Group 1

Alexander Kneer

Katya Hristova

Michelle Ogrinc

Ananth Sampathkumar

Ranad Shqeirat

Group 2

Kim Sagami

Mijeong Field

Yunseok Oscar Kang

Erika Lau

Velina Mirincheva

Abdul Muhammad

Group 3

Sophia Sebti

Rafael Enriquez

Michael Huang

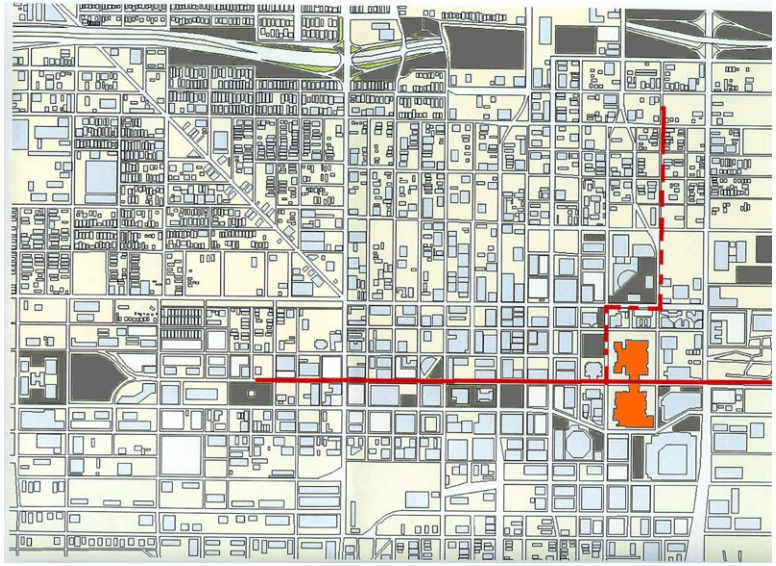
Chuan-Fang Lin

Yehoshuah Yehudah

Professors: Mahjoub Elnimeiri & Hatice Sozer

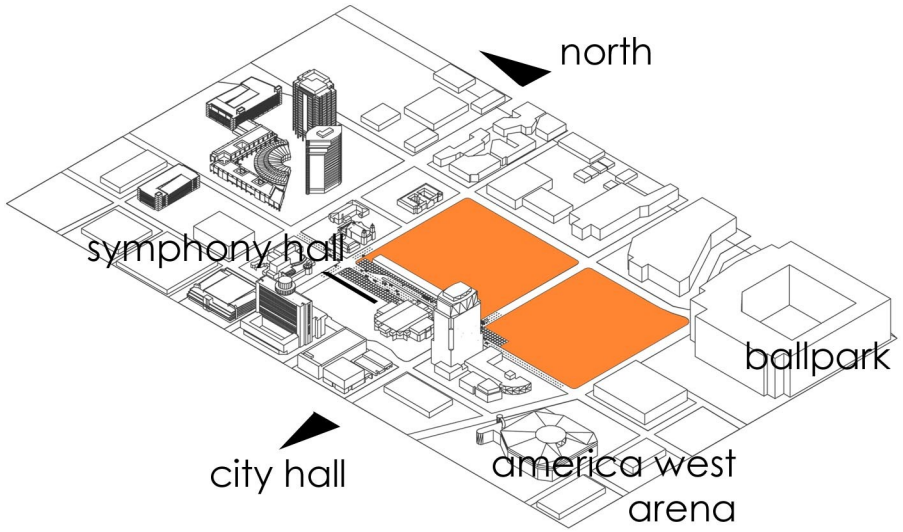
Sponsor: Skidmore Owings & Merrill

+PROJECT: CONVENTION CENTER



+THE SITE:

The site, situated in downtown Phoenix, has the size of 2x4 regular city blocks. Washington street, on axis with the Phoenix city hall in the west, cuts the site in two parts. Next to the area are the Symphony Hall, Bank One Ballpark and the America West Arena.



+PROGRAM:

exhibition space -	600,000sf
ball room -	50,000sf
meeting rooms	150,000sf
lobby&concourses	10,000sf : 1 truck berth
support space food service	200,000sf

Group 1

Alexander Kneer

Katya Hristova

Michelle Ogrinc

Ananth Sampathkumar

Ranad Shqeirat

Group 2

Kim Sagami

Mijeong Field

Yunseok Oscar Kang

Erika Lau

Velina Mirincheva

Abdul Muhammad

Group 3

Sophia Sebti

Rafael Enriquez

Michael Huang

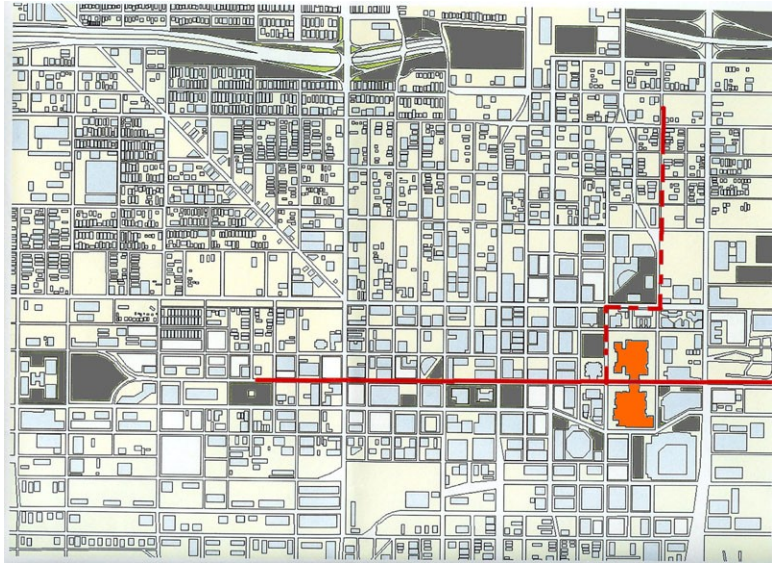
Chuan-Fang Lin

Yehoshuah Yehudah

Professors: Mahjoub Elnimeiri & Hatice Sozer

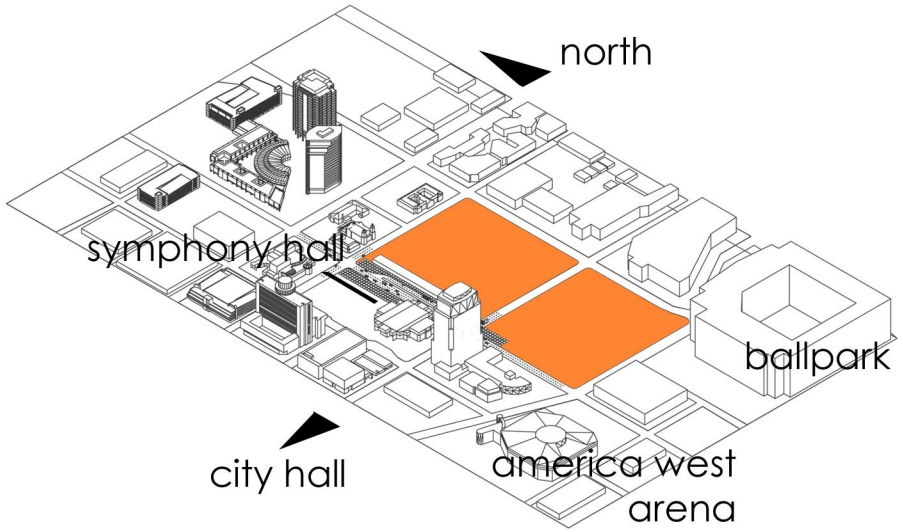
Sponsor: Skidmore Owings & Merrill

+PROJECT: CONVENTION CENTER



+THE SITE:

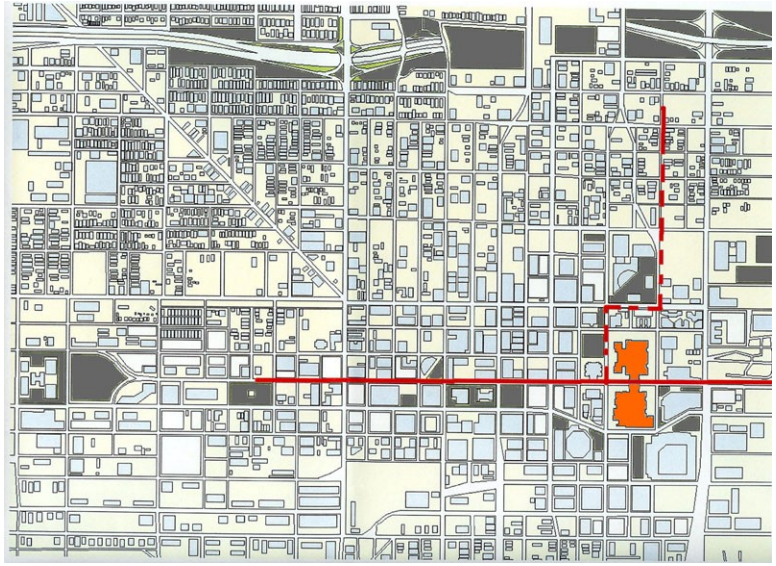
The site, situated in downtown Phoenix, has the size of 2x4 regular city blocks. Washington street, on axis with the Phoenix city hall in the west, cuts the site in two parts. Next to the area are the Symphony Hall, Bank One Ballpark and the America West Arena.



+PROGRAM:

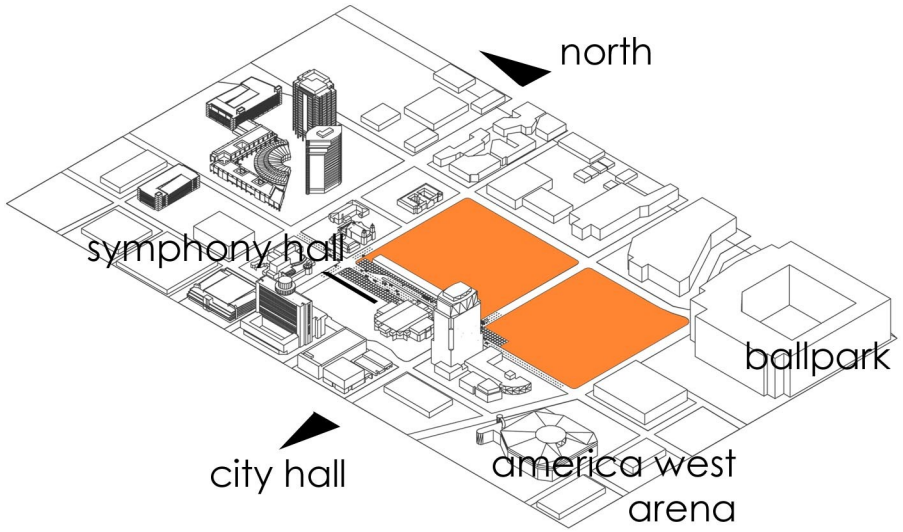
exhibition space -	600,000sf
ball room -	50,000sf
meeting rooms	150,000sf
lobby&concourses	10,000sf : 1 truck berth
support space food service	200,000sf

+PROJECT: CONVENTION CENTER



+THE SITE:

The site, situated in downtown Phoenix, has the size of 2x4 regular city blocks. Washington street, on axis with the Phoenix city hall in the west, cuts the site in two parts. Next to the area are the Symphony Hall, Bank One Ballpark and the America West Arena.

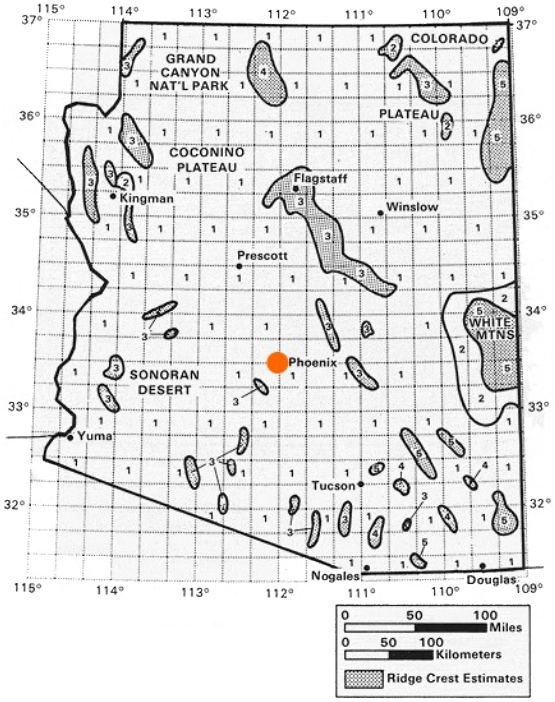


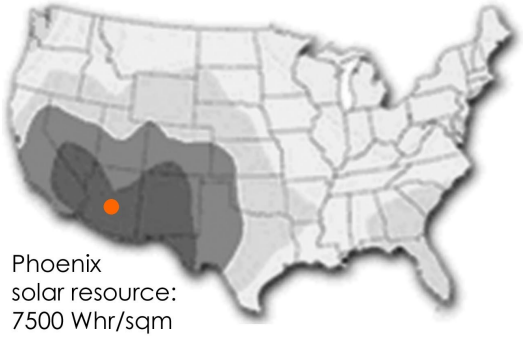
+PROGRAM:

exhibition space -	600,000sf
ball room -	50,000sf
meeting rooms	150,000sf
lobby&concourses	10,000sf : 1 truck berth
support space food service	200,000sf

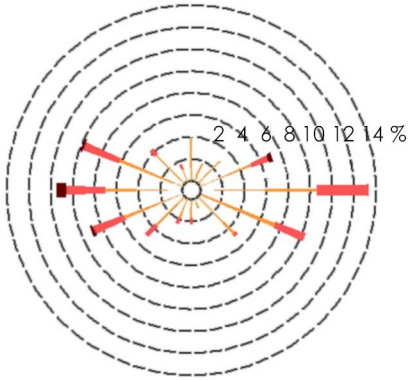
+CLIMATE:

+wind class 1 (up to 9.8 mph





Phoenix
solar resource:
7500 Whr/sqm
(highest in the U.S.)



Phoenix
main wind
directions

+precipitation:

annual average 7 in.

35 days

+relative humidity:

27%

clear days: 214

+temperature

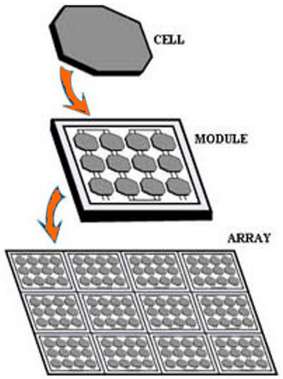
Annual average 70° F

July 78° F - 105° F

January 38° F - 65° F

PV TECHNOLOGY :ADVANTAGE

+ renewable & clean source of energy
+ decreases dependence on foreign oil supplies
+ delivers and stores electricity more efficiently
+ energy efficiency means using less energy to accomplish the same task



+ MONOCRYSTALLINE SILICON CELLS

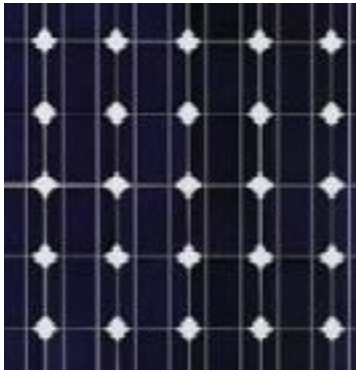
highest efficiency (24%) / most expensive

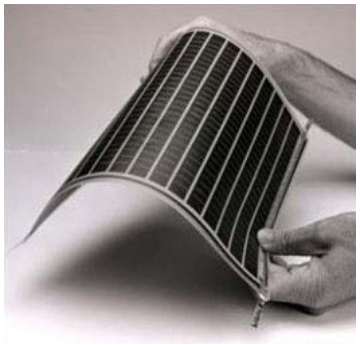
+ POLYCRYSTALLINE SILICON CELLS

cheaper than monocrystalline/ slightly less efficient (19%)

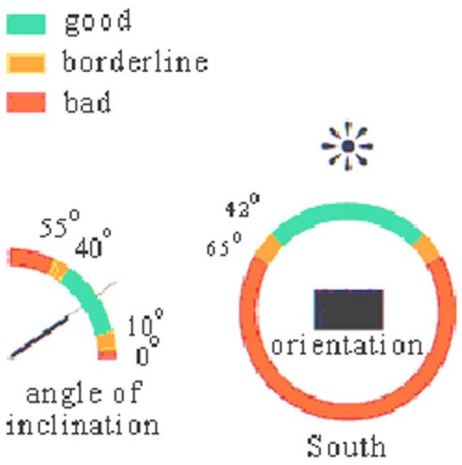
+ THIN-FILM SILICON

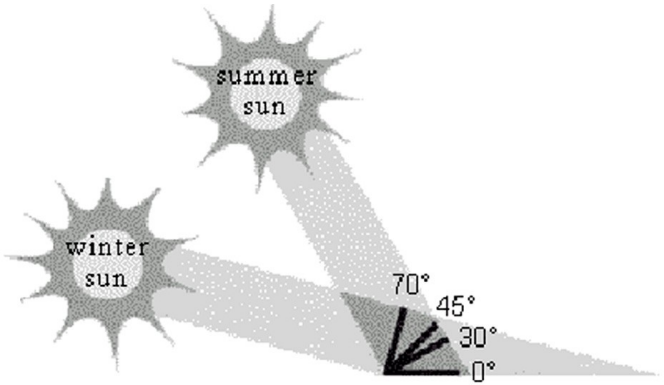
thin films of semi-conductive and conductive materials deposited on glass; least expensive/ least efficient (16%)





•The power yielded from a panel depends on its angle of inclination towards the sun. The optimum angle is dependant on the latitude of the site's location. There are fixed panels as well as panels that track the sun's movement.



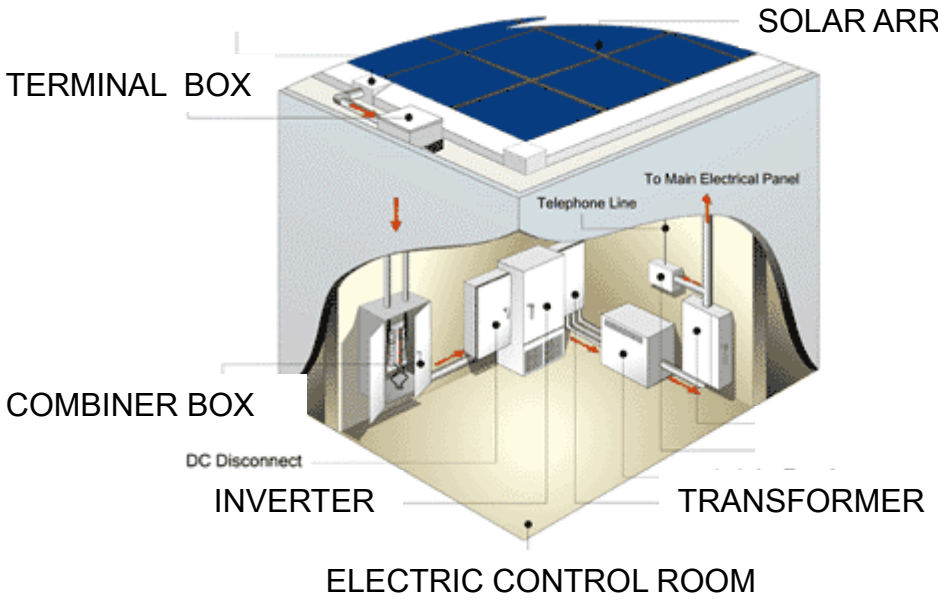


- State of Arizona - Homeowners can claim a 25% tax credit on up to $4,000 of solar devices installed on a residence
- Arizona Public Service Co offers $2.00 per Watt rebate; maximum rebate is $10,000 per customer
- Solar devices are exempt from Arizona State Sales Tax

Efficiency Factors

- Temperature
- Relative Humidity
- Wind Loads
- Radiation
- Shading
- Orientation
- Lifetime
- Array Condition

Basic components



Comparison of Photovoltaics and Wind

	PV			Wind		
Size	4 panels	8 panels	15 panels	1.5 m	3 m	7 m
Capacity (kW)	0.21	0.42	0.79	0.25	1.5	10
Output (kWh/yr)	387	767	1451	800	3,000	20,000
Storage Cost	$1,400	$1,400	$2,800	$1,400	$2,800	$14,000
Total Cost	$4,200	$6,700	$11,600	$3000	$10,000	$36,000
$/kWh	10.9	8.7	8.0	3.8	3.3	1.8

Assumes 6 m/s average wind speed at hub height and 5 sun hours per day.
Installation not included.
PV prices; Real Goods.
All systems use same quality battery; $1/amp-hour
Storage = 80% of rated capacity usable.

PV modules will account for 1/3 to ½ of the initial cost

TYPES OF TURBINES:

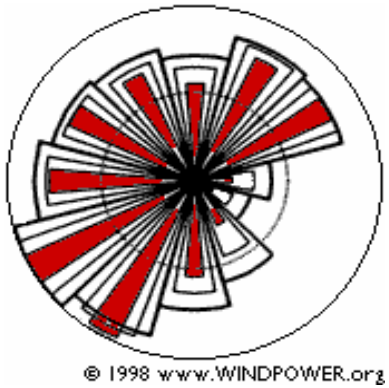
Horizontal axis wind turbines

Horizontal axis wind turbines

LOCATION & ORIENTATION

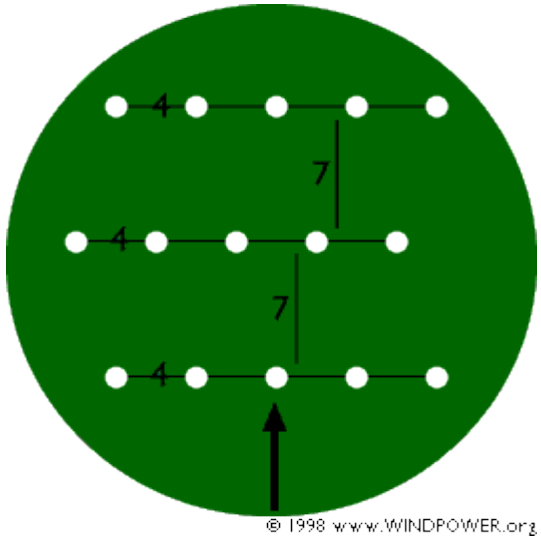
Factors influencing location :

Wind conditions
Topological features
Grid connection and reinforcement
Surrounding built environment



Factors influencing Orientation :

5 - 9 rotor diameters in the prevailing wind direction
3 - 5 rotor diameters
in perpendicular direction



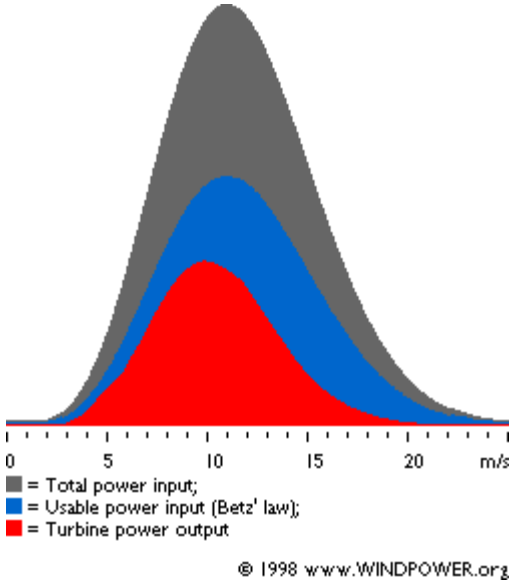
EFFICIENCY:

Betz law:

only 59% energy transformation possible

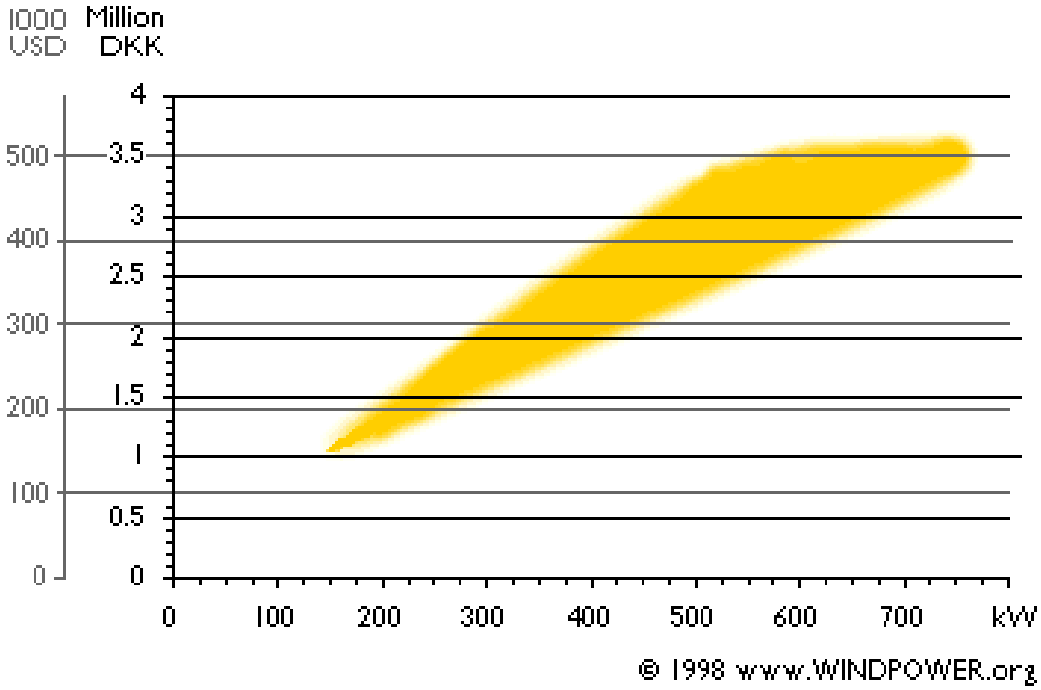
The energy output depends on:

- the wind speed - varies with the cube of the wind speed
- the density of the air (height of the location)
- the rotor area - increases with the square of the rotor diameter.



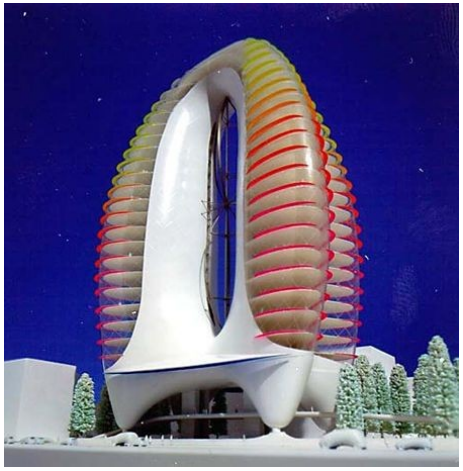
COST CONSIDERATIONS:

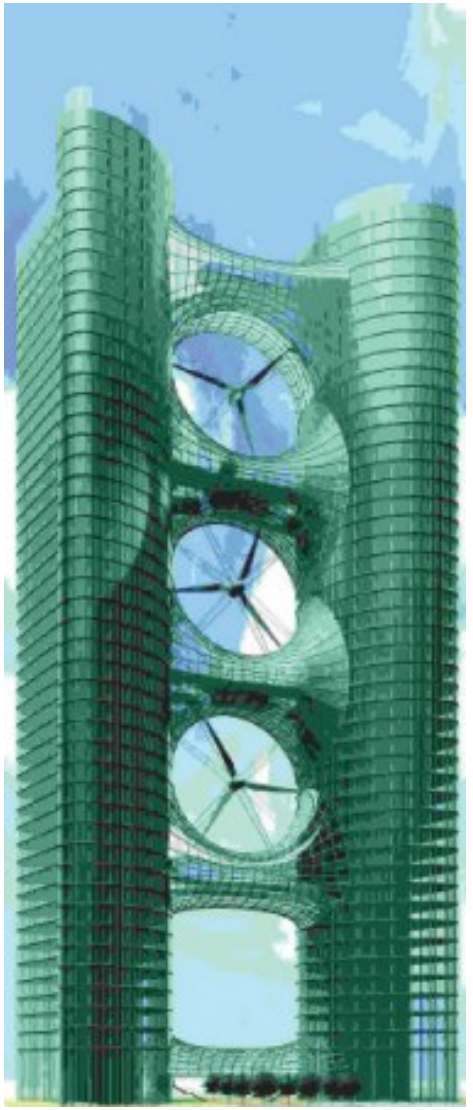
factors influencing cost:
Energy output
Scale of the project
Installation cost
Operation and maintenance cost



INTEGRATION INTO THE BUILT ENVIRONMENT

1. Stand-alone structures
2. Retro-fitting existing buildings
3. Full integration into the built form
4. Partial integration into the built form

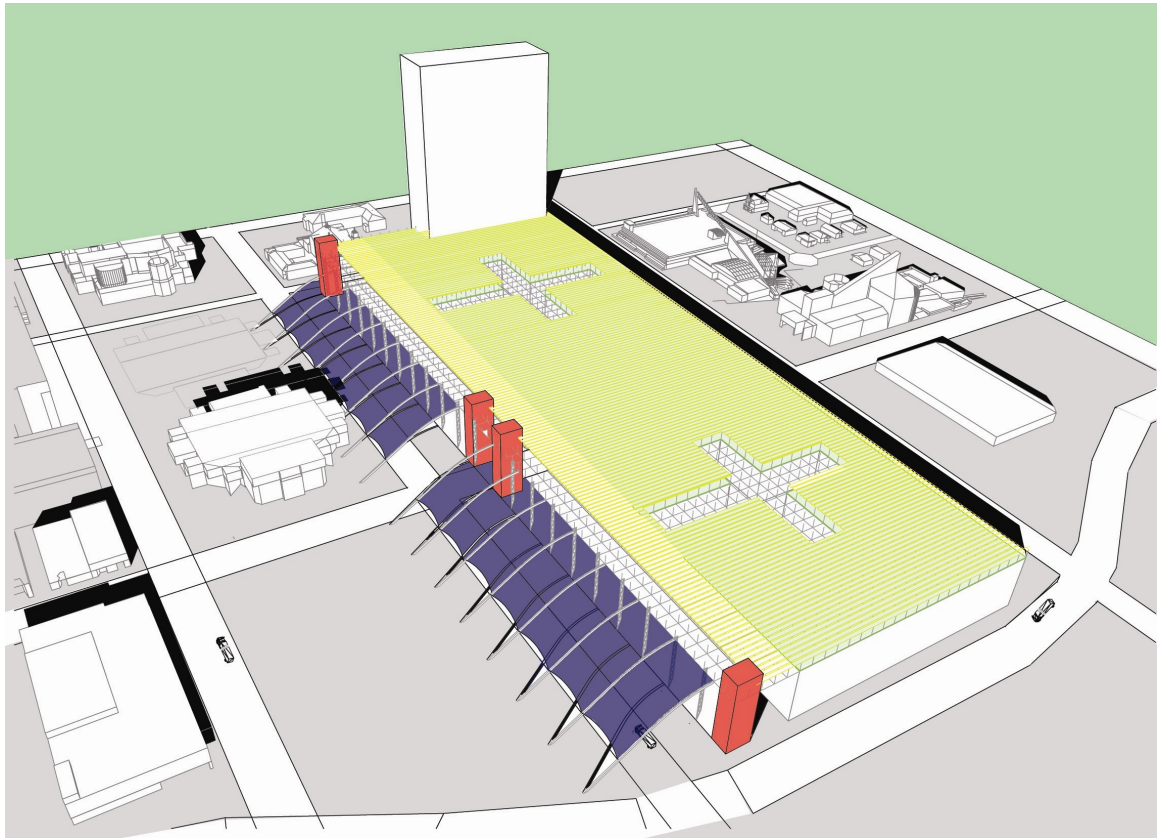




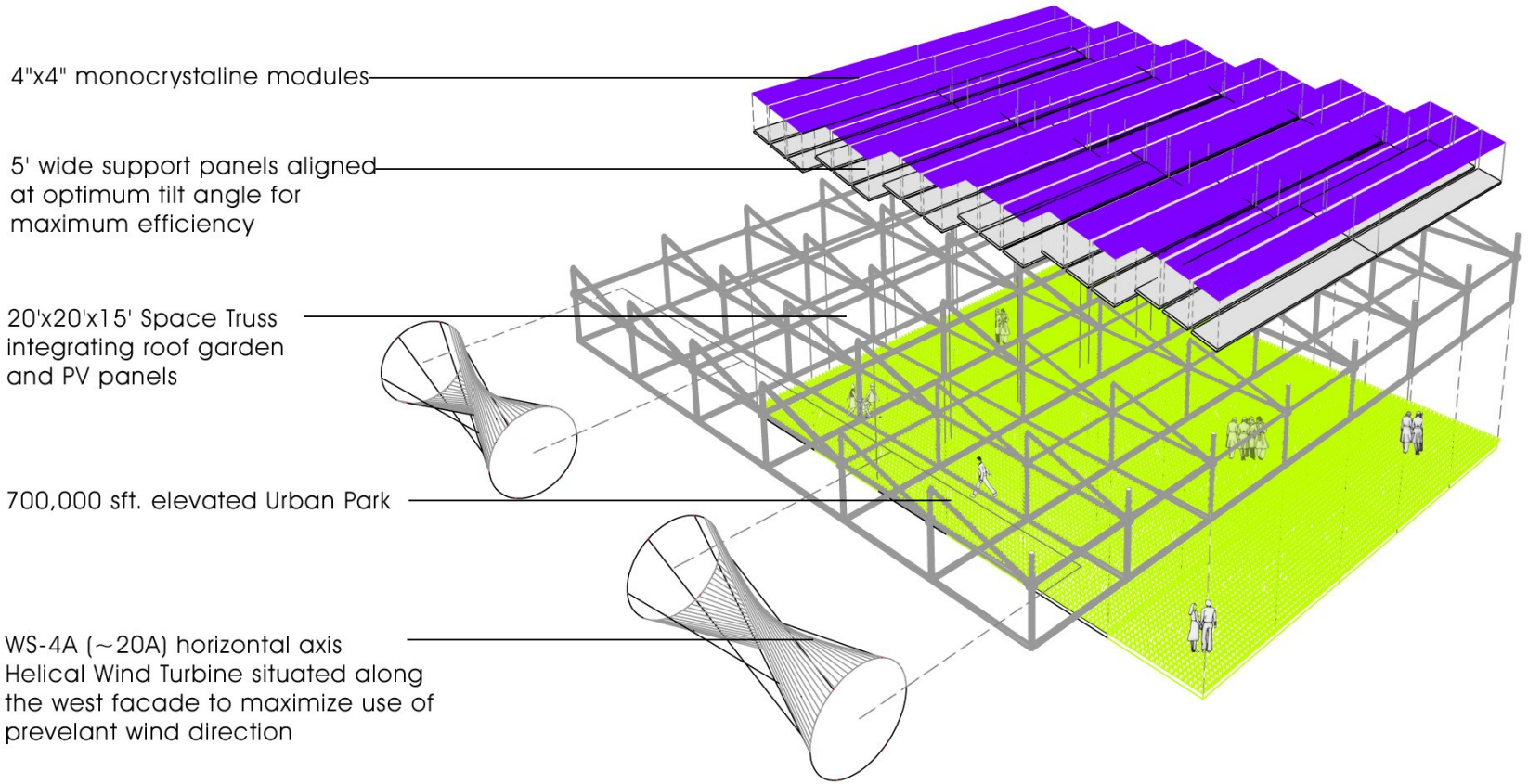
PROPOSED INTERVENTION

INTEGRATION OF

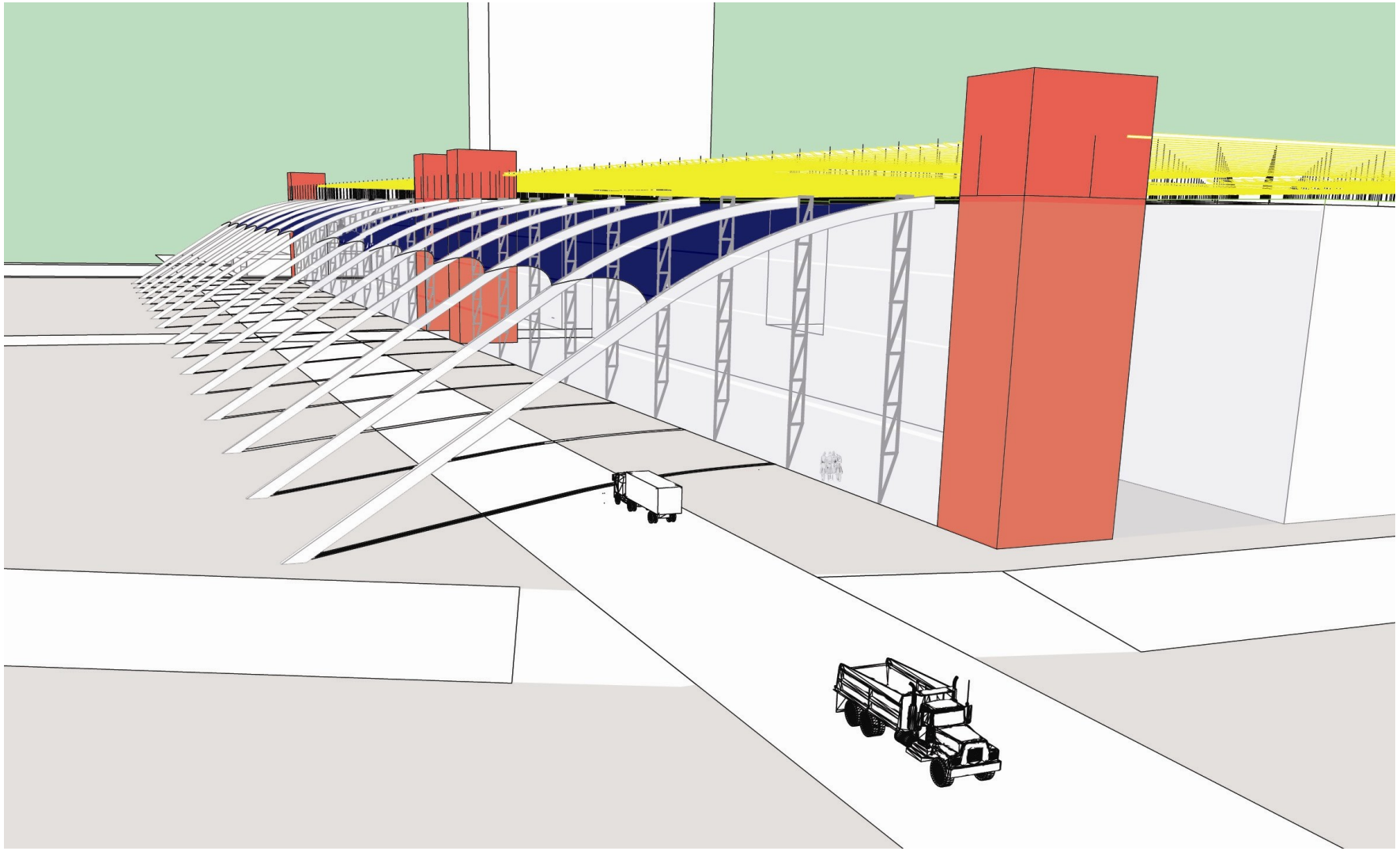
1. PHOTOVOLTAIC CELLS ON ROOF SURFACE AND SOUTH FAÇADE TO GENERATE ELECTRICITY AND SERVE AS AN EFFECTIVE SHADING DEVICE
2. WIND TURBINE TECHNOLOGY ON WEST FAÇADE
3. 700,00sft. OF GREEN AREA ON ROOF SURFACE PROVIDING THE CITY WITH AN URBAN PARK.
4. 2 SETS OF COURTYARDS THAT SERVE AS LARGE LIGHT WELLS INTRODUCING NATURAL LIGHT INTO THE CENTRAL SECTION OF THE BUILDING.
5. PASSIVE COOLING TECHNOLOGY IN THE COURTYARDS THAT DEFLECT LIGHT INTO THE BUILDING AND COOL HOT HUMID AIR WHICH THEN GETS RECIRCULATED.
6. RETRACTABLE MEMBRANES THAT PREVENT SOLAR GAIN ON THE WEST FAÇADE DURING THE LATTER HALF OF THE DAY.



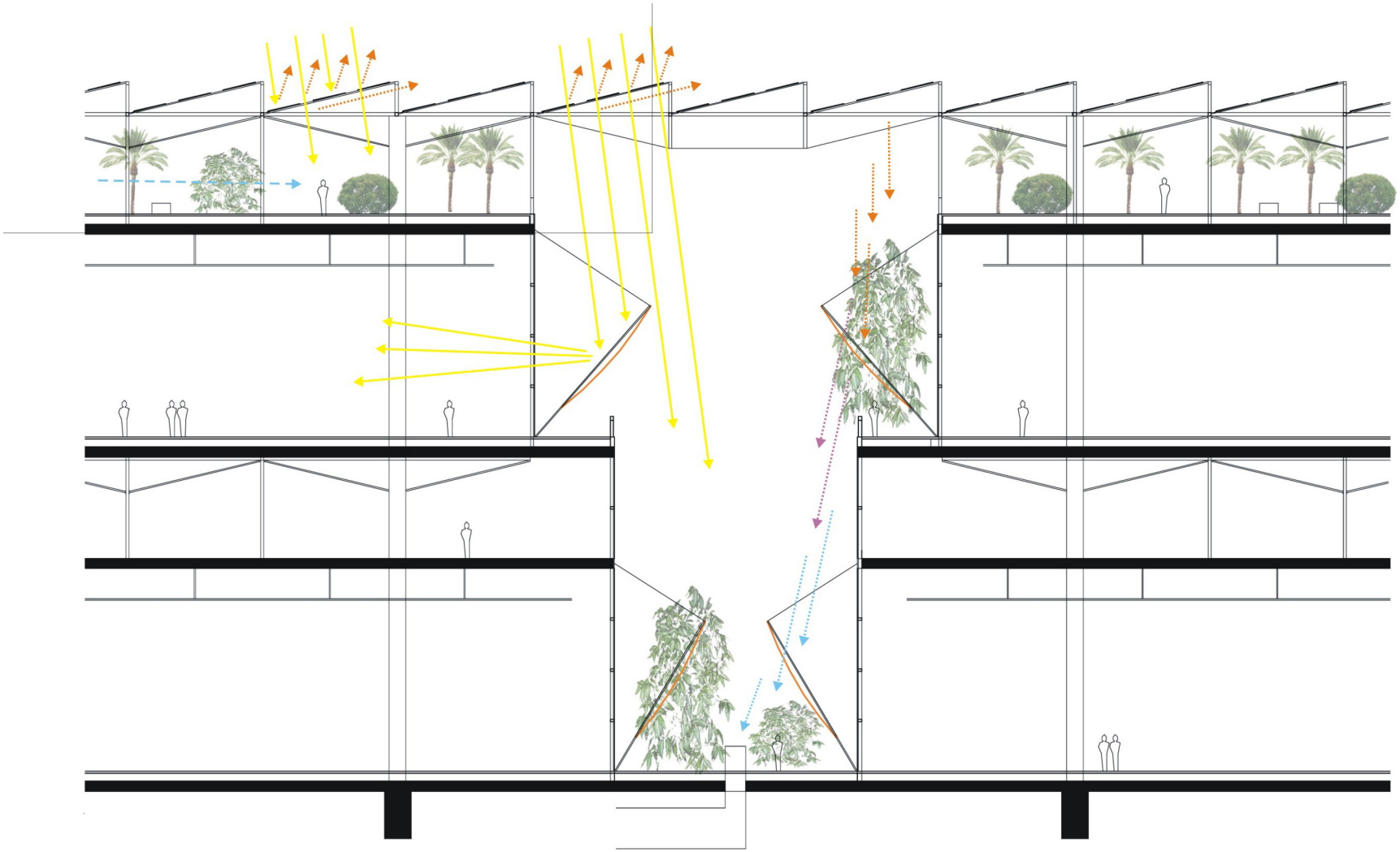
EXPLODED VIEW



SOUTH-WEST BIRD'S EYE VIEW



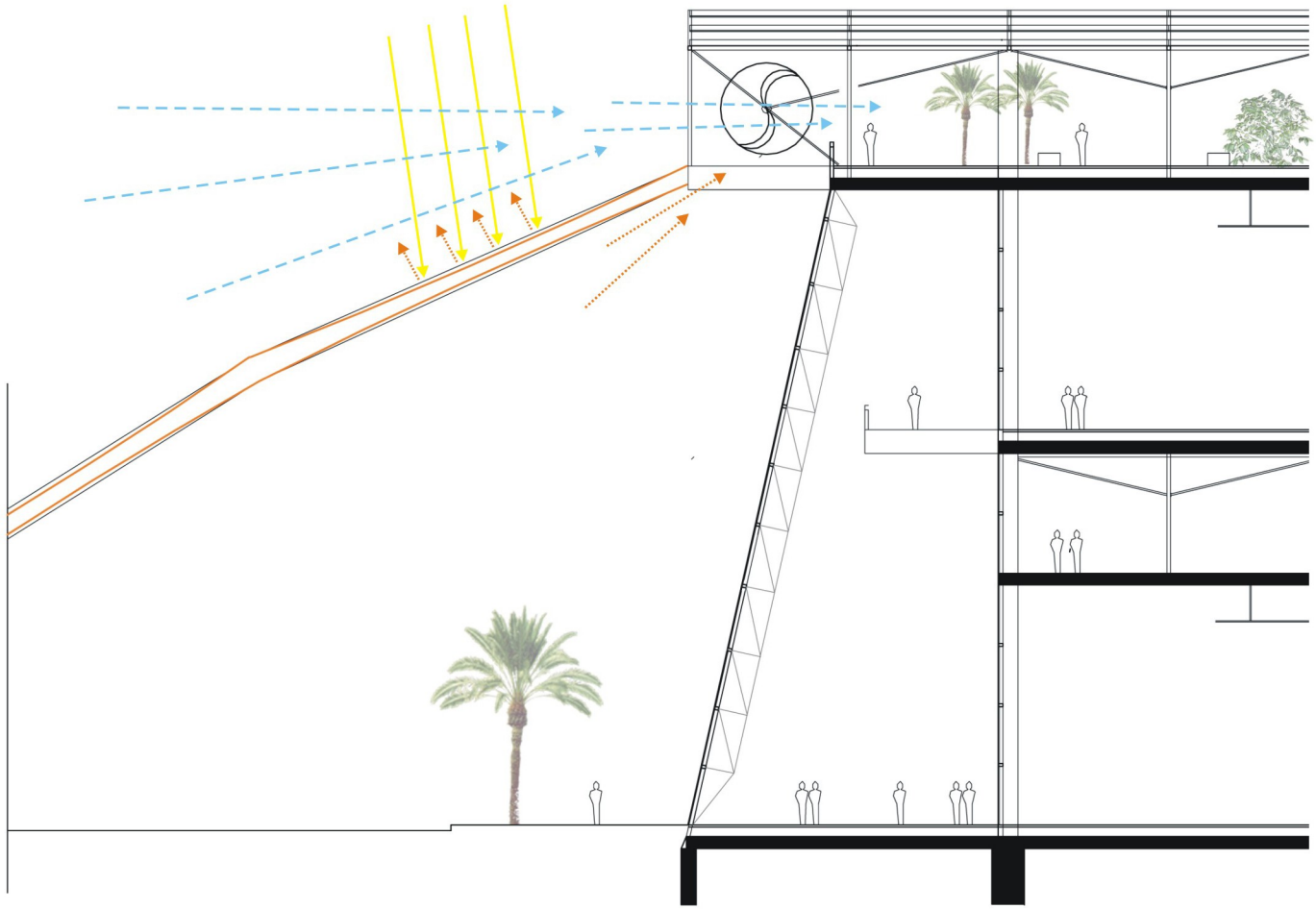
SECTION THROUGH THE COURTYARD

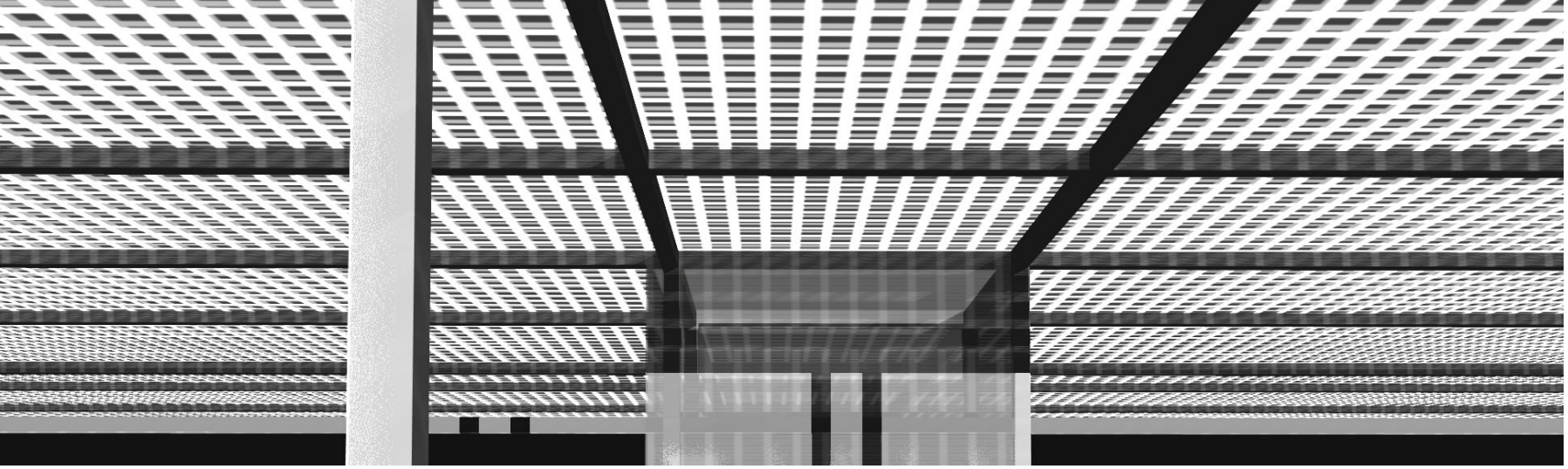


COURTYARD ELEVATION

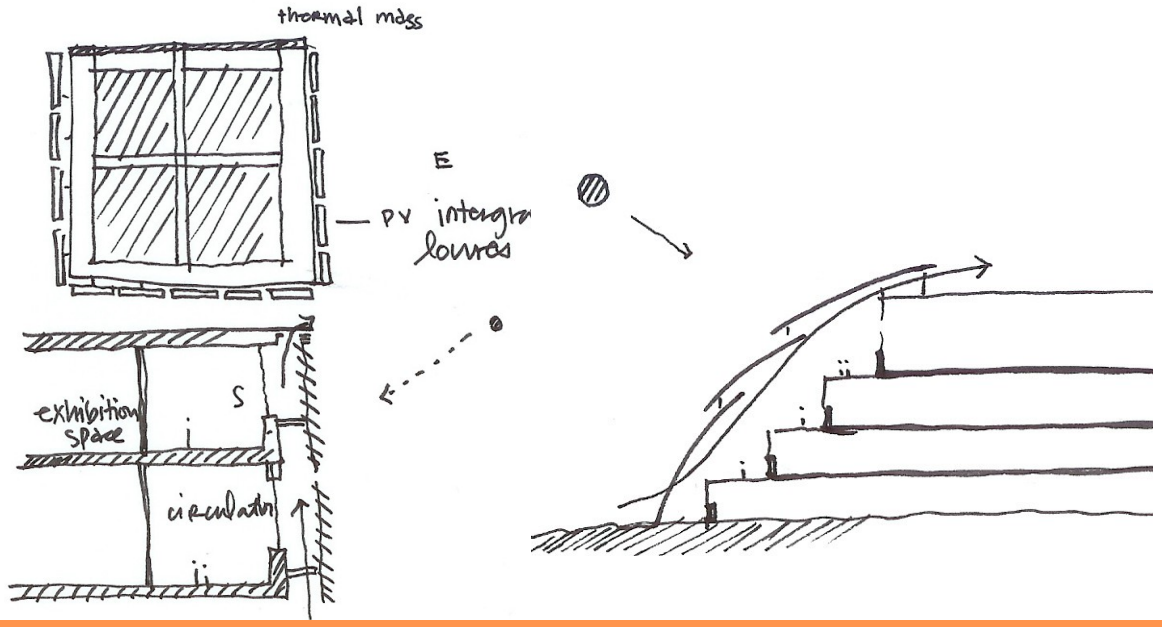
DAMP MEMBRANES ALTERNATING WITH GLAZED PANELS SERVE TO DEFLECT LIGHT INSIDE AND COOL INCOMING WARM AIR

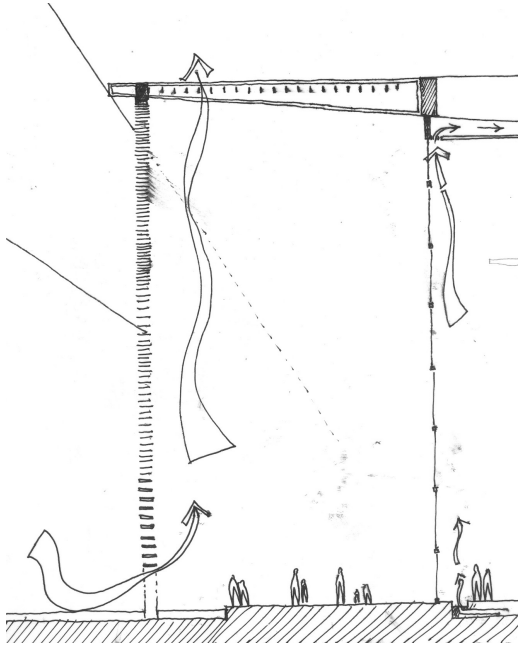
SECTION THROUGH WEST FACADE

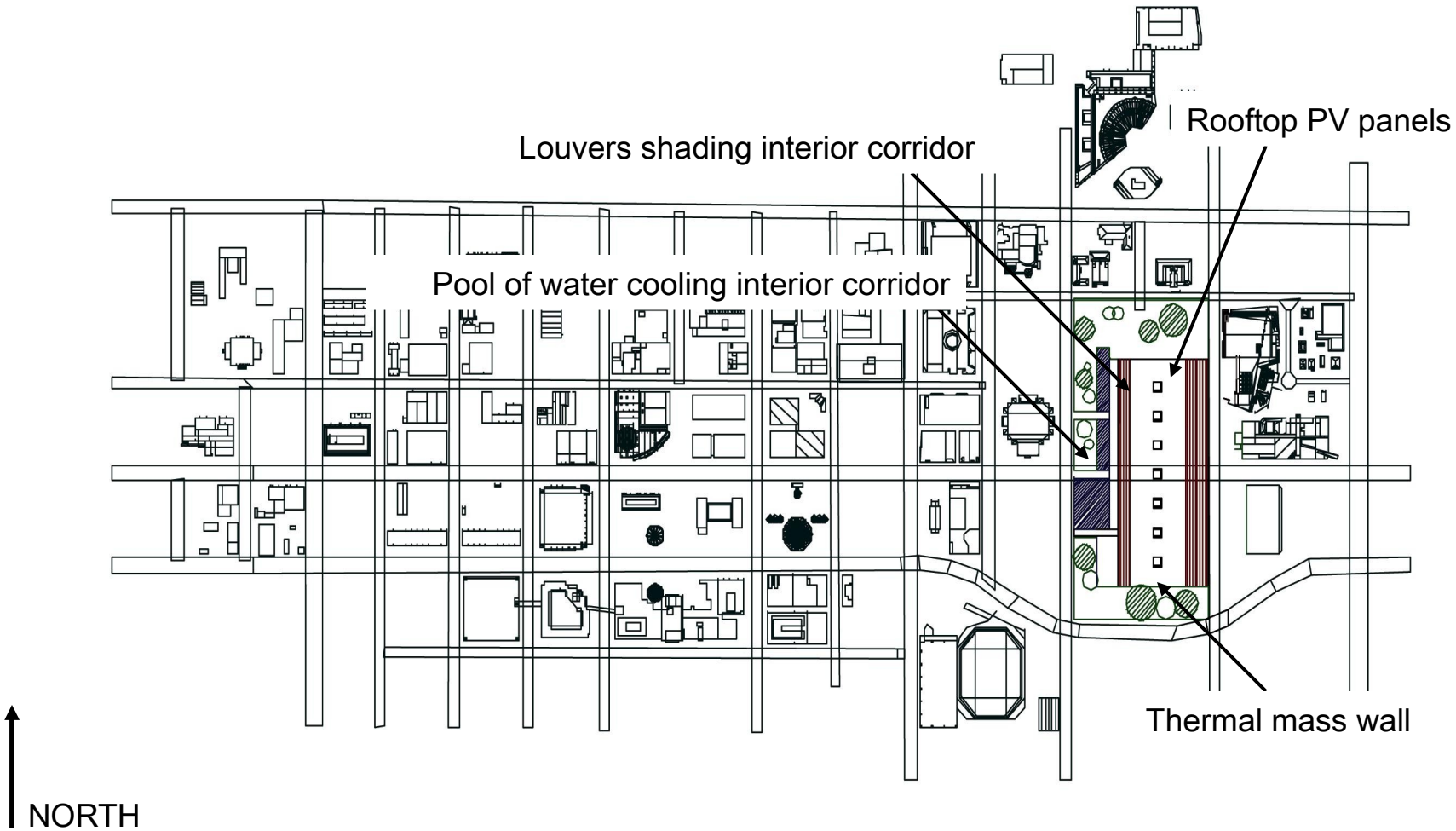


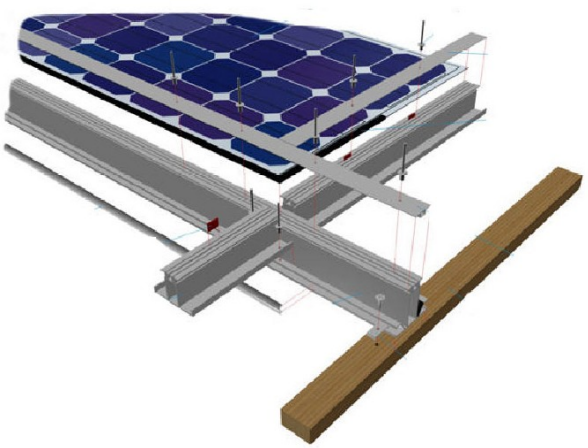


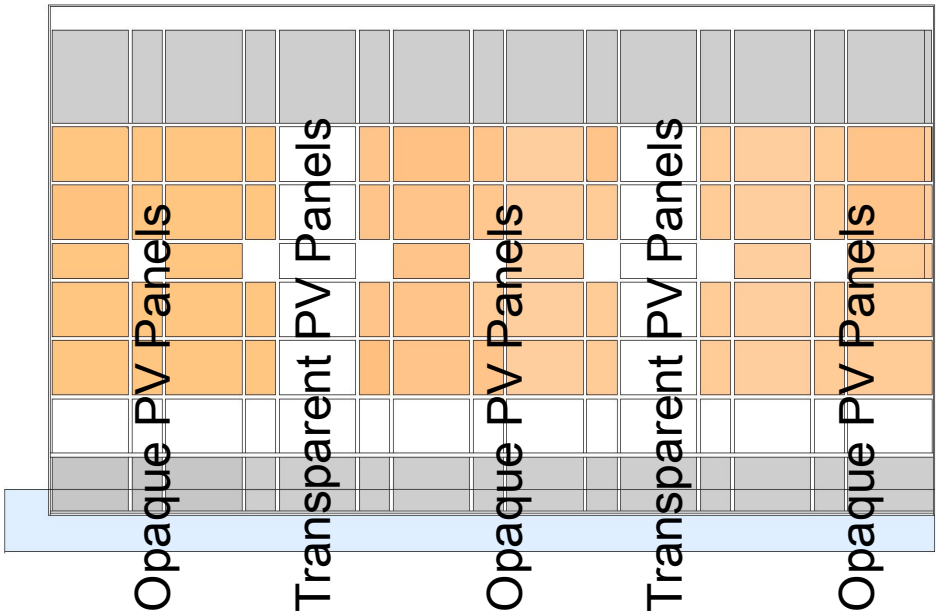
GROUP 2

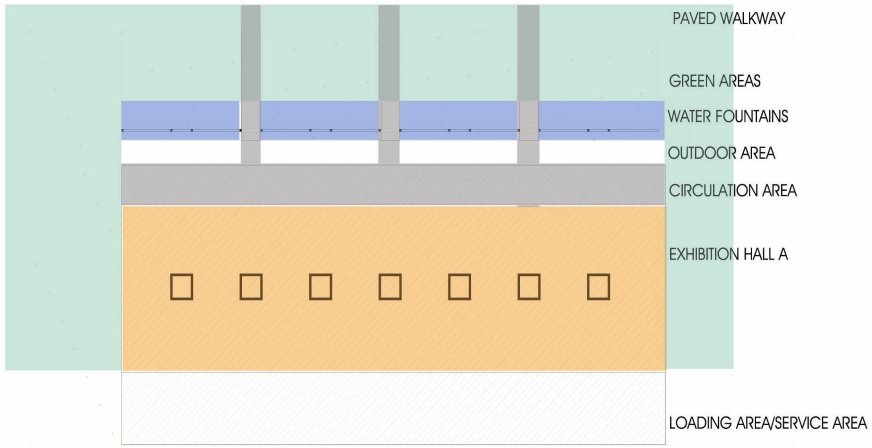

thermal mass
E
PV integra
louvres
exhibition
space
S
circulatn



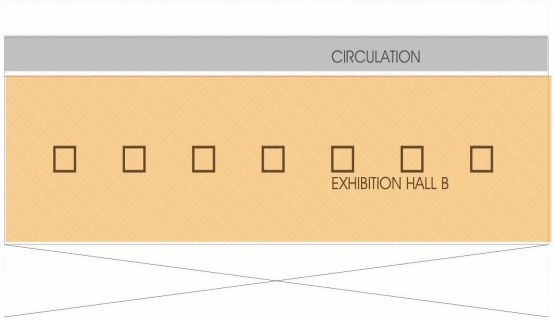

Rooftop PV panels
Louvers shading interior corridor
Pool of water cooling interior corridor
Thermal mass wall
NORTH



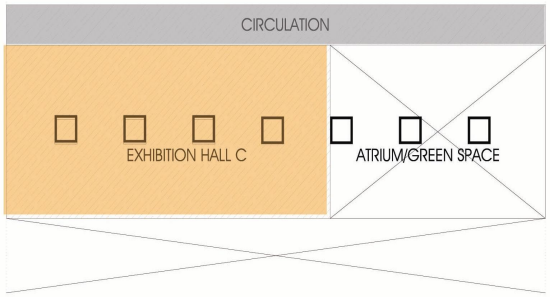

Opaque PV Panels
Transparent PV Panels
Opaque PV Panels
Transparent PV Panels
Opaque PV Panels



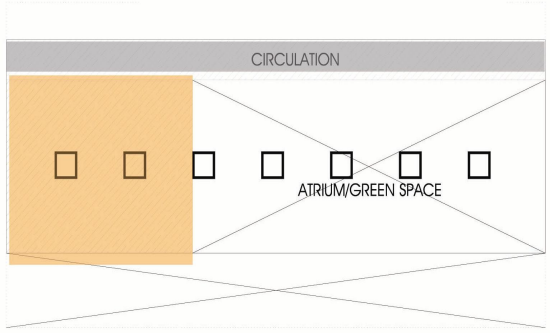
FIRST FLOOR PLAN



SECOND FLOOR PLAN

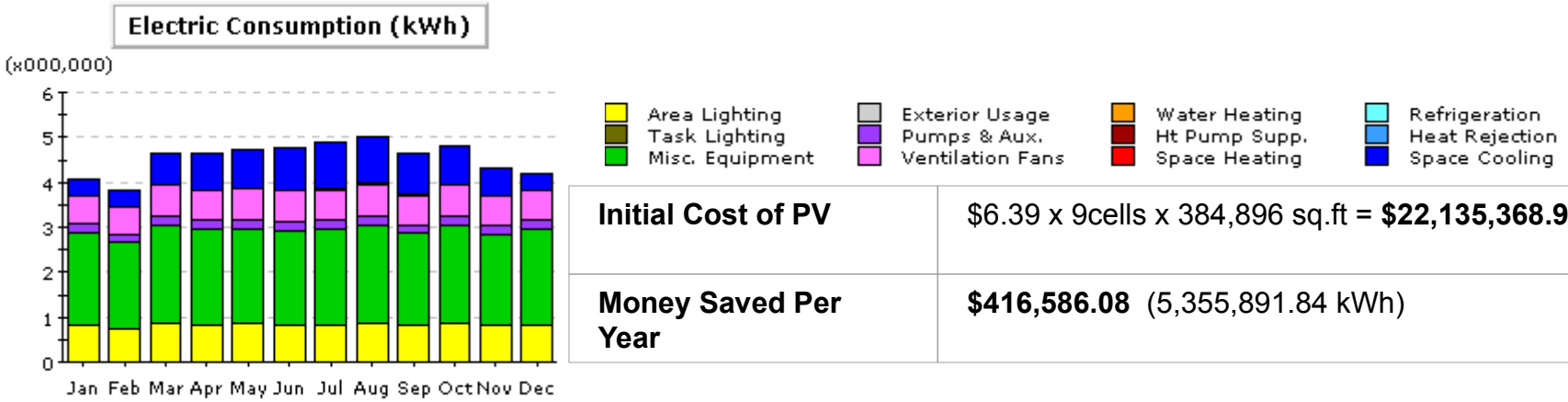


THIRD FLOOR PLAN



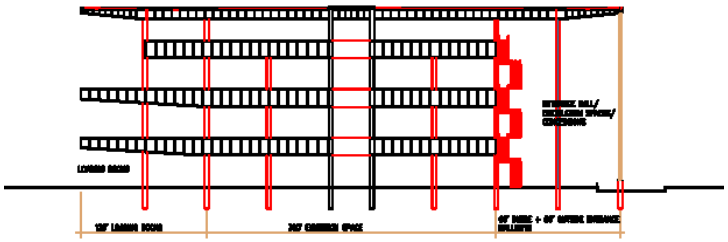
FOURTH FLOOR PLAN

ENERGY COST CALCULATIONS

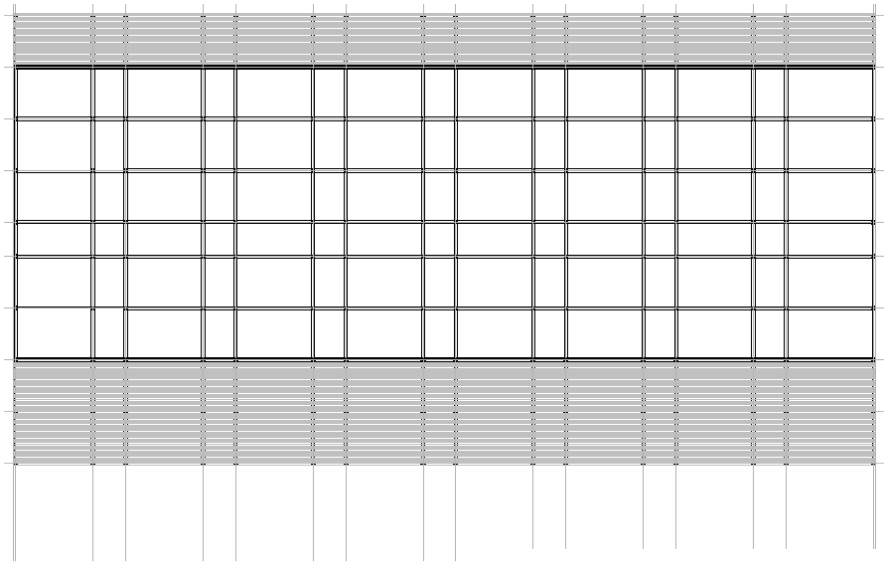


Initial Cost of PV	$6.39 x 9cells x 384,896 sq.ft = **$22,135,368.96**
Money Saved Per Year	**$416,586.08** (5,355,891.84 kWh)

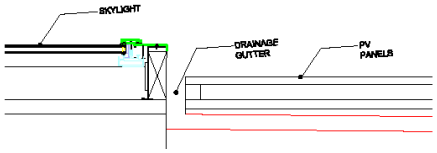
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Space Cool	0.35	0.39	0.72	0.81	0.88	0.94	1.04	1.03	0.92	0.86	0.63	0.36	8.93
Heat Reject	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.03	0.02	0.01	0.00	0.00	0.14
Vent Fans	0.63	0.59	0.68	0.66	0.67	0.67	0.67	0.69	0.64	0.68	0.63	0.65	7.86
Pumps & Aux.	0.20	0.19	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.21	0.20	0.20	2.46
Misc. Equip.	2.06	1.91	2.18	2.11	2.12	2.10	2.12	2.18	2.05	2.18	2.05	2.12	25.16
Area Lights	0.81	0.75	0.86	0.84	0.85	0.83	0.84	0.86	0.81	0.87	0.81	0.84	9.96
Total	**4.05**	**3.82**	**4.66**	**4.63**	**4.72**	**4.76**	**4.92**	**5.01**	**4.65**	**4.81**	**4.32**	**4.17**	**54.53**



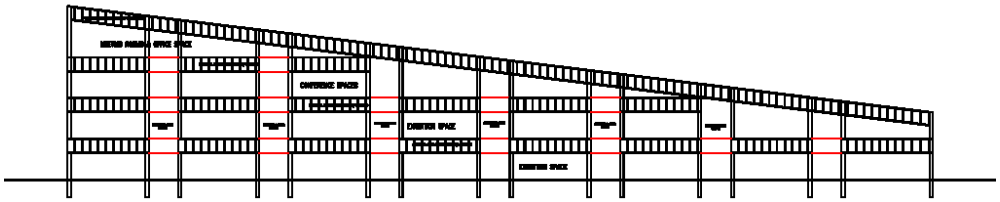
Cross Section



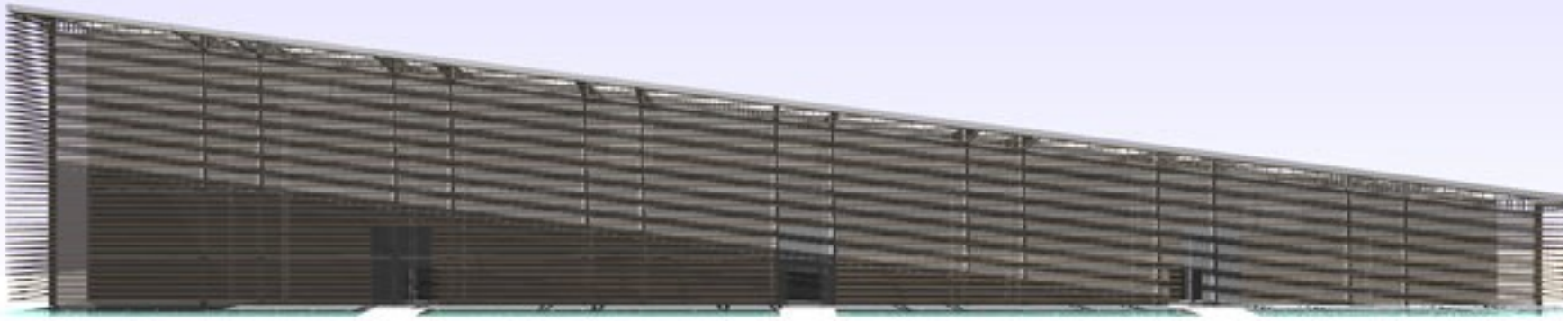
Roof Structure Plan



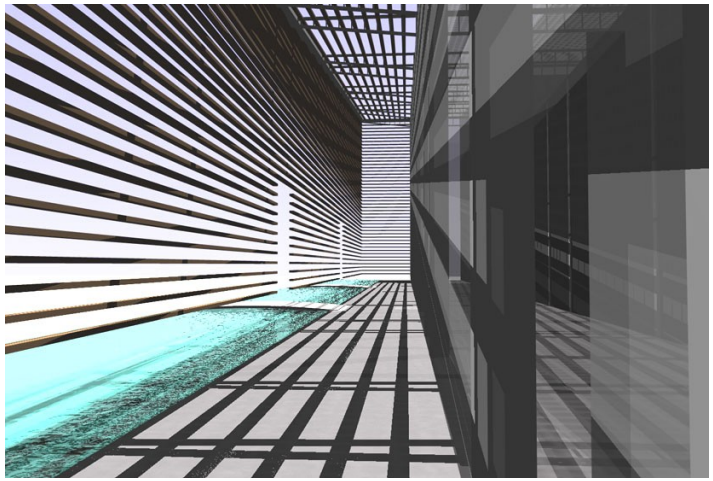
Roof Drainage Section



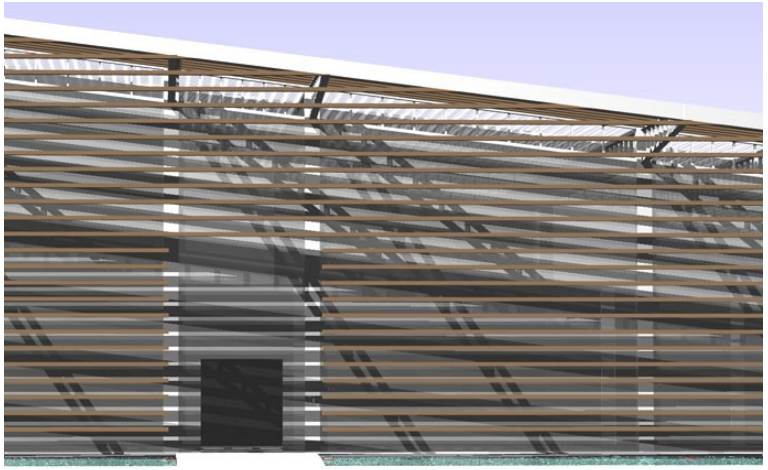
Longitudinal Section



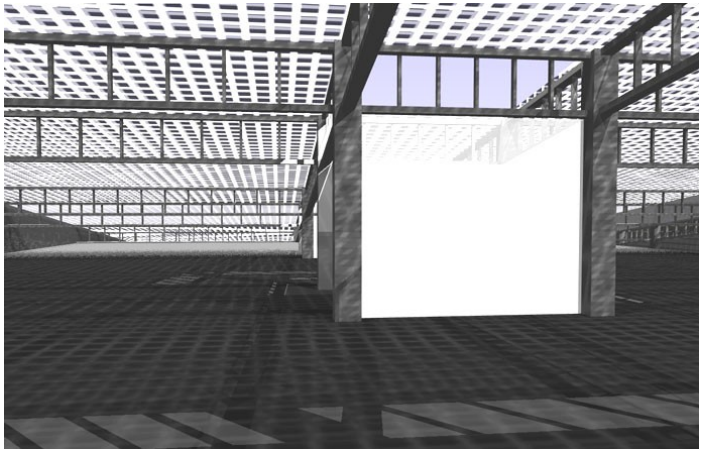
WEST ELEVATION



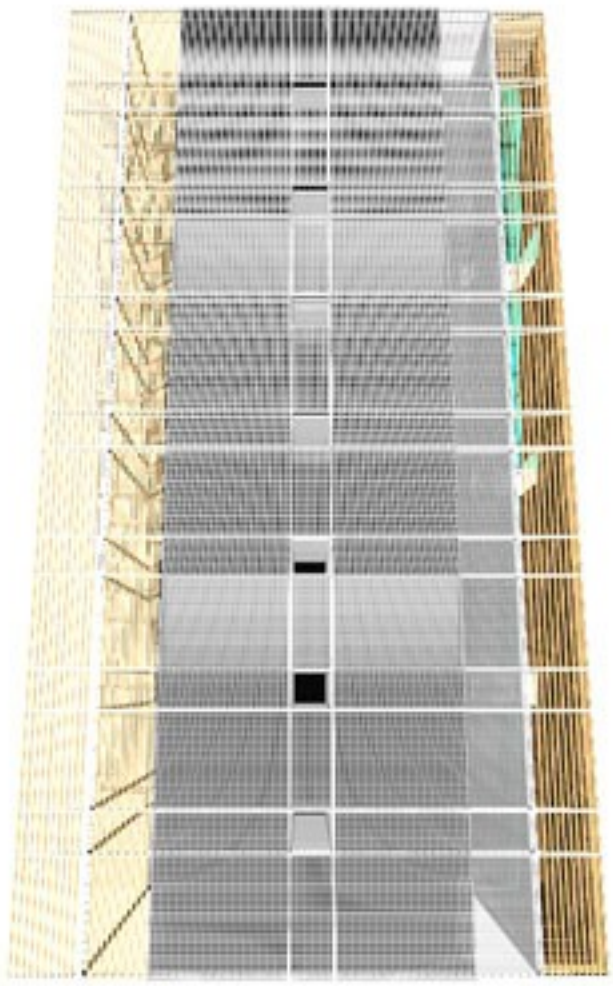
INTERIOR CORRIDOR



WEST ENTRANCE

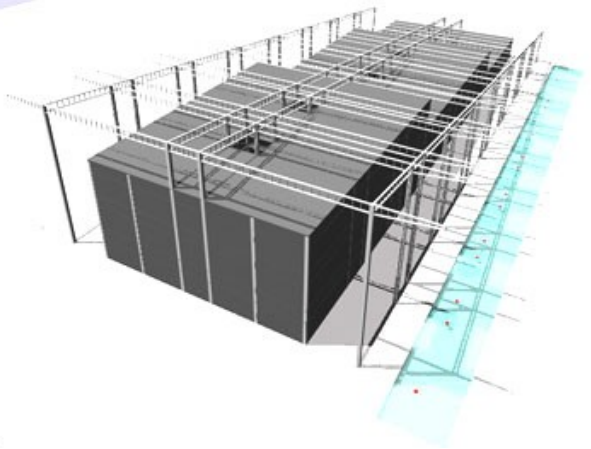


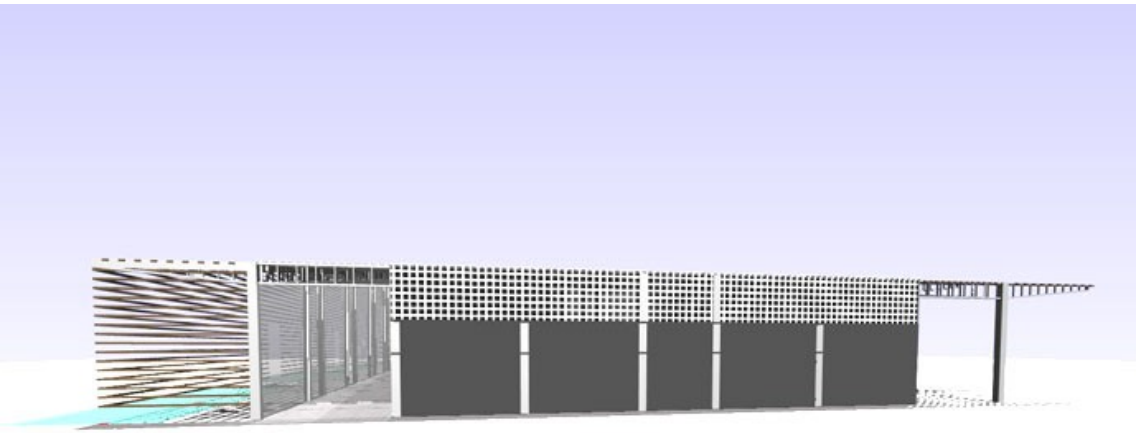
INTERIOR PERSPECTIVE



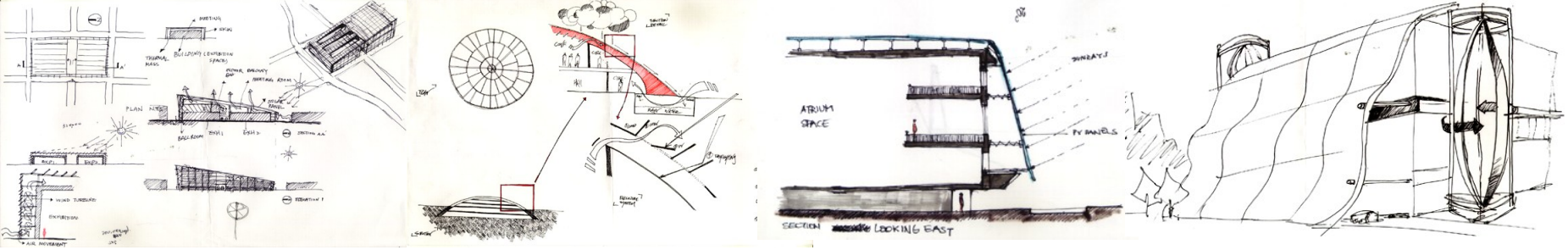
ROOF PERSPECTIVE

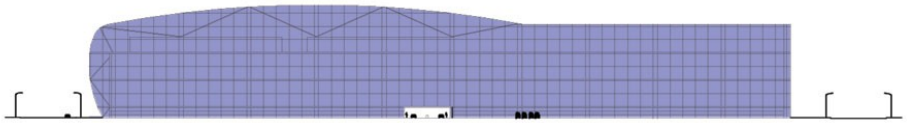
STRUCTURAL PERSPECT



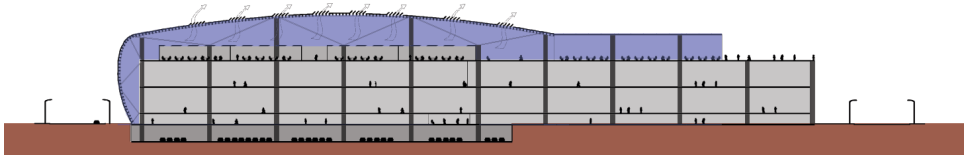


SOUTH ELEVATION

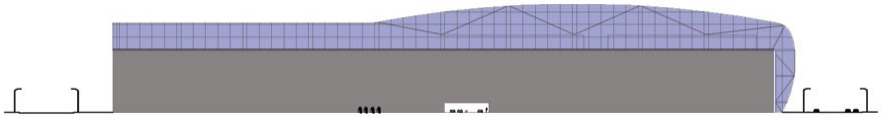




East Elevation

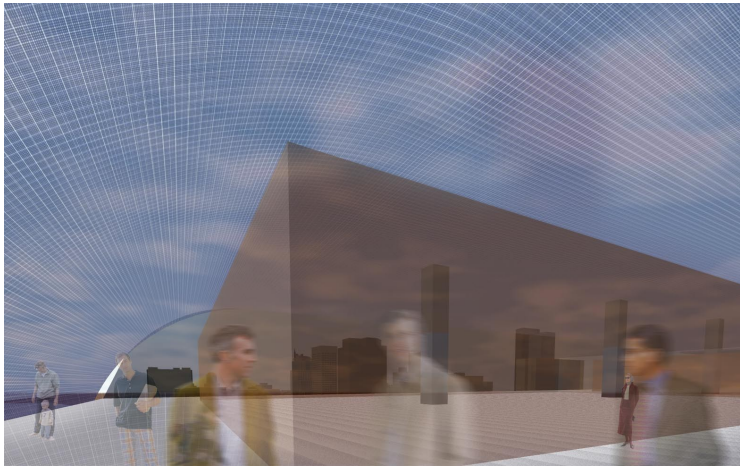


Longitudinal Section

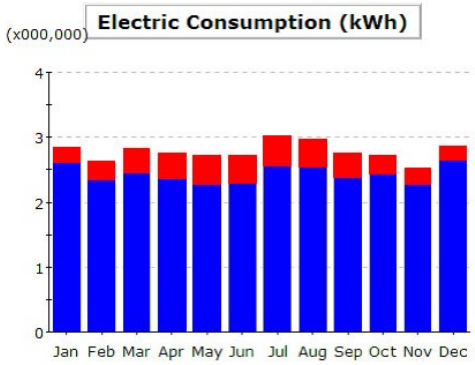


West Elevation

Perspective of Pedestrian Roof Space

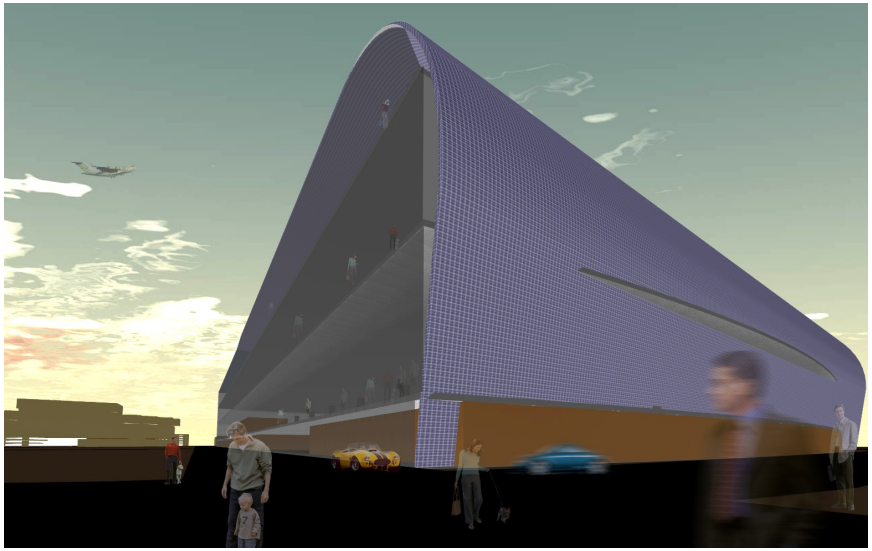


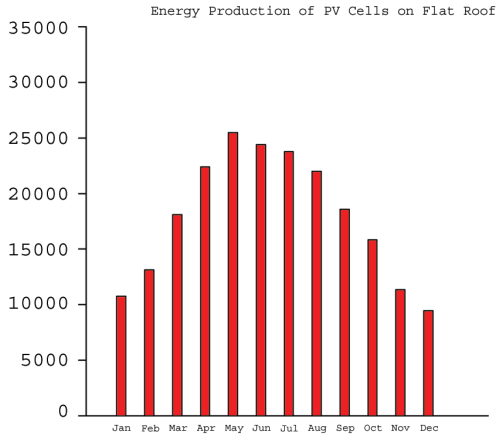
Perspective of Pedestrian Roof Space



Total Energy Consumed

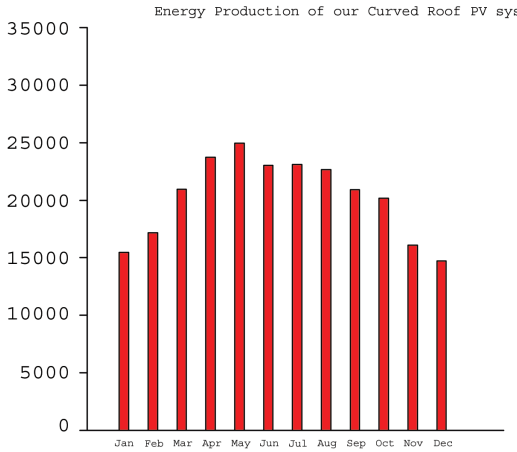
54000000 kW/per year





Total Energy Produced

215155 kW/per year



242922 kW/per year

+With a 54,000,000 kW/per year consumption, and the tilted roof design producing 242,922 kW/per year.

+We chose to use the MonoCrystaline PV Cells from the company Airtherm at $6.39 per cell. With a surface area of 200,000 sq ft covered with pv cells, the cost of installation will be $11,502,000 USD.

+Therefore the payback period will be approximately 48 years, as opposed to a flat roof which would be 59 years