Al Majaz

4.433 Modeling Urban Energy Flows

Final Presentation

Norhan Bayomi, *Building Technology*
Jake Sobstyl, *Civil and Environmental Engineering*
Asresh Guttikonda, *Urban Studies and Planning*

Al Majaz

Proposal for a Neighborhood in Kuwait City

Neighborhoods in Kuwait have lost their charm and become glorified parking lots. What can we do about it and are there any guidelines that can help us in designing better neighborhoods?

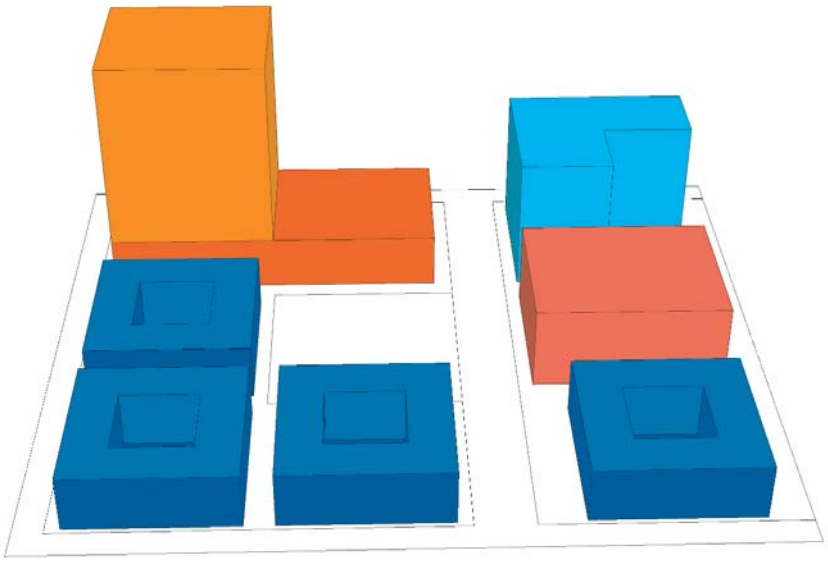
Re-Kuwait, 2015

Al Majaz: Neighborhood Design Drivers

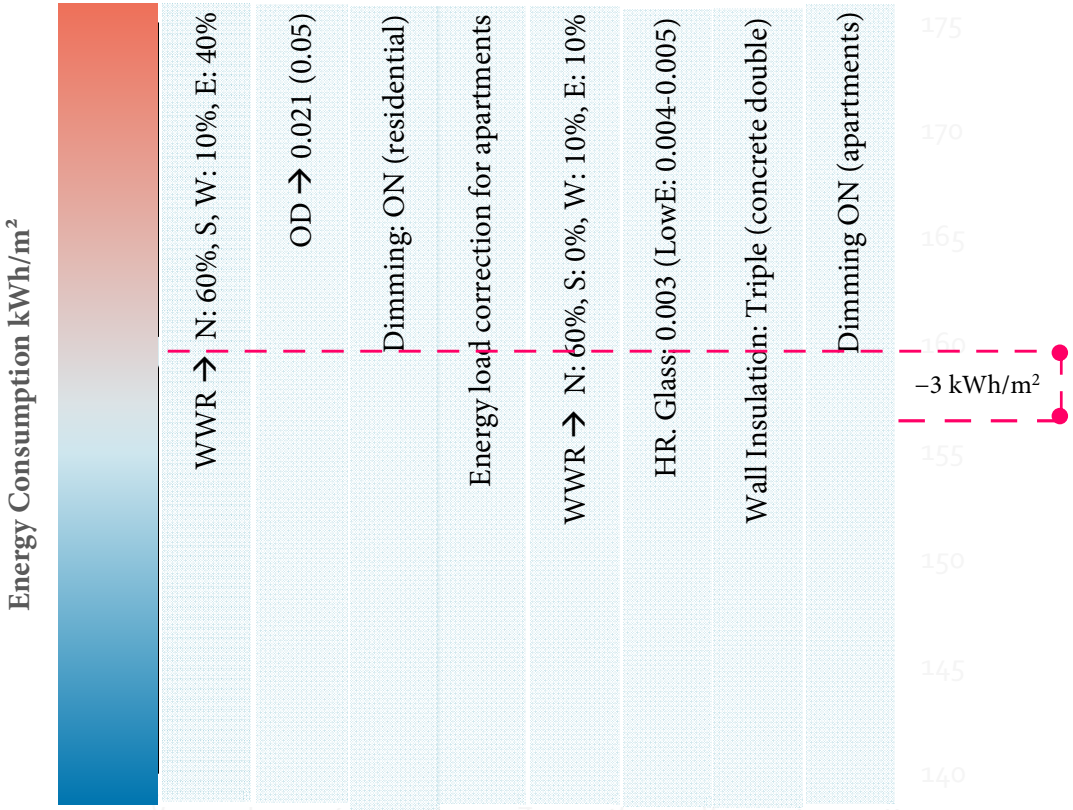
Guiding Principles	Main Goals
Energy Efficiency	• Meeting energy needs through building energy efficiency.
Connectivity	• Denser urban form which promotes public transport and walkability. • Establishing the idea of “The Option of Living a car-free lifestyle”.
Liveliness	• Outdoor thermal comfort to promote greater outdoor space use, walking and biking.

The Protoblock

Energy Analysis



125	67kWh/m²	1.48
Occupancy	PVP	FAR



The Protoblock

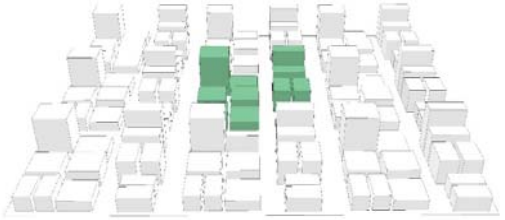
Energy Analysis

	A - High	A - Base	A - Low	B - High	B - Base	B - Low
EUI	171	176	178	159	170	183
Future EUI (2050)	181	187	191	175	180	193
% change	5.8%	6.3%	7.3%	10.1%	5.9%	5.5%
sDA	0.47	0.67	0.84	0.48	0.62	0.93
EUI per person	0.90	1.41	2.20	0.67	1.17	2.15
Future EUI per person (2050)	0.95	1.50	2.36	0.74	1.24	2.27
Total Score	18	13	7	**21**	19	12

Points
5
4
3
2
1
0

B - High

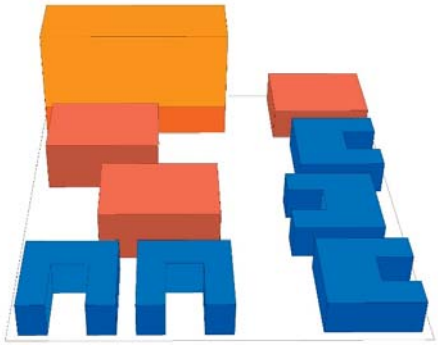
B - Base

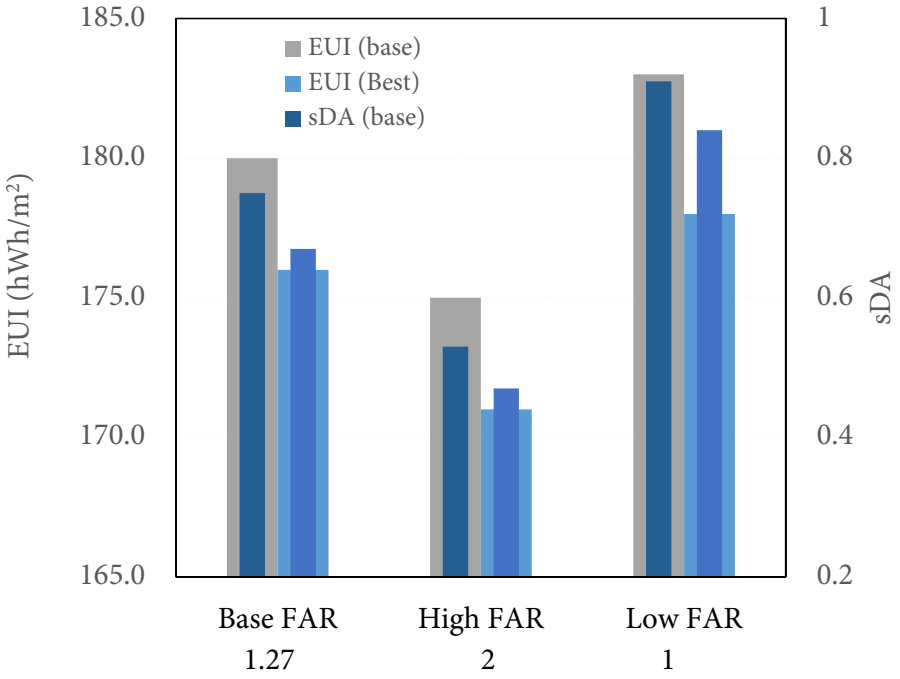


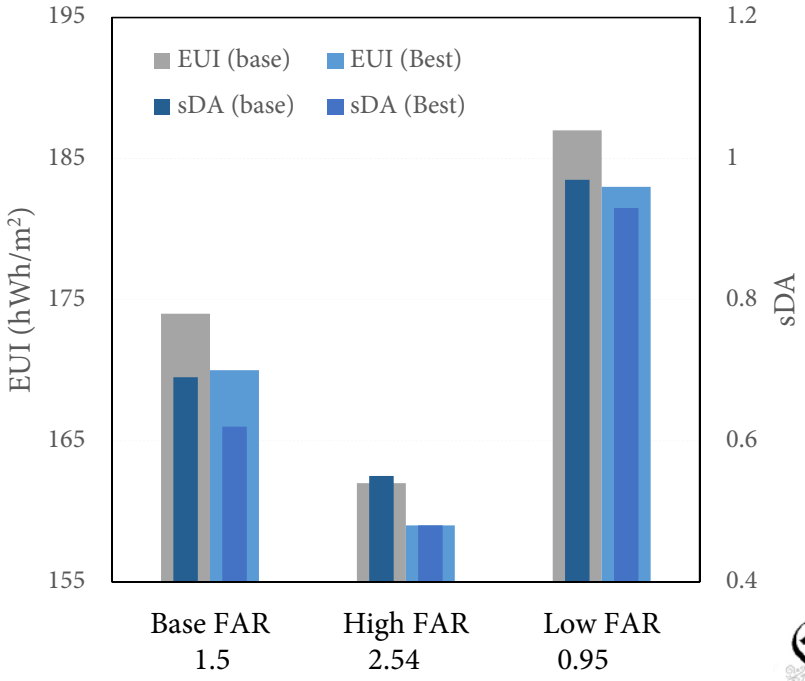
A - High

The Protoblock

Daylight Analysis

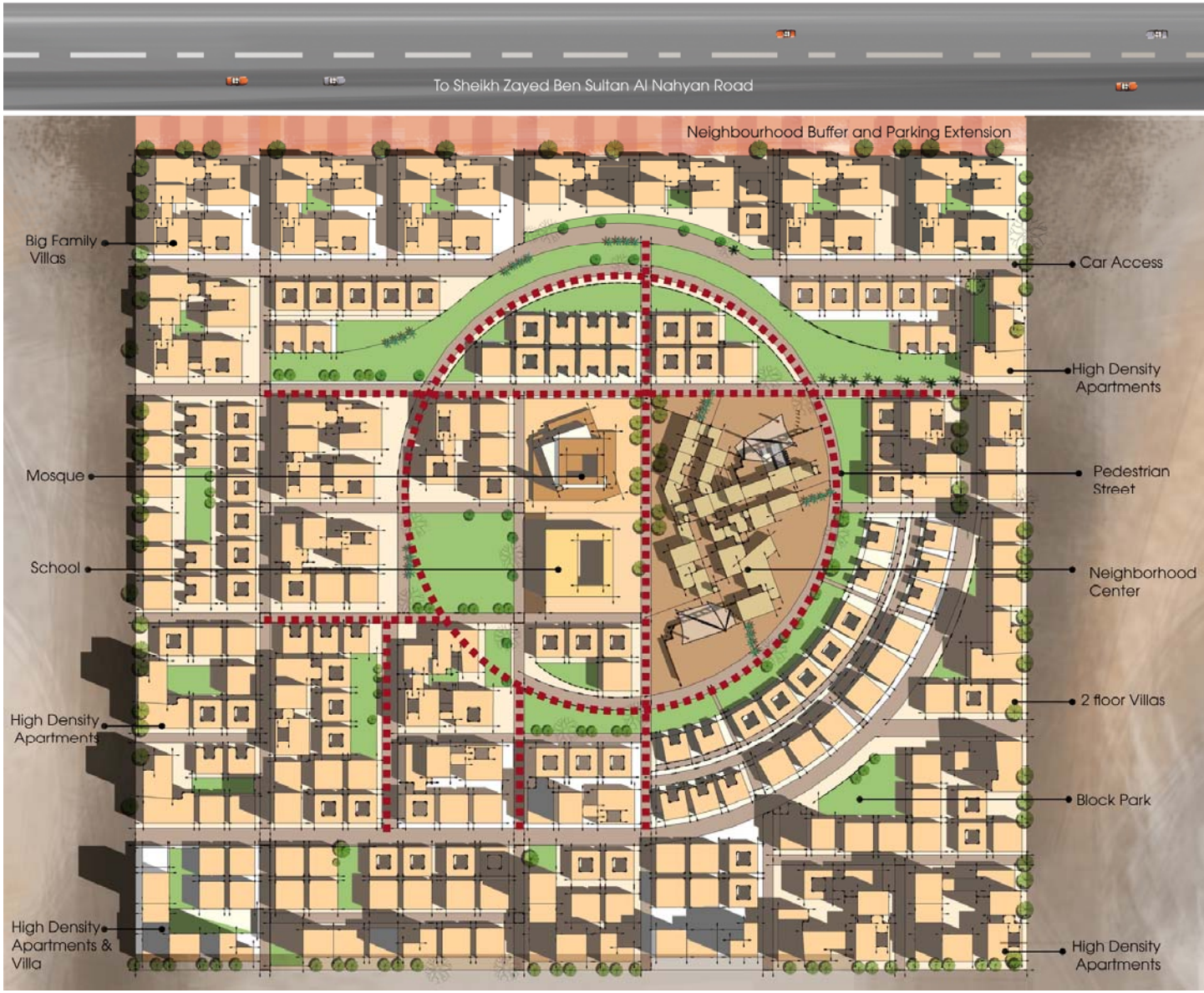






Neighborhood Design

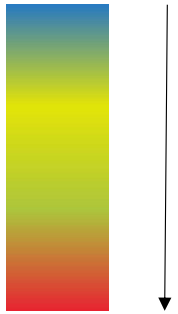
Programming and Massing



Neighborhood Energy Consumption

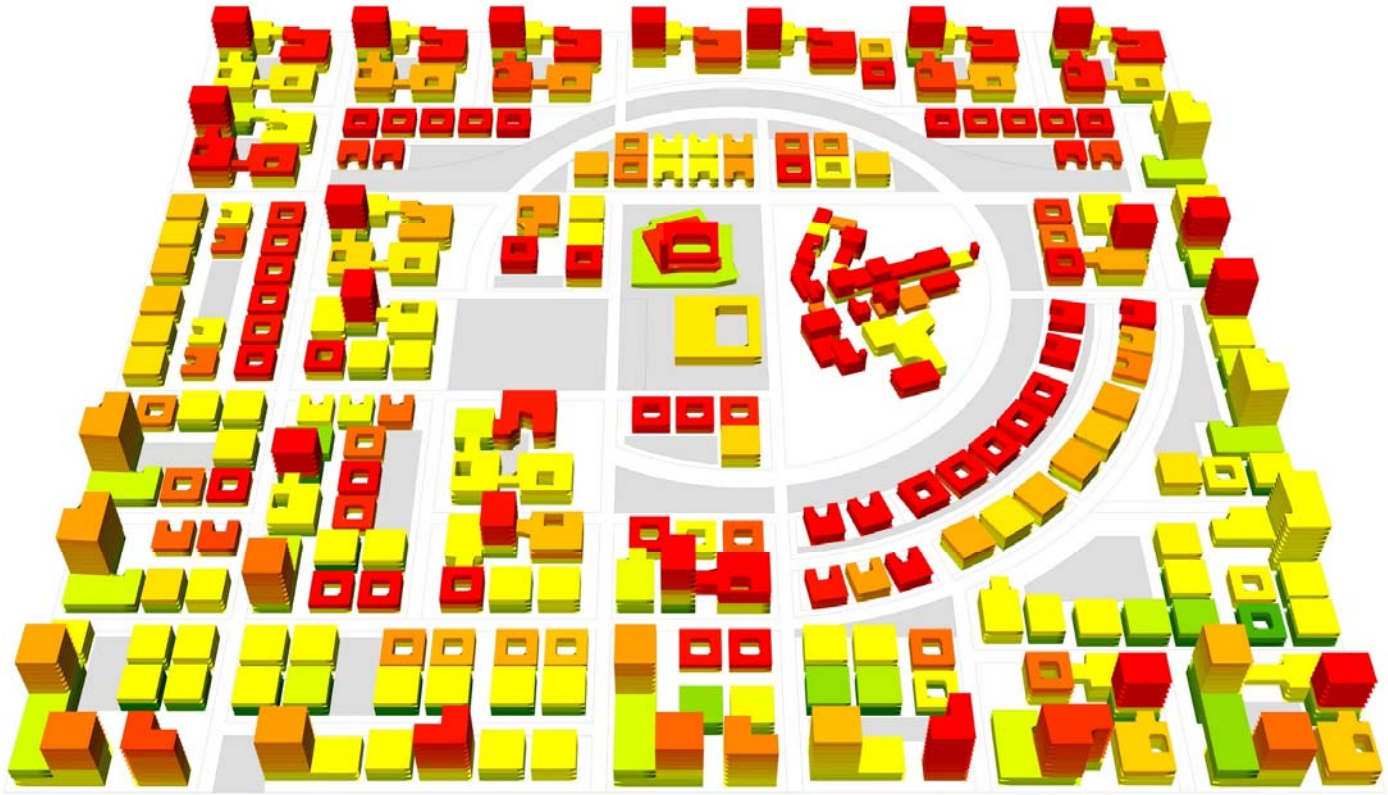
Present - 48,709,489 kWh
2050 - 51,200,920 kWh

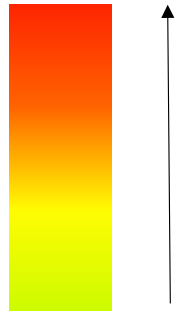
5% increase in energy consumption



Increasing
Energy
Consumption

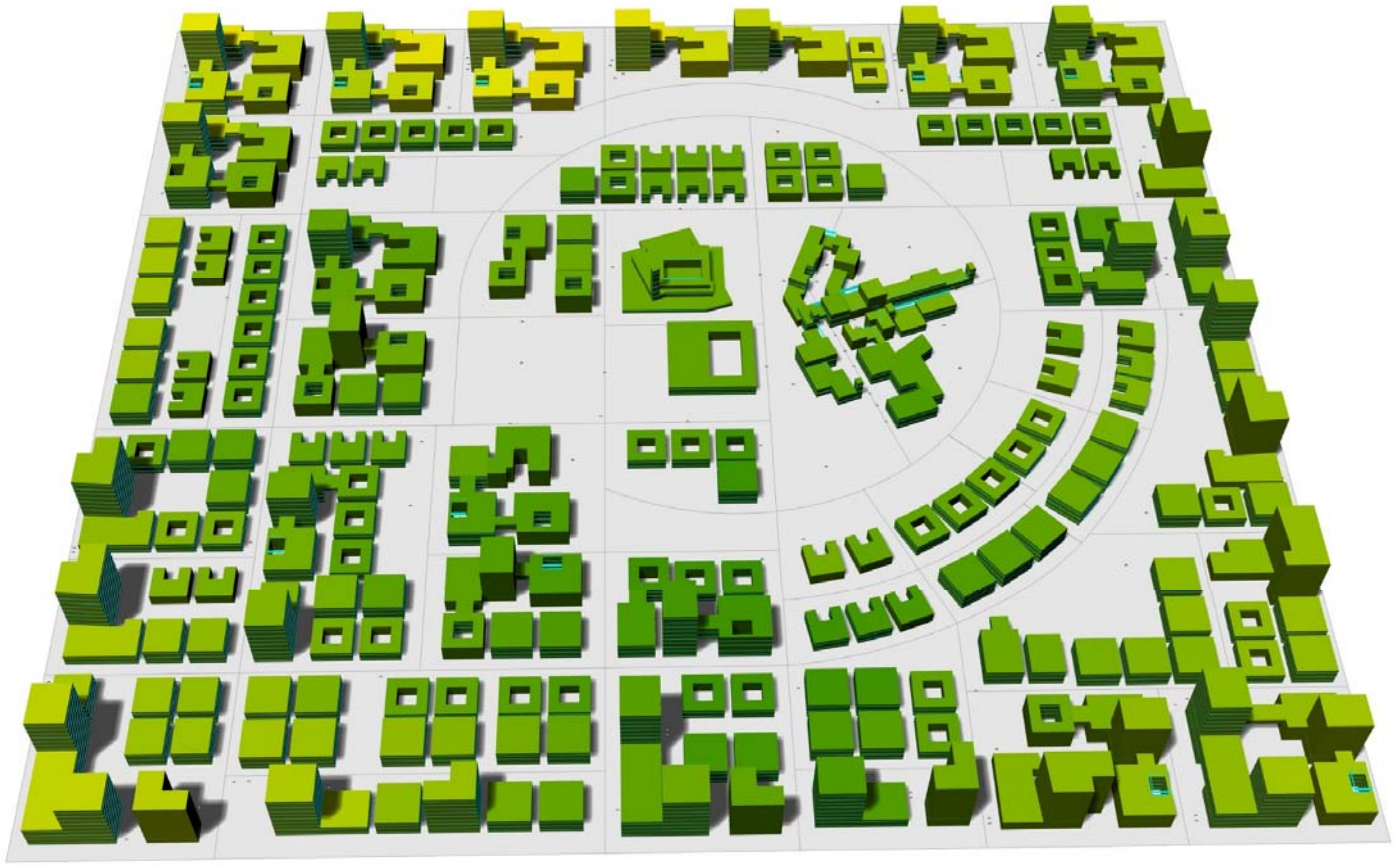
Neighborhood Daylight Performance

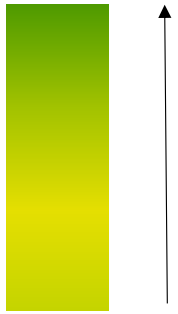




Increasing sDA

Neighborhood Walkability Performance

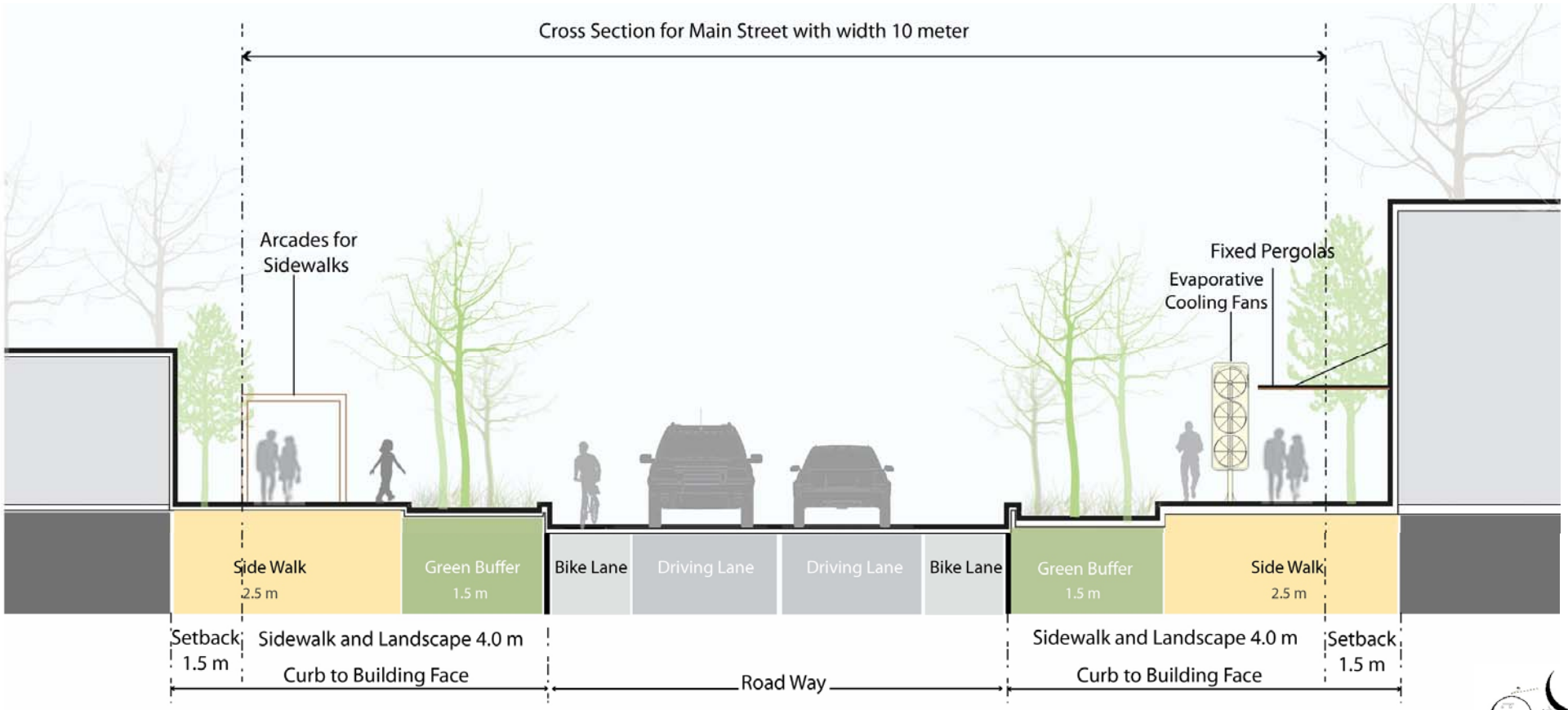




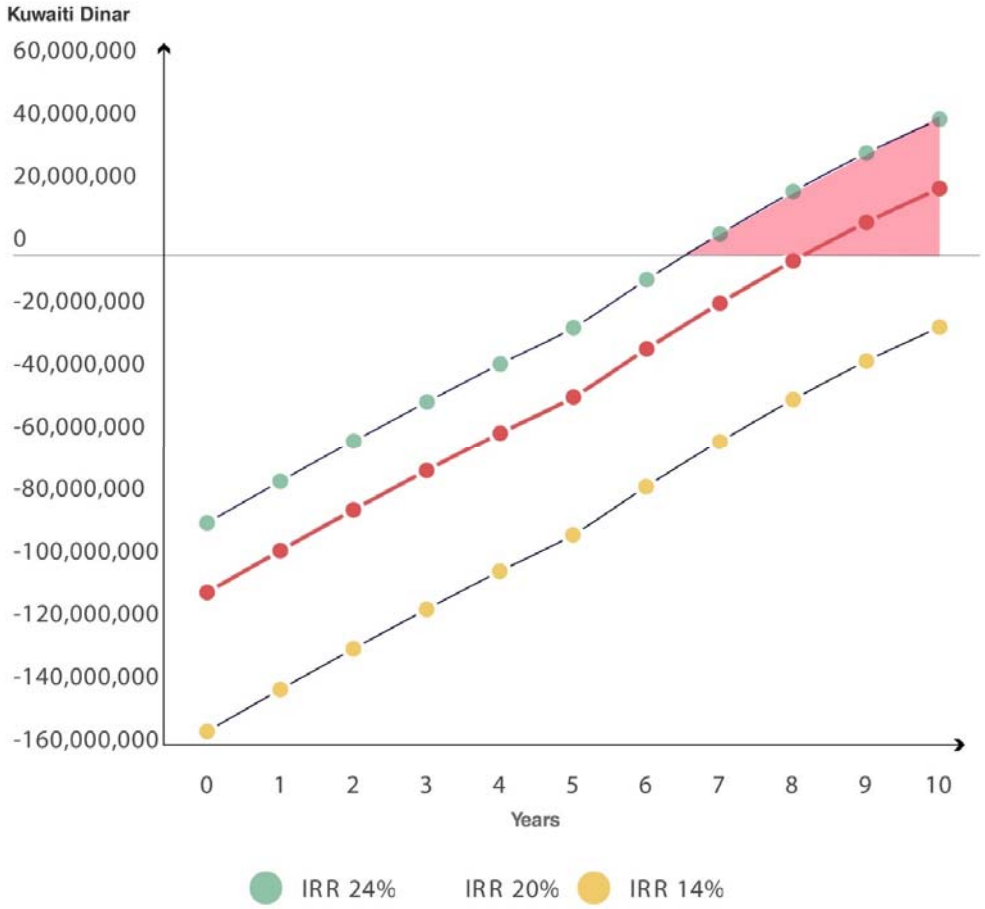
Increasing
Walkability

Neighborhood Design

Street Cross Sections



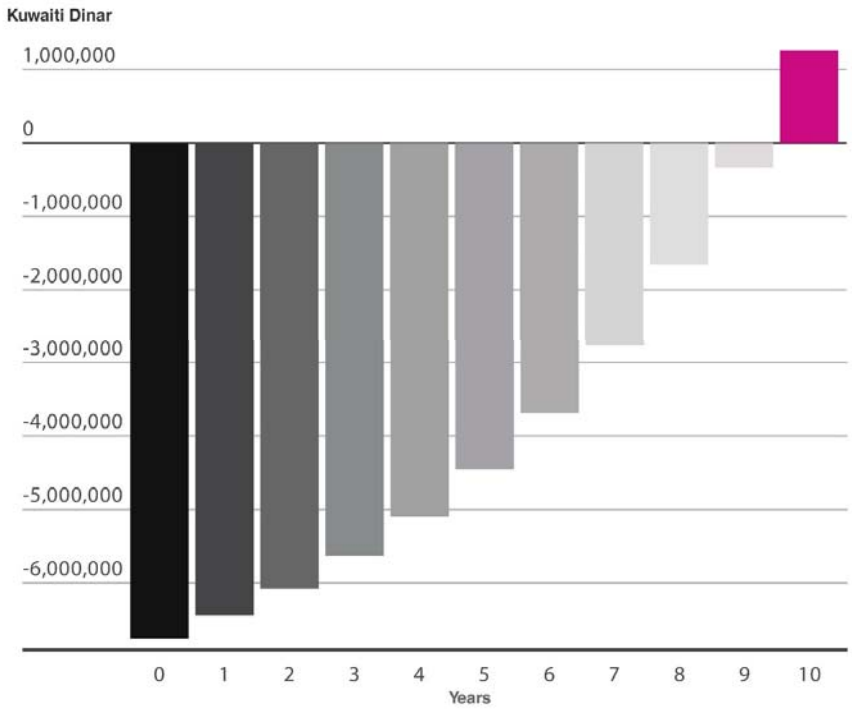
Neighborhood Financial Performance

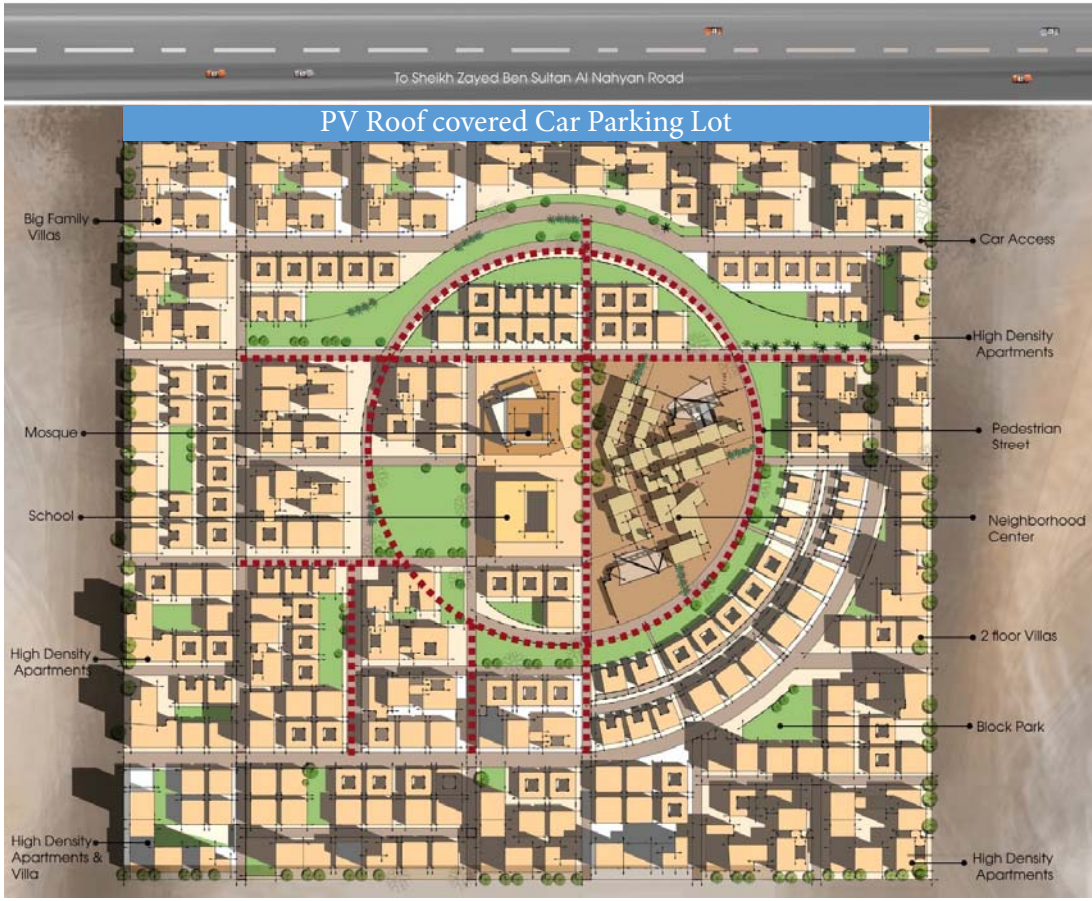


With the low discount rate of 2.5% set by the Federal Bank of Kuwait, initial high capital investment poses low opportunity cost with a break-even point at 8-10 years

Neighborhood PV Potential: 17% of total energy consumption with a PV Parking Lot

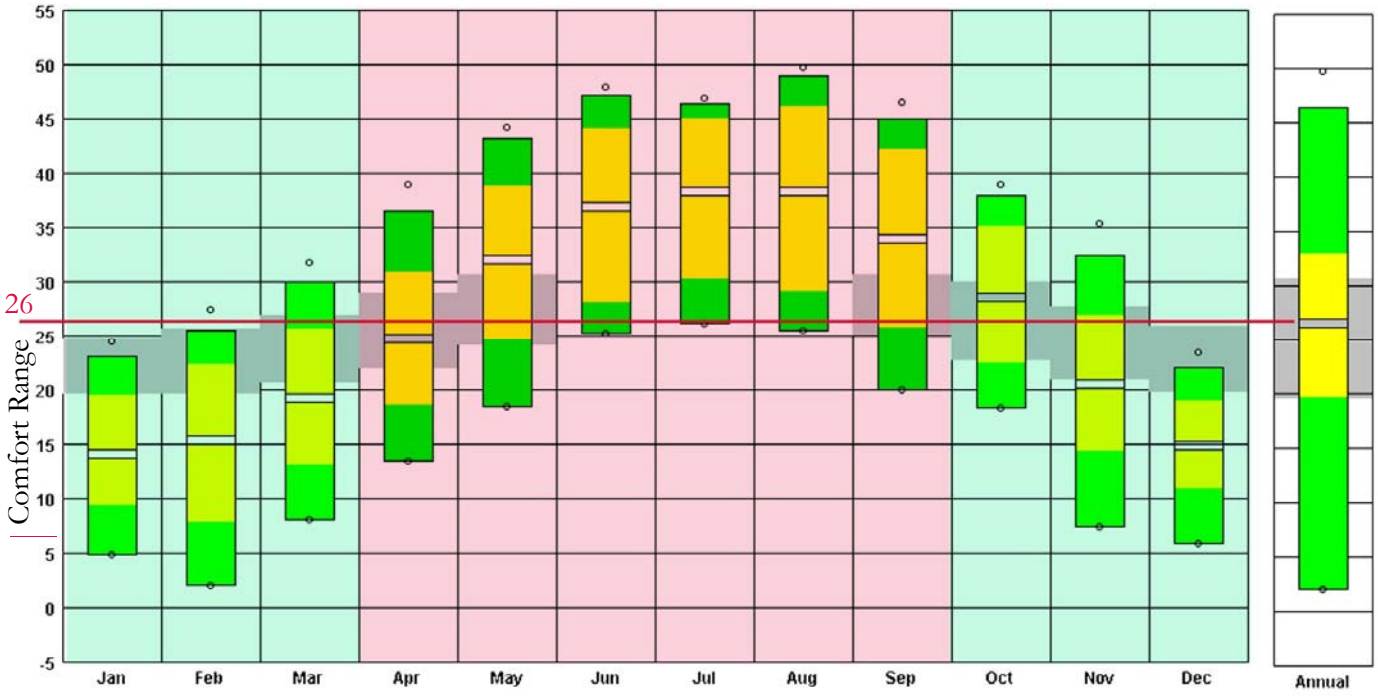
PV cash flow for 10-year period with 2.3m^2 BestSun Panel priced at 595 Dinar





M. A. Hadi et al. Economic Assessment of the Use of Solar Energy in Kuwait. Global Journal of Business Research, 7:2 (2013)

Outdoor Thermal Comfort



Goal**: Improve outdoor thermal comfort between **April** and **September

Analysis Area: *Neighborhood Market*

Why is Outdoor Thermal Comfort Important?

Sabil and Wikala of Dhul Fiqar Oda Basha , *Pascal Xavier Coste*

Souq Al Wafik, Qatar

Marakech Street, Morocco

Outdoor Thermal Comfort: Streets in Kuwait City

Typical Commercial Street, *Kuwait City*

Typical Residential Street, *Kuwait City*

Outdoor Thermal Comfort: Streets in Kuwait City

Bab Al Shaara'ya- Cairo, *Pascal Xavier Coste*

Typical Commercial Street, *Kuwait City*

Typical Residential Street, *Kuwait City*

Outdoor Shading

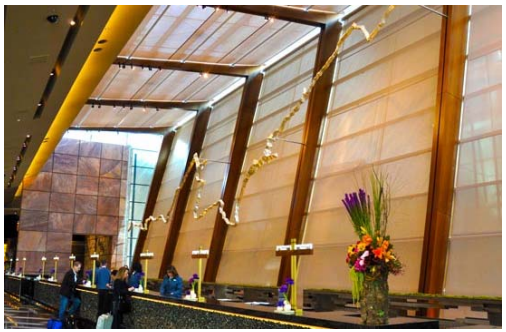
Temporary Shading
- One Level Pergola
- Two Level Pergola
- Tent
- Mixed System

Mechanical Shading
- Sliding Panels
- Tinted Canopy

Fixed Shading
- Arcades
- Feina

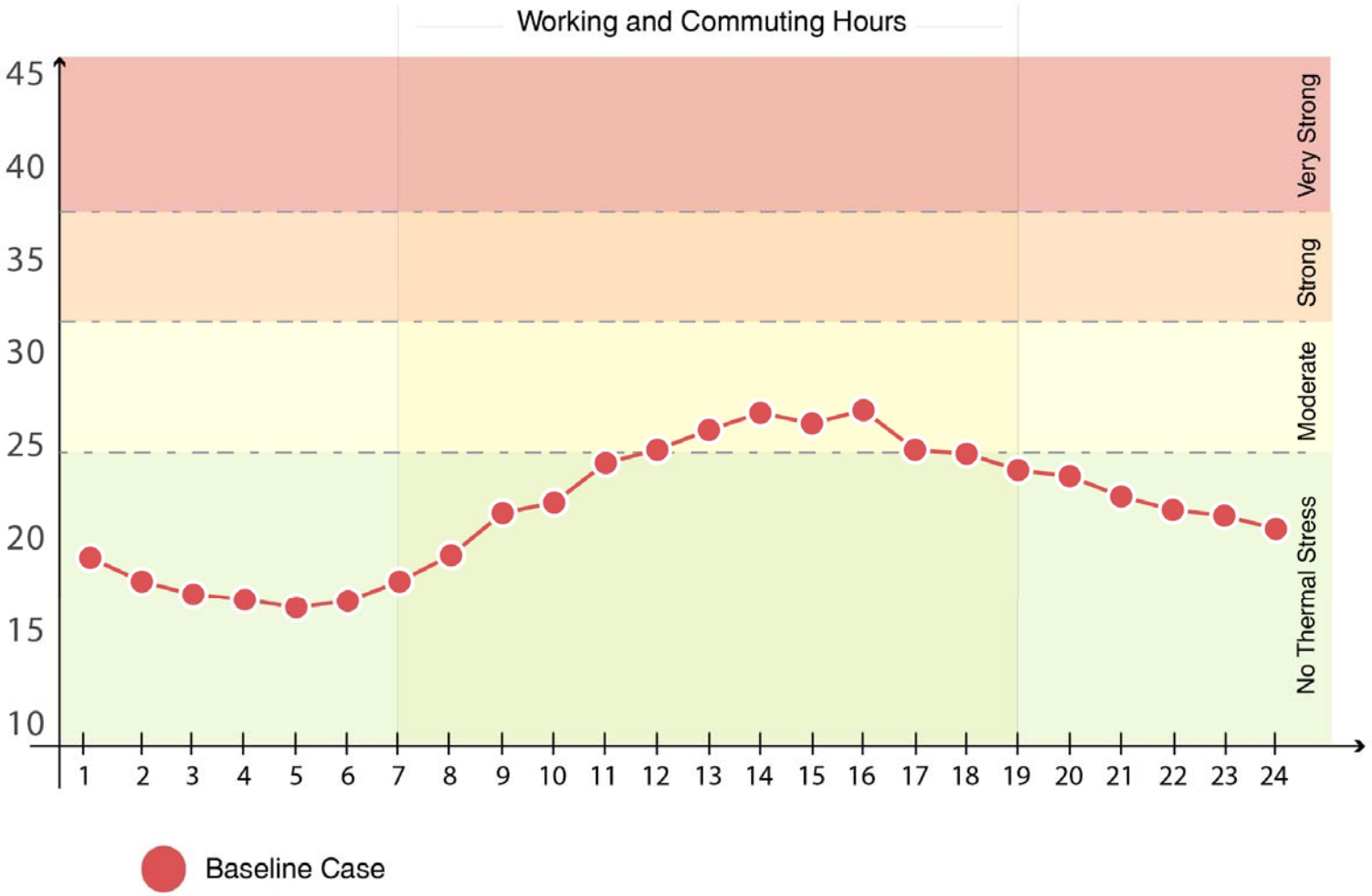




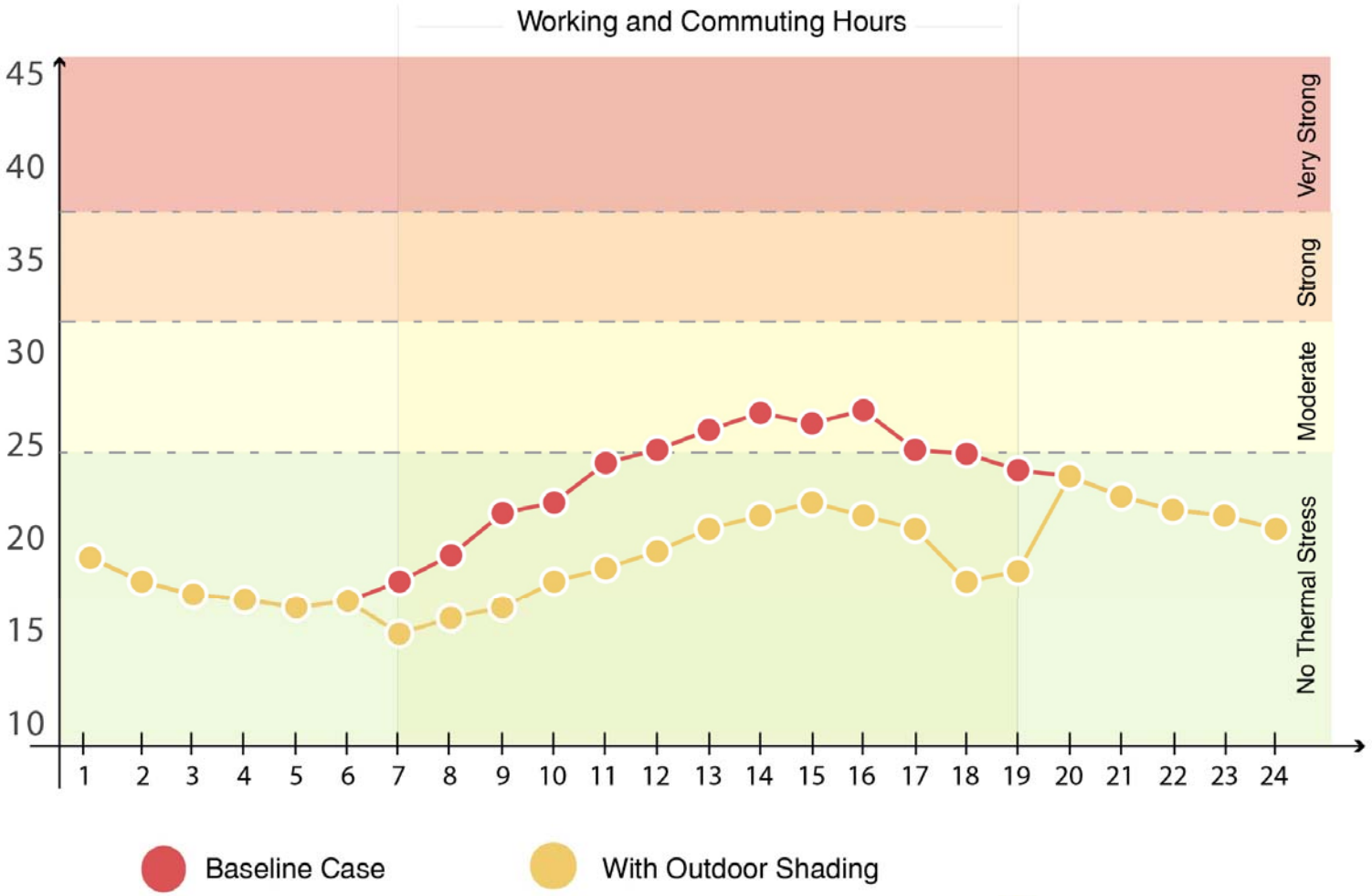



Current “state-of-the-Art” evaporative cooling

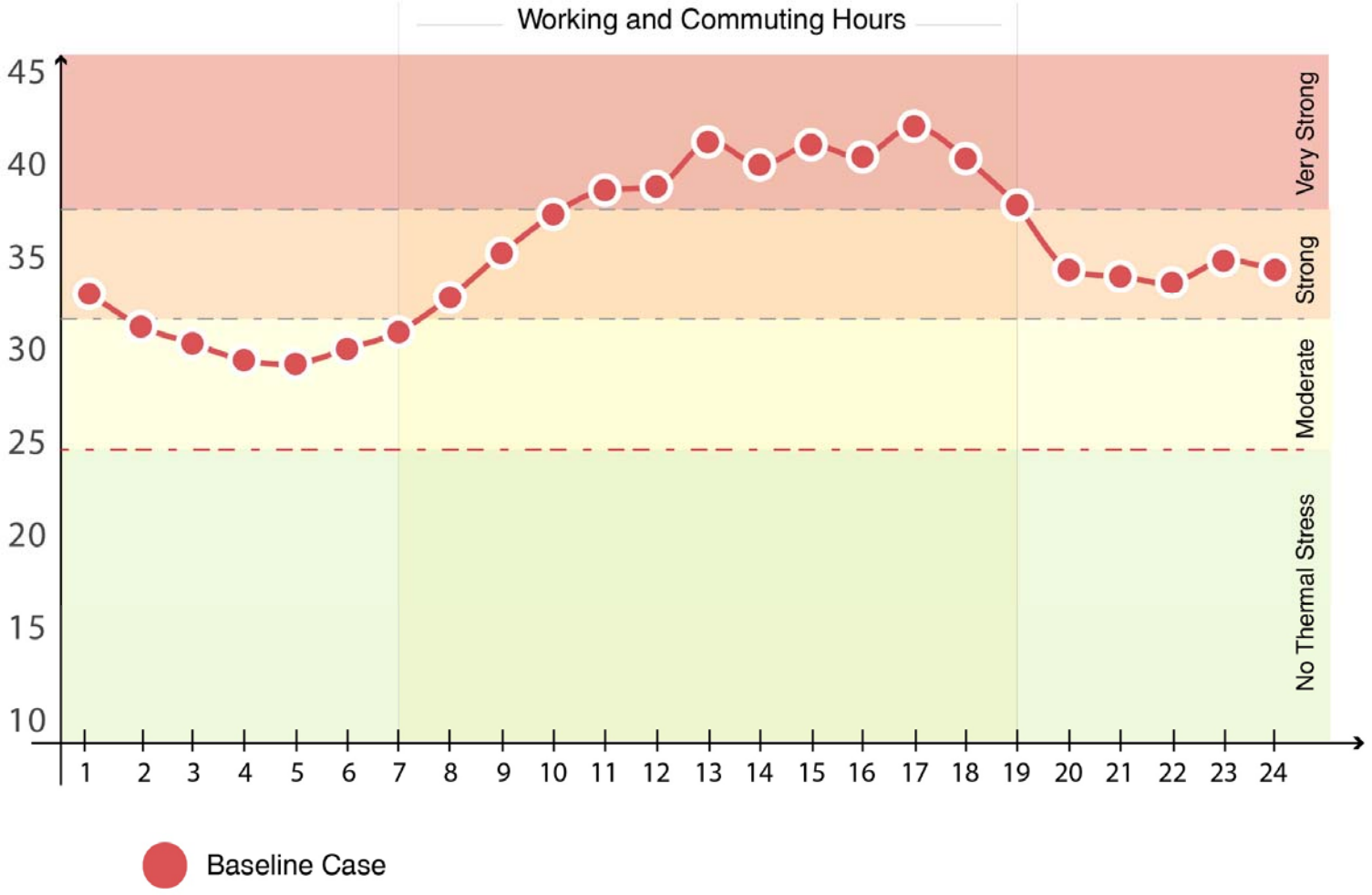
Analysis of Outdoor Thermal Comfort: April



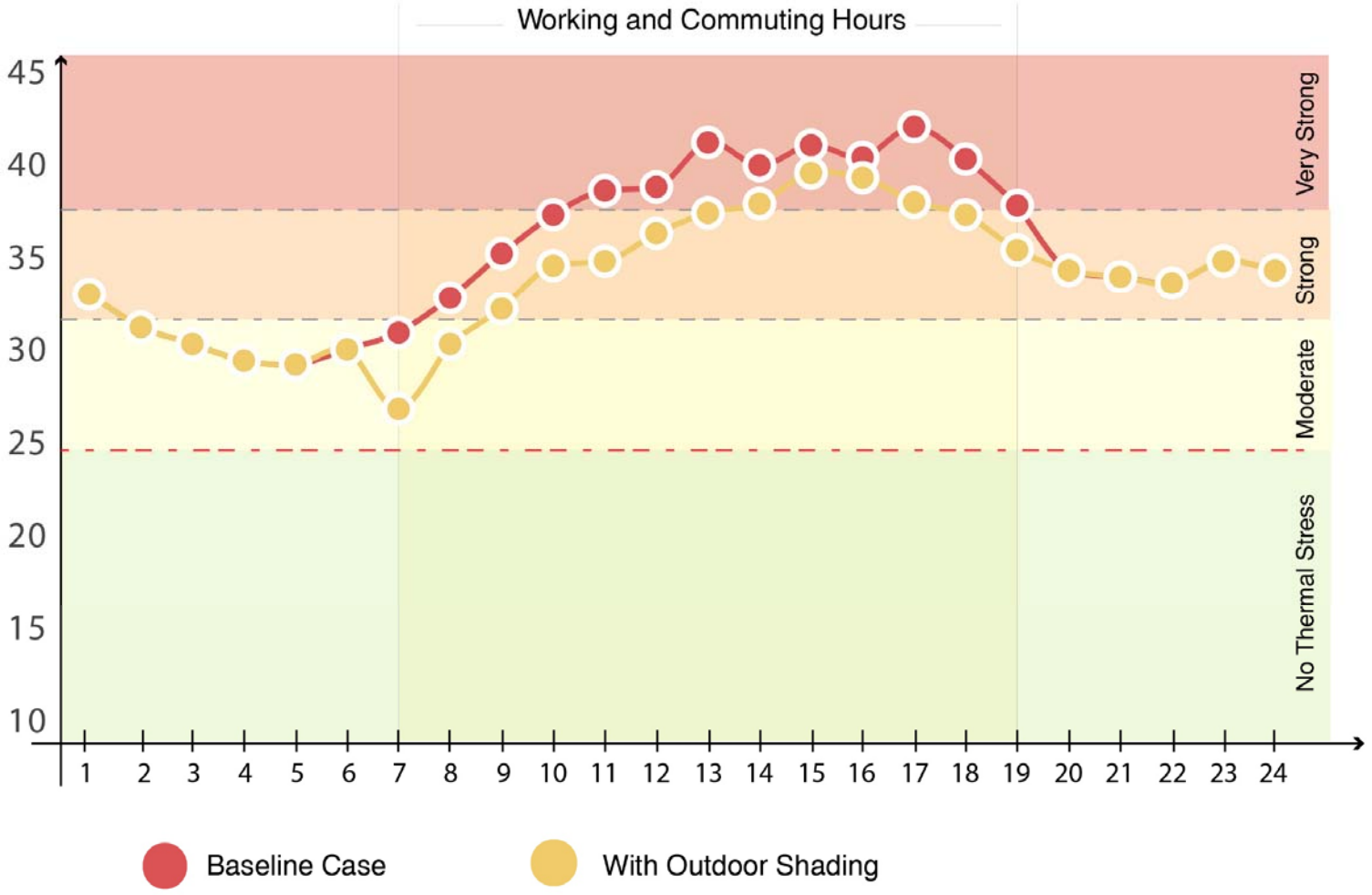
Analysis of Outdoor Thermal Comfort: April



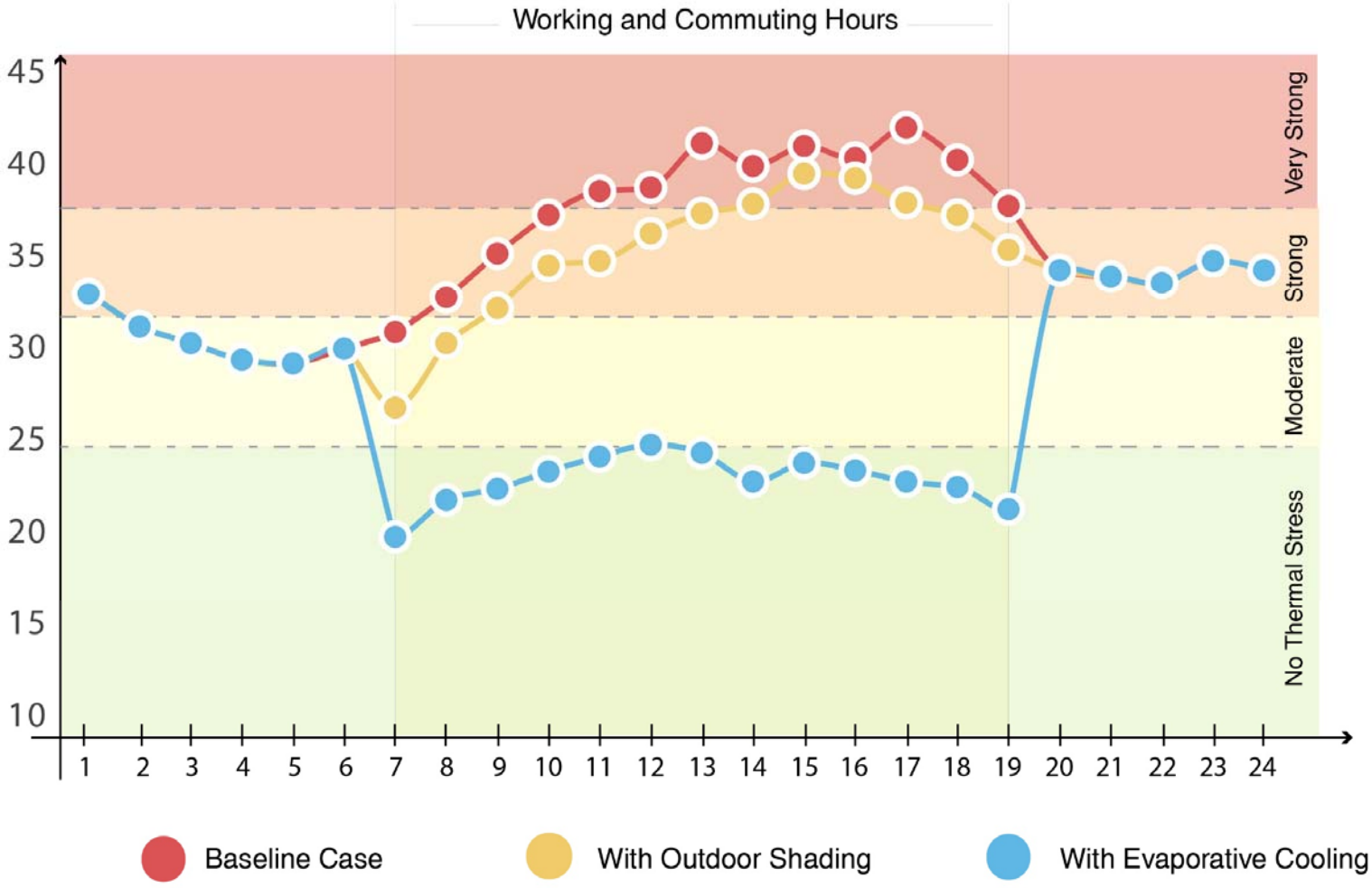
Analysis of Outdoor Thermal Comfort: July



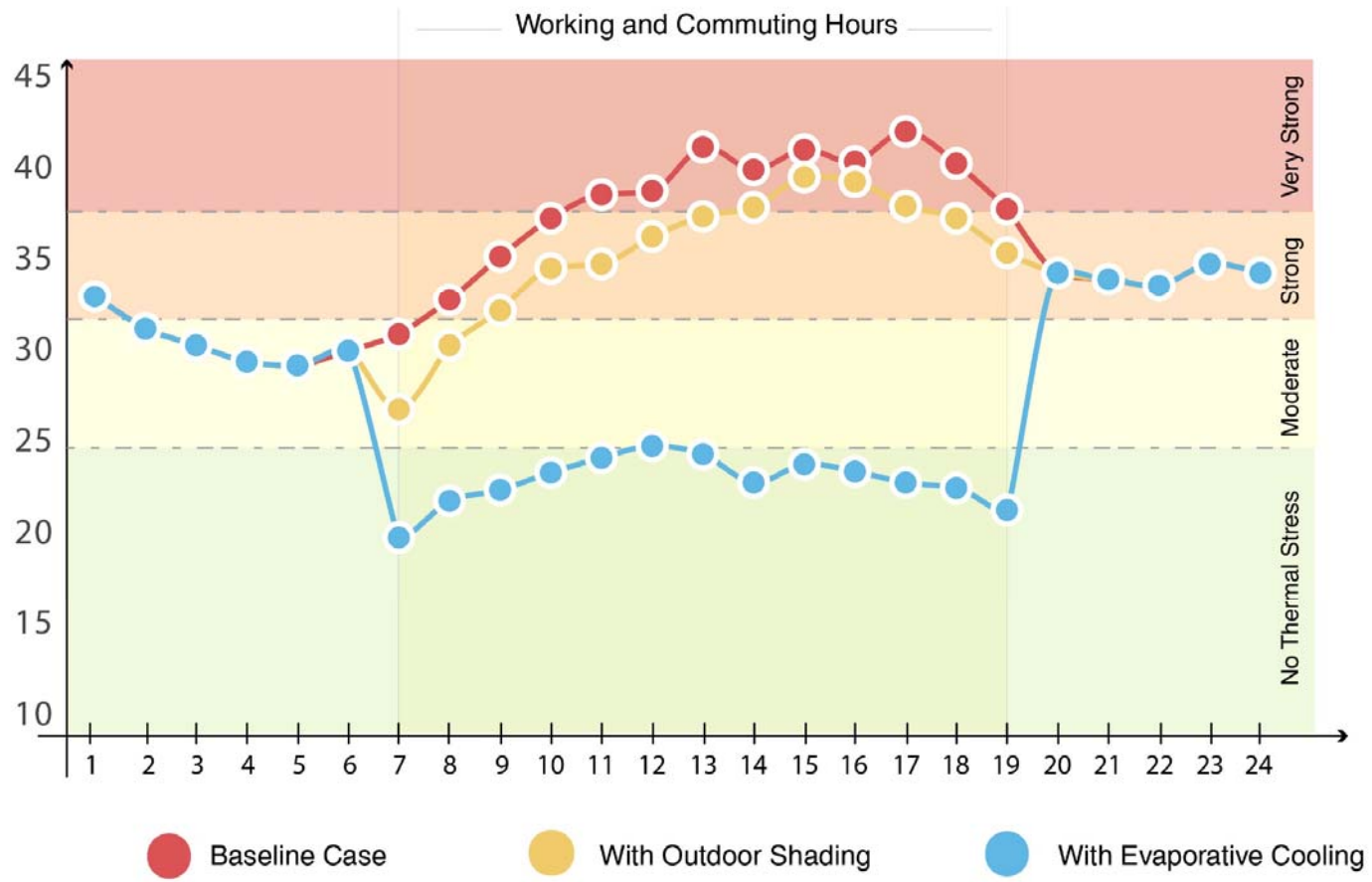
Analysis of Outdoor Thermal Comfort: July



Analysis of Outdoor Thermal Comfort: July



Applying evaporative cooling to Market Place during one of the hottest months



Urban Guidelines

Energy Efficiency

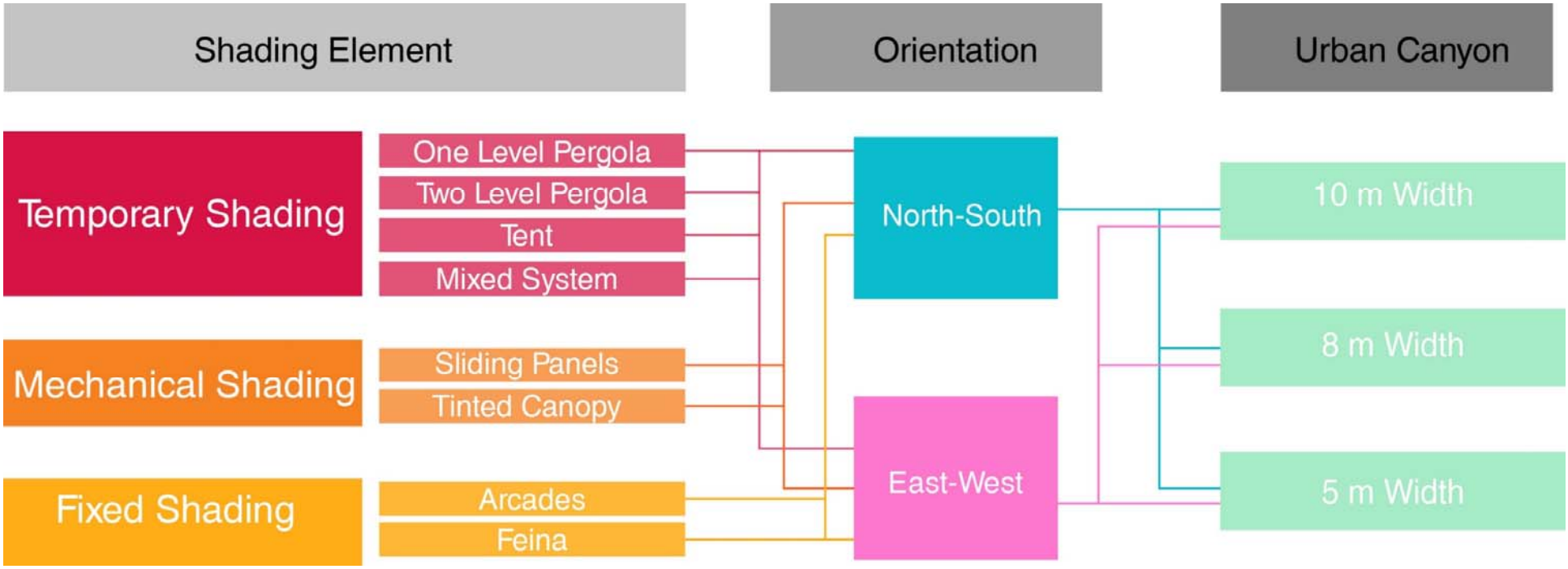
- Performative: To stabilize energy demand and encourage efficient use of resources, tenants will have to cover the full cost of every kWh of electricity* above the baseline set with UMI standards

- Prescriptive: Every kWh/m2 of energy consumption above the average baselines is going to be at tenant's expense:
  - Office: 115kWh/m^2
  - Residential Apartments: 155kWh/m^2
  - Residential Villas: 159kWh/m^2
  - Retail: 245kWh/m^2

* The price of kWh of electricity is currently set at ~0.04 Dinar and has been rising on average by 20% each year for the past 5 years

Urban Guidelines

Outdoor Spaces

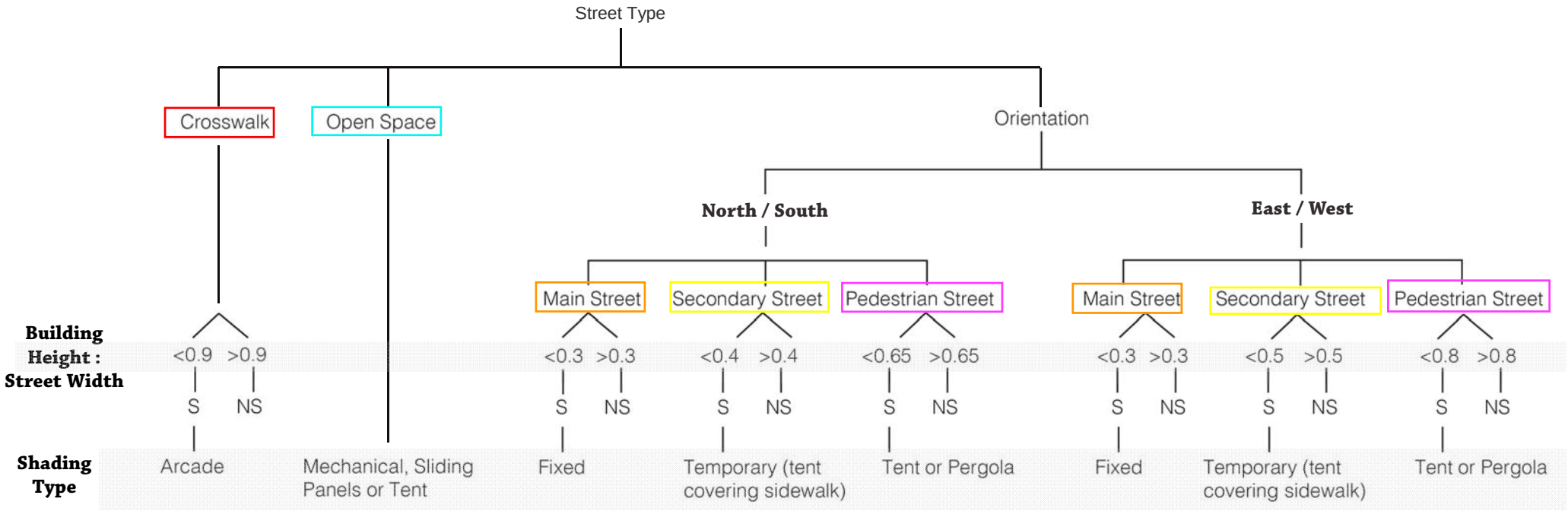


Neighborhood Outdoor Thermal Comfort Performance

		North/South	East/West	North/South	East/West	North/South	East/West
	Building Height to Street Width Ratio	0.3	0.3	0.375	0.375	0.6	0.6
	No Shading	33	34	44	36	67	59
Temporary Structure	One Level Pergola	54	55	58	52	71	63
Temporary Structure	Two Level Pergola	55	55	58	51	71	63
Temporary Structure	Tent	54	55	57	51	71	64
Temporary Structure	Mixed	54	54	58	50	71	63
Mechanical	Tinted Panels (All)	56	55	60	52	72	63
Mechanical	Sliding Panels	55	54	58	51	71	63
Fixed	Arcades	45	45	51	44	71	61
Fixed	Feina	48	48	54	49	71	64

Urban Guidelines

Energy Efficiency Incentives



Urban Guidelines

Outdoor Spaces

- Performative: For months between October and April, maximizing the pedestrian outdoor walkable area that's within an acceptable comfortable level defined by UTCI < 28^0C

- Prescriptive: For the following cases in the city of Kuwait outdoor shading must be installed:

    - Open outdoor spaces used for gatherings, recreational purposes must have sliding panels or tents covering the entire area

    - Crosswalks in areas with where building height to street width ratio (BH:SW) is less than 0.9 must have arcades.

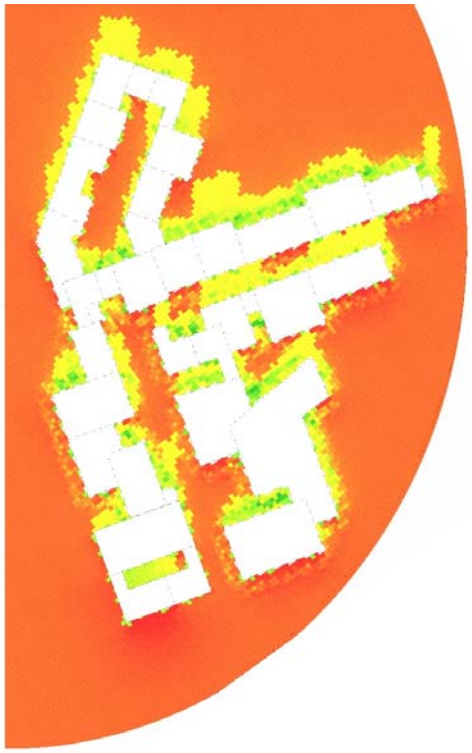
    - Main streets must have fixed shading installed to cover pedestrian areas, if BH:SW is less than 0.3.

    - Secondary streets must have temporary shading installed to cover pedestrian areas, if BH:SW is less than:
        - 0.4 for North/South orientated streets
        - 0.5 for West/East orientated streets

    - Pedestrian streets must have tents or pergolas installed, if BH:SW is less than:
        - 0.65 for North/South orientated streets
        - 0.8 for West/East orientated streets

Neighborhood Outdoor Thermal Comfort Performance

70% out of Comfort Range



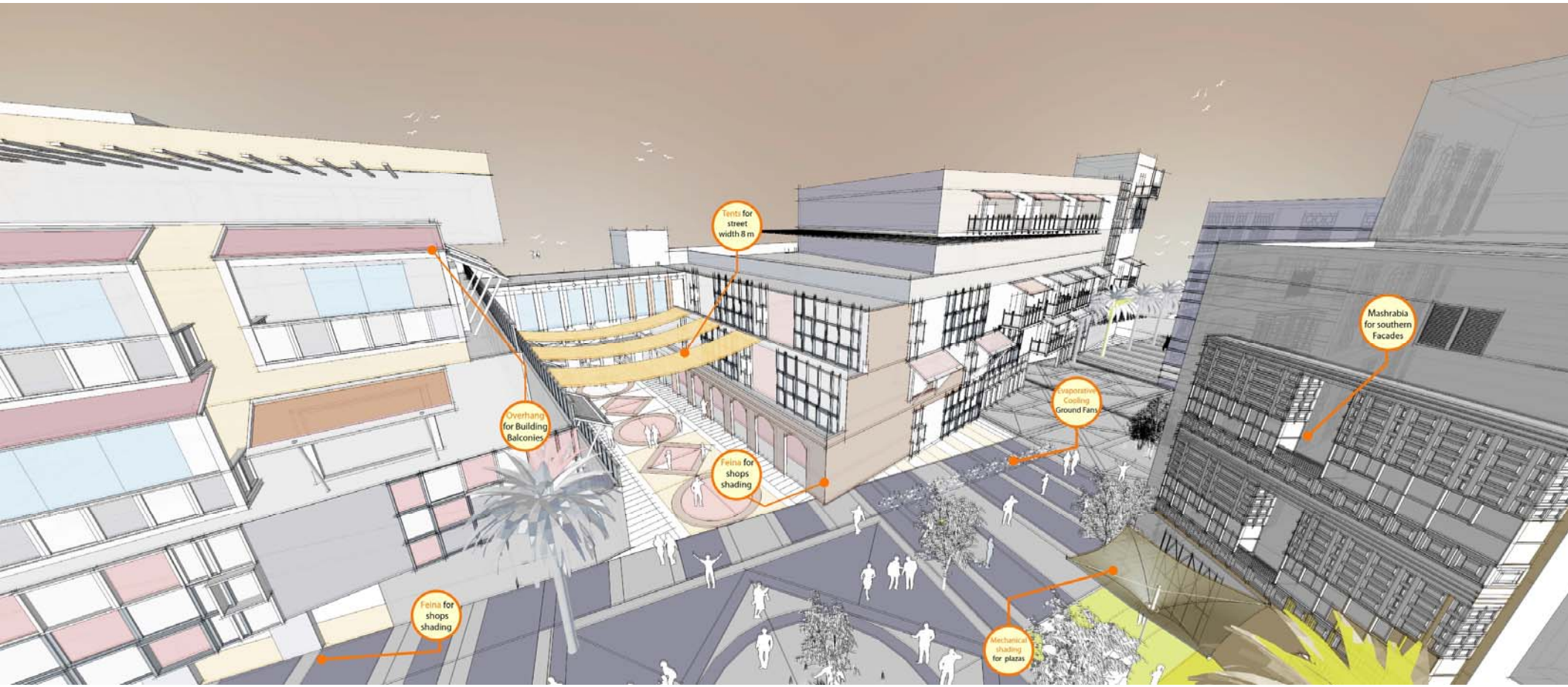
- No Shading

90% Within the Comfort Range

- Plazas covered with tents
- Narrow Streets: No shading or light temporary Shading

Simulation Scope: Neighborhood Market Area

Neighborhood Renderings



Neighborhood Renderings

Neighborhood Renderings

Market Place

Neighborhood Renderings

Apartment Block

Neighborhood Scorecard: Al Majaz Neighborhood

Land area (m^2)	**259,279**
Building area (m^2)	**302,500**
Residents (pp/m^2 land)	**0.035**
Workers (pp/m^2 land)	**0.055**

170	1966	6020	56	72	12
kWh/m²/year	**kWh/m²**	**kgCO²/m²**	**% DA**	**% WS**	**% ROI**
OPERATION ENERGY	EMBODIED ENERGY (50 years)	BUILDING GHG EMISSIONS (50 years)	DAYLIGHT AREA	WALKABILITY SCORE	FINANCIAL RETURN (1 year)

Reflections

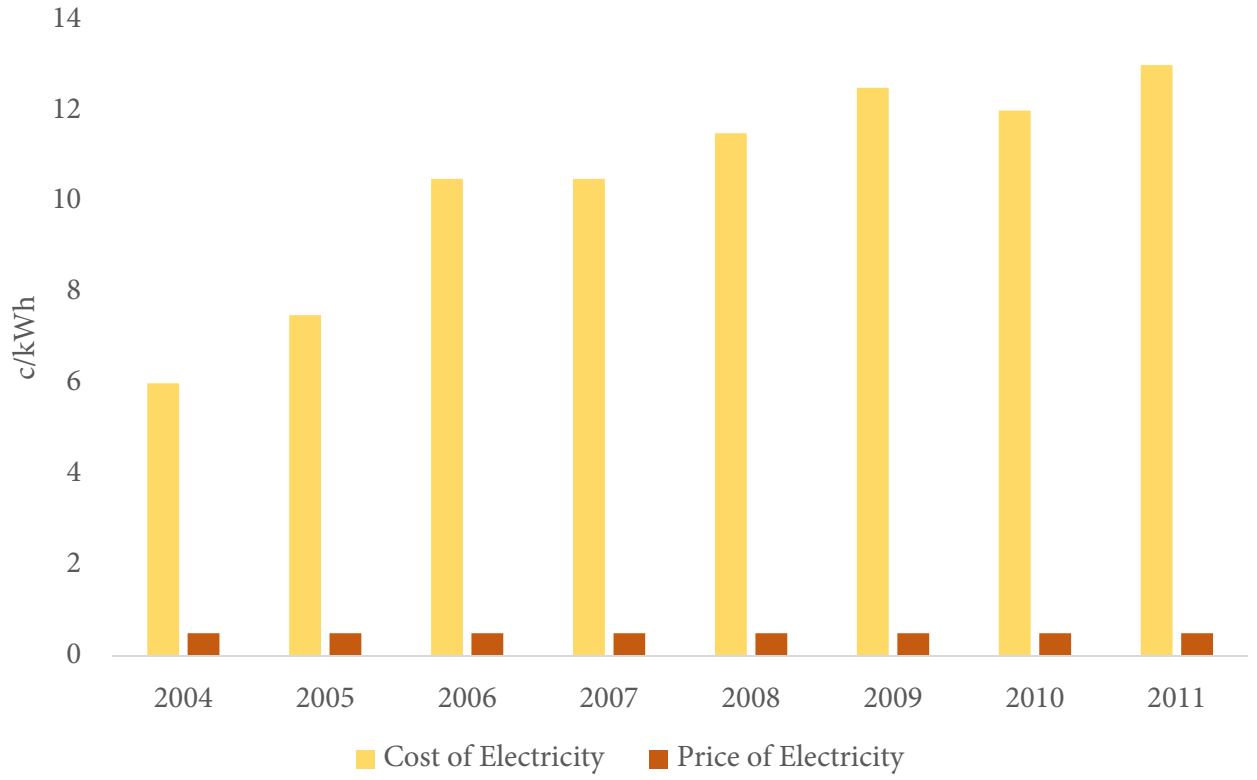
- Urban Guidelines as a first step towards more energy efficiency buildings and better outdoor spaces – pricing mechanism/financial incentives/behavioral
- Applicability to other contexts – other cities in the region with similar climatic conditions
- These elements contributes to Kuwait's greenhouse emissions targets
- For increasing population, move from land-inefficient villas with apartment complexes.
- Improve outdoor thermal comfort will be key in improving walkability.

Future Work

- Reduce usage of cars - is it enough?
- Underground Parking? Costs
- Biking


BILLA
FICHTNER Fichtner Germany

BACK-UP SLIDES


14
12
10
8
6
4
2
0
c/kWh
2004
2005
2006
2007
2008
2009
2010
2011
Cost of Electricity
Price of Electricity

Urban Guidelines

Applying the Rules

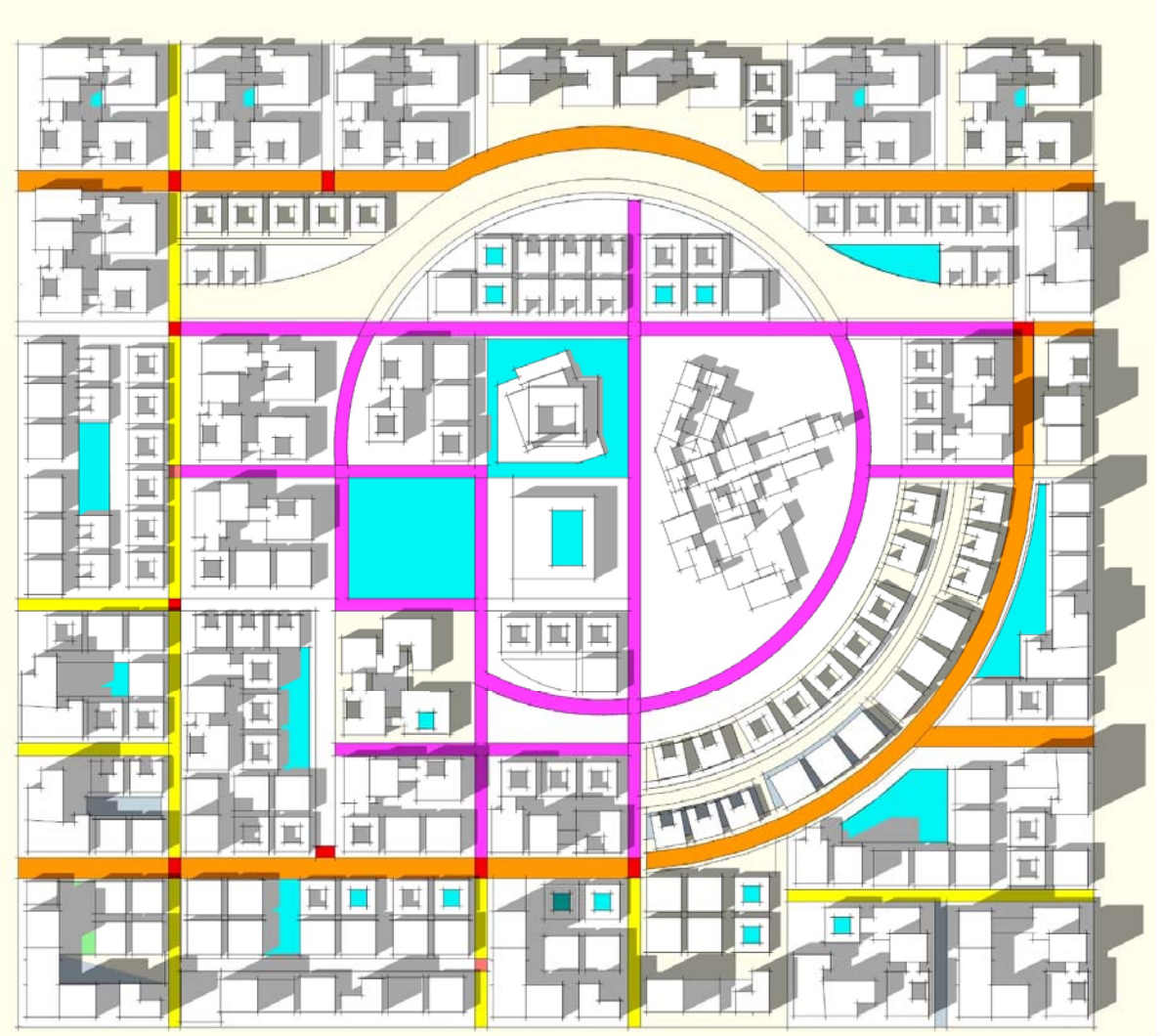
Main Street

Secondary Street

Pedestrian Street

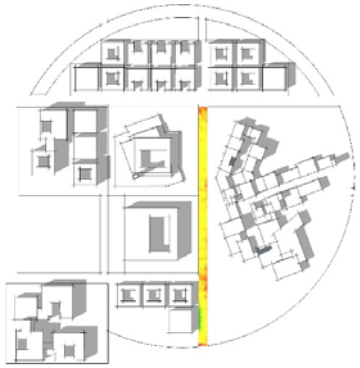
Street crossings

Open Spaces

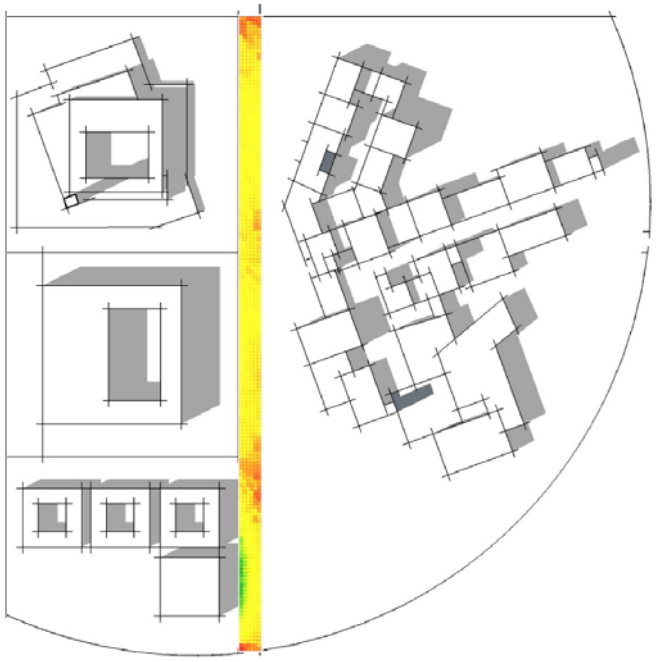


Urban Guidelines

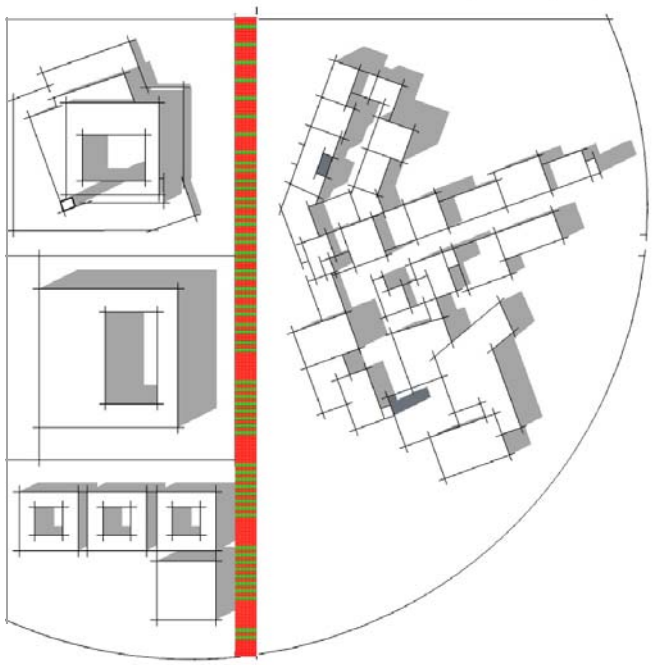
Testing the Rules



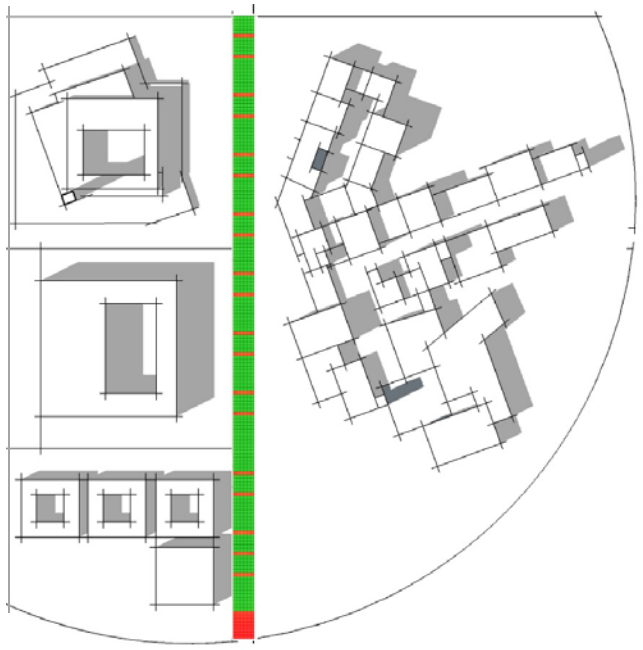
A. Mosque Route



No Shading: 0% in comfort Range



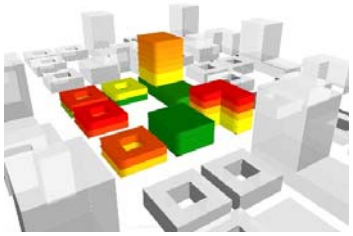
Pergola Shading: 31 % in comfort Range



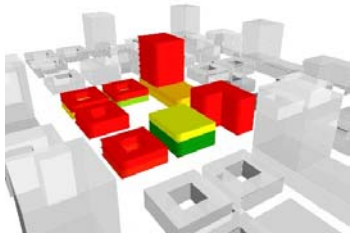
Tent Shading: 95 % in comfort Range

The Protoblock

Daylight Analysis

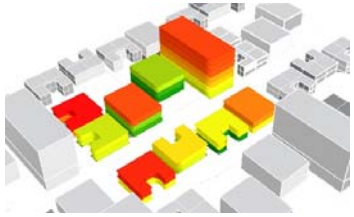


South: 20%

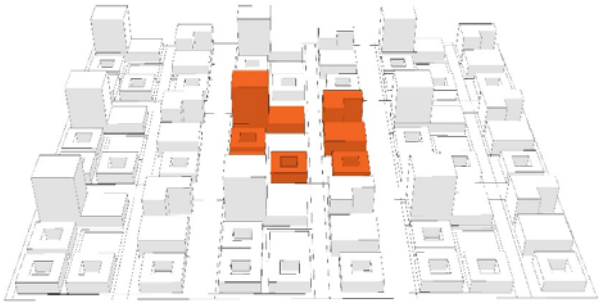


All 40%

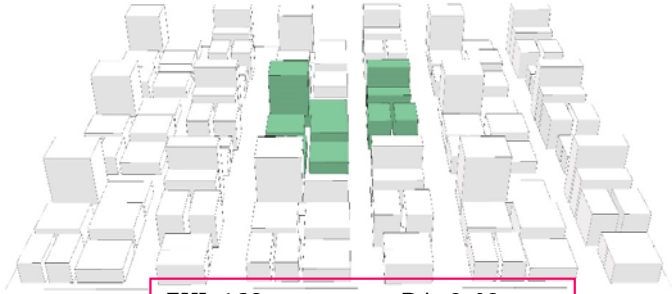
South:20%



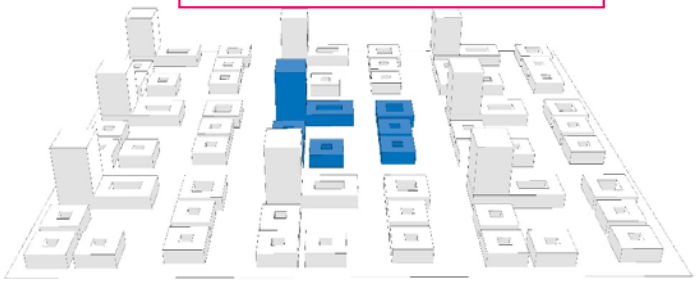
All 40%



EUI: **174** sDA: **0.49**



EUI: **169** sDA: **0.40**

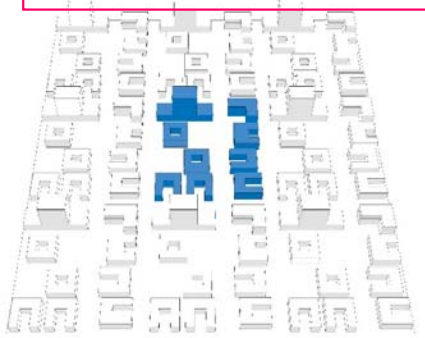


EUI: **165** sDA: **0.65**

Design Proposal (A)

EUI: **154** sDA: **0.43**

EUI: **150** sDA: **0.38**

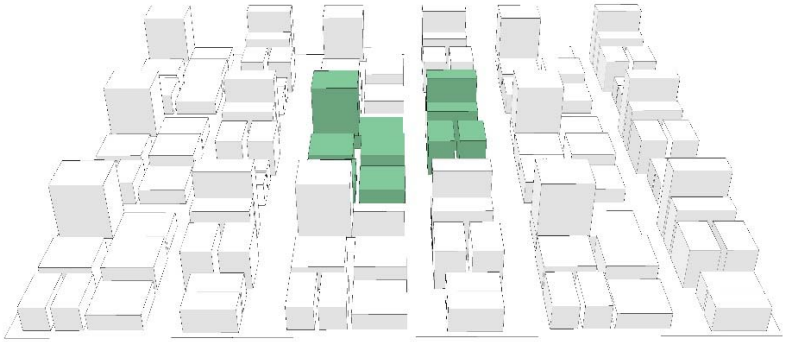


EUI: **164** sDA: **0.73**

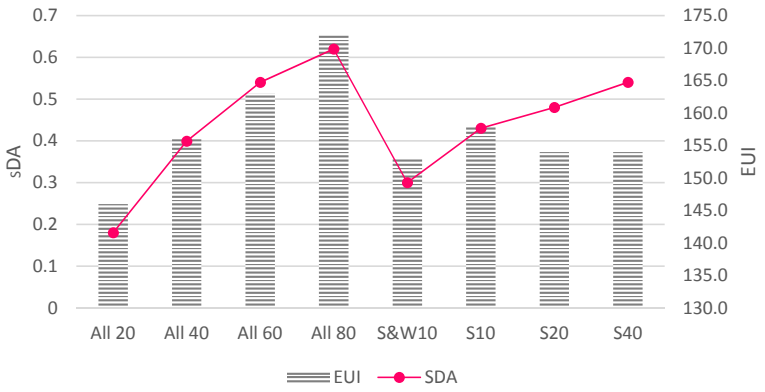
Design Proposal (C)

The Protoblock

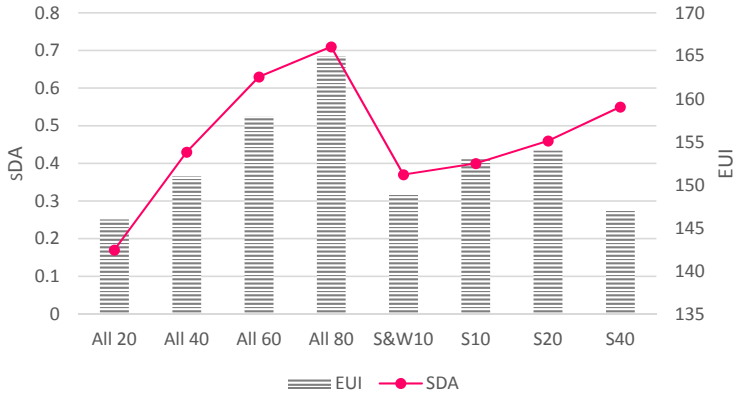
Daylight Analysis



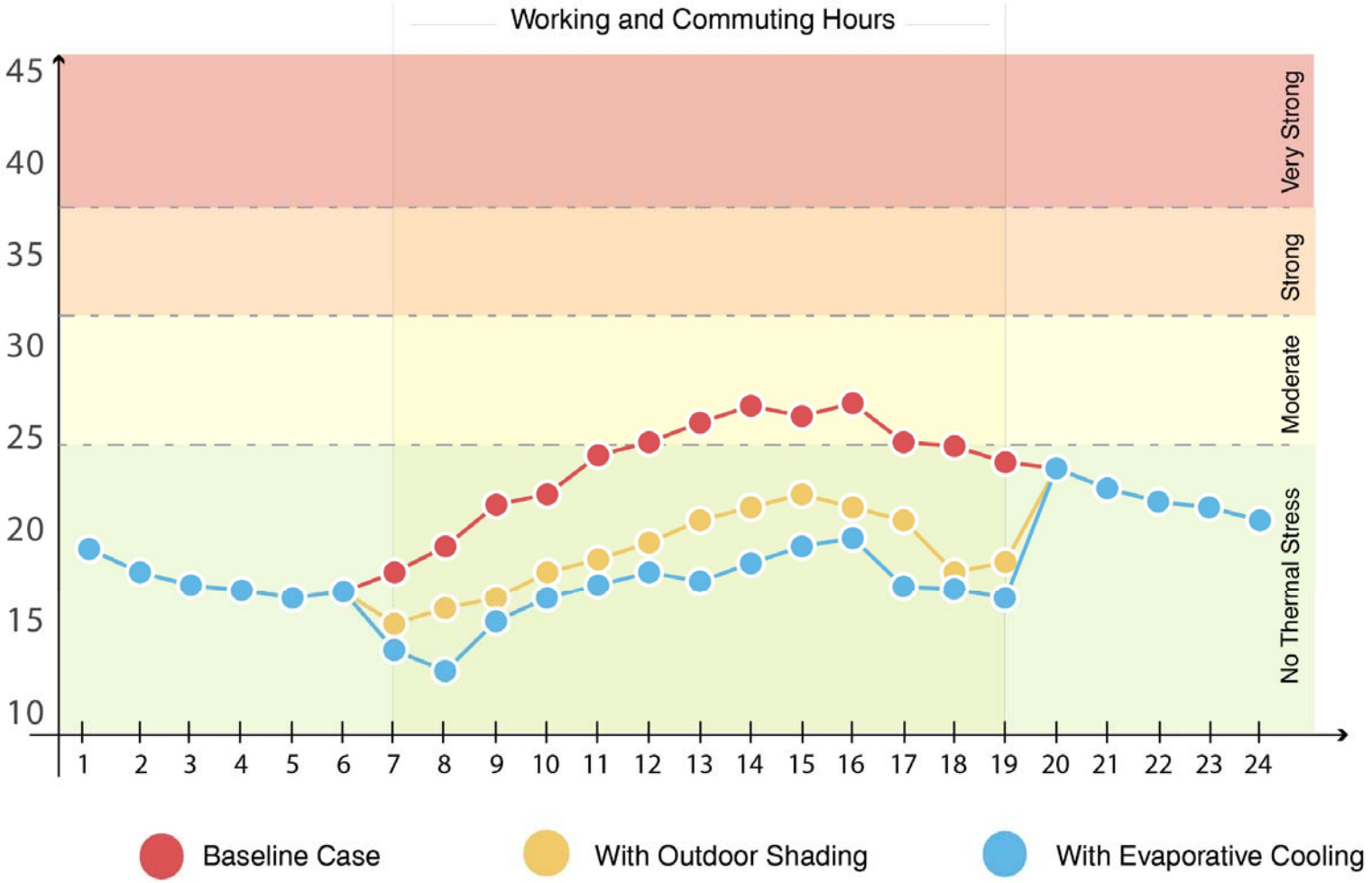
Model A:High FAR



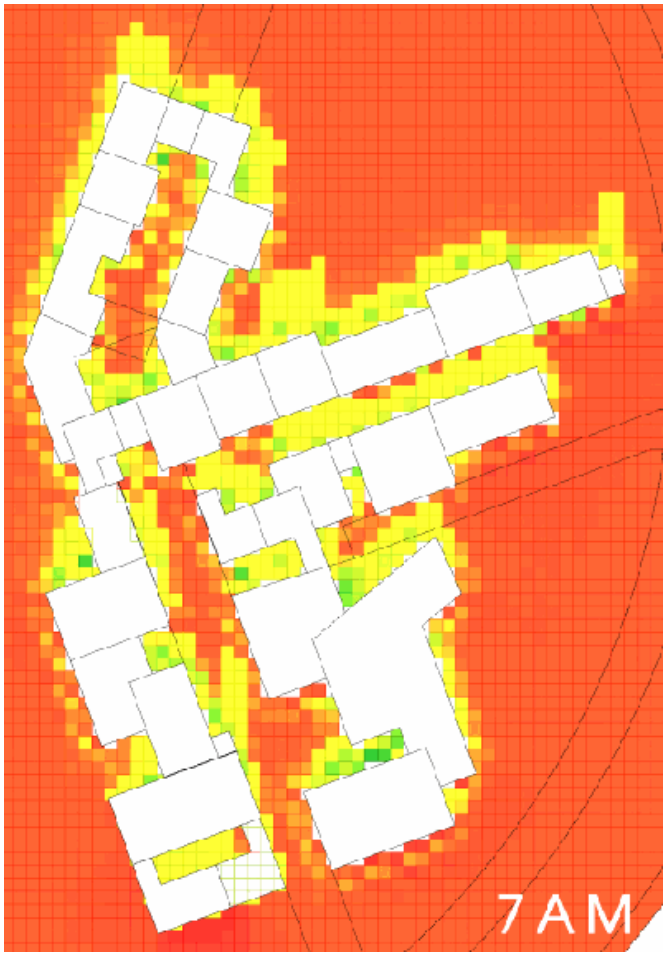
Model C: High FAR

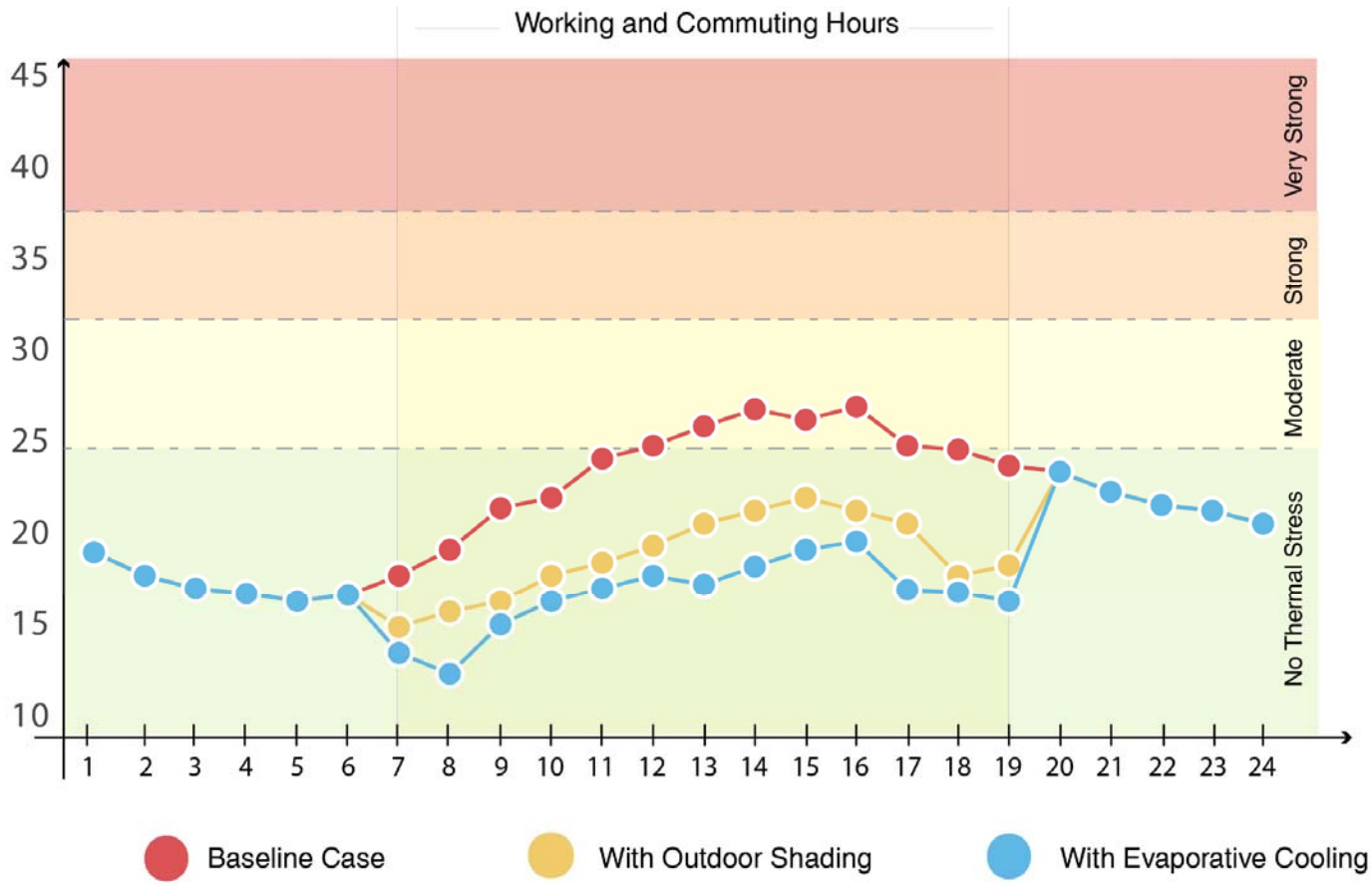


Outdoor Thermal Comfort: April

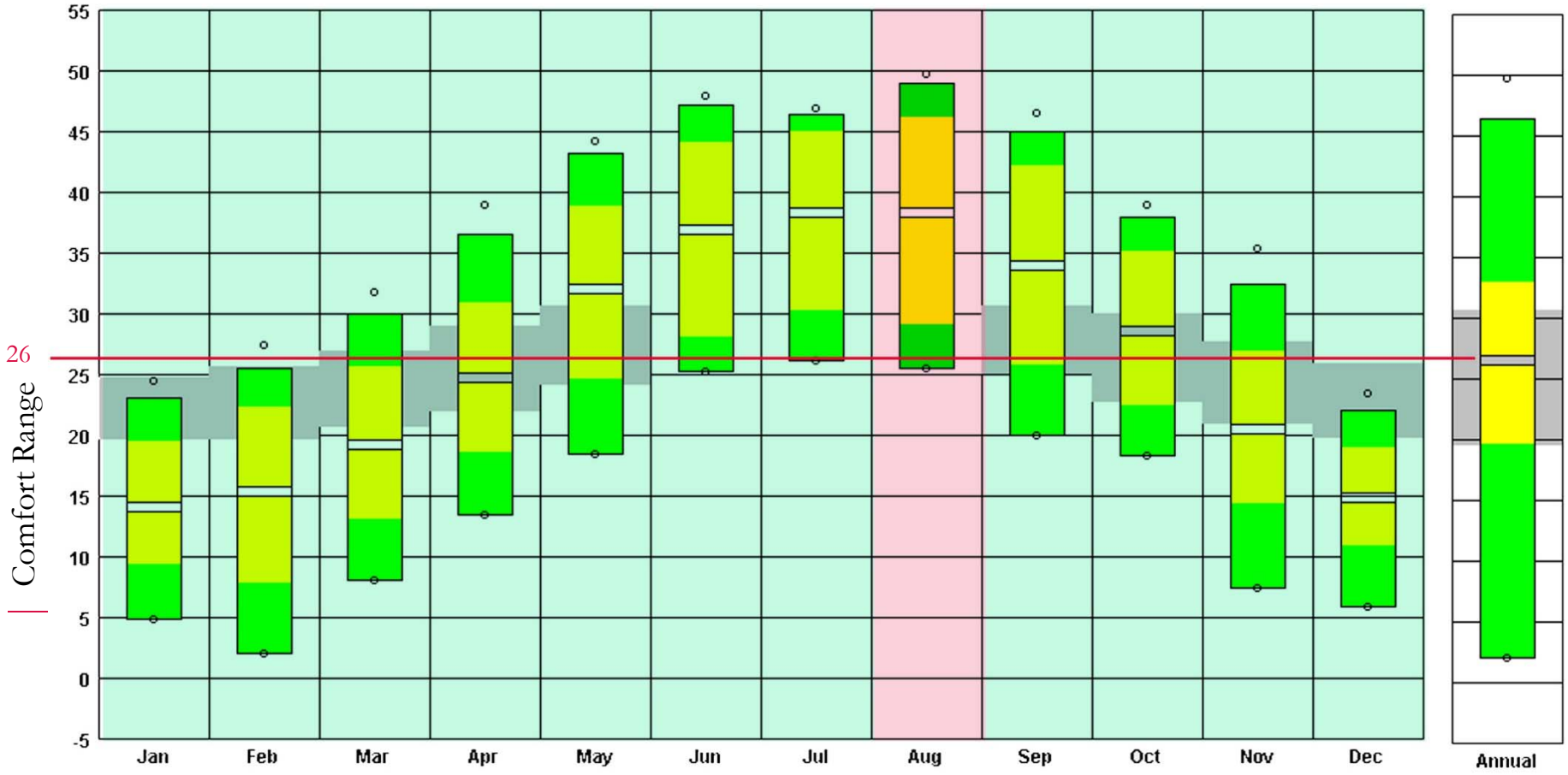


Outdoor Thermal Comfort: April

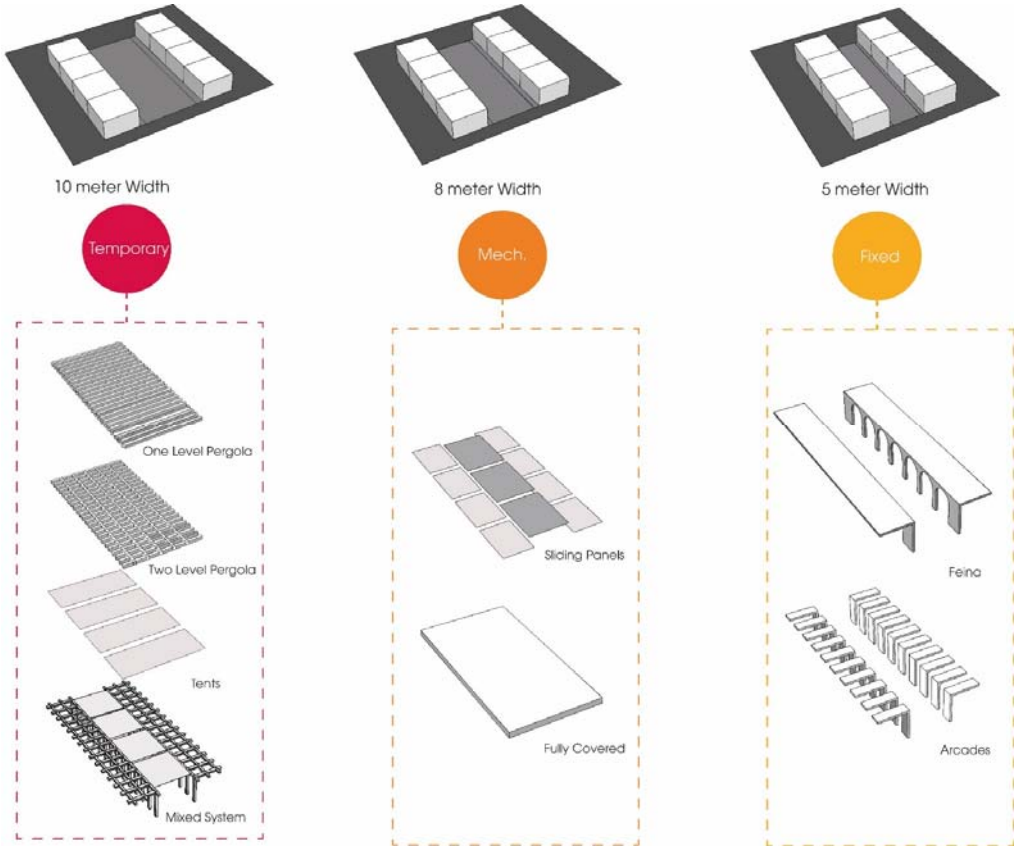




Outdoor Thermal Comfort



Neighborhood Outdoor Thermal Comfort Performance



Neighborhood Embodied Energy