BIOPHILIC SKYLIGHT

MASDAR CITY, ABU DHABI

BIOPHILIC SKYLIGHT

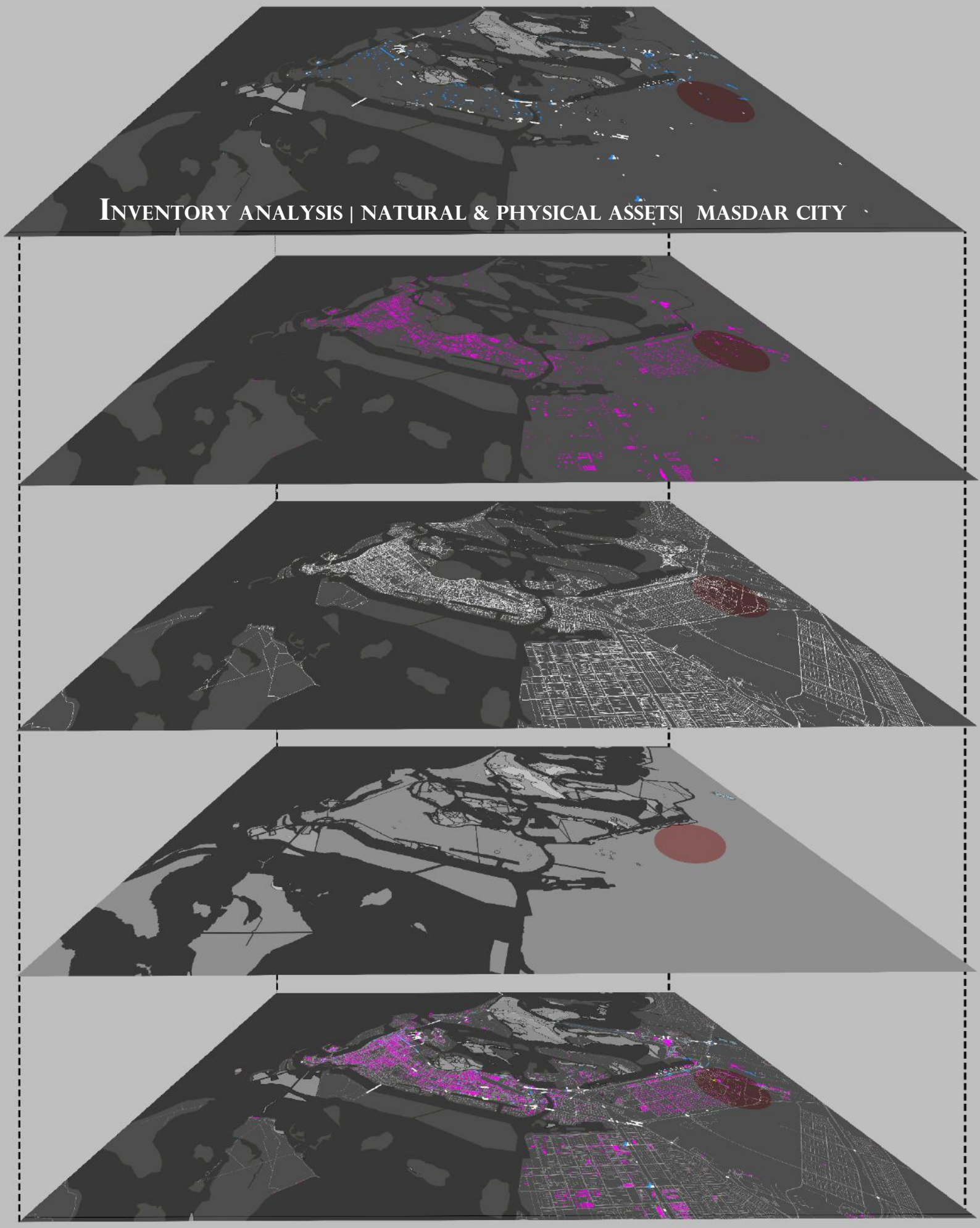
PROPOSAL

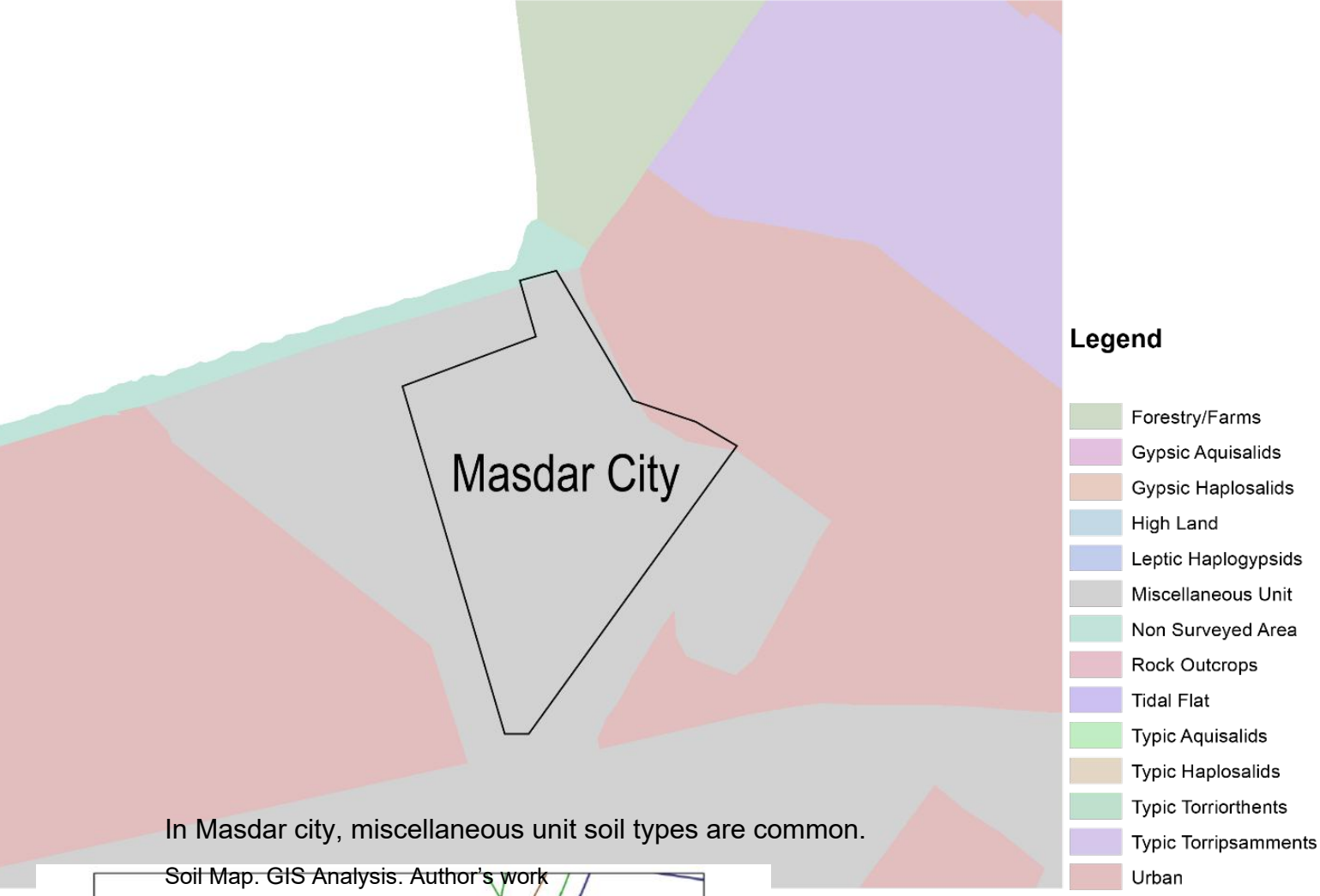
Our world is facing numerous challenges: a massive transformation of natural resources, atmospheric degradation, climate change and an energy dilemma. Non-renewable resources have cause dramatic chemical pollution. Moreover, non-renewable energies are limited and following population growth, the consumption and demand for energy is currently far outstripping the amount of energy produced. In order to minimize pollution, it is crucial to “get back to nature” and integrate carbon-free solutions into planning processes. Biophilic skylight could be a good example of connecting the dots between humans and environment by providing a public green space integrated with a renewable energy, where people will have the chance to not only relax and engage with nature but also interact with other people.

This design aims to create an open public space with biophilic and therapeutic value that will provide educational, relaxing, historical-cultural, gathering spaces for a plethora of groups. Moreover, this space will integrate renewable energy that will be represented as an architectural structure (roof-sculpture) that will also provide a shelter for the visitors. The Onyx Solar Photovoltaic system will be used to create this structure, which will generate free and clean energy. Moreover, its optimized solar factors enhance thermal comfort inside the structure and provide a pleasant atmosphere to the visitors.

Biophilic skylight structure will provide a constantly changing view of the sky. The platforms and viewpoints that will take the visitors to different levels will provide an opportunity for visitors to observe the distinctive type of gardens and diverse flora from different points.

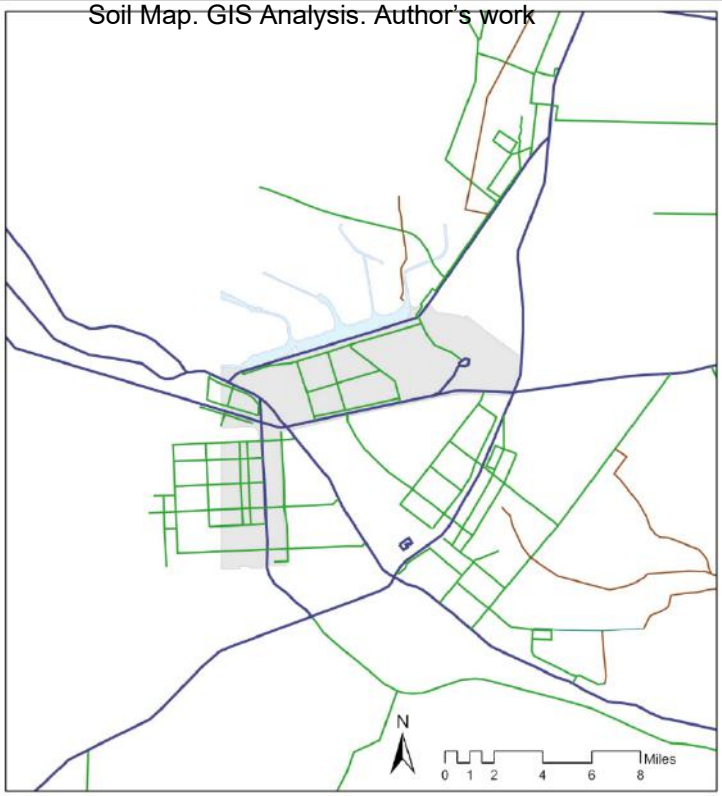
The main goal of this design project is to create a public, open space integrated with renewable energy, which will encourage the visitors to not only pass through space but stay, feel at home, gather, relax, and interact with other ethnic groups.


INVENTORY ANALYSIS | NATURAL & PHYSICAL ASSETS| MASDAR CITY



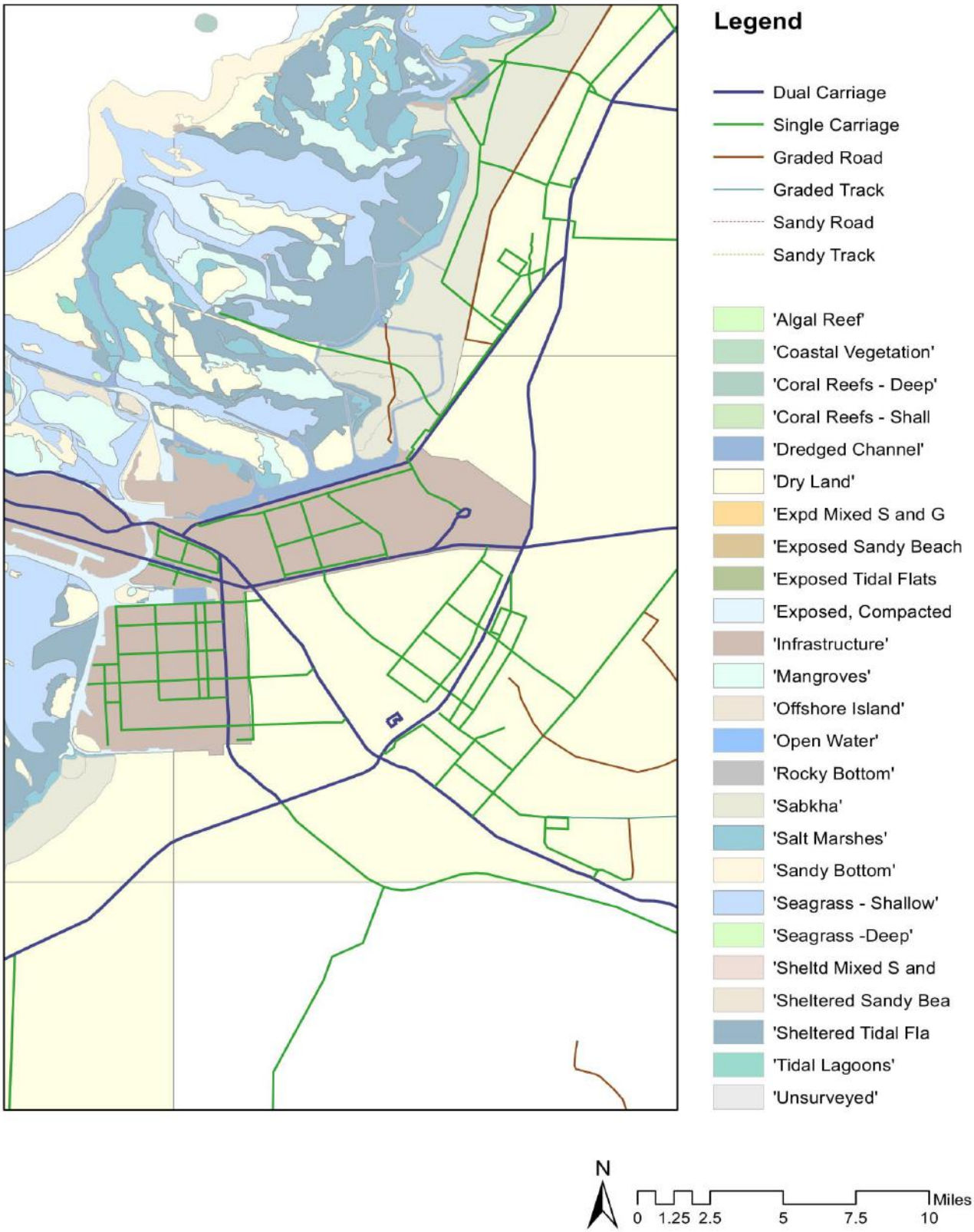
In Masdar city, miscellaneous unit soil types are common.

Soil Map. GIS Analysis. Author's work

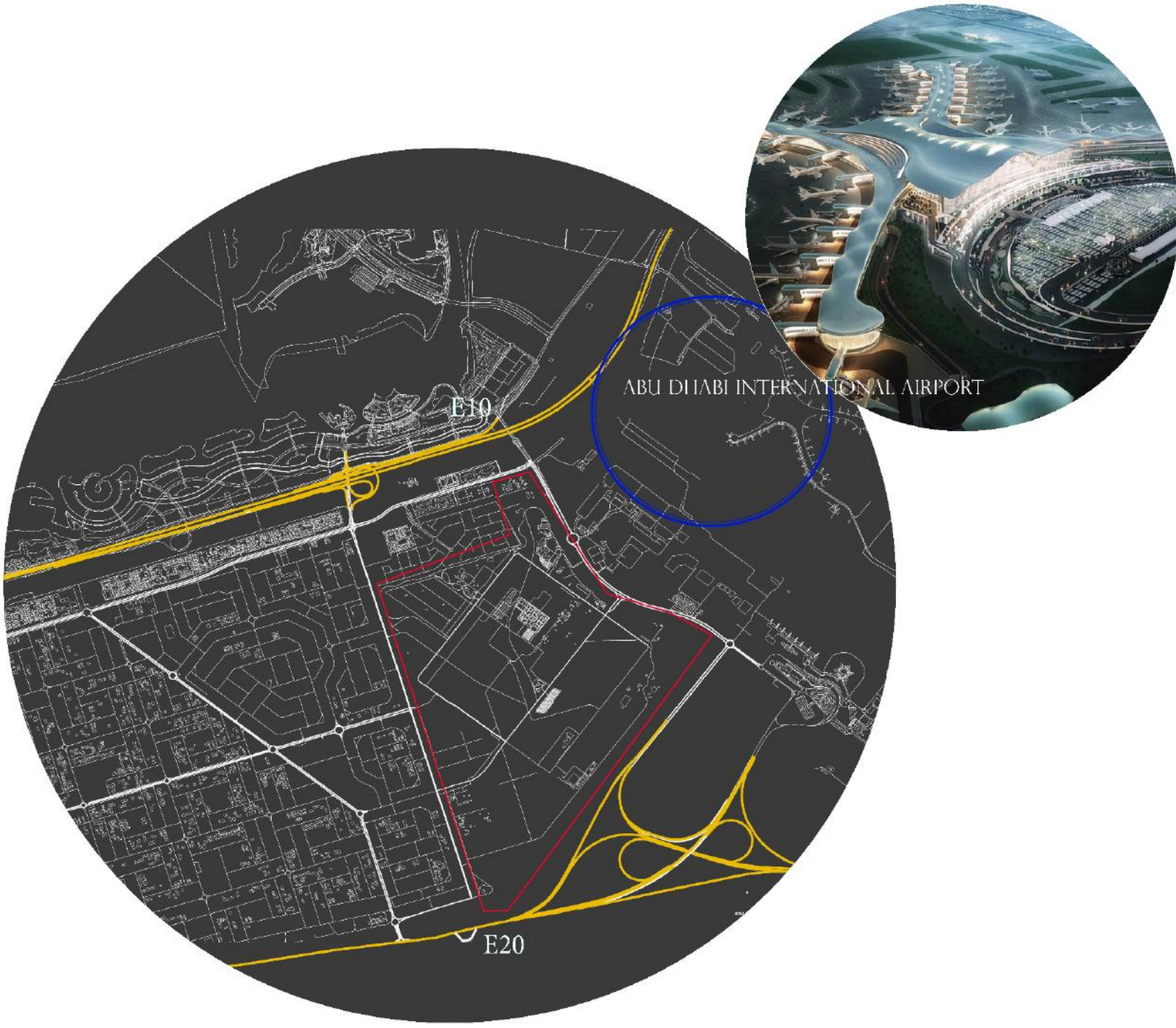


Circulation map around Masdar City.

GIS Analysis. Author's work

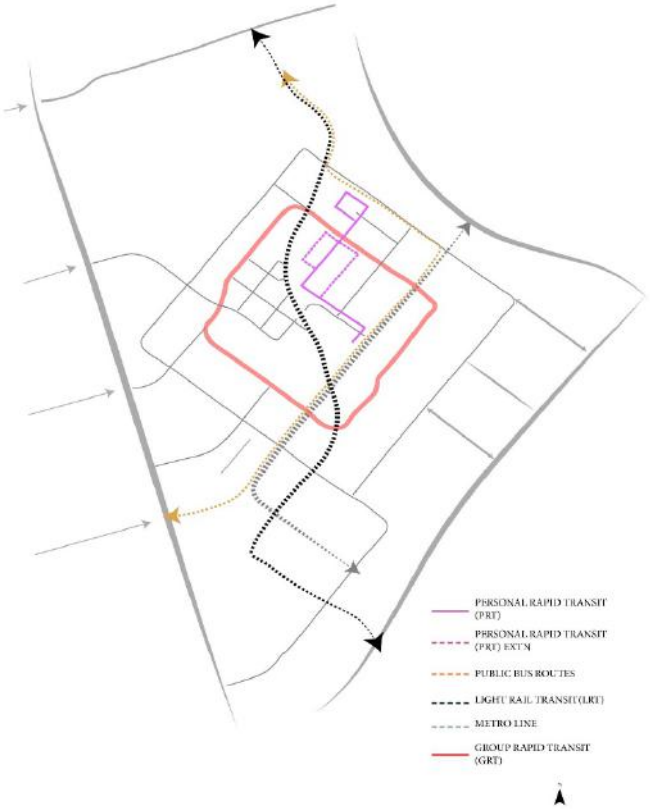


Land use. GIS Analysis. Author's work

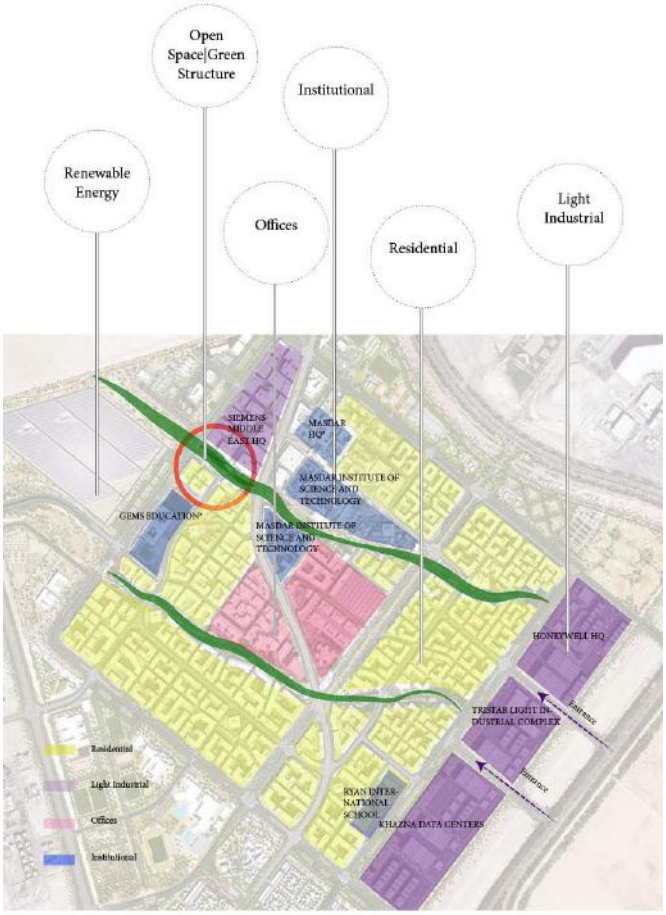


Masdar City boundary and main circulation. Author’s work

Green corridors at Masdar city

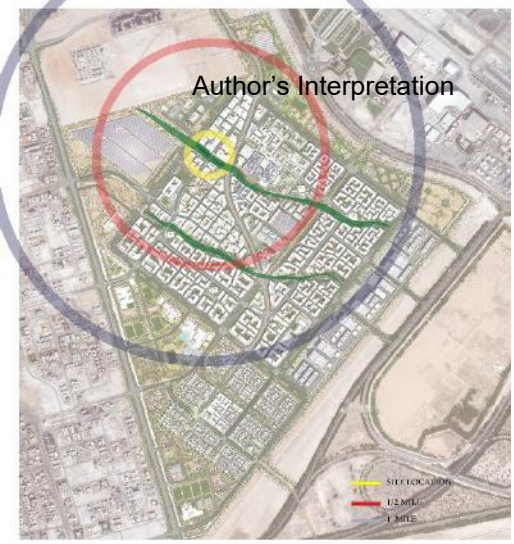


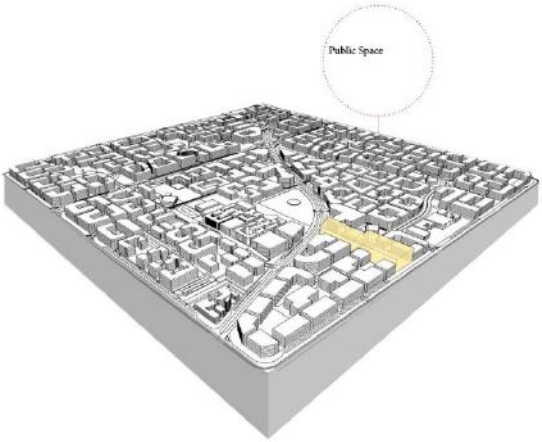
Masdar City Transportation map. Author's work



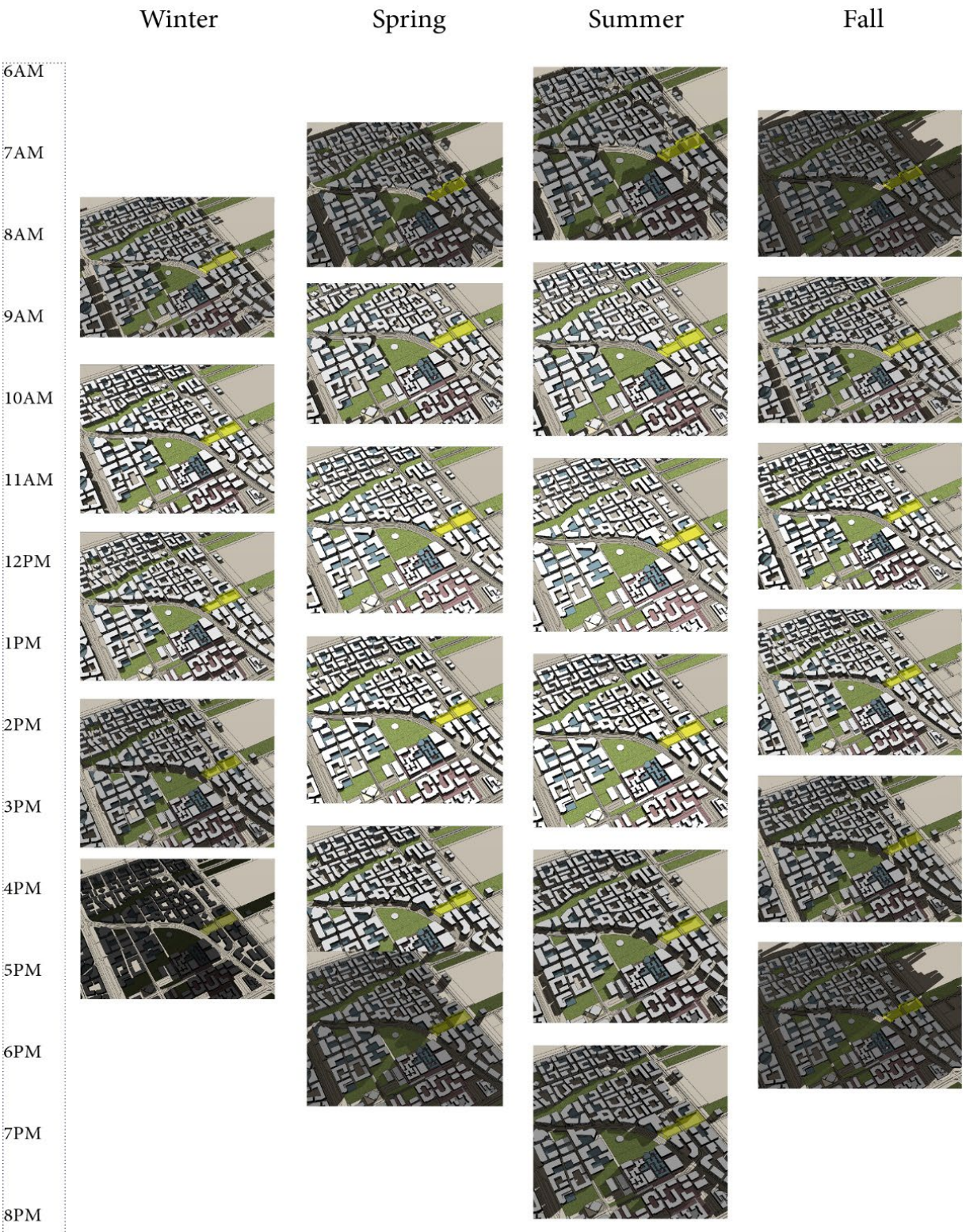
Zonning, Building survey at Masdar City.

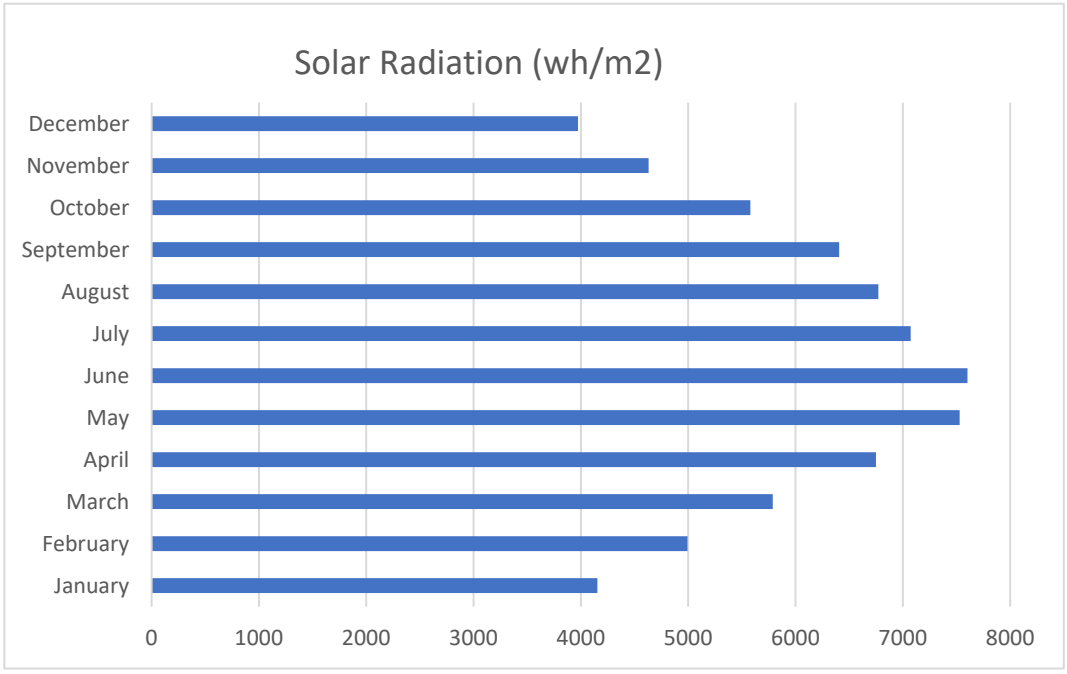
Bubble Diagram of Masdar city. Author's work

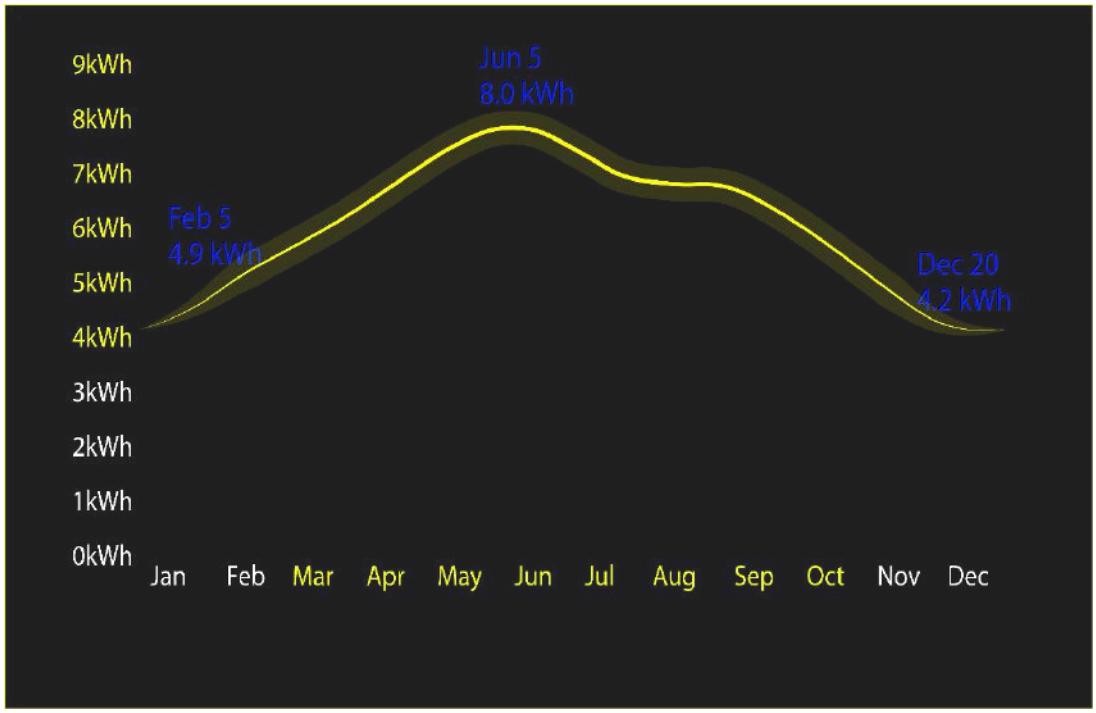

Author's Interpretation


Public Space

In order to analyze the shade and the length of the day in Masdar City, a 3D model was built in Sketchup and based on the location sun orientation and shade was observed every two hours daily in each season. The orientation and shade were observed every two hours during the day.



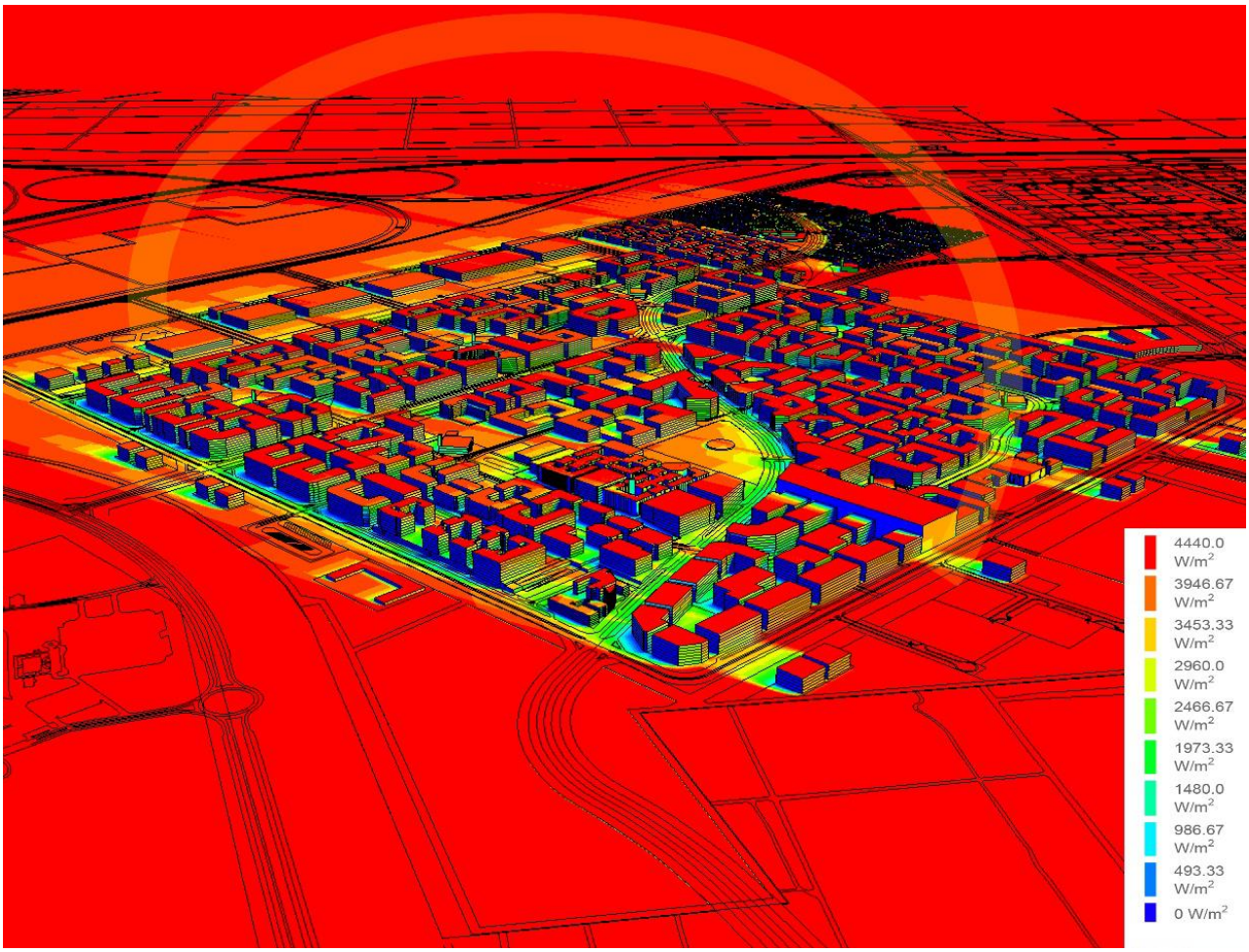




Average Daily Incident Shortwave Solar Energy. Author's work based on the Abu Dhabi, United Arab Emirates data.

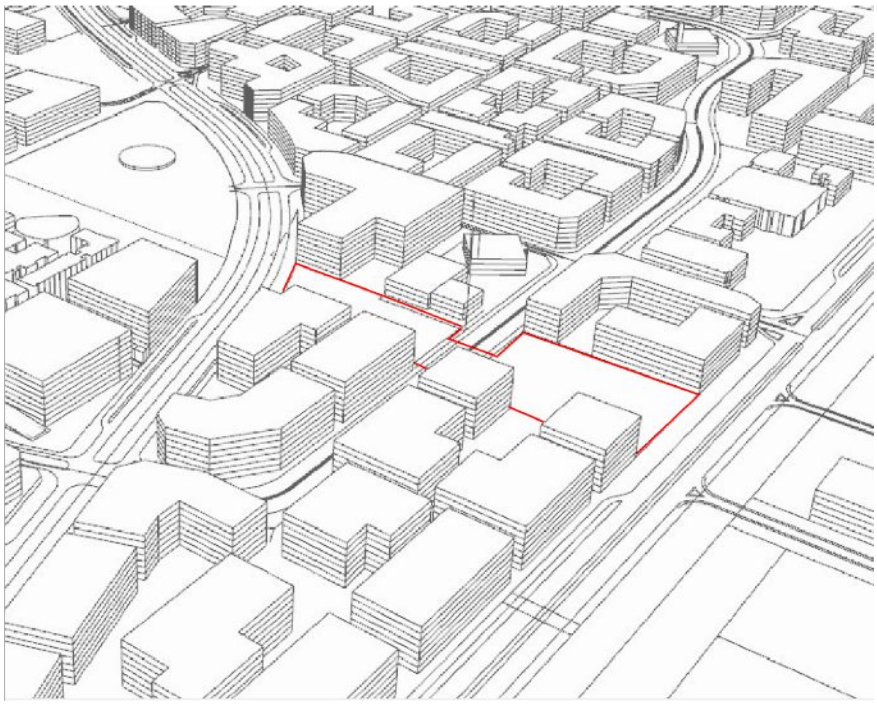
In order to analyze solar radiation and average daily incident shortwave solar energy in Masdar city deeper and observe the most suitable areas for the photovoltaic panels, a

3D model of Masdar city was analyzed in Sketchup by using the extension model of ‘’Solar Energy Analysis’’.

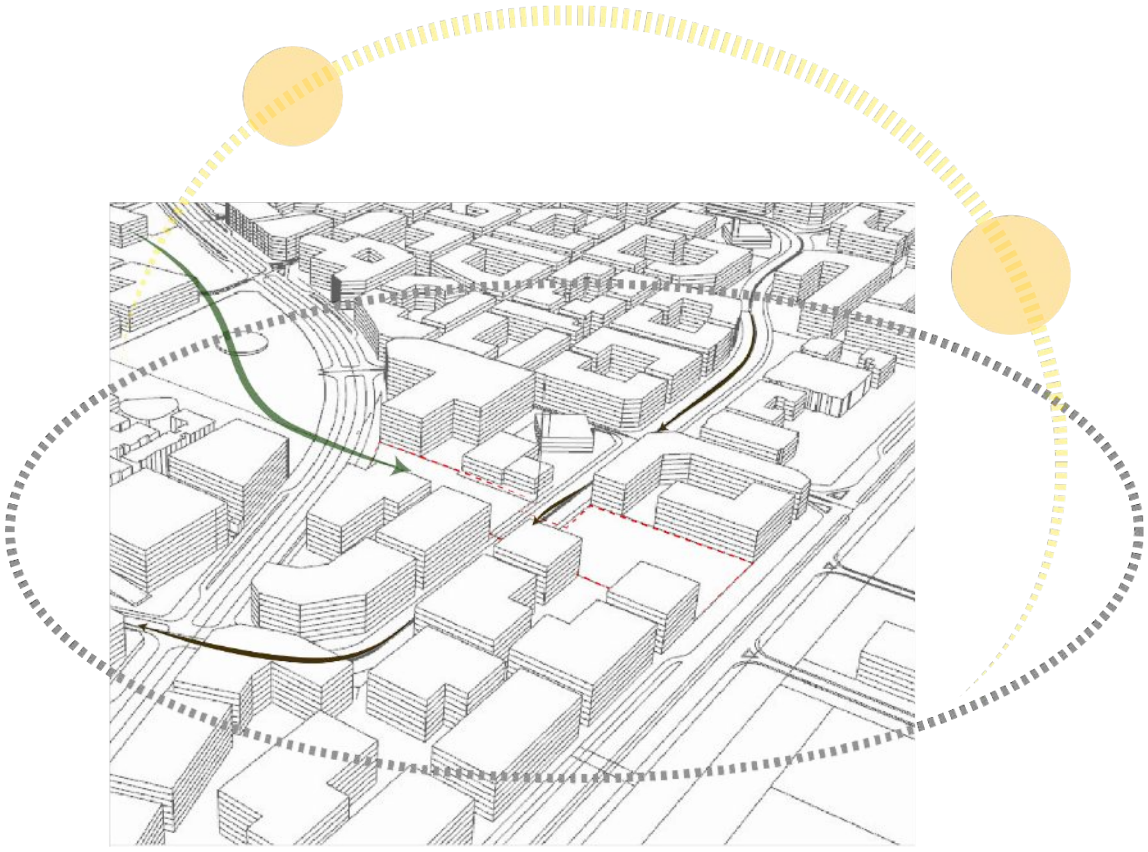


The results of the solar analysis showed that most of the roofs of Masdar city buildings are suitable for installing photovoltaic panels, which can provide carbon-free, renewable energy for the city.

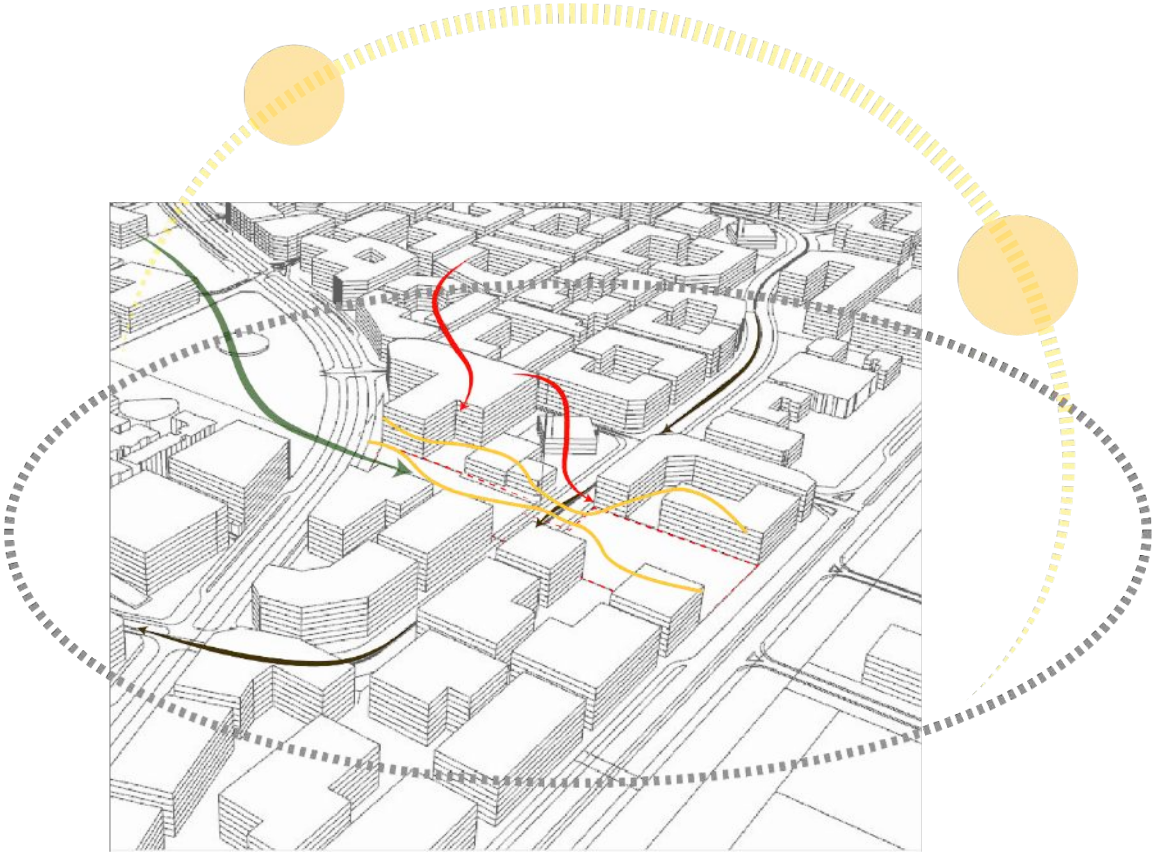
The results of this analysis also showed that Masdar city streets receive less radiation than wider streets (80 ft or more). The radiation is between 2500 W/m2 and in the narrower streets (45 ft or less), the radiation varies from 500W/m2 to 0W/m2 depending on the location.



Site boundary of the proposed area for the Biophilic Skylight. Author's work.

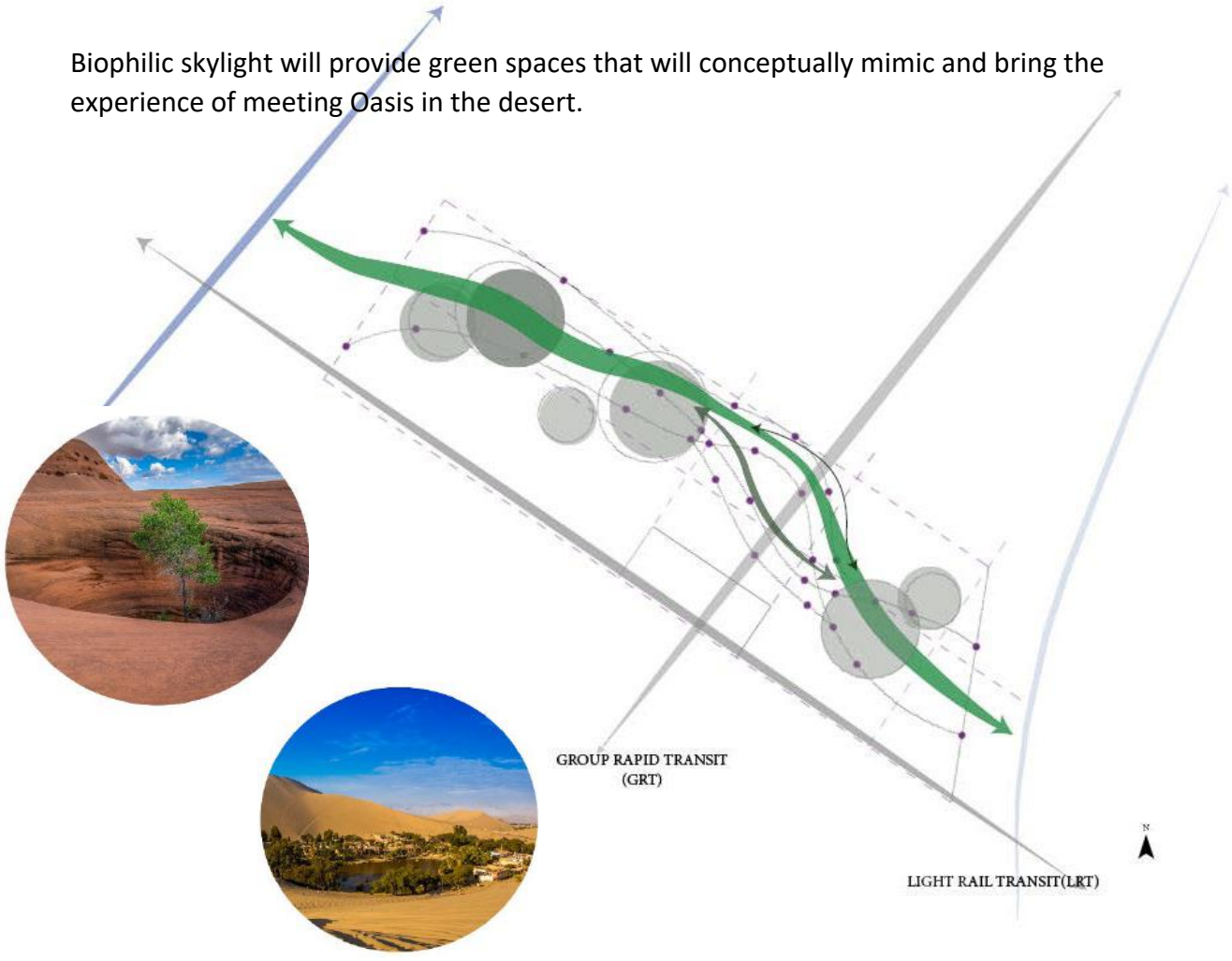


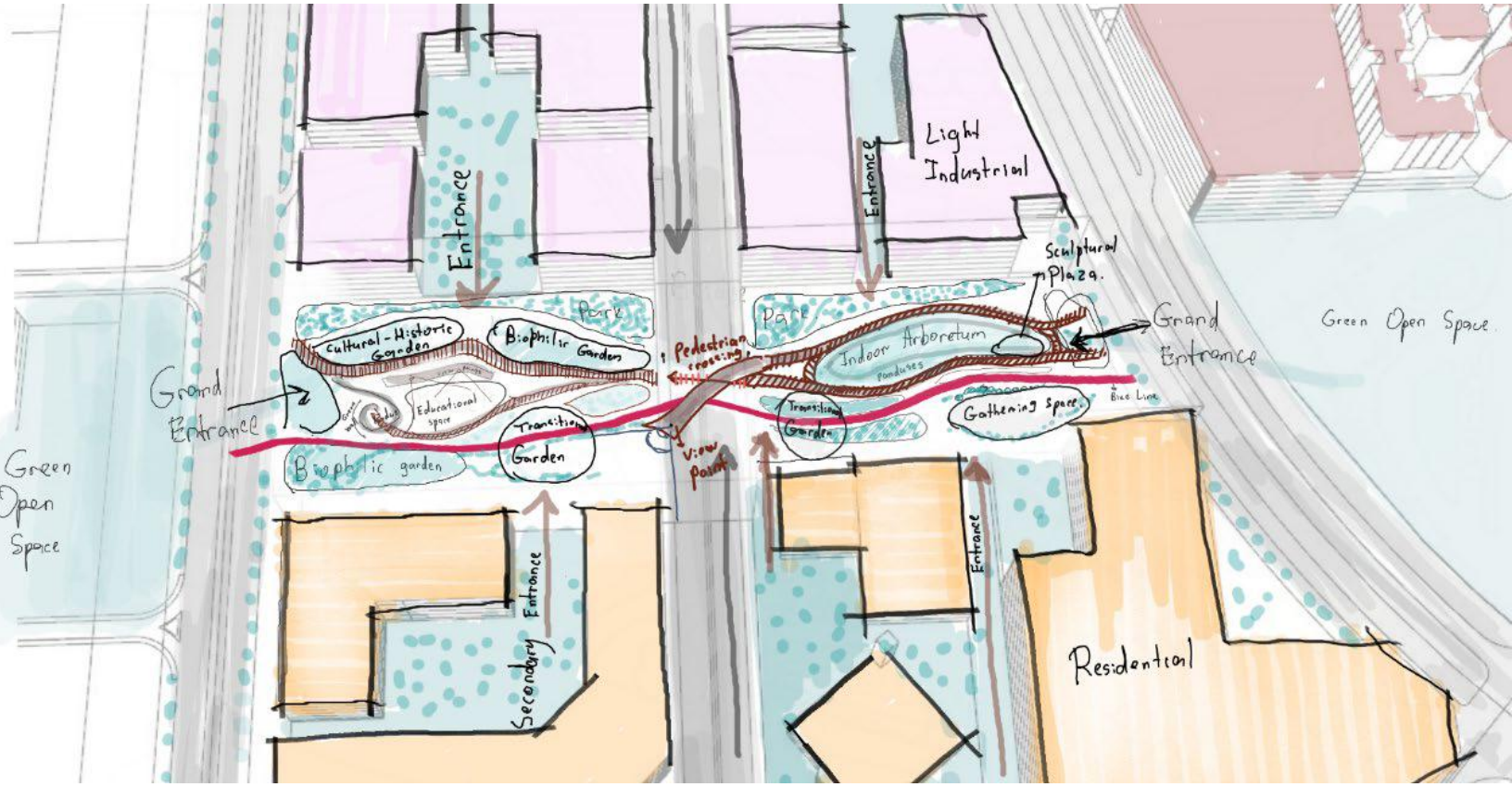
Sun Direction and existing circulation. Author's work



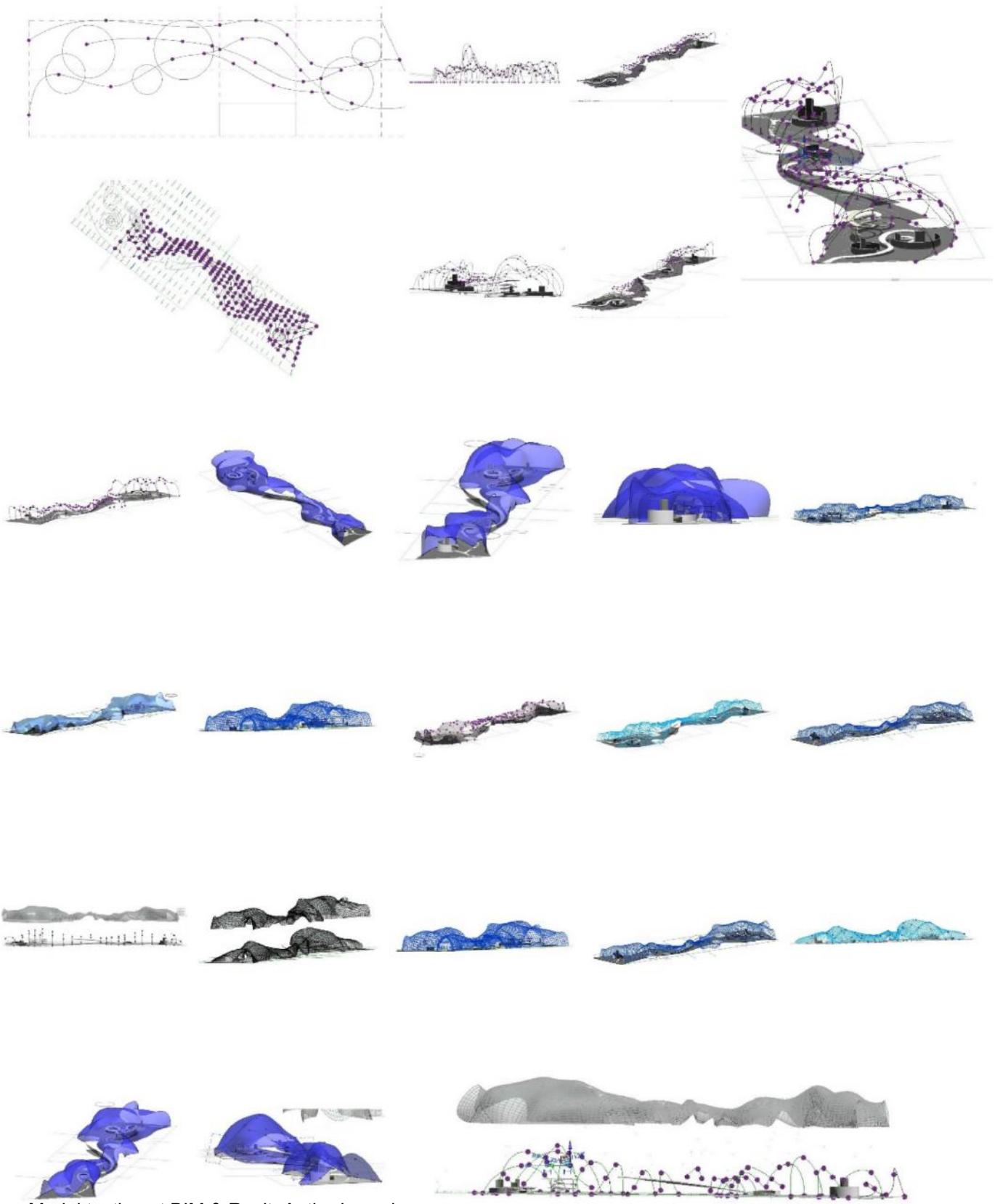
Schematic Design. Author's work.

Biophilic skylight will provide green spaces that will conceptually mimic and bring the experience of meeting Oasis in the desert.

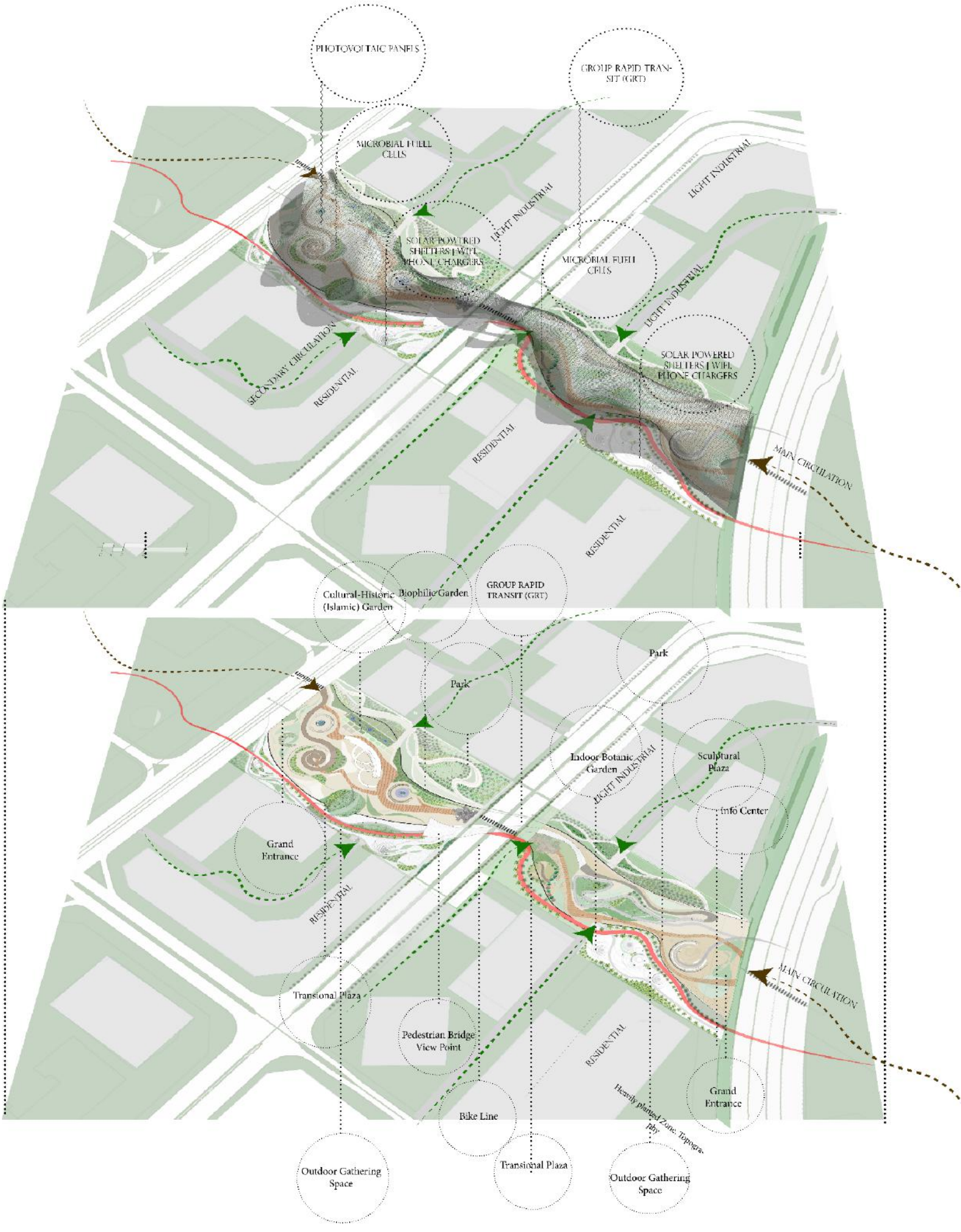




Preliminary programming. Hand sketching. Author's work



Model testing at BIM & Revit. Author’s work.

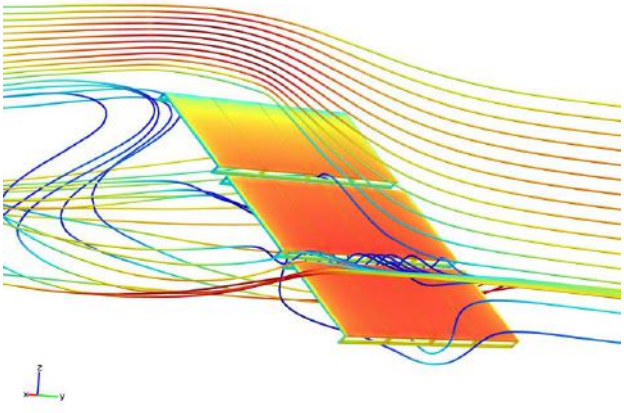

PHOTOVOLTAIC PANELS
GROUP RAPID TRANSIT (GRT)
MICROBIAL FUELL CELLS
LIGHT INDUSTRIAL
SOLAR POWERED SHELTERS | WIFI, PHONE CHARGERS
MICROBIAL FUELL CELLS
LIGHT INDUSTRIAL
SECONDARY CIRCULATION
RESIDENTIAL
SOLAR POWERED SHELTERS | WIFI, PHONE CHARGERS
RESIDENTIAL
MAIN CIRCULATION
RESIDENTIAL
Cultural-Historic (Islamic) Garden
Biophilic Garden
GROUP RAPID TRANSIT (GRT)
Park
Park
Indoor Botanic Garden
LIGHT INDUSTRIAL
Sculptural Plaza
Info Center
Grand Entrance
RESIDENTIAL
Transional Plaza
Pedestrian Bridge View Point
MAIN CIRCULATION
RESIDENTIAL
Grand Entrance
Bike Line
Heavily planted Zone. Topography
Outdoor Gathering Space
Transional Plaza
Outdoor Gathering Space

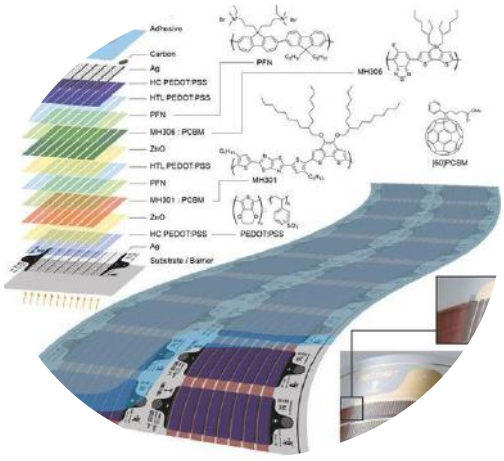
The ‘’biophilic skylight’’ has three secondary openings from the residential building side and two openings from the light industrial side, which connects the outside environment with the open space and encourages local residents and visitors to engage with nature.

Plant Selection for the green open spaces of Biophilic Skylight. Authors work

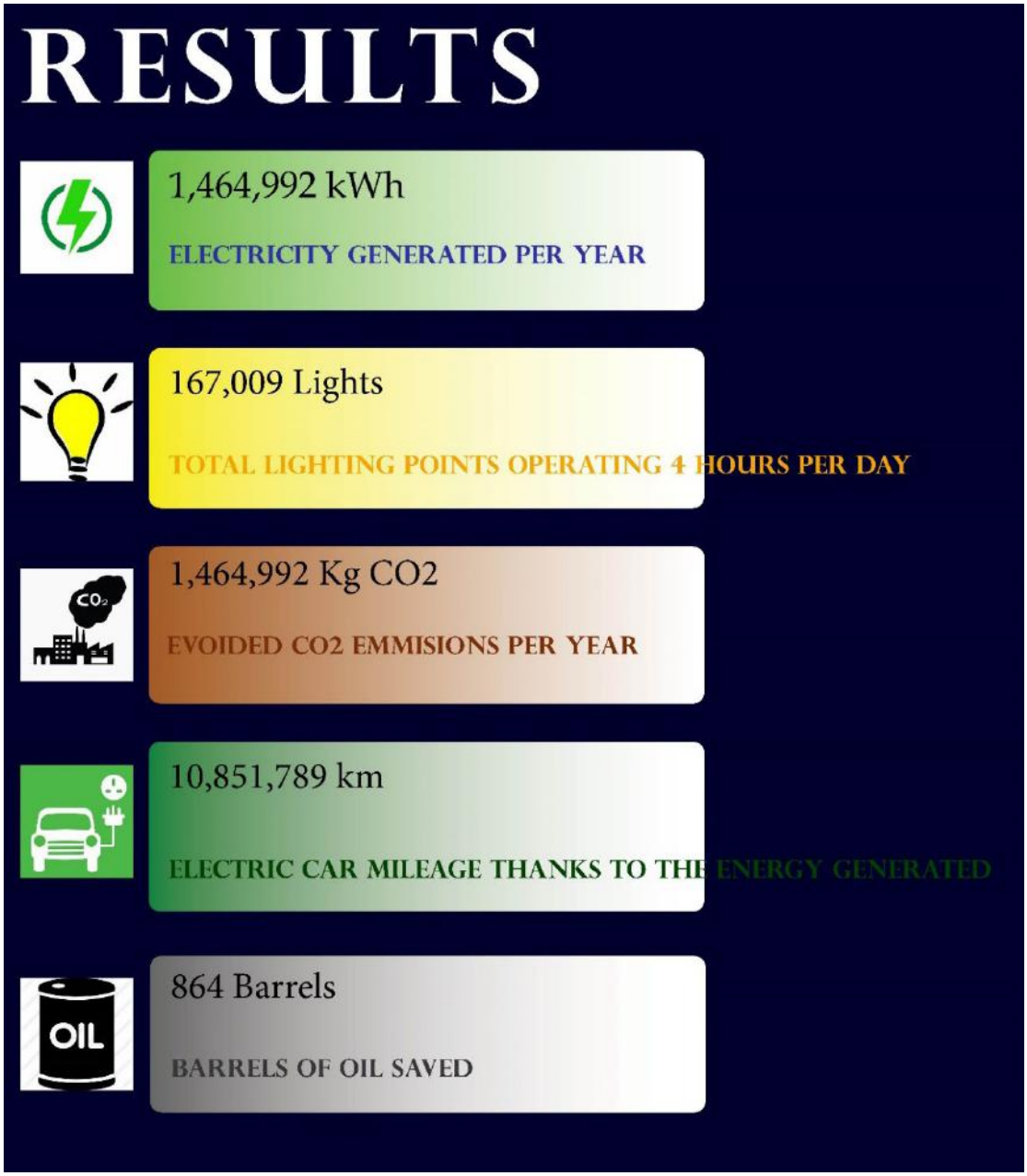
Material Selection

The Onyx Solar Photovoltaic glass system was chosen for the roof structure. The photovoltaic glass generates free and clean energy. Moreover, its optimized solar factor enhances thermal comfort inside the building. It completely offsets the energy demand for indoor air conditioning and it drastically reduces the cost of electricity. Photovoltaic glass also filters 99% of ultraviolet radiation (UV), which may have a harmful effect on interiors, furniture, and humans. Moreover, it reduces the transmission of infrared radiation by up to 90%. Given these properties, PV photovoltaic glass maximizes the performance of the building's envelope, enabling buildings to become vertical power generators.





Onyx photovoltaic panels.



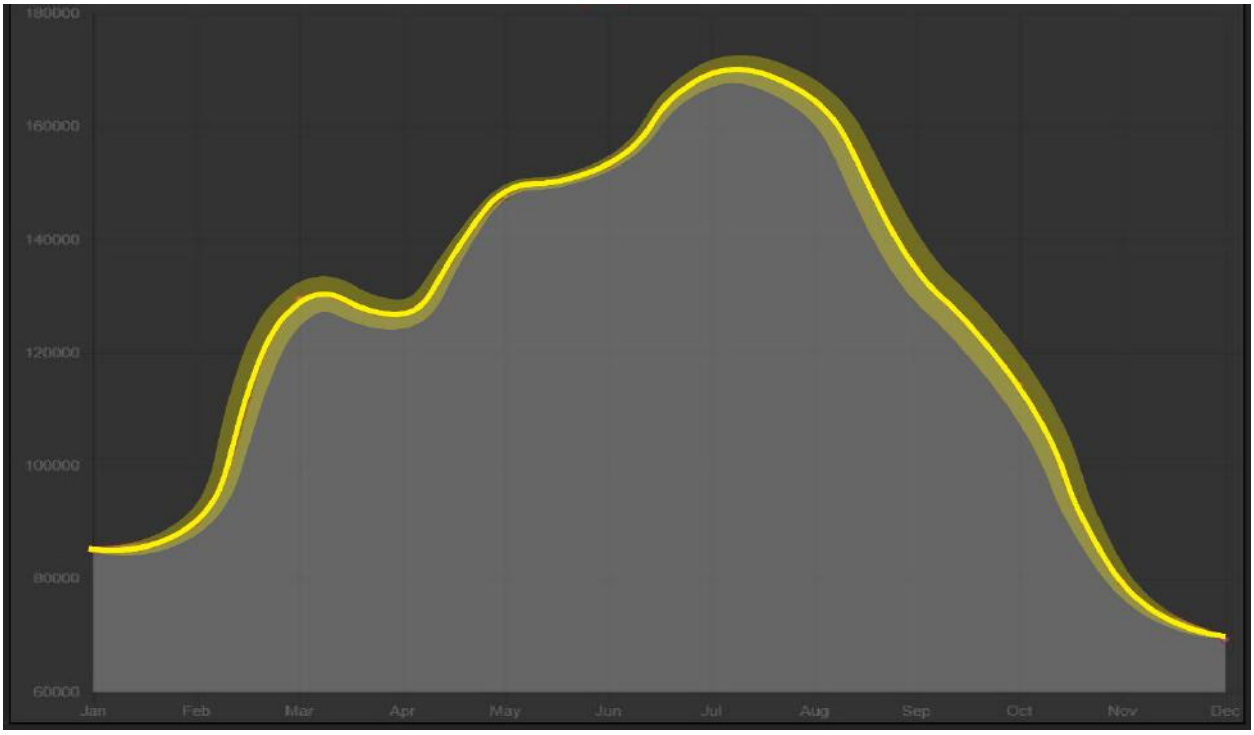
TECHNICAL DATASHEET	MEDIUM TRANSPARENCY PHOTOVOLTAIC GLASS	
Max. Power	34 Wp/sqm	
Visible Light Transmittance	17.3%	16.3%
SHGC	34% 15%*	32% 12%*
U - Value	5.7 1.2*	5.2 1.2*

UV Transmittance	1.5%	0.3%
Exterior reflectance	7.6%	7%
Acoustic insulation	32(-1;-3) 37(-1;-5)*	34(-1;-3) 37(-1;-5)*

Solar Photovoltaic Glasses	**Annual energy generated**	**Relative Contribution**	**Capital cost**	**Return over Lifespan**
Solar Photovoltaic Glasses	1,465MWh	91%	962,000$	13,172,000$
Plant Microbial Fuel Cells	150MWh	9%	290,000$	1,372,000$
Total	1615 MWh	100%	1,252,000$	14,544,000$

In order to make the Biophilic skylight structure more biomorphic, open and transparent to the sky, there was chose medium transparency photovoltaic glasses that can generate 34WP/sqm.

In order to analyze how much average energy could generate the photovoltaic roof calculations were made based on the location, square feet of the panels and the capacity of selected photovoltaic glass. The results of the calculation showed that the biophilic structure that becomes a home for the photovoltaic glasses has a capacity to generate 1, 464, 992 kWh per year that is equivalent of 1,464 MWH. It can light 167, 009 Lights 4 hours per day, save 864 barrels per year, generate 10, 851,789km electric car mileage thanks and avoid 941,544 kg CO2 emissions per year.



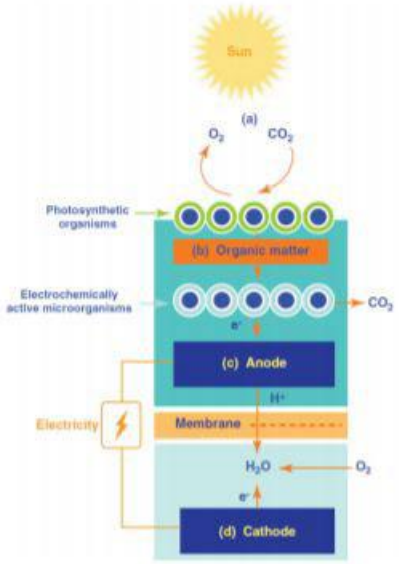
Average monthly electricity production from the Biophilic Skylight structure.

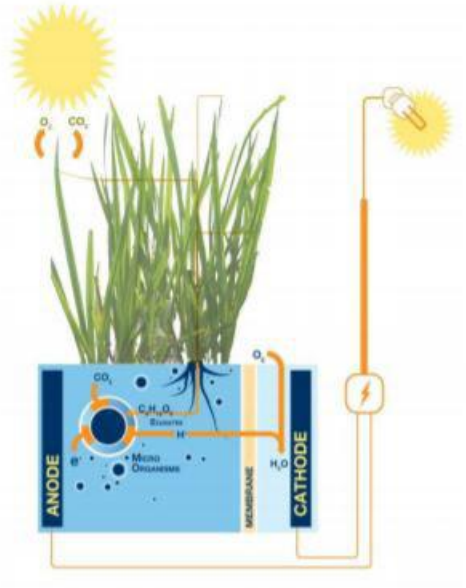
Month	Average daily electricity production from the given system (kwh)	Average monthly electricity production from the given system (kwh)	Average daily sun of global irradiation per square meter received by the modules of the given system (kwh/m2)	Average sum of global irradiation per square meter received by the modules of the given system (kwh/m2)
January	2, 747.87	85,183.92	3.53	109.52
February	3,218.98	90,130.30	4.16	116.36
March	4,175.90	129,453.03	5.47	169.58
April	4,230.66	126,919.77	5.55	166.59
May	4,764.13	147,687.94	6.33	196.15
June	5,108.53	153,255.98	6.88	206.53
July	5,468.00	169.507.95	7.45	230.94
August	5,309.37	164,590.47	7.21	223.59
September	4,501.08	135.032.53	6.04	181.21
October	3,686.11	114,269.39	4.86	150.72
November	2,649.22	79,476.51	3.43	102.98
December	2,241.41	69,483.74	2.89	89.45

Yearly average	4,008.44	122,082.63	5.32	161.97
Total for year			1,464,991.53	1,943.63

Plant Microbial Fuel cells

According to (Helder, 2012) The Plant-Microbial Fuel Cell generates the electricity by using living plants and bacteria. Biophilic Skylight will produce 150 MWh of (P-MFC) energy.





Conclusion

This project demonstrates that in one place there can be a correlation between nature and architecture, integration between biophilia, biomimicry, open space, and renewable energy, which will not only benefit the city with carbon-free clean energy but also provide a biophilic view and stimulate people's engagement with nature.