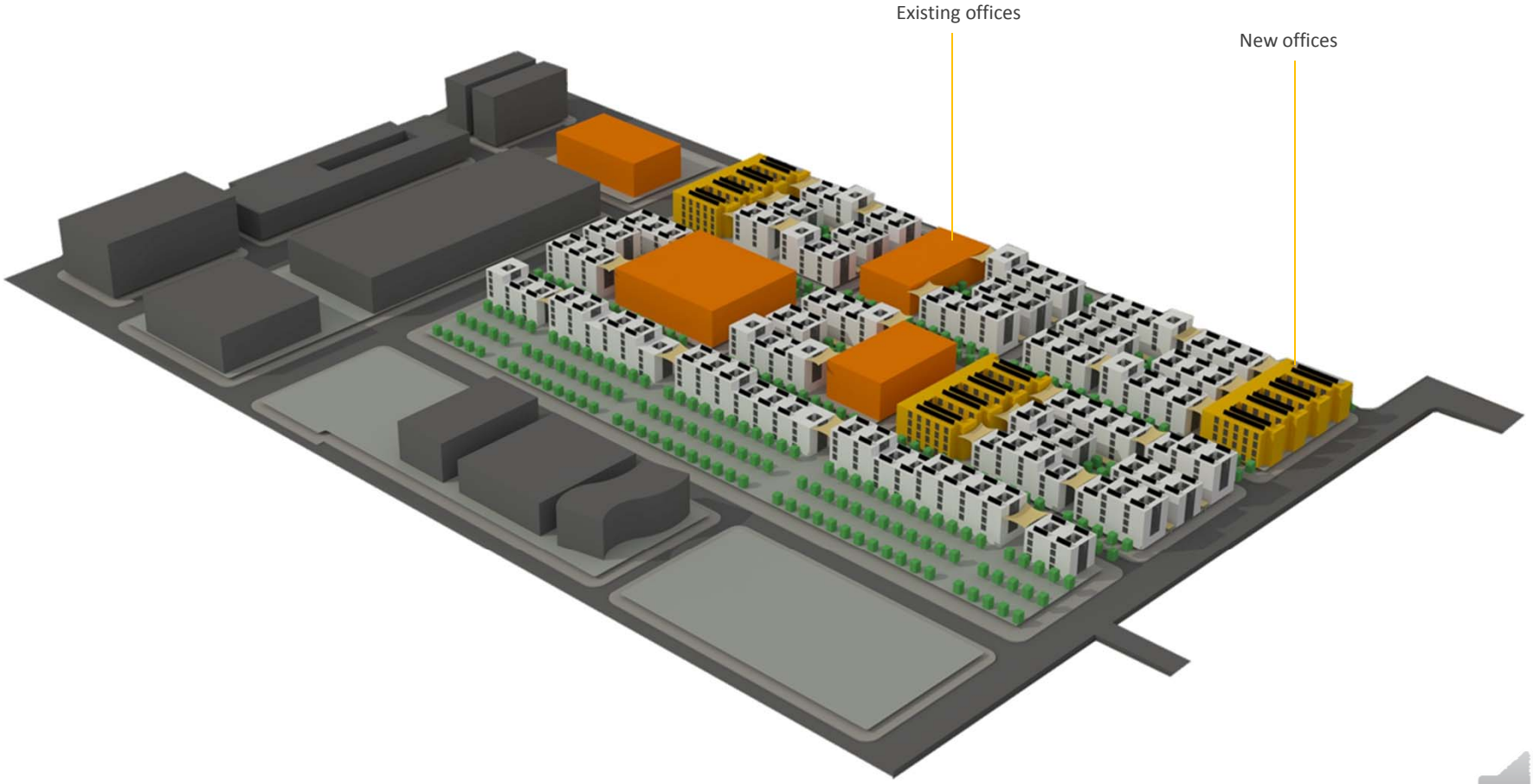
It takes advantage of obsolete buildings and a profitable site to propose a sustainable and integrated place, in dialogue to the **traditional** typology and to the **present** requirements.



2. SUSTAINABLE NEIGHBORHOOD: **PROPOSAL**

Existent offices surface: 35.000m2
New offices surfaces: 12.000m2

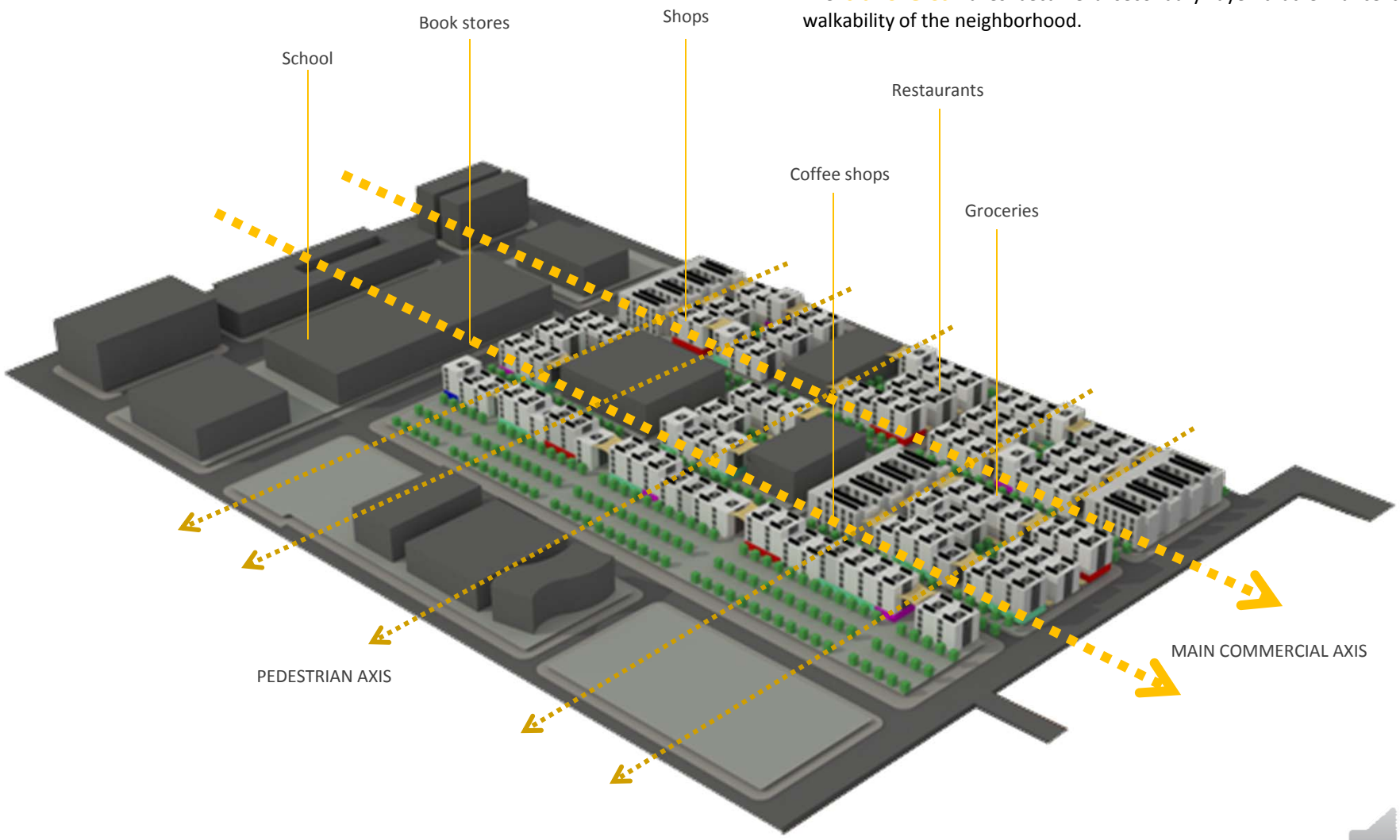
The new offices are designed and located strategically to protect the housing from the sun radiation of the **East** and the **West**.



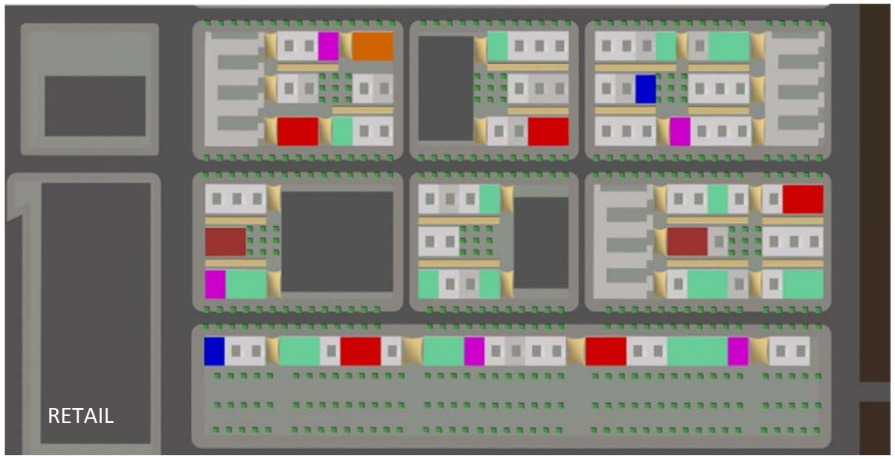
2. SUSTAINABLE NEIGHBORHOOD: **PROPOSAL**

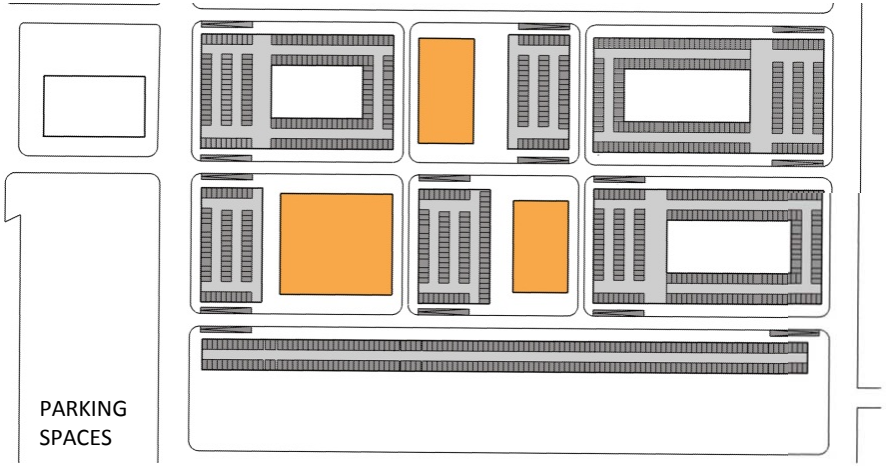
Longitudinal axes are supported by the presence of retail and activity.

The **transversal** axes became a secondary layer that enhance the walkability of the neighborhood.



2. SUSTAINABLE NEIGHBORHOOD: **WALKABILITY**

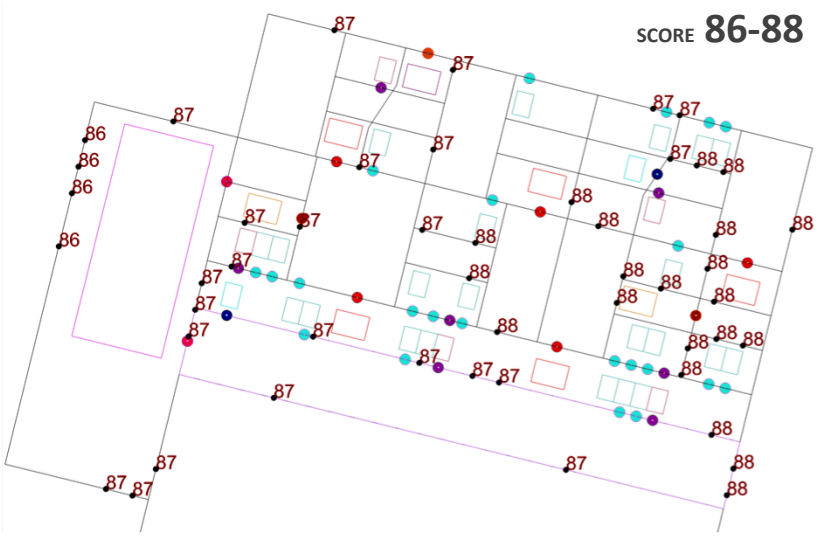




RETAIL		m2	required	coefficient	total m2
grocery		400	4.4	0.75	1320
coffee		400	4.4	0.25	440
restaurant		800	2.2	0.32	563.2
bank		800	2.2	0.25	440
book		1500	1.17	0.13	228.8
shopping		1500	1.17	1.3	2288
parks		3000	0.59	1	1760
schools		3000	0.59	2	3520
entertainment		5000	0.35	0.6	1056

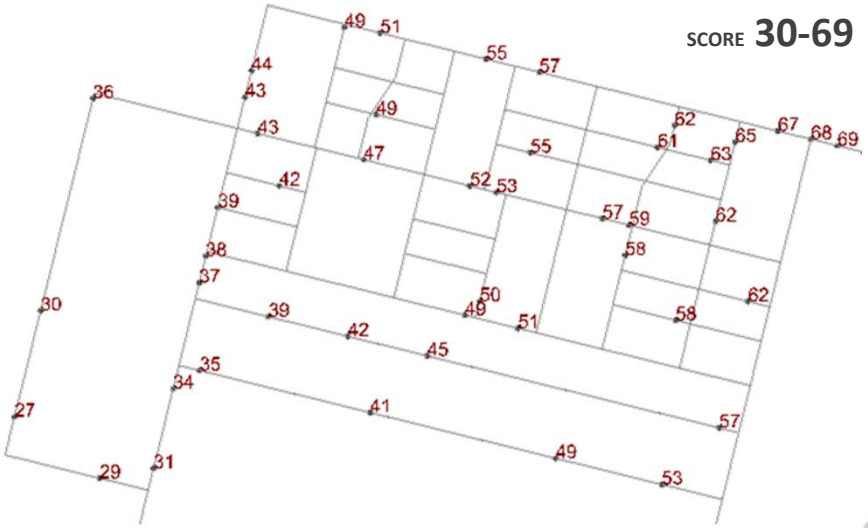
POPULATION 2000 inhabitants

SCORE **86-88**

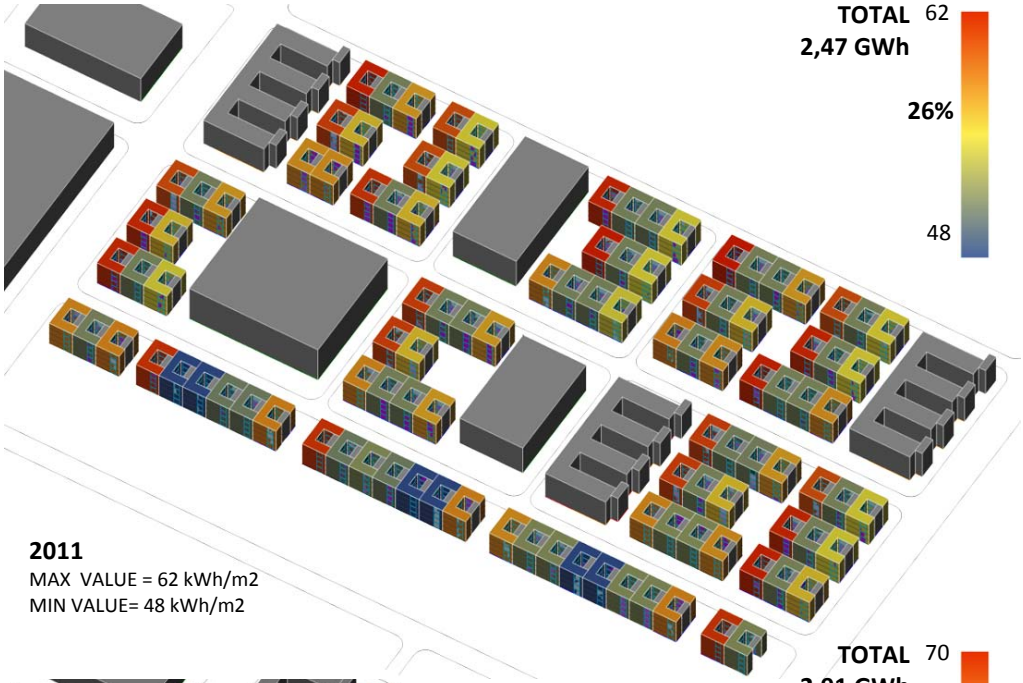


WALKSCORE – **ON SITE RETAIL**

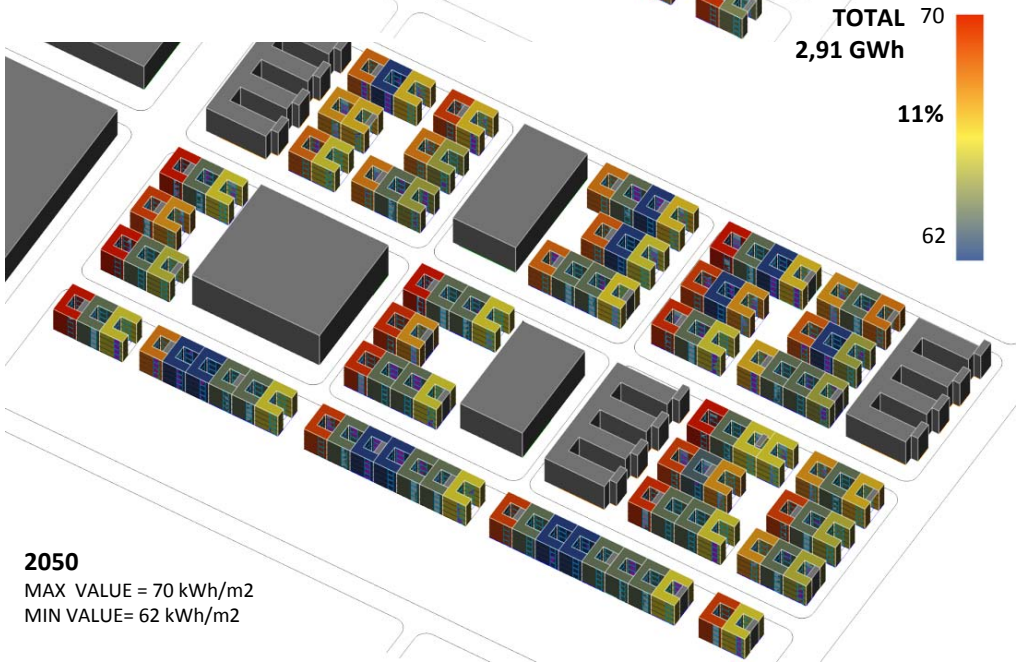
SCORE **30-69**



WALKSCORE – **OUT SITE RETAIL**



2011
MAX VALUE = 62 kWh/m2
MIN VALUE= 48 kWh/m2



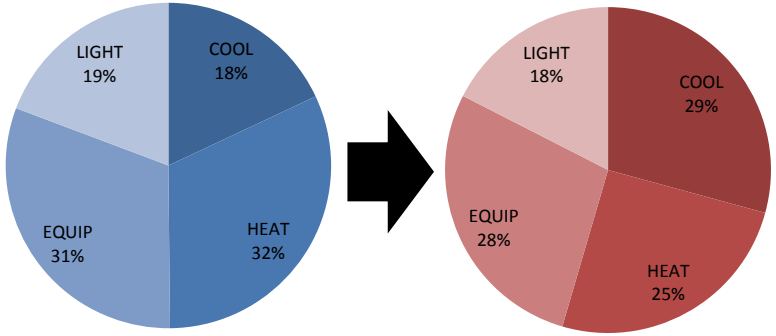
2050
MAX VALUE = 70 kWh/m2
MIN VALUE= 62 kWh/m2

SUSTAINABLE NEIGHBORHOOD: ENERGY USE ANALYSIS

1. **2011 SCENARIO:** The main energy use comes from heating, and the total energy use for housing is 2.47 GWh.
2. **2050 SCENARIO:** The main energy use comes from cooling, and the total energy use for housing is 2.91GWh.

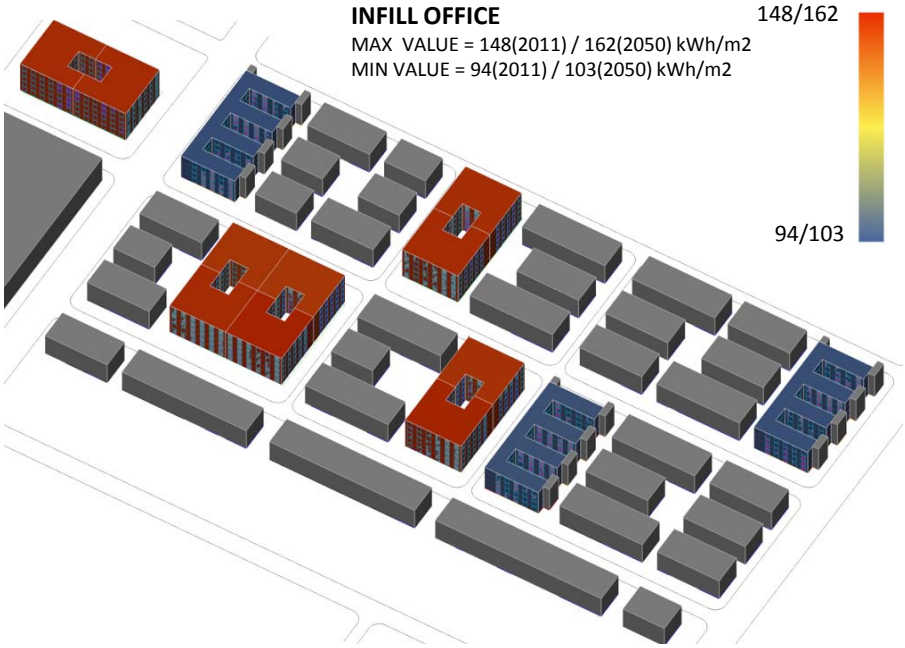
There is a global increase in 39 years of a **18%.**

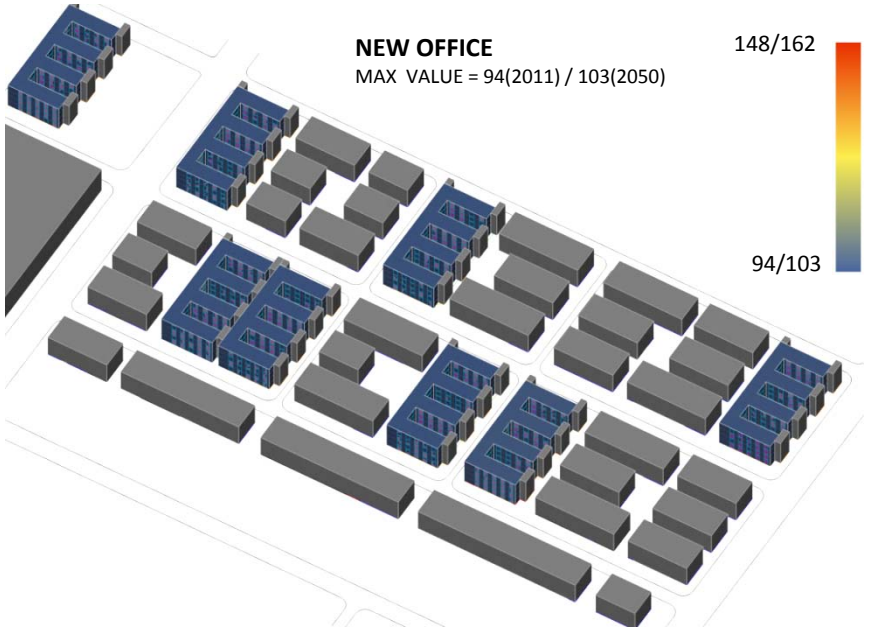
Number of Houses	110
Number of Floors	4
Number of Residents	330
Floor area per building	400 m2
Total Floor Area	44000m2
Neighborhood Size	49000 m2
FAR	1.37



2011
BREAKDOWN

2050
BREAKDOWN

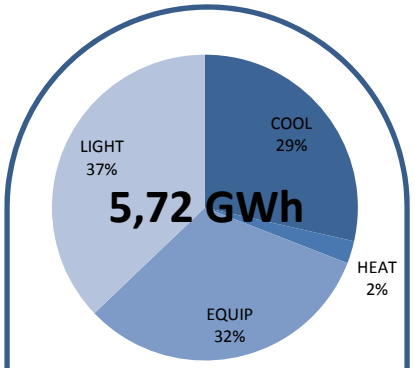




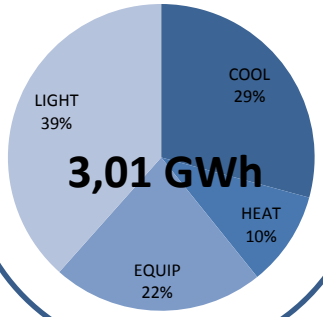
SUSTAINABLE NEIGHBORHOOD: ENERGY USE ANALYSIS

1. **INFILL SCENARIO:** Four existing office buildings are kept and 3 more are added to the plan. Existing perform a 37% worse.
2. **TABULA RASA:** All buildings are renovated to a number of 7 structures with no apparent difference in performance. The total energy us is

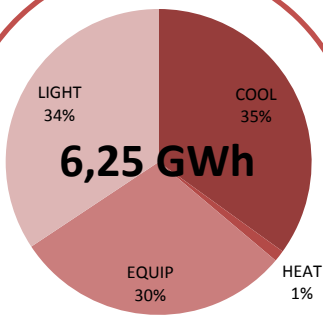
There is a global increase in 39 years of a **9%** for infill and **10%** for tabula rasa**.**



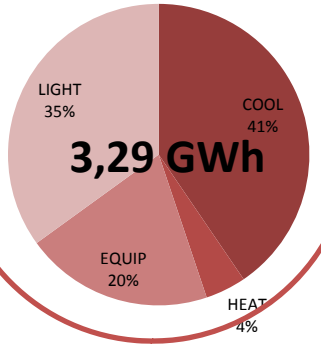
2011 INFILL BREAKDOWN



2011 NEW BREAKDOWN



2050 INFILL BREAKDOWN

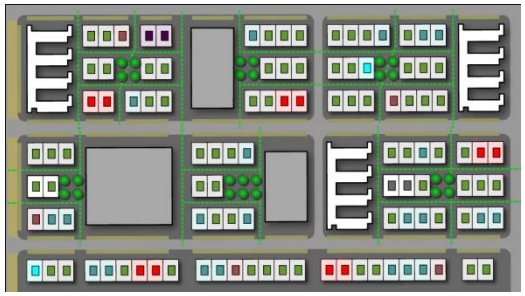


2050 NEW BREAKDOWN

3. ANALYSIS OF SCENARIOS AND CONCLUSION

3. SCENARIOS ANALYSIS:

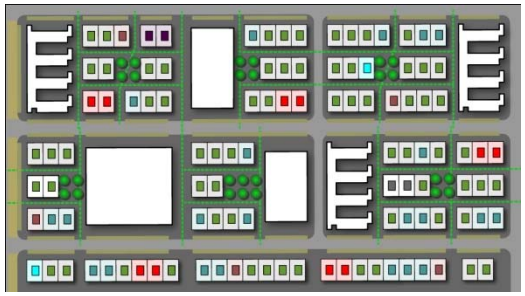
PROPOSAL SCENARIOS FOR 2011/2055



SCENARIO #1

INFILL ONLY

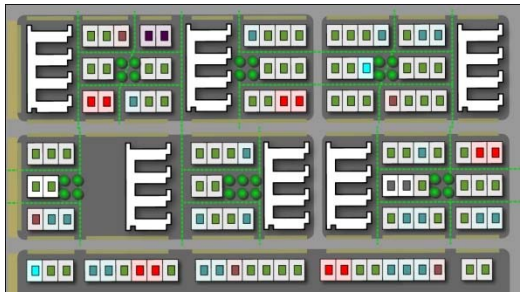
Infill 110 housing buildings + commercial
Provide 3 new office buildings
Keep existing office buildings
Operation EUI 150KHW/m2



SCENARIO #2

INFILL + RETROFITTING

Infill 110 housing buildings + commercial
Provide 3 new office buildings
Retrofit existing office buildings
-Retrofit uses 30% of building embodied energy
-Retrofit saves 20% of building EUI



SCENARIO #3

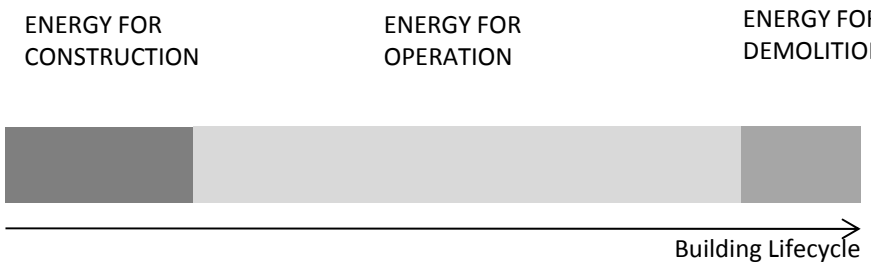
TABULA RASA

Infill 110 housing buildings + commercial
Provide 6 new office buildings
-Operation EUI 94 KWH/m2 according to E+

3. SCENARIOS ANALYSIS:

EMBODIED ENERGY IN THE PROPOSAL

LCA GENERAL PHASING

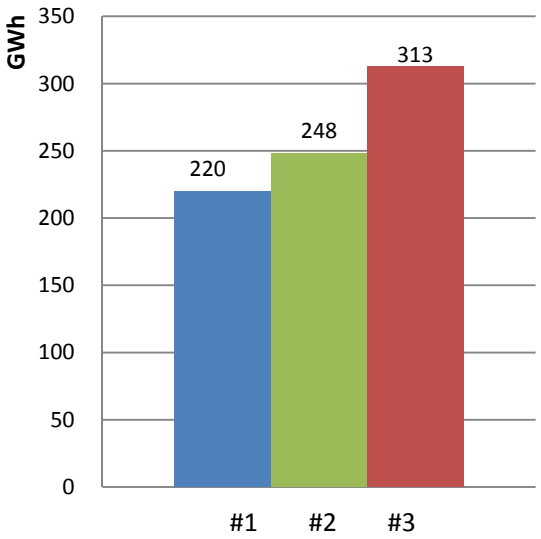


EMBODIED ENERGY CONSIDERATION

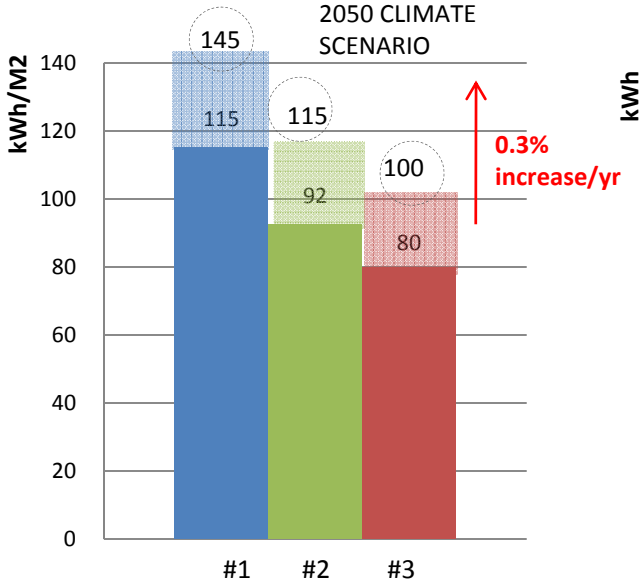
Modeling embodied energy of the proposal using a SIMPLIFIED LCA with energy and carbon information from ECOINVENT based database for Spanish construction costs.

HOUSE BUILDING	CONSTRUCTION	2513 kWh/m2
OFFICE BUILDING	CONSTRUCTION	5758 kWh/m2
OFFICE BUILDING	DEMOLITION	72 kWh/m2

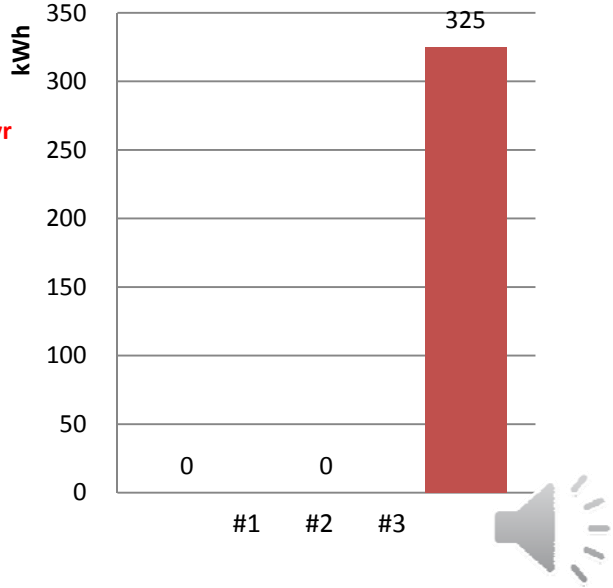
CONSTRUCTION



OPERATION

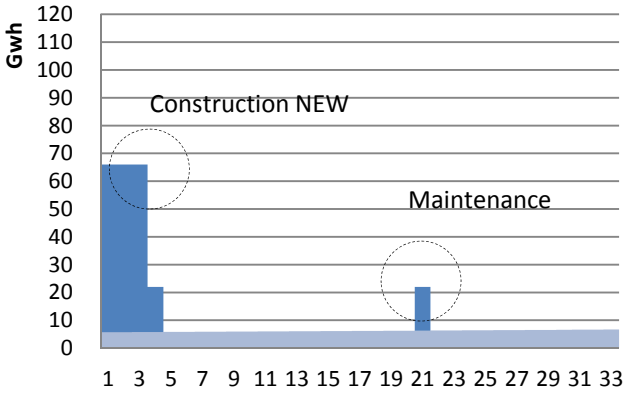


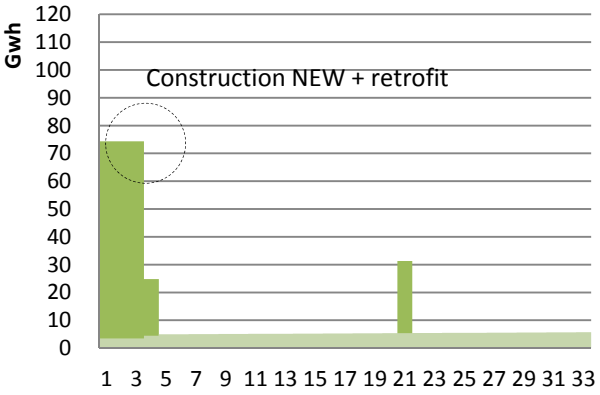
DEMOLITION

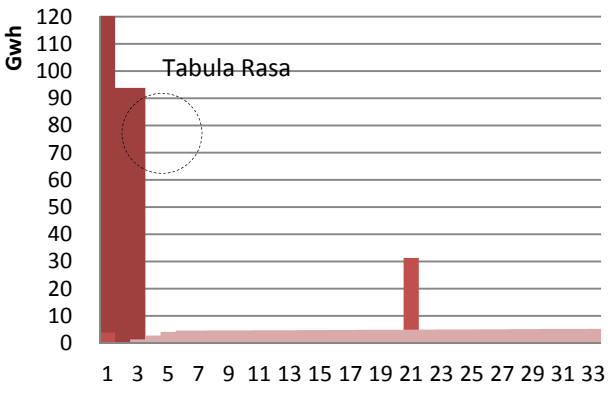


3. SCENARIOS ANALYSIS:

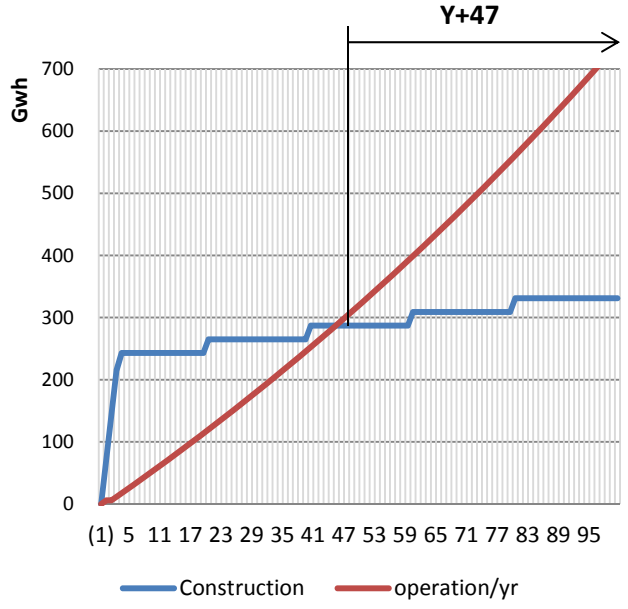
RELATION EMBODIED ENERGY / OPERATION ENERGY



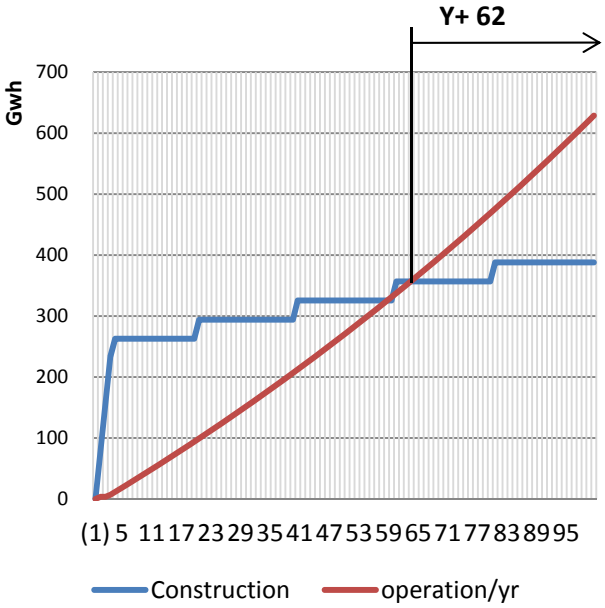




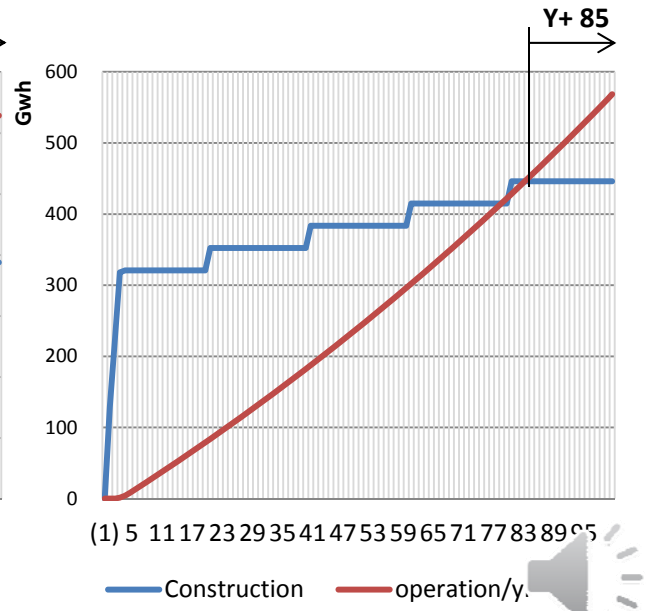
SCENARIO #1
INFILL ONLY



SCENARIO #2
INFILL + RETROFITTING



SCENARIO #3
TABULA RASA

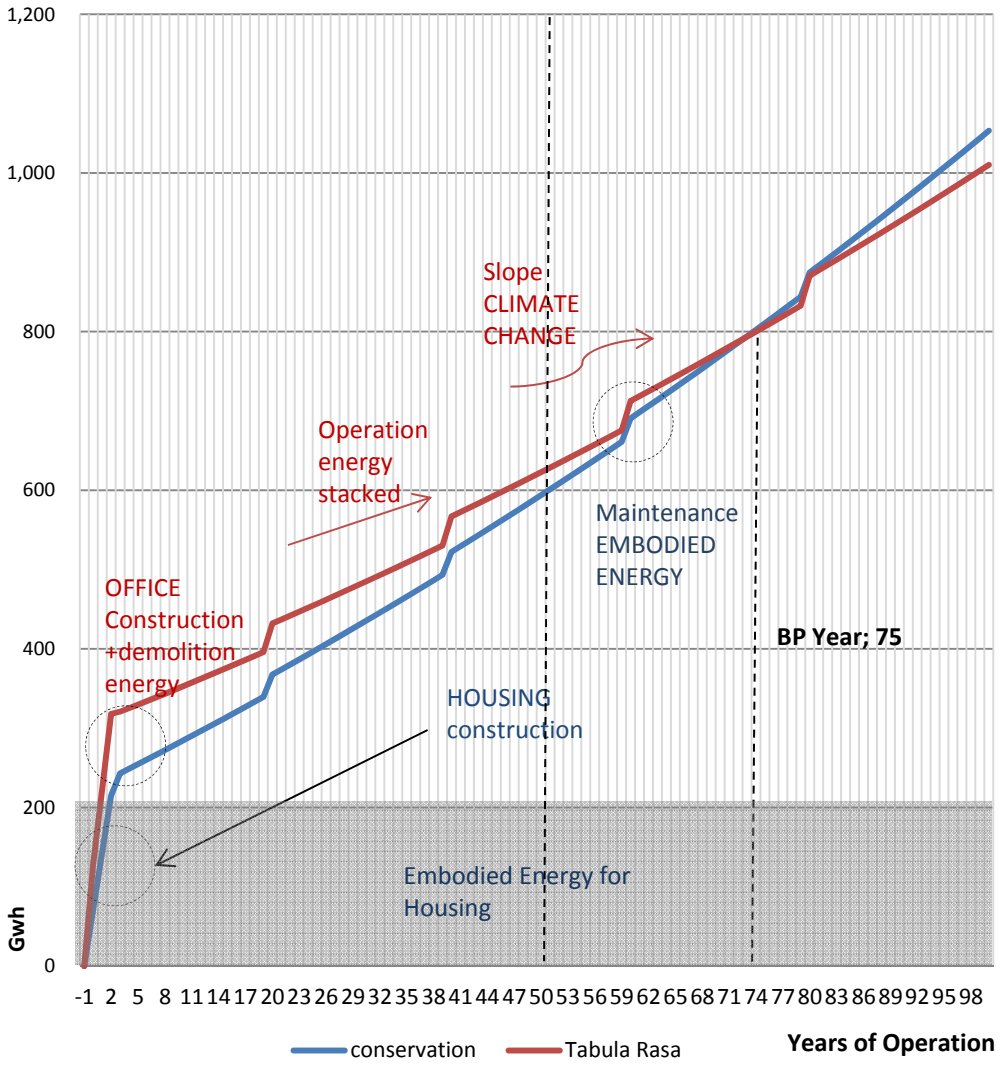


3. SCENARIOS ANALYSIS:

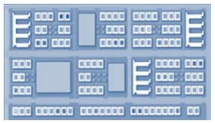
TOTAL ENERGY TIME EVOLUTION

LIFECYCLE ENERGY COST COMPARISON 1

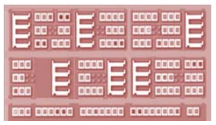
Infill vs tabula rasa



SCENARIO #1: Infill only



SCENARIO #3: Tabula Rasa



BOTH SCENARIOS MEET AFTER 75 YEARS AND FROM THAT MOMENT ON TABULA RASA IS BETTER:

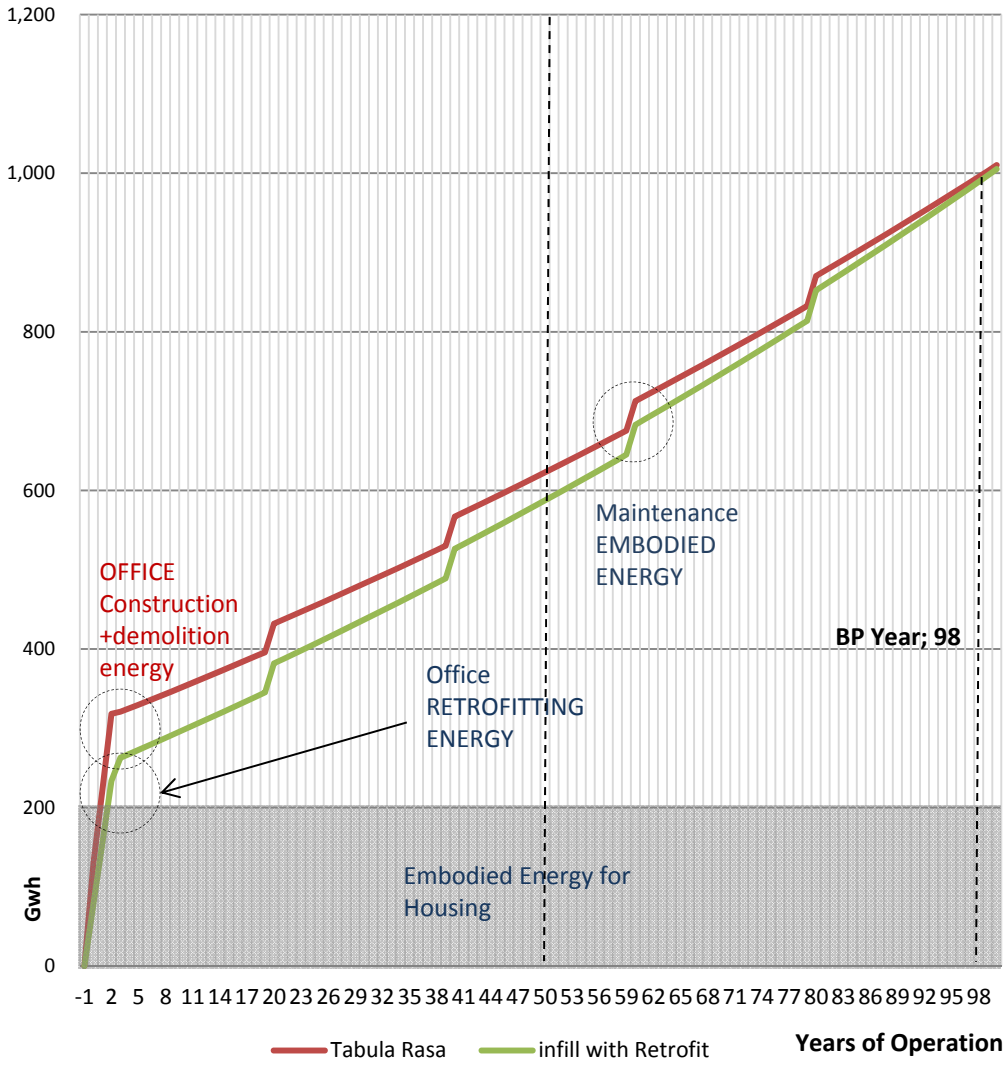
CROSSING POINT > THAN 50 YEAR
INFILL HASBETTER ENERGY USE

3. SCENARIOS ANALYSIS:

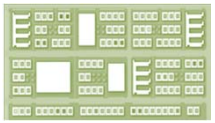
TOTAL ENERGY TIME EVOLUTION

LIFECYCLE ENERGY COST COMPARISON 2

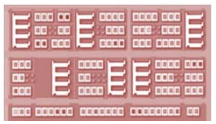
Infill+ Retrofitting vs Tabula Rasa



SCENARIO #2: Infill+Retrofitting



SCENARIO #3: Tabula Rasa



BOTH SCENARIOS MEET AFTER 98 YEARS AND FROM THAT MOMENT ON TABULA RASA IS BETTER:

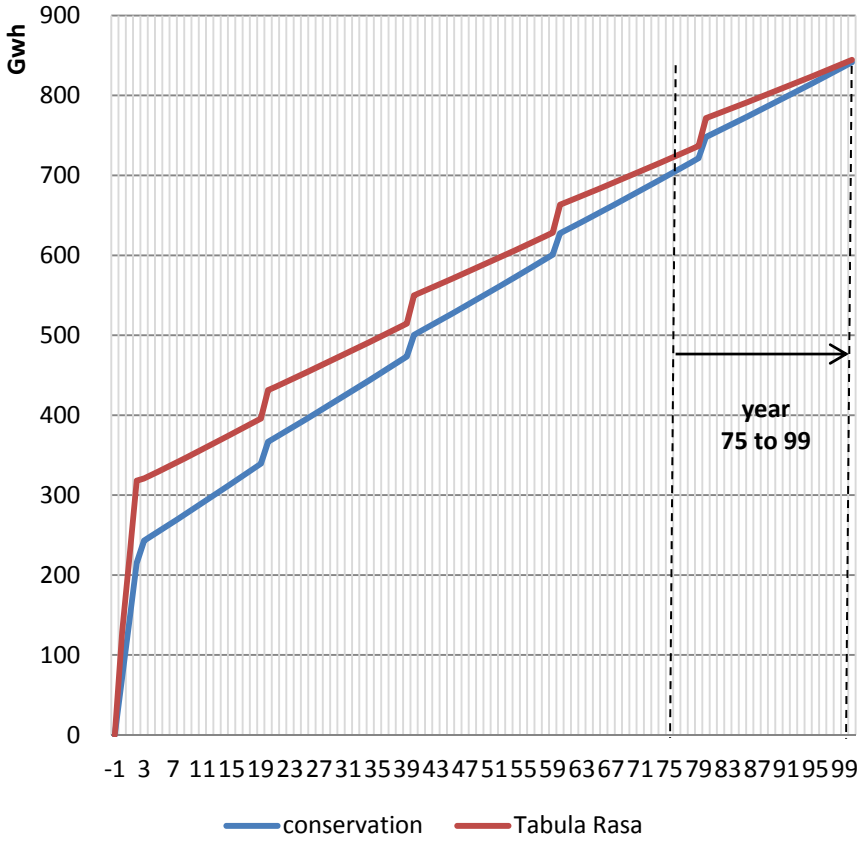
CROSSING POINT > THAN 50 YEAR
RETROFIT HAS BETTER ENERGY USE

3. SCENARIOS ANALYSIS:

EFFECT OF TECHNOLOGY IMPROVEMENT

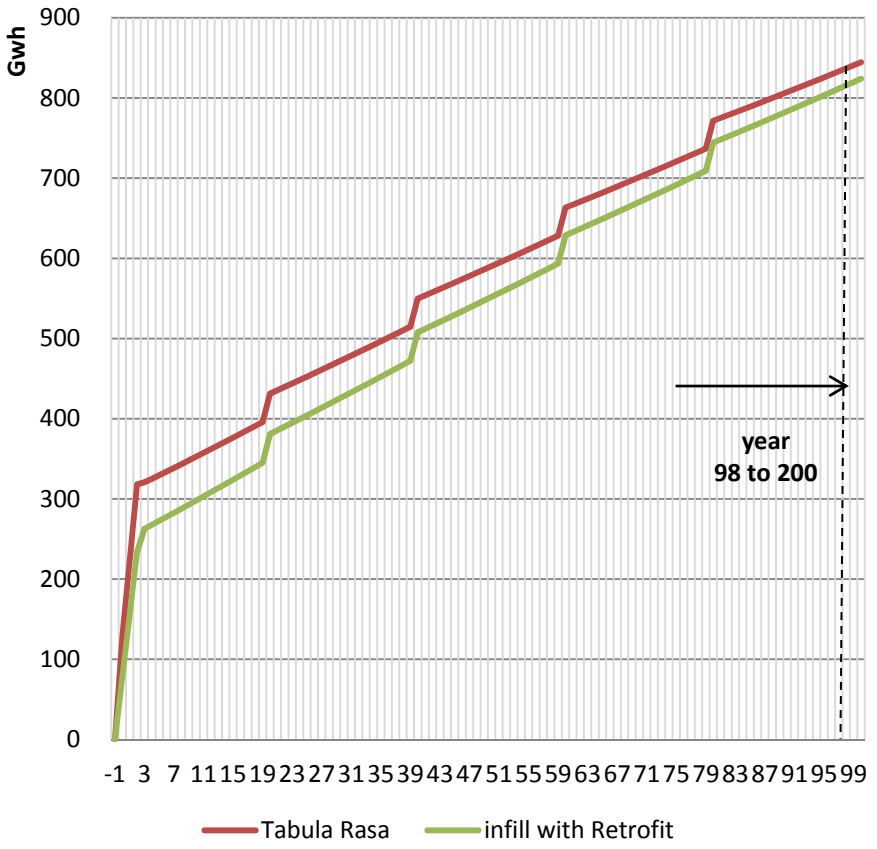
LIFECYCLE ENERGY COST COMPARISON 1B

Infill vs Tabula Rasa (15% Tech. Improvement)



LIFECYCLE ENERGY COST COMPARISON 2B

Infill+ Retrofitting vs Tabula Rasa (25% Tech. Improvement)



ASSUMING AN IMPROVEMENT OF EFFICIENCY IN TECHNOLOGIES OF A 15% EVERY 20 YEARS

THE MEETING POINT ADVANCES IN TIME
INFILL AND RETROFIT PROVES SIGINIFICANTLY BETTER

3. SCENARIOS ANALYSIS:

GUIDELINES AND CONCLUSIONS

1. A REALISTIC ANALYSIS OF THE ENERGY USE AND CARBON EMISSION OF AN URBAN PROPOSAL IN AN EXISTING URBAN GRID **REQUIRES A LONG TERM STUDY**.

2. THE SELECTION OF AN INFILL INTERVENTION OVER A TABULA RASA ONE **DEPENDS ON THE PROPORTION OF EXISTING AND NEW CONSTRUCTION BUILDINGS**, BECAUSE THE EMBODIED ENERGY BECOMES A FACTOR IMPORTANT ENOUGH TO AFFECT THE LIFE CYCLE RESULTS.

3. THE MEETING POINT IN TIME OF TOTAL ENERGY CONSUMPTION FOR DIFFERENT URBAN DEVELOPMENTS DETERMINES THE **LONG TERM BENEFIT DEPENDING ON THE CONSIDERED LIFE TIME OF THE BUILDINGS**.

4. DENSE URBAN GRID LAYOUTS, ALONG WITH SHADING DEVICE, CAN SIGNIFICANTLY CONTRIBUTE TO THE CONTROL OF **OUTDOOR COMFORT IN HOT SUNNY CLIMATES**, AND HELP REDUCING THE AMOUNT OF URBAN TRAVELLING.

REVITALIZING SEVILLA'S EXPO '92 AREA

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