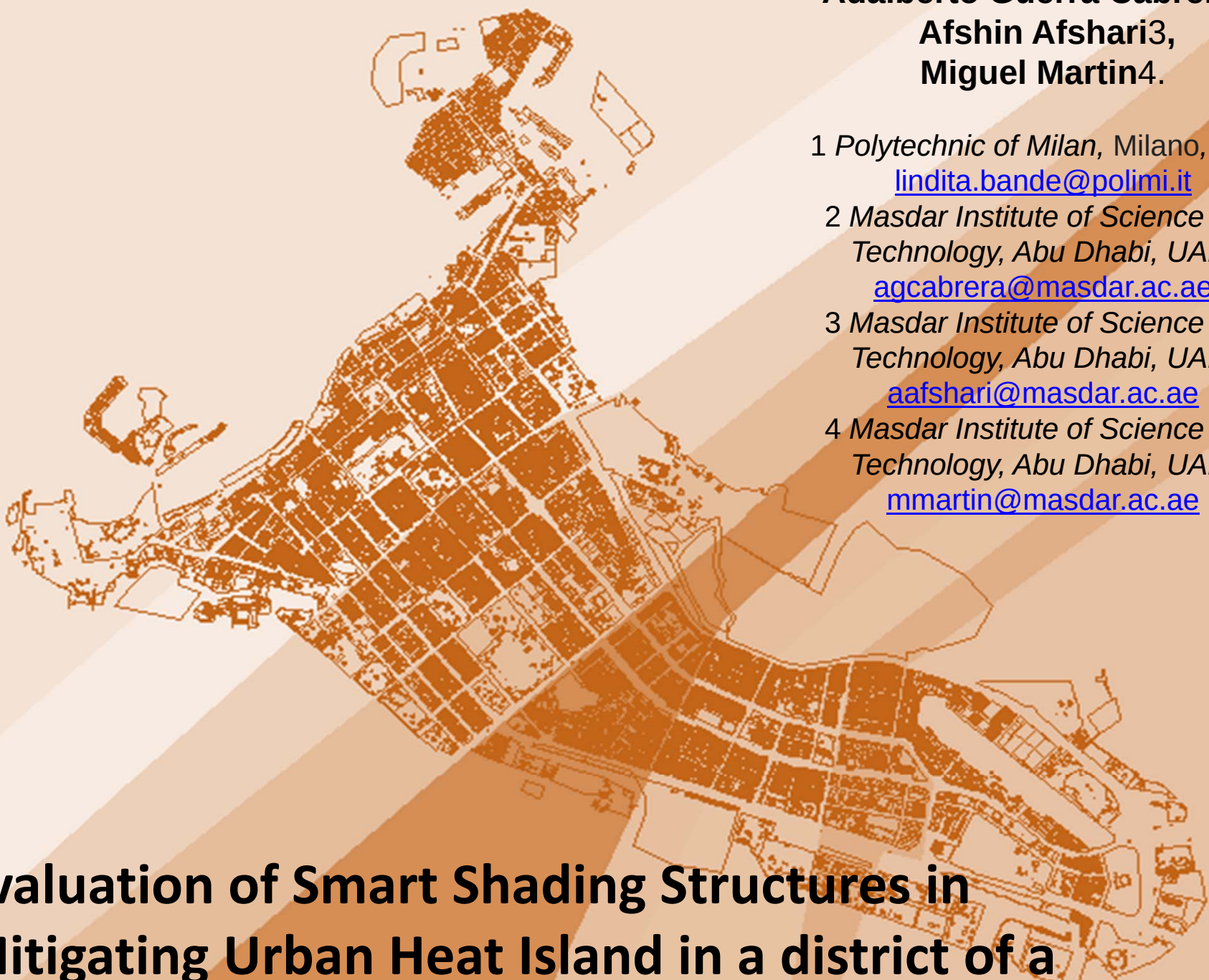


An aerial map of Abu Dhabi, United Arab Emirates, showing the city's layout with a grid-like street pattern in the central urban area and more irregular patterns in the surrounding regions. The map is rendered in a light orange/brown color scheme, matching the background of the slide.

**Lindita Bande¹,
Adalberto Guerra Cabrera²,
Afshin Afshari³,
Miguel Martin⁴.**

*1 Polytechnic of Milan, Milano, Italy,
lindita.bande@polimi.it*

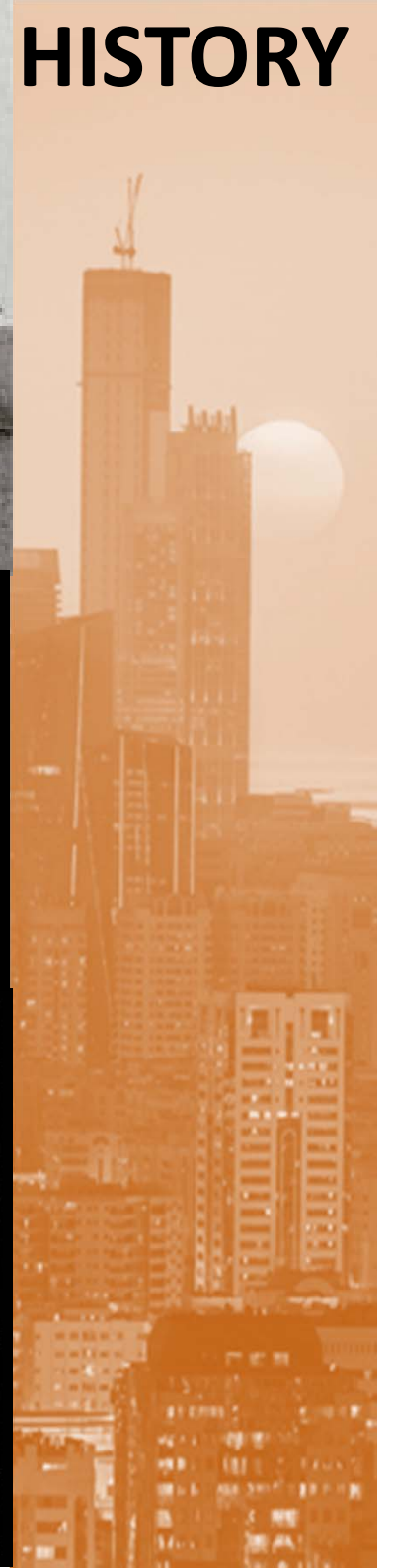
*2 Masdar Institute of Science and
Technology, Abu Dhabi, UAE,
agcabrera@masdar.ac.ae*

*3 Masdar Institute of Science and
Technology, Abu Dhabi, UAE,
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mmartin@masdar.ac.ae*

**Evaluation of Smart Shading Structures in
Mitigating Urban Heat Island in a district of a
Hot Arid Climate City (Abu Dhabi).**

THE HISTORY



Abu Dhabi 1955 with Royal Palace visible



Abu Dhabi 1955.



Abu Dhabi 1966.

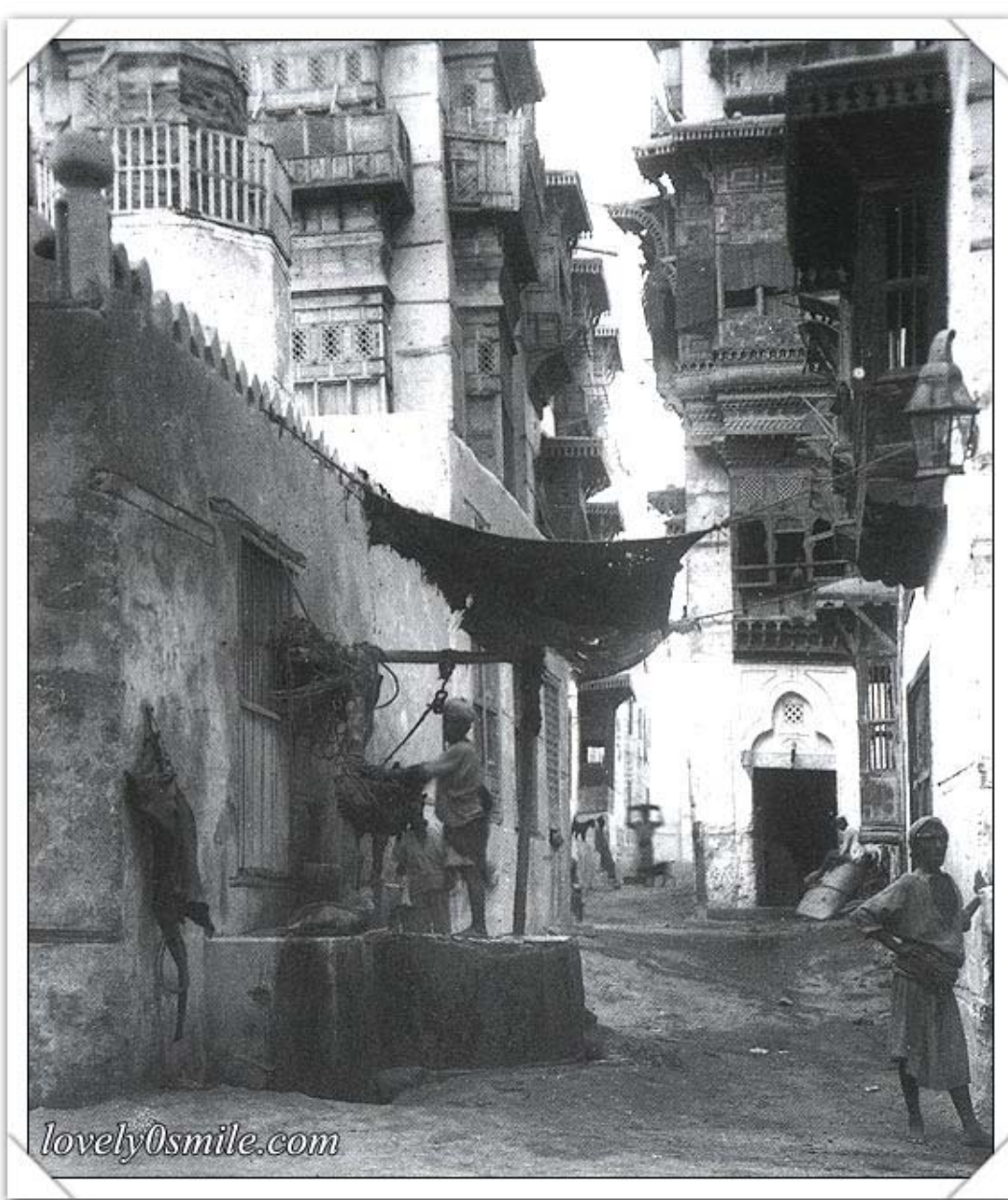
Abu Dhabi 1970.



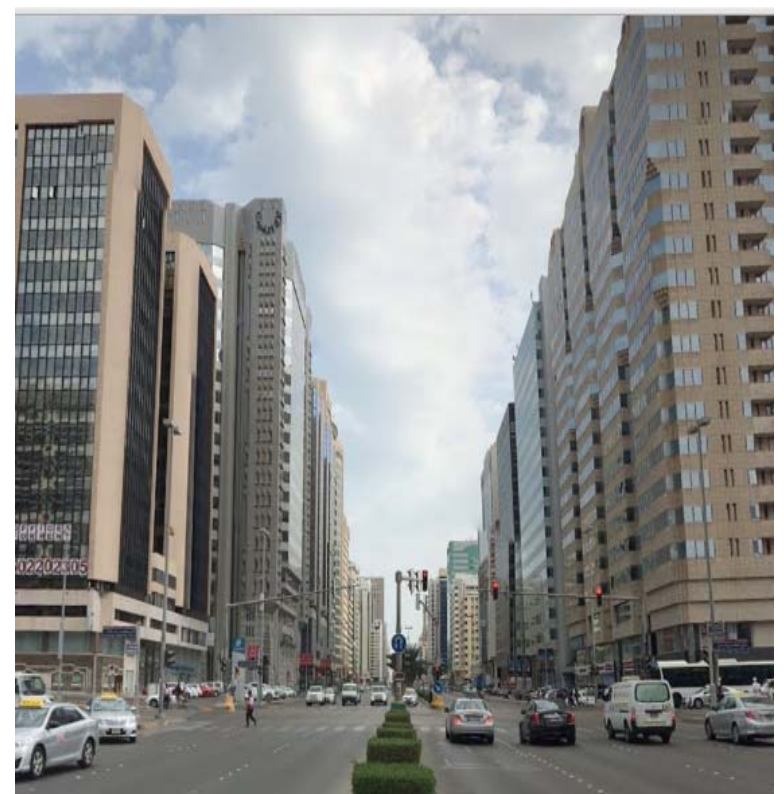
Abu Dhabi 2014.



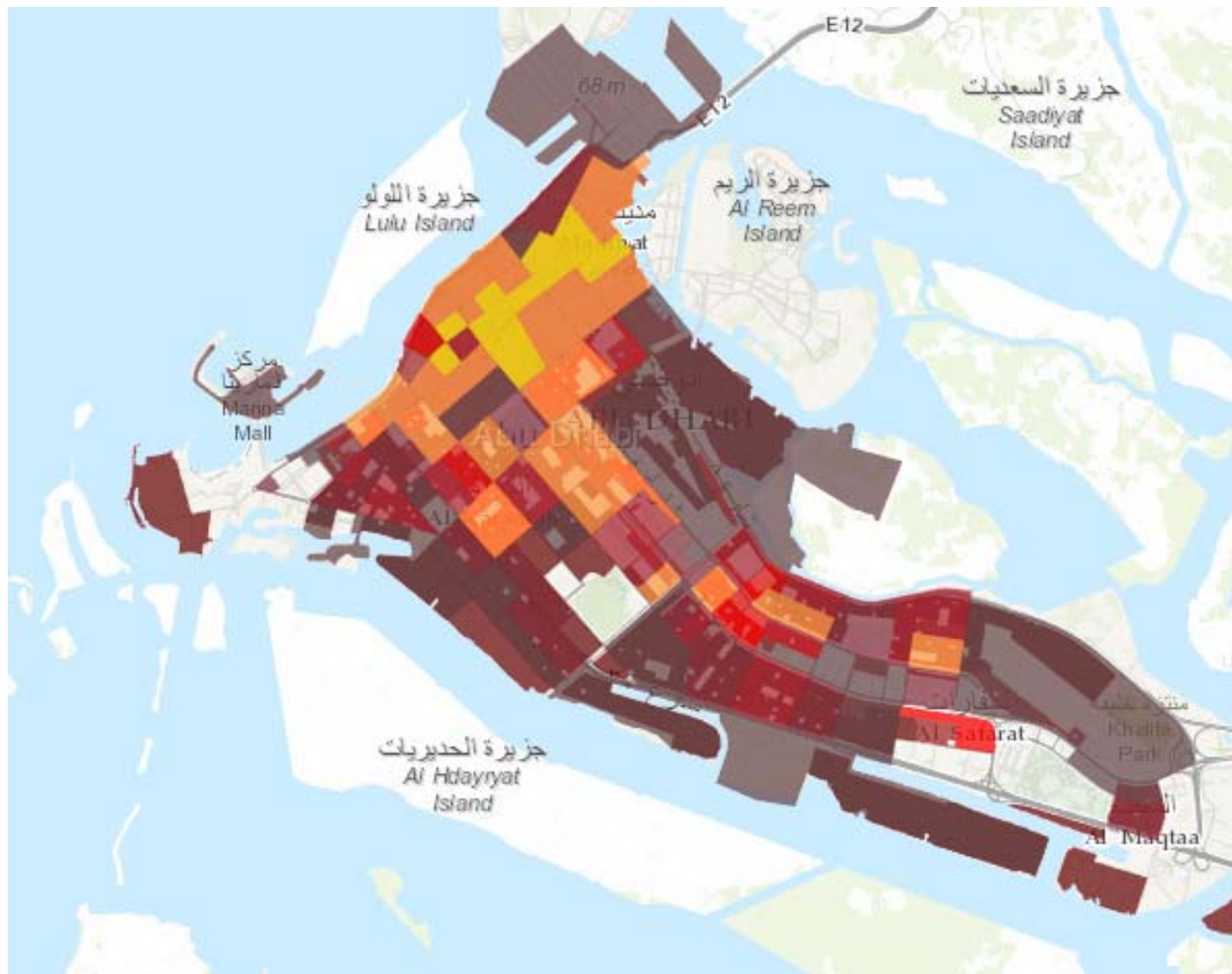
THE CITY TRANSFORMATION



شارع في مدينة جدة، ١٣٣٥ هـ / ١٩١٦ م
 الملك عبدالعزيز آل سعود
 في عيون وألوان الحورين



HISTORY VS MODERN



POPULATION DENSITY AND THE LATEST TEMPERATURE MEASURED IN ABU DHABI



Type/age	Date	No. of floors	Building Systems					Orientation	No. of Buildings	Average floor space, m ²	Average Energy Intensity, kWh/m ² /yr	General Comments
			Windows	SB	Central	Roofing	Appliances					
Residential (Old - 1961)	1961	3-5	x	x	x			Area where it used to be a residence and now used as a store	11,108	560.00	415.00	
Residential (Old - Large)	1951	3+	x	x	x			Area where it was a residence and has multiple use floors	10,013	250.00	250.00	
Residential (Old - Low Rise)	1951	3-5	x	x	x			Buildings that are used to be a residence but are now used as a commercial building or a store	441	400.00	280.00	
Residential (Old - Medium Rise)	1951	3-5	x	x	x	x		Buildings that have a mix of use floors that consist of residential, commercial and store	1,271	170.00	220.00	
Residential (Old - High Rise)	1951	3+	x	x	x	x		Buildings that are used exclusively as apartments or flats and have more than 5 floors	440	170.00	220.00	
Residential (Old)	1951	3+	x	x	x	x		Buildings that are used exclusively as residences, other than flats and apartments	1,363	470.00	100.00	
Commercial (Old - Low Rise)	1951	3-5	x	x	x	x		Buildings that are used exclusively for commercial offices and are more than 5 floors	286	480.00	270.00	
Commercial (Old - Medium Rise)	1951	3-5	x	x	x	x		Buildings that are used exclusively for commercial offices and are more than 5 floors	315	470.00	340.00	
Commercial (Old - High Rise)	1951	3+	x	x	x	x		Buildings that are used exclusively for commercial offices and are more than 5 floors	34	2000.00	210.00	
Commercial (Old - Low Rise)	1951	3-5	x	x	x	x		Buildings that have a mix of use floors and have a combination of commercial offices, shops or the ground floor and residential floors	75	660.00	570.00	
Commercial (Old - Medium Rise)	1951	3-5	x	x	x	x		These buildings have a mix of use floors and commercial offices on the lower floors and residential floors on the upper floors	120	2540.00	280.00	
Commercial (Old - High Rise)	1951	3+	x	x	x	x		Buildings that are used exclusively for commercial offices and are more than 5 floors	1,003	810.00	250.00	
Commercial (Old)	1951	3+	x	x	x	x		Commercial buildings, used as shops, restaurants, and other, regardless of building use or number of floors	54	1,050.00	660.00	
Commercial (Old)	1951	3+	x	x	x	x		Commercial buildings, used as shops, restaurants, and other, regardless of building use or number of floors	1,006	1,170.00	620.00	
Commercial (Old)	1951	3+	x	x	x	x		Commercial buildings, used as shops, restaurants, and other, regardless of building use or number of floors	1,100	2,010.00	220.00	
Industrial (Old)	1951	3+	x	x	x	x		Industrial buildings, used as factories	110	1,740.00	170.00	
Industrial (Old)	1951	3+	x	x	x	x		Industrial buildings, used as factories	70	1,840.00	400.00	
Industrial (Old)	1951	3+	x	x	x	x		Industrial buildings, used as factories	110	400.00	470.00	
Industrial (Old)	1951	3+	x	x	x	x		Industrial buildings, used as factories	110	400.00	400.00	
Industrial (Old)	1951	3+	x	x	x	x		Industrial buildings, used as factories	1,106	1,110.00	400.00	

*Excludes for all buildings

DIFFERENT DISTRICT TYPOLOGY TAKEN INTO STUDY.

AIM OF THE RESEARCH:

- MEASURING THE IMPACT OF URBAN SHADING DEVICE INTO THE MITIGATION OF UHI.**
- MEASURING THE ENERGY SAVING IN THE COOLING LOAD OF THE DIFFERENT TYPOLOGIES OF BUILDINGS IN THE 5 CONSIDERED DISTRICTS AS A RESULT OF THE UHI MITIGATION STRATEGY.**

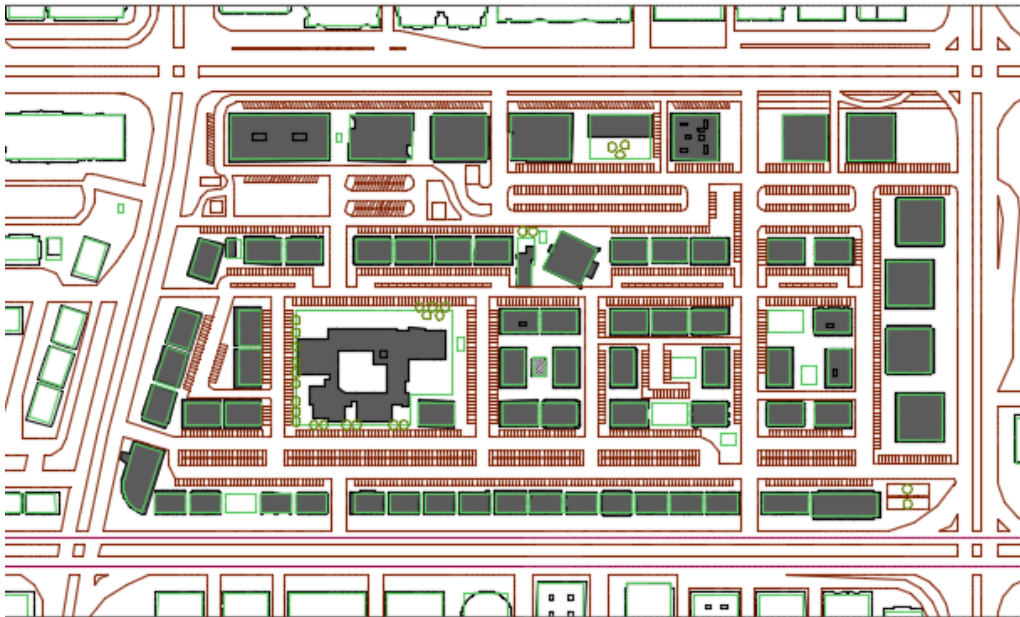
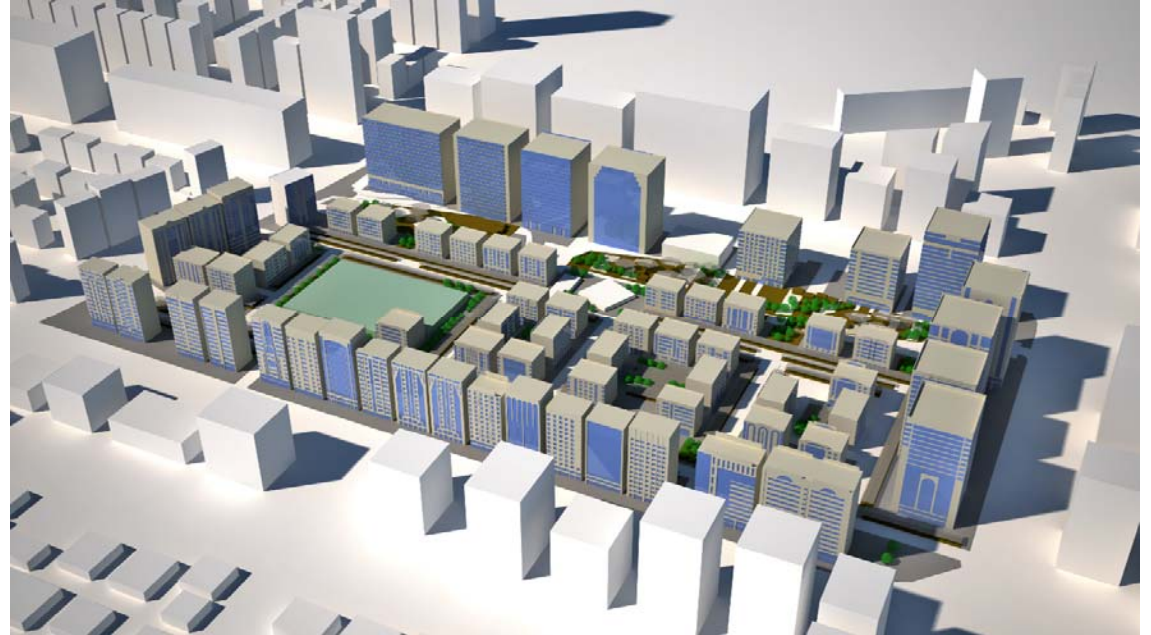
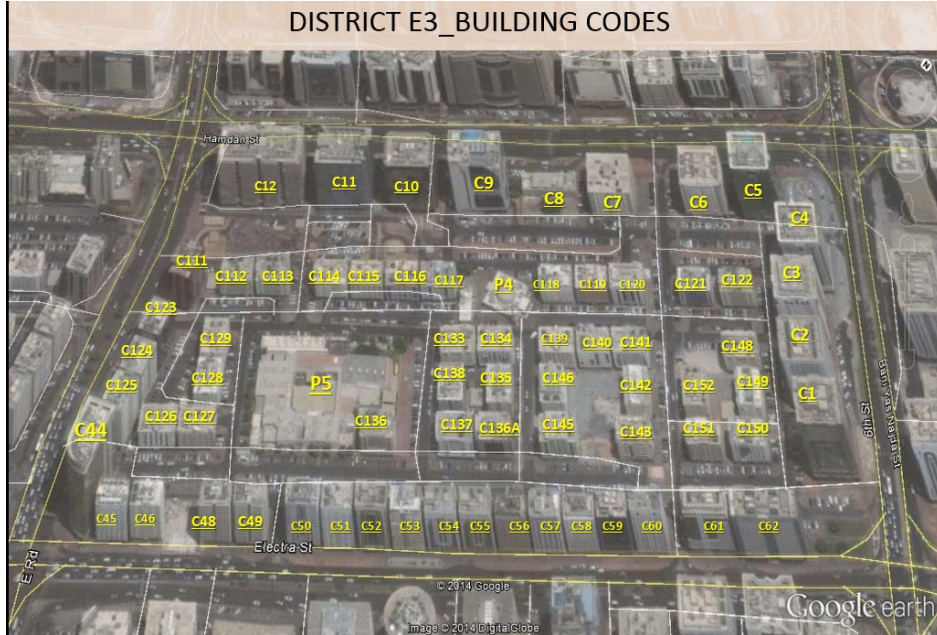
INNOVATION :

- COMPARISON OF TRADITIONAL SHADING WITH SMART SHADING DEVICES AS A UHI MITIGATION STRATEGY.**
- HAVING YEARLY TOTAL ENERGY SIMULATION OF EACH DISTRICT BY USING A MODIFIED YEARLY WEATHER FILE FROM DIFFERENT TOOLS IN A CITY AS ABU DHABI.**

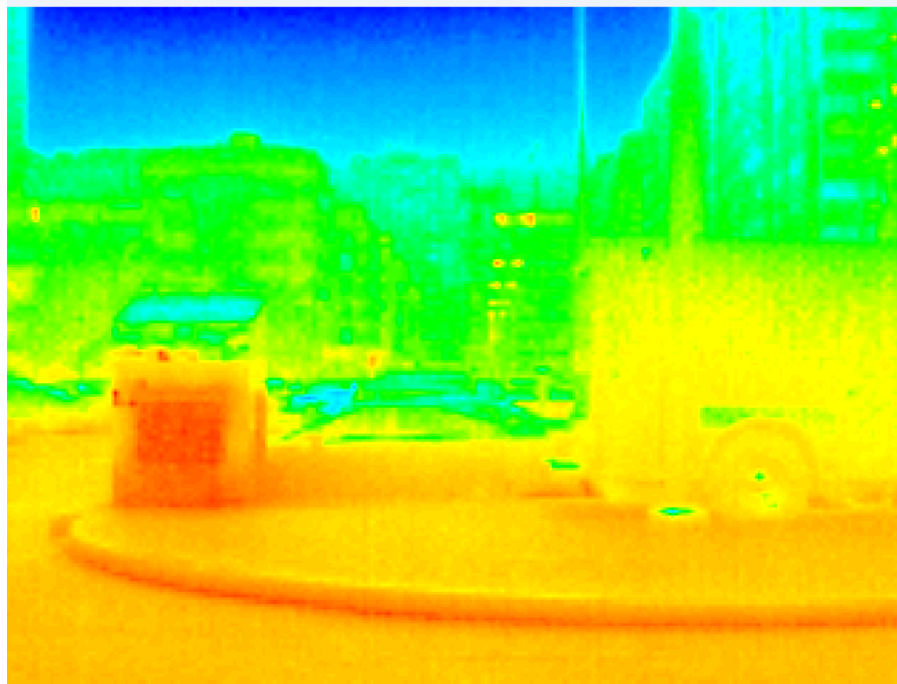
TOOLS USED IN THE RESEARCH:

- | | | |
|---------------------|-----------------|-----------------|
| -ENVI MET | | |
| -ENERGY PLUS | -RHINO | -AUTOCAD |
| -UMI | -ECOTECH | -3D MAX |
| -GRASSHOPPER | | |

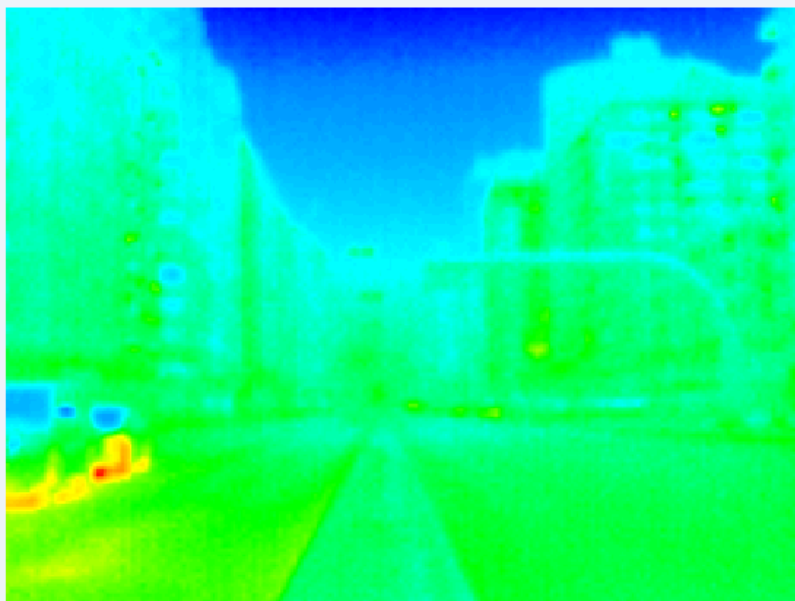
DISTRICT E3_BUILDING CODES



THE CASE STUDY – E3

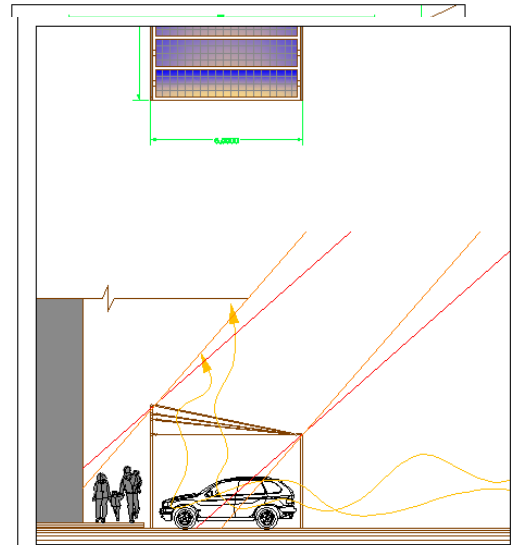
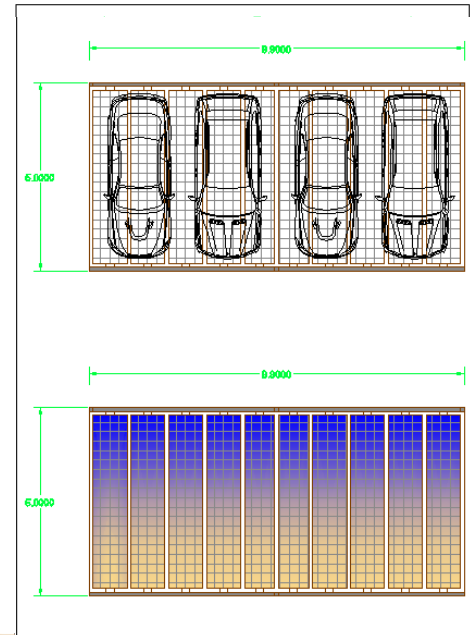
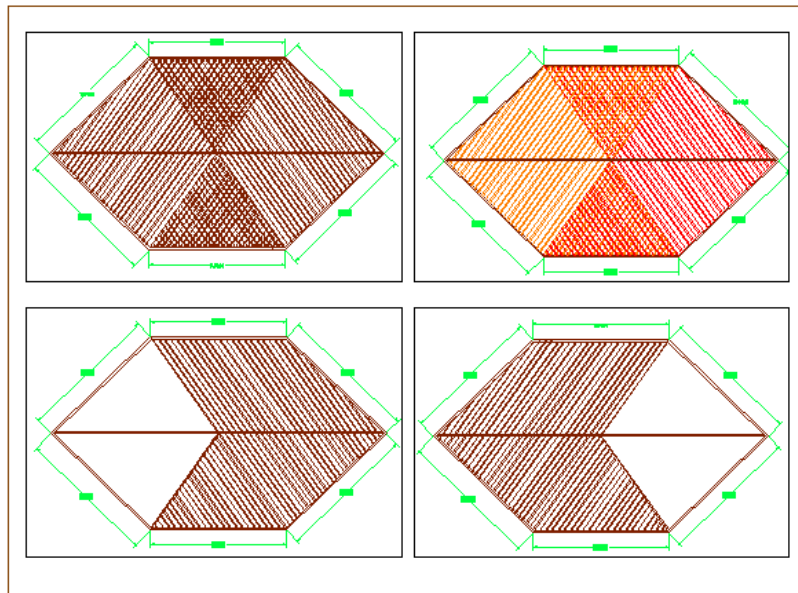
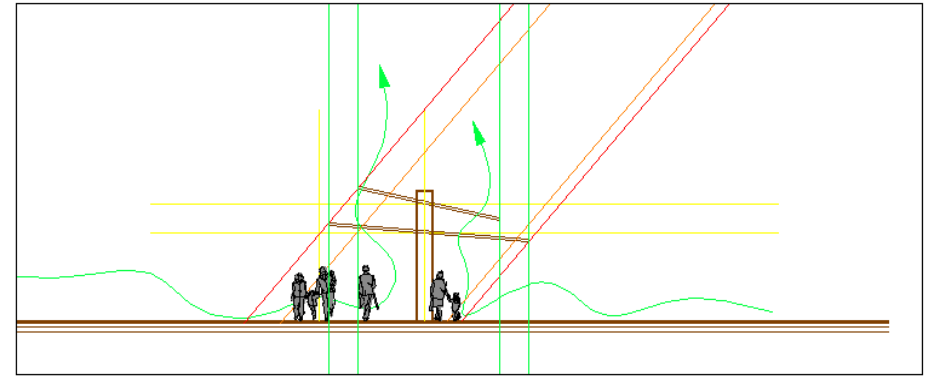
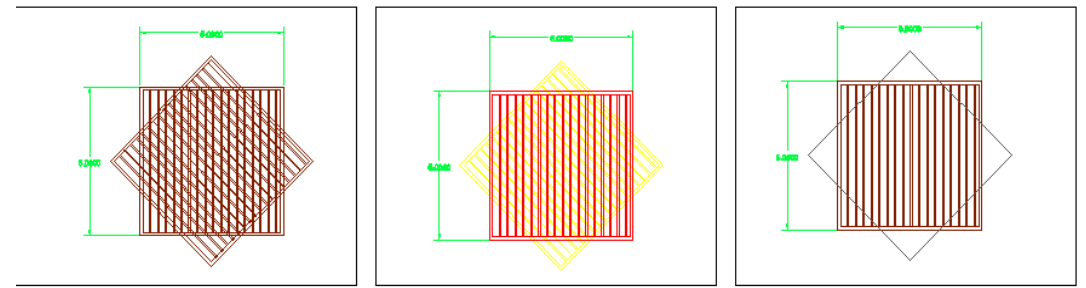
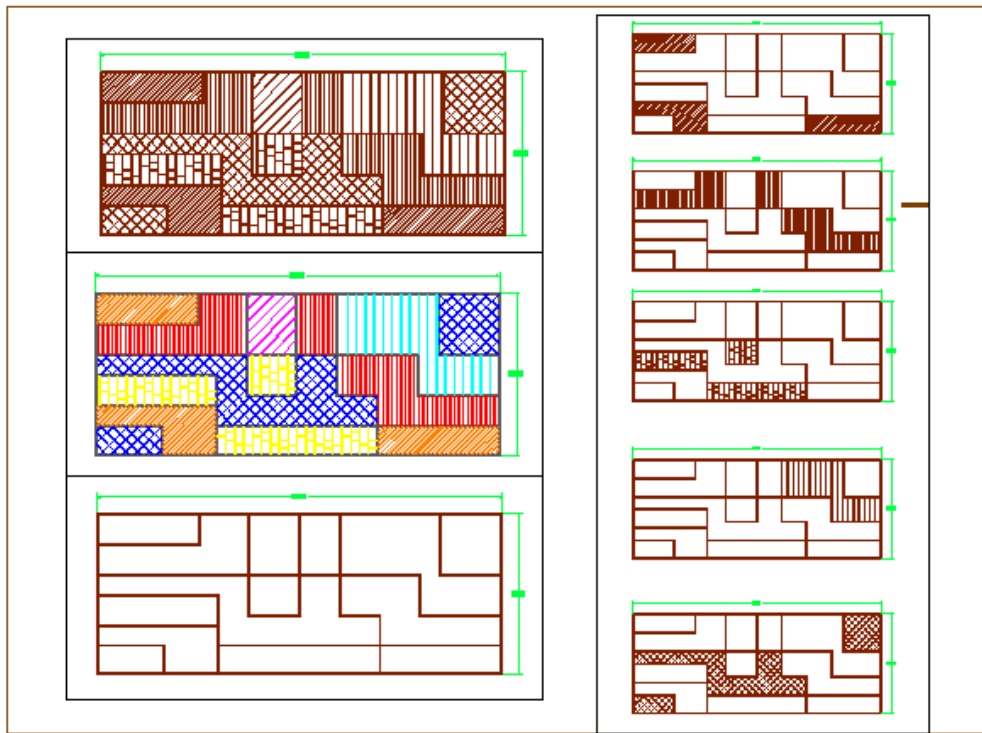


District E3 thermal image at evening.

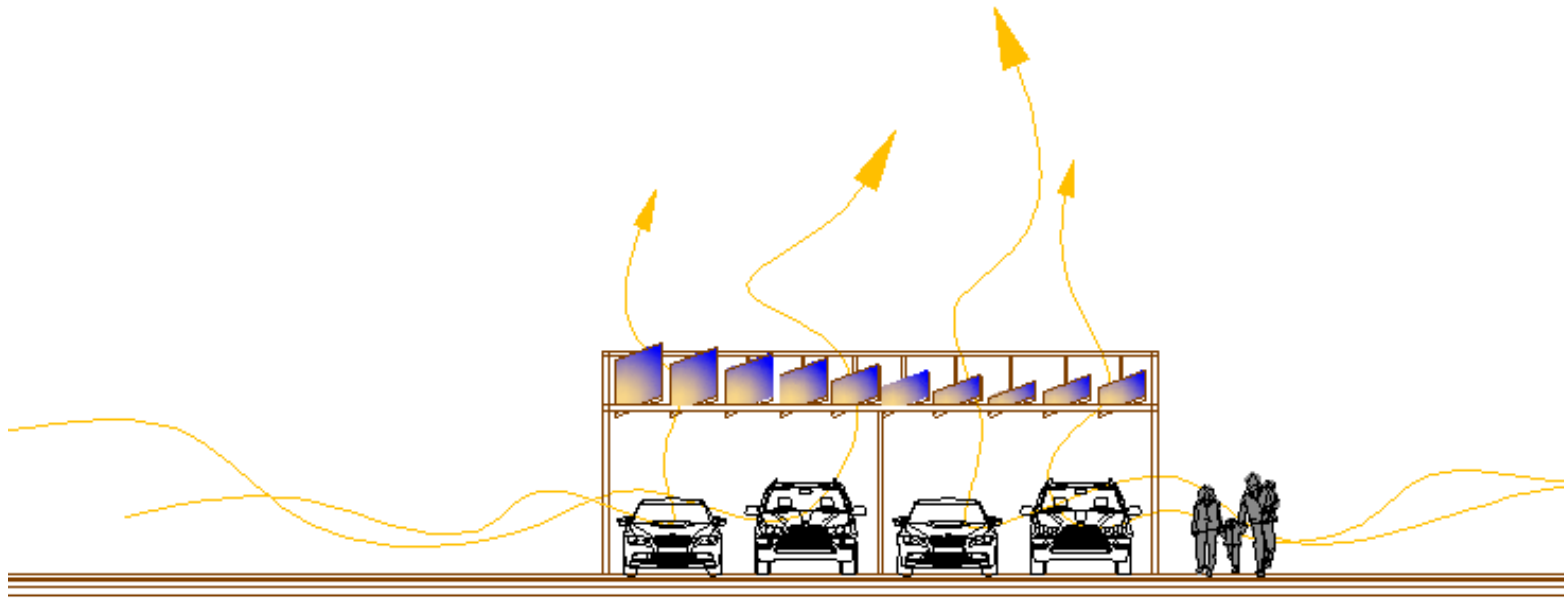
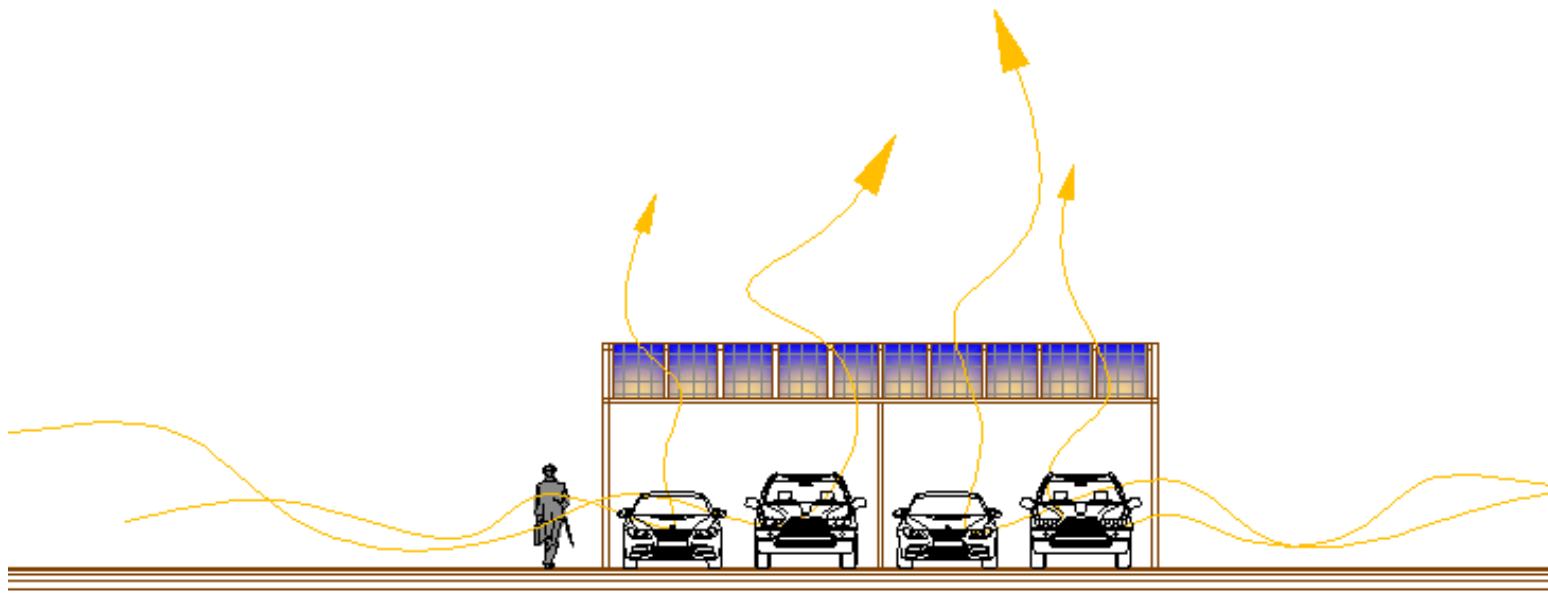


District E3 thermal image at morning.

UHI EFFECT DOWNTOWN ABU DHABI



SHADING DEVICES TYPOLOGY 1



SHADING DEVICES TYPOLOGY 3

STEP 1: PREPARING THE BASE FILE

Arch GIS, AutoCAD, 3D Max, ECOTECH, ENVI met.

STEP 2: CREATING THE LINK FOR THE YEARLY WEATHER FILE

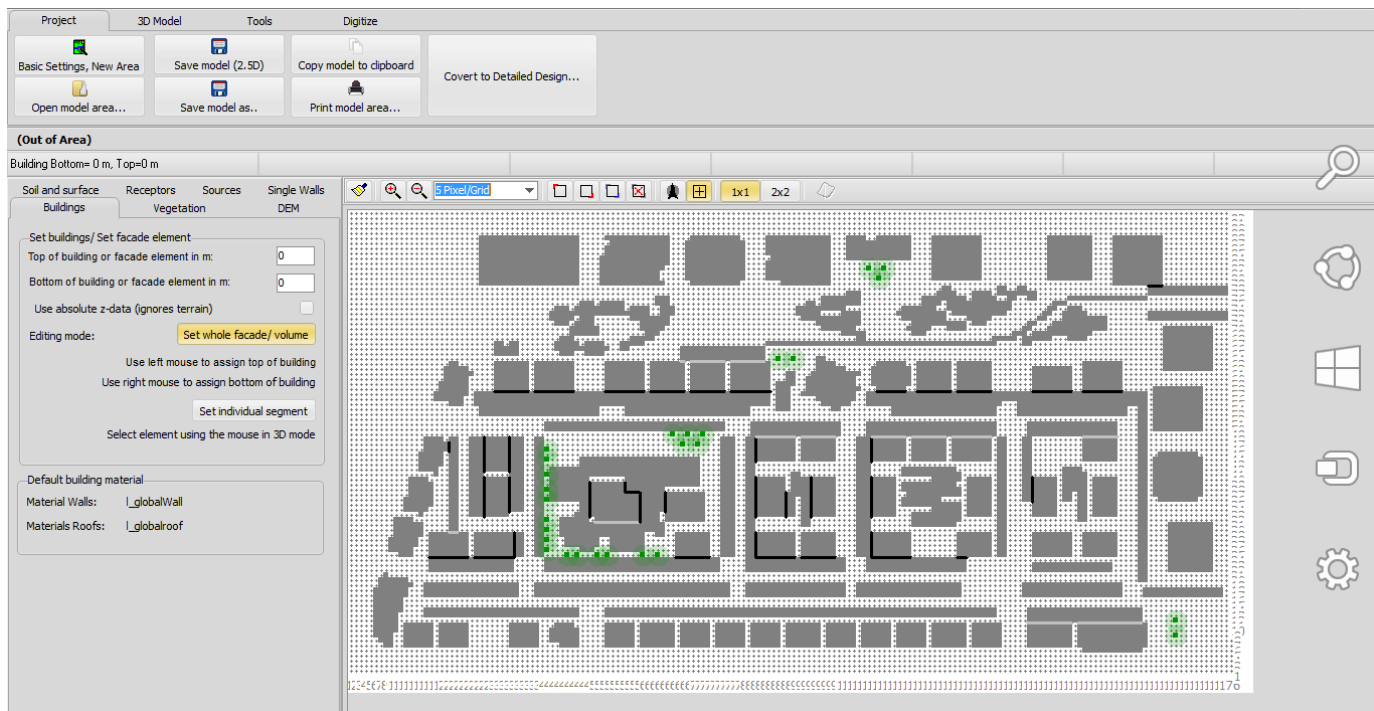
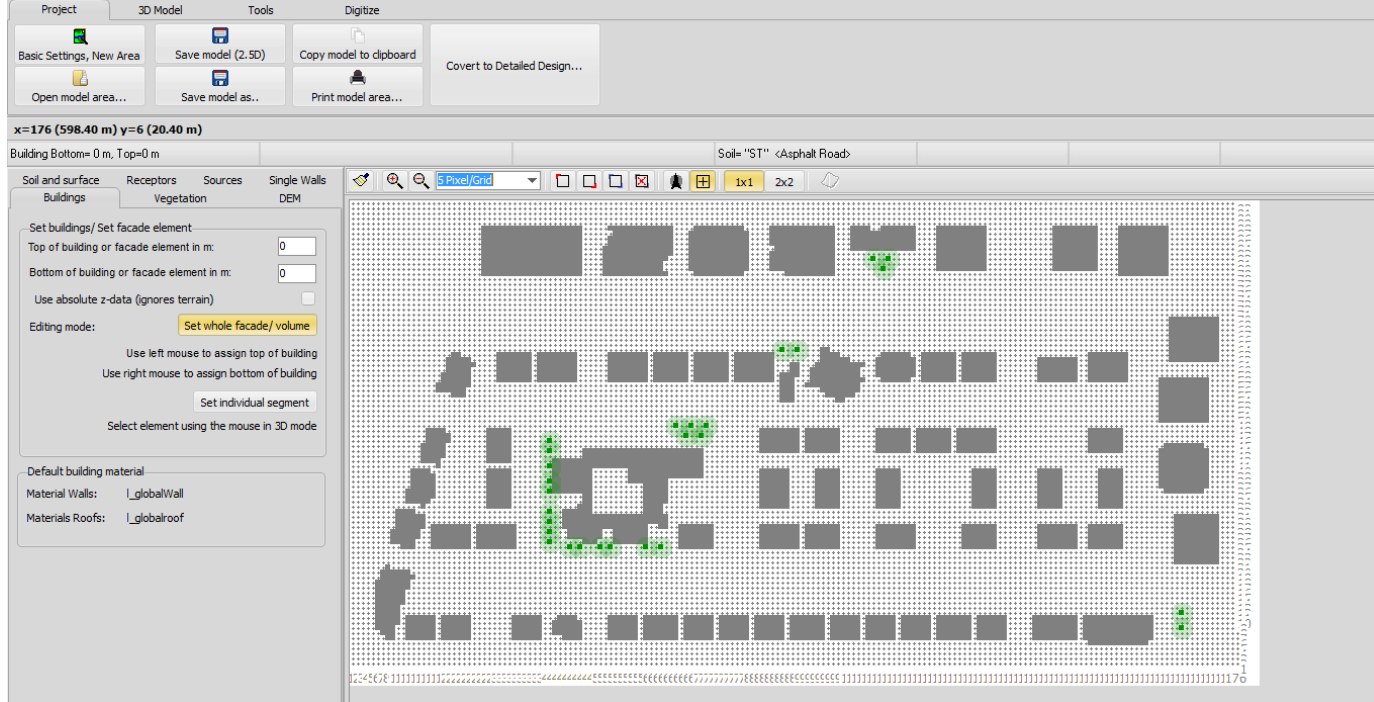
MATLAB

STEP 3: ENERGY SIMULATION

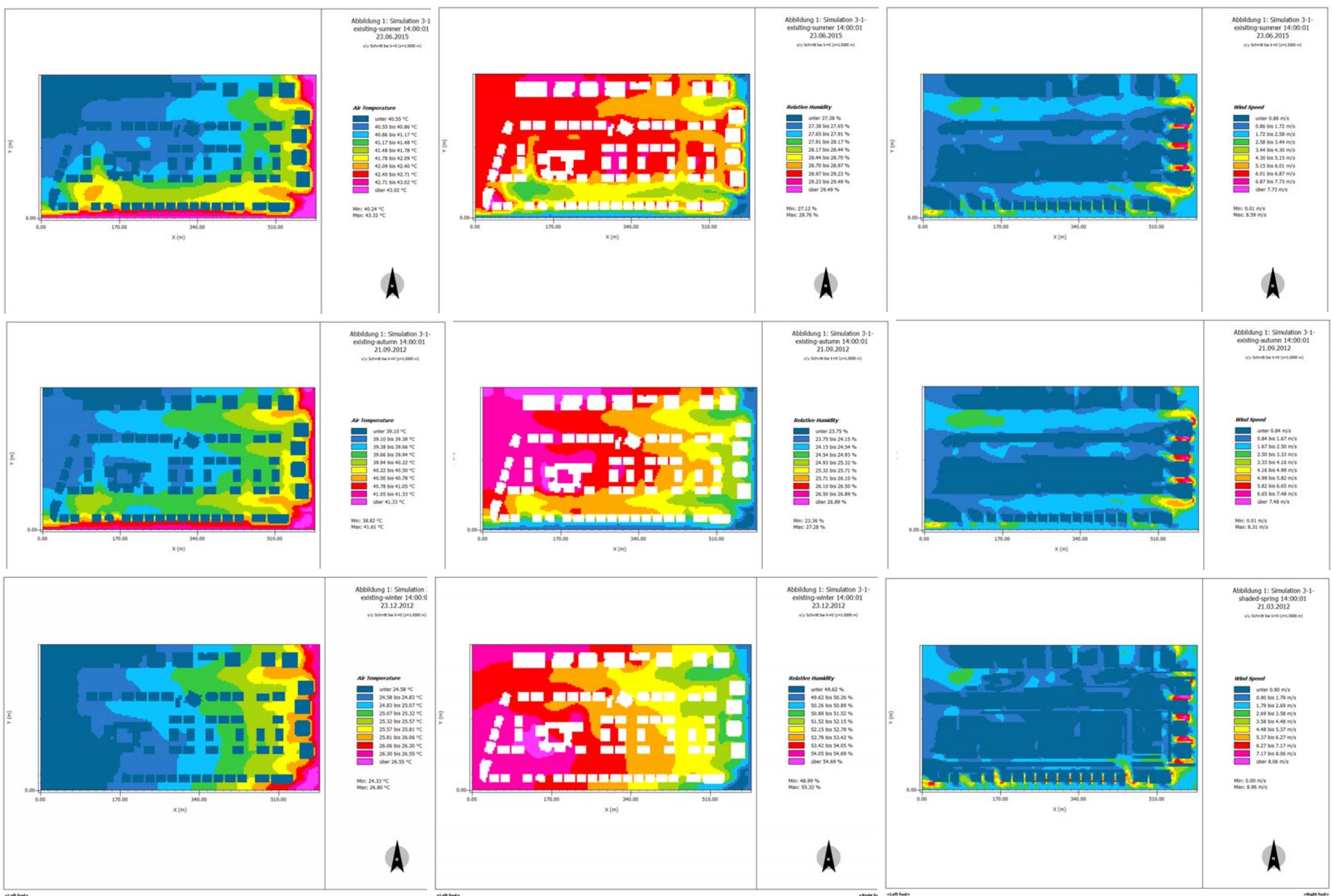
UMI, RHINO, ENERGYPLUS, GRASSHOPPER



THREE STEPS AND THREE MAIN TOOLS

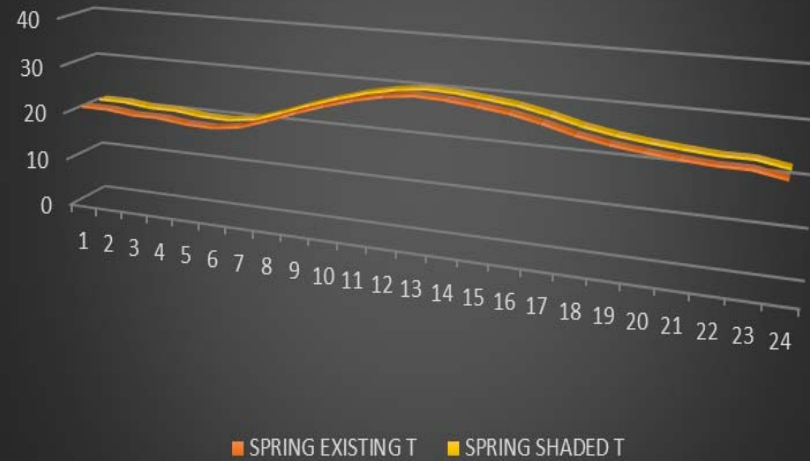


ENVI met AS A FIRST TOOL

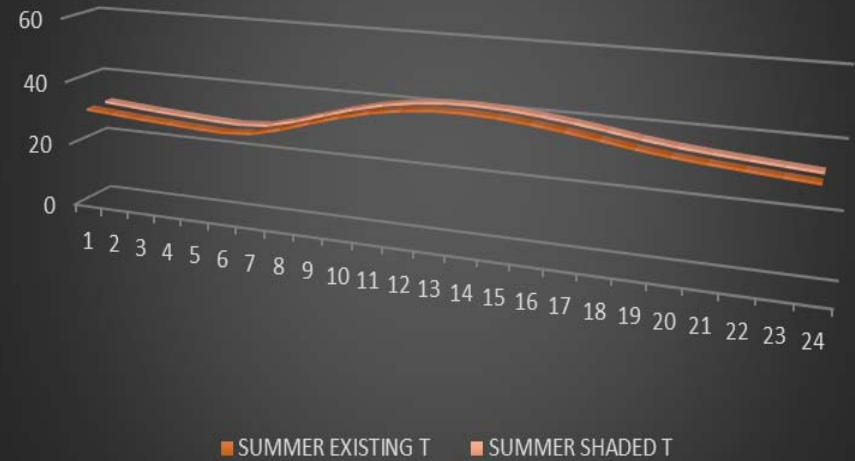


FIRST RESULTS IN ENVI met

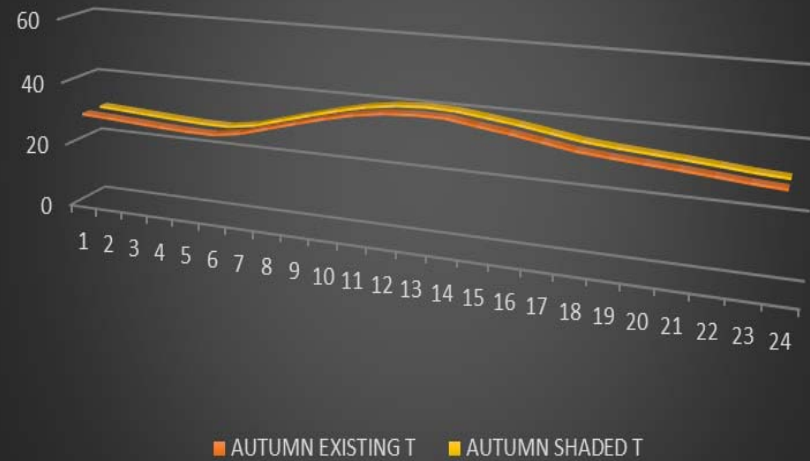
Spring T



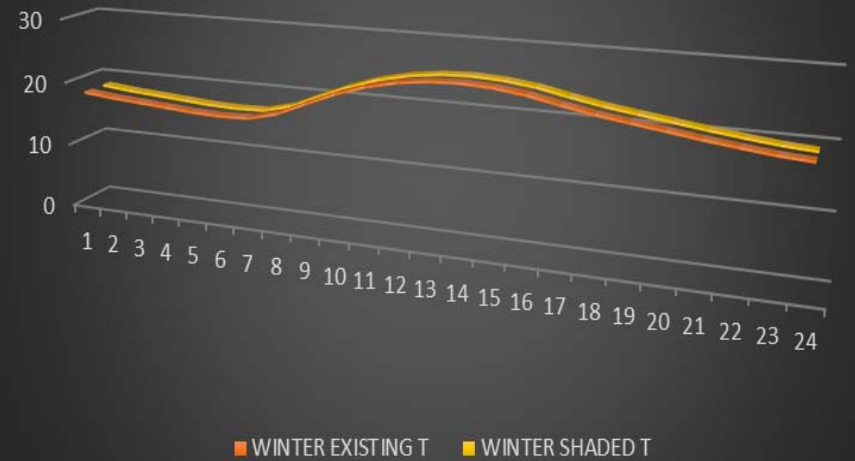
Summer T



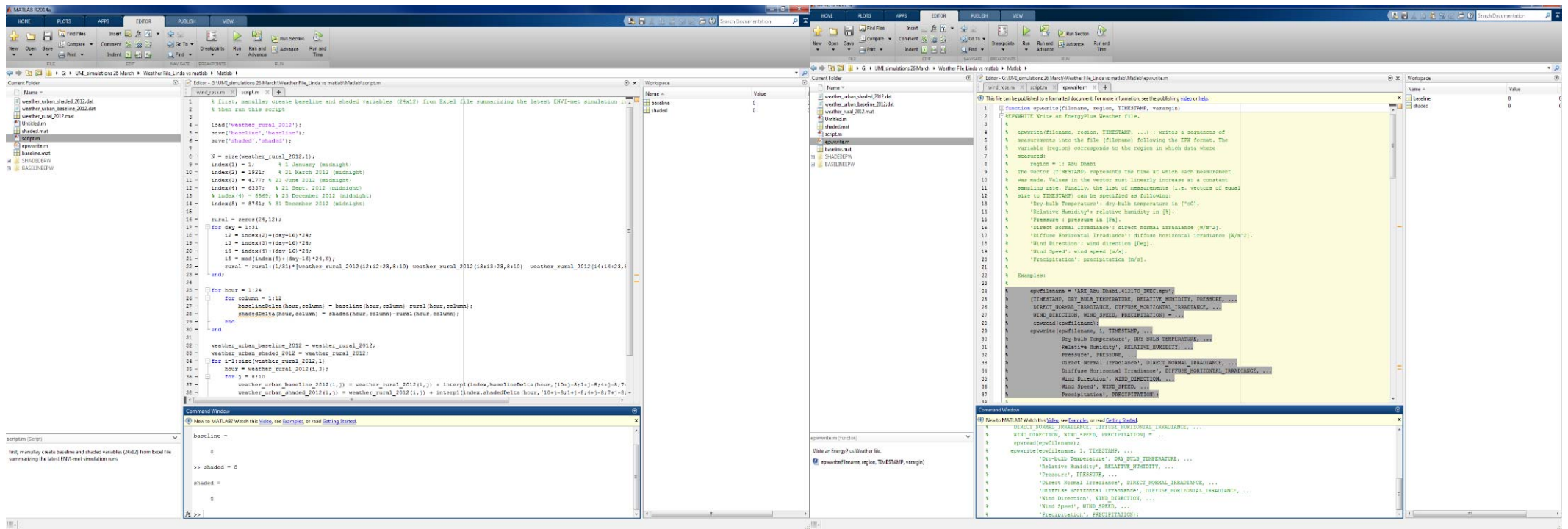
Autumn T



Winter T



THE DIFERENCE IN TEMPERATURE



SCOPE: YEARLY WEATHER FILE

**INPUT: 4 DAYS NEW WEATHER DATA,
YEARLY BASE WHEATHER DATA**

OUTPUT: NEW YEARLY WEATHER DATA

BASE TOOL: MATLAB

MATLAB AS A SECOND TOOL

Sensors in the Main Island of Abu Dhabi

Validation of the simulated weather file.

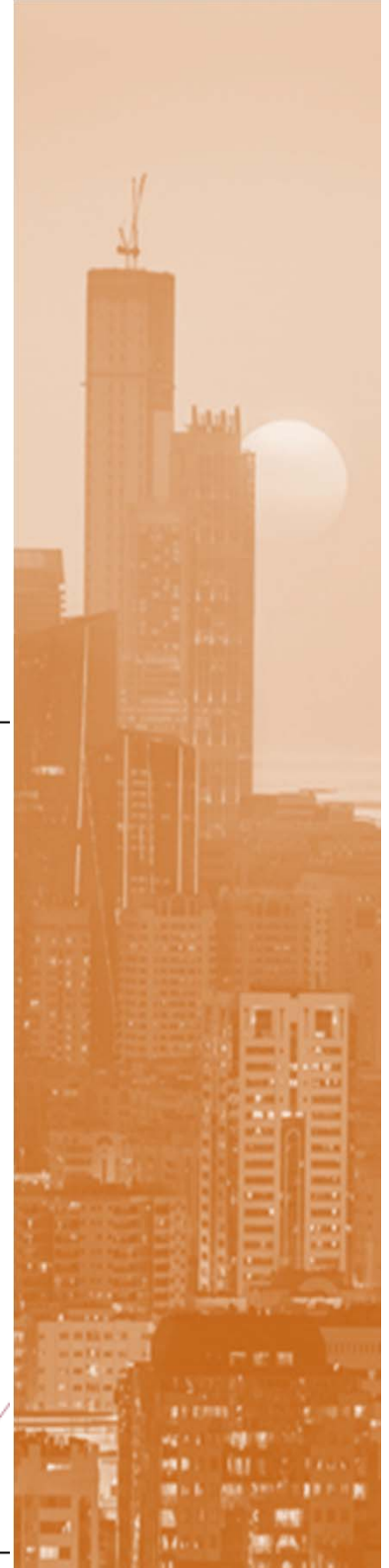
Scope: Real data of the temperature, relative humidity, wind speed.

Use: The real data will be used to calibrate the models of energy simulations that are used in the laboratory.

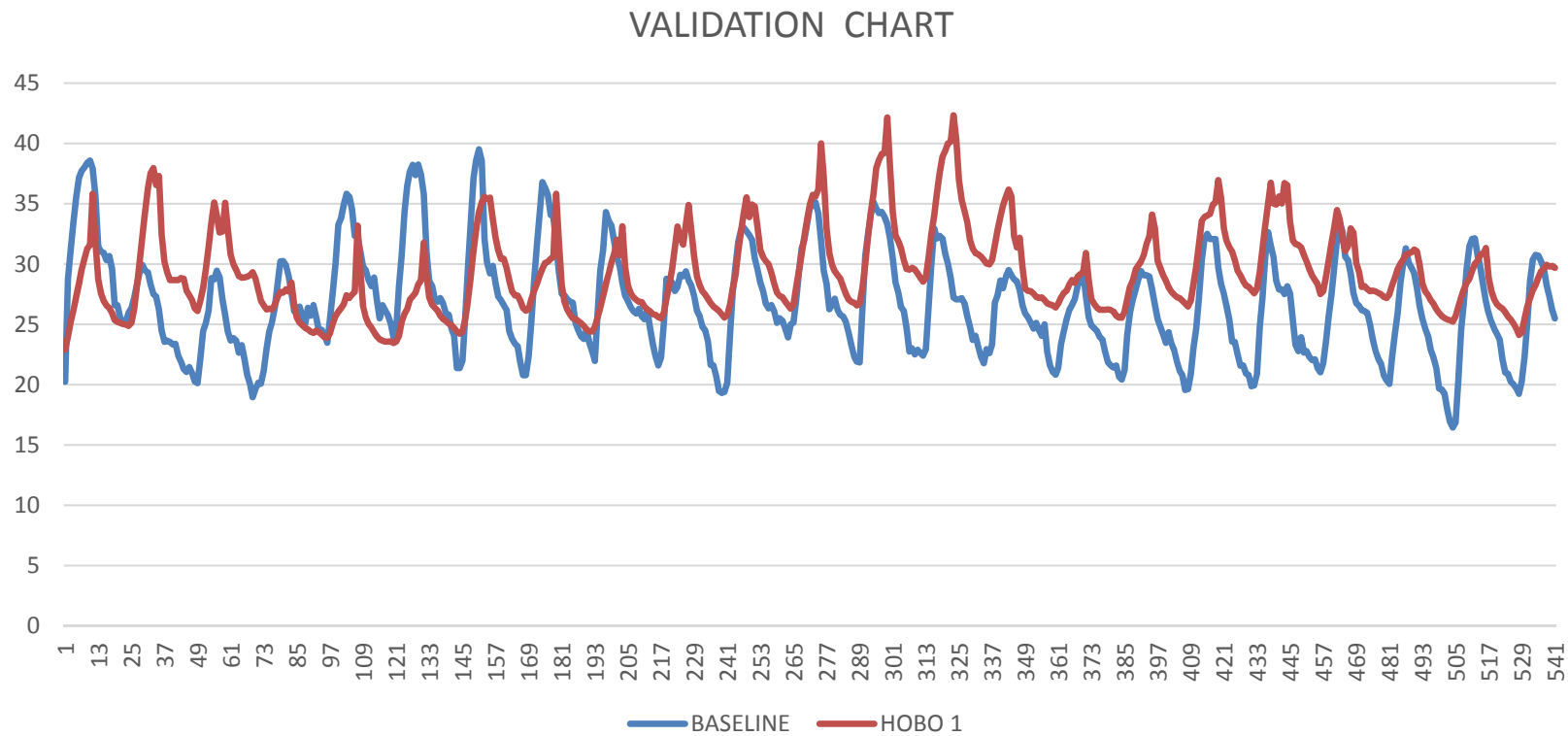
Result: The results of the validation will give realistic energy simulation.

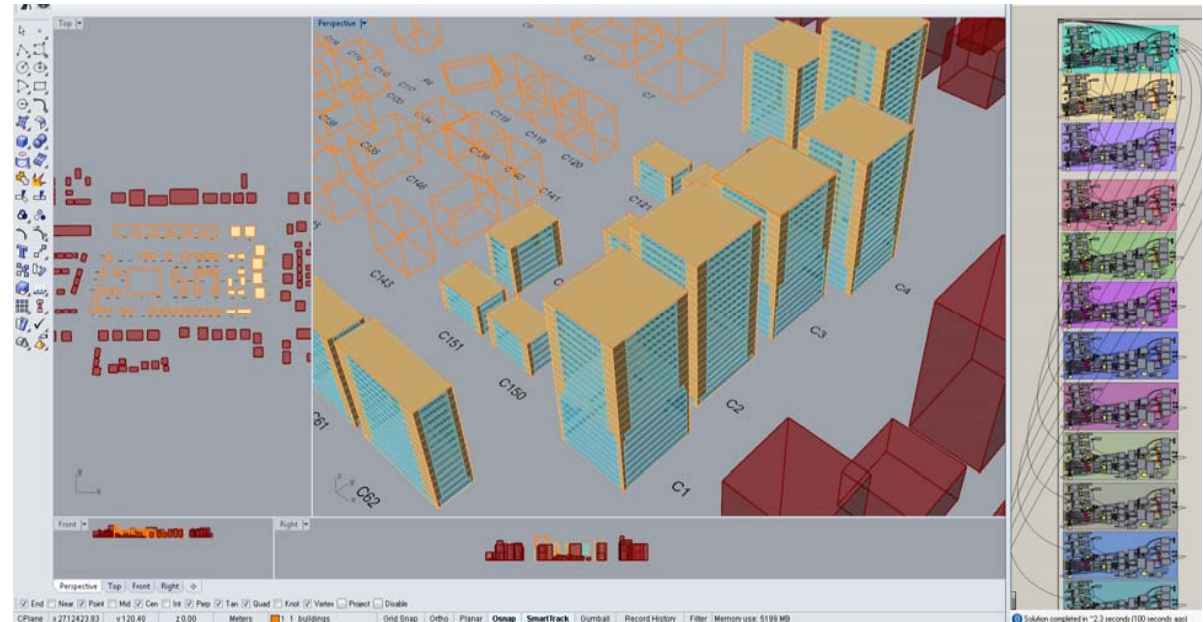
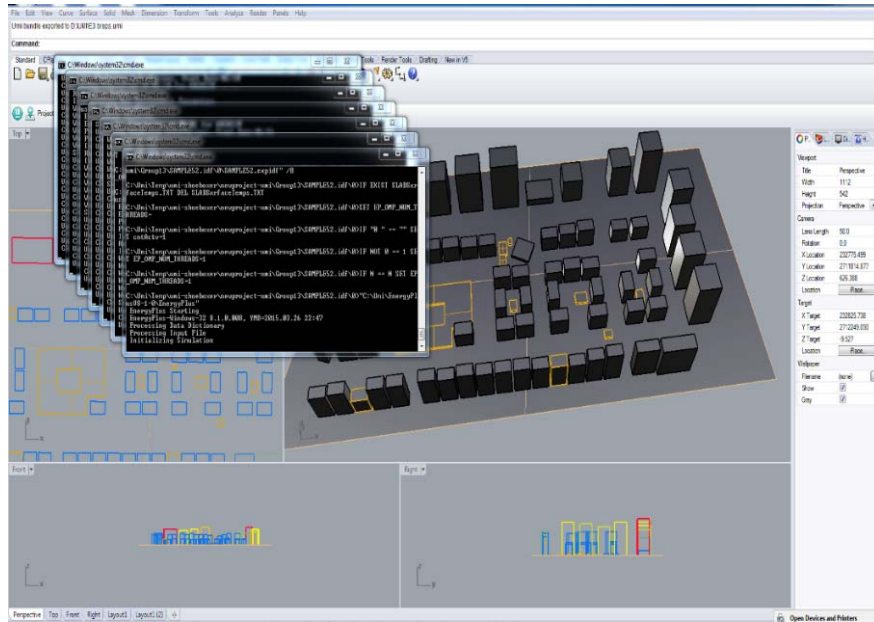
Time: The monitoring will last 6 month in total, April- September 2016

Location Downtown Abu Dhabi



Validation of the simulated weather file.





SCOPE: ENERGY SIMULATION

INPUT: MODEL, TEMPLATES, WEATHER FILE

OUTPUT: ENERGY CONSUMPTION

BASE TOOL: RHINO, ENERGY PLUS, UMI, GRASSHOPPER

UMI/GRASSHOPPER AS A THIRD TOOL

Building	Baseline (Envimet) (weather file base_2)	Shaded (ENVIMET longwave) (shade_4)	Difference with Baseline	Shaded (ENVIMET shortwave+longwave) (shade_4)	Difference with Baseline
C1	4,472,000.00	4,464,500.00	0.17%	4,456,600.00	0.34%
C2	3,769,500.00	3,766,200.00	0.09%	3,758,300.00	0.30%
C3	5,467,700.00	5,461,400.00	0.12%	5,462,000.00	0.10%
C4	3,513,700.00	3,505,700.00	0.23%	3,505,700.00	0.23%
C5	11,052,000.00	11,044,000.00	0.07%	11,044,000.00	0.07%
C6	2,505,200.00	2,499,200.00	0.24%	2,499,200.00	0.24%
C61	875,943.53	871,209.00	0.54%	866,584.00	1.07%
C62	1,903,800.00	1,898,300.00	0.29%	1,892,200.00	0.61%
C121	240,734.50	239,720.00	0.42%	227,486.00	5.50%
C122	261,948.00	260,763.00	0.45%	251,175.77	4.11%
C148	505,051.00	503,416.00	0.32%	500,637.00	0.87%
C149	465,952.00	464,430.38	0.33%	463,176.00	0.60%
C150	431,644.00	430,427.91	0.28%	425,524.00	1.42%
C151	452,628.00	451,487.87	0.25%	451,260.00	0.30%
C152	653,117.00	651,038.17	0.32%	650,012.00	0.48%
	36,570,918.03	36,511,792.33	0.16%	36,453,854.77	0.32%

GOAL OF THE FIRST CASE STUDY: MEASURING THE ENERGY SAVING.

TESTING THE RESULT: FUTURE STEP

DIRECT COST: THE SHADING DEVICES AND THE INTERVENTION.

DIRECT COST RECOVERY: ENERGY SAVING IN THE DISTRICT BUILDINGS.

INDIRECT PROFIT: OUTDOOR COMFORT, WALKABILITY.

FINAL RESULTS

Baseline (Envimet) (weather file base_2)	Shaded (ENVIMET longwave) (shade_4)	Difference with Baseline	Shaded (ENVIMET shortwave+longwave) (shade_4)	Difference with Baseline
36,570,918.03	36,511,792.33	0.16%	36,453,854.77	0.32%

	Temperature Reduction	Energy Saving	
	0.4 degrees	0,32 %	

FINAL RESULTS



Thank you.