

Sponsor: Skidmore Owings & Merrill LLP Dr. Mahjoub Elnimeiri, Raymond Clark, Peter Ellis

Team 1: Office Zone

SAHAR ABBASZADEH FARD MAGDY IBRAHIM SANG MIN PARK GORAN VESELINOVIC MICHAEL GEROULIS Team 2: Residential Zone

EMERALD CRUZ RUSSELL KELLY KELBY PHILLIPS ERIKA LAU Team 3: Residential Zone

ALLAN CHUNG ALICJA MORZYC KATHERINE PANEK RAFAL TROJNIAK Team 4: Office Zone

CHING CHAN MEGHAN PECAUT LINDSEY PHILLIPS SHANE STALEY

CHICAGO:

Climatic Data and Related Building Design Considerations

°Latitude

41°

Shading Needed – Period June – August

Shadow Angles – South Side 65°

Prevailing Winds – Winter SW – 12.0 MPH

Prevailing Winds – Summer NE – 10.0 MPH



CHICAGO:

Climatic Data and Related Building Design Considerations



CHICAGO:

Climatic Data and Related Building Design Considerations



Basic Area of Concern



Trump Tower Project, Chicago, IL

Group 1 Proposals



Solar Chimney

Modular window-wall systems with PV

Sky Garden

First Concept:

SOLAR CHIMNEY







First Concept:

SOLAR CHIMNEY





Location: South-East impractical acute-angled corner.

This chimney will funnel air from ground level through a wind turbine located at the very top.

Materials: Includes a steel structure, supported from floor slabs at each level, and a glass or plastic tube-like chimney.

SOLAR CHIMNEY



First Concept:

At the base of this construction would be a giant umbrella-type structure:

- i) scoop fresh air up into the chimney
- ii) to shield a plaza located at the southwest corner of the building

At the top, a turbine would be installed, to convert this wind into a form of energy.

Some sort of shielding device would have to be constructed here as well, to protect the turbine from particles and debris.



Modular window-wall systems with PV



Modular window-wall systems with PV

The panel is designed as a one modular piece with everything installed: the blinds have the PV on the outer surface before the inner skin which consists of double low-E clear glass.

The chamber between two skins insures that PV cells do not get hot by means of natural ventilation



Modular window-wall systems with PV



Modular window-wall systems with PV

Questions and Concerns

- How do we ventilate the Panels?
- How do we clean the interior of the module?
- What is the best angle of the blinds?
- How do the modules connect with each other?
- How the blinds work?

Modular window-wall systems with PV



Modular window-wall systems with PV

Detail showing the double skin window module



Modular window-wall systems with PV

Window-wall system incorporating PV modules



Third Concept:

Sky Garden



Third Concept:

Sky Garden



- Two general possibilities for installing photovoltaic cells in high-rise building are building facades and roof. In this project, the sky garden with PV roof is another possibility as an architectural element of the building or the system.
- Rest and refugee area with green.
 - Dynamic overall shape.

Third Concept:

Sky Garden





Total Energy Consumption

Using E-Quest for calculating Electric Consumption (kWh x000)

	Zone 1	Zone 2	Zone 3	Zone 4	Total
Space Cool	1,083.20	785.80	668.10	1,800.00	4,337.10
Heat Reject.	28.00	20.50	17.50	-	66.00
Refrigeration	-	-	-	-	
Space Heat	674.30	519.50	489.40	1,050.00	2,733.20
HP Supp.		-		810.00	
Hot Water	277.20	198.60	165.70	620.00	1,261.50
Vent. Fans	581.00	422.00	360.00	750.00	2,113.00
Pumps & Aux.	457.50	330.30	277.90	-	1,065.70
Ext. Usage	-	_		-	
Misc. Equip.	2,670.30	1,916.90	1,597.90	1,920.00	8,105.10
Task Lights	235.20	168.50	140.60	-	544.30
Area Lights	1,471.30	1,025.70	818.90	2,480.00	5,795.90
Total	7,478.00	5,387.90	4,535.90	9,430.00	26,831.80

Annual Energy Consumption by End-use.



Number of PV Panels



Energy Saving Calculation for the proposed scheme

IPRO 323- Spring 200)2							
Task Group I								
Façade			East		South		West	
Zone 0 Nomber of modules			East 36		500lli 65		West 36	-
Health Center		5	180		325		180	
5 floors @ 16' fl2fl		-						
Area of PV at 41' (Blind are	ea)	46.2		8316		15015		8316
Area of PV at 90' (Spandre		18.7		3366		6077.5		3366
Zone 1 Nomber of modules			36		65		36	
Office		10	360		650		360	
10 floors @ 13' fl2fl			2.50					
Area of PV at 41' (Blind are	ea)	33.2		11952		21580		11952
Area of PV at 90' (Spandre	l area)	18.7		6732		12155		6732
Zone 2 Nomber of modules			36		53		36	
Office		13	468		689		468	
13 floors @ 13' fl2fl								
Area of PV at 41' (Blind are	ea)	33.2		15537.6		22874.8		15538
Area of PV at 90' (Spandre	area)	18.7		8751.6		12884.3		8751.6
Zone 3 Nomber of modules			36		41		36	
Office		14	504		574		504	
14 floors @ 13' fl2fl								
Area of PV at 41' (Blind are	ea)	33.2		16732.8		19056.8		16733
Area of PV at 90' (Spandre	l area)	18.7		9424.8		10733.8		9424.8
Zone 4 Nomber of modules			36		29		36	
Residential		31	1116		899		1116	
31 floors @ 11' fl2fl								
Area of PV at 41' (Blind are	ea)	24.5		27342		22025.5		27342
Area of PV at 90' (Spandre	area)	18.7		20869.2		16811.3		20869
Total Area of PV at 41'	100%		79880.4		100552		79880	
Total Area of PV at 90'	70%	49144		58661.9		49143.6		
Total PV Area with tilt fac	tor		34400.5 114281	saft	41063 141615	saft	34401 114281	saft
		75%		100%		80%		
Total PV Area with tilt & O	rientat		85710.7		141615		91425	

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Percentage of Energy savings per year 17.34	\rightarrow	Percentage of Energy savi	ings per v	/ear				17.34	

Group 2 Proposals



Double window-wall with PV

Wind Turbines

DOUBLE WINDOW-WALL WITH PV



Plan view of the curtain wall



IPRO 323 Spring 2002

First Concept:

First Concept: DOUBLE WINDOW-WALL WITH PV



Detail of the Enclosure System



Elevation of the tower with incorporation of wind turbines located on various mechanical floors



Detailed Elevation







Location of wind turbines in plan

Level	Height	Wind Speed	Power/ Turbine Area	Turbine Area	Total Power	Façade Area lost	Power/ Façade Area
Roof	330 m	27 m/s	2,362 W/m ²	42 m ²	99,204 Watts	None	N/A
3	201 m	16 m/s	492 W/ m ²	63 m ²	30,996 Watts	1,525 m ²	20.3 W/ m ²
2	137 m	11 m/s	160 W/ m²	63 m ²	10,080 Watts	1,870 m ²	5.4 W/ m²
1	78 m	6 m/s	26 W/ m ²	84 m ²	2,184 Watts	2,175 m ²	1.0 W/ m²

Group 3 Proposals



(South Side)

(West Side)

Curtain wall system

First Concept: Parabolic Trough Collectors

Flat Panel vs. Concentrators

Parabolic Trough Concentrators are the simplest parabolic concentrating systems.





Second Concept: Sun Motor Tracking System

One-axis vs. Two-axis Tracking systems.





One-axis tracking



Two-axis tracking

Second Concept: Sun Motor Tracking System





This is how a sensored panel works

AC Energy and Cost Savings

Station Identification		Energy Production				
City	Chicago	Month	Energy	Energy Value		
State:	IL		(kWh)	(\$)		
Latitude:	41.78 ° N	1	440	35.20		
Longitude:	87.75 ° W	2	494	39.52		
Elevation:	190 m	3	642	51.36		
PV System Specifications	3	4	751	60.08		
AC Rating:	4.0 kW	5	861	68.88		
Array Type:	1-Axis Tracking	6	847	67.76		
Array Tilt :	41.8 °	7	871	69.68		
Array Azimuth:	180.0 °	8	757	60.56		
Energy Specifications	100.0	9	675	54.00		
0, 1	0.0 4//01/6	10	599	47.92		
Cost of Electricity:	8.0 ¢/kWh	11	377	30.16		
		12	312	24.96		
		Year	7625	610.00		

-A flat panel system will be used over a concentrator. The concentrator is an efficient way of gathering sun, but due to overheating and an expensive cooling and tracking system, it is not economical.

-To protect the PV panels from the strong turbulence of Chicago winds, a double wall façade is used. The panels still remain effective and will be able to operate longer due to less stress being placed on the fragile panels. In addition, vents in the wall will allow for natural cooling and the use of the double wall gives residents access to a balcony year round.

-A tracking system will be used to make efficient use of the panels. The panels will be able to track the sun's path through the sky during the solar window.

-As a result an effective design is created that allows the building to function with the use of PV panels.

South Side Curtain Wall



West Side Curtain Wall



Group 4 Proposals



Corners with Prefabricated Units Prefabricated Units Applied to Facade

First Concept: Corners with Prefabricated Units



Utilizing South facade for maximum sun and wind power

First Concept:

Corners with Prefabricated Units





First Concept: Corners with Prefabricated Units



Middle Floors (Office)





Bottom Floors (Office)



Floor Plans with Turbine Location

First Concept:

Corners with Prefabricated Units





Proposed Form

Proposed Lighting Scheme

Second Concept: Prefabricated Units Applied to Facade



Units attached to slab, generator in spandrel

Second Concept: Prefabricated Units Applied to Facade



Wind direction



Conclusion

Prefabricated units allow for ease of installation, as well as maintenance

Shaping the building can control and increase the energy produced by wind as well as create dynamic interior spaces

During the day, the PV panels visually mark where the energy is being produced

Using the units to power exterior lighting is a visual portrayal that the building is utilizing renewable energy and changing in response to fluctuating environmental conditions